

March 25, 2025

# Draft Assessment Methodology for Oregon's 2026 Integrated Report

For development of the Water Quality Status Report and List of Impaired Waters

Pursuant to Clean Water Act Sections 303(d) and 305(b) and OAR 340-041-0046



This document was prepared by  
The Oregon Department of Environmental Quality  
Water Quality Assessment Program  
700 NE Multnomah Street, Portland Oregon, 97232

Contact: Lesley Merrick  
Phone: 971-323-7228

Or

Travis Pritchard  
Phone: 503-887-4346

Or

Kaegan Scully-Engelmeyer  
Phone: 503-575-5224

[Visit the Water Quality Assessment Program web page](#)



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800-452-4011 | TTY: 711 | [deqinfo@deq.oregon.gov](mailto:deqinfo@deq.oregon.gov)

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# Executive summary

The federal Clean Water Act requires Oregon to report on the quality of its surface waters every two years. The Oregon Department of Environmental Quality assesses Oregon surface waters to determine if they meet water quality standards to protect beneficial uses. The result of these analyses and conclusions is called the "Integrated Report" because it combines the requirements of Clean Water Act section 305(b) to develop a status report and the section 303(d) requirement to develop a list of impaired waters.

U.S. Environmental Protection Agency regulations require states to describe the methodology, data and information used to identify and list segments of waterbodies that are considered "water quality limited" -- or impaired -- and require cleanup plans known as Total Maximum Daily Loads. This draft Assessment Methodology contains the "decision rules" DEQ will use to compare data and information to existing water quality standards for the development of Oregon's 2026 Integrated Report.

For the 2026 Integrated Report, DEQ is proposing a significant revision to the assessment methodology for freshwater biocriteria. Supporting information for these can be found on the [Assessment Methodology Updates website](#).

## Acknowledgements

DEQ would like to acknowledge the valuable contributions of the independent scientific peer review panel that evaluated DEQ's first iteration of the freshwater biocriteria assessment methodology update. Recommendations from this panel lead to more robust approach to interpreting this narrative biocriteria water quality standard.

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# Introduction

The federal Clean Water Act Section 305(b) ([40 CFR 130.8](#)) requires that states submit a biennial water quality inventory report in April of even numbered years. The report provides information on the water quality of all state surface waters; the extent to which state waters provide for the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife, and allow recreational activities in and on the water; and how pollution control measures are helping to attain water quality standards.

The CWA Section 303(d) ([40 CFR 130.7](#)) additionally requires that each state identify waters where existing pollution controls are not stringent enough to achieve state water quality standards and establish a priority ranking of these waters. Section 303(d) requires states to develop Total Maximum Daily Loads for the identified impaired waters. TMDLs provide a science-based approach to cleaning up polluted water to meet state water quality standards. A TMDL is a numerical value that represents the highest amount of a pollutant a surface water body can receive and still meet the water quality standards. The list of impaired waters needing TMDLs (303(d) list) becomes effective and can be used in Clean Water Act Programs after EPA approval.

[EPA guidance](#) recommends that states submit an integrated report to satisfy 305(b) and 303(d) requirements. The Integrated Report presents the results of assessing available data and information against Oregon's numeric and narrative water quality criteria to determine waterbody status. DEQ submits the Integrated Report to the EPA through the [ATTAINS database](#).

EPA [regulations](#) require states to describe the methodology by which data and information is used to identify and list water quality limited segments requiring TMDLs. The assessment methodology contains the "decision rules" used to evaluate data and information. Oregon Administrative Rules ([OAR 340-041-0046](#)) also require the specific parameter assessment methodologies be identified. Oregon Revised Statute ([ORS 468B.039](#)) which was adopted by the legislature in 2015, requires DEQ to: (1) solicit independent scientific and technical input on alternative assessment methodologies, including scientific peer review as appropriate; (2) provide adequate public notice and an opportunity for public comment on draft assessment methodologies; (3) provide an informational overview of the draft assessment methodologies before the Oregon Environmental Quality Commission (EQC); and (4) provide an opportunity for public comment on the draft assessment methodologies during the EQC meeting.

This document describes how DEQ will develop Oregon's 2026 Integrated Report for Clean Water Act Section 305(b) and 303(d). The methodology is consistent with the key elements of

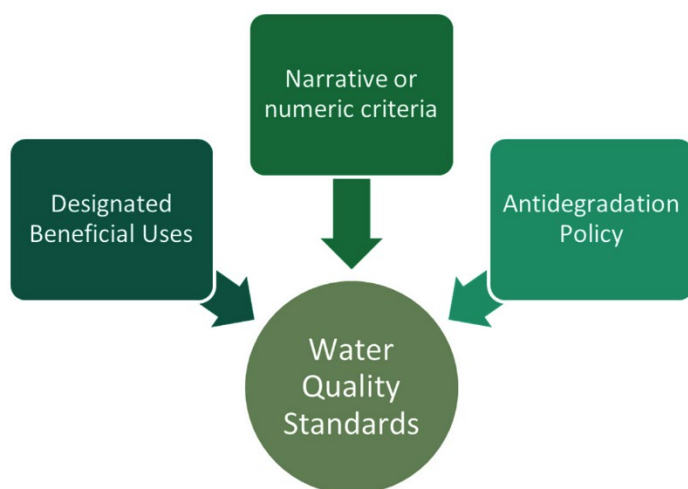


Oregon's water quality standards and is the framework DEQ uses to assess water quality conditions. The methodology builds on DEQ's protocols from previous 305(b)/303(d) assessments. The 303(d) list produced from the 2026 Integrated Report incorporates, updates, and supplements 303(d) lists from previous assessment years. After submittal and approval by EPA, it will become Oregon's effective 303(d) list.

## Timeline of past 303(d) actions and related rule revisions:

- EPA approved [Oregon's 2022 303\(d\)](#) list on Sept. 1, 2022
- DEQ submits [2024 Integrated Report](#) to EPA on March 12, 2025

# Oregon's Water Quality Standards



The objective of the Clean Water Act is to restore and maintain the physical, chemical and biological integrity of the nation's waters (CWA Section 101(a)). To achieve this objective, states develop and adopt water quality standards. Water quality standards include beneficial uses, narrative and numeric criteria, and anti-degradation and implementation policies (Figure 1). Oregon's water quality standards are adopted in Oregon Administrative Rules (OAR) [Chapter 340 Division 41](#). These rules include policies and criteria that are applicable throughout the state.

Figure 1. Components of water quality standards.

Beneficial uses for Oregon waters are designated by the EQC. General beneficial uses are designated by water basin or waterbody in OAR 340-041-0101 through OAR 340-041-0340, Figure 1, and Tables 101A through 340A, Figure 101A, Figures 220C through 220H, Figures 230C through 230H, Figures 300C and 300D and Figure 320C. Specific areas designated for coastal water contact recreation use and shellfish harvesting were added in August 2016. Specific fish uses are further designated in Tables 101B through 250B and Figures 130A through 340B. Beneficial fish use designations include explicit water body segment locations and time periods throughout the state for sensitive salmonid species and life stages that were added to Oregon's water quality standards in 2003.

Oregon water quality standards include statewide narrative criteria established in [OAR 340-041-0007](#). Narrative criteria include provisions for:

- Prohibitions on fungi or other growths that negatively impact beneficial uses (OAR 340-041-0007(9)).
- Prohibitions on tastes, odors, or toxic conditions that negatively impact beneficial uses (OAR 340-041-0007(10)).
- Prohibitions on bottom deposits that negatively impact beneficial uses (OAR 340-041-0007(11)).
- Prohibitions on objectionable discoloration, scum, oily sheens, floating solids, coatings on aquatic life (OAR 340-041-0007(12)).
- Prohibitions on aesthetic conditions offensive to human senses (OAR 340-041-0007(13)).

A statewide antidegradation policy is established in [OAR 340-041-0004](#) to guide decisions that affect water quality. Additional policies for applying water quality standards to determine impaired waters are contained in [OAR 340-041-0046](#) and in standards for specific pollutants.

Oregon water quality standards for specific pollutants or conditions are established in [OAR 340-041-0009](#) (bacteria) through [OAR 340-041-0036](#) (turbidity). These standards contain both narrative and numeric criteria for specific pollutants or conditions. Some pollutant criteria are applicable in waters with specified beneficial use designations, such as numeric criteria for temperature and dissolved oxygen that apply where and when certain fish uses are designated. Table 1 summarizes Oregon's beneficial uses and the narrative and numeric criteria that protect those uses. For the Integrated Report, DEQ evaluates pollutant data independently to determine whether beneficial uses are being supported. DEQ applies the currently effective criteria approved by EPA for CWA 303(d) purposes. The methodology to evaluate each pollutant is described in the [Assessment Methodology for Specific Pollutants or Parameters](#) section of this document.

Table 1. Oregon surface waters designated beneficial uses and related criteria.

Designated Beneficial Uses		Criteria Protecting Beneficial Use	
Designated Use*	Use Subcategory**	Narrative Criteria	Parameter Numeric Criteria
<b>Aesthetic Quality</b>		Statewide Narrative Criteria - Aquatic Weeds, Algae	Chlorophyll-a
<b>Boating</b>		Statewide Narrative Criteria - Aquatic Weeds	No specific applicable numeric criteria
<b>Fish and Aquatic Life</b>		Narrative Criteria for: Biocriteria, Temperature, Toxic Substances, Turbidity	Dissolved Oxygen pH Temperature Total Dissolved Gas Toxic Substances - Aquatic Life
	Fish Use - Borax Lake Chub	Narrative Criteria for Temperature	Dissolved oxygen
	Fish Use - Bull Trout Spawning and Juvenile Rearing		Dissolved oxygen Temperature
	Fish Use - Cool Water Species	Narrative Criteria for Temperature	Dissolved oxygen
	Fish Use - Core Cold Water Habitat	Protecting Cold Water Narrative	Dissolved oxygen Temperature
	Fish Use - Lahontan Trout		Dissolved oxygen Temperature
	Fish Use - Redband and Hybrid Trout		Dissolved oxygen Temperature
	Fish Use - Redband or Lahontan Cutthroat Trout		Dissolved oxygen Temperature
	Fish Use - Salmon and Steelhead Migration Corridors	Cold Water Refuge Narrative	Dissolved oxygen Temperature
	Fish Use - Salmon and Steelhead Spawning		Dissolved oxygen Temperature

Designated Beneficial Uses		Criteria Protecting Beneficial Use	
Designated Use*	Use Subcategory**	Narrative Criteria	Parameter Numeric Criteria
	Fish Use - Salmon and Trout Rearing and Migration		Dissolved oxygen Temperature
<b>Fishing** (Consumption)</b>		Toxic Substances Narrative Criteria – Consumption advisories	Toxic Substances - Human Health
	Fishing - Shellfish Harvesting	Statewide Narrative Criteria – Harmful Algae Blooms Narrative Criteria for Bacteria	Bacteria – Fecal Coliform Toxic Substances - Human Health
<b>Irrigation</b>			WDMC Site specific criteria in 340-041-0315****
<b>Livestock Watering</b>		Statewide Narrative Criteria - Harmful Algae Blooms Narrative Criteria for Bacteria	WDMC Site specific criteria in 340-041-0315
<b>Private Domestic Water Supply</b>		Statewide Narrative Criteria – Harmful Algae Blooms Narrative Criteria for Bacteria Narrative Criteria for Turbidity	Toxic Substances - Human Health (water + org. only)
<b>Public Domestic Water Supply</b>		Statewide Narrative Criteria - Harmful Algae Blooms Narrative Criteria for Bacteria Narrative Criteria for Turbidity	Toxic Substances - Human Health (water + org. only)
<b>Water Contact Recreation</b>		Statewide Narrative Criteria - Harmful Algae Blooms Narrative Criteria for Bacteria	Bacteria – E. coli and Enterococci

\* Commercial navigation and transportation, Hydropower, Industrial water supply and Wildlife & hunting beneficial uses are protected by other more sensitive uses. DEQ may assess these uses dependent on the data and information provided.

\*\* The Shad and Sturgeon spawning and rearing use is supported by protection of more sensitive uses.

\*\*\*Fishing Use – Human consumptive use of fish and shellfish are protected by the Toxic Substances – Human Health criteria; Fish resources are protected under Fish and Aquatic Life.

\*\*\*\*WDMC – West Division Main Canal near Hermiston, in northeastern Oregon.

## Georeferenced standards maps

For convenience, the designation of beneficial uses by water basin or waterbody described in OAR 340-041-0101 through OAR 340-041-0350, and accompanying figures and tables, and additional factors affecting the application of basin-specific criteria described in OAR 340-041, are depicted in DEQ's a web-based GIS mapping application, [Oregon Integrated Report Interactive Web Map](#) Application.

While this web-based mapping tool is intended to be as accurate as possible. In the case of any discrepancy, the correct interpretation of the water quality standards rules within [OAR-340-041](#) shall take precedence over any depictions, such as the web-based mapping application, which is not officially adopted into rule by the EQC.

## **Integrated Report process**

DEQ prepares the Integrated Report by assembling data and information about surface waters in Oregon, comparing data and information to appropriate Oregon water quality standards, determining the condition and status of waters where data and information are available, updating assessments from previous reporting, and identifying the waters that do not meet water quality standards and support beneficial uses. The steps are described more fully in the following sections. The process is complete when DEQ receives approval from EPA on the final list of water quality limited waters that require a TMDL (Category 5: 303(d) list).

### **Tribal waters**

Only those waters that are under the State of Oregon's jurisdiction are subject to the state's 303(d) and 305(b) assessment and reporting requirements. DEQ does not intentionally include tribal waters when assessing water quality or developing the 303(d) list and DEQ does not develop TMDLs for tribal waters unless a specific government-to-government collaboration is requested by a tribe. When a water body lies partially within tribal reservation boundaries, DEQ only assesses the segments that are within Oregon's jurisdiction to prepare Oregon's 303(d) list. Waters that form the boundary between tribal reservations and Oregon lands are assessed for the report.

### **Assembling data and information**

To gather information on water quality for the report, DEQ assembles all available internal data, conducts a data query from publicly available state and federal databases and issues a public call for data. All data and information are reviewed by DEQ to determine completeness (required metadata elements) and data quality requirements. The process of assembling data and information for the report is described in more detail in the following sections.

### **Data window**

The assessment window for the 2026 Integrated Report includes data collected between Jan. 1, 2020 and Dec. 31, 2024.

## Call for data

DEQ will issue a public call for data for the report by posting information on DEQ's [website](#) and notifying interested parties using an electronic email subscription list. The subscription list includes federal agencies, state agencies, tribes, local governments, academic institutions, watershed councils, private and public organizations, and individuals from the public.

DEQ provides electronic templates for submittal of numeric grab chemical, biological and continuous data. Required data elements (monitoring location information, sample dates, etc.) are highlighted in the template to ensure completeness. Non-numeric data that cannot be tabulated in a spreadsheet must be related to specific locations within Oregon's waters. DEQ makes its water quality assessment conclusions on a water body-specific basis, and therefore, cannot base its assessment on generalized water quality information or information that is at a regional scale.

Data collected in recent years within the data window specified in the "call for data" may be submitted for consideration in the assessment. Data submitted previously that DEQ did not use because of quality assurance (QA) concerns should not be resubmitted unless new QA information is submitted that enables DEQ to use the data.

Data submitted after the deadline stated in the data call will not be considered for the current assessment/listing but can be resubmitted for the next assessment/listing cycle. Detailed data submittal information is specified in Oregon's [2026 Integrated Report Call for Data Submission Guidelines](#).

## Metadata requirements

To be able to evaluate data for the Integrated Report, DEQ requires that metadata accompany the sampling results submitted in response to the call for data, and all other readily available sources. Required metadata are listed below. Missing or incomplete metadata may make data unusable for the report.

- Location of each monitoring station in latitude and longitude and the reference datum (example – NAD83).
- Water body name and description of the monitoring location.
- Date the sample was taken.
- Parameter(s) measured.
- Measured result for each parameter.
- Unit of measurement.
- Method used for measurement, including method detection limits (MDL) or reporting limits (RL) where applicable.

- Identification of data quality (such as Final, Rejected or Provisional)
- Identification of organization responsible for collecting and reporting the data.

## Readily available data

DEQ pulls readily available numeric data from publicly available water quality databases which use a common reporting structure and contain the metadata requirements listed above. Information on water quality related advisories and reports are also pulled as outlined in parameter specific methods. Table 2 summarizes the main sources of readily available data and information DEQ currently uses.

Table 2. Current sources of readily available data used in the Integrated Report

Data Source
<a href="#">DEQ Ambient Water Quality Monitoring System (AWQMS)</a>
<a href="#">Water Quality Portal</a>
<a href="#">USGS - National Water Information System (NWIS)</a>
<a href="#">Oregon Water Resources Department</a>
<a href="#">City of Portland Bureau of Environmental Services</a>
<a href="#">Washington Department of Ecology</a>
Newport Hydrographic Line
<a href="#">NOAA West Coast Ocean Acidification Cruises</a>
<a href="#">Oregon Invasive Species Hotline</a>
<a href="#">Oregon Public Health Advisories for Recreation (Harmful Algal Blooms, Fish Consumption Advisories, Shellfish and Beach Use)</a>
<a href="#">Oregon Department of Agriculture - Recreational Shellfish Biotoxin Closures</a>

## Data quality requirements

All data used in the Integrated Report must have a project plan (Quality Assurance Project Plan or similar) and use widely accepted sampling and analysis methods. Internal DEQ and data collected through the Volunteer Monitoring Program must have data quality level of A or B. Data quality levels for parameters measured in the field are assigned following [DEQ's Data Quality Matrix](#). Analytical or laboratory analyzed data are assigned data quality levels based on quality control and assurance protocols and DEQ's internal data review. Data submitted through the call for data and queried from outside of DEQ will be screened for completeness, data quality and submission requirements and reasonable range of results. A reasonable range of results is determined by comparing the data to existing data from the region (sub-basin or basin scale). Third-party data must be labeled as "Final", or equivalent, to be included in the analysis. If data meet this first screen, DEQ will include it in its assessment. If the data are incomplete or out of the reasonable range, DEQ will analyze quality control data and may also follow up with the submitter

for supporting documentation. The intent of the validation is not to eliminate data that may be showing a shift outside of a reasonable range, but rather to ensure that there is not an error in transcription or reporting units. Analytical laboratory data will be reviewed against current quality control limits established for the analytical method or the QC limits established by the laboratory that performed the testing and supplied the data to DEQ. Where sample results included duplicates collected for QA/QC purposes, the primary sample result will be evaluated and counted only as one result.

## Censored data values

Due to limitations in field and laboratory chemical analysis procedures, low concentrations of some substances cannot be precisely measured. Analytical test procedures include both a Method Detection Level (MDL) and a Minimum Reporting Level (MRL). The MDL is the concentration above which a sample can be discerned from a sample blank (zero). The MRL is the concentration above which an analyte can be both detected, and an accurate concentration determined. Both values are laboratory- and instrument-dependent and can be significantly different for the same analyte.

There is no consistent reporting requirement for labs to record minimum detection and reporting levels. For example, some labs will report to the MRL while others report to the MDL. For this reason, DEQ will use the generic term Quantitation Limit (QL) to include MRL, MDL and any other reporting limit used by third parties.

For waterbodies with no quantifiable sample results:

- Waterbodies will be assessed as Category 2; Attaining where samples have been collected but all values are reported below the lowest available QL and the QL is less than the numeric criteria.
- Waterbodies will be assessed as Category 3D; Not Technologically Feasible to Assess where samples have been collected but all values are reported below the lowest available QL, and the QL is greater than the numeric criteria ([Assessment Categories](#)).

For waterbodies with a mix of quantifiable and censored data, DEQ will use the following methods for the application of the exact binomial test statistical method and the calculation of the geometric mean to apply to the human health criteria.

- When the QL is greater than the numeric criteria value,  $\frac{1}{2}$  of the value of the water quality criteria will be substituted for any sample reported as censored.
- When the QL is less than the numeric criteria,  $\frac{1}{2}$  of the value of the lowest QL will be substituted for any sample reported as censored.
- Samples reported as greater than the Maximum QL, use value.
  - For example, a bacteria sample reported as >2000 MPN, 2000 MPN will be used.



Sample concentrations measured between the MRL and the MDL are often reported as an estimated value, because the precision of the method is not enough to determine the exact concentration. For samples reported as estimated, DEQ will use the value and assign an assessment category based on these rules:

- When the QL is less than the numeric criteria and an impairment determination is based on solely estimated or a combination of estimated and quantifiable results, waterbodies will be assessed as Category 3B when quantifiable results alone do not indicate impairment.
  - In cases with drastically different QL values, it may be appropriate to omit the portion of the dataset with a higher QL from the assessment of the data.
- When the QL is greater than the numeric criteria, waterbodies will be assessed using the estimated values.

## Determining water quality status

The goal of the Integrated Report is to provide information about the condition and quality of Oregon's surface waters. Using available data, information, and water quality standards, DEQ reaches conclusions about whether conditions support the beneficial uses designated for the waterbody and meet water quality standards applicable in the water. The conclusions are communicated by using a set of assessment status categories described in EPA guidance and commonly used by states completing 303(d) and 305(b) Integrated Reports.

## Assessment categories

[EPA guidance](#) continues to recommend using five reporting categories as shown in Table 3 to classify water quality status for Oregon waters. The categories represent varying levels of beneficial use support, ranging from Category 1, where all designated uses for a water body are supported, to Category 5, where a waterbody is impaired and a TMDL is required to return the water to a condition where the water quality standards are met.

DEQ uses the policy of independent applicability to assess attainment of water quality standards, as recommended by EPA. Within an assessment unit, each water quality standard with sufficient data or information is evaluated independently and a category is assigned for that parameter. These parameter assessment conclusions are reported in DEQ's online database application. Since no waterbody has sufficient data or information to assess all Oregon's designated uses and water quality standards, DEQ does not classify waters as Category 1. Figure 2 summarizes DEQ's general process for assigning assessment categories to assessed parameters.

Table 3. Assessment reporting categories used to classify water quality status of Oregon's surface waters

Category	Description
<b>Category 1</b>	All designated uses are supported. (Oregon does not have sufficient data to assess this category.)
<b>Category 2</b>	Available data and information indicate that assessed designated uses are supported and the water quality standard is attained.*
<b>Category 3</b>	Insufficient data to determine whether a designated use is supported.
	Oregon further sub-classifies waters if warranted as: <b>3B: insufficient data; potential concern:</b> Insufficient to determine use support but some data indicate non-attainment of a criterion. <b>3C: insufficient data; non-reference condition:</b> Biocriteria scores differ from reference condition, but are not classified as impaired <b>3D: insufficient data; not technologically feasible to assess:</b> Insufficient data to determine use support because numeric criteria are less than quantitation limits.
<b>Category 4</b>	Data indicate that at least one designated use is not supported but a TMDL is not needed. This includes:
	<b>4A:</b> TMDLs that will result in attainment of water quality standards and beneficial use support have been approved.
	<b>4B:</b> Other pollution control requirements are expected to address pollutants and will result in attainment of water quality standards.
	<b>4C:</b> Impairment caused by pollution, not by a pollutant (e.g., flow or lack of flow are not considered pollutants).
<b>Category 5</b>	Data indicate a designated use is not supported or a water quality standard is not attained and a TMDL is needed. This category constitutes the Section 303(d) list that EPA will approve or disapprove under the Clean Water Act.
	<b>5C: Impaired; Climate Change Related:</b> Data indicate a designated use is not supported or a water quality standard is not attained and there is sufficient information to suggest impairment is primarily due to global climate change. Waterbodies in this category will be added to the Section 303(d) list that EPA will approve or disapprove under the CWA, but given a low priority for TMDL development while appropriate restoration solutions are pursued. By maintaining these waters within category 5 (impaired waters needing a TMDL), this approach provides a public accounting of the true status of climate change related impairments. <b>5R: Impaired – Advanced restoration plan:</b> Restoration plans for a particular pollutant are in place in advance of a TMDL.

\*This category applies only to the assessed designated use or water quality standard. Other designated uses or water quality standards may or may not be attained.

## Impaired status

DEQ considers a waterbody to have an impaired status when data or information show it does not meet narrative or numeric water quality criteria and therefore that at least one beneficial use is not being fully supported. This status can be assigned for the entire year or for a defined

season based on the criteria being evaluated and is equivalent to the definition of “water quality limited” in the Oregon Administrative Rules (OAR) Chapter 340 Division 41 [340-041-0002](#) (70).

## **The 303(d) list of impaired waters – Category 5**

Section 303(d) of the CWA, states, territories, and authorized tribes are required to develop lists of impaired waters termed the 303(d) list. Oregon’s 303(d) list is made up of all Category 5 assessments, where data indicate a designated use is not supported or a water quality standard is not attained and a TMDL is needed. The 303(d) list also includes a priority ranking for the development of TMDL projects in the next two years. EPA will approve or disapprove Oregon’s 303(d) list under the Clean Water Act.

EPA’s recent [Vision for the Clean Water Act Section 303\(d\) Program](#) recognizes that TMDL development and implementation may take time and there are cases in which pursuing restoration approaches in advance of developing a TMDL may provide an effective path to restore water quality. In these cases, EPA recommends the use of a sub-Category 5R to identify waterbodies where restoration plans for a particular pollutant are in place in advance of a TMDL. DEQ may use the designation of Category 5R for waterbodies on the 303(d) list with such a plan in place and may use this as a rationale for a low TMDL priority ranking.

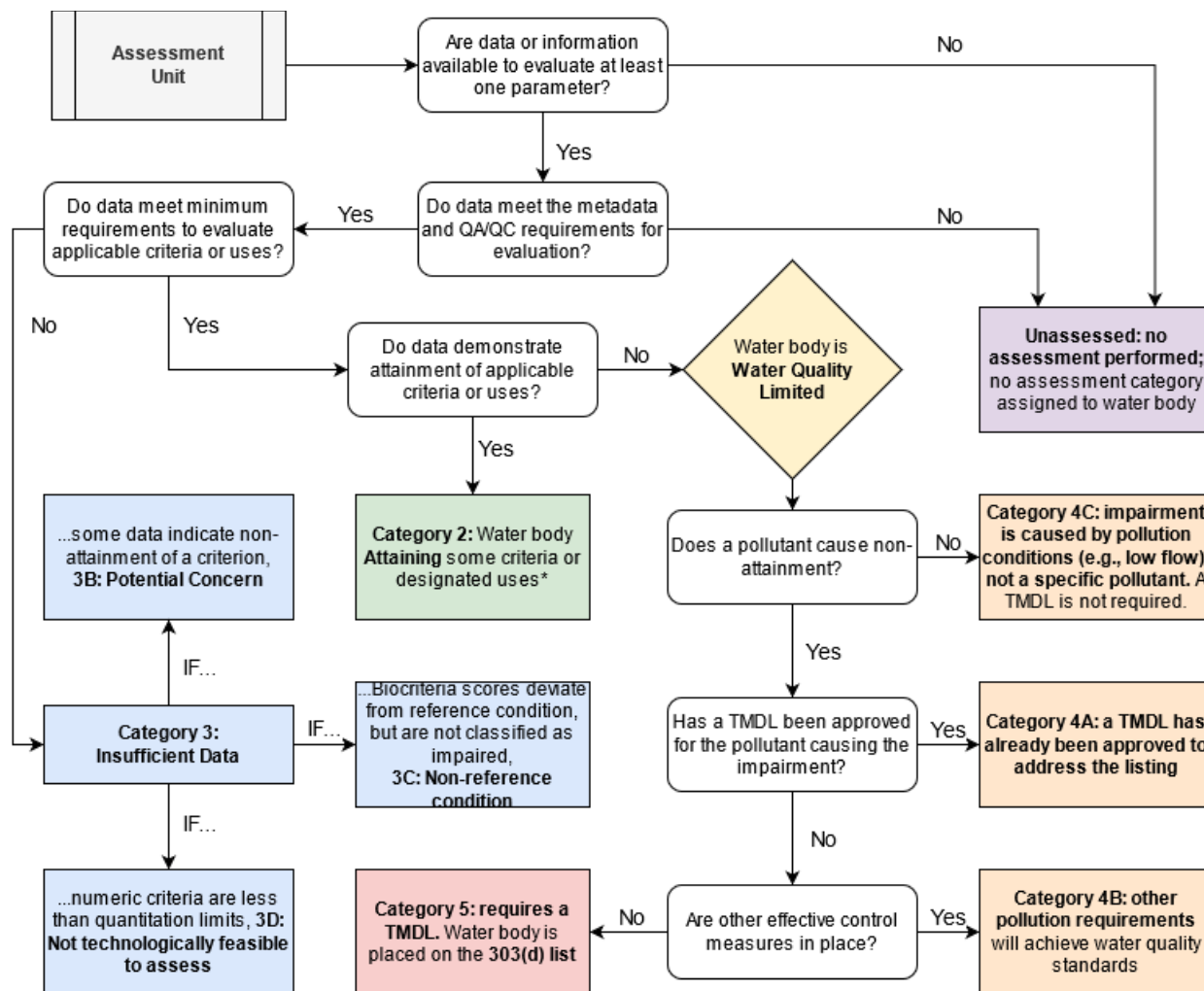
## **Other ways to identify impaired waters – Category 4**

In addition to the CWA requirements, each assessment cycle EPA releases a [guidance memo](#) outlining their expectations for reporting. Over the years, DEQ has applied this guidance to use other assessment categories to identify impaired waters. Specifically, waterbodies are moved from Category 5 to Category 4 once DEQ does one of the following: develops a TMDL for an impaired waterbody that EPA approves (Category 4A), demonstrates the impairment is caused by pollution not a pollutant (Category 4C), or demonstrates it is addressing the impairment using a required pollution control plan other than a TMDL (Category 4B). A Category 4B plan, must ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period. DEQ and EPA must accept the Category 4B plan before EPA approves the removal of the affected waterbody from the 303(d) list (Category 5).

If a Category 4B plan is proposed in its Integrated Report submission, DEQ will include a rationale to support the decision. The rationale will address the following six elements:

1. Identification of assessment unit and statement of problem causing the impairment
2. Description of the pollution controls and how they will achieve WQS, including a description of the pollutant loads needed to meet WQS and a description of the requirements under which the controls will be implemented

3. An estimate or projection of the time when WQS will be met
4. Schedule for implementing pollution controls
5. Monitoring plan to track effectiveness of pollution controls
6. Commitment to revise pollution controls, as necessary



\*Note that Oregon does not use **Category 1: All designated uses are supported**, since no water body in the state has sufficient data available to assess all designated uses and water quality standards.

Figure 2. Flowchart for assigning assessment categories for the 2026 Integrated Report

## Evaluating data and information

To characterize conditions in Oregon waters, DEQ assembles water quality data and information available from monitoring locations or sampling points on a water body. Samples may have been collected from one or more sampling locations and analyzed for a variety of pollutants or other chemical or physical characteristics. Monitoring may have occurred once or multiple times at a single location. The site monitoring data are the basis for characterizing the overall water quality status in a water body. The requirements and protocols for evaluating site monitoring data for specific pollutants and water quality standards are discussed in detail in the Assessment methodologies for specific pollutants or parameters section.

There are several water quality parameters that have separate numeric criteria for freshwater, saltwater, or estuary water types. To determine where freshwater and saltwater criteria apply, DEQ follows [Oregon administrative rules](#) and [EPA guidance](#). Marine waters are defined in [OAR 340-041-0002](#)(34) as "...all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of the State of Oregon." Estuarine waters are defined in [OAR 340-041-0002](#)(22) as "...all mixed fresh and oceanic waters in estuaries or bays from the point of oceanic water intrusion inland to a line connecting the outermost points of the headlands or protective jetties." In 2018, DEQ adopted the Oregon Coastal Atlas estuary classification using the Federal Coastal and Marine Ecological Classification Standard (CMECS) implemented by the Oregon Department of Land Conservation and Development to delineate the extent of estuaries and define where specific water quality criteria should apply. CMECS classification will be used to apply "estuary" criteria for dissolved oxygen, pH, nuisance phytoplankton, and to determine applicability of the more stringent of the saltwater and freshwater criteria for aquatic life toxic pollutants ([OAR 340-041-0033](#)–Table 30).

As part of the data review, DEQ confirms that site location information and analytical data results are complete, accurate, and appropriate for evaluation. Correct location information is critical to assign the monitoring site to the correct assessment unit which determines applicable water quality standards and appropriate numeric criteria to apply. Accurate and complete information about sample and analytical results is critical to determine if site data are comparable to a water quality standard and meet the assessment methodology for the specific pollutant or parameter.

## Assessment units

Integrated Report conclusions are reported to EPA at an assessment unit level. Each state, tribe or territory is responsible for determining how waters will be partitioned into these reporting units. DEQ defines assessment units as segments of streams, rivers or water body areas that are

predetermined based on similar hydrology and represent similar environmental hydrographic characteristics. Assessment units (AUs) are represented spatially by the USGS High Resolution National Hydrography framework (NHDH; 1:24,000 or better resolution). Beginning with the 2020 reporting cycle, DEQ has classified all surface waterbodies on the NHDH into manageable units for assessment and reporting purposes. The classification scheme for defining units is defined by water type in the following sub-sections and outlined in Figure 3.

In general, all of Oregon's assessment units:

- Are fixed locations that will remain the same over reporting cycles
- May contain multiple monitoring stations
- Will be assigned an overall status (Impaired, Attaining, Insufficient data or Unassessed) for each applicable beneficial use

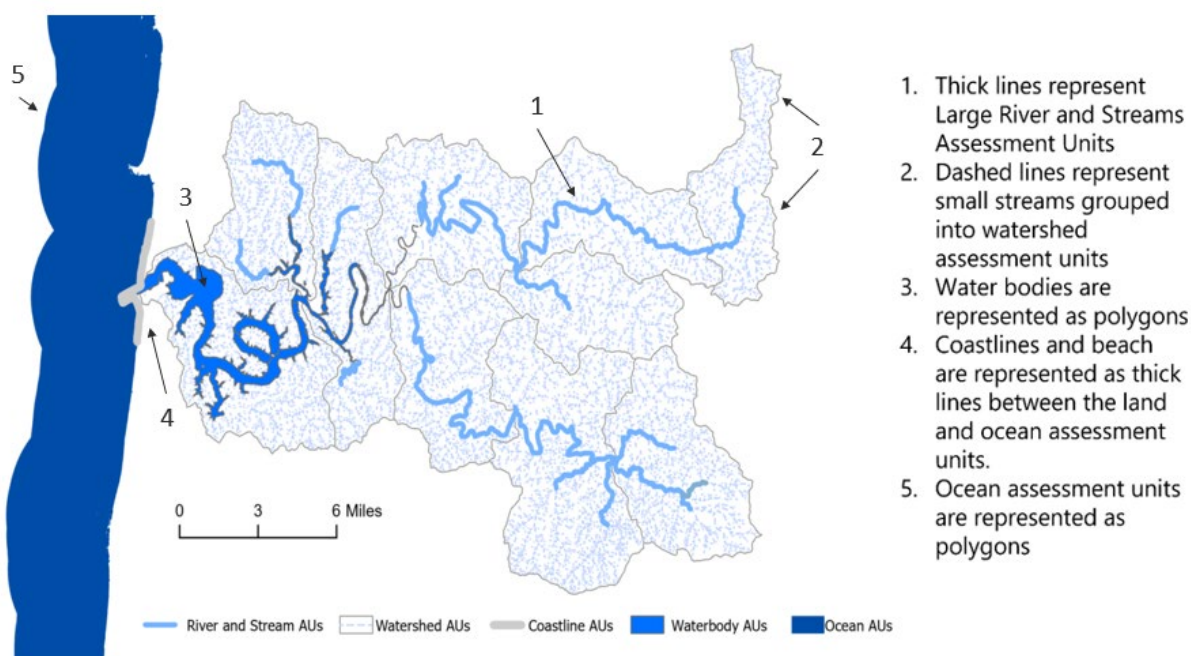


Figure 3. Assessment units are represented as polygons and/or lines in the web map application as determined by water body type.

## River and stream assessment unit classification

Oregon's large river and stream units are defined by a [Strahler Stream Order](#) of five and higher. Assessment units were broken based on the following information:

1. A change in designated use based on water body type. For most of the state, this does not create many breaks.
2. A change in stream order. This hydrologic break accounts for the input of major tributaries.

3. If neither designated use nor stream order change occurs, then the assessment unit is broken at a [hydrologic unit code](#) of 10 or HUC10 boundary.

Fish use designations (i.e., spawning designations) were not used to define assessment units.

The only exception to the classification scheme above is the Columbia and Snake river assessment units. For these rivers, DEQ aligned its assessment units for the Columbia and Snake rivers, with the bordering states of Washington and Idaho. DEQ cautions that although Assessment units may align between states, assessment conclusions may be different due to different data evaluated or different WQ criteria and assessment methodologies.

## **Watershed assessment unit classification**

When moving to fixed assessment units using the NHDH, DEQ defined assessment units for the entire stream network statewide. This resulted in the need to classify headwater streams and small feeder drainages, many of which are intermittent. To account for this, all streams with a Strahler Stream Order of 4 or less are grouped into a watershed unit that encompasses an entire HUC12 or sub-watershed. This is currently the smallest HUC classification in Oregon.

## **Lakes, reservoirs, and estuaries assessment unit classification**

Lakes and reservoirs greater than 20 hectares are classified as separate assessment units defined by NHDH water body features. Smaller lake units will be added as data becomes available. DEQ uses the [Coastal and Marine Ecological Classification Standard](#) (CMECS) to define the extent of estuaries. Each estuary assessment unit defined by area may be further divided based on the applicable bacteria indicator (freshwater or coastal).

## **Beach and coastal assessment units**

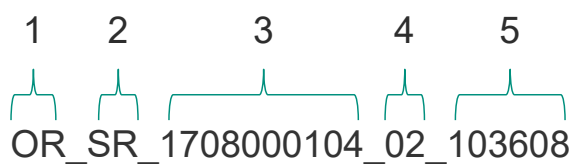
Beach assessment units are defined using NHDH coastline segments for the entire length of the Oregon coast. Delineation of beach assessment units followed existing beaches as designated by Oregon Health Authority and EPA for recreational bacteria monitoring programs. Where no beaches were designated by these agencies, DEQ used imagery interpretation of continuous beach landforms delineated by headlands and estuary mouths.

## **Ocean assessment units**

DEQ worked with the scientific/technical workgroup for the assessment of ocean acidification and hypoxia to redefine ocean assessment units based on hydrological and environmental factors rather than the land based HUC 8 classification used in previous cycles. The six ocean units encompass Oregon territorial waters which extend three miles offshore.



## How to read an assessment unit ID (AU\_ID)



1 = State identifier (Oregon)

2 = AU type

SR = large Stream/River

WS = Watershed Unit

LK = Lake/Reservoir

EB = Estuary

CL = Coastline

OC = Ocean

3 = HUC10 (for rivers and streams assessment units) or HUC12 for watershed units

4 = Beneficial Use Code

5 = Six digit unique identifier

## Assessment unit data evaluation and reporting

One assessment unit can have data for over 150 unique parameters, collected from multiple monitoring locations. Methodologies to determine assessment conclusions for each parameter are outlined in the [Assessment Methodologies for Specific Pollutants or Parameter](#). The overall status of an assessment unit, which is presented in the web map application and reported to EPA, is determined by the following hierarchy:

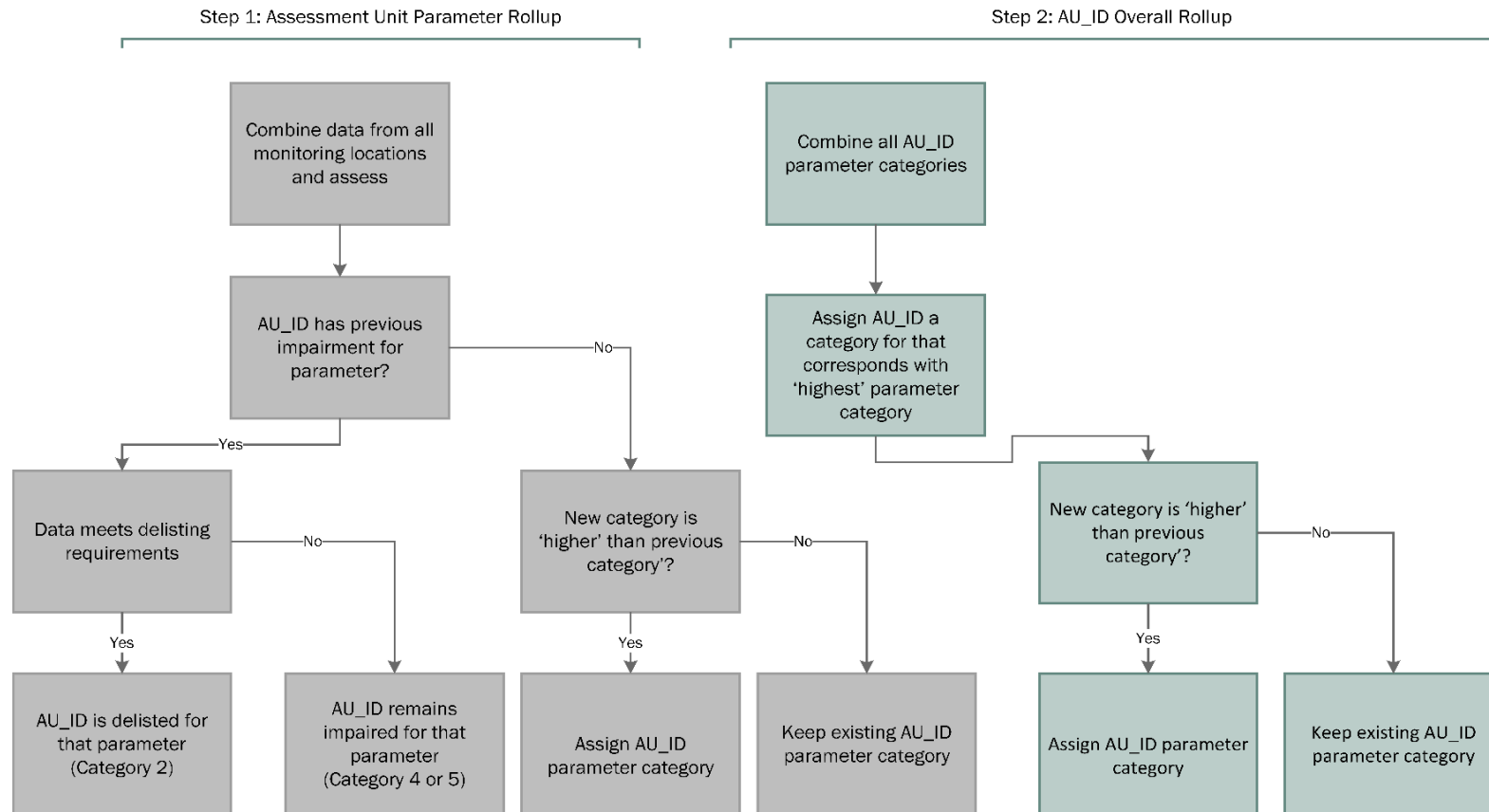
**Category 5 or 4 (Impaired) > Category 2 (Attaining) > Category 3 (Insufficient Data)**

The assessment unit will be given the overall status that reflects the highest parameter categorization (where 5 is considered higher than 2) according to the above hierarchy.

## Data pooling for non-watershed units

For rivers, streams, waterbodies (lakes, reservoirs and estuaries), coastline and ocean assessments (i.e., non-watershed units), data from individual monitoring locations in assessment units are pooled together to determine a category for each parameter. Data within assessment units are evaluated using the methods for each specific parameter to determine if the pollutant level exceeds a water quality standard and is a cause for beneficial use impairment. Figure 4 displays the flow from parameter assessment conclusions to a final assessment unit status.

## Assessment Unit rollup (Non-watershed units)



IR Category hierarchy :  
Category 5 or 4 (Impaired) > 2 > 3B > 3 > 3D

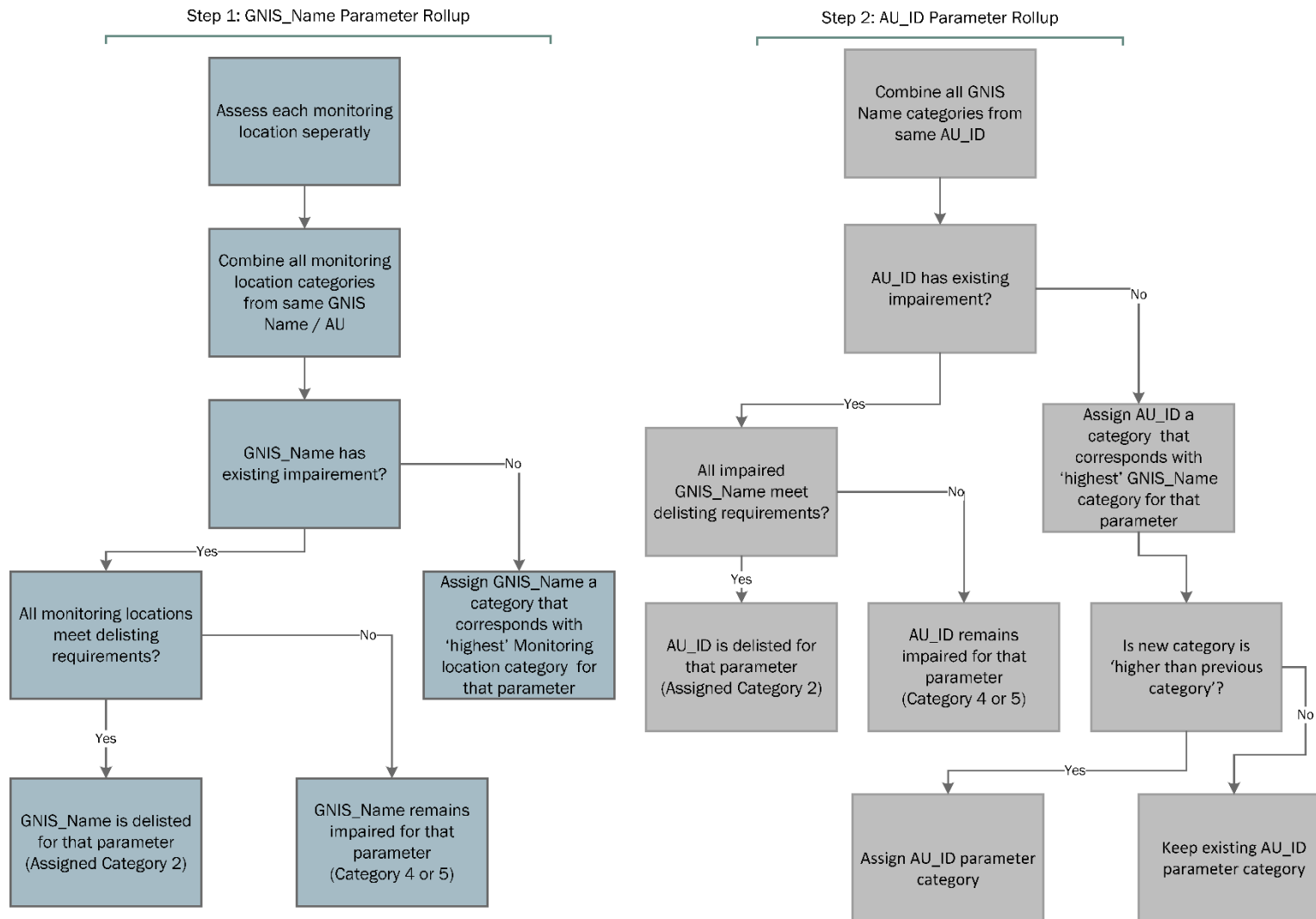
With the exception of delistings, if an AU was previously categorized at a 'higher' category than categorized in the current cycle, the AU\_ID keeps the previous assessment categorization. E.g., if an AU parameter was assessed as attaining (category 2) in 2024, and the 2026 assessment was categorized as insufficient data (category 3), the AU\_ID will remain categorized as attaining.

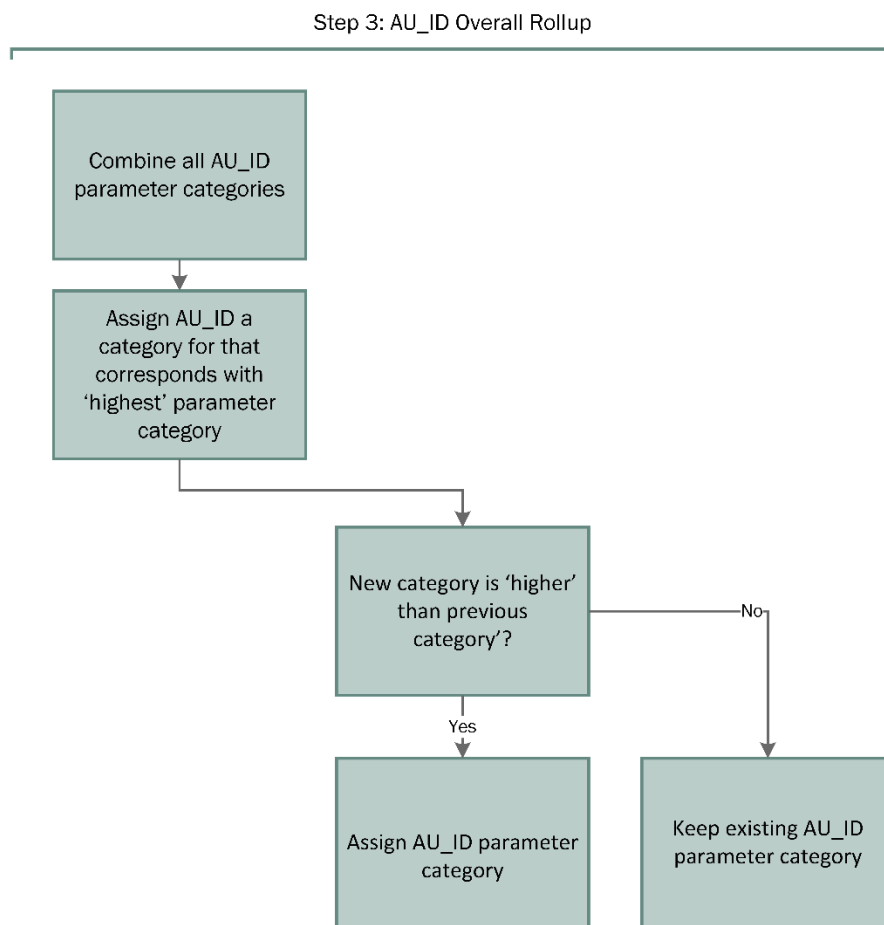
Figure 4. Flowchart used to define assessment unit status in non-watershed units

## **Watershed unit assessment by monitoring station**

DEQ assesses watershed units by monitoring station and makes parameter categorical determinations of impairment or attainment at each individual monitoring station. This determination is then rolled up to an individual stream (as defined by the NHDH [GNIS Name](#)) within the unit and then finally to a single assessment unit conclusion to meet EPA reporting requirements (Figure 5). Assessment by station within a watershed assessment unit allows DEQ to identify the specific stream with impairments and provides more precise assessment of the dataset. Identification of impaired streams in watershed units may inform monitoring partners of localized impairments and guide restoration activities and future monitoring. This method also recognizes the inherent difference between assessing watershed units, which involves grouping small streams into a single assessment conclusion, versus assessing other types of assessment units, in which hydrologic connectivity is more clearly defined.

# Watershed Unit Parameter Categorization Rollup





IR Category hierarchy :  
 Category 5 or 4 (Impaired) > 2 > 3B > 3 > 3D

With the exception of delistings, if an AU was previously categorized at a 'higher' category than categorized in the current cycle, the AU\_ID keeps the previous assessment categorization. E.g., if an AU parameter was assessed as attaining (category 2) in 2024, and the 2026 assessment was categorized as insufficient data (category 3), the AU\_ID will remain categorized as attaining.

Figure 5. Flowchart used to define assessment status in watershed assessment units.

## General methodologies for parameter assessments

DEQ uses a [statistical hypothesis](#) testing approach (binomial test) to derive a critical number of sample excursions (single measurement that does not meet numeric water quality criteria) that scales with the number of representative samples to evaluate beneficial use attainment status of waterbodies. The binomial method allows DEQ to quantify a level of statistical confidence and error when different sample sizes are used for making listing and delisting decisions. Unless an alternate statistical method of evaluation is included as part of the water quality standard, as indicated in the Assessment Methodologies for Specific Pollutants or Parameters sections, the numeric water quality criteria for aquatic life toxic substances (OAR-340-041-8033, [Table 30](#)) and conventional pollutants will be evaluated using the exact binomial test for proportions method. Human health toxic substances criteria (OAR-340-041-8033, [Table 40](#)) will be evaluated for attainment against the geometric mean of pollutant concentrations for all samples within the data window.

### Determining attainment

DEQ has retained the current assessment methodology and 15% effect size and selected to control Type II error rates (when an impaired water body is incorrectly identified as attaining) by setting a minimum sample size to make a Category 2 determination.

DEQ selected a Type II error rate ( $\beta$ ) of approximately 10% which corresponds to a 90% power value ( $1 - \beta$ ) to support its minimal sample size recommendations for both Aquatic Life toxics criteria and conventional pollutants (Table 4). This is consistent with the Type I error rate (when an attaining water body is erroneously identified to be impaired) chosen for impairment and implemented in the 2018/2020 Integrated Report.

Table 4. Minimum sample size recommendations for Category 2

	Minimum sample size for Category 2
<b>Aquatic Life Toxics</b>	10
<b>Conventional Pollutants</b>	8

### Water quality criteria for aquatic life: toxic substances and conventional pollutants

For a given sample size, if the number of exceedances is equal to or greater than the number of exceedances identified in Table 6 and Table 7 the water body will be placed in Category 5. Waters will be assessed for listing and delisting purposes based on the numeric criterion thresholds described in Table 5 indicating that the water quality criteria are exceeded. The critical proportion

for toxic substances is 5% of samples with 90% confidence. The critical proportion of conventional pollutants is 10% of samples with 90% confidence (except for summary metrics derived from continuously recorded data). The number of sample excursions that result in an impairment per sample size are shown in Table 6 and Table 7.

Table 5. Listing and delisting methods for numeric criteria

	Chronic		Acute		Confidence Level
	Category 2*	Category 5*	Category 2*	Category 5*	Minimum
<b>Aquatic Life Toxics Criteria</b>	Binomial: $\leq 5\%$ of samples exceed the criterion value	Binomial: $> 5\%$ of samples exceed the criterion value	Binomial: $\leq 5\%$ of samples exceed the criterion value	Binomial: $> 5\%$ of samples exceed the criterion value	90%
<b>Conventional Pollutants</b>	Binomial: $\leq 10\%$ of samples exceed the criterion value	Binomial: $> 10\%$ of samples exceed the criterion value	NA	NA	90%
<b>Human Health Toxics Criteria</b>	Geometric mean sample concentration $\leq$ criterion value	Geometric mean sample concentration $>$ criterion value	NA	NA	NA

\*For waterbodies not currently listed as Category 5, the critical values for listing in Table 6 and Table 7. apply. For waterbodies currently listed as Category 5, the critical values for delisting in Table 10 and Table 11 apply.

## Determining impairment – statistical methods

### Critical values for listing acute and chronic toxic substances

- Null hypothesis: Actual exceedance proportion is  $\leq 5\%$
- Alternate hypothesis: Actual exceedance proportion is  $> 5\%$
- Minimum confidence level is 90%
- A minimum sample size of two is required

Table 6. Minimum number of sample excursions required to list as impaired for toxic substances

Sample Size	List if excursions $\geq$ :
2-18	2*
19-22	3

Sample Size	List if excursions $\geq$ :
23-35	4
36-49	5
50-63	6
64-78	7
79-92	8
93-109	9
110-125	10
126-141	11
142-158	12
159-174	13
175-191	14
192-200	15
>200	See <a href="#">generalized binomial listing formula</a> to calculate the number of excursions
* The use of 2 excursions to list is extended for sample sizes $\leq 18$	

### Critical values for listing conventional pollutants

- Null hypothesis: Actual exceedance proportion is  $\leq 10\%$
- Alternate hypothesis: Actual exceedance proportion is  $> 10\%$
- Minimum confidence level is 90%
- A minimum sample size of five is required

Table 7. Minimum number of sample excursions required to list as impaired for conventional pollutants

Sample Size	List if excursions $\geq$ :
5 - 11	2*
12-18	4
19-25	5
26-32	6
33-40	7
41-47	8
48-55	9
56-63	10
64-71	11
72-79	12
80-88	13



Sample Size	List if excursions $\geq$ :
89-96	14
97-104	15
105-113	16
114-121	17
122-130	18
131-138	19
139-147	20
148-156	21
157-164	22
165-173	23
174-182	24
183-191	25
192-199	26
$\geq 200$	See <a href="#">generalized binomial listing</a> formula to calculate the number of excursions
* The use of 2 excursions to list is extended for sample sizes $< 11$ .	

### Generalized binomial listing formula

For sample sizes greater than 200, calculate  $\alpha$  from the right tailed probability of the cumulative binomial distribution:

$$\alpha = \text{Excel}^{\circledR} \text{ Function BINOMDIST}(n-k_i, n, 1 - p_1, \text{TRUE})$$

Where,

$n$  = the number of samples,

$k_i$  = the critical value of the minimum number of sample excursions needed to place a water on the section 303(d) list, and

$p_1$  = regulatory critical exceedance rate.

BINOMDIST( ) is an Excel<sup>®</sup> software function that returns cumulative left tail binomial probabilities.

The number of excursions required to list is the value of  $k_i$ , where the initial value of  $k_i=2$  for  $n=2$ , and  $k_i$  is incrementally increased by 1, until  $\alpha \leq 0.10$ .

The critical number of excursions can be calculated in [R Statistical Software](#) by using the following equations:

For Toxics:

$$x = \text{ifelse}(n \leq 18, 2, \text{qbinom}(0.90, n, 0.05, \text{lower.tail} = \text{TRUE}) + 1)$$

For Conventional Parameters:

$$x = \text{ifelse}(n \leq 11, 2, \text{qbinom}(0.90, n, 0.10, \text{lower.tail} = \text{TRUE}) + 1)$$

Where,

n = the number of samples,

x = critical excursion value

## Water quality criteria for human health: toxic substances

Numeric water quality criteria for the protection of human health from toxic substances shall be evaluated as the geometric mean of the observed samples of pollutant concentration.

Assessment conclusions will be based on the geometric mean of samples, and require a minimum of three samples to be considered representative of the water body.

## Overwhelming evidence

When sample sizes are minimal or established assessment methodology has not been developed for a particular parameter, but there is additional information that impairment is likely, DEQ will implement the concept of “overwhelming evidence” (Table 8). Overwhelming evidence uses multiple lines of evidence based on a specific rationale to conclude that a water body is impaired. In this case, a Category 5 status may be used where supporting credible evidence indicate that the applicable beneficial uses are not being fully supported. Any listing decisions made for parameters without existing assessment methodologies will be clearly explained in an amendment made to the Assessment Methodology when the draft report is made available for public comment. DEQ would consider the following factors for indicators of overwhelming evidence and reserve the right to use additional lines of evidence.

Table 8. Factors used in implementing the concept of overwhelming evidence

<b>Extreme exceedance of criteria</b>	<ul style="list-style-type: none"><li>• Samples exceed at 2x the acute magnitude</li></ul>
<b>Other lines of evidence</b>	<ul style="list-style-type: none"><li>• Documented fish kill</li><li>• Studies or other data/info that demonstrate impairment at a specific location</li><li>• Public health advisories</li></ul>
<b>Parameters where no assessment methodology has been established</b>	<ul style="list-style-type: none"><li>• Credible data and/or information with multiple lines of evidence indicating a pollutant is impacting a designated beneficial use in a particular location</li></ul>

## Category 3B: Insufficient data; potential concern

During the assessment process, DEQ will evaluate all factors such as magnitude of exceedance, critical time periods and additional lines of evidence when making impairment decisions. Although DEQ has tried to anticipate all cases where Category 3B may be used, this is not an exhaustive list (Table 9). There will be cases that fall outside of the guidelines that have been laid out and DEQ will address these on a site-specific basis and document them within the assessment rationale. Accumulation of assessment experience will continue to inform and contribute to future revisions of DEQ's assessment methodology.

Table 9. Category 3B guidelines

<b>Insufficient data</b>	<ul style="list-style-type: none"><li>• At least 1 sample exceeds the magnitude of the criteria</li><li>• AND dataset does not meet minimum size requirement for Category 5</li><li>• BUT no overwhelming evidence of impairment exists.</li></ul>
<b>Conflicting indicators of attainment</b>	<ul style="list-style-type: none"><li>• When samples measured as total recoverable exceed a dissolved criterion.</li></ul>
<b>Data not quantifiable</b>	<ul style="list-style-type: none"><li>• Exceeding samples below the method minimum reporting (MRL);</li></ul>
<b>When assessing hardness-dependent criteria or use of the Biotic Ligand Model with defaults</b>	<ul style="list-style-type: none"><li>• BOTH measured and default input criteria are used</li><li>• AND measured input criteria sample data do not meet minimum sample size</li><li>• AND some samples exceed criteria generated from default data</li></ul>

## Delisting waterbodies

Once a waterbody is found to be water quality limited and is assigned to Category 5: 303(d) status, it remains on Oregon's 303(d) list until DEQ delists or removes it from the 303(d) list and EPA approves the delisting. This section describes the rationale DEQ uses to justify delisting waterbodies from Category 5: 303(d) and assigning another status category.

### Current information shows an error in the Category 5: 303(d) listing

A waterbody is delisted if there is information to show that the Category 5: 303(d) status was assigned in error. New data or review of the current assessment evaluation may show errors in previous listings due to (1) monitoring location errors (2) incorrect inclusion of inappropriate data or data not meeting data quality requirements, (3) data evaluations not consistent with the assessment protocols, (4) listing of waterbodies that already have TMDLs in place, or (5) duplicate listings for the same water body and pollutant. The delisting is supported with a description and documentation of the error and the information used to correctly assign a

status category to the water body. The delisting action is noted as DELISTING\_ORIG\_INCORRECT in the reporting spreadsheet.

## **Water quality standards have changed or no longer apply in certain waterbodies**

If water quality standards have been revised since a water body was listed in Category 5: 303(d), the data and information available for the current assessment are evaluated using the currently applicable criteria and the current assessment methodology. If water quality standards have changed or the beneficial use designations for a water body have been refined since it was first listed in Category 5: 303(d), the numeric or narrative water quality criteria appropriate to the currently designated beneficial use are applied to evaluate data and information. When available, data will be assessed against revised water quality standards. See [Assessment Methodologies for Specific Pollutants or Parameter](#) for more detailed protocols for the pollutants with recent Oregon water quality standards changes.

If available information demonstrates that the currently effective criteria are being attained, the water body is delisted and placed in Category 2: Attaining. The delisting action is noted as WQS\_STANDARDS\_CHANGED in the reporting spreadsheet. When no data are available to evaluate against currently applicable criteria, or data are insufficient to demonstrate attainment of the current criteria, the water body remains in Category 5: 303(d).

If the beneficial use designation is no longer appropriate in a water body, and specific pollutant criteria do not apply, the previously listed water body is delisted. No status category is assigned in this case. The delisting action is noted as DELISTING\_WQS\_NOT\_APPLICABLE in the reporting spreadsheet. This may be the case for waters previously listed for temperature or dissolved oxygen based on spawning criteria, where the current designated use of the water body does not include salmonid or resident trout spawning use. Once delisted, the assessment for the outdated criteria or beneficial use will no longer be reported in subsequent Integrated Reports.

If there are no currently applicable criteria because the pollutant criteria are withdrawn, the previously listed water body is delisted. No status category is assigned. The delisting action is noted as WQS\_STANDARDS\_CHANGED in the reporting spreadsheet.

## **Water quality standard pollutant changed**

With the water quality standard changes, several toxic substance criteria for a family or group of chemicals were replaced by criteria for individual chemicals. Examples are criteria for chemical groups such as dichlorobenzenes, dichloroethylenes, halomethanes, and polynuclear aromatic hydrocarbons that are replaced with individual criteria. Data and information available for the

current assessment are evaluated using the currently applicable criteria for the individual pollutants which are discussed in more detail in [Assessment Methods by Pollutant or Parameter](#).

If available information demonstrate that the currently effective criteria are being met for individual pollutants in the group, the water body listing for the chemical group is delisted with the delisting action noted as WQS\_STANDARDS\_CHANGED in the reporting spreadsheet. The water body is reported as Category 2: Attaining based on data for individual pollutants in the water body. When no data are available to evaluate against currently applicable criteria for individual pollutants, or data are insufficient to demonstrate attainment of the current criteria for individual pollutants, the water body remains in Category 5: 303(d).

### **TMDLs approved for water body and pollutant**

After TMDLs for a water body and pollutant are completed by DEQ and approved by EPA, the water body can be delisted from Category 5: 303(d) and placed in Category 4A: Water Quality Limited TMDL Approved with the delisting action noted as DELISTING\_4A in the reporting spreadsheet. The water body retains the water quality limited status (per OAR 340-41-0002(70)) until information shows that water quality standards are attained. If a TMDL is developed for a pollutant on a watershed scale, all water body segments listed for that pollutant criteria within the watershed are delisted and placed in Category 4A. When the EPA approval of the TMDL states that the allocations will lead to attainment of the water quality criteria and that other waterbodies identified as impaired for those pollutants do not need to be added to the Category 5: 303(d) list, waters identified as impaired in subsequent assessments are given the status of Category 4A: Water Quality Limited TMDL approved.

### **Other pollution control requirements in place**

When pollution controls or practices required by local, state, or federal authorities are in place, and will result in the attainment of water quality standards in a reasonable period of time, these other requirements may be satisfactory alternatives to TMDLs that address impaired water and achieve restoration. Examples of other requirements are point source National Pollutant Discharge Elimination (NPDES) permits, water treatment system upgrades or CWA Section 401 certification conditions for hydroelectric projects that address all of the significant pollutant sources on a water body. The measures and conditions are expected to result in attainment of water quality standards. When these control measures are in place, the waterbodies will be delisted from Category 5: 303(d) and placed in Category 4B: Water Quality Limited Other Control Measures in Place with the delisting action noted as DELISTING\_4B in the reporting spreadsheet.

### **Pollutant does not cause impairment**

When data or information indicate that water body impairment is not being caused by pollutants, but rather pollution, the water can be delisted from Category 5: 303(d) and placed in Category 4C: Water Quality Limited but a pollutant does not cause the impairment. The delisting action is noted as DELISTING\_4C in the reporting spreadsheet. EPA defines a pollutant according to Section 502(6) of the Clean Water Act. In Oregon's 1998 assessment, DEQ placed waterbodies on the Category 5: 303(d) list based on observations that habitat modification and flow modification caused impairments of beneficial uses in those waters. Habitat modification listings were based on information indicating inadequate pool frequency and lack of large woody debris. Flow modification listings were based on inadequate flow to maintain in-stream water rights purchased by Oregon Department of Fish and Wildlife. However, EPA subsequently clarified that flow and habitat modification are pollution but not pollutants under the Clean Water Act. In 2002, ODEQ removed these waterbodies from the 303(d) list and placed them in Category 4C.

## **New data or information shows water quality standards are attained**

A water body is delisted and assigned to Category 2: Attaining if there is sufficient information from the current assessment to evaluate the pollutant or parameter and the information demonstrates that currently applicable water quality standards are being met according to the parameter specific delisting method. Data used for delisting must meet data quality requirements as described in the QA/QC requirements and parameter specific "Data Requirements" sections. The delisting action is noted as WQS\_NEW\_DATA in the reporting spreadsheet. For watershed assessment units, all monitoring locations and individual streams within the unit must be attaining for the entire AU to be delisted.

For watershed assessment units, DEQ tracks AUs status as a sum of the assessed streams within a watershed unit. To delist a watershed assessment unit, all impaired streams within that assessment unit must be delisted through the delisting process.

## **Delisting – statistical methods**

Waters shall be considered for delisting if data in the period of record meet the minimum data requirement to delist. Unless specified as part of the water quality standard or indicated in the [parameter specific assessment methodologies](#), the minimum sample size is 18 for aquatic life toxic substances, 15 for conventional pollutants, and five for human health toxics criteria. DEQ will evaluate samples representative of the conditions in the water body as specified in [Evaluating data and information](#).

## **Aquatic Life: toxic substances and conventional pollutants**

Waters will be removed from the section 303(d) list if the number of sample excursions above the numeric criterion thresholds supports rejection of the null hypothesis as presented in Table 10 indicating that the water quality criteria are attaining. The critical proportion for toxic substances is 5% of samples with 90% confidence. The critical proportion of conventional pollutants is 10% of samples with 90% confidence. The number of sample excursions correlating to an impairment conclusion per sample size are shown in Table 10 and Table 11.

### Critical values for delisting chronic toxic substances

- Null Hypothesis: Actual exceedance proportion is  $>5\%$
- Alternate hypothesis: Actual exceedance proportion is  $\leq 5\%$
- Minimum confidence level is 90%
- A minimum sample size of 18 is required

Table 10. Maximum number of sample excursions to delist as impaired for toxic substances

Sample Size	Delist if excursions $\leq$ :
18-22	1
23-35	2
36-49	3
50-63	4
64-78	5
79-94	6
95-109	7
110-125	8
126-141	9
142-158	10
159-174	11
175-191	12
192-200	13
$>200$	See <a href="#">generalized delisting formula</a> to calculate the number of excursions

### Critical values for delisting conventional pollutants

- Null hypothesis: Actual exceedance proportion is  $>10\%$
- Alternate hypothesis: Actual exceedance proportion is  $\leq 10\%$
- Minimum confidence level is 90%

- A minimum sample size of 15 is required

Table 11. Maximum number of sample excursions to delist as impaired for conventional pollutants

Sample Size	Delist if excursions $\leq$ :
15	1
16-18	2
19-25	3
26-32	4
33-40	5
41-47	6
48-55	7
56-63	8
64-71	9
72-79	10
80-88	11
89-96	12
97-104	13
105-113	14
114-121	15
122-130	16
131-138	17
139-147	18
148-156	19
157-164	20
165-173	21
174-182	22
183-191	23
192-199	24
$\geq 200$	See generalized <a href="#">binomial delisting formula</a> to calculate the number of excursions



## Generalized binomial delisting procedure

For sample sizes greater than 200, calculate  $\alpha$  from the left tail probability of the cumulative binomial distribution:

$$\alpha = 1 - \text{Excel}^{\text{®}} \text{ Function BINOMDIST } (ka-1, n, p1, \text{TRUE})$$

Where,

n = the number of samples,

Ka = maximum number of measured exceedances to determine a water body is attaining, and should be removed from the 303(d) list, and

p1 = unacceptable exceedance proportion.

BINOMDIST( ) is an Excel software function that returns cumulative left tail binomial probabilities.

The number of excursions required to delist is the value of ka, where the initial value of ka=1 for n=10. ka is incrementally increased by 1, until  $1-\alpha \leq 0.90$ .

The critical number of excursions for delisting can be calculated in R Statistical Software **Error! Bookmark not defined.** by using the following equations:

For Toxics:

$$x = \text{ifelse}(n < 18, \text{NA\_real}, \text{qbinom}(0.90, n, 0.05, \text{lower.tail} = \text{TRUE}) - 1)$$

For Conventional Parameters:

$$x = \text{ifelse}(n < 15, \text{NA\_real}, \text{qbinom}(0.90, n, 0.10, \text{lower.tail} = \text{TRUE}) - 1)$$

Where, n = the number of samples,

x = critical excursion value

## Delisting for dissolved oxygen

Dissolved oxygen specific delisting requirements can be found in the parameter-specific assessment methods in [Assessment – Dissolved Oxygen](#).

## Delisting for Temperature

Temperature specific delisting requirements can be found in the parameter-specific assessment methods in [Assessment – Temperature](#).

## Delisting for human health: toxic substances

Numeric water quality criteria for the protection of human health from toxic substances will be evaluated as the geometric mean of the observed samples of pollutant concentration. Waters will be removed from the 303(d) list if the geometric mean of samples representative of the water body are less than the numeric criterion threshold.

## **Public review**

Public comment for this draft methodology will be open March 25, 2025, for a 45-day comment period. Opportunity to comment on the draft methodology will also be provided at the fall 2025 Environmental Quality Commission meeting.

DEQ will review the submitted public comments and make changes as appropriate. DEQ will prepare a document summarizing public comments and agency response to those comments.

## **Submittal of Oregon's Integrated Report and 303(d) list**

EPA developed a national online data system, The Assessment, Total Maximum Daily Load Tracking and Implementation System ([ATTAINS](#)) and requires states to report Integrated Report conclusions into this system. ATTAINS is a publicly accessible database that standardizes reporting systems used by different states, tribes and territories. DEQ will submit Oregon's Section 303(d) list of Category 5: Water quality limited waters needing a TMDL to US EPA Region 10 through ATTAINS for review and approval. Along with the Section 303(d) list, DEQ will also submit to EPA the Integrated Report, response to comments, the applicable Assessment Methodology and a TMDL prioritization schedule. Only waterbodies in the Category 5: Water quality limited waters needing a TMDL (Section 303(d) list) are subject to EPA's approval.

# Assessment methodologies for specific pollutants or parameters

For the Integrated Report, DEQ evaluates water quality data and information to determine if the water quality standards set out in Oregon Administrative Rules Chapter 340 Division 41 (OAR 340-041) are being met. The following sections describe specific methods for assessment of groups or individual parameters/pollutants, narrative and numeric criteria, and designated uses. The water quality standard citation from Oregon Administrative Rules is given for each parameter. Each parameter and criterion is evaluated independently. Data are evaluated for each assessment unit, and an overall status is assigned to the water body assessment unit segment based on the available site monitoring data and information. Data are not available for all parameters in each water body. Therefore, Category 1 indicating all designated uses are supported and all criteria are met is not used for Oregon's assessment.

The methods for the Integrated Report evaluation build on, update, and replace methodologies used in past water quality assessments for 303(d) and 305(b) reporting. Results from previous assessments remain valid and are incorporated in each new Integrated Report unless updated with new data or information or revised assessment protocols. All updated protocols for pollutants or parameters applied for the 2024 Integrated Report are described in the following sections.

## Assessment - aquatic weeds or algae

PARAMETER	BENEFICIAL USE
Aquatic Weeds	Boating, Aesthetic Quality
Algae	Aesthetic Quality
Harmful algal blooms	Domestic Water Supply, Irrigation, Livestock Watering, Water Contact Recreation

## Water quality standards

[340-041-0007](#)

### Statewide Narrative Criteria

(9) The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or that are injurious to health, recreation, or industry may not be allowed;

## Assessment methodology

This method will be used to implement the statewide narrative criterion that prohibits deleterious or injurious effects on aquatic and human beneficial uses from biological growths and will be applied specifically to aquatic weeds or algae. The growth of aquatic weeds or algae does not in itself indicate deleterious or injurious effects on beneficial uses. Nor does it identify whether a pollutant or which pollutant is causing the impairment and should be addressed by point source or other controls through a Total Maximum Daily Load. This assessment protocol identifies the indicators used to determine that beneficial uses have been negatively affected by the presence of excess algal or weed growth.

## Data evaluation

Information on aquatic weeds are obtained from the [Oregon Invasive Species Hotline](#) and assessed based on the Oregon Department of Agriculture classification system.

Recreational health HABs information and data are obtained from the [Oregon Health Authority Cyanobacteria Advisory Archive](#) and assessed based on duration, frequency and magnitude of the bloom.

Drinking water cyanotoxin data is pulled from various organizations stored in DEQ's AWQMS database.

## Data requirements

Information, numeric HABs data or/and public health advisories.

## Assignment of Assessment Category

### Category 5: water quality limited, TMDL needed (303(d) list)

- **Aquatic weeds:** Documented reports of excessive growths of invasive, non-native aquatic plants that dominate the assemblage in a water body and have a harmful effect on fish or aquatic life or are injurious to health, recreation, or industry. Plants include aquatic species on the Oregon Department of Agriculture Noxious Weed Policy and Classification System designated as "A", "B", or "T" weeds or those covered by a quarantine in OAR 603-052-1200.
- **Algae:** Documented evidence that algae, including periphyton (attached algae) or phytoplankton (floating algae), are causing other standards to be exceeded (e.g., pH, chlorophyll a, or dissolved oxygen) or impairing a beneficial use
- **Harmful algal blooms (HABs):**
  - Recreational Uses:** Any public health advisory issued by the Oregon Health Authority, in conjunction with other federal, state, county, city or local agencies, within the data window which;
    - (1) is a permanent health advisory; **OR**
    - (2) has reoccurred for two or more times in the IR data window, but does not have associated cyanotoxin data (advisory issued with 2021 OHA guidance<sup>1</sup>); **OR**
    - (3) a single advisory issued with 2024 OHA guidelines which require cyanotoxin data above recreational use values<sup>2</sup>; **OR**
  - Drinking Water uses:**
    - (4) finished water exceeds EPA Drinking Water Health Advisories for Cyanotoxins for vulnerable groups<sup>3</sup> **AND** the waterbody is the source of water for a public water system; **OR**
    - (5) raw source water exceeds EPA Drinking Water Health Advisories for Cyanotoxins for vulnerable groups **AND** the waterbody is the source of water for a public water system **AND** the Public Water System operator reports that cyanotoxins are causing operational difficulty; **OR**

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<sup>1</sup> [OHA Oregon Cyanobacteria Harmful Algae Bloom Surveillance \(CHABS\) Program ADVISORY GUIDELINES](#) – August 2021

<sup>2</sup> [OHA Oregon Cyanobacteria Harmful Algae Bloom Surveillance \(CHABS\) Program ADVISORY GUIDELINES](#) – May 2024

<sup>3</sup> [EPA Drinking Water Health Advisories for Cyanotoxins](#)

**Livestock watering uses:**

- (6) where there is a livestock watering use and state and local partners confirm a HAB related animal illness or death occurred.

**Category 4: water quality limited, TMDL not needed**

- **Category 4A** - TMDLs for specific pollutants have been completed and approved to address the excessive or harmful aquatic weed or algae growth in a water body.
- **Category 4B** - Another control mechanism such as an aquatic vegetation management plan is in place and is being implemented to control plant growth, including measures to mitigate harmful algal blooms.
- **Category 4C** - Adequate information indicates that the algae or weed growth is not due to pollutants or is a natural condition.

**Category 3: insufficient data**

Available data or information for the water body are not sufficient to determine if the narrative criterion is being met.

**Category 3B: insufficient data; potential concern**

**Harmful algae blooms**

Single season public health advisory issued by the Oregon Health Authority **AND** no associated toxin data" (advisory issued before 2024 OHA guidance<sup>4</sup> was in effect)

OHA issued a precautionary advisory based on the current 2024 guidance.

If raw source water exceeds EPA Drinking Water Health Advisories levels for Cyanotoxins for vulnerable groups for waterbodies with known drinking water intakes **AND** no operational difficulty are reported

**Category 2: attaining**

Not applicable.

**Delisting – new data:**

- **Harmful algae blooms:** Water body must be free of an OHA recreational advisory for the IR data window with at least three years of critical period cyanotoxin data below OHA advisory levels.

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<sup>4</sup>[OHA Oregon Cyanobacteria Harmful Algae Bloom Surveillance \(CHABS\) Program ADVISORY GUIDELINES](#)  
– August 2021

- For HABs-related impairments to drinking water beneficial uses, DEQ will work with partners to ensure the underlying causes of the bloom in the source water have been reduced and that all cyanotoxin data from finished water in the IR data window are below EPA Drinking Water Health Advisories for Cyanotoxins for vulnerable groups.
- **Aquatic weeds and algae:** Water body must be free of excessive growth of aquatic weeds and algae for more than three consecutive seasons and have supplemental data and information (photos) for at least two of those seasons.

## Assessment - bacteria

PARAMETER	BENEFICIAL USE
<b>E. Coli</b>	Water Contact Recreation – Freshwater
<b>Enterococcus</b>	Water Contact Recreation – Coastal Water
<b>Fecal Coliform</b>	Fishing – Shellfish Harvesting

## Water quality standards

### [340-041-0009](#)

#### **Bacteria**

- (1) Numeric Criteria: Organisms commonly associated with fecal sources may not exceed the criteria in subsections (a)-(c) of this section:
  - (a) Freshwater contact recreation:
    - (A) A 90-day geometric mean of 126 E. coli organisms per 100 mL;
    - (B) No single sample may exceed 406 E. coli organisms per 100 mL.
  - (b) Coastal water contact recreation, as designated in OAR 340-041-0101, 340-041-220, 340-041-230, 340-041-300 and 340-041-0320:
    - (A) A 90-day geometric mean of 35 enterococcus organisms per 100 mL;
    - (B) Not more than ten percent of the samples may exceed 130 organisms per 100 mL.
  - (c) Shellfish harvesting, as designated in 340-041-0101, 340-041-220, 340-041-230, 340-041-300 and 340-041-0320:
    - (A) A fecal coliform median concentration of 14 organisms per 100 mL;
    - (B) Not more than ten percent of the samples may exceed 43 organisms per 100 mL.
- (2) A minimum of five samples in a 90-day period is required for calculating the criteria in sections (1)(a)(A) and (1)(b)(A) and (B) of this rule.
- (3) Raw Sewage Prohibition: No sewage may be discharged into or in any other manner be allowed to enter the waters of the State, unless such sewage has been treated in a manner the Department approved or otherwise allowed by these rules.
- (4) Animal Waste: Runoff contaminated with domesticated animal wastes must be minimized and treated to the maximum extent practicable before it is allowed to enter waters of the State.
- (5) Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing, or shellfish propagation, or otherwise injurious to public health may not be allowed.



## Assessment method

Bacteria related to fecal sources can impair beneficial uses of water for recreation and fishing use by shellfish harvesting. Oregon has established water quality standards for relevant bacterial indicators for specific designated uses and various water types (Table 12).

As salinity increases in estuarine waters, *E. coli* tend to die-off while enterococci remain viable. When data and information for the applicable bacterial indicator in a marine, estuarine, or freshwater location are available, the corresponding criteria are applied to assess each use designated for the water.

Table 12. Bacterial indicators and criteria

Designated use	Bacterial indicator	Criteria metric (CFU/100 mL)	Threshold Value (CFU/100 mL)
Freshwater contact recreation	<i>E. coli</i>	Geometric mean $\leq 126$	No more than 10% $> 406^*$
Coastal water contact recreation	Enterococcus	Geometric mean $\leq 35$	No more than 10% $> 130$
Shellfish harvesting	Fecal coliform	Median $\leq 14$	No more than 10% $> 43$

## Data evaluation

### Designated uses

Water contact recreation is broadly designated in Oregon. Unless designated otherwise, the *E. coli* criteria are applicable in all freshwaters throughout the state to protect this use. Coastal water contact recreation is designated for parts of estuaries and Oregon's territorial marine waters up to three miles offshore. For these more saline waters, enterococcus is the applicable indicator of fecal contamination. Starting in the 2024 IR cycle, for freshwater streams that flow over beaches directly into the ocean, enterococcus can be used as a bacterial indicator to assess the support of the freshwater contact recreation use when there is insufficient *E. coli* data in an assessment unit (Figure 6). When enterococcus is used as the indicator for freshwater contact recreation, assignment of assessment categories will follow the coastal contact recreation method. Magnitude, duration



Figure 6. Example of freshwater streams that cross the beaches and the extent of applicability of this update shown in yellow

and frequency are evaluated through a 90-day geometric mean greater than 35 Enterococci organisms per 100 mL or more than 10% of all samples within the IR data window exceed 130 enterococci organisms per 100 mL according to the exact binomial test. If both indicators have sufficient data in an assessment unit, E. coli will be used for evaluating freshwater contact recreation use and enterococcus data will not be included in the assessment.

Oregon's bacteria standards include maps of areas designated for coastal contact recreation where the enterococcus criteria are applicable in OAR 340-041-0101 (Columbia River), 340-041-0220 (Mid-Coast Basin), 340-041-0230 (North Coast Basin), 340-041-0300 (South Coast Basin) and 340-041-0320 (Umpqua Basin). For estuaries in the Rogue Basin, E. coli criteria are the applicable indicator.

Shellfish harvesting is a designated use in marine waters and in estuarine coastal areas shown on the maps in OAR 340-041-0101 (Columbia River), 340-041-0220 (Mid-Coast Basin), 340-041-0230 (North Coast Basin), 340-041-0300 (South Coast Basin) and 340-041-0320 (Umpqua Basin). The fecal coliform criteria are applicable to protect this use. Areas designated for shellfish harvesting and coastal contact recreation frequently overlap in the coastal basins. When these uses overlap, both indicators and criteria are in effect and are assessed separately by beneficial use.

For reference, the information for designated uses mapped in OAR 340-041-0101 to 340-041-0320 are also depicted in water quality standards layer on the [IR web map](#).

DEQ will assess existing E.coli data to make the determination of impairment or attainment for the recreational use for those freshwater assessment units previously identified as impaired for fecal coliform. This methodology will apply only to those waterbodies where current E.coli data exists. Additional E. coli monitoring will be required to remove the fecal coliform listing for those fresh waters previously identified as Category 5 for fecal coliforms where no current E. coli data exists.

## **Data requirements**

Data from sampling sites for bacterial indicators are evaluated using the appropriate criteria for the designated use. Numeric results reported down at or below the quantitation Limit, ½ of the value of the lowest QL used to calculate the geometric mean or median.

A 90-day geometric mean shall be calculated for any rolling period of 90 days with at least five samples available by taking the nth root of the product of the concentration of each sample collected within a 90-day period for which  $n \geq 5$ .

$$GM90 = \sqrt[n]{x_1 x_2 \dots x_n}$$

Where:

n = number of samples

xn = bacteria sample concentration, as number of organisms per 100 mL

For fecal coliform, the median sample concentration shall be calculated for the entire period of record once there are at least five samples available.

## **Assignment of assessment category**

### **Water contact recreation – freshwater**

#### **Category 5: water quality limited, TMDL needed (303(d) list)**

Any 90-day geometric mean greater than 126 E. coli organisms per 100 mL **OR** more than 10% of all samples within the IR data window exceed 406 E. coli organisms per 100 mL according to the exact binomial test, based on the minimum sample size identified in the binomial table for listing Table 7.

#### **Category 4: water quality limited, TMDL not needed**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant leading to attainment of water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

#### **Category 3: insufficient data**

Insufficient data are available for evaluation of a 90-day geomean (defined in Data Requirements section above), and the IR window contains less than eight samples with no single sample greater than 406 E. coli organisms per 100 mL.

#### **Category 3B: insufficient data; potential concern**

Insufficient data are available for evaluation of a 90-day geomean (defined in Data Requirements section above), and the IR window contains less than eight samples with one or more samples greater than 406 E. coli organisms per 100 mL.

## **Category 2: attaining**

All 90-day geometric means are less than or equal to 126 E. coli organisms per 100 mL, **AND/OR** the IR window contains eight or more samples (as outlined in the [Determining Attainment](#) section) and  $\leq 10\%$  of all samples exceed 406 E. coli organisms per 100 mL according to the exact binomial test.

## **Water contact recreation – coastal water**

### **Category 5: water quality limited, TMDL needed (303(d) list)**

A 90-day geometric mean greater than 35 Enterococci organisms per 100 mL **OR** more than 10% of all samples within the IR data window exceed 130 enterococci organisms per 100 mL according to the exact binomial test, based on the minimum sample size identified in the binomial table for listing Table 7.

### **Category 4: water quality limited, TMDL not needed**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

### **Category 3: insufficient data**

Insufficient data are available for evaluation of a 90-day geomean (defined in Data Requirements section above), and the IR window contains less than eight samples with no single sample greater than 130 Enterococci organisms per 100 mL.

### **Category 3B: insufficient data; potential concern**

Insufficient data are available for evaluation of a 90-day geomean (defined in Data Requirements section above), and the IR window contains less than eight samples with one or more samples exceeding 130 Enterococci organisms per 100 mL **OR** the Oregon Beach Monitoring Program has issued one or more advisories based on monitoring results for enterococci, not including precautionary advisories.

## **Category 2: attaining**

If there is sufficient data to calculate a geometric mean all 90-day geometric means are less than or equal to 35 enterococci organisms per 100 mL, **AND** the IR window contains eight or more samples (as outlined in the [Determining Attainment](#) section) and  $\leq 10\%$  of all samples exceed 130 enterococci organisms per 100 mL according to the exact binomial test.

If there is insufficient data to calculate a geometric mean, and the IR window contains eight or more samples (as outlined in the [Determining Attainment](#) section) and  $\leq 10\%$  of all samples exceed 130 enterococci organisms per 100 mL according to the exact binomial test

## **Fishing - shellfish harvesting**

### **Category 5: water quality limited, TMDL needed (303(d) list)**

A median fecal coliform concentration greater than 14 fecal coliform organisms per 100 mL with a minimum of five samples, **OR** more than 10% of all samples exceed 43 fecal coliform organisms per 100 mL with a minimum of 5 samples using the 10% raw score method.

### **Category 4: water quality limited, TMDL not needed.**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

### **Category 3: insufficient data**

Less than eight samples are available for evaluation (as outlined in the [Determining Attainment](#) section), and no single sample is greater than 43 fecal coliform organisms per 100 mL.

### **Category 3B: insufficient data; potential concern**

Less than eight samples are available for evaluation (as outlined in the [Determining Attainment](#) section), but one sample is greater than 43 fecal coliform organisms per 100 mL.

## **Category 2: attaining**

A median fecal coliform concentration less than or equal to 14 fecal coliform organisms per 100 mL based on a minimum of eight samples (as outlined in the [Determining Attainment](#) section); **AND** no more than 10% of all samples are greater than 43 fecal coliform organisms per 100 mL, with a minimum of five samples using the 10% raw score method.

## **Delisting – new data**

Assessment units with sufficient data in the data window to meet the [Delisting – statistical methods](#) requirements for conventional pollutants and all available geometric means are less than the critical metric value (Table 12).

## Assessment – biocriteria freshwater

PARAMETER	BENEFICIAL USE
Biocriteria	Fish and Aquatic Life - Freshwater

## Water quality standards

### 340-041-0011

#### **Biocriteria**

Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.

## Assessment methodology - freshwater

[Detrimental changes in resident biological](#) communities are a form of [pollution](#). [EPA guidance](#) recommends using biological community assessments as an indicator for aquatic life beneficial use support. DEQ uses the method described here to implement Oregon’s narrative standard for biocriteria in freshwater by assessing the conditions in biological communities. However, the assessment methodology does not identify specific pollutants as potential causes of impairment, which is outside of the scope of the methodology. EPA guidance recommends listing waters with aquatic use impairments as Category 5: 303(d) even if the [pollutant is not known](#).

This method is based on biological community information for freshwater macroinvertebrates at Reference sites throughout Oregon. Freshwater macroinvertebrates include insects, crustaceans, snails, clams, worms, mites, etc. DEQ used updated procedures to identify sites that are least disturbed by anthropogenic activities and uses these sites as Reference sites. DEQ’s updated biological assessment tools use information from these Reference and Most Disturbed sites coupled with environmental predictors to set expectations of intact benthic communities in the waters<sup>5</sup>. The method applies numeric benchmarks to evaluate the integrity of aquatic biological communities.

## Data evaluation

This methodology has been revised for the 2026 Integrated Report, a detailed description of changes made and rationale decisions made is available in the accompanying [Technical Support Document](#). DEQ will use two indexes to assess biological integrity of macroinvertebrate

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<sup>5</sup> Stoddard, J. L., Larsen, D. P., Hawkins, C. P., Johnson, R. K., & Norris, R. H. (2006). [Setting expectations for the ecological condition of streams: the concept of reference condition](#). Ecological applications, 16(4), 1267-1276.

communities in wadeable streams (typically smaller streams that do not require a boat for sampling). First, DEQ's updated Observed over Expected (O/E) predictive model uses natural environment predictors (not influenced by human disturbance) to determine the most appropriate reference sites to set expected taxa at a sample site. The reporting index O/E, which is the ratio of **observed** taxa at sample site to taxa **expected** if the site was in [reference condition](#), represents loss of native expected reference taxa richness. Second, DEQ's new predictive Multi Metric Index (MMI) uses Reference and Most Disturbed sites to characterize ecological structure and function based on four individual metrics used in the index. Both models cover all of Oregon except for the Northern Basin and Range ecoregion (80) in the southeast corner of the state due to lack of applicable Reference sites. Waterbodies in this region will be assessed by best professional judgement until a bioassessment tool for this region is developed.

DEQ will use numerical assessment benchmarks for each index to interpret the narrative biocriteria water quality standard. The benchmarks are statistical-based percentiles of index values for Reference calibration samples used to build the models, with the 10th percentile representing the impairment benchmark and the 25th representing the attainment benchmark.

### **Linking assessment benchmarks to ecological condition**

DEQ's [OAR 340-041-0002](#) defines "Ecological Integrity" as "the summation of chemical, physical, and biological integrity capable of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region." In DEQ's previous freshwater biocriteria methodology, taxa loss (derived from O/E v1.0) was the key attribute used to describe changes in macroinvertebrate assemblages. A critique of this method was that there are aspects of ecological integrity, particularly ecological function, that are not well described by taxa loss alone. The use of two models together in this methodology update describes five aspects of macroinvertebrate assemblage composition and structure, is an important improvement on DEQ's previous approach.

While O/E and MMI models are derived using biologically based metrics to describe ecological condition in a variety of ways, it is challenging to interpret the resulting numeric output in ecological terms. The BCG is a conceptual model describing how ecological attributes change in response to human disturbance<sup>6</sup>. Though fundamentally qualitative, the stressor response curve generated in the construction of the BCG offers a practical way to interpret the numeric

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<sup>6</sup> Stamp, J. 2022. Calibration of the Biological Condition Gradient (BCG) for Macroinvertebrate Assemblages in Freshwater Wadeable Streams in the Pacific Northwest Maritime Region of Oregon and Washington. Prepared for US EPA Office of Water and US EPA Region 10.



assessment benchmarks for O/E and MMI models in ecological terms. Linking the O/E and MMI indexes to the BCG narrative helps identify the changes in ecological condition the attainment and impairment benchmarks represent. In other words, relating O/E and MMI scores to the BCG can provide information on the ecological consequences (what is lost) by falling below a certain benchmark. To demonstrate this, O/E and MMI sample scores across all disturbance gradients were plotted along with their associated BCG categories between 2-6, each of which represents a narrative description of ecological condition (Figure 7).

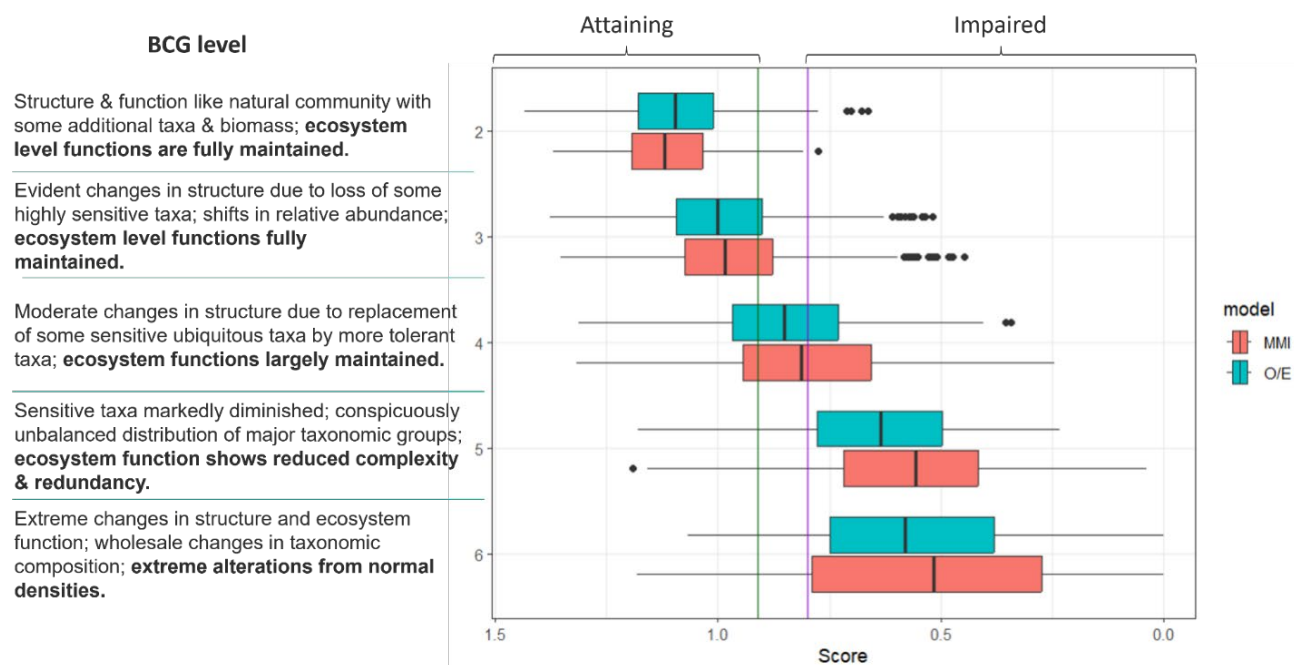


Figure 7. Box plots of O/E and MMI scores for all sites in DEQ's AWQMS database linked to the narrative levels of the Biological Condition Gradient index for western Oregon.

The benchmarks for the two indexes will be used as multiple lines of evidence via the hybrid assessment framework (Figure 8). In this approach, the O/E and MMI assessment benchmarks are used in conjunction to classify waterbody status. DEQ's previous biocriteria assessment methodology relied on a single macroinvertebrate index of biotic condition (O/E v1.0), which represents a single aspect of macroinvertebrate assemblage conditions (loss of expected Reference taxa richness). Incorporating the MMI adds an index that assesses conditions of four other aspects of assemblage composition and structure, providing a broader assessment of aquatic life use support. In addition, the hybrid approach requires attainment and impairment decisions to be confirmed by both indices, which reduces the potential error in assessment conclusions based on an individual index.

When both MMI and O/E index values are above the attaining assessment benchmarks, the waterbody will be classified as attaining (Category 2). When both index values are below the

impairment assessment benchmark, the waterbody will be classified as impaired (Category 5). In cases when at least one index value falls between the assessment benchmarks but neither falls below the impairment benchmark, the waterbody will be classified in “Category 3C: insufficient data; non-Reference condition: Biocriteria scores differ from Reference condition, but are not classified as impaired”. This sub-category was created in the [2020 IR](#) to identify waterbodies with minimally disturbed biological condition from those units that are on the cusp of impairment, or in what is commonly considered “fair” condition in bioassessment. In cases where one index value falls below the assessment benchmark for impairment and the other index value does not, DEQ will classify the waterbody as “Category 3B: insufficient data; potential concern” and will prioritize the waterbody for follow up monitoring. Those waterbodies that lack sufficient data quality or are outside of the index calibration area will be assigned “Category 3: Insufficient data to determine whether a designated use is supported”.

- Category 5 – Both indexes indicate impairment
- Category 2 – Both indexes indicate attainment
- Category 3C: insufficient data; non-Reference condition, but not impaired – This category is used to classify waterbodies that are closer to attainment than impairment
- Category 3B: Potential Concern – This category is used to classify waterbodies where one model indicates impairment and the other does not. It is used to indicate uncertainty in the assessment and recommendation for follow up monitoring

Hybrid Assessment Framework		O/E v2.0		
		<i>Biological impact &amp; deviation from natural background ≤ 0.79</i>	<i>Differs from reference, but not impaired &gt;0.79 and ≤ 0.91</i>	<i>Biological impact does not deviate from natural background &gt; 0.91</i>
MMI v1.0	<i>Biological impact &amp; deviation from natural background MMI score ≤0.81</i>	Impaired – Cat 5	Category 3B – Potential Concern	
	<i>Differs from reference, but not impaired &gt;0.81 and ≤ 0.90</i>	Category 3B – Potential Concern	Cat 3C – differs from reference, but is not impaired	
	<i>Biological impact does not deviate from natural background &gt; 0.90</i>		Cat 2 - Attaining	

Figure 8. Hybrid assessment framework for freshwater biocriteria that combines multiple lines of evidence to determine assessment category.

## Data requirements

For DEQ to evaluate data using this assessment methodology, the data must meet the following specifications and data quality requirements:

- At least two samples are available at the assessment unit level for river and stream units or monitoring location level for watershed assessment units.
- Samples must be collected during or after 1998 to be comparable to the Reference site data used to build the models,
- Samples must be collected within the model index period of June 1 through October 15,
- Samples must be collected using standard field methods and identified to appropriate taxonomic levels as described in the [DEQ Mode of Operations Manual](#) or equivalent protocols used throughout the Pacific Northwest,
- Samples are collected from wadeable streams,
- Samples are collected from riffle habitats or using transect methods (multi-habitat samples that have been shown to be equivalent to riffle samples),
- Samples must contain a total abundance greater than 300 organisms,
- Waterbodies must be similar enough to the Reference population (examples outliers excluded from routine use of O/E and MMI indexes include all large (non-wadeable) rivers, sites in ecoregion 80 and glacier runoff dominated streams). This may be determined by best professional judgment of assessment and biological monitoring staff.

Data from macroinvertebrate samples collected by organizations other than DEQ may be considered for the assessment and will be evaluated using the DEQ's bioassessment tools if all DEQ data quality objectives, file formats, and taxonomic consistency are acceptable.

An average index value will be calculated for all valid samples in an assessment unit or station in a watershed assessment unit for the period of record. The average value will be used for comparison to the applicable assessment benchmark.

## Other approaches to assess biological integrity in freshwater

While this methodology is DEQ's preferred approach and provides the most robust and contemporary method for assessing biological integrity in smaller, wadeable streams and rivers, other approaches may be appropriate and used for specific cases and data sets. For example, in studies examining the effects in non-wadeable rivers and/or of point-sources, study designs may look at upstream-downstream changes in macroinvertebrate community composition and function.

While macroinvertebrates are the most commonly studied community, other aquatic communities such as fish and algae are equally valid for assessing the biological integrity of freshwater systems. At this time, DEQ does not have MMIs or predictive models for fish or algal communities that are routinely used. However, several well developed MMIs exist for these communities and may be considered suitable. In addition, metrics of community composition and function may be used in certain study designs, especially in assessing point-source impacts.

These approaches are useful to study both wadeable and larger, non-wadeable systems. DEQ will determine on a case-by-case basis if the data quality of such studies is sufficient to use for assessment purposes.

DEQ may consider alternative approaches to identifying impairment to macroinvertebrate communities or, if available, may assess data from other aquatic communities (e.g., fish, algae). DEQ's determination will consider metrics or indexes representing community composition and/or function based on taxonomic count data. The data must be supported by supplementary materials outlining field and laboratory procedures as well as quality assurance plans. DEQ's aquatic ecologists will review the submitted data and apply appropriate published indexes if at all possible, or alternatively use standardized assessment techniques to determine if the data identifies impaired biological conditions sufficient for Category 5 assignment.

## **Assignment of assessment category**

Following the assessment flowchart (Figure 9) index scores will be compared to assessment benchmarks and assigned categories based on the hybrid framework.

### **Category 5: water quality limited, TMDL needed (303(d) list)**

Waterbodies with 2 or more macroinvertebrate samples that meets the data requirements and the average MMI and O/E index values are less than or equal to both the impairment assessment benchmark values.

### **Category 4: water quality limited, TMDL not needed**

Where DEQ has information relating specific pollutants to impaired biological conditions in the water body, a TMDL can be developed. Where data are available for specific pollutants identified as causing detrimental changes to biological communities, and TMDLs have been approved with load allocations for all the pollutants, the water body will be placed in Category 4A if no additional TMDLs are needed. Waterbodies will also be placed in Category 4C for biological criteria if adequate information is available to indicate that detrimental changes to biological communities are due to pollution and not a pollutant.

### **Category 3C: insufficient data; non-Reference condition**

Assessment units identified as Category 3C; insufficient data; non-Reference condition refer to assessment units that are neither impaired nor equivalent to Reference conditions and may reflect minimal disturbance. These are likely to be the sites that may be the easiest to reverse the impairment through restoration and best management practices in the watershed.

Waterbodies will be assigned this category when the average of at least one index value falls between the assessment benchmarks for that index but neither falls below the impairment benchmark.

### **Category 3B: insufficient data; potential concern**

The average of one index value is less than or equal to the impairment assessment benchmark and the average of the other index value is greater than the impairment benchmark. Waterbodies in this Category will be recommended for additional monitoring due to the uncertainty to attainment status.

### **Category 3: insufficient data to determine whether a designated use is supported**

Waterbodies with just one sample, are not adequately represented by the population of Reference sites, or have low counts less than 300 total abundance.

### **Category 2: Attaining**

Waterbodies with macroinvertebrate sampling data that meets the data requirements and both MMI and O/E index values are greater than the attainment assessment benchmarks.

## **Delisting – new data**

For the 2026 IR cycle, DEQ will assess all the high quality macroinvertebrate data in AWQMS going back to 2000 with this updated methodology. Existing biocriteria impairments will be removed from the 303(d) list when the assessment units are assigned Category 2, 3C or 3B with the rationale of new assessment methodology applied (Attains Code: WQS\_NEW\_ASMT\_METHOD).

For previous 303(d) listings based on a single sample, DEQ will not delist if both of the index values are below the 5th percentile of Reference calibration samples used in model development (O/E = 0.75 and MMI = 0.77). Previous 303(d) listings based on a single sample that have at least one index value > 5th percentile may be removed from the 303(d) list and placed in Category 3 (insufficient data) until data requirements are met for assessment using the updated methodology. DEQ will review these on a case-by-case basis and provide a detailed rationale for any proposed delistings.

After the 2026 IR cycle, waterbodies may be delisted for biocriteria based on multiple site sampling events showing results that are attaining benchmarks. A minimum of two samples in different years within the most recent 5-year time period must be collected in the same sampling season and assessment unit (or waterbody for watershed type units), with all samples showing results that attain appropriate benchmarks. These waters will be placed in Category 2: Attaining.

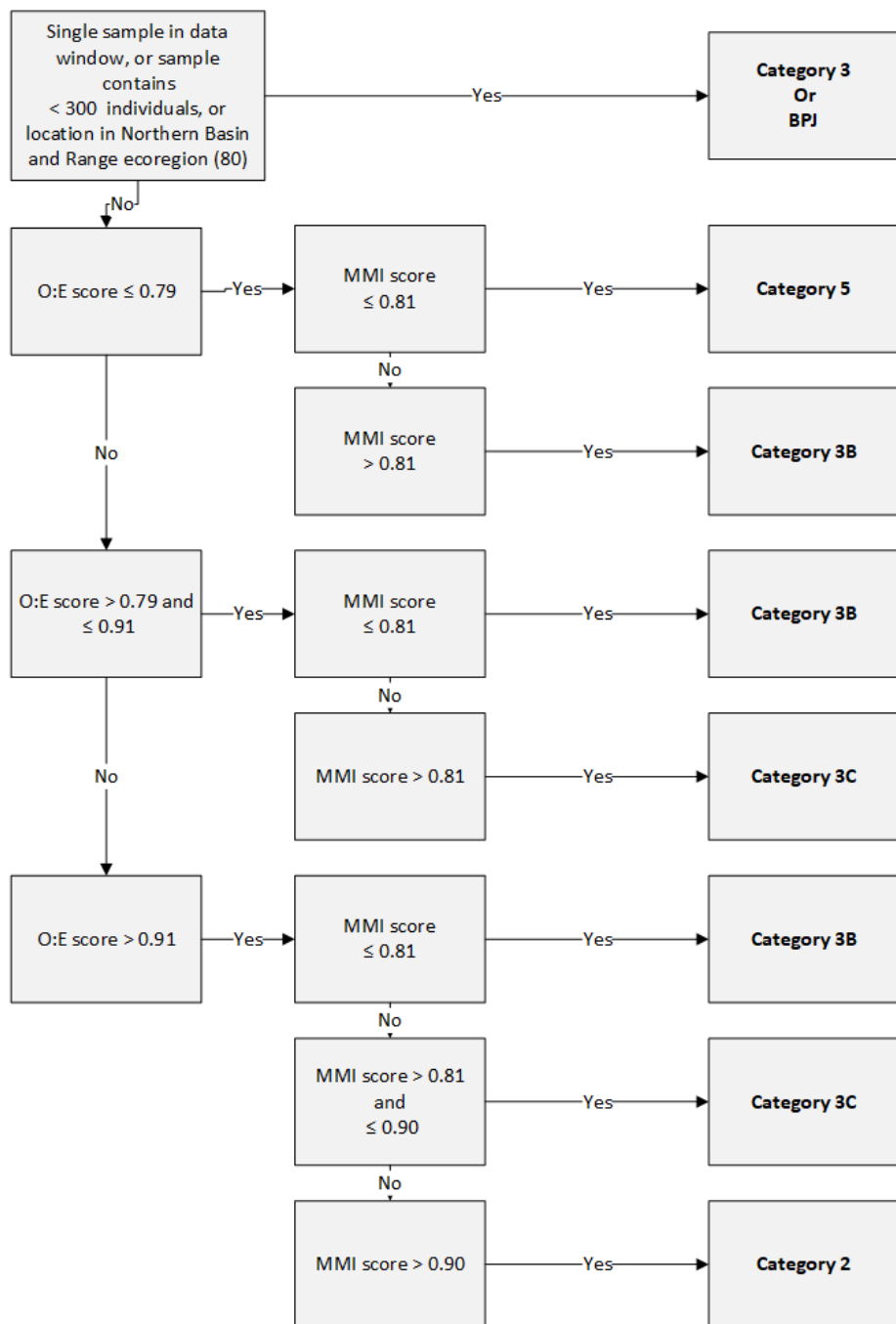


Figure 9. Assessment flowchart for freshwater biocriteria.

## Assessment – biocriteria marine waters – ocean acidification

PARAMETER	BENEFICIAL USE
Aragonite/Pteropod Shell Dissolution	Fish and Aquatic Life – Marine Waters

### Water quality standards

#### [340-041-0011](#)

##### **Biocriteria**

Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.

### Assessment methodology - Ocean Acidification in Marine waters

The ocean absorbs about 30% of the carbon dioxide (CO<sub>2</sub>) that is released into the atmosphere. As levels of atmospheric CO<sub>2</sub> increase from human activity [the amount of carbon dioxide absorbed by the ocean also increases](#). As excess CO<sub>2</sub> is absorbed by seawater, a series of chemical reactions result in changes in the carbonate chemistry, lowering the pH of ocean waters. This reduction in ocean pH, called ocean acidification, poses a threat to the integrity of marine species and food webs. Calcifying invertebrates appear to be particularly vulnerable<sup>7,8</sup>.

The goal of this methodology is to assess changing ocean conditions while also distinguishing between natural variability and long-term change using the existing biocriteria narrative water quality standards. Biological assessments provide direct measures of the cumulative response of the biological community to stressors and the beneficial use support status for aquatic life. As with DEQ's implementation of the biocriteria water quality standard for freshwater, this methodology requires understanding natural background conditions in the absence of stressors (reference conditions).

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<sup>7</sup> Barton, A., Hales, B., Waldbusser, G. G., Langdon, C., & Feely, R. A. (2012). [The Pacific oyster, \*Crassostrea gigas\*, shows negative correlation to naturally elevated carbon dioxide levels: Implications for near - term ocean acidification effects](#). *Limnology and oceanography*, 57(3), 698-710.

<sup>8</sup> Wootton, J. T., Pfister, C. A., & Forester, J. D. (2008). [Dynamic patterns and ecological impacts of declining ocean pH in a high-resolution multi-year dataset](#). *Proceedings of the National Academy of Sciences*, 105(48), 18848-18853.

The methodology applies a hybrid marine biocriteria assessment framework that allows for the assessment of biological and chemical metrics individually or in combination, depending on data availability. In this framework, biologically relevant numeric benchmarks are used to evaluate the degree of impact. The methodology does not by itself identify which pollutant should be addressed by point source or other controls through a Total Maximum Daily Load. U.S. Environmental Protection Agency guidance recommends listing waters with aquatic use impaired based directly on biological response as Category 5: 303(d) even if the pollutant is not known.

This is a new assessment methodology for use in the 2024 Integrated Report. An accompanying technical support document outlines the rationale, process, and approach DEQ is proposing to use to assess ocean acidification impacts for water quality assessment.

## Data evaluation

With assistance from a group of technical experts, DEQ developed an ocean acidification biocriteria assessment framework by identifying clearly defined lines of evidence and indicators to assess biological impacts related to ocean acidification. This ocean acidification methodology will assess biological impacts to calcifying zooplankton (*Limacina helicina*) in Oregon's territorial waters in response to changes in ocean carbonate chemistry. Pteropods (*L. helicina*, and others) are pelagic sea snails that rely on the biomineral aragonite ( $\text{CaCO}_3$ ) to form and maintain their shells. As a result, the degree of shell dissolution is closely linked with the saturation state of aragonite ( $\Omega_{\text{ar}}$ ) in the water column<sup>9</sup>. The strength of pteropods as a bioindicator for ocean acidification impact is based on global abundance and distribution, well documented stressor-specific sensitivity, ranging from evidence of exposure (e.g., shell dissolution), sublethal and lethal responses,<sup>10,11,12</sup> and role as an important prey group for ecologically and economically

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<sup>9</sup> Feely, R.A., Alin, S.R., Carter, B., Bednaršek, N., Hales, B., Chan, F., Hill, T.M., Gaylord, B., Sanford, E., Byrne, R.H. and Sabine, C.L., 2016. [Chemical and biological impacts of ocean acidification along the west coast of North America](#). *Estuarine, Coastal and Shelf Science*, 183, pp.260-270

<sup>10</sup> Lischka, S., Büdenbender, J., Boxhammer, T., & Riebesell, U. (2011). [Impact of ocean acidification and elevated temperatures on early juveniles of the polar shelled pteropod \*Limacina helicina\*: mortality, shell degradation, and shell growth](#). *Biogeosciences*, 8(4), 919-932.

<sup>11</sup> Bednaršek, N., Klinger, T., Harvey, C. J., Weisberg, S., McCabe, R. M., Feely, R. A., Newton, J., & Tolimieri, N. (2017). [New ocean, new needs: Application of pteropod shell dissolution as a biological indicator for marine resource management](#). *Ecological Indicators*, 76, 240–244.

<sup>12</sup> Lischka, S., & Riebesell, U. (2012). [Synergistic effects of ocean acidification and warming on overwintering pteropods in the Arctic](#). *Global Change Biology*, 18(12), 3517-3528.



important fishes, birds, and whale in some parts of the Pacific Ocean.<sup>13,14,15</sup> This robust and well-defined relationship between pteropod shell dissolution and aragonite ( $\Omega_{ar}$ ) allow biological measurements of severe shell dissolution and chemical measurements of aragonite ( $\Omega_{ar}$ ) to be the basis for biological impact assessment.<sup>16,17,18</sup>

## Data metrics and benchmarks

Aragonite saturation state ( $\Omega_{ar}$ ) will serve as the basis for the chemical metrics used in this assessment because it represents the best available science to measure OA stress to pteropods<sup>19</sup>. Procedures and core principles to quantify aragonite ( $\Omega_{ar}$ ) are outlined in McLaughlin et al. (2015), Dickson et al. (2007), and Dickson (2010).<sup>20,21,22</sup> These widely approved procedures describe the primary measurement parameters required to derive aragonite ( $\Omega_{ar}$ ), as well as the relative uncertainty associated with each combination of parameters<sup>20</sup>. As a derived value, uncertainty in aragonite ( $\Omega_{ar}$ ) calculation is a product of several sources of potential error, including independent measurements of multiple carbonate parameters as well as the thermodynamic constants used to relate carbonate species to one another. To address these

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<sup>13</sup> Armstrong, J. L., Boldt, J. L., Cross, A. D., Moss, J. H., Davis, N. D., Myers, K. W., Walker, R. V., Beauchamp, D. A., & Halderson, L. J. (2005). [Distribution, size, and interannual, seasonal and diel food habits of northern Gulf of Alaska juvenile pink salmon, \*Oncorhynchus gorbuscha\*](#). Deep Sea Research Part II: Topical Studies in Oceanography, 52(1), 247–265.

<sup>14</sup> Aydin, K. Y., McFarlane, G. A., King, J. R., Megrey, B. A., & Myers, K. W. (2005). [Linking oceanic food webs to coastal production and growth rates of Pacific salmon \(\*Oncorhynchus\* spp.\), using models on three scales](#). Deep Sea Research Part II: Topical Studies in Oceanography, 52(5), 757–780.

<sup>15</sup> Karpenko, V., Volkov, A., & Koval, M. (2007). Diets of Pacific Salmon in the Sea of Okhotsk, Bearing Sea, and Northwest Pacific Ocean. North Pac Anadromous Fish Commission Bull, 4.

<sup>16</sup> Bednaršek, N., Feely, R. A., Reum, J. C. P., Peterson, B., Menkel, J., Alin, S. R., & Hales, B. (2014). [Limacina helicina shell dissolution as an indicator of declining habitat suitability owing to ocean acidification in the California Current Ecosystem](#). *Proceedings of the Royal Society B: Biological Sciences*, 281(1785), 20140123.

<sup>17</sup> Bednaršek, N., Feely, R. A., Howes, E. L., Hunt, B. P. V., Kessouri, F., León, P., Lischka, S., Maas, A. E., McLaughlin, K., Nezlin, N. P., Sutula, M., & Weisberg, S. B. (2019). [Systematic Review and Meta-Analysis Toward Synthesis of Thresholds of Ocean Acidification Impacts on Calcifying Pteropods and Interactions With Warming](#). *Frontiers in Marine Science*, 6, 227.

<sup>18</sup> Waldbusser, G. G., Hales, B., Langdon, C. J., Haley, B. A., Schrader, P., Brunner, E. L., Gray, M. W., Miller, C. A., & Gimenez, I. (2015). [Saturation-state sensitivity of marine bivalve larvae to ocean acidification](#). *Nature Climate Change*, 5(3), 273–280.

<sup>19</sup> Bednaršek, et al. (2019), "[Systematic Review and Meta-Analysis.](#)"

<sup>20</sup> McLaughlin, K., Weisberg, S. B., Dickson, A. G., Hofmann, G. E., Newton, J. A., Aseltine-Neilson, D., ... & Steele, B. (2015). [Core principles of the California Current Acidification Network: Linking chemistry, physics, and ecological effects](#). *Oceanography*, 28(2), 160–169.

<sup>21</sup> Dickson, Andrew. 2010. "The Carbon Dioxide System in Seawater: Equilibrium Chemistry and Measurements." *Guide to Best Practices for Ocean Acidification Research and Data Reporting* 17–40.

<sup>22</sup> Dickson, Andrew Gilmore, Christopher L. Sabine, James Robert Christian, Charlene P. Barger, and North Pacific Marine Science Organization, eds. 2007. *Guide to Best Practices for Ocean CO<sub>2</sub> Measurements*. Sidney, BC: North Pacific Marine Science Organization.

and other sources of uncertainty, members of the California Current Acidification Network have suggested an uncertainty range of aragonite  $\Omega_{ar}$  +/- 0.2 when linking changes in ocean chemistry to aragonite  $\Omega$  changes in ecosystem function.<sup>20</sup>

Two benchmarks are needed within each data type to use the hybrid framework for Integrated Report categorical assessment. For each data type, a value is needed above which experts have confidence about biological impact based on a single data type (referred to as “independently applicable (IA)” benchmark), and one above which indicates biological impact, but requires confirmation multiple line of evidence (referred to here as a “combined line of evidence (CLOE)” benchmark). Use of each benchmark will be determined based on data availability within an assessment unit during the assessment period. In cases where two lines of evidence are available for assessment DEQ will rely on the combined lines of evidence benchmark, whereas in instances where only a single line of evidence is available DEQ will employ the independently applicable benchmark for that data.

Aragonite saturation state  $\Omega_{ar}$  thresholds for severe shell dissolution derived experimentally, through expert consensus, and through a field stress-response study range from 1.06 to 1.3, with the final recommended value of 1.2.<sup>23,24</sup> For the purposes of this assessment methodology DEQ has adopted the uncertainty range of +/- 0.2 outlined in McLaughlin et al. (2015) to identify the two aragonite  $\Omega_{ar}$  biological impact benchmarks for severe pteropod shell dissolution<sup>18</sup>. The lower end of the 0.2 range around  $\Omega_{ar} = 1.2$  will define the IA benchmark and the upper end will define the CLOE benchmark. DEQ and the workgroup believe aragonite  $\Omega_{ar} = 1.0$  ( $1.2 - 0.2$ ) is a suitable IA benchmark value that provides the certainty needed to determine impairment on chemical data alone, and aragonite  $\Omega_{ar} = 1.4$  ( $1.2 + 0.2$ ) is a suitable “CLOE benchmark to indicate biological impact but require biological

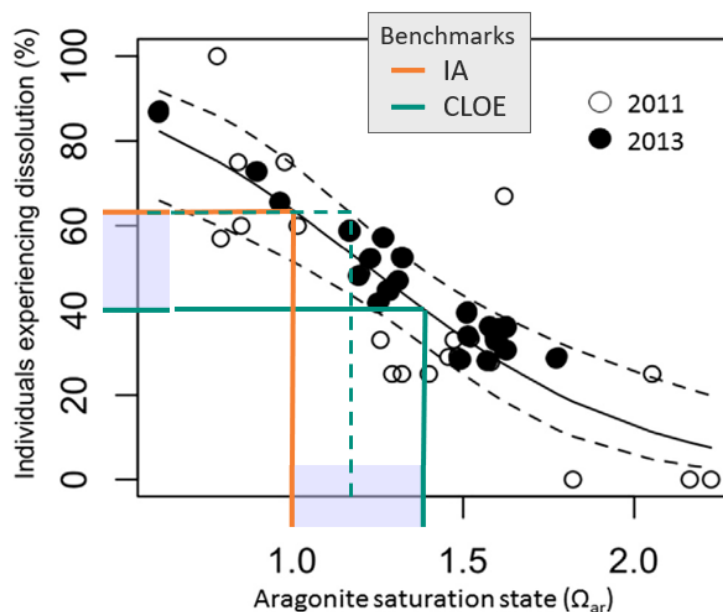


Figure 10. Figure from Feely et al. (2016) modified to show derivation of DEQ’s assessment benchmark value for OA

<sup>23</sup> Bednaršek, et al. 2019. [“Systematic Review and Meta-Analysis,”](#)

<sup>24</sup> Bednaršek, et al. 2014. [“Limacina Helicina Shell Dissolution,”](#)

data confirmation to determine impairment. The application of these chemical benchmarks to the pteropod/aragonite relationship serves as the translation to derive corresponding severe shell dissolution benchmarks (Figure 10).

The biological metric for this assessment will be the percentage of individuals within a pteropod (*L. helicina*) sample with severe shell damage (Type II & Type III) based on detailed procedures outlined in Bednaršek et al. (2012).<sup>25</sup> DEQ selected 62% and 40% individuals with Type II/III dissolution as the IA and CLOE biological benchmarks, respectively. The rationale for this choice is as follows. Utilizing the regression relationship of  $\Omega_{ar}$  versus % individuals with Type II/III dissolution<sup>26</sup>, 62% of individuals with dissolution represents the upper 95th confidence limit of an  $\Omega_{ar} = 1.2$  (Figure 10 – dashed line), the threshold at which severe dissolution occurs.<sup>27</sup> According to Bednaršek et al. (2017, Fig 1d), a benchmark of 62% of individuals with Type II/III dissolution correlates to a mean survival probability of roughly 50%, which aligns with an acute (Lethal Concentration to 50% of the sample) effect, suggesting that 62% of individuals with Type II/III dissolution represents a severe effects/lethality threshold (Figure 10- orange line).<sup>28</sup> While the CLOE benchmark (40% individuals with combined Type II/ III dissolution) accounts for some natural variability in biological response, and therefore requires a second line of evidence from the chemical indicator to determine impairment (Figure 10 – green line).

## Natural background conditions

A critical piece of biocriteria assessment for the determination of aquatic life beneficial use impairment is establishing the natural background exceedance of the IA and CLOE benchmarks. Nearshore environments with seasonal upwelling (such as Oregon's territorial sea) intermittently become undersaturated with respect to aragonite ( $\Omega_{ar} < 1$ ) under naturally occurring conditions (Harris et al. 2013).<sup>29</sup> Thus, it is expected that chemical assessment benchmarks may be naturally exceeded with some frequency, and some percentage of pteropods would naturally be affected by Type II/III dissolution.

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<sup>25</sup> Bednaršek, N., Tarling, G. A., Bakker, D. C., Fielding, S., Cohen, A., Kuzirian, A., McCorkle, D., Lézé, B., & Montagna, R. (2012). [Description and quantification of pteropod shell dissolution: A sensitive bioindicator of ocean acidification](#). *Global Change Biology*, 18(7), 2378–2388.

<sup>26</sup> Feely, et al., 2016. ["Chemical and Biological Impacts,"](#)

<sup>27</sup> Bednaršek, et al. 2019. ["Systematic Review and Meta-Analysis,"](#)

<sup>28</sup> Bednaršek, N., Feely, R. A., Tolimieri, N., Hermann, A. J., Siedlecki, S. A., Waldbusser, G. G., McElhany, P., Alin, S. R., Klinger, T., Moore-Maley, B., & Pörtner, H. O. (2017). [Exposure history determines pteropod vulnerability to ocean acidification along the US West Coast](#). *Scientific Reports*, 7(1), 4526.

<sup>29</sup> Harris, Katherine E., Michael D. DeGrandpre, and Burke Hales. 2013. ["Aragonite Saturation State Dynamics in a Coastal Upwelling Zone."](#) *Geophysical Research Letters* 40(11):2720–25.

A well developed and routinely applied approach to determine OA natural background condition is to estimate the contribution of anthropogenic carbon ( $C_{anth}$ ) to observational measurements to quantify the shift from pre-industrial times.<sup>30</sup>

For the biological indicator, DEQ is proposing to use the most recently published pre-industrial estimates of natural background percentage individuals with Type II/III dissolution in the nearshore (36-39%) as evidence that the CLOE benchmark (40%) is on the upper end of the range of natural background condition (Figure 11), and impact should be confirmed with the chemical indicator.<sup>28</sup> DEQ is proposing that published pre-industrial pteropod dissolution estimates in nearshore environments provide sufficient evidence that levels chosen for the IA and CLOE benchmarks represent a deviation from natural background conditions. For this reason, biological IA and CLOE benchmark values will be evaluated directly to determine an excursion without additional comparison to natural background conditions.

Year	Location	$\Omega_{ar}$ , preind.	$\Omega_{ar}$ , current	% Ind. with severe dissolution, preind.
2011	nearshore	1.39	1.05	39
2013	nearshore	1.46	1.08	36
2011	offshore	2.21	1.51	8
2013	offshore	2.09	1.43	12

Figure 11. Adapted from Feely et al. (2016) reported on average current and estimated pre-industrial period aragonite saturation states and percentage of individuals affected by severe dissolution for nearshore and offshore regions of CCE calculated for years 2011 and 2013

Unlike the biological indicator, which serves as an integrator of exposure time and frequency in the water column, chemical observational data represent a snapshot in time or a selected portion of the water column. Thus, for the chemical indicator, DEQ is proposing that observational data must not only be compared to benchmark values but also evaluated against estimated background conditions to determine an excursion. Documented biological impacts related to OA taking place from decreasing available aragonite occur in part because the stratified boundary (horizon) of undersaturated ( $\Omega_{ar} < 1$ ) conditions is moving up the water column. Pre-industrial estimations of carbonate chemistry can be used to compare present day observations of  $\Omega_{ar}$  in the vertical water column to those expected in the absence of anthropogenic carbon. Additionally, these pre-industrial estimates can be used to generate a depth horizon for a given  $\Omega_{ar}$  value, where concentrations in the water column below the horizon are expected to occur under natural background conditions, and above which concentrations were not expected to occur (Figure 12). DEQ believes estimated pre-industrial depth horizons of chemical benchmarks represent one way to compare current observational data with natural background conditions to determine impairment. At each profile monitoring

<sup>30</sup> Feely, et al., 2016. "[Chemical and Biological Impacts](#),"

location, DEQ will employ the best available estimate of pre-industrial depth horizon to confirm the deviation from natural background condition. Sample results below the depth horizon will be excluded from the remaining categorical assessment steps (Figure 12). Remaining results above the pre-industrial depth horizon will be pooled by assessment unit, and DEQ will use existing precedent of a 10% exceedance rate with a 90% confidence rate according to the exact binomial test to determine impairment. Steps for model derived depth horizons and additional options DEQ may use to derive similar depth estimates are outline in the Technical Support Document.

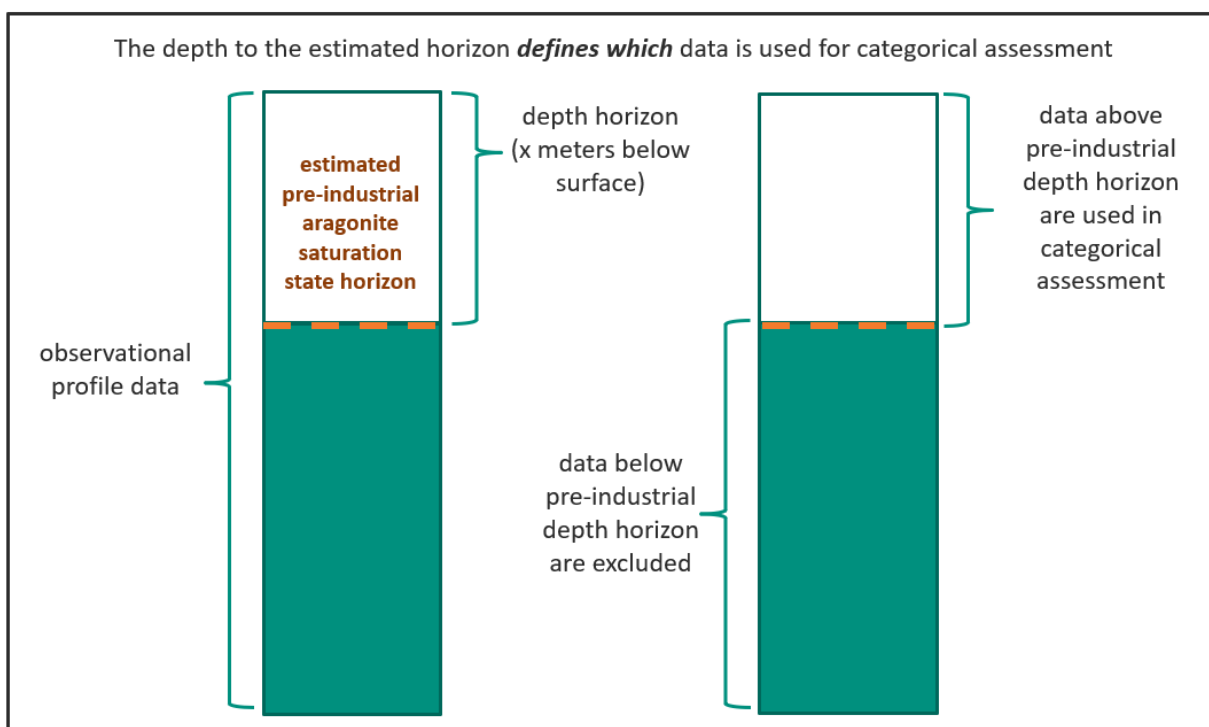


Figure 12. Pre-industrial aragonite saturation state horizon estimates will be used to define which data will be used in categorical assessment to determine impairment

## Data requirements

Biological and chemical data for this assessment must be:

- Collected within the critical period and critical area
  - Critical period of April through the end of September is defined by the temporal overlap of (1) changes in ocean conditions in Oregon associated with seasonal

upwelling and (2) the temporal window of data used to define the pteropod aragonite relationship.<sup>31,32</sup>

- Critical area – defined by the spatial overlap of three considerations: (1) the boundaries of and/or relevance to Oregon’s territorial waters, (2) likely pteropod habitats, and (3) applicability of pre-industrial calculations used to define natural background conditions in nearshore waters. This will be evaluated on a case-by-case basis.
- Biological data
  - Must have two or more representative samples. DEQ will use an average to compare to the appropriate assessment benchmark.
  - Consistent with sampling procedures outlined during NOAA hydrographic cruises.<sup>33,34</sup>
  - Biological samples used to calculate the assessment metric must contain at least 15 organisms.
  - Calculations of the metric (% individuals with severe shell dissolution) are consistent with sample processing and the categorization scheme outlined in Bednarsek et al. (2012).<sup>35</sup>
- Chemical data
  - Each Assessment Unit must have five unique (different date/time) vertical profiles
  - Each profile must have vertical resolution sufficient to be representative of the water column.
  - Vertical profiles with  $\Omega_{ar}$  derived from two of four possible carbonate measurements (seawater pH, partial pressure carbon dioxide (pCO<sub>2</sub>), total dissolved inorganic carbon (TCO<sub>2</sub>), or total alkalinity (TA)) combined with salinity, temperature, and depth.<sup>36</sup> DEQ will not employ algorithm-derived approaches internally to derive  $\Omega_{ar}$  in the 2024 Integrated Report cycle, but will accept pre-calculated  $\Omega_{ar}$  data derived via widely approved approaches so long as the associated calculation error rates are not greater than +/- 0.2  $\Omega_{ar}$  as described in McLaughlin et al. (2015).<sup>36</sup>
  - When not reported directly, DEQ will use the [seacarb](#) R package to calculate  $\Omega_{ar}$ .

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<sup>31</sup> Bednaršek, et al., 2017. "[Exposure History Determines](#),"

<sup>32</sup> Bednaršek, et al. 2014. "[Limacina Helicina Shell Dissolution](#),"

<sup>33</sup> Bednaršek, et al., 2017. "[Exposure History Determines](#),"

<sup>34</sup> Bednaršek, et al., 2014. "[Limacina Helicina Shell Dissolution](#),"

<sup>35</sup> Bednaršek, et al., 2012. "[Description and quantification](#),"

<sup>36</sup> McLaughlin, et al., 2015. "[Core Principles](#),"

- An approach to determine the best available representation of pre-industrial depth horizon to confirm the deviation from natural background condition.

### **Other approaches to assess biological integrity in marine waters**

DEQ may consider alternative approaches to identifying biological impairment to marine communities. DEQ acknowledges that impairment determinations can be made based on overwhelming evidence where multiple sources of data and/or information indicate impairment. This may include the use of some combination of observational data, published literature, and best professional judgment when interpreting data and information submitted to the agency for assessment purposes. If this approach is taken, a detailed rationale will be included in the Integrated Report.

Numeric data must be supported by supplementary materials outlining field and laboratory procedures as well as project plan that includes a purpose statement, the number of samples collected, and quality assurance and quality control protocols for collecting and analyzing samples.

### **Assignment of assessment category**

For the 2024 IR DEQ will be assessing waterbodies for impacts to biological response as a result of changing OA conditions and will therefore be evaluating Categories 5 and 3 using both data types. For the 2024 IR cycle, DEQ will not determine biocriteria attainment (Category 2) because there is uncertainty in the level of protection provided by the current CLOE benchmarks. The hybrid framework for OA biocriteria assessment (Figure 13) and decision tree for assigning assessment categories (Figure 14) outline how DEQ will assess data for categorical determination.

Global climate change, occurring as a result of excess carbon dioxide emissions into the atmosphere, is a wide ranging issue that can have impacts on water quality and beneficial use support. DEQ is taking leadership on developing assessment methodologies to identify these impacts through the Section 303(d) listing process. However, the challenge of addressing climate change related impairments demands a strategic approach and will require additional tools and resources to accompany the suite of Clean Water Act management and implementation tools traditionally used to restore impaired waters. For this reason, DEQ will use Sub-Category 5C to identify climate change related waterbody impairments on the 303(d) list, while also recognizing a broader approach than the traditional TMDL and restrictions on permitted discharges may be needed to find effective solutions.

		Aragonite Saturation State ( $\Omega_{ar}$ )			
		No data	> 1.4	$\leq 1.4$ (CLOE)	$\leq 1.0$ (IA)
% pteropods with severe shell dissolution	No data	No assessment	Category 3 (insufficient data)	Category 3B (potential concern)	Category 5 (IA - Chem)
	< 40	Category 3 (insufficient data)	Category 3 (insufficient data)		
	$\geq 40$ (CLOE)	Category 3B (potential concern)		Category 5 (CLOE)	
	$\geq 62$ (IA)	Category 5 (IA – Bio)			

Figure 13. Marine biocriteria hybrid assessment framework outlining categorical assignments based on biological and/or chemical data. IA=Independently Applicable benchmark, CLOE = Combined Lines of Evidence benchmark



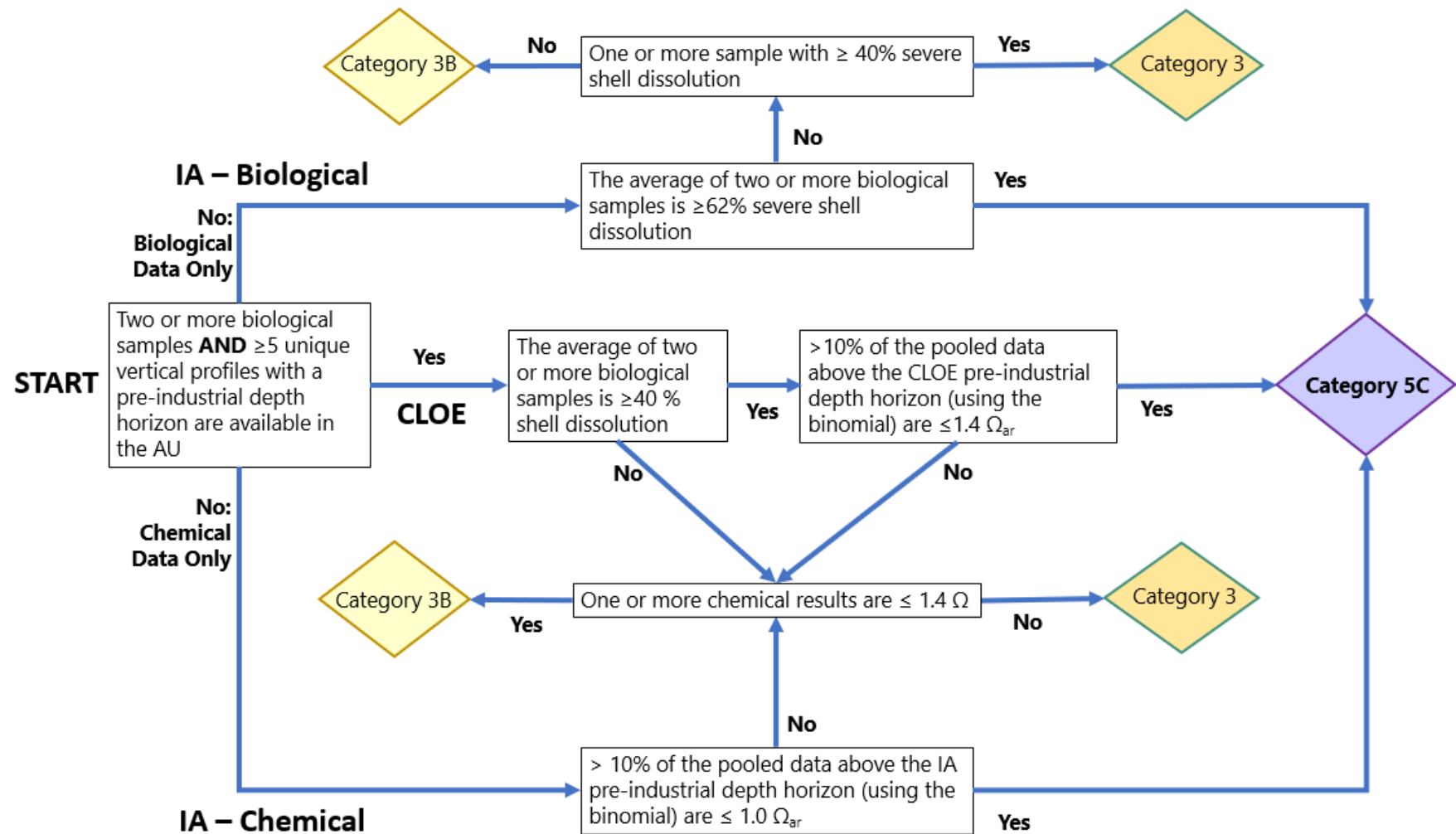


Figure 14. Decision tree for assigning assessment categories based on OA hybrid biocriteria assessment framework

## **5C: Impaired; Climate Change Related**

Biological data - independently applicable

The average of two or more representative pteropod samples in an assessment unit that meet data requirements is greater than or equal to 62 % individuals with severe shell dissolution.

**OR**

Chemical data - independently applicable

- At least five unique (different date/time) vertical profiles representative of the water column collected in the critical assessment windows and data window
- Greater than 10% of all vertical profile results in an assessment unit above the estimated pre-industrial depth horizon of 1.0  $\Omega$ ar are less than or equal to 1.0  $\Omega$ ar according to the exact binomial test for conventional pollutants

**OR**

Combined line of evidence - biological data and chemical data

The average of two or more representative pteropod samples in an assessment unit that meet data requirements is greater than or equal to 40% pteropods with severe shell dissolution.

**AND**

- At least five unique (different date/time) vertical profiles representative of the water column collected in the critical assessment windows and data window
- Greater than 10% of all vertical profile data in an assessment unit above the estimated pre-industrial depth horizon of 1.4  $\Omega$ ar are less than or equal to 1.4  $\Omega$ ar according to the exact binomial test for conventional pollutants

### **Category 4**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address a pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

### **Category 3B: insufficient data; potential concern**

Waterbodies will be placed in Category 3B: insufficient data; potential concern when:

Biological data only

Only a single pteropod sample is available in an assessment unit that meets data requirements with greater than or equal to 40% individuals with severe shell dissolution

**OR**

Chemical data only

When fewer than five unique (different date/time) vertical profiles representative of the water column are available in an assessment unit:

- One or more results is less than or equal to 1.4  $\Omega$ ar.

When more than five unique (different date/time) vertical profiles representative of the water column are available in an assessment unit:

- Less than 10% of all vertical profile data in an assessment unit above the estimated pre-industrial depth horizon of 1.4  $\Omega$ ar are less than or equal to 1.4  $\Omega$ ar according to the exact binomial test for conventional pollutants **and** one or more results is less than or equal to 1.4  $\Omega$ ar.

**OR**

Combined lines of evidence - biological data and chemical data

One line of evidence meets the conditions for Category 5, while the other line of evidence meets the conditions for Category 3.

### **Category 3: insufficient data**

Waterbodies will be placed in Category 3: insufficient data when:

Biological data only

Only a single pteropod sample is available in an assessment unit that meets data requirements, and it has less than 40% individuals with severe shell dissolution.

**OR**

Chemical data only

Fewer than five unique (different date/time) vertical profiles representative of the water column are available in an assessment unit above and all results are greater to 1.4  $\Omega$ ar.

**OR**

Combined lines of evidence - biological data and chemical data

A single pteropod sample or an average of multiple samples is available in an assessment unit that meets data requirements, and it is less than 40% individuals with severe shell dissolution

**AND**

When all unique (different date/time) vertical profiles representative of the water column in an assessment unit above the estimated pre-industrial depth horizon of 1.4  $\Omega$ ar are greater than 1.4  $\Omega$ ar.

**Category 2: attaining**

DEQ will not be using OA impact benchmarks (outlined above) to determine attainment for the narrative biocriteria in the 2024 assessment.

**Delisting – new data**

Without a pathway to attainment DEQ will evaluate potential delisting on a case-by-case basis.

## Assessment - chlorophyll-a (nuisance phytoplankton growth)

PARAMETER	BENEFICIAL USE
Chlorophyll-a	Aesthetic Quality

### Water quality standards

#### [340-041-0019](#)

##### **Nuisance Phytoplankton Growth**

(1) (a) The following values and implementation program must be applied to lakes, reservoirs, estuaries and streams, except for ponds and reservoirs less than ten acres in surface area, marshes and saline lakes:

(b) The following average chlorophyll-a values must be used to identify waterbodies where phytoplankton may impair the recognized beneficial uses:

(A) Natural lakes that thermally stratify: 0.01 mg/1;

(B) Natural lakes that do not thermally stratify, reservoirs, rivers and estuaries: 0.015 mg/1;

(C) Average chlorophyll-a values may be based on the following methodology (or other methods approved by the Department): A minimum of three samples collected over any three consecutive months at a minimum of one representative location (e.g., above the deepest point of a lake or reservoir or at a point mid-flow of a river) from samples integrated from the surface to a depth equal to twice the secchi depth or the bottom (the lesser of the two depths); analytical and quality assurance methods must be in accordance with the most recent edition of Standard Methods for the Examination of Water and Wastewater.

(2) Upon determination by the Department that the values in section (1) of this rule are exceeded, the Department may:

(a) In accordance with a schedule approved by the Commission, conduct such studies as are necessary to describe present water quality; determine the impacts on beneficial uses; determine the probable causes of the exceedance and beneficial use impact; and develop a proposed control strategy for attaining compliance where technically and economically practicable. Proposed strategies could include standards for additional pollutant parameters, pollutant discharge load limitations, and other such provisions as may be appropriate. Where natural conditions are responsible for exceedance of the values in section (1) of this rule or beneficial uses are not impaired, the values in section (1) of this rule may be modified to an appropriate value for that water body;

(b) Conduct necessary public hearings preliminary to adoption of a control strategy, standards or modified values after obtaining Commission authorization;

- (c) Implement the strategy upon adoption by the Commission.
- (3) In cases where waters exceed the values in section (1) of this rule and the necessary studies are not completed, the Department may approve new activities (which require Department approval), new or additional (above currently approved permit limits) discharge loadings from point sources provided that it is determined that beneficial uses would not be significantly impaired by the new activity or discharge.

## **Assessment methodology**

This method shall be used to evaluate impairment of aesthetic quality caused by excessive algae growth. The concentration of chlorophyll-a is used to indicate undesirable discoloration of the water body.

## **Data evaluation**

Chlorophyll-a concentration results collected over a three month consecutive period will be averaged and compared applicable criteria based on water body type.

## **Data requirements**

A minimum of three samples collected over any three consecutive months (at least one per month) at a minimum of one representative location (e.g., above the deepest point of a lake or reservoir or at a point mid flow of a river).

## **Assignment of assessment category**

### **Category 5: water quality limited, TMDL needed (303(d) list)**

The average Chlorophyll-a value over three consecutive months exceeds the value referenced in the rule **OR** >10% of monthly averages within the IR data window exceed the referenced values according to the exact binomial test.

### **Category 4: water quality limited, TMDL not needed**

TMDLs for specific pollutants have been completed and approved to address nuisance phytoplankton growth and exceedance of chlorophyll a values in a water body (Category 4A); Another control mechanism such as a control strategy developed and adopted according to OAR 340- 041-0019(2) is being implemented to control phytoplankton growth (Category 4B); Adequate information indicates that phytoplankton proliferation is not due to pollutants or is a natural condition (Category 4C).

### **Category 3: insufficient data**

Less than 3 samples available in three consecutive months to calculate an average, or less than one sample available in any month of the three consecutive month period.

### **Category 3B: insufficient data; potential concern**

Where one monthly sample exceeds the value referenced in the rule, but less than three samples are available in three consecutive months to calculate an average.

### **Category 2: attaining**

The average Chlorophyll a value over three consecutive months is less than the value referenced in the rule **OR**  $\leq 10\%$  of monthly averages within the IR data window exceed the referenced values according to the exact binomial test.

## **Delisting – new data**

Assessment units with sufficient data in the data and window to meet the [Delisting – statistical methods](#) requirements for conventional pollutants will be removed from the 303(d) list and put in Category 2: Attaining.

## Assessment – Dissolved Oxygen

PARAMETER	BENEFICIAL USE
Dissolved Oxygen	Fish and Aquatic Life

### Water quality standards

#### [340-041-0016](#)

##### **Dissolved oxygen**

Dissolved oxygen (DO): No wastes may be discharged and no activities may be conducted that, either alone, or in combination with other wastes or activities, will cause violation of the following standards: The changes adopted by the Commission on Jan. 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on Jan. 10, 1996, apply:

(1) For waterbodies identified as active spawning areas in the places and times indicated on the following Tables and Figures set out in OAR 340-041-0101 to 340-041-0340: Tables 101B, 121B, and 190B; and Figures 130B, 151B, 160B, 170B, 180A, 201A, 220B, 230B, 260A, 271B, 286B, 300B, 310B, 320B, and 340B, (as well as any active spawning area used by resident trout species), the following criteria apply during the applicable spawning through fry emergence periods set forth in the tables and figures and, where resident trout spawning occurs, during the time trout spawning through fry emergence occurs:

- (a) The dissolved oxygen may not be less than 11.0 mg/L. However, if the minimum intergravel dissolved oxygen, measured as a spatial median, is 8.0 mg/L or greater, then the DO criterion is 9.0 mg/L;
- (b) Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 11.0 mg/L or 9.0 mg/L criteria, dissolved oxygen levels must not be less than 95 percent of saturation;
- (c) The spatial median intergravel dissolved oxygen concentration must not fall below 8.0 mg/L.

(2) For waterbodies identified by the Department as providing cold-water aquatic life, the dissolved oxygen may not be less than 8.0 mg/L as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/L, dissolved oxygen may not be less than 90 percent of saturation. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 8.0 mg/L as a 30-day mean



minimum, 6.5 mg/L as a seven-day minimum mean, and may not fall below 6.0 mg/L as an absolute minimum (Table 15);

(3) For waterbodies identified by the Department as providing cool-water aquatic life, the dissolved oxygen may not be less than 6.5 mg/L as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 6.5 mg/L as a 30-day mean minimum, 5.0 mg/L as a seven-day minimum mean, and may not fall below 4.0 mg/L as an absolute minimum (Table 15);

(4) For waterbodies identified by the Department as providing warm-water aquatic life, the dissolved oxygen may not be less than 5.5 mg/L as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 5.5 mg/L as a 30-day mean minimum, and may not fall below 4.0 mg/L as an absolute minimum (Table 15);

(5) For estuarine water, the dissolved oxygen concentrations may not be less than 6.5 mg/L (for coastal waterbodies);

(6) For ocean waters, no measurable reduction in dissolved oxygen concentration may be allowed.

Table 13. Dissolved oxygen & intergravel dissolved oxygen criteria (OAR-340-041-0016, TABLE 21)

D.O. Standard	Concentration and Period <sup>1</sup> (All Units are mg/L)				Use/Level of Protection
	30-D	7-D	7- Mi	Min	
<b>Salmonid Spawning</b>		11.0 <sup>2, 3</sup>		9.0 <sup>3</sup> IGDO: 8.04	Principal use of salmonid spawning and incubation of embryos until emergence from the gravels. Low risk of impairment to cold-water aquatic life, other native fish and invertebrates.
<b>Cold Water</b>	8.05		6.5	6.0	Principally cold-water aquatic life. Salmon, trout, cold-water invertebrates, and other native cold-water species exist throughout all or most of the year. Juvenile anadromous salmonids may rear throughout the year. No measurable risk level for these communities.
<b>Cool Water</b>	6.5		5.0	4.0	Mixed native cool-water aquatic life, such as sculpins, smelt, and lampreys. Waterbodies includes estuaries. Salmonids and other cold-water biota may be present during part or all of the year but do not form a dominant component of the community structure. No measurable risk to

					cool-water species, slight risk to cold-water species present.
<b>Warm Water</b>	5.5			4.0	Waterbodies whose aquatic life beneficial uses are characterized by introduced, or native, warm-water species.
<b>Marine / No Risk</b>	No Change from Background				The only DO criterion that provides no additional risks is "no change from background". Waterbodies accorded this level of protection include marine waters and waters in Wilderness areas.

**OAR-340-041-0002, TABLE 21 (Continued)**

**Note:**

Shaded values present the absolute minimum criteria, unless the Department believes adequate data exists to apply the multiple criteria and associated periods.

1 **30-D** = 30-day mean minimum as defined in OAR 340-41-006.

**7-D** = 7-day mean minimum as defined in OAR 340-41-006.

**7-Mi** = 7-day minimum mean as defined in OAR 340-41-006.

**Min** = Absolute minimums for surface samples when applying the averaging period, spatial median of IGDO.

2 When Intergravel DO levels are 8.0 mg/L or greater, DO levels may be as low as 9.0 mg/L, without triggering a violation.

3 If conditions of barometric pressure, altitude and temperature preclude achievement of the footnoted criteria, then 95 percent saturation applies.

4 Intergravel DO criterion, spatial median minimum.

5 If conditions of barometric pressure, altitude, and temperature preclude achievement of 8.0 mg/L, then 90 percent saturation applies.

**OAR 340-041-0006**

**Definitions**

[...]

(15) "Daily Mean" for dissolved oxygen means the numeric average of an adequate number of data to describe the variation in dissolved oxygen concentration throughout a day, including daily maximums and minimums. For calculating the mean, concentrations in excess of 100 percent of saturation are valued at the saturation concentration.

[...]

(22) "Estuarine Waters" means all mixed fresh and oceanic waters in estuaries or bays from the point of oceanic water intrusion inland to a line connecting the outermost points of the headlands or protective jetties.

(27) "Intergravel Dissolved Oxygen" (IGDO) means the concentration of oxygen measured in the water within the stream bed gravels. Measurements should be taken within a limited time period before emergence of fry.

(34) "Marine Waters" means all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of the State of Oregon.

[...]

(38) "Minimum" (Min) for dissolved oxygen means the minimum recorded concentration including seasonal and diurnal minimums.

(39) "Monthly (30-D) Mean Minimum" for dissolved oxygen means the minimum of the 30 consecutive-day floating averages of the calculated daily mean dissolved oxygen concentration.

[...]

(59) "Spatial Median" means the value that falls in the middle of a data set of multiple intergravel dissolved oxygen (IGDO) measurements taken within a spawning area. Half the samples should be greater than and half the samples should be less than the spatial median.

[...]

(73) "Weekly (7-D) Mean Minimum" for dissolved oxygen means the minimum of the seven consecutive-day floating average of the calculated daily mean dissolved oxygen concentration.

(74) "Weekly (7-Mi) Minimum Mean" for dissolved oxygen means the minimum of the seven consecutive-day floating average of the daily minimum concentration. For application of the criteria, this value is the reference for diurnal minimums.

## **Assessment methodology**

Assessment methods for dissolved oxygen are determined by data type and criteria by applied. Figure 15 and Figure 16 provide decision trees to document the processes.

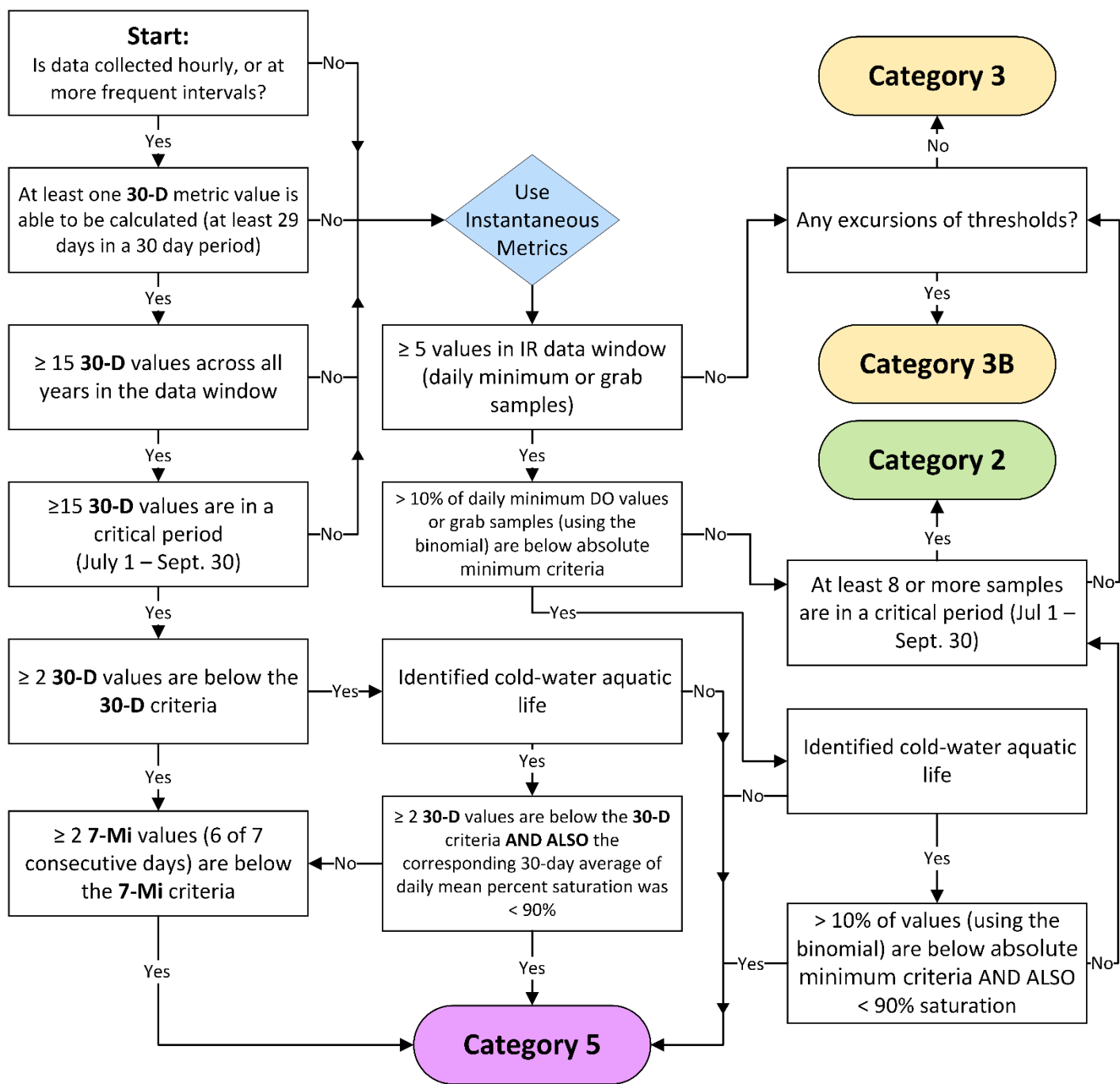


Figure 15. The decision tree for assessment of the dissolved oxygen year-round criteria

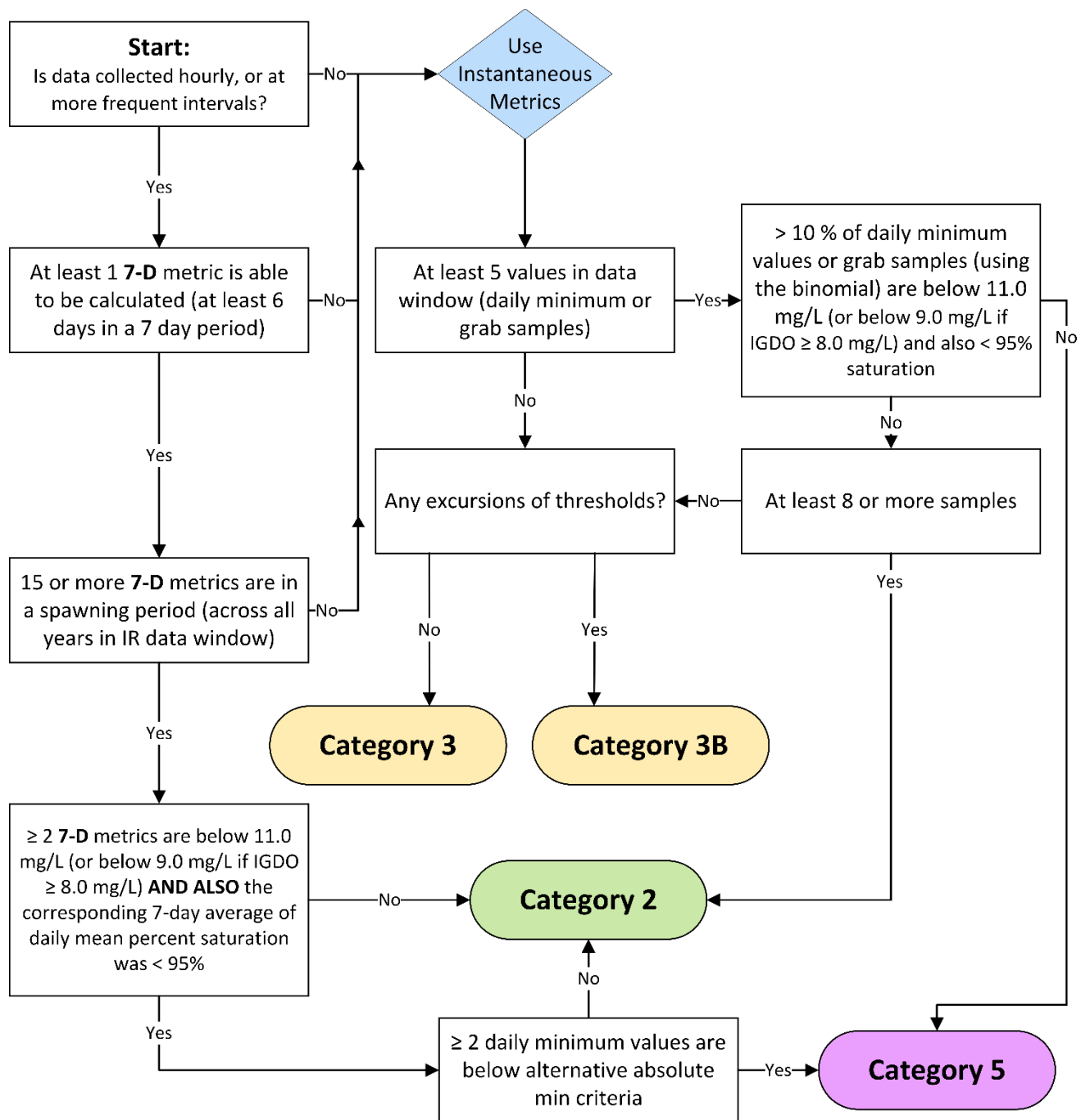


Figure 16. The decision tree for assessment of the dissolved oxygen spawning criteria

## Data evaluation

### Determining Applicable Criteria

The application of the various dissolved oxygen criteria is based on designated fish use as described in the tables and figures in OAR-340-041-016 (1). For convenience, the interpretation of this information is detailed in the Dissolved Oxygen Standard Implementation Guidance and depicted for reference in the water quality standards layer on DEQ [IR web map](#).

### Time Period

**Spawning time-period:** The spawning criteria shall be applied for places and times indicated, in the tables and figures referenced in OAR-340-041-0016 (1), as having active salmon and steelhead spawning, or any additional assumed spawning by resident trout species. Listed status of waterbodies in violation of the spawning criteria is in effect only during the applicable spawning date range for the water body.

**Year-round:** The year-round dissolved oxygen criteria apply year-round. For some locations, a more stringent spawning criteria may apply in addition to the year-round criterion for part of the year. Listed status of waterbodies in violation of the year-round criteria are in effect year-round.

**Critical period:** The critical period for assessing compliance with the year-round dissolved oxygen standard is the summer period July 1 – September 30, when seasonal trends in dissolved oxygen are expected to be near annual minimums.

## Data requirements

### Continuous time series dissolved oxygen concentration

The Department shall apply the Monthly (30-D) Mean Minimum, Weekly (seven-day) Minimum Mean, and alternate absolute minimum, when it determines sufficient continuously monitored data is available.

For calculating daily means and minimums, measurements from at least 22 hours in each day must be available. Sufficient data will include, but may not be limited to, at least 29 daily mean values for calculating a 30-day average, and at least six daily mean values for calculating a seven-day average.

To assess the year-round criteria using continuous data, at least 15 instances of the 30-D metric data must be collected during the year-round critical period (July 1 – September 30) within the integrated report data window. To assess the spawning criteria using continuous data, 15

instances of the 7-D metric must be collected during the spawning period within the integrated report data window.

In the absence of sufficient continuous monitoring of dissolved oxygen, attainment of the dissolved oxygen criterion shall be assessed as instantaneous or “grab” measurements. The daily minimum dissolved oxygen concentration shall be used as the “grab” sample unit.

Sites having insufficient data to be assessed as continuous data will be assessed according to the instantaneous criteria in the previous section. Where multiple samples are collected on the same day, the minimum DO concentration will be used in the assessment.

For the details of the following procedures please see Figure 15 and Figure 16.

## Assignment of assessment category

### Instantaneous (or grab) dissolved oxygen evaluation

The D.O. criteria metrics are absolute minimum D.O. concentrations referenced in OAR-340-041-016 (1)(a) – (6) (Table 16) These criteria are also depicted in grey boxes on OAR-340-041-0006, Table 21 (see Table 15, above).

Table 14. Instantaneous Minimum Dissolved Oxygen Criteria to Protect Aquatic Life

Dissolved Oxygen Standard	Salmonid Spawning	Cold Water	Cool Water	Warm Water	Estuary	Marine
<b>D.O. Criteria (mg/L)</b>	11.0*	8.0	6.5	5.5	6.5	No change from background
<b>% Saturation Allowance</b>	Not less than 95 % saturation	Not less than 90 % saturation	—	—	—	—
<b>IGDO Criterion (mg/L)</b>	8.0	—	—	—	—	—

\*Shall be 9.0 mg/L if data shows the IGDO criterion of 8.0 mg/L is also attained.

### Category 5: water quality limited, TMDL needed (303(d) list)

Where greater than 10% of the samples within the IR data window collected on separate days for the time-period of interest (spawning or year-round critical period) are less than the appropriate criterion **AND** are also less than the percent saturation allowance (where applicable) according to the exact binomial test.

#### **Category 4: water quality limited, TMDL not needed**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address the pollutant and result in the attainment of water quality standards (Category 4B),

#### **Category 3: insufficient data**

Less than five samples within the IR data window collected on separate days for the time-period of interest (spawning or year-round critical period) with no sample less than the appropriate criterion, **AND** all samples less than the appropriate criterion are also less than the percent saturation allowance **OR** less than eight samples are in a critical period **AND** no sample is less than the appropriate criterion.

#### **Category 3B: insufficient data; potential concern**

Less than five samples within the IR data window collected on separate days for the time-period of interest (spawning or year-round critical period); where at least one sample is less than the appropriate criterion **AND** is also less than the percent saturation allowance (where applicable) **OR** less than eight samples are in a critical period **AND** one sample is less than the appropriate criterion.

#### **Category 2: attaining**

For a minimum of eight samples less than or equal to 10% of samples within the IR data window in the time-period of interest (spawning or non-spawning) are less than the appropriate criterion according to the exact binomial test **AND** are also less than the corresponding percent saturation allowance.

### **Continuous dissolved oxygen evaluation**

#### **Category 5: water quality limited, TMDL needed (303(d) list)**

Where the Department concludes that sufficient continuously monitored data has been collected, it shall assign waterbodies to Category 5 if **ANY** of the following criteria are exceeded:

##### **Year-round**

- Two or more of the 30-D consecutive rolling averages of the daily mean of dissolved oxygen concentration **AND** for those waterbodies classified as cold water, the corresponding 30-day average of daily mean percent saturation is less than the applicable criterion.
- Two or more of the 7-Mi consecutive rolling average of the daily minimum concentration of dissolved oxygen is less than the applicable criterion.



- Two or more of the daily minimum concentration of dissolved oxygen is less than the alternate minimum criteria (Min) (Table 15).

### **Spawning**

- Two or more of the 7-D consecutive rolling average of the daily mean of dissolved oxygen concentration **AND** the corresponding 7-day average of daily mean percent saturation is less than the applicable criterion, or 9.0 mg/L if data shows the IGDO criterion is also attained.
- Two or more of the daily minimum concentration of dissolved oxygen is less than the alternate minimum criteria (Min) (Table 15).

### **Category 2: attaining**

Where the Department concludes that sufficient continuously monitored data has been collected, it shall assign waterbodies to Category 2 if **ALL** of the following metrics are attained:

#### **Year-round**

- No more than one of the 30-D consecutive rolling averages of the daily mean of dissolved oxygen concentration **AND** for those waterbodies classified as cold water, the corresponding 30-day average of daily mean percent saturation is less than the applicable criterion.
- No more than one of the 7-Mi consecutive rolling average of the daily minimum concentration of dissolved oxygen is less than the applicable criterion.
- No more than one of the daily minimum concentration of dissolved oxygen is less than the Min. alternate minimum criteria.

### **Spawning**

- No more than one of the 7-D consecutive rolling average of the daily mean of dissolved oxygen concentration **AND** the corresponding 7-day average of daily percent saturation is less than the applicable criterion.
- No more than one of the daily minimum concentration of dissolved oxygen is less than the Min. alternate minimum criteria (Min) (Table 15).

### **Delisting – new data**

A waterbody is delisted and assigned to **Category 2: Attaining** if there is sufficient information from the current assessment to evaluate the pollutant or parameter, and the information demonstrates that currently applicable water quality standards are being met. Data used for delisting must meet data quality requirements as described below.

An assessment unit will be eligible for delisting for dissolved oxygen if the assessment unit meets one of the following scenarios:

**I. Full critical period (or spawning option):**

- a. Continuous metrics analysis results in a category 2 designation of attaining criteria **and**
- b. Dataset must include a minimum of three years (does not have to be consecutive) of data that represent at least 80% of the critical period (July 1– September 30) in each year.

**II. Short term probe deployments:**

- a. Dataset includes a minimum of three years of data that contains at least five full days of continuous dissolved oxygen per critical period month per year (i.e., for year-round, 15 sample days in critical period per year) **and**
- b. < 10% (using the binomial) of daily minimums are below the Instantaneous Minimum Dissolved Oxygen Criteria identified in Table 16 as described in the Delisting Waterbodies Section of the Integrated Report Assessment methodology.

In addition, for the next listing cycle, assessment units may be delisted if the following conditions are met:

**III. Grab samples**

- a. Dataset includes three years of data that contain at least two results for each critical period month, and
- b. There are no excursions of any applicable criteria

For spawning delistings, the critical period represents the entire spawning period. DEQ intends to reevaluate minimum data requirements for spawning delistings as more data becomes available.

## Assessment – marine dissolved oxygen

PARAMETER	BENEFICIAL USE
Dissolved oxygen	Fish and aquatic life – marine waters

## Water quality standards

### [340-041-0016](#)

**Dissolved oxygen** (excerpt for marine waters)

Dissolved oxygen (DO): No wastes may be discharged and no activities may be conducted that, either alone, or in combination with other wastes or activities, will cause violation of the following standards: The changes adopted by the Commission on Jan. 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on Jan. 10, 1996, apply:

(6) For ocean waters, no measurable reduction in dissolved oxygen concentration may be allowed”

### **From Table 15 of OAR-340-041-0016:**

The only DO criterion that provides no additional risks is “no change from background”. Waterbodies accorded this level of protection include marine waters and waters in Wilderness areas.

## Assessment methodology

Seasonal hypoxia (low oxygen conditions) is a natural feature in upwelling regions in the Eastern Pacific, such as Oregon’s territorial sea, but recent research suggests that hypoxic events have been increasing in frequency, duration, and occurring in locations where they are not commonly observed.<sup>37</sup> These changes have raised concerns that biological impacts are taking place outside of natural ecosystem variability, and that aquatic life beneficial uses are not being fully supported in some areas. For this assessment, DEQ is proposing an approach that will allow the agency to quantify measurable reduction of DO in Oregon’s territorial sea for the purposes of interpreting Oregon’s narrative marine DO criteria for aquatic life beneficial use support.

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<sup>37</sup> Chan, F., Barth, J. A., Lubchenco, J., Kirincich, A., Weeks, H., Peterson, W. T., & Menge, B. A. (2008). [Emergence of Anoxia in the California Current Large Marine Ecosystem](#). *Science*, 319(5865), 920–920.

This is a new assessment methodology for use in the 2024 report. An accompanying Technical Support Document outlines the rationale, process, and approach DEQ is proposing to use to assess hypoxia impacts for water quality assessment.

## **Data evaluation**

For the 2024 report, DEQ is proposing to adopt a hybrid framework wherein two lines of evidence will be used to assess aquatic life beneficial use support. One line of evidence will rely on quantifying measurable reduction by comparing observational data with background conditions established either through long term observational data sets or modeled conditions. The second line of evidence will use established DO biological impact benchmarks to provide a biological lens to determine whether measurable reduction is likely affecting aquatic life beneficial use support.

## **Biologically relevant benchmark**

Narrative criteria are descriptions of the conditions necessary for a waterbody to attain its designated use. The dissolved oxygen thresholds summarized in Chan et. al. (2019) provide examples of biological responses to low dissolved oxygen conditions in marine environments.<sup>38</sup> Hypoxic conditions (dissolved oxygen levels of 1.4 ml/l (2.0mg/L; 62µmol/kg) or less) are reported to have biological impacts, ranging from changes in behavior, decreased metabolic fitness, to overall organism survival.<sup>39</sup> This value will be the numeric benchmark used to assess beneficial use support for fish and aquatic and by which the measurable reduction would be evaluated.

## **Quantifying change from background**

In determining the degree of change that constitutes “measurable reduction” for the purposes of assessment, DEQ will rely on quantitative measurements of change relevant to the data and information available and may utilize multiple approaches as needed. DEQ will adapt methodologies outlined in published literature relevant to quantifying shifts in marine DO relevant to Oregon’s territorial waters such as Pierce et al., (2012), Adams et al., (2013), and

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<sup>38</sup> Chan, F., Barth, J. A., Kroeker, K. J., Lubchenco, J., & Menge, B. A. (2019). THE DYNAMICS AND IMPACT OF OCEAN ACIDIFICATION AND HYPOXIA: Insights from Sustained Investigations in the Northern California Current Large Marine Ecosystem. *Oceanography*, 32(3), 62–71.

<sup>39</sup> Vaquer-Sunyer, Raquel, and Carlos M. Duarte. “[Thresholds of Hypoxia for Marine Biodiversity.](#)” *Proceedings of the National Academy of Sciences* 105, no. 40 (October 7, 2008): 15452–57.

others.<sup>40,41</sup> DEQ will also consult with regional experts as needed to ensure adaptations to methodologies to satisfy the approach outlined in this document are appropriate based on data types and locations. Detailed summaries of the application of these methodologies will be provided in the assessment rationale at the AU-parameter level of reporting.

Establishing background condition for comparison purposes is a critical component of determining measurable reduction. Changing ocean conditions are typically evaluated on decadal rather than yearly or seasonal scales. Where available, DEQ will evaluate a measurable reduction based on observational datasets collected at consistent locations over multiple decades. In assessment units where this temporal coverage is not available, DEQ will rely on validated model output to quantify background conditions.

### **Chemical data metric**

Oceanographic DO data is measured and reported in a variety of ways. For consistency with common reporting values, DEQ will convert marine DO measurements to ml/l. DEQ is proposing to use a daily statistic of the value DO representing the lower 10th percentile as the assessment metric from which to evaluate the frequency of exceedances of the biologically relevant benchmark. This daily summary statistic allows comparison of historical data to recent observational data. Additionally, the statistic characterizes the lowest values in the water column where measurable reduction has been documented to occur, while not basing the assessment on a daily minimum value which can be a subject to data quality concerns.

### **Data requirements**

Chemical data for this assessment must be:

- Collected within the critical period
  - DEQ will consider April through the end of September as the critical assessment window for marine DO.
- Observational data
  - Data must be collected under a project plan with widely approved sample collection methods.
  - Historical data will be evaluated for quality by consulting regional experts and published literature.

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<sup>40</sup> Pierce, S. D., Barth, J. A., Shearman, R. K., & Erofeev, A. Y. (2012). [Declining Oxygen in the Northeast Pacific](#). *Journal of Physical Oceanography*, 42(3), 495–501.

<sup>41</sup> Adams, K. A., Barth, J. A., & Chan, F. (2013). [Temporal variability of near-bottom dissolved oxygen during upwelling off central Oregon](#). *Journal of Geophysical Research: Oceans*, 118(10), 4839–4854.

- To calculate daily 10th percentiles, a minimum vertical resolution sufficient to represent the water column.
- Model output
  - Validated in state waters.
  - Accounts for spatial and temporal variability in DO conditions.
  - DEQ may request guidance from technical workgroup members to interpret model performance for temporal, spatial and climatic variations.

### **Other approaches to assess biological integrity in marine waters**

It is important to note that the two lines of evidence outlined in the hybrid framework are not the only lines of evidence DEQ will consider in marine DO narrative criteria assessment. DEQ acknowledges that impairment determinations can be made based on overwhelming evidence where multiple sources of data and/or information indicate impairment. This may include the documented periods of prolonged anoxia tied to biological impact or the use of some combination of observational data, published literature, and best professional judgment to interpreting data and information submitted to the agency for assessment purposes. If this approach is taken, a detailed rationale will be included in the Integrated Report.

### **Assignment of assessment category**

For the 2024 report, DEQ will be assessing waterbodies for impacts to biological response as a result of increasing frequency and duration of nearshore hypoxic events and will therefore be evaluating Category 5 and 3. Without a clear understanding of what values levels of dissolved oxygen in marine waters equate to the beneficial use being fully supporting, DEQ will not be assessing for attainment. The hybrid framework for hypoxia in marine waters assessment (Figure 17) and decision tree for assigning assessment categories (Figure 18) outline how DEQ will assess data for categorical determination.

Global climate change, occurring as a result of excess carbon dioxide emissions into the atmosphere, is a wide ranging issue that can have impacts on water quality and beneficial use support. DEQ is taking leadership on developing assessment methodologies to identify these impacts through the Section 303(d) listing process. However, the challenge of addressing climate change related impairments demands a strategic approach and will require additional tools and resources to accompany the suite of Clean Water Act management and implementation tools traditionally used to restore impaired waters. For this reason, DEQ will use Sub-Category 5C to identify climate change related waterbody impairments on the 303(d) list, while also recognizing a broader approach than the traditional TMDL and restrictions on permitted discharges may be needed to find effective solutions.

		Observational Data		
		≤ 1.4 ml/l	> 1.4 ml/l	No data
Background Conditions	Observational deviation from background	Category 5 (combined lines of evidence)	Category 3B (potential concern)	No assessment
	Modeled deviation from background	Category 5 (combined lines of evidence)	Category 3B (potential concern)	No assessment
	No evidence of deviation from background	Category 3B (potential concern)	Category 3 (insufficient data)	No assessment

Figure 17. Marine dissolved oxygen hybrid assessment framework relies on multiple lines of evidence for categorical assignments.

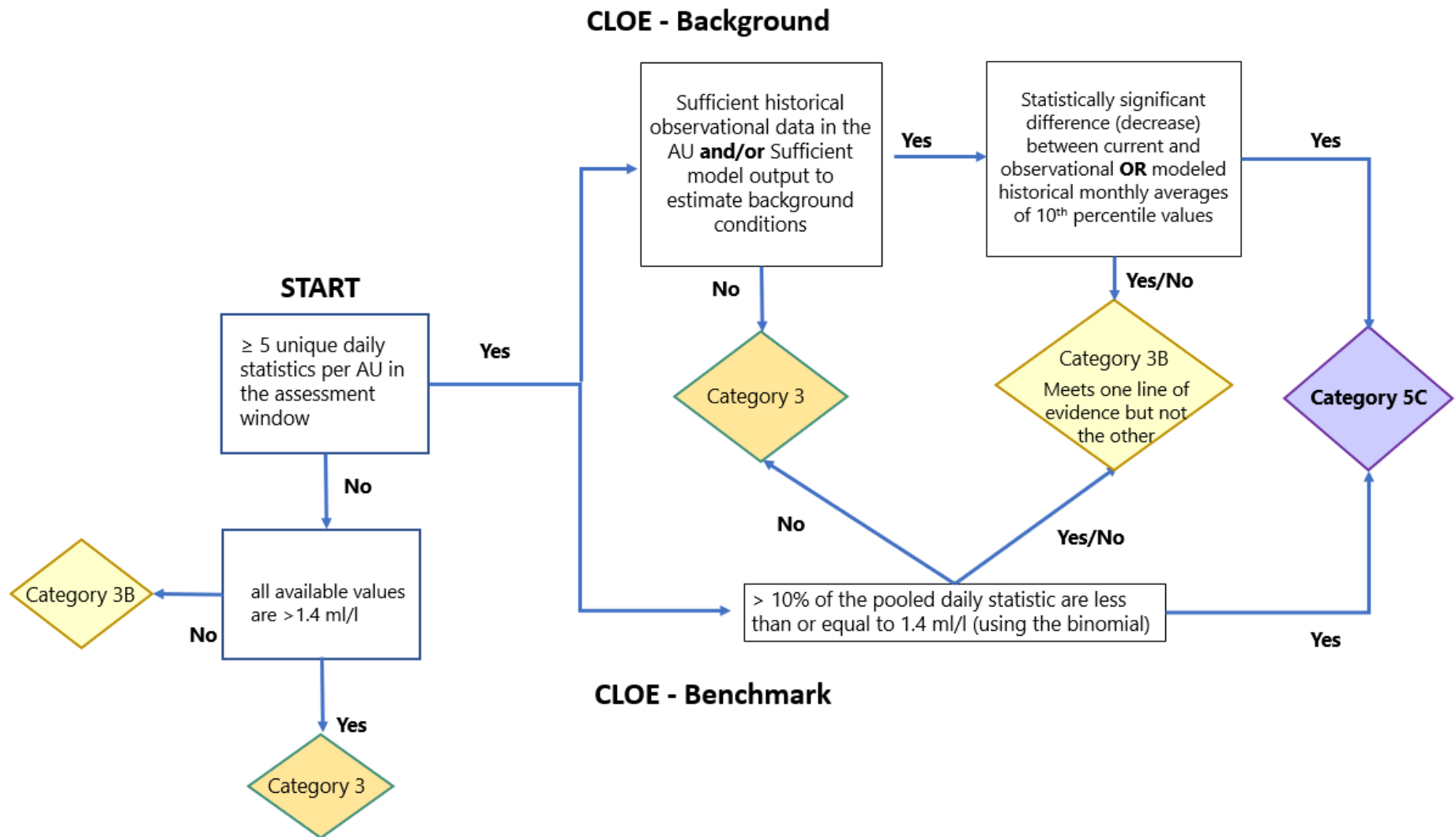


Figure 18. Decision tree for assigning categories based on the marine dissolved oxygen assessment framework



### **Category 5C: Impaired; Climate Change Related**

Within the critical assessment window, at least five unique daily statistics where greater than 10% are less  $\leq 1.4$  ml/l according to the exact binomial test for conventional pollutants.

#### **AND**

There is a statistically significant difference (decrease) in marine DO during the critical assessment window based on either observed or modeled historical conditions.

### **Category 4**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

### **Category 3B: insufficient data; potential concern**

Waterbodies will be placed in Category 3B: insufficient data; potential concern when one line of evidence does not indicate impairment (illustrated in **Figure 18**).

### **Category 3: insufficient data**

Waterbodies will be placed in Category 3: insufficient data when both lines of evidence do not indicate impairment (illustrated in **Figure 18**).

#### **OR**

Fewer than five unique daily statistics are available the critical assessment window and no values are less than 1.4 ml/l.

### **Category 2: attaining**

DEQ will not be using hypoxia related benchmarks to determine attainment for the narrative marine dissolved oxygen criteria.

### **Delisting – new data**

Without a pathway to attainment DEQ will evaluate potential delisting on a case-by-case basis.

## Assessment - pH

PARAMETER	BENEFICIAL USE
pH	Fish and Aquatic Life

## Water quality standards

### 340-041-0021

#### pH

(1) Unless otherwise specified in OAR 340-041-0101 through 340-041-0350, pH values (Hydrogen ion concentrations) may not fall outside the following ranges:

(a) Marine waters: 7.0-8.5;

(b) Estuarine and fresh waters: See basin-specific criteria (OAR 340-041-0101 through 340-041-0350).

(2) Waters impounded by dams existing on Jan. 1, 1996, which have pH values that exceed the criteria are not in violation of the standard, if the Department determines that the exceedance would not occur without the impoundment and that all practicable measures have been taken to bring the pH in the impounded waters into compliance with the criteria.

### **340-041-0101 through 340-041-0350**

Basin-specific criteria

Table 15. Summary of pH basin-specific criteria (OAR 340-041-0101 through 340-041-0350)

Basin or Water Body	OAR	Water	Criteria Range
General	<b>340-041-0021(1)(a)</b>	Marine	7.0 to 8.5
General	<b>340-041-0021(1)(b)</b>	Estuarine and fresh waters	See basin-specific criteria
Columbia River	<b>340-041-0104(1)</b>	Main stem Columbia River (mouth to river mile 309):	7.0 to 8.5
Snake River	<b>340-041-0124(1)</b>	Main stem Snake River (river miles 260 to 335)	7.0 to 9.0
Deschutes Basin	<b>340-041-0135(1)(a)</b>	All other basin streams (except Cascade lakes)	6.5 to 8.5
	<b>340-041-0135(1)(b)</b>	Cascade lakes above 3,000 feet altitude	6.0 to 8.5

Basin or Water Body	OAR	Water	Criteria Range
Goose and Summer Lakes Basin	<b>340-041-0145(1)(a)</b>	Goose Lake	7.5 to 9.5
	<b>340-041-0145(1)(b)</b>	All other basin waters	7.0 to 9.0*
Grande Ronde Basin	<b>340-041-0156(1)</b>	All basin streams (other than main stem Snake River)	6.5 to 9.0*
Hood Basin	<b>340-041-0165(1)(a)</b>	Hood River Basin streams (except main stem Columbia River and Cascade lakes)	6.5 to 8.5
	<b>340-041-0165(1)(b)</b>	Cascade lakes above 3,000 feet altitude	6.0 to 8.5
John Day Basin	<b>340-041-0175(1)</b>	All basin streams (other than the main stem Colombia River)	6.5 to 9.0*
Klamath Basin	<b>340-041-0185(1)(a)</b>	Fresh waters except Cascade lakes	6.5 to 9.0*
	<b>340-041-0185(1)(b)</b>	Cascade lakes above 5,000 feet altitude	6.0 to 8.5
Malheur Lake Basin	<b>340-041-0195(1)</b>	All	7.0 to 9.0*
Malheur River Basin	<b>340-041-0207(1)</b>	All	7.0 to 9.0*
Mid Coast Basin	<b>340-041-0225(1)(a)</b>	Marine waters	7.0 to 8.5
	<b>340-041-0225(b)</b>	Estuarine and fresh waters	6.5 to 8.5
North Coast Basin	<b>340-041-0235(1)(a)</b>	Marine waters	7.0 to 8.5
	<b>340-041-0235(1)(b)</b>	Estuarine and fresh waters	6.5 to 8.5
Owyhee Basin	<b>340-041-0256(1)</b>	All	7.0 to 9.0*
Powder/Burnt Basins	<b>340-041-0265(1)</b>	All basin streams (other than main stem Snake River)	6.5 to 9.0*
Rogue Basin	<b>340-041-0275(1)(a)</b>	Marine waters	7.0 to 8.5

Basin or Water Body	OAR	Water	Criteria Range
	<b>340-041-0275(1)(b)</b>	Estuarine and fresh waters (except Cascade lakes)	6.5 to 8.5
	<b>340-041-0275(1)(c)</b>	Cascade lakes above 3,000 feet altitude	6.0 to 8.5
Sandy Basin	<b>340-041-0290(1)(a)</b>	All basin waters (except main stem Columbia River and Cascade lakes)	6.5 to 8.5
	<b>340-041-0290(1)(b)</b>	Cascade lakes above 3,000 feet altitude	6.0 to 8.5
South Coast Basin	<b>340-041-0305(1)(a)</b>	Estuarine and fresh waters	6.5 to 8.5
	<b>340-041-0305(1)(b)</b>	Marine waters	7.0 to 8.5
Umatilla Basin	<b>340-041-0315(1)</b>	All basin streams (other than main stem Columbia River)	6.5 to 9.0*
Umpqua Basin	<b>340-041-0326(1)(a)</b>	Marine waters	7.0 to 8.5
	<b>340-041-0326(1)(b)</b>	Estuarine and fresh waters (except Cascade lakes)	6.5 to 8.5
	<b>340-041-0326(1)(c)</b>	Cascade lakes above 3,000 feet altitude	6.0 to 8.5
Walla Walla Basin	<b>340-041-0336</b>		6.5 to 9.0*
Willamette Basin	<b>340-041-0345(1)(a)</b>	All basin waters (except main stem Columbia River and Cascade lakes)	6.5 to 8.5
	<b>340-041-0345(1)(b)</b>	Cascade lakes above 3,000 feet altitude	6.0 to 8.5.

\*When greater than 25 percent of ambient measurements taken between June and September are greater than pH 8.7, and as resources are available according to priorities set by the Department, the Department will determine whether the values higher than 8.7 are anthropogenic or natural in origin.

## Assessment methodology

The pH of water, commonly understood as acidity or alkalinity, is a measure of the hydrogen or hydronium ions concentration. It is reported on a logarithmic scale where values under 7 represent acidic waters and values above 7 represent alkaline waters. Chemical and biological processes in natural waterbodies are influenced by the pH of the water. It is one of the most important environmental factors limiting species distributions in aquatic habitats. The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.).

DEQ compares pH data to basin specific range of numeric criteria in Table 17. Cascade Lakes natural and man-made lakes at elevations over 3,000 or 5,000 feet have naturally occurring low pH and are given specific criteria in Table 17.

## Data evaluation

Where only continuous data are available, DEQ will use the exact binomial test twice (10-10 rule). First, where greater than 10 percent of a specific day's time series measurements fall outside the range of the appropriate criterion, the day is considered in violation of its water quality standard according to the exact binomial test and that day is considered an excursion. Second, all sample days in the assessment units are compiled and where greater than 10% of the days are excursions, the water body would be considered impaired according to the exact binomial test.

Where both continuous and grab datasets are available, DEQ will use the following method for pH assessment.

- Determine a daily exceedance value for each day where greater than 10% of the time-series measurements are outside the range of the appropriate criterion according to the exact binomial test.
- Tally the number of exceedances of grab data results
- Confirm that there are not data for the same location and day for grab and continuous results. Where both grab and continuous data results exist for the same location and day, preference will be given to continuous dataset statistics.
- Sum the number of grab samples and sample days from continuous results
- Sum the number of daily exceedances and the number of grab sample exceedances

Use the exact binomial with the same critical values for listing conventional pollutants (i.e., Null Hypothesis: Actual exceedance proportion is  $\leq 10\%$ ) to determine the critical value of exceedances and the final assessment category.

## **Data requirements**

DEQ will use both grab (instantaneous) and continuous (time series) data sets. Where only grab data are available, DEQ will compare samples to water quality criteria and use the exact binomial test to determine categorical assignment.

## **Assignment of assessment category**

### **Category 5: water quality limited, TMDL needed (303(d) list)**

#### **Grab only:**

For five or more samples, greater than 10% of the samples are outside the range of the appropriate criterion according to the exact binomial test.

#### **Continuous only (10-10 rule):**

First, where greater than 10% of a day's time series measurements fall outside the range of the appropriate criteria, the day is considered an excursion according to the exact binomial test

Second, where greater than 10% of the days are excursions, according to the exact binomial test, the water body would be considered impaired

### **Category 4: water quality limited, TMDL not needed**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

### **Category 3: insufficient data**

Fewer than eight samples collected on separate days or sample days for continuous data in the assessment data window and no values are outside of the range of appropriate criteria.

#### **Category 3B: insufficient data; potential concern**

Fewer than eight samples collected on separate days or sample days for continuous data in the assessment data window and one or more values are outside of the range of appropriate criteria.

## **Category 2: attaining**

### **Grab only:**

For eight or more samples, less than or equal to 10% of the samples are outside the range of the appropriate criterion according to the exact binomial test.

### **Continuous only:**

Less than 10% of daily time series measurements fall outside the range of the appropriate criterion according to the exact binomial test, the day is considered attaining its water quality standards.

Second, for a minimum of eight daily samples, where less than 10% of the days are excursions according to the exact binomial test.

## **Delisting – new data**

Assessment units with sufficient data in the data and window to meet the [Delisting – statistical methods](#) requirements for conventional pollutants will be removed from the 303(d) list and put in Category 2: Attaining.

## Assessment - Sedimentation

PARAMETER	BENEFICIAL USE
Sediment/others	Fish and Aquatic Life

## Water quality standards

### [340-041-0007](#)

#### Statewide Narrative Criteria

(11) The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed;

## Assessment methodology

Waterbodies have been previously listed<sup>42</sup> using stream specific documentation, which demonstrated excessive sedimentation was a significant limitation to fish or other aquatic life. This included information indicating beneficial use impairment (aquatic community status, deviation from biomonitoring reference sites, or fishery data) and measurement data such as cobble embeddedness or percent fines.

For future assessments, DEQ will be evaluating approaches to apply a numeric benchmark based on measurements of stream conditions to implement the narrative criteria.

## Data evaluation

DEQ will evaluate data and information received to determine if there is [overwhelming evidence](#) of impairment.

## Data requirements

Data or information must be associated with a specific water body.

## Assignment of assessment category

Categorical listings for sedimentation will be made using sampling site documentation in conjunction with other data and overwhelming evidence of impairment.

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<sup>42</sup> [Listing Criteria for Oregon's 1998 303\(d\) List of Water Quality Limited Water Bodies](#)



## **Delisting – new data**

There is no current delisting process for sedimentation. Assessment units will be evaluated for delisting on a case by case basis.

# Assessment - Temperature

PARAMETER	BENEFICIAL USE
Water Temperature	Fish and Aquatic Life

## Water quality standards

### [340-041-0002](#)

#### Definitions

(57) "Seven-Day Average Maximum Temperature" means a calculation of the average of the daily maximum temperatures from seven consecutive days made on a rolling basis.

### [340-041-0028](#)

#### Temperature

[...]

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

- (a) The seven-day-average maximum temperature of a stream identified as having salmon and steelhead spawning use on subbasin maps and tables set out in OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, 320B, and 340B, may not exceed 13.0 degrees Celsius (55.4 degrees Fahrenheit) at the times indicated on these maps and tables;
- (b) The seven-day-average maximum temperature of a stream identified as having core cold water habitat use on subbasin maps set out in OAR 340-041-101 to 340-041-340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 16.0 degrees Celsius (60.8 degrees Fahrenheit);
- (c) The seven-day-average maximum temperature of a stream identified as having salmon and trout rearing and migration use on subbasin maps set out at OAR 340-041-0101 to 340-041-0340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 18.0 degrees Celsius (64.4 degrees Fahrenheit);

(d) The seven-day-average maximum temperature of a stream identified as having a migration corridor use on subbasin maps and tables OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 151A, 170A, and 340A, may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit). In addition, these water bodies must have coldwater refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body. Finally, the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern;

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

(f) The seven-day-average maximum temperature of a stream identified as having bull trout spawning and juvenile rearing use on subbasin maps set out at OAR 340-041-0101 to 340-041-0340: Figures 130B, 151B, 160B, 170B, 180A, 201A, 260A, 310B, and 340B, may not exceed 12.0 degrees Celsius (53.6 degrees Fahrenheit). From August 15 through May 15, in bull trout spawning waters below Clear Creek and Mehlhorn reservoirs on Upper Clear Creek (Pine Subbasin), below Laurance Lake on the Middle Fork Hood River, and below Carmen reservoir on the Upper McKenzie River, there may be no more than a 0.3 degrees Celsius (0.5 Fahrenheit) increase between the water temperature immediately upstream of the reservoir and the water temperature immediately downstream of the spillway when the ambient seven-day-average maximum stream temperature is 9.0 degrees Celsius (48 degrees Fahrenheit) or greater, and no more than a 1.0 degree Celsius (1.8 degrees Fahrenheit) increase when the seven-day-average stream temperature is less than 9 degrees Celsius.

[...]

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

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

[...]

(9) Cool Water Species.

(a) No increase in temperature is allowed that would reasonably be expected to impair cool water species. Waters of the State that support cool water species are identified on subbasin tables and figures set out in OAR 340-041-0101 to 340-041-0340; Tables 140B, 190B and 250B, and Figures 180A, 201A and 340A

(b) See OAR 340-041-0185 for a basin-specific criterion for the Klamath River.

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

[...]

(12) Implementation of the Temperature Criteria

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

(d) Low Flow Conditions. An exceedance of the biologically-based numeric criteria in section (4) of this rule... will not be considered a permit violation during stream flows that are less than the 7Q10 low flow condition for that water body.

## Assessment methodology

Seven day average daily maximum (7DADM) values from continuous data recorders are evaluated against criterion values identified in Table 18 using the following protocols and.

## Data evaluation

### Determining Applicable Criteria

Table 16. Numeric temperature criteria

Designated Fish Use	Temperature Criterion, °C
<b>Year-Round Criteria</b>	
Salmon & trout rearing & migration	18.0
Core cold water habitat	16.0
Migration corridor (salmon & steelhead)	20.0
Lahontan cutthroat or redband trout	20.0
Bull trout spawning & juvenile rearing	12.0
<b>Spawning Criteria</b>	
Salmon & steelhead spawning	13.0

### Designated fish uses

The year-round fish uses designated for protection of fish and aquatic life are indicated in in OAR 340-041-0101 to 340-041-0340: Figures 130A, 151A, 160A, 170A, 180A, 201A, 220A, 230A, 260A, 271A, 286A, 300A, 310A, 320A, and 340A; Tables 101B, 120B, 121B, 130B 140B,151B, 160B, 170B, 180A, 190B, 201A, 250B, 260A, 310B, and 340B. For convenience, the information from the fish use figures and tables are also reproduced on the DEQ [IR web map](#).

#### Designated spawning time periods

In streams designated as salmon and steelhead spawning areas, the salmon & steelhead spawning criterion (13°C) shall be applied ONLY during the time periods indicated in tables and figures referenced in OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, 320B, and 340B. Outside of these designated spawning time periods, the year-round criteria shall apply. For convenience, the information from the spawning use tables and figures are also reproduced on the DEQ Integrated Report web map application.

## **Application of the Klamath River cool water species narrative criterion for temperature in 340-041-0028 (9)(b)<sup>43</sup>**

To ensure the protection of Lost River and Shortnose Suckers in the five-mile reach of the Klamath and Link Rivers associated with the urban areas of Klamath Falls, if two or more 7DADM values exceed 28°C in this reach, except when the air temperature or low flow exclusions apply, DEQ will determine that the cool water species narrative criterion is not being attained in this reach for purposes of CWA section 303(d) assessments. This reach is depicted on the DEQ [IR web map](#).

### **Applicability to tributary waters**

For tributary waters that are not identified on the “Fish Use Designations” maps referenced in section (4) of the rule, the applicable criteria for these waters are the same criteria as is applicable to the nearest downstream water body depicted on the applicable map. This does not apply to the “Salmon and Steelhead Spawning Use Designations” maps.

### **Data requirements**

Continuous data must be collected to reliably capture the daily maximum temperature for at least six of seven consecutive days. At a minimum, monitoring data should be collected during the critical warm period (July 1 to September 30) that adequately captures peak temperatures **OR** any applicable spawning periods to be sufficient to demonstrate attainment of the criteria. Instantaneous or “grab” temperature readings are not sufficient to be evaluated against the biologically based numeric criteria.

### **Calculating the seven-day average maximum temperature metric**

The seven-day average daily maximum (7DADM) stream temperature is an average of the daily maximum water temperatures for seven consecutive days. The average daily maximum temperature value for each seven-day period is assigned to the last (7th) calendar day of each period.

The 7DADM is repeated for each consecutive 7-day period on a moving or rolling basis. For example, the 7DADM for August 10 is calculated from Tmax for August 4 to August 10; the 7DADM for August 11 is calculated from August 5 to 11, etc.

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<sup>43</sup> [Memorandum RE: Implementation of Cool Water Species Criterion for Klamath River Sucker](#), March 6, 2017.

$$7DADM = \frac{1}{7} \sum_{i=1}^7 T_{\max-i}$$

Where:

i = day in the sequence

Tmax = maximum temperature of day, i

When spawning criteria apply, the first 7-day averaging period begins on the date the spawning period begins. The first 7DADM value will be assigned to the 7th calendar day following the start date of the spawning period. Therefore, the 7th calendar day of the spawning period is the first day that the 7DADM is required to meet the spawning criteria.

The exceedance is attributed to daily maximum air temperatures that exceed the 90th percentile value of annual maximum seven-day average maximum air temperatures calculated using at least 10 years of air temperature data

## **Assignment of assessment category**

### **Category 5: water quality Limited, TMDL needed (303(d) list)**

Any two instances of the seven-day-average daily maximum temperature exceed the applicable criteria within a three-year period.

Potential listings shall be reviewed for exception under the air temperature exclusion and low flow exclusion before being finalized. Listings that DEQ determines are subject to the air temperature exclusion will be confirmed prior to publishing the final 303(d) list. Listings invalidated due to the air temperature exclusion shall be placed in Category 2, or will be put through the delisting process is applicable.

### **Category 4: water quality limited, TMDL not needed**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address impairment and the pollutant will attain water quality standards (Category 4B),

### **Category 3: insufficient data**

When less 80 percent of data collected during the critical warm period or an applicable spawning period and no excursions.

### **Category 3B: insufficient data; potential concern**

When temperature data are collected and show at least one instance of the seven-day-average daily maximum temperature exceeding the criteria within a three-year period, but data are insufficient to place in Category 5.

### **Category 2: attaining**

When continuous temperature data are collected, no seven-day-average of the daily maximum temperature exceed the applicable criterion. Data represent the duration of the critical warm period or an applicable spawning period. Attainment of the year-round criteria and the spawning criteria shall be listed separately within a water body.

### **Delisting – new data**

A water body is delisted and assigned Category 2: Attaining if there is sufficient information from the current assessment to evaluate the pollutant or parameter, and the information demonstrates that currently applicable water quality standards are being met. Data used for delisting must meet data quality requirements described below. An assessment unit will be eligible for delisting for temperature if the assessment unit meets the following scenario:

#### **For year-round listings:**

1. Assessment results in a Category 2 designation (no excursions of the 7DADM temperature criteria) **and**
2. Dataset must include a minimum of three years (does not have to be consecutive) of data in the current IR data window that represent at least 80% of the critical period (July 1– September 30).

#### **For spawning listings:**

1. Assessment results in a Category 2 designation (no excursions of the spawning 7DADM temperature criteria) **and**
2. Dataset must include a minimum of three years (does not have to be consecutive) of data in the current IR data window that represent at least 80% of the spawning critical period (spawning period overlap of April through November). If the spawning period extends across the non-critical period months, the dataset must include 80% of the period from each of the fall and spring critical periods.



## Assessment - Total Dissolved Gas

PARAMETER	BENEFICIAL USE
Total dissolved gas – Saturation	Fish and Aquatic Life

## Water Quality Standards

### [340-041-0031](#)

#### **Total Dissolved Gas**

(1) Waters will be free from dissolved gases, such as carbon dioxide, hydrogen sulfide, or other gases, in sufficient quantities to cause objectionable odors or to be deleterious to fish or other aquatic life, navigation, recreation, or other reasonable uses made of such water.

(2) Except when stream flow exceeds the ten-year, seven-day average flood, the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection may not exceed 110 percent of saturation. However, in hatchery-receiving waters and other waters of less than two feet in depth, the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection may not exceed 105 percent of saturation.

## Assessment methodology

Releasing water over the dams' spillways is a fishery-management tool on the Columbia River and other rivers in Oregon. However, spilling water over the dams increases the level of total dissolved gas in the river. Water plunging from a spillway traps air and carries it to a depth where the pressure forces the gas into solution. Total dissolved gas levels above 110 percent of saturation can cause gas bubble trauma in fish. This methodology is used to assess waters impacted by the excess total dissolved gases.

## Data evaluation

Data reported to DEQ and/or in the DEQ AWQMS database.

## Data requirements

Total dissolved gas data reported as percent saturation.

## Assignment of assessment category

**Category 5: water quality limited, TMDL needed (303(d) list)**

Greater than 10% of the samples exceed 110% saturation or applicable temporary criteria approved by the Environmental Quality Commission according to the exact binomial test **OR** a survey identifies beneficial use impairment due to total dissolved gas such as assessment of fish conditions.

**Category 4: water quality limited, TMDL not needed**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

**Category 3: insufficient data**

Available data are not sufficient to determine if the use is impaired.

**Category 2: attaining**

Less than or equal to 10% of the samples are outside the range of the appropriate criterion according to the exact binomial test **AND** no impairments have been observed from dissolved gases, such as carbon dioxide, hydrogen sulfide, or other gases.

**Delisting – new data**

There is no current delisting process for total dissolved gas. Assessment units will be evaluated for delisting on a case by case basis.

## Assessment - toxic substances

PARAMETER	BENEFICIAL USE
<b>TABLE 30: Aquatic Life Water Quality Criteria for Toxic Pollutants</b>	Fish and Aquatic Life
<b>TABLE 40: Human Health Water Quality Criteria for Toxic Pollutants</b>	Fishing (Consumption) - Shellfish Harvesting
<b>TABLE 40: Human Health Water Quality Criteria for Toxic Pollutants (water + organism only)</b>	Domestic Water Supply
<b>Public Health Advisories</b>	Fishing (Consumption) - Shellfish Harvesting

## Water quality standards

### [340-041-0007](#)

#### **Statewide Narrative Criteria**

(10) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish may not be allowed;

### [340-041-0033](#)

#### **Toxic Substances**

(1) Toxic Substances Narrative. Toxic substances may not be introduced above natural background levels in waters of the state in amounts, concentrations, or combinations that may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare or aquatic life, wildlife or other designated beneficial uses.

(2) Aquatic Life Numeric Criteria. Levels of toxic substances in waters of the state may not exceed the applicable aquatic life criteria as defined in Table 30 under OAR 340-041-8033.

(3) Human Health Numeric Criteria. The criteria for waters of the state listed in Table 40 under OAR 340-041-8033 are established to protect Oregonians from potential adverse health effects associated with long-term exposure to toxic substances associated with consumption of fish, shellfish and water.

**NOTE:** Tables 30, 31 and 40 are found under [OAR 340-041-8033](#) and 340-041-8033

Division 41 Tables and Figures

(1) Table 30: Aquatic Life Water Quality Criteria for Toxic Pollutants. This table, referenced in OAR 340-041-0033, contains information about the applicability and content of the criteria contained in the table.

(2) Table 31: Aquatic Life Water Quality Guidance Values for Toxic Pollutants. This table, referenced in OAR 340-041-0033, contains information about the applicability and content of the criteria contained in the table.

(3) Table 40: Human Health Water Quality Criteria for Toxic Pollutants. This table, referenced in OAR 340-041-0033, contains information about the applicability and content of the criteria contained in the table.

[ED. NOTE: Tables referenced are not included in rule text.]

## Assessment methodology

Oregon's toxic substance water quality standards in [OAR 340-041-0033 Table 30 and Table 40](#) contain detailed information on how to apply and calculate criteria in footnotes, endnotes, supplemental equations and tables, and cited model software. The following section describes additional protocols for specific toxic pollutants to make best use of all available data. Pollutant chemicals in EPA National Recommended Water Quality Criteria documents are correlated to chemical names and unique CAS registry number and are identified with criteria in Table 30 and Table 40.<sup>44,45,46,47</sup> DEQ has developed additional memoranda to address analytical and monitoring issues for specific toxic pollutants and criteria.<sup>48</sup> DEQ follows these guidelines to resolve questions on how to group various chemical species and evaluate data for the Integrated Report assessment. The sections below include criteria-specific detailed protocols for aquatic life criteria followed by human health criteria.

## Pollutant specific aquatic life water quality criteria

### Alkalinity criterion

EPA's recommendation for the aquatic life freshwater criterion for alkalinity is "20 mg/L or more as CaCO<sub>3</sub> except where natural concentrations are less."<sup>49</sup> Alkalinity should not be below this value to protect aquatic life.

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<sup>44</sup> [EPA National Recommended Water Quality Criteria](#)

<sup>45</sup> [National Institute of Standards and Technology](#)

<sup>46</sup> [Agency for Toxic Substance and Disease Registry](#)

<sup>47</sup> [US EPA Substance Registry Services](#)

<sup>48</sup> Memorandums with Recommendations for Analysis and Implementation of Specific Toxic Pollutants are available at DEQ's [Standards for Toxics Pollution webpage](#)

<sup>49</sup> 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001

Alkalinity is a measure of carbonate and bicarbonate ions and the buffering capacity of water to pH changes. Freshwater systems have natural variations in pH that are related to photosynthetic activity and other inorganic and organic chemical reactions. Applying the alkalinity criterion as an isolated standard may lead to incorrect conclusions about overall natural water quality or the causes of beneficial use impairments. For Integrated Report evaluations, analytical data indicating alkalinity less than the criterion is flagged as a **Category 3B Insufficient Data:**

**Potential concern.** Professional judgment should be used during TMDL development or on a case-by-case basis to consider alkalinity information along with information for other related pollutants such as pH, chlorophyll a, aquatic weeds or algae growth, and dissolved oxygen when addressing beneficial use support.

### **Aluminum criteria**

In 2021, EPA promulgated freshwater aluminum aquatic life criteria for Oregon<sup>50</sup> as the result of a 2016 federal consent decree. The promulgated aluminum criteria are based on EPA's current recommended freshwater aluminum aquatic life criteria published in 2018.<sup>51</sup> The criteria vary with the water chemistry parameters pH, dissolved organic carbon (DOC), and hardness, because these parameters modify aluminum toxicity to aquatic life. The aluminum aquatic life criteria magnitudes are determined by inputting pH, DOC, hardness and into EPA's Aluminum Criteria Calculator based on multiple linear regression models and species sensitivity distributions. This calculator produces instantaneous criteria values that account for changes in toxicity of aluminum to aquatic life due to differences in water chemistry.

Aluminum is naturally occurring and may be found in many different chemical forms in the aquatic environment. However, not all forms of aluminum are toxic to aquatic organisms. EPA defines "bioavailable aluminum" (or the bioavailable fraction of aluminum) as: "the amount of aluminum that is available to cause a biological response in an aquatic organism."<sup>52</sup> The non-bioavailable (and therefore non-toxic) fraction of aluminum includes large suspended particles, clays, and aluminosilicate minerals. The aluminum criteria were based on toxicity tests performed in laboratory waters that were free of colloidal, particulate, and clay-bound aluminum. The aluminum criteria are expressed as total recoverable aluminum, because in the absence of suspended solids, the total recoverable aluminum fraction is also the bioavailable fraction. However, when total recoverable aluminum is measured in an ambient water body, the

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<sup>50</sup>USEPA (2021). Federal Aluminum Aquatic Life Criteria Applicable to Oregon. Docket No. 40 CFR Part 131. Docket No. EPA-HQ-OW-2016-0694.

<sup>51</sup> USEPA (2018). Final Aquatic Life Ambient Water Quality Criteria for Aluminum. Office of Water. Docket No. EPA-822-R-18-001.

<sup>52</sup>USEPA (2021). Federal Aluminum Aquatic Life Criteria Applicable to Oregon. Docket No. 40 CFR Part 131. Docket No. EPA-HQ-OW-2016-0694.

suspended particles, clays and minerals are included in the measured concentration value. The rule, as recorded in the federal register, recognizes that "total recoverable aluminum concentrations measured in natural waters may overestimate the potential risks of toxicity to aquatic organisms if suspended solids, clays, or particulate matter to which aluminum may be bound are present, because total recoverable methods measure bioavailable and non-bioavailable forms of aluminum."<sup>53</sup> In the promulgated rule, EPA included the option for Oregon to use bioavailable fraction of aluminum implement the criteria in ambient waters.

At the time of the promulgation, a method for measuring bioavailable aluminum had been proposed and was planned for submission as a standard method to the ASTM. In 2022, the DEQ laboratory and others began using the analytical method described by Rodrigues et al.<sup>54</sup> to quantify bioavailable aluminum in surface waters.<sup>55</sup>

### **Sufficient bioavailable aluminum**

For waterbodies with sufficient bioavailable aluminum results in the IR data window to determine either impairment Table 6 or attainment Table 4, DEQ will assess the data according to the aquatic life toxics methodology.

### **Only total recoverable aluminum**

For waterbodies where only total recoverable aluminum data are available, if greater than 5% of total recoverable samples exceed criteria with 90% confidence according to the exact binomial test, the assessment unit will be placed in Category 3B.

### **Both bioavailable and total recoverable aluminum**

For waterbodies with insufficient bioavailable samples in the IR data window to determine attainment Table 4, but where a combination of bioavailable and total recoverable is available, the assessment unit will be placed in Category 3B if the combined samples exceed criteria with 90% confidence according to the exact binomial test. DEQ will prioritize collection of bioavailable data at these locations.

If the combined samples do not exceed criteria with 90% confidence according to the exact binomial test, the assessment unit will be placed in Category 3.

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<sup>53</sup> USEPA (2021). Federal Aluminum Aquatic Life Criteria Applicable to Oregon. Docket No. 40 CFR Part 131. Docket No. EPA-HQ-OW-2016-0694.

<sup>54</sup> Rodrigues et al. (2019). Determination of bioavailable aluminum in natural waters in the presence of suspended solids. *Environmental Toxicology and Chemistry*, 38(8), 1668-1681.

<sup>55</sup> Standard Operating Procedure. Extraction of Bioavailable Al and Fe at pH of 4.0. Oregon Department of Environmental Quality, 2022. DEQ22-LAB-0009-SOP

## **Use of default values**

If a default DOC input parameter value is used (along with measured pH and hardness) to determine criteria, and the bioavailable aluminum concentration exceeds the criteria according to the exact binomial test, the water body will be listed as Category 5 (consistent with the use of default input parameters for copper). If the aluminum concentration exceeds the default regional aluminum criteria (absent measured pH or hardness data) according to the exact binomial test, the water body will be listed as Category 3B.

## **Ammonia criteria**

Aquatic life criteria for ammonia are pH, temperature, and salinity dependent. Additionally, different equations are used to calculate acute criteria values (one-hour average) for ammonia, based on presence or absence of salmonids. Ammonia chronic criteria values are calculated as 30-day rolling averages. See OAR 340-041-8033 Table 30(a-c) and DEQ's websites and calculators for instructions to calculate the appropriate criteria for each sample result. These criteria cannot be exceeded more than once every three years on average. Acute ammonia criteria are assessed using the exact binomial test. To be assessed as Category 2; Attaining, less than 5% of the samples may exceed the appropriate criterion according to the exact binomial test.

For the assessment data evaluation, if temperature or pH data are not available, criteria are not calculated and the sample result is not evaluated. Ammonia criteria for estuarine waters are calculated using the appropriate equations for freshwater. EPA recommends criteria calculations not be extrapolated beyond the pH and temperature range specified in the criteria calculation equations. To calculate criteria for results with pH values outside the specified range (6.5 - 9.0), DEQ uses 6.5 when reported pH values are less than 6.5, and 9.0 when reported pH values are greater than 9.0.

Ammonia criteria for saltwater are established for un-ionized ammonia (NH<sub>3</sub>) which is the principal toxic form of ammonia.<sup>56</sup> For the assessment data evaluation, the criteria for marine sites are calculated using the saltwater equations. Marine sites are identified using geographic information and confirmed with salinity or conductivity data. A default salinity value of 10 ppt is used if site specific data are not available.

## **Arsenic criteria**

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<sup>56</sup> 1989, [Ambient Water Quality Criteria for Ammonia \(Saltwater\)-1989](#), U.S. EPA Office of Water, EPA 440/5-88-004;

Oregon's aquatic life criteria for arsenic apply to dissolved concentrations of total inorganic arsenic (arsenic (III) plus arsenic (V)). Available data for arsenic are typically for either total recoverable or total dissolved arsenic. DEQ completed an Oregon specific study of 460 samples of paired total recoverable and inorganic arsenic data. Based on its results, absent inorganic arsenic data, DEQ will use a conversion factor of 0.80 (freshwater) and 0.59 (estuary) to convert total recoverable arsenic to inorganic arsenic for assessment purposes.

### **Cadmium criteria**

The aquatic life cadmium criteria for freshwater are hardness-dependent and must be calculated for each result. EPA promulgated Federal Clean Water Act acute aquatic life criterion for Oregon effective on 3/6/2017 and provided equations and conversion factors to calculate the acute criterion for dissolved cadmium concentration in freshwater.<sup>57</sup> DEQ uses the more conservative ecoregion hardness default values for acute cadmium criterion which is consistent with the protective default values used for other hardness-based metals (Table 19).

The freshwater acute criterion is calculated using the equations and conversion factors in Table 30 Endnote E. The freshwater chronic criterion is calculated using the equations and conversion factors in Table 30 Endnote F.

DEQ prefers to use ambient hardness data specific to the sample result, but uses ecoregion default values when sample data are not available in order to calculate criteria for cadmium and other hardness-dependent metals.

### **Chlordane (CAS No. 57749) and heptachlor (CAS No. 76448) criteria**

Aquatic life criteria for chlordane are applied to sample results reported for the technical product (CAS No. 12789036) or non-specific chlordane (CAS No. 57749), or to the sum of isomers, other constituents, and metabolites of chlordane including cis-chlordane (synonym  $\alpha$ -chlordane) (CAS No. 5103719), trans-chlordane (synonym  $\gamma$ -chlordane) (CAS No. 5103742),  $\gamma$ -chlordane (CAS No. 5566347), cis-nonachlor (CAS No. 5103731), trans-nonachlor (CAS No. 39765805), and oxychlordane (CAS No. 27304138). Another known major constituent of chlordane mixtures is heptachlor (CAS No. 76448). Aquatic life criteria for heptachlor are applied separately for this chemical.

### **Chloride**

Chloride is a major component of salinity and it is expected that elevated chloride concentration will occur naturally in estuary areas. Therefore, DEQ will not apply the freshwater criterion for

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<sup>57</sup> [Aquatic Life Criteria for Cadmium in Oregon](#), Federal Register 82 FR 9166 02/03/2017, p 9166-9174



chloride in estuaries. Data from coastal streams near estuaries will be evaluated for salinity values or spatial proximity to brackish waters before applying the freshwater criteria.

## **Chlorine**

The aquatic life criteria for chlorine in freshwater and saltwater are expressed as “total residual chlorine” which is the sum of free and combined chlorine.<sup>58</sup>

## **Chromium criteria**

The aquatic life criteria include criteria for two oxidation states of chromium - chromium III (trivalent) and chromium VI (hexavalent). The criteria for chromium III are hardness-dependent and must be calculated.

Most sample analyses are done for total chromium and do not report concentrations for the separate oxidation states.<sup>59</sup> To evaluate available data, results for total chromium are compared to the most stringent applicable criterion for either oxidation state. When chromium data are available as total chromium, and the chromium VI (hexavalent) criteria are exceeded, waterbodies will be identified as Category 3B: Insufficient Data - Potential Concern until follow up monitoring can occur for laboratory confirmation of chromium VI, specifically. When chromium data are available as total chromium, and the chromium III (trivalent) criteria are exceeded, waterbodies will be identified as Category 5. Table 30 Endnote F contains the conversion factors to convert total chromium to dissolved chromium.

## **Copper criteria**

The aquatic life criteria for copper in freshwater are functions of water chemistry including ions, alkalinity, organic carbon, pH, and temperature in the water column. The criteria are derived using the biotic ligand model referenced in Table 30 Endnote N. DEQ prefers to use criteria derived from site-specific measured input parameter values for the model. If measured data for one or more of the model input parameters are not available, DEQ will follow the copper criteria implementation procedures<sup>60</sup> and (1) substitute an estimated input parameter or use default values, or (2) derive a default action value using regional default input parameter values for the biotic ligand model. DEQ will subsequently assess the data according to the exact binomial test procedures.

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<sup>58</sup> 2023 DEQ [Memorandum RE: Implementation Instructions for the Water Quality Criterion Chlorine](#) (CAS #: 7782-50-5)

<sup>59</sup> 2014 [DEQ Memorandum RE: Implementation Instructions for Water Quality Criteria Chromium III](#) (CAS #: 16065-83-1) and Chromium VI (CAS #: 18540-29-9)

<sup>60</sup> DEQ 2016, [Implementation of the Freshwater Aquatic Life Water Quality Standards for Copper](#)

The aquatic life criteria for copper in saltwater are not derived from the model, and results for copper are compared to the applicable saltwater criteria in Table 30.

### **Cyanide criteria**

The aquatic life criteria for cyanide are expressed as free cyanide ( $\mu\text{g (CN)/L}$ ). DEQ uses total or “available” cyanide data as a conservative surrogate for free cyanide in cases where there are no analytical results based on free cyanide.<sup>61</sup>

### **DDT, DDD, and DDE criteria**

The aquatic life criteria for DDT 4,4' specify that the criteria apply to the total concentration of DDT and its metabolites. The total concentration of DDT and its metabolites should not exceed this value. DEQ sums analytical data results for DDT and metabolites.<sup>62</sup>

### **Demeton criteria**

The aquatic life criteria for demeton are applicable to sample results reported as demeton (CAS No. 8065483) and disulfoton (CAS No. 298044). The two pesticides are toxicologically similar and EPA uses toxicity data for both compounds. DEQ applies the demeton criteria to both pesticide products.

### **Endosulfan criteria**

The aquatic life criteria for the group endosulfan are applied to sample results reported for endosulfan (CAS No. 115297) or to the sum of sample results reported for the isomers  $\alpha$ -endosulfan (CAS No. 959988) and  $\beta$ -endosulfan (33213659).

### **Guthion (azinphos methyl) criteria**

Aquatic life criteria for Guthion are applied to results for Guthion (labeled Azinphos-methyl in the AWQMS database) (CAS No. 86500) but not for the metabolic breakdown product azinphos methyl oxygen analog (CAS No. 961228).

### **Hexachlorocyclohexane, BHC, and lindane criteria**

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<sup>61</sup> 2022 DEQ [Memorandum RE: Implementation Instructions for Free and Total Cyanide Water Quality Criteria](#) (CAS #: 57-12-5)

<sup>62</sup> 2014, [DEQ Memorandum RE: Implementation Instructions for Water Quality Criterion DDT, -4,4'](#) (CAS #: 50-29-3)

BHC gamma (synonym hexachlorocyclohexane (Lindane)) are applied to sample results reported for that chemical (CAS No. 58899). The pesticide product Lindane is generally > 99% the gamma isomer (synonyms  $\gamma$ -HCH or  $\gamma$ -BHC).

### **Iron criterion**

The aquatic life criterion for iron is applicable to total recoverable concentrations of iron in a water sample. Sample results for dissolved iron fractions are not considered valid to use to determine attainment of the criteria. This is because the dissolved iron concentration generally constitutes only a fraction of total iron concentration in an ambient water sample. However, if the dissolved iron fraction exceeds the iron criterion, the results are counted as valid results to determine exceedance since the total fraction will also exceed the criterion.

### **Mercury criteria**

The aquatic life criteria for mercury apply to total mercury in the water column.

### **Parathion criteria**

The aquatic life criteria for parathion are applied to results for ethyl parathion (CAS No. 56382).

### **PCB criteria**

The aquatic life criteria for PCBs (Polychlorinated Biphenyls) are applied to either the sum of sample results reported as Aroclors, or the sum of sample results reported as individual congeners.

### **Pentachlorophenol criteria**

The aquatic life criteria for pentachlorophenol (CAS No. 87865) in freshwater are pH-dependent and will be calculated by using equations given in Table 30. Saltwater criteria are not pH-dependent.<sup>63</sup>

Generally, as pH decreases, the toxicity of pentachlorophenol increases. If pH data are not available, the freshwater criteria for pentachlorophenol cannot be calculated.

### **Phosphorus criterion**

The aquatic life criterion of 0.1  $\mu\text{g/L}$  applies to elemental phosphorus (P) in marine or estuarine waters to protect marine organisms against toxic effects.<sup>64</sup>

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<sup>63</sup> 1986, Ambient Water Quality Criteria for Pentachlorophenol, U.S. EPA Office of Water, EPA 440/5-86-009.

<sup>64</sup> 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001 for Phosphorus

## **Pollutant specific human health water quality criteria**

Numeric water quality criteria for the protection of human health from toxic substances shall be evaluated as the geometric mean of the observed samples of pollutant concentration.

Assessment conclusions will be based on the geometric mean (based on a minimum of three samples) of representative samples of the waterbody.

### **Arsenic criteria**

Oregon's human health criteria for arsenic are based on total inorganic arsenic (CAS No. 7440382) rather than total recoverable arsenic. Similar to assessment of aquatic life criteria above, DEQ will use a conversion factor of 0.80 (freshwater) and 0.59 (estuary) to convert total recoverable arsenic to inorganic arsenic for assessment purposes. If the geometric mean for inorganic arsenic concentration, which are converted from total recoverable arsenic are greater than 2.1 µg/L the water body will be placed in Category 5.

### **Beryllium criteria**

Oregon's Clean Water Act human health criteria for beryllium were withdrawn in June 2010. However, public drinking water systems in Oregon are subject to the federal Safe Drinking Water Act Maximum Contaminant Level (MCL) for beryllium (4 µg/L). To identify where beryllium is impairing drinking water beneficial use, DEQ compares available data to the beryllium MCL. If sample results from public water system (PWS) source water and finished water exceed the MCL, the water body will be placed in Category 5: Water Quality Limited, TMDL Needed (303(d) List).

### **Bis chloromethyl ether (CAS No. 542881) criteria**

Current human health criteria include numeric criteria for chloromethyl ether, bis (CAS 542881). However, there are no recommended [analytical methods](#) to measure this chemical in water samples given its rapid hydrolysis in water.

### **Chlordane (CAS No. 57749) and heptachlor (CAS No. 76448) criteria**

Human health criteria for chlordane are applied to sample results reported for the technical product (CAS No. 12789036) or non-specific chlordane (CAS No. 57749), or to the sum of isomers, other constituents, and metabolites of chlordane including cis-chlordane (synonym α-chlordane) (CAS No. 5103719), trans-chlordane (synonym γ-chlordane) (CAS No. 5103742), γ-chlordane (CAS No. 5566347), cis-nonachlor (CAS No. 5103731), trans-nonachlor (CAS No. 39765805), and oxychlordane (CAS No. 27304138).

Another known major constituent of chlordane mixtures is heptachlor (CAS No. 76448). Human health criteria for heptachlor are applied separately for this chemical.

## **Cyanide criteria**

Human health criteria for cyanide specify the criteria apply to total cyanide (CAS No. 57125). Information from [EPA guidance](#) used to develop Oregon's criteria indicates the recommended criteria were derived from drinking water MCLs that are based on free cyanide (µg (CN)/L). DEQ uses total cyanide data as a conservative surrogate for free cyanide.

## **DDT, DDD, and DDE criteria**

Human health criteria are specified for DDT 4,4' (CAS No. 50293), DDD 4,4' (CAS No. 72548), and DDE 4,4' (CAS No. 72559). [DEQ implementation guidance](#) indicates results for each pollutant are compared to the appropriate human health criteria.

## **Dichlorobenzenes criteria**

Human health criteria for the class dichlorobenzenes were replaced with criteria for the individual isomers dichlorobenzene (m) 1,3 (CAS No. 541731), dichlorobenzene (o) 1,2 (CAS No. 95501), and dichlorobenzene (p) 1,4 (CAS No. 106467). Results for each isomer are compared to the individual criterion.

## **Dichloroethylenes criteria**

Human health criteria for the class dichloroethylenes were replaced with criteria for the individual chemicals dichloroethylene 1,1 (synonyms 1,1-dichloroethene or 1,1-DCE) (CAS No. 75354) and dichloroethylene trans 1,2 (CAS No. 156605). Results for each chemical are compared to the individual criterion.

## **Dichloropropene criteria**

Human health criteria for the compound dichloropropene were replaced with criteria for the compound specifically identified as dichloropropene 1,3 (CAS No. 542756). Only this specific chemical is compared to the criteria.

## **Dinitrophenols criteria**

Human health criteria include numeric criteria for the class of dinitrophenol isomers (CAS No. 25550587) and for one of the isomers dinitrophenol 2,4 (CAS No. 51285). [DEQ implementation guidance](#) indicates analytical results measured as dinitrophenol 2,4 are used as the surrogate for the dinitrophenol criteria.

## **Dioxin (2,3,7,8-TCDD) (CAS No. 1746016) criteria**

Human health criteria for dioxin are applied to sample results reported for the specific congener 2,3,7,8-tetrachlorodibenzodioxin (TCDD) (CAS No. 1746016).

### **Diphenylhydrazine 1,2 (CAS No. 122667) criteria**

Human health criteria include numeric criteria for diphenylhydrazine 1,2 to protect human health. Diphenylhydrazine 1,2 is difficult to analyze given its rapid decomposition rate in water. Instead, azobenzene, which is a decomposition product of 1,2 diphenylhydrazine, is analyzed as an estimate of this chemical. The [water quality criterion](#) for diphenylhydrazine 1,2 will be applied to analytical results from azobenzene.

### **Endosulfan criteria**

Human health criteria include values for individual chemicals endosulfan Alpha, endosulfan Beta, and endosulfan sulfate.

### **Halomethanes criteria**

Human health criteria for the class Halomethanes include individual criteria for bromoform (synonym tribromomethane) (CAS No. 75252), dichlorobromomethane (CAS No. 75274), methyl bromide (CAS No. 74839), and methylene chloride (synonym dichloromethane) (CAS No. 75092). These criteria are applied to sample results for the individual chemicals.

### **Hexachlorocyclohexane, BHC, and lindane criteria**

Human health criteria for BHC gamma (synonym hexachlorocyclohexane (Lindane)) are applied to sample results reported for that chemical (CAS No. 58899). The pesticide product Lindane is generally > 99% the gamma isomer (synonyms  $\gamma$ -HCH or  $\gamma$ -BHC).

Human health criteria for the isomer BHC alpha (synonyms hexachlorocyclohexane alpha,  $\alpha$ -HCH or  $\alpha$ -BHC) are applied to results for that chemical (CAS No. 319846).

Human health criteria for the isomer BHC beta (synonyms, hexachlorocyclohexane beta,  $\beta$ -HCH or  $\beta$ -BHC) are applied to results for that chemical (CAS No. 319857).

Human health criteria for the hexachlorocyclo-hexane-technical (CAS No. 608731) apply to the technical grade pesticide which is a mixture consisting of  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ , and  $\epsilon$  isomers. To be consistent with implementation guidance, [DEQ applies](#) the hexachlorocyclo-hexane-technical criteria to the sum of analytical results for the four major isomers.

### **Manganese criterion**

Oregon's human health criterion for manganese for "fish consumption only" applies only in saltwater for total manganese to protect consumption of oysters and other marine mollusks in marine and estuarine sites.

### **Mercury and methylmercury criteria**

The human health criterion for mercury is expressed as a fish tissue concentration of methylmercury (CAS No. 22967926) rather than total mercury in the water column and applies only to fish consumption.

Data for mercury in fish tissue from resident fish are analyzed for total mercury using EPA Method 7473, rather than methylmercury.<sup>65</sup> Scientific literature indicates that 90% or more of mercury in fish muscle (tissue not including skin) is methylmercury.<sup>66</sup> To evaluate data, DEQ uses sample results for total mercury in skinless fish fillets reported in mg/kg with "significant figures" limited to two decimal places. Based on the approximation that 90% of the reported mercury is methylmercury, DEQ concludes that any total mercury fish tissue result exceeding the methylmercury criterion (0.040 mg/kg) is a reasonable approximation of the methylmercury component in fish tissue. Fish tissue analyses for mercury may be from skinless fillets of individual fish, individual whole fish analyses, or composited skinless fillets from multiple fish. DEQ compares geometric mean concentrations of mercury from skinless fish fillets in individual resident fish to the human health fish tissue criterion following EPA guidance.<sup>67</sup>

DEQ also reviews fish consumption advisories issued due to mercury levels in fish to identify where mercury is causing impaired beneficial use for fish consumption.

### **Nitrosamines criteria**

The human health criteria apply to the nitrosamine class of nitrogen containing chemicals as well as for the following individual derivatives in the class:

- Nitrosodibutylamine N- (CAS No. 924163)
- Nitrosodiethylamine N- (CAS No. 55185)
- Nitrosodimethylamine N- (CAS No. 62759)
- Nitrosodi-n-propylamine, N (CAS No. 621647)
- Nitrosodiphenylamine N- (CAS No. 86306)

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<sup>65</sup> 2007, Method 7473, Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry. U.S. EPA Office of Solid Waste

<sup>66</sup> Ullrich, S.M., Tanton, T.W. and Abdrashitova, S.A., 2001. Mercury in the Aquatic Environment: A Review of Factors Affecting Methylation. *Critical Reviews in Environmental Science and Technology*, **31**(3): 241-293.

<sup>67</sup> US EPA Office of Science and Technology, 2001. Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. EPA 823-R-10-001. Washington, D.C.

- Nitrosopyrrolidine N- (CAS No. 930552)

The sum of all the results for individual nitrosamines is compared to the criteria for Nitrosodiethylamine N. This is the most toxic of the nitrosamine derivatives and its numerical criteria are equal to the criteria established for [total nitrosamines](#).

### **PCB criteria**

The human health criteria for PCBs (Polychlorinated Biphenyls) are applied to either the sum of sample results reported as Aroclors, or the sum of sample results reported as individual congeners.

DEQ also reviews fish consumption advisories issued due to PCB levels in fish to identify where PCBs are causing impaired beneficial use for fish consumption.

### **Pentachlorophenol criteria**

The human health criteria for pentachlorophenol are not pH-dependent and water quality data can be directly compared to the criteria.

### **Polynuclear aromatic hydrocarbons criteria**

The human health criteria for the group Polynuclear Aromatic Hydrocarbons (PAHs) are evaluated based on the individual criteria for the following isomers:

- Acenaphthene (CAS 83329)
- Anthracene (CAS 120127)
- Benz[a]anthracene (CAS 56553)
- Benzo[a]pyrene (CAS 50328)
- Benzo[b]fluoranthene (CAS 205992)
- Benzo[k]fluoranthene (CAS 207089)
- Chrysene (CAS 218019)
- Dibenzo[a,h]anthracene (CAS 53703)
- Fluoranthene (CAS 206440)
- Fluorene (CAS 86737)
- Indeno[1,2,3-c,d]pyrene (CAS 193395)

### **Pyrene (CAS 1290000)**

## **Data evaluation**

Data from sampling sites are evaluated using the following protocols. Unless specified otherwise in pollutant-specific protocols below, the assumed durations associated with grab samples are 1-hour (acute) and 96-hours (chronic). The following methodologies apply to all toxics. Where



there are specific considerations for particular criteria, those are specified in further detail within the Assessment Methodology sections above.

## **Determining applicable criteria**

### **Oregon's statewide narrative**

The statewide narrative criteria generally protect fish and aquatic life, and human consumption of drinking water and fish from toxic conditions and effects. Oregon's toxic substance narrative and numeric water quality standards protect human health, fish and aquatic life, and wildlife beneficial uses of water.

DEQ uses the narrative and numeric toxic pollutant criteria to determine where pollutants are causing impairments to applicable beneficial uses. Some toxic pollutants have criteria that apply to more than one beneficial use. For the assessment, DEQ applies criteria relevant to each use to determine water quality conditions and identify waters with impaired beneficial uses. Additional information about criteria applicable at specific locations is available using the DEQ water quality standards maps web tool.

### **Aquatic life**

The [OAR 340-041-8033 Table 30](#) criteria establish levels for specific toxic substances that are not to be exceeded more than once every three years on average to protect fish and aquatic life. DEQ evaluates data from the water column using the most stringent of the acute (1-hour average) or chronic (4-day average) pollutant criterion appropriate for the type of water (freshwater or saltwater).

To determine when freshwater or saltwater criteria are applicable, DEQ follows Oregon rules and EPA guidance.<sup>68</sup> Marine waters are defined in OAR 340-041-0002(34) as "...all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of the State of Oregon." For marine waters, DEQ applies the saltwater criteria. Estuarine waters are defined in OAR 340-041-0002(22) as "...all mixed fresh and oceanic waters in estuaries or bays from the point of oceanic water intrusion inland to a line connecting the outermost points of the headlands or protective jetties." In 2018, DEQ adopted the Oregon Coastal Atlas estuary classification using the Federal [Coastal and Marine Ecological Classification Standard](#) (CMECS) implemented by the Oregon Department of Land Conservation and Development to delineate the extent of estuaries and define where specific water quality criteria should apply. CMECS classification is used to determine applicability of the more stringent of the saltwater and freshwater criteria as described above in the Evaluating data and information section.

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<sup>68</sup> 2002, [National Recommended Water Quality Criteria: 2002](#), U.S. EPA Office of Water, EPA 822-R-02-047p.9.

The aquatic life toxicity of some pollutants is a function of water chemistry factors such as pH, temperature, salinity, or hardness. The applicable criterion is calculated for each monitoring result using water chemistry data. Criteria for ammonia, pentachlorophenol, and metals including cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the equations, factors, and models cited in Table 30: Aquatic Life Water Quality Criteria for Toxic Pollutants.

### **Human health uses – drinking water and fishing**

Statewide narrative and toxic substance narrative criteria protect human beneficial uses of water for drinking water and fishing. Public health advisories limiting fish consumption due to pollutant concentrations in fish or shellfish tissue are direct indicators of impairments to human beneficial uses and are used by DEQ to identify waters impaired by toxic pollutants.

The OAR 340-041-8033 Table 40 criteria protect human uses of water for public and private domestic water supply (i.e., drinking water consumption) and fishing (i.e., fish and shellfish consumption). DEQ evaluates data from the water column using the 'water + organism' criterion where both drinking water and fishing are designated uses. Most freshwaters in Oregon are designated for both drinking water and fishing. When fishing is a designated use but drinking water is not, DEQ applies the 'organism only' criterion. Most estuaries, marine waters, or saline waters are not designated for drinking water. In marine waters and estuaries if there is no 'organism only' criterion for a specific pollutant, DEQ may apply the 'water + organism' criterion. The criterion for methylmercury is the only fish consumption criterion based on fish tissue concentrations.

## **Data requirements**

### **Total recoverable or dissolved metals criteria**

Oregon's human health and aquatic life criteria for metals are established for either the "total recoverable" or "dissolved" fraction of the pollutant in water. The dissolved metal concentration in a water sample is usually a lesser proportion of the total recoverable metal concentration in the water. To evaluate water quality data, DEQ compares sample results to the applicable criteria using parameter results that match the fraction specified by the criterion, when available. Where sample results for both total recoverable and dissolved fractions are reported for the same date, only the result matching the fraction of the applicable criterion is evaluated.

### **Total recoverable criteria**

When the criterion is expressed as a total recoverable fraction, sample results for the dissolved fraction are considered valid for determining impairment. If the dissolved sample result exceeds

the total recoverable criterion the samples may be used to assign Category 5. A dissolved sample result less than a total recoverable criterion is not considered valid for determining attainment of the criterion, and the samples may be used to assign Category 3, but not Category 2, unless there are enough valid total recoverable samples to assign Category 2.

### **Dissolved criteria**

When the criterion is expressed as a dissolved fraction, sample results for the total fraction are considered valid if the sample result is converted to an equivalent dissolved fraction by multiplying by a site-specific conversion factor or translator. The converted results are valid to determine attainment or impairment of the dissolved criterion.

When no site-specific translator is available, but the total recoverable sample is less than a dissolved criterion, it is considered valid to determine attainment of the criterion and may be used to assign Category 2. If total recoverable samples are greater than a dissolved criterion, Category 3B may be assigned if there are no other dissolved samples to indicate impairment.

### **Hardness-dependent criteria**

The freshwater aquatic life criteria for six toxic metals (cadmium, chromium III, lead, nickel, silver, and zinc) are a function of hardness (mg/L) in the water column. Criteria for these metals are calculated using the equations and factors provided in Table 30 Endnote F and in 40 CFR Part 131 the federal criteria for acute cadmium in Oregon.<sup>69,70</sup> Total recoverable hardness values are used to derive criteria for metals concentrations.

If hardness is not directly reported as CaCO<sub>3</sub>, the following equation<sup>71</sup> is used to calculate hardness from the concentration of Ca<sup>+2</sup> and Mg<sup>+2</sup>, if available. All units are in mg/L:

$$\text{Hardness, equivalent CaCO}_3 = 2.497 \text{ Ca}^{+2} + 4.1189 \text{ Mg}^{+2}$$

To determine the hardness-dependent criteria, DEQ follows EPA guidance to use the concentration of ambient hardness to calculate criteria, even if the actual ambient hardness is

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<sup>69</sup> 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001

<sup>70</sup> [Federal Clean Water Act criterion promulgated for Oregon](#) effective 3/6/2017. 40 CFR Part 131 [EPA-HQ-OW-2016-0012; FRL-9958-40-OW] RIN 2040-AF60

<sup>71</sup> 1998, Standard Methods for the Examination of Water and Wastewater, 20th edition, American Public Health Association, American Water Works Association, Water Environment Federation

less than 25 mg/L as calcium carbonate, and a maximum hardness value of 400 mg/L as calcium carbonate, even if the actual ambient hardness is greater than 400 mg/L as calcium carbonate.<sup>72</sup>

DEQ will preferentially use concurrent measured hardness values when available but will use default values when needed for calculating protective hardness criteria. When ambient hardness concentration data is not available for a specific metal sample, DEQ will apply one of the default hardness values depending on the Ecoregion where the sample was collected (Table 19).

Table 17. Ecoregion default hardness values

Ecoregion	Default Hardness (mg/L)
Blue Mountains	21.7
Cascades	10.0
Coast Range	14.5
Columbia Plateau	23.4
Columbia River Mainstem	48.7
Eastern Cascades Slopes and Foothills	19.3
Klamath Mountains	28.5
Northern Basin and Range	32.3
Snake River Plain	80.9
Willamette Valley	25.0

## Assignment of assessment category

### Category 5: water quality limited, TMDL needed (303(d) list)

#### For fish and aquatic life

For two or more samples, greater than 5% of the samples exceed the appropriate **aquatic life criterion** according to the exact binomial test for listing Table 6;

#### For fishing and shellfish harvesting

The geometric mean of a minimum of three or more samples is greater than the appropriate **human health criterion**;

**OR**

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<sup>72</sup> 40 CFR Section 131.36(c)(4)(i). EPA 2002, [National Recommended Water Quality Criteria: 2002. U.S. Environmental Protection Agency. EPA-822-R-02-047](#). EPA-822-R-02-047, p.8. November 2002.

Any fish or shellfish consumption advisory issued by the Oregon Health Authority or Oregon Department of Agriculture for a specific water body based on pollutants in fish or shellfish tissue. Fish advisories are posted at:

<http://public.health.oregon.gov/newsadvisories/Pages/RecreationalAdvisories.aspx> or <https://www.oregon.gov/ODA/programs/FoodSafety/Shellfish/Pages/ShellfishClosures.aspx>

**OR**

The geometric mean of a minimum of three or more valid results exceeds the fish tissue criterion for methylmercury if the results are from skinless fillets of individual fish and/or shellfish.<sup>73</sup>

**OR**

The arithmetic mean of two or more valid results exceeds the fish tissue criterion for methylmercury if the results are from composited skinless fillets from multiple fish and/or shellfish of the same species.

**For domestic water supply**

The geometric mean of a minimum of three or more samples is greater than the appropriate human health (water + organism) criterion.

**Category 4: water quality limited, TMDL not needed**

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

**Category 3B: insufficient data; potential concern**

**For fish and aquatic life**

For fewer than 10 samples, one exceedance of the appropriate **aquatic life criterion**.

**For fishing and shellfish harvesting**

For fewer than three samples, more than one sample is greater than the appropriate **human health criterion**.

**Category 3D: insufficient data; not technologically feasible to assess**

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<sup>73</sup> Protocol based on US EPA Office of Science and Technology, 2001. Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. EPA 823-R-10-001. Washington, D.C.

**For fishing and shellfish harvesting or domestic water supply**

Data are not sufficient to determine use support because numeric criteria are less than quantitation limits.

**Category 3: insufficient data**

Data are not sufficient to determine impairment or attainment (unless assigned Category 3B).

**For fishing and shellfish harvesting**

Less than three valid samples for methylmercury in fish tissue when the results are from skinless fillets of individual fish and/or shellfish,

**OR**

Less than two samples for methylmercury in fish tissue from a composite sample composed of skinless fillets of multiple fish and/or shellfish of the same species.

**Category 2: attaining****For fish and aquatic life**

For a minimum of 10 samples, less than or equal to 5% of the samples exceed the appropriate aquatic life criterion according to the exact binomial test (see [Water Body Assessment](#));

**For fishing and shellfish harvesting**

The geometric mean of a minimum of three (3) valid samples is less than or equal to the appropriate human health criterion;

**OR**

Public health advisories are no longer needed based on fish tissue concentrations of pollutants;

**OR**

The geometric mean of a minimum of three valid samples meeting the human health criterion for methylmercury when the results are from skinless fillets of individual fish and/or shellfish;

**OR**

The arithmetic mean of a minimum of two valid samples meeting the human health criterion for methylmercury when the results are from a composite sample composed of skinless fillets of multiple fish and/or shellfish of the same species.

**For domestic water supply**

The geometric mean of a minimum of three valid samples is less than or equal to the appropriate human health (water + organism) criterion.

**Delisting – new data****For fish and aquatic life**

Assessment units with sufficient data in the data and window to meet the [Delisting – statistical methods](#) requirements for toxic pollutants will be removed from the 303(d) list and put in Category 2: Attaining.

**For human health criteria**

Numeric water quality criteria for the protection of human health from toxic substances will be evaluated as the geometric mean of the observed samples of pollutant concentration. Waters will be removed from the 303(d) list if the geometric mean of samples representative of the water body are less than the numeric criterion threshold.

## Assessment – turbidity

PARAMETER	BENEFICIAL USE
Turbidity	Domestic water supply
Turbidity	Fish and aquatic life

## Water quality standards

### [340-041-0007](#)

#### Statewide Narrative Criteria

(10) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish may not be allowed;

(11) The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed;

(12) Objectionable discoloration, scum, oily sheens, or floating solids, or coating of aquatic life with oil films may not be allowed;

(13) Aesthetic conditions offensive to the human senses of sight, taste, smell, or touch may not be allowed;

### **340-041-0036**

#### **Turbidity**

Turbidity (Nephelometric Turbidity Units, NTU): No more than a ten percent cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity. However, limited duration activities necessary to address an emergency or to accommodate essential dredging, construction or other legitimate activities and which cause the standard to be exceeded



may be authorized provided all practicable turbidity control techniques have been applied and one of the following has been granted:

(1) Emergency activities: Approval coordinated by the Department with the Oregon Department of Fish and Wildlife under conditions they may prescribe to accommodate response to emergencies or to protect public health and welfare;

(2) Dredging, Construction or other Legitimate Activities: Permit or certification authorized under terms of section 401 or 404 (Permits and Licenses, Federal Water Pollution Control Act) or OAR 14I-085-0100 et seq. (Removal and Fill Permits, Division of State Lands), with limitations and conditions governing the activity set forth in the permit or certificate.

## **Assessment methodology**

Turbidity measures the “cloudiness” of water; more precisely, it measures the extent to which light is scattered and absorbed by suspended sediment, dissolved organic matter, and, to a lesser extent, plankton and other microscopic organisms<sup>74</sup>. Turbidity is also referred to as the inverse of the “clarity” of water. Light that is not scattered or absorbed by turbidity-causing particles passes through the water. In other words, increased turbidity reduces the distance that light can penetrate into the water column. This methodology detail how DEQ assess turbidity for domestic drinking water and fishing and aquatic life uses.

## **Data evaluation**

DEQ will evaluate data or information submitted through the Call for Data to assess turbidity impairments for applicable beneficial uses.

## **Data requirements**

DEQ turbidity assessment of the drinking water criteria is based on voluntary submission of data and information by drinking water providers.

## **Assignment of assessment category**

### **Category 5: water quality limited, TMDL needed (303(d) list)**

#### **For fish and aquatic life**

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<sup>74</sup> Clesceri, L. S., A. E. Greenberg, and A. D. Eaton (eds.) 1994. Standard Methods for the Examination of Water and Wastewater, 20 ed. American Public Health Association, Washington, DC.

A systematic or persistent increase (of greater than 10%) in turbidity due to an operational activity that occurs on a persistent basis (e.g., dam release or irrigation return, etc.).

**For domestic water supply**

For impairments to beneficial use as drinking water supply, Public Water System operator indicates that high turbidity days (days with turbidity  $\geq 5$  NTU) are causing operational difficulty **AND** source water data validate this impairment. The data are considered to validate an impairment if more than 45 high turbidity days per year occur for any year for which data are available.

**Category 3: insufficient data**

**For fish and aquatic life**

There is insufficient data to show whether or not a systematic or persistent increase in turbidity due to an operational activity is occurring on a persistent basis

**For domestic water supply**

Available data are not sufficient to determine if the use is impaired. One or more turbidity shutdowns are documented in the Safe Drinking Water Information System database, but there is not data to demonstrate whether shutdown is due to a large storm event or indicates a problem and impaired beneficial use.

**Category 3B: insufficient data; potential concern**

For beneficial use as drinking water supply, available data are not sufficient to determine if the use is impaired, but indicate a potential concern. The Public Water System operator indicates that high turbidity days are causing operational difficulties, but there is not data available to validate this impairment, or if shutdowns due to high turbidity may be the result of unusual or infrequent weather events.

**Category 2: attaining**

**For fish and aquatic life**

Less than a 10% increase in turbidity due to an operational activity that occurs on a persistent basis (e.g., dam release or irrigation return, etc.).

**For domestic water supply**

Public Water System operator indicates that high turbidity days are not causing operational difficulty **AND/OR** source water data show 45 or less high turbidity days per year for all years for which data are available.

### **Delisting – new data**

There is no current delisting process for turbidity. Assessment units will be evaluated for delisting on a case-by-case basis.

# Appendix A: State and federal rules, guidance, and policies

The 2024 Integrated Report methodology is consistent with the following state and federal rules, guidance, and policies:

- Water Quality Standards, Beneficial Uses, Policies, and Criteria for Oregon: [Oregon Administrative Rules Chapter 340 Division 41](#)
- June 22, 1998 DEQ Letter to EPA Region 10, [Policy Clarification of Oregon Water Quality Standards Revisions](#)
- February 4, 2004 DEQ Letter to EPA Region 10, [Oregon Responses to EPA Questions on State's Water Quality Temperature Standards](#)
- [EPA memoranda to states for each reporting cycle 2002-2024](#)
- July 2002, [Consolidated Assessment and Listing Methodology](#), First Edition, U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds
- Federal Water Pollution Control Act §1315, [Chapter 26 - Water Pollution Prevention and Control](#)
- [40 CFR Part 130.7](#) (Code of Federal Regulations)
- [40 CFR Part 130.8](#) (Code of Federal Regulations)

