Listing Methodology for Determining Water Quality Impairments from Pathogens

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Alaska Department of Environmental Conservation
Division of Water

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1.0 Executive Summary

Section 303(d) of the Clean Water Act requires states to publish and update a list of impaired waters, known as the 303(d) list. Alaska's Integrated Report includes the "303(d) list of water quality limited waters" which satisfies the requirement of Section 303(d) to biennially produce a list of waters that are not meeting surface water quality standards (WQS) despite the implementation of technology-based effluent limits or other pollution control strategies. The 303(d) list of impaired waters of the Integrated Report is subject to EPA approval or disapproval.

The goal of this document is to establish the Alaska Department of Environmental Conservation (DEC) assessment and listing methodology process for waters potentially impacted by pathogens and identify those waters whose designated uses are not met on a consistent basis.

In 2012, EPA updated the recreational water quality criteria (RWQC) recommendations for protecting human health in coastal and non-coastal waters designated for primary contact recreation use (e.g., swimming). The recommendations include the use of the indicator bacteria *Escherichia coli (E. coli)* (freshwater) and enterococci (marine water). These two indicators exhibit the strongest correlation to swimming-associated illness. In 2017, Alaska adopted *E. coli* and enterococci to replace fecal coliform as the indicator bacteria for contact recreation uses in Alaska's water quality standards and Beaches Environmental Assessment & Coastal Health (BEACH) monitoring programs. This document reflects DEC's implementation of those criteria.

DEC reserves the right to update this methodology from time to time based on scientific advances and departmental policy requirements.

2.0 General Guidelines

DEC makes listing and delisting determinations based on scientifically valid monitoring data collected under an approved sampling and analysis plan (SAP) consistent with Alaska water quality standards, Quality Assurance Project Plan (QAPP)[1] and, the Alaska Consolidated Assessment and Listing Methodology (AK CALM). This methodology includes information on the quantity and characteristics of data needed to be deemed sufficient and credible for these decisions.

Section 303(d) listing determinations should be based on laboratory analyses with an approved QAPP for any fecal coliform, E. coli or enterococci bacteria samples. Accepted test methods for pathogens are specified in 18 AAC 70 according to approved editions of *Standard Methods for the Examination of Water and Wastewater;* other laboratory methods may be used but should be reviewed and approved by DEC.

Generally, most waterbodies are designated for more than one use per 18 AAC 70.040, in such instances Alaska regulations protect for the most stringent uses.

[1] DEC's QAPP procedures are available at http://www.dec.state.ak.us/water/wqapp/wqapp_index.htm.

2.1 Pathogen Source Assessment

Determining the source of the pathogen concentrations should be conducted when investigating elevated levels of bacteria in a waterbody or waterbody segment. Waters with data indicating impairment will be placed in Category 5 unless DEC determines that human activities do not cause or contribute to exceedances of water quality standards, per 18 AAC 70.010(b). A determination about the conditions contributing to the pollution occurs on a case-by-case basis and require a well-reasoned, best professional judgment coupled with information or data to validate the assessment. Evidence of what is causing elevated levels of bacteria whether anthropogenic or an exacerbation of wildlife sources, including bird colonies, rookeries, etc. should be identified and adequately characterized to ensure consistency with state and federal assessment and listing policies.

2.1.1 Microbial Source Tracking (MST)

If possible, microbial source tracking (MST) should be used to determine the presence or absence of human sources. MST refers to a group of analytical protocols used to determine the source of fecal contamination and applicable to a fresh and marine waters. MST techniques attempt to determine whether fecal bacteria are being introduced into waterbodies through human, wildlife, or domestic animal sources. MST is based on the principles that some pathogens have an exclusive or preferential association with a particular host, and that these host-associated microorganisms are shed in fecal matter and can be detected in water bodies (Simpson *et al* 2002[2], EPA 2005[3]).

MST can be an effective tool for water quality management if employed with a clear understanding of the benefits and limitations of the specific method(s). MST technology is a rapidly evolving field and water quality project managers should have a good understanding of the study's goals and objectives to help guide the appropriate MST method.

More information on using microbial source tracking can be found on the EPA website, www.epa.gov/sites/production/files/2015-07/documents/mst_for_tmdls_guide_04_22_11.pdf

2.2 General Data Assessment and Analysis Guidelines

The following sections expand briefly on areas that should be considered when preparing an assessment for pathogens. These areas should be expanded on in a QAPP or Sampling and Analysis Plan.

2.2.1 Data Quality Analysis

Adequate data quality is necessary to make well-grounded attainment and impairment decisions. Assessments based on larger sample sets are preferable because they are more likely to yield accurate results founded on a robust data set to support any long or short-term statistical trends than those based on smaller sample sets. Data or information collected should assist with the determination that the WQS *are or are not exceeded*, or that designated uses *are or are not impaired*, and that such

[2] Joyce M. Simpson, Jorge W. Santo Domingo, and Donald J. Reasoner. Microbial Source Tracking: State of the Science. *Environmental Science & Technology* 2002 *36* (24), 5279-5288

[3] USEPA. 2005. Microbial Source Tracking Guide Document. Office of Research and Development, Washington, DC. EPA-600/R-05/064

measurements are representative of the waterbody. DEC will determine if the elements of water quality data and supplemental information meet the applicable requirements of a QAPP.

Water quality data and information that are collected and submitted without a QAPP, or are collected under a QAPP for which the level of confidence is low, may not be relied upon to make an impairment determination. Such data and information may only be considered as ancillary information to support an attainment or impairment determination.

2.2.2 Sampling Considerations

When preparing a QAPP it is important to determine data quality objectives and clearly define the information needed for assessment purposes. Clearly defining the goals will assist with determining the level of quality data needed to support specific decisions and conclusions about the project's objectives (i.e., BEACH grant monitoring, 303(d) determinations).

Sampling locations should be tailored appropriately for the area being sampled. Collected samples should be representative of the waterbody and should adequately characterize pathogen contamination. Sampling plans may want to take into account historic water quality and variability and the presence of physical features that have the potential to affect the distribution of pathogens (e.g., point sources, bird nesting areas, stormwater outfalls). Other sampling considerations that can affect the water quality include: seasonal variations (spring thaw, summer base, and fall storms) as well as high- and low-tide variables. Ideally the samples should capture various hydrological and meteorological conditions, anthropogenic and non- anthropogenic impacts, sampling frequency, number of samples collected, diurnal variations, and the temporal and spatial sampling coverage of the waterbody.

Alaska possess unique obstacles that should be considered when preparing a QAPP or SAP. For example: identifying local laboratories; sample transportation to a laboratory; finding a person trained[4] in water sample collection; analytical test hold times; inclement weather conditions; and funding. These examples are for consideration and should not be considered inclusive of the potential challenges.

2.2.2.1 Flow Conditions

Microbial pathogens generally show a positive association with flow and may require special considerations with respect to monitoring frequency and timing. Sampling should occur during a range of stream flows or seasonal conditions that may influence bacteria concentrations. If it is deemed necessary to sample during peak flow events or during spring break-up, the data set should contain samples collected during a range of stream flow conditions and results should be compared to other flows for assessment purposes.

2.3 Data Development

In order to determine if a waterbody exceeds the water quality standard for the appropriate designated use, the sample results should be compared against two benchmarks:

1. Geometric mean, and

[4] A person who has been trained or possesses the education, experience and expertise to collect environmental samples.

2. The maximum value that 10 percent of the samples cannot exceed.

2.3.1 Calculating the Geometric Mean

A geometric mean (EPA, 2010) tends to mitigate the effect of very high or low data values which may bias an arithmetically calculated mean. This approach is helpful when analyzing bacteria concentrations as levels may vary anywhere from 10 to 10,000 fold over a given period.

For assessment purposes, the geometric mean is based on the minimum number of samples obtained during separate 24-hour periods over any consecutive 30-day assessment interval, as determined in the QAPP or SAP. In order to evaluate all 30-day intervals, a rolling 30-day geometric mean should be calculated and plotted to determine the timing and magnitude of exceedance of the 30-day geometric mean criterion.

2.3.2 Use of Non-Detect Samples

It is appropriate to consider non-detect samples when calculating the geometric mean for assessment purposes. Rather than eliminating the "non-detects" from the assessment data, these results and sample results measured below the detection limit will be calculated as 50% of the method detection limit. This approach may not be appropriate during the analysis of water quality trends.

The approach on how non-detect samples will be used for assessment purposes should be discussed in the QAPP.

3.0 Fresh Water Designated Uses and associated Bacteria Criteria - Fecal Coliform and Escherichia coli (*E. coli*)

Alaska water quality criteria for fecal coliform and *E. coli* bacteria are specified in 18 AAC 70.020(b)(2) for fresh water uses. A waterbody designated for fresh water uses include corresponding criteria (numeric or narrative) unless a waterbody has been reclassified under 18 AAC 70.230 or subject to site-specific criteria under 18 AAC 70.236, in which case, revised criteria can be found in a table under the respective section.

3.1 Bacteria Criteria for Fecal Coliform - Fresh Water Uses

Table 1 below, establishes the numeric fecal coliform bacteria criteria and the associated designated use for five (5) fresh water designated uses, noting there is not numeric or narrative bacteria criteria for Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife 18 AAC 70.020(b)(2)(C).

Table 1: Designated Use and Fecal Coliform Criteria for Fresh Water Uses

Designated Use	Criteria
(A) Water Supply (i) drinking, culinary, and food processing	In a 30-day period, the geometric mean may not exceed 20 fecal coliform/100 ml, and not more than 10% of the samples may exceed 40 fecal coliform /100 ml.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	In a 30-day period, the geometric mean of samples may not exceed 200 fecal coliform /100 ml, and not more than 10% of the samples may exceed 400 fecal coliform /100 ml. For products not normally cooked and for dairy sanitation of unpasteurized products, the criteria for drinking water supply, (2)(A)(i), apply.
(A) Water Supply (iii) aquaculture	For products normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 200 fecal coliform /100 ml, and not more than 10% of the samples may exceed 400 fecal coliform /100 ml. For products not normally cooked, the criteria for drinking water supply, (2)(A)(i), apply.
(A) Water Supply (iv) industrial	Where worker contact is present, the geometric mean of samples taken in a 30-day period may not exceed 200 fecal coliform /100 ml, and not more than 10% of the samples may exceed 400 fecal coliform /100 ml.
(B) Water Recreation (ii) secondary recreation	In a 30-day period, the geometric mean of samples may not exceed 200 fecal coliform /100 ml, and not more than 10% of the total samples may exceed 400 fecal coliform /100 ml.

3.1.1 Bacteria Criteria for Escherichia coli (*E. coli)* - Fresh Water Uses

Alaska water quality criteria for Escherichia coli are specified in 18 AAC 70.020(b)(2)(B) for one (1) fresh water designated use, contact recreation.

The numeric *E. coli* criteria protect for contact recreation where immersion and inadvertently ingesting water is likely and are shown below in Table 2.

The *E. coli* numeric criteria are not applicable in marine waters.

Table 2: Designated Use and E. coli Criteria for Fresh Water Uses

Designated Use	Criteria
(B) Water Recreation **(i) contact recreation**	In a 30-day period, the geometric mean of samples may not exceed 126 Escherichia coli (E. coli) colony forming units (CFU)/ 100ml, and not more than 10% of the samples may exceed a statistical threshold value (STV) of 410 E. coli CFU/100 ml.

3.2 Determining Water Quality Impairments from Pathogens for Fresh Water Uses - for Fecal Coliform and *E. coli*

The following sections outline the process DEC uses to determine fresh water use impairments for the indicator bacteria, fecal coliform and *E. coli*. The sections also provide DEC's expectations as they relate to the sampling and assessment period, minimum number of samples, and the methodology on how an exceedance determination will be made.

The prescribed method for determining water quality impairments are the same both fecal coliform and *E. coli*.

For more information and details on data quality used for water quality assessments and impairment determinations, refer to Section 2.0 of this document.

3.2.1 Assessment and Sampling Period

The assessment period over which data is collected should span a minimum of two years. Assessment periods do not need to be consecutive but should be within five years. Older data (> 5 years) may be applicable when determining if a waterbody meets or exceeds water quality criteria if pollutant sources causing the impairment have not substantially changed or more recent confirmatory data is collected. If conditions have changed, older data may be considered ancillary evidence. Data older than 10 years should not be used to determine impairment, but may be used in trend analysis or other modelling for protection or restoration purposes.

Bacteria levels can be affected by environmental factors, therefore, the assessment period should be representative of both ambient and adverse pollution conditions. Environmental factors such as seasonal temperature conditions, heavy water use periods, flow conditions or a combination of may be considered during sample collection as these may impact the representativeness of the waterbody. Waters with repetitive exceedances in a single 30-day period may be prioritized for additional monitoring in that season or in subsequent years.

The minimum 30-day sampling interval should be representative of conditions and should not artificially inflate the proportion of samples to either meet or exceed the criteria.

Data sets that do not have at least two distinct 30-day sampling intervals distributed over the course of a minimum of a two year period are considered insufficient for listing and delisting purposes.

The assessment and sampling period should be defined in the sampling and analysis plan or QAPP and are project specific.

3.2.2 Minimum Number of Samples

The number of samples required for fecal coliform bacteria and/or *E. coli* criteria are a minimum of five (5) samples within the 30-day sampling interval as established in Section 3.2.1. DEC recommends that ten (10) samples be collected within the 30-day period, but recognize that certain restrictions and complications (*i.e.* inclement weather conditions, funding, etc.) may prevent this from happening. More samples can support a more robust data set and should be considered when preparing the sampling and analysis plan.

It is preferable that sample collection be spread over the 30-day period, when possible. Avoid taking all samples on the same day or on a few consecutive days that would not represent the whole 30-day period because sample collection should not capture an isolated event (e.g., sewage spill).

Two or more samples may be taken on the same day, but should not be taken at the same sampling location. When collecting duplicate samples, the higher concentration of the samples will be used.

Data sets with fewer than ten samples for a 30-day period are less desirable for the purposes of making a determination of impairment or attainment.

3.2.3 Impairment Determination

Bacteria data will be grouped and evaluated by individual water year, which extends from October 1 of one year through September 30 of the following year. DEC may also define a specified critical period or season in which the criteria need to be met, based on water temperatures and seasonal water use patterns. This time period is typically defined in the QAPP or SAP and may bracket specific months or seasons in which bacteria levels are more prone to exceed criteria. Where a critical period applies, DEC will assess bacteria for the critical period as well as for the entire water year.

DEC considers the following shall be met when determining an impairment determination:

i. A waterbody is considered impaired when at least one 30-day sampling period per water year demonstrates an exceedance of one or both parts of the criterion (i.e., 30 day geometric mean; or not more than 10% may exceed provisions) during two years of sampling taken within a five year margin.

ii. If more than one 30-day sampling period is obtained within the same water year the data will be evaluated using a 30-day geometric mean and seasonal percentage of the number of samples that exceed the 10% provision.

   - If less than 10 samples are collected, then 1 sample exceeding the 10% maximum criteria is considered an exceedance;
   - If more than 10 samples are collected, then the seasonal percentage of the number of samples exceeding the rolling 30-day period will be evaluated against the 10% provision, if more than 10% for any 30-day period then it will be considered an exceedance.

iii. If both are triggered, exceeding the rolling geometric mean and the 10% may exceed provisions, in the same 30-day period is considered one exceedance.

iv. Each year of sampling will be examined separately for assessment purposes.

DEC bases impairment determinations on a persistent impairment to the waterbody. When an exceedance has been determined, DEC's recommended approach is:

- Exceedances found in one of the 30-day sampling period be followed by an additional 30-day sampling period during the same season of a subsequent year or sooner to validate the persistence of the water quality impairment.

Collecting information on the conditions that may have triggered exceedances (e.g., seasonal activities, flow conditions, temperature) is recommended, but not required to determine impairment.

4.0 Marine Water Designated Uses and associated Bacteria Criteria - Enterococci (contact recreation only) and Fecal Coliform (other uses)

Alaska water quality criteria for fecal coliform bacteria and enterococci are specified in 18 AAC 70.020(b)(14) for marine water uses. A waterbody designated for marine water uses include corresponding criteria (numeric or narrative) unless a waterbody has been reclassified under 18 AAC 70.230 or subject to site-specific criteria under 18 AAC 70.236, in which case revised criteria can be found in a table under the respective section.

4.1 Bacteria Criteria for Fecal Coliform- Marine Water Uses

The numeric fecal coliform bacteria criteria and the associated designated use for five of the seven designated use categories are specified at 18 AAC 70.020(b)(14) and shown below in Table 3, noting bacteria criteria are not applicable for Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife 18 AAC 70.020(b)(14)(C). Fecal coliform criteria for the Harvesting for Consumption of Raw Mollusks or Other Aquatic Life Use can be found in section 5.1.

Table 3: Designated Use and Fecal Coliform Criteria for Marine Water Uses

Designated Use	Criteria
(A) Water Supply **(i) aquaculture**	For products normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 200 fecal coliform/100 ml, and not more than 10% of the samples may exceed 400 fecal coliform/100 ml. For products not normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 20 fecal coliform/100 ml, and not more than 10% of the samples may exceed 40 fecal coliform/100 ml.
(A) Water Supply **(ii) seafood processing**	In a 30-day period, the geometric mean of samples may not exceed 20 fecal coliform/100 ml, and not more than 10% of the samples may exceed 40 fecal coliform/100 ml.

(A) Water Supply **(iii) industrial**	Where worker contact is present, the geometric mean of samples taken in a 30-day period may not exceed 200 fecal coliform/100 ml, and not more than 10% of the samples may exceed 400 fecal coliform/100 ml.
(B) Water Recreation **(ii) secondary recreation**	In a 30-day period, the geometric mean of samples may not exceed 200 fecal coliform/100 ml, and not more than 10% of the samples may exceed 400 fecal coliform/100 ml.

4.2 Bacteria Criteria for Enterococci - Marine Water Uses - Contact Recreation Use

The federal BEACH Act of 2000 specifies the following water quality criteria for coastal recreation (contact) in marine waters and was promulgated by the EPA for Alaska in 2004 and published in the Federal Register in 69 FR 67217-67243. Since 2004, the criteria values have changed and the enterococci bacteria criteria were adopted into Alaska regulations, 18 AAC 70.020(b)(14)(B) in 2017 (Table 4).

Table 4: Designated Use and enterococci Criteria for Marine Water Uses

Designated Use	Criteria
(**B) Water Recreation** **(i) contact recreation**	In a 30-day period, the geometric mean of samples may not exceed 35 enterococci Colony Forming Unit (CFU)/100 ml, and not more than 10% of the samples may exceed a statistical threshold value (STV) of 130 enterococci CFU/100 ml.

4.3 Determining Water Quality Impairments from Pathogens for Marine Water Uses - Fecal Coliform and Enterococci

The following sections outline the prescribed methodology for determining water quality impairments in marine waters for the indicator bacteria, fecal coliform and enterococci. The paragraphs provide DEC's expectations as they relate to the sampling and assessment period, minimum number of samples, and are the same for both fecal coliform and enterococci.

For more information and details on data quality used for impairment determinations, refer to Section 2.0 of this document.

4.3.1 Assessment and Sampling Period

The assessment period over which data is collected should span a minimum of two years. Assessment periods do not need to be consecutive but should be within five years. Older data (> 5 years) may be applicable when determining if a waterbody meets or exceeds water quality criteria if pollutant sources causing the impairment have not substantially changed or more recent confirmatory data is collected. If conditions have changed, older data may be considered ancillary evidence. Data older than 10 years should not be used to determine impairment, but may be used in trend analysis or other modelling for protection or restoration purposes.

Bacteria levels can be affected by environmental factors, therefore, the assessment period should be representative of both ambient and adverse pollution conditions. Environmental factors such as seasonal temperature conditions, heavy water use periods, flow conditions or a combination of should be considered during sample collection as these may impact the representativeness of the waterbody. Waters with repetitive exceedances in a single 30-day period may be prioritized for additional monitoring in that season or in subsequent years.

The minimum 30-day sampling intervals should be representative of conditions and should not artificially inflate the proportion of samples to either meet or exceed the criteria.

The assessment and sampling period should be defined in the sampling and analysis plan or QAPP and are project specific.

4.3.2 Minimum Number of Samples

The number of samples required for fecal coliform bacteria and/or enterococci criteria are a minimum of five (5) samples within the 30-day sampling interval as established in Section 4.3.1. DEC recommends that ten (10) samples be collected with the 30-day period, but recognize that certain restrictions and complications (*i.e.* inclement weather conditions, funding, etc.) may prevent this from happening. More samples can support a more robust data set and should be considered when preparing the sampling and analysis plan.

It is preferable that sample collection be spread over the 30-day period, when possible. Avoid taking all five or ten samples on the same day or on a few consecutive days that would not represent the whole 30-day period because samples should not capture an isolated event (e.g., sewage spill).

Two or more samples may be taken on the same day, but should not be taken at the same sampling point. When collecting duplicate samples, the higher concentration of the samples will be used.

Data sets with fewer than ten samples for a 30-day period are less desirable for the purposes of making a determination of impairment or attainment.

4.3.3 Impairment Determination

Bacteria data will be grouped and evaluated by individual water year, which extends from October 1 of one year through September 30 of the following year. DEC may also define a specified critical period or season in which the criteria need to be met, based on water temperatures and seasonal water use patterns. This time period is typically defined in the QAPP or SAP and may bracket specific months or seasons in which bacteria levels are more prone to exceed criteria. Where a critical period applies, DEC will assess bacteria for the critical period as well as for the entire water year.

DEC considers the following shall be met when determining an impairment determination:

i. When at least one 30-day sampling period per water year demonstrates an exceedance of one or both parts of the criterion (i.e., 30-day geometric mean; or not more than 10% may exceed provision) during two years of sampling taken within a five year margin.

ii. If more than one 30-day sampling period is obtained within the same water year the data will be evaluated using a 30-day geometric mean and seasonal percentage of the number of samples that exceed the 10% provision.

- If less than 10 samples are collected, then 1 sample exceeding the 10% maximum criteria is considered an exceedance;
- If more than 10 samples are collected, then the seasonal percentage of the number of samples exceeding the rolling 30-day period will be evaluated against the 10% provision, if more than 10% for any 30-day period then it will be considered an exceedance.

iii. If both are triggered, exceeding the rolling geometric mean and the 10% may exceed provision, in the same 30-day period will be considered one exceedance.

iv. Each year of sampling will be examined separately for assessment purposes.

DEC bases impairment determinations on a persistent impairment to the waterbody. When an exceedance has been determined, DEC's recommended approach is:

- Exceedances found in one of the 30-day sampling period be followed by an additional 30-day sampling period during the same season of a subsequent year or sooner to validate the persistence of the water quality impairment.

Collecting information on the conditions that may have triggered exceedances (e.g., seasonal activities, flow conditions, temperature) is recommended, but not required to determine impairment.

5.0 Determining Water Quality Impairments from Fecal Coliform Bacteria for the "Harvesting for Consumption of Raw Mollusks or Other Aquatic Life" Marine Water Use

The protocol for shellfish use classification determinations are based upon the National Shellfish Sanitation Program[5] (NSSP) requirements. Both the Department of Environmental Conservation's Division of Environmental Health, Food Safety and Sanitation Program (EH) and the Division of Water (DOW) are responsible for the protection of people who consume raw shellfish and other aquatic life.

5.1 Bacteria Criteria for Fecal Coliform - Marine Water Uses

The numeric fecal coliform bacteria criteria and the associated designated use is for the designated use is specified at 18 AAC 70.020(b)(14)(D) and shown below in Table 5, noting this bacteria criteria is not applicable for Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife 18 AAC 70.020(b)(14)(C).

Table 5: Designated Use and Fecal Coliform Criteria for Marine Water Use

[5] National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish. 2013 Revision. U.S. Food and Drug Administration: http://www.fda.gov/downloads/Food/GuidanceRegulation/FederalStateFoodPrograms/UCM350344.pdf.

Designated Use	Criteria
(D) Harvesting for Consumption of Raw Mollusks or Other Raw Aquatic Life	The geometric mean of samples may not exceed 14 fecal coliform/100ml, and not more than 10% of the samples may exceed; - 43 MPN* per 100ml for a five-tube decimal dilution test; - 49 MPN per 100ml for a three-tube decimal dilution test; - 28 MPN per 100ml for a twelve-tube single dilution test; -31 CFU per 100ml for a membrane filtration test.

*Most Probable Number (MPN): the statistic that represents the number of individuals most likely present in a given sample, based on test data.

5.2 Determining Water Quality Impairments from Pathogens for Marine Water Uses - Fecal Coliform

Alaska designates all marine waters for harvesting for consumption of raw mollusks or other raw aquatic life and are regulated through the DOW; however, waters that have been designated as commercial shellfish growing areas are monitored through the Division of Environmental Health Food Safety and Sanitation Program[6]. Both programs are tasked with protecting public health as well as water quality from the risks of fecal contamination in harvested shellfish.

5.2.1 Assessment and Sampling Period

The assessment period over which data is collected should span a minimum of two years. Assessment periods do not need to be consecutive but should be within five years. Older data (> 5 years) may be applicable when determining if a waterbody meets or exceeds water quality criteria if pollutant sources causing the impairment have not substantially changed or more recent confirmatory data is collected. If conditions have changed, older data may be considered ancillary evidence. Data older than 10 years should not be used to determine impairment, but may be used in trend analysis or other modelling for protection or restoration purposes.

[6] When fecal coliform are monitored in waters designated as state approved shellfish harvesting and growing waters, these waters are also subject to 18 AAC 34.010(19).

In instances where the classification status of a shellfish growing area has been downgraded[7] or factors affecting the distribution of pollutant sources have increased or new sources have been identified, DEC may require more recent data to demonstrate the status of water quality.

At least one 90-day sampling interval per year for two years are needed to make attainment or impairment decisions. The two 90-day sampling intervals should be representative of the location's conditions, both spatially and temporally. Sources of pollution are not necessarily point source discharges and can include any meteorological, hydrological or seasonal events that result in elevated fecal coliform levels.

Sample collection should be carried out in a way which allow the 90-day sampling period to represent both ambient and adverse pollution conditions. It must also encompass wet and dry weather and low and high tide periods. One or two high values may or may not be indicative of impairment because fecal coliform is fairly abundant in the natural environment. For this reason, use of a larger sample size will enhance the accuracy and offer a higher level of confidence before making impairment determinations.

The assessment and sampling period should be defined in the SAP or QAPP and are project specific.

5.2.2 Minimum Number of Samples

Fifteen (15) samples will be needed to calculate the geometric mean to assess the water quality of the designated use. Once 15 samples have been collected to establish the geometric mean, the following assessment period will require the collection of a minimum of five (5) additional samples.

If the 15 samples are unable to be collected in the 90-day period, additional samples can be collected, in the following year, during the same 90-day period to have enough for assessment purposes. Additional samples can be collected, but will be calculated as one year of data.

For example, during the first 90-day period eight samples are collected. The following year (during the same 90-day period), 12 samples were collected for a total of 20 samples. This will qualify as one year of data even though it has been two years of data collection. In a following year, an additional five samples will be necessary to for assessment and comparison purposes.

Sample collection should be spread over a 90-day period or the established assessment period or harvesting season. Avoid taking all samples on the same day or on a few consecutive days that would not represent the whole 90-day period because samples should not capture an isolated event (e.g., sewage spill).

Two or more samples may be taken on the same day, but should not be taken at the same sampling point. When collecting duplicate samples, the higher concentration of the samples will be used.

[7] Classification status of potential commercial shellfish growing areas is done by means of a sanitary survey. Results of the survey classify the waters into one of five categories. Downgrading the classification of a shellfish growing area is a function of several metrics (*i.e.* a shoreline survey and bacteriological samples) and can help recognize adverse pollution conditions.

If water quality samples begin to demonstrate elevated levels of fecal contamination without sufficient justification (ex., heavy rain fall or sewage treatment plant failure) it may be prudent to revisit the SAP or QAPP. Identifying what may be contributing to the increase (*i.e.,* sources, sampling errors, etc.) may be beneficial for the assessment determination and protection of the designated use.

5.2.3 Impairment Determination

Bacteria data will be grouped and evaluated by individual water year, which extends from October 1 of one year through September 30 of the following year. DEC may also define a specified critical period or season in which the criteria need to be met, based on water temperatures and seasonal water use patterns. This time period is typically defined in the QAPP or SAP and may bracket specific months or seasons in which bacteria levels are more prone to exceed criteria. Where a critical period applies, DEC will assess bacteria for the critical period as well as for the entire water year.

DEC considers the following shall be met when determining an impairment determination:

i. When <u>one</u> 90-day sampling period demonstrates an exceedance of one or both parts of the criterion (i.e., 90-day geometric mean; or not more than 10% may exceed provision) during two years of sampling taken within a five year margin.
    - When the minimum 15 samples is established, if one sample exceeds the 10% maximum criteria or geometric mean, this will be considered and exceedance.

ii. When two 90-day sampling periods have been collected during two years[8] of sampling, a minimum of 20 samples will be available for assessment purposes.
    - If two samples exceed the 10% maximum provision or the geometric mean, this will be considered an exceedance;
    - The two years of data may be combined for a seasonal evaluation of the geometric mean and 10% provision.

iii. The geometric mean and the 10% percent provision of the criteria must be met in each of two 90-day sampling periods. Data from two years, at a minimum, must show that water quality has not exceeded both provisions in order to demonstrate persistent attainment.

iv. Triggering both, exceeding the 90-day geometric mean and the 10% may exceed provisions, in the same 90-day period is considered one exceedance.

DEC bases impairment determinations on a persistent impairment to the waterbody. When an exceedance has been determined, DEC's recommended approach is:

- Exceedances found in one of the 90-day sampling periods are followed by an additional 90-day sampling period during the same season of a subsequent year to validate the persistence of the water quality impairment.

[8] This assumes that the 15 minimum samples in the first 90-day period was collected in one year. Refer to Section 5.2.2 for more information on minimum number of samples.

Collecting information on the conditions that may have triggered exceedances (e.g., seasonal activities, flow conditions, temperature) is recommended, but not required to determine impairment.

If a shellfish beach in closed on multiple accounts within a 2 year period, the DOW may investigate the cause and assess for impairment. This does not constitute an automatic impairment determination.

6.0 Overwhelming Evidence

In cases where data is limited due to small or incomplete datasets, DEC may apply the concept of Overwhelming Evidence in which information besides the total number of samples is used in the decision making process. EPA's 2002 CALM states:

"An assessment methodology should take into account the balance between desired data requirements and the practical realities affecting the availability of information and the strength of the available evidence… Generally, decisions should be based on very small sample sizes only when there is overwhelming evidence for impairment."

Overwhelming evidence uses multiple lines of evidence to determine whether a particular narrative threshold is exceeded. DEC will consider overwhelming evidence in cases where sample sizes do not meet minimum criteria or sampling data is inconclusive and yet there is other overwhelming evidence of an impairment. DEC will also consider the anthropogenic factors (e.g., current and historic regulatory practices, watershed monitoring data) may be contributing to reduced water quality. DEC does not consider the factors noted as overwhelming evidence to alone be sufficient for placement of an AU in Category 5. Data used for overwhelming evidence must meet at least data level 2 qualification in Table 1.

DEC will consider the following:

- Best professional judgement – the dataset must provide clearly valid, reliable, and relevant exceedances of a numeric criterion of sufficient magnitude, frequency and/or duration to ensure that a "real" impairment exists based on limited data.
- Weight of evidence – quality and quantity of all readily available data and ancillary information (e.g. biological evaluations, older data, pollutant source information).
- Timing of exceedances – consideration of factors that may be contributing to the presence of pollutant concentrations including weather and flow (e.g. storm events).
- Data are not associated with wastewater treatment system upset or other short-term event.

7.0 Removal of a Waterbody from the Section 303(d) List for Pathogens

The current listing policy used by DEC and outlined in the Integrated Report dictates that removing a waterbody from the Section 303(d) list requires a level of data equivalent to what was used in the initial Section 303(d) listing determination. Data from two years, at a minimum, must show that water quality has not exceeded both the geometric mean and the 10% maximum criteria. The two years do not need to be consecutive as long as there is no year in between where the water quality standard is not met. The two most recent years are needed to demonstrate consistent attainment of the water quality standard.

Sampling plans for removing a waterbody should be designed to capture whether or not changes have occurred that have resulted in the waterbody meeting water quality standards.

Sampling should be specifically designed to determine whether:

(1) Documented pollutant sources still exist.

(2) Pollution controls are sufficient.

(3) WQS attainment status is persistent.

(4) Not attributable to an anthropogenic source (i.e., bacteria present are due to wildlife)

Table 6 Summary Table for Fresh and Marine Water: Assessment and Exceedance Determination Methods

Fresh Water Bacteria	Unit of Measure	Assessment Period	Minimum # of Samples[9]	Exceedance Determination	Additional Exceedance Considerations
Fecal Coliform	• 30-day geometric mean, AND • 10% of samples	Two 30-day sampling interval during a two year period	5 samples in each 30-day period, however, 10 samples are preferred.	At least (2) 30-day sampling periods demonstrates an exceedance of the criteria during the assessment period	More than one 30-day sampling period: ❖ Rolling 30-day GM, ≤ 10 samples, one sample exceeding, GM or 10% provision is an exceedance > 10 samples, the seasonal percentage of the # of samples exceeding the rolling 30-day period will be evaluated against the 10% provision. If more than 10% of samples exceed any 30-day period is considered an exceedance
E. coil	• 30-day geometric mean, AND • 10% of samples	Two 30-day sampling interval during a two year period	5 samples in each 30-day period, however, 10 samples are preferred.	At least (2) 30-day sampling periods demonstrates an exceedance of the criteria during the assessment period	
Marine Water Bacteria	Unit of Measure	Assessment Period	Minimum # of Samples	Exceedance Determination	
Fecal Coliform	• 30-day geometric mean, AND • 10% of samples	Two 30-day sampling interval during a two year period	5 samples in each 30-day period, however, 10 samples are preferred.	At least (2) 30-day sampling periods demonstrates an exceedance of the criteria during the assessment period	
Enterococcus	• 30-day geometric mean, AND • 10% of samples	Two 30-day sampling interval during a two year period	5 samples in each 30-day period, however, 10 samples are preferred.	At least (2) 30-day sampling periods demonstrates an exceedance of the criteria during the assessment period	
Marine Water Bacteria *Harvesting for Consumption of Raw Mollusks or Other Aquatic Life*	Unit of Measure	Assessment Period	Minimum # of Samples	Exceedance Determination	
Fecal Coliform	• 90-day geometric mean, AND • 10% of samples may not exceed the specified methodology[10]	Two 90-day sampling interval/ harvest season during a two year period	15 samples needed to calculated the geometric mean • 5 samples per assessment period there after	• At least (2) 90-day sampling periods demonstrates an exceedance of the criteria during assessment period	If it can be demonstrated that advisory conditions apply for 90 consecutive calendar days in a year, consult with EH

Sample collection should represent the most adverse conditions, meaning when it is expected pathogen concentrations will be the highest. Therefore, sampling a range of stream flows, seasonal conditions or even sample collection location can likely assist determining what external factors influence pathogen concentrations- remembering 303(d) listed waterbodies are impacted from human activities and not natural conditions.

[9] (2) samples are acceptable in 1 day but cannot be taken at same sample location
[10] Values found at 18 AAC 70(b)(14)(D)

8.0 References

Environmental Protection Agency, 2010. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. PB85-227049