# 2022 Integrated Report Assessment Methodology

## Background paper: Assessment of watershed units by monitoring station

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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

### Assessment Unit Background

The Integrated Report conclusions are based upon assessment of predetermined segments of waterbodies, often referred to as assessment units. The Clean Water Act leaves it up to individual states to determine how waters will be partitioned for reporting purposes. Prior to the 2018/2020 Integrated Report, DEQ established stream segments based on the data available for each parameter and water quality criteria (which may be seasonal in nature).

This methodology presented several challenges from a reporting perspective. Inconsistent stream segments for different parameters led to difficulty in data summarization, such that overlapping segments could lead to unintentional double counting of impaired waters. In other cases, stream segments based on one monitoring location were often too long for the information to be considered useful for assessment purposes. In addition, since this methodology created new segments each reporting cycle, the assessed segments were redefined every two years, making it very difficult to track changes from cycle to cycle and made statewide summaries challenging for the public to understand. Figure 1 illustrates an example of Powder River segments assessed in 2012, and new assessment units assessed in 2018/2020.

The inconsistency in stream segmentation made delistings challenging. Identifying which waters should be delisted due to newly collected data was difficult and led to waterbodies not being removed from the impaired waters list when new data showed attainment of beneficial uses.

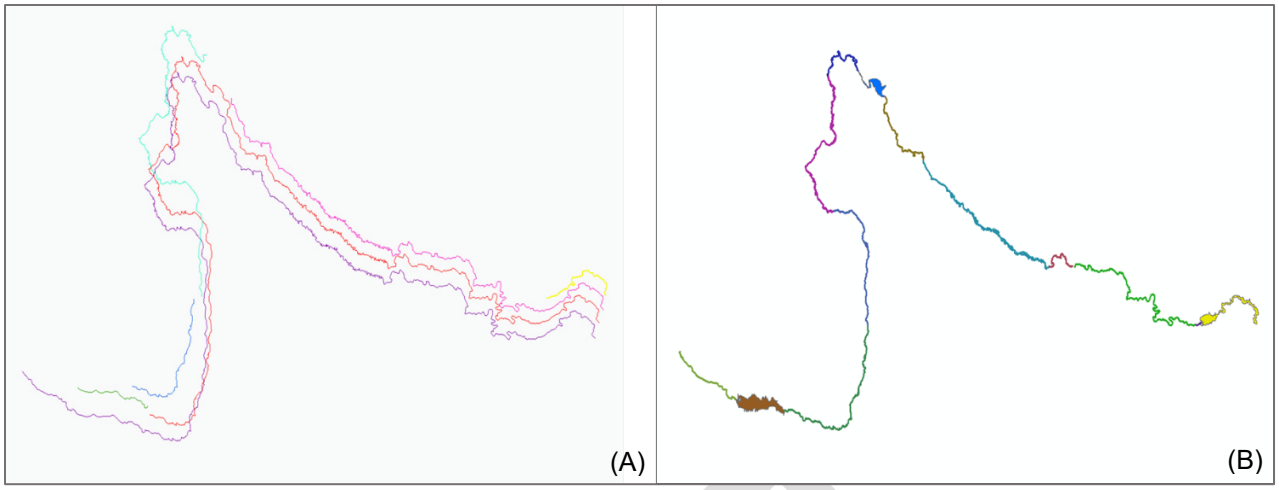



*Figure 1. (A) Powder River Listed Segments from the 2012 IR color coded by pollutant; (B) 13 Powder River Assessment Units in 2018/2020 IR. Colors represent fixed assessment units.*

Also, prior methodologies relied upon use of the StreamNet 1:100,000 scale hydrography data as a basis for identifying stream segments which included a longitude/latitude identifier that was embedded in the stream segment identifiers. Since not all assessed waters were represented in this low resolution hydrography, LLIDs were often artificially generated. These artificial LLIDs lacked associated spatial data referenced to the stream layer, which made it difficult to track assessments back to a location. Due to the piecemeal approach of manually geo-referencing missing segments, duplicate assessments were often created for the same parameter on the same waterbody.

## Fixed Assessment Units

Following an EPA analysis in 2015 of DEQ's assessment processes, DEQ was instructed to redesign how assessment units were delineated in order to meet the Assessment Total Maximum Daily Load Tracking and Implementation System (ATTAINS) reporting requirements. In 2016, DEQ redefined the method by which water body segments would be delineated, assessed, and reported on in the 2018/2020Integrated Report and subsequent reports. The goals of the revised assessment unit structure were:

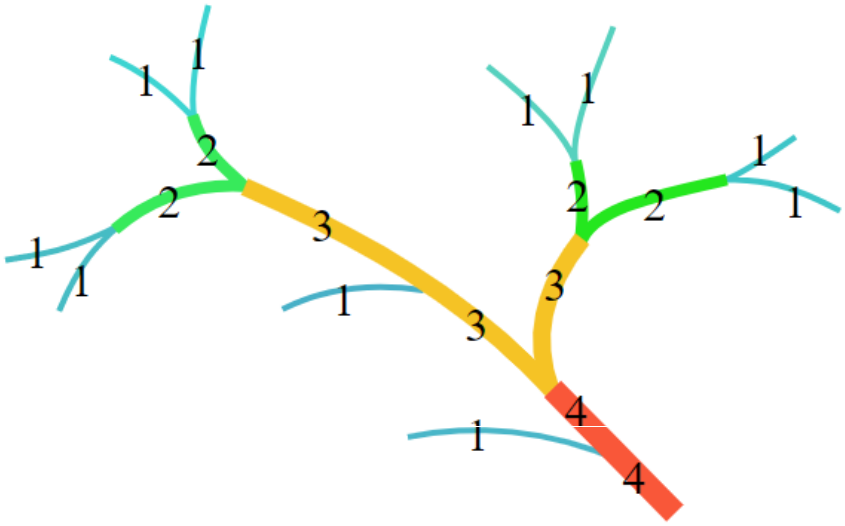
1. Consistency between reporting cycles of the Integrated Report
2. Alignment with the National Hydrography Dataset which is the national and state standard for defining and mapping waterbodies
3. Create a manageable number of assessment units that could be assessed every two years
4. Align with EPA's ATTAINS reporting requirements
5. Base units on hydrologically relevant breaks, rather than human activity (land use changes, point sources, etc.)

The basis of DEQ's new assessment units was adoption of the High Resolution National Hydrography framework, which is both the national and state standard for defining waterbodies spatially. The NHDH is a digital geospatial dataset that represents the surface water of the entire United States at a scale of 1:24,000 or better. Oregon adopted the NHDH as the hydrologic framework standard, replacing the LLID system (1:100,000). Use of the NHDH allows DEQ to

create consistent assessments across reporting cycles and align with EPA's reporting requirements.

When moving to the high resolution NHDH, DEQ defined assessment units for the entire stream network statewide. Keeping to the stated goal of using hydrology to define assessment units, DEQ's approach was to break larger rivers and streams when a significant tributary enters. Defining assessment units statewide also resulted in the need to classify headwaters and small feeder drainages, many of which are characterized by intermittent streams. DEQ evaluated various water quality assessment methodologies and found that defining assessment units at a watershed scale is a well-established methodology employed by many other states (e.g. California, Ohio, Michigan, etc.) for meeting EPA reporting requirements and to provide a practicable mechanism for assessing lower order (small) stream areas. Based on these established methods, DEQ grouped the smallest streams at the sub-watershed or HUC-12[1] level. In the absence of this approach for apportioning smaller streams, Oregon would have more than 2 million different assessment units in need of assessment, which is impractical relative to the state's monitoring and assessment resources.

The redefined assessment units were used in the 2018/2020 Integrated Report and include five types of assessment units: (1) watershed, (2) river and streams, (3) lakes, reservoirs and estuaries, (4) coastal beach and (5) ocean and they are summarized below:

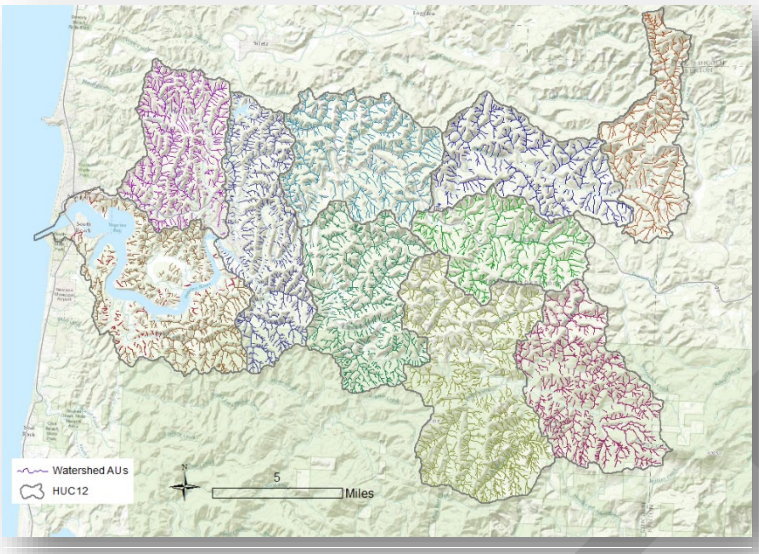


**Watershed**

All streams with a Strahler Stream Order[2] of four or less are grouped into a watershed unit that is broken at the HUC12 or sub-watershed scale (Figure 2). This is currently the smallest HUC classification in Oregon. Figure 3 provides an illustration of watershed units.

[1] The United States is divided and sub-divided into successively smaller hydrologic units which are classified into four levels: regions, subregions, accounting units, and cataloging units. The hydrologic units are arranged or nested within each other, from the largest geographic area (regions) to the smallest geographic area (cataloging units). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system. HUC-12 is the smallest classification currently available in Oregon. Seaber, P.R., Kapinos, F.P., and Knapp, G.L., 1987, Hydrologic Unit Maps: U.S. Geological Survey Water-Supply Paper 2294, 63 p.

[2] Strahler stream order is a method used to define stream size based on a hierarchy of tributaries and is available online. The index of a stream or river may range from 1 (a stream with no tributaries) to 12 (globally the most powerful river, the Amazon, at its mouth).




**River and streams**
Rivers and streams assessment units are defined by a Strahler Stream Order of five and higher. Assessment unit breaks are based on a change in designated beneficial use, change in stream order, or if neither of these separate the flow path, then it is broken at the HUC-10 level.

**Lakes, reservoirs, estuaries**
Lakes and reservoir greater than 20 hectares are classified as separate assessment units defined by area. DEQ uses the Coastal and Marine Ecological Classification Standard to define the extent of estuaries. Where other relevant data layers and information indicate differences in estuary homogeneity, such as changes in bacteria use classifications, further divisions may occur in estuary assessment units.

**Coastal beach**
Beach assessment units are defined using NHD coastline segments for the entire length of the Oregon coast. Delineation of beach assessment units follow existing beach designations established by OHA and EPA for recreational bacteria monitoring programs. Where no beach designations occur, DEQ uses imagery interpretation of continuous beach landforms delimited by headlands and estuary mouths.

**Ocean**
Ocean assessment units were defined using Oregon's HUC 8 boundaries from the shoreline to the border of Oregon territorial waters which extend up to three miles offshore.

## Focus on watershed units in the 2018/2020 Integrated Report

During the 2018/2020 Integrated Report public comment period, DEQ received numerous comments regarding DEQ's approach to the grouping of smaller waterbodies (Strahler Stream Order 4 or lower) into watershed units. Comments focused on DEQ's inclusion of irrigation infrastructure in watershed units, concerns about the use of a single assessment conclusion for multiple waterbodies within an assessment watershed unit, application of beneficial uses to all waterbodies within a watershed assessment unit, and the visualization methods used in reporting impaired waterbodies within watershed assessment units. DEQ's response to these subjects for the 2018/2022 are summarized below.

### Irrigation infrastructure

DEQ's assessment programs is required to assess waters of the state, which has a broad statutory definition in Oregon Statutes (ORS 468B.005): *"Waters of the state" means lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon, and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters that do not combine or effect a junction with natural surface or underground waters) that are located wholly or partially within or bordering the state or within its jurisdiction*.

Additionally, there is currently no statewide geographic information system layer available to accurately delineate waterbodies within the NHD framework based on differentiating natural and man-made infrastructure used for irrigation. Therefore, to maintain alignment with the NHD, DEQ has opted to retain watershed units grouped at the sub-watershed or HUC-12 level until HUC-14 delineations are available in Oregon or resources become available to reevaluate this issue.

### Application of beneficial uses to all waterbodies

Beneficial uses are designated in rule at the basin scale by OAR Chapter 340, Division 41. As there are no specific exemptions for irrigation infrastructure in rule, water quality criteria intended to protect the designated beneficial uses are applicable. The requirement of CWA Sections 303(d) and 305(b) are to assess beneficial uses and determine whether or not the currently designated uses are being supported. Determination as to whether those uses are applicable does not fall under the purview of the Integrated Report process, but rather is a function of the water quality standards program.

### Single assessment conclusion for multiple waterbodies

Watershed units are delineated by the smallest NHD layer available in Oregon, which is currently the HUC-12 level. The need to group smaller waterbodies together aligns with DEQ's stated goal "to create a manageable number of assessment units that can be assessed every two years". DEQ does not have the capacity to assess more than two million waterbodies and meet the biennial reporting deadline. Creating a single assessment conclusion for the watershed unit as a whole aligns with EPA's ATTAINS reporting requirements, and is also consistent with established methodologies in other states.

### Visualization of impaired waterbodies

DEQ revised its map display to represent watershed units as polygons rather than stream hydrography. Impaired assessment units are represented by the transparent purple shading as rather than the redlining of stream networks used in the public notice draft. By representing watershed units as polygons, DEQ is clarifying that an impairment exists within the watershed; not that all of the waterbodies in the unit are impaired.

## Moving forward in 2022

Following closure of the 2018/2020 Integrated Report public comment period**,** DEQ began exploring options to revise methodologies for defining watershed assessment units but still remain true to the goals identified in the improvement process. Some of the comments were outside the control of the assessment group and were determined to be infeasible. DEQ focused its efforts on addressing those comments, which both adhered to the stated goals previously outlined in this document and are deemed feasible given available resources.

## Options explored

### Define assessment units at the NHDH reach level

The NHDH framework is broken into reaches, referred to as reach codes, which are defined to be unbroken stretches of surface water[3]. Because the number of waterbody reach codes in Oregon total over 2 million, this is not a viable option for defining assessment units. Based on available resources, DEQ needs to group smaller waterbodies into a manageable number of units significantly less than the two million waterbodies that would result from an assessment unit methodology based on the "reach" level.

### Create smaller watershed units

DEQ looked at whether including 4th order streams as rivers/streams units and grouping 3rd order streams and lower would alleviate some of the concerns expressed regarding lack of hydrologic connection within sub-watersheds. This modification did not, however, make a significant difference in addressing the lack of hydrologic connection or the total number of watershed units. The number of assessment units decreased by approximately 150 units which created a significant amount of work for comparatively little difference in the number of watershed assessment units.

### Splitting watershed units by land use

DEQ explored breaking watershed units by land use. Land use, however, is not fixed and is subject to change over time. This would not meet the goal of maintaining the consistency between Integrated Report reporting cycles. This method also did not align with DEQ's goals to have hydrologically based assessment unit breaks and provide a manageable number of assessment units.

### Splitting watershed units by water quality standards

Splitting watershed units by change in water quality standards added layers of complexity to an already complex system and was not relevant for all parameters. Assessment units would also be subject to change with updates and revisions to water quality standards. This method did not align with DEQ's goals to have hydrologically based assessment unit breaks and remain consistent over time.

[3] See https://usgs-mrs.cr.usgs.gov/NHDHelp/WebHelp/NHD_Help/Introduction_to_the_NHD/Reaches_and_Reach_Codes/Reach_Codes.htm#:~:text=A%20reach%20is%20a%20continuous,%2C%20or%20a%20lake%2Fpond for more information on reach codes.

**Split watershed assessment units by separating irrigation district water (natural and man-made infrastructure) from natural stream hydrology in watershed units on a statewide basis**

Lack of statewide GIS coverage of irrigation infrastructure made this option infeasible at this time. Additionally, this method did not align with DEQ's goal of alignment with the NHD. Maintenance of this layer would be separate from the NHD update process which would make DEQ responsible for maintenance of the layer with each subsequent update.

**Assess watershed units at each monitoring station**

Current assessment methodologies for watershed units pool data together from multiple monitoring locations in the sub-watershed to arrive at a single assessment unit conclusion. In the 2018/2020 Integrated Report, data were pooled to maximize the number of data points available for assessment and to arrive at a single assessment unit conclusion to report to EPA. By doing this, specific details about where impairments occurred in a given sub-watershed could be evaluated through analysis of the raw assessment data files.

DEQ explored the option of assessing watershed units at each monitoring station and rolling up to an assessment conclusion. Under this option, the Integrated Report interactive map would illustrate attainment or impairment at each monitoring station (Figure 4). If one monitoring station were considered impaired, the assessment unit would be identified as impaired. This alternative would remain consistent with the NHD, and assessment results would be clearly identified by monitoring location.

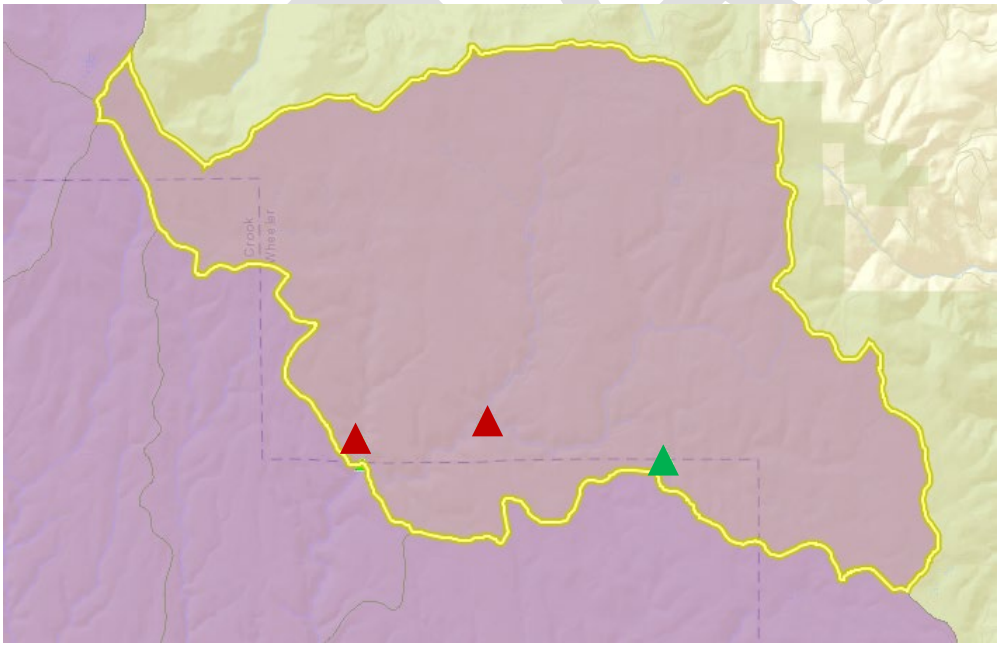


*Figure 4. Watershed unit assessment by station example. Monitoring stations assessed as Category 5 for at least one parameter are shown in red, while monitoring stations assessed as Category 2 are represented as green triangles.*

## Recommended methodology for watershed assessment units for the 2022 Integrated Report

DEQ reviewed all of the options and assessed the feasibility of each alternative while striving to balance the concerns of stakeholders. DEQ's recommendation is to assess watershed units by monitoring station and make the determination of impairment or attainment at the monitoring station level. This determination must then be rolled up to a single watershed unit conclusion in order to meet EPA reporting requirements. Therefore, if a single monitoring station is identified as impaired, the entire watershed unit would be considered impaired (Figure 5).

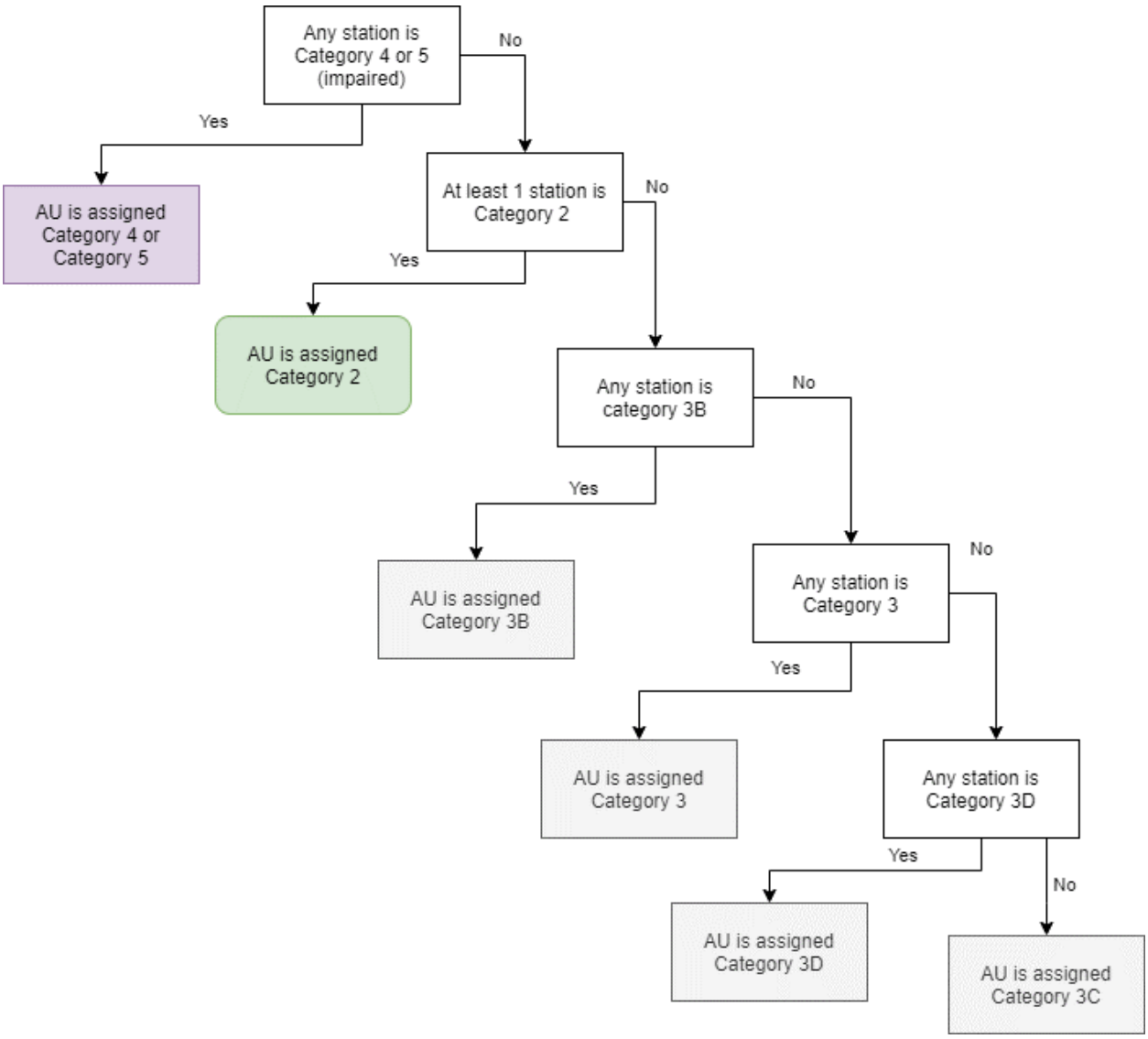



*Figure 5. Assessment flow chart*

Although DEQ is recommending a methodology revision for assessment of watershed units in the 2022 Integrated Report, it is important to recognize the outcomes associated with making this change. On one hand, assessing by station can provide greater resolution to the assessment of watershed units by providing a more detailed rationale of assessment conclusions at each individual monitoring station. This methodology avoids combining (or grouping) data from non-hydrologically connected waterbodies within a subwatershed. An impaired watershed assessment

unit indicates that an impairment exists within the watershed, not necessarily that the entire watershed is impaired. Assessment by station identifies the specific impairments that exist within the watershed and provides more precise assessment of the dataset. Identification of impaired stations may inform monitoring partners of localized impairments and guide restoration activities and future monitoring. This method also recognizes the inherent difference of grouping small streams into watershed units and is unique from all other types of assessment units through which the hydrologic homogeneity is more clearly defined. Visual representation of Integrated Report conclusions would be more clearly identified for smaller order streams, and the method aligns with other water quality reporting (i.e. DEQ Status & Trends Reports).

On the other hand not pooling data from multiple monitoring stations within a watershed unit will lead to reduced numbers of samples assessed at each individual monitoring station. Assessment units may meet minimum data requirements when data from all monitoring locations are pooled together, but can fail to reach minimum data requirements when monitoring locations are assessed separately (Figure 4). The methodology change would likely have minimal impact on assessments for temperature or other conventional parameters, but would most likely affect assessment conclusions for toxic parameters. Conventional parameters are inexpensive to collect and analyze and are commonly sampled at more frequent intervals whereas toxics data collection can be very costly to collect and analyze and is generally done in a more targeted fashion.

In order to grasp the extent of this impact, DEQ analyzed toxics data from watershed assessment units that were assessed in the 2018/2020 Integrated Report to determine how many more watershed assessment units would be assessed as Category 3 as opposed to Category 2 or Category 5. DEQ simulated a five-year period of record by limiting the data to Jan. 1, 2013, through Dec. 31, 2017, (approximately 120 watershed assessment units).

Using a minimum data requirement of two samples for a category 5 conclusion, 24 assessment unit/parameter combinations from 14 unique watershed assessment units, or 12 percent, would not meet data requirements for a Category 5 conclusion if data were pooled by monitoring station, but would meet minimum data requirements if data were pooled by assessment unit.

DEQ repeated this analysis for a Category 2 conclusion using a minimum data requirement of 10 samples. Eighty-three assessment unit/parameter combinations from 17 unique watershed assessment units or14 percent would not meet data requirements for a Category 2 conclusion if we pooled by monitoring station, but met minimum data requirements if data were pooled by assessment unit.

The analysis was also repeated for delisting using a minimum data requirement of 18 samples to delist. Sixty-four assessment unit/parameter combinations from 14 unique watershed assessment units, or 12 percent would not meet minimum data requirements for delisting if data were pooled by monitoring station, but met minimum data requirements if data were pooled by assessment unit.

For example, in this highly monitored watershed example described in Figure 6, there are 37 monitoring stations within a single watershed unit. Using the 2018/2020 dataset, given a five-year period of record for the next Integrated Report, only one station would meet minimum

sample size requirements. More data collection at each monitoring station may be warranted in watershed assessment units for a Category 2 conclusion or for delisting purposes.

To summarize, for toxics assessments, the recommended revised methodology would lead to fewer assessment units meeting minimum data requirements to be identified as either Category 5 or Category 2. Similarly, fewer assessment units would be eligible for delisting. However, despite the modest increase in Insufficient Data assessments (Category 3) for watershed units, DEQ believes this impact is offset by the increased specificity.