Appendix O

Selenium Assessment Method for Lake Koocanusa and the Kootenai River in Montana

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ACRONYMS

ARM	Administrative Rules of Montana
AU	assessment unit
BC	British Columbia
BPJ	best professional judgement
CFR	Code of Federal Regulations
CWA	Clean Water Act
CWAIC	Clean Water Act Information Center
^{o}C	degrees Celsius
DEQ	Montana Department of Environmental Quality
DQA	data quality assessment
EPA	Environmental Protection Agency
EQuIS	Environmental Quality Information System
FWP	Montana Fish, Wildlife and Parks
HDPE	high-density polyethylene
HNO_3	nitric acid
MCA	Montana Code Annotated
mg/kg dw	milligrams per kilogram dry weight
µg/L	micrograms per liter
MT-eWQX	Montana EQuIS Water Quality Exchange
MWQA	Montana Water Quality Act
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
TMDL	Total Maximum Daily Load
US	United States
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WARD	Water Quality Assessment and Reporting Documentation
WQD	Water Quality Division
WQPB	Water Quality Planning Bureau
WQS	Water Quality Standard

1.0 INTRODUCTION

This document details the Montana Department of Environmental Quality's (DEQ) site-specific selenium assessment method for the Lake Koocanusa reservoir and the Kootenai River. DEQ assesses surface water quality pursuant to Title 75, Chapter 5, Part 7 of the Montana Water Quality Act (MWQA) and Section 303(d) of the federal Clean Water Act (CWA) (See Section 75-5-702, Montana Code Annotated [MCA] and 33 US Code § 1251). Water quality standards (WQS) must protect the beneficial uses of a given waterbody. The state of Montana classifies waterbodies based on their designated beneficial uses, as found in the Administrative Rules of Montana (ARM) sections 17.30.621-629. All assessment units (AUs) on Lake Koocanusa and the Kootenai River have a B-1 use classification. State law requires waters classified as B-1:

> *"Are to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply"* (ARM 17.30.623).

This document will be used to assess the aquatic life beneficial use for all AUs within Lake Koocanusa and the Kootenai River in Montana. The most sensitive beneficial use to selenium in these waters is the growth and propagation of salmonid fishes and associated aquatic life. Selenium is a pollutant for which Total Maximum Daily Loads (TMDL) can be developed.

1.1 BACKGROUND INFORMATION

Selenium is a member of the chalcogen group (Group 16) on the periodic table of elements. Classified as a nonmetal, selenium has properties of both metals and nonmetals. It is a naturally occurring chemical element that is nutritionally essential in small amounts, but toxic at higher concentrations (EPA, 2021).

Selenium appears in the CWA Section 307(a)(1) list of toxic and priority pollutants. It bioaccumulates in tissues, predominantly through dietary exposure, with egg-laying vertebrates determined to be the most sensitive. Selenium is transferred to the eggs of adult female fish during vitellogenesis where it replaces the sulfur in proteins (Janz *et al*., 2010). During development of Montana's site-specific selenium standards in ARM 17.30.632, fish were determined to be the most sensitive ecological endpoint in Lake Koocanusa and the Kootenai River (DEQ, 2020).

Selenium toxicity in fish manifests through reproductive impairment, via maternal transfer to eggs, resulting in embryo toxicity and teratogenicity (i.e., deformities) (Chapman *et al*., 2010). Extremely high concentrations of selenium can be lethal to adult fish, but this is not common. More frequently, fish populations are affected by chronic low dose exposure to selenium. Refer to DEQ (2020) for additional details on selenium toxicity and the toxicological exposure pathway in Lake Koocanusa and the Kootenai River.

1.2 APPLICABILITY

This assessment method applies only to Lake Koocanusa from the US-Canada international boundary to Libby Dam and the mainstem Kootenai River from the outflow below Libby Dam to the Montana-Idaho border (ARM 17.30.632).

Lake Koocanusa is a 90-mile-long transboundary reservoir in northwest Montana and southeast British Columbia (BC) (DEQ, 2020). The reservoir was formed by the impoundment of the Kootenai River following the construction of Libby Dam in 1972. Lake Koocanusa was created under the Columbia River Treaty between the United States (US) and Canada to provide hydroelectric power and flood control (Storm *et al*., 1982). The total surface area of Lake Koocanusa at full pool within Montana's borders is 28,994 acres.

The Kootenai River is 485 miles long. It originates in southeast BC, flows across the US-Canada border via Lake Koocanusa, extends through Montana and Idaho, then returns to BC where it flows through Kootenay Lake, and terminates upon reaching the Columbia River in Castlegar, BC. The segment within Montana's state border is approximately 50 miles long and is entirely within the Northern Rockies Level III Ecoregion (Woods *et. al*, 2002).

1.3 Common Sources, Pathways, and Factors Influencing Occurrence

Selenium is a naturally occurring element found in sedimentary rocks, shales, coal and phosphate deposits, and soils (EPA, 2021); weathering of natural sources can release selenium into surface water. Selenium can also come from anthropogenic sources. Data collected by DEQ and investigations by McDonald *et. al* (2009) and Storb *et. al* (2023) suggest there are no identified significant sources of selenium (natural or anthropogenic) to Lake Koocanusa or the Kootenai River that originate in Montana.

The primary source of selenium to Lake Koocanusa and the Kootenai River is the anthropogenic release into the environment from historic and present-day mining operations in the Elk Valley of BC (DEQ, 2020). Coal in the Elk Valley belongs mainly to the Mist Mountain Formation of the Jurassic-Cretaceous Kootenay Group and is part of the East Kootenay coalfields (Grieve, 1952). Bedrock in the Elk Valley is excavated to access coal seams underneath for metallurgical steelmaking coal production. The excavation process creates a by-product called overburden (waste rock) which becomes exposed to oxidation, increasing selenium mobilization through infiltration and runoff to nearby groundwater and surface water including the Elk River in BC, a major tributary to Lake Koocanusa (DEQ, 2020).

Diet is the dominant pathway of selenium exposure for aquatic life, with the largest step in accumulation occurring at the base of the food web. Selenium is assimilated into the tissue of primary producers, then transferred to primary consumers, and then further transferred to predators (EPA, 2021; **Figure 1-1**). Selenium bioaccumulation and transfer through the food web can be influenced by the hydrology, biogeochemistry, and food web dynamics of the ecosystem (EPA, 2021).

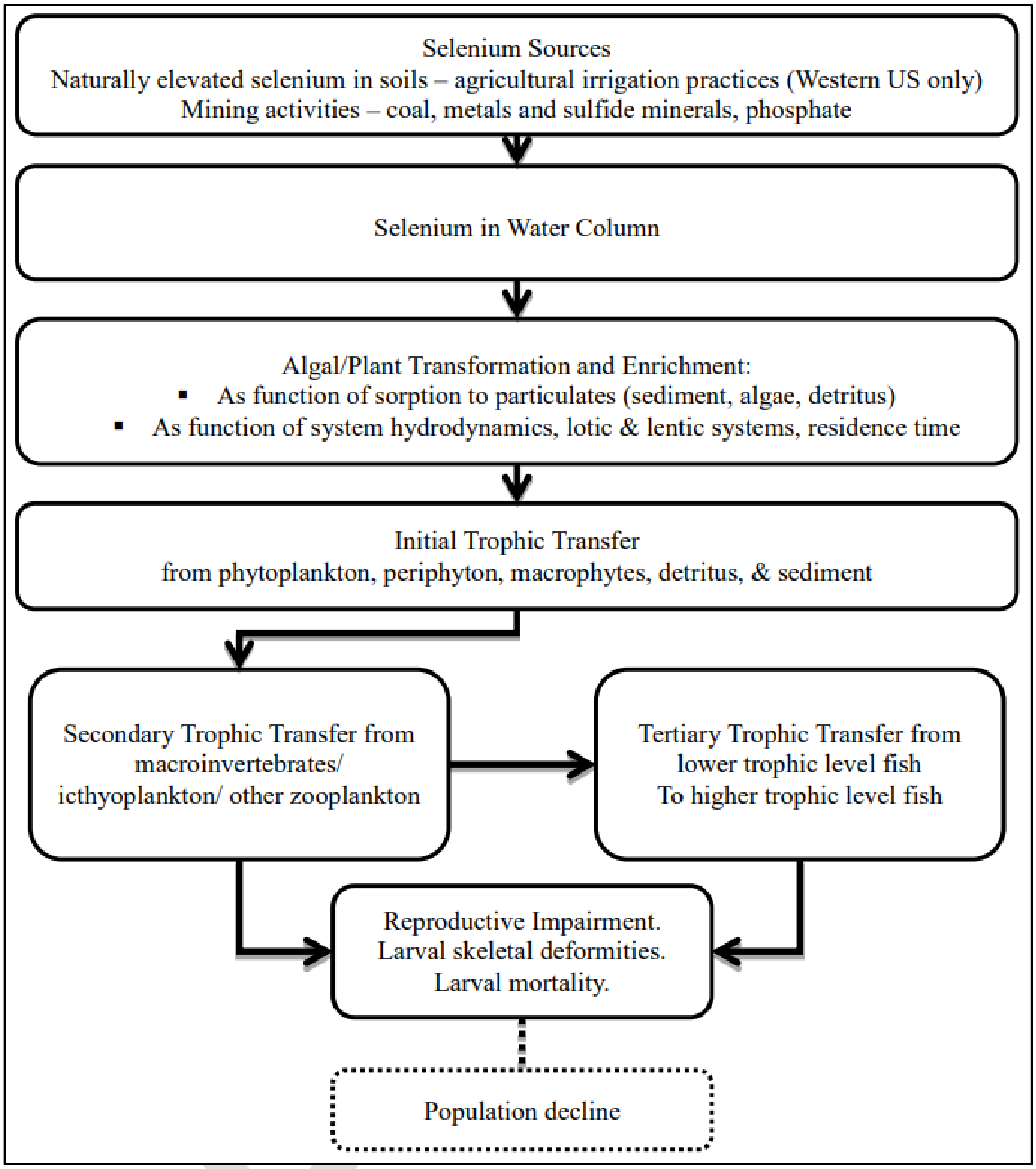

Figure 1-1. Diagram of selenium partitioning, bioaccumulation, and effects in the aquatic environment (EPA, 2021).

2.0 Lake Koocanusa and Kootenai River Selenium Water Quality Standards

Montana WQS designate the allowable concentration of pollutants, or the condition of a waterbody that will protect the beneficial uses. Beneficial uses and water quality criteria provide the framework for achieving federal CWA (40 CFR 131.2) and MWQA (75-5-102, MCA) goals and protections for Montana's water resources.

Montana is required under Section 303(c)(2)(B) of the CWA to establish water quality criteria for toxic pollutants; selenium is a toxic and priority pollutant under Section 307(a)(1) of the CWA. Montana adopted selenium standards into state law on December 25, 2020 to protect the beneficial uses of Lake Koocanusa and the Kootenai River at ARM 17.30.632. These WQS were approved by the Environmental Protection Agency (EPA) on February 25, 2021. The selenium standards for Lake Koocanusa and the Kootenai River (**Table 2-1**) are expressed as fish tissue and water column (dissolved selenium) concentrations.

Table 2-1. Selenium standards for Lake Koocanusa and the Kootenai River.

Media Type	Fish Tissue			Water Column
Criterion Element	**Egg/Ovary**	**Muscle**	**Whole Body**	**Monthly Average Exposure**
Magnitude	15.1 mg/kg dw	11.3 mg/kg dw	8.5 mg/kg dw	0.8 µg/L in Lake Koocanusa 3.1 µg/L in Kootenai River
Duration	Instantaneous measurement	Instantaneous measurement	Instantaneous measurement	30 days
Frequency	Not to be exceeded	Not to be exceeded	Not to be exceeded	Shall not be exceeded more than once in 3 years, on average

mg/kg dw = milligrams per kilogram dry weight, µg/L = micrograms per liter.

DEQ followed the 2016 EPA selenium criteria guidance presented in Appendix K to develop the site-specific chronic water column standard for Lake Koocanusa (EPA, 2016). DEQ adopted the national recommended 304(a) criteria for fish tissue in Lake Koocanusa and the Kootenai River as well as the monthly average exposure water column criteria for the Kootenai River (EPA, 2016). The water column standards are chronic values with no acute selenium standard included since the greatest toxicity risk to aquatic life is from chronic dietary exposure.

3.0 Monitoring Methods and Data Quality Considerations

Waterbody condition must be evaluated based on all existing and readily available data and information (§75-5-702, MCA; 40 CFR 130.7(b)(5)). This section describes several considerations for monitoring and assessing data quality when performing selenium assessments pursuant to this assessment method.

3.1 Parameters Required for Assessment

Data considered for assessment purposes must be either dissolved selenium water column concentrations or fish tissue selenium concentrations (egg/ovary, whole body, or muscle). Montana's numeric WQS concentrations are provided in micrograms per liter (µg/L) for water column concentrations and milligrams per kilogram dry weight (mg/kg dw) for fish tissue samples. All data should be converted to these unit conventions during assessments.

3.2 Field Monitoring Protocols

Procedures used when collecting and analyzing selenium samples vary by sample media. Water column samples are to be collected on-site in high-density polyethylene (HDPE) bottles and preserved with nitric acid (HNO_3). The samples are then stored on ice (≤6°C) until delivery to the laboratory for analysis

(Makarowski, 2020). DEQ advises recording the depth at which each water column selenium concentration sample was taken for Lake Koocanusa.

Fish tissue samples are to be collected and processed by qualified personnel with appropriate training. Close coordination with Montana Department of Fish, Wildlife, and Parks (FWP) fisheries biologists during sampling is highly recommended. Measurements and observations associated with sampling (fish species, length, and weight) should be taken in the field, or as required by a sampling and analysis plan. Detailed descriptions of fish capture methods (electrofishing, gillnetting, etc.) are beyond the scope of this assessment method.

3.3 Monitoring Locations and Spatial Independence

This section includes factors that may affect where sampling should occur, as well as factors to be considered (e.g., depths, distance between sites, zones) when evaluating spatial independence of samples. For attainment decisions, all areas of an AU are expected to meet WQS.

3.3.1 Water Column

Water column sampling considerations relevant to monitoring locations and spatial independence differ between Lake Koocanusa, a reservoir, and the Kootenai River, a large river. While any location may be sampled, it is preferred to have data that represent the entire AU. At a minimum, it is recommended that locations expected to have greater selenium concentrations be targeted.

Lake Koocanusa

Several sampling sites have been established on Lake Koocanusa for collection of long-term water quality data including the International Boundary, where selenium concentrations may be higher. Continued sampling of these established sites is encouraged to strengthen long-term data sets. It is understood that individual sampling locations may vary slightly depending on reservoir levels and other variables (Presser and Naftz, 2020). The assessor may decide to visualize and describe data by zones, but it will not affect how the data are analyzed for beneficial use assessment.

Samples should be collected from multiple depths based on DEQ’s current understanding that dissolved selenium concentrations may vary by depth throughout the reservoir. Selenium concentration data collected within the epilimnion (surface), metalimnion (middle), and hypolimnion (deepest) layers should be aggregated separately by layer. Vertical profile measurements of depth and temperature that accompany selenium concentration data can be used to distinguish between these layers.

The assessor must carefully consider all data within the AU and decide if and how the data should be aggregated or segregated for statistical analysis. To maintain spatial independence, if multiple sites are located within a one-mile radius from one another and data are from the same depth layer (epilimnion, metalimnion, or hypolimnion), the assessor should combine those data into a single site.

Kootenai River

Water column samples collected from the Kootenai River will be considered spatially independent if they are collected at least one mile apart. Samples from sites closer than one mile may be considered spatially independent if there is a major tributary inflow or other substantial change between them. Only data collected from within an AU may be applied to assessment decisions for that AU. As mentioned above for Lake Koocanusa, it is recommended that well-established sampling sites be revisited to bolster long-term understanding of selenium in the system.

3.3.2 Fish Tissue

Considerations pertaining to fish tissue monitoring locations and spatial independence are the same for Lake Koocanusa and the Kootenai River. When selecting species to sample, considerations include, but are not limited to, their sensitivity to selenium, bioaccumulation potential, and diet (**Appendix A**). Fish are mobile; therefore, it is appropriate to aggregate data from sites across an entire AU. However, if analysis shows significant differences within species at various sites, the assessor may evaluate fish tissue data by site rather than combining them across the AU. Fish tissue data must be segregated by species and tissue type within an AU. Generally, individual fish samples are preferred over composite samples to capture the full range of concentrations. However, composite samples are acceptable and are particularly appropriate for small-bodied fish. Only data from the same fish species and the same fish tissue type (egg/ovary, muscle, or whole body) are to be aggregated for comparison to the applicable standard. Additionally, to avoid survivor-bias where only surviving adult fish are sampled, if logistics allow, it is recommended that both adult and juvenile fish be sampled to deepen understanding of selenium bioaccumulation in fish in this system.

3.4 Monitoring Timeframe and Temporal Independence

This section includes factors that may affect when sampling should occur and factors to be considered (e.g., frequency, time of year, spawning periods) when evaluating temporal independence of samples.

Frequency and duration are components of all WQS. For selenium in Lake Koocanusa and the Kootenai River, these are defined in ARM 17.30.632 and differ between water column and fish tissue standards. Water column values are computed as a 30-day average (duration) not to be exceeded more than once in three years, on average (frequency). Fish tissue values are instantaneous measurements (duration) not to be exceeded (frequency) (**Table 2-0**). Fish tissue data reflects integrative accumulation of selenium over time and space in the fish population(s) at a given site (EPA, 2021); therefore, an instantaneous measurement is applied.

3.4.1 Water Column

For the purposes of this assessment method, the 30-day average concentration may be interpreted as a monthly average. The selenium WQS for Lake Koocanusa and the Kootenai River are applicable year-round; therefore, water column selenium data may be collected during any time of the year. To ensure data are collected when selenium concentrations may be greatest, and to strengthen an overall understanding of selenium in this system, it is recommended that monitoring efforts include data collection year-round.

While the magnitude of water column selenium standards differs between Lake Koocanusa (0.8 µg/L) and the Kootenai River (3.1 µg/L), the duration and frequency are calculated the same. The 30-day average will be calculated per site and depth for Lake Koocanusa, and per site for the Kootenai River using discrete samples collected during a single month. If the assessor receives high quality data reported as a daily or weekly composite for which there is no record of the individual samples comprising the composite, then the assessor will use the reported composite value as part of the calculation for the 30-day average. If individual samples are collected at the same site and depth for Lake Koocanusa, or at the same site for the Kootenai River, then each sample should be treated as an individual discrete sample to be included in the 30-day average calculation. This approach includes the full range of concentrations recorded.

To determine when to sample Lake Koocanusa or the Kootenai River, it may be important to consider how each waterbody is managed. Lake Koocanusa is managed for hydroelectric power and flood control. Water levels in the reservoir are lowest in late winter and early spring (i.e., February through April) and highest in summer and early fall (i.e., August through October) (USFWS, 2020). Kootenai River flows are managed by the United States Army Corps of Engineers (USACE) Libby Dam operations. The release of water from Libby Dam into the Kootenai River considers spring white sturgeon spawning and fish migration while mitigating floods and generating power (USFWS, 2020). Kootenai River flows are variable and do not follow a traditional hydrograph. Higher flows may occur in the spring (i.e., May-June) and in the late fall (i.e., November-December). However, Kootenai River flows do not always follow this pattern and they are not consistent from year to year because flows are dependent on annual water supply forecasts and Variable-Flow Flood Control, in conjunction with management goals for Lake Koocanusa (USFWS, 2020). To capture when concentrations may be greatest in Lake Koocanusa, sampling efforts may consider monitoring both during spring freshet when selenium loading is expected to be higher and during the winter/early spring when reservoir levels are the lowest. If possible, sampling year-round for both waterbodies is recommended.

3.4.2 Fish Tissue: Egg/ovary

The type of fish tissue (egg/ovary, whole body, or muscle) targeted for collection will depend on the time of year and the species being sampled. Egg/ovary concentrations have the greatest correlation to reproductive harm in fish, and therefore are the preferred fish tissue to be sampled.

DEQ uses a table prepared by FWP that identifies appropriate egg/ovary sampling times based on spawning periods for fish species known to inhabit Lake Koocanusa and/or the Kootenai River (**Appendix B**). Water temperature is a key factor affecting fish spawning times (Hoffman *et al*., 2002); therefore, there may be instances when fish spawn outside of the periods defined in **Appendix B**. Egg/ovary data from fish sampled outside of the spawning period shown in **Appendix B** may be considered appropriate to use upon the evaluation and direction of FWP fisheries biologists. Egg/ovary tissue data from across the spawning period as defined in **Appendix B** may be aggregated.

3.4.3 Fish Tissue: Whole Body or Muscle

For selenium assessments, egg/ovary is the preferred fish tissue to be sampled. However, whole body and muscle tissues may be sampled as an alternative if reasonable attempts to obtain egg/ovary data are unsuccessful. Selenium concentrations in these tissues will provide representative information on selenium bioaccumulation and ecological exposure at almost any time of the year (except during, and/or immediately before or after, spawning periods for females). It is expected that selenium concentrations may vary across species (EPA, 2021). Recognizing the logistical challenges associated with fish tissue sample collection it is recommended, but not required, to use male fish for muscle samples because their selenium levels are more stable than female fish. Additionally, female fish should not be sampled during, and/or immediately before or after, their respective species' spawning period. Whole body or muscle tissue data from across the same calendar year of collection may be aggregated.

3.5 Minimum Data Requirements

This section describes minimum data requirements that are necessary to perform statistical analyses for making selenium impairment decisions for the specific waters this method pertains to. **Sections 3.5.1 and 3.5.2** outline the data requirements for listing an AU as impaired, and **Section 3.5.3** outlines the requirements for delisting an AU. **Table 3-1** summarizes all data types and their respective minimum and preferred data requirements.

Table 3-1. Minimum and preferred data requirements.

Media Type	Data Type	Allowable Exceedance Frequency	Required Minimum # of samples	Preferred # of samples
Water column	30-day averages, within 3-year period	Shall not be exceeded more than once in 3 years, on average	2	≥ 4
	Samples per 30-day average, spaced one week apart	N/A	1	≥ 2
Fish Tissue	5 individual fish **or** a composite of 5 fish	Not to be exceeded	1	≥ 4

3.5.1 Water Column

Minimum requirements for selenium water column data are provided to guide assessors when performing quality assessments of readily available data. For Lake Koocanusa and the Kootenai River, at least two 30-day averages are required per three-year period to make WQS attainment decisions. These 30-day averages may be from the same year or separate years. At least one 30-day average per calendar year is recommended. When planning for a monitoring project to address this assessment method, additional 30-day periods of data are strongly encouraged.

It is recommended that each 30-day average should include at least two samples spaced one week apart. However, if a site is sampled only once per month, that data can be used to represent a 30-day average in attainment decisions. Further considerations for calculating water column 30-day averages are included in **Section 4.3**.

3.5.2 Fish Tissue

The species list in **Appendix A** is to be used as a guide to assist fish tissue sampling. However, the WQS were developed to protect all fish species. Therefore, any fish species data can be used for WQS attainment decisions as long as the minimum data requirements are met. Fish tissue concentrations for multiple species of fish may be determined and considered when making assessment determinations. An AU can be listed as impaired if one species shows an exceedance.

Fish tissue sample results shall be reported as a single value representing an average of individual fish samples or a composite sample, each option requiring a minimum number of five individuals from the same species (ARM 17.30.632). One composite sample (comprising at least five individuals) meets the minimum data requirements for this assessment method.

All fish samples used during assessments must meet the following specifications:

- All samples that are aggregated or composited to represent an average result must be of the same fish species and tissue type combination.
- All samples must be from the same AU.
- All aggregated egg/ovary samples must be collected within the same spawning period as outlined in **Section 3.4.2**.
- All aggregated muscle and whole body samples must be collected within the same year as outlined in **Section 3.4.3**.

3.5.3 Delisting

Due to the bioaccumulative and persistent properties of selenium in aquatic systems, DEQ will delist an impaired AU after three consecutive years of fish tissue and water column data show zero exceedances of the corresponding WQS.

If any AU is listed because of exceedances in a specific species' fish tissue, those same species and tissue types must be targeted during the delisting process. Whichever fish species and tissue types were initially used to list the waterbody as impaired must show zero exceedances for three consecutive years, in addition to all other species and tissue types. Yet, all applicable readily available fish tissue results must be used for all listing decisions and must meet standards.

3.6 Data Quality

Data must meet quality requirements to be included in the attainment decision-making process. DEQ's quality assurance/quality control (QA/QC) protocols are provided in the Beneficial Use Assessment Method (Makarowski, 2020 - Sections 5.0 and 6.0) and the Quality Assurance Project Plan (QAPP) for Water Quality Planning Bureau (WQPB) Environmental Data Operations (DEQ, 2022 - Section 2.0). These documents also include information regarding the programmatic approach to assessments, approved monitoring methods, and data quality objectives aimed at protecting and improving water quality.

Many other organizations also collect water quality data and information which may be useful for DEQ's selenium assessments. DEQ will accept credible data related to the current condition of Lake Koocanusa and the Kootenai River from external entities in accordance with the guidelines from Section 5.0 of the Beneficial Use Assessment Method (Makarowski, 2020). Data quality requirements apply to all data incorporated while making assessment decisions, whether collected internally (by DEQ) or externally. Data that do not meet DEQ's data quality objectives will not be included in the assessment but may be used to supplement the assessment determination (Makarowski, 2020).

3.7 Data Quality Assessment Overview

Data quality assessment (DQA) is the scientific and statistical evaluation of data to determine whether data obtained from monitoring operations are of the right type, quality, and quantity to support water quality assessments (EPA, 2002). Assessors use DEQ's Water Quality Assessment and Reporting Documentation (WARD) system to document the DQA outcomes (pass or fail) for each parameter group being assessed per beneficial use. All data quality indicators must be met to pass the DQA; if a single indicator is not met, the DQA fails for that parameter group. An assessor may override-pass or override-fail a DQA, but they must accompany this override with adequate justification.

Additional data quality screening may be necessary before the data set is ready to support attainment decisions (EPA, 2002), for example:

- Handling non-detects
- Evaluating database flags
- Evaluating QC samples (e.g., field duplicates and field blanks)
- Verifying holding time and incubation times were adhered to
- Reviewing QA/QC control reports
- Investigating errors in collection or analysis
- Addressing missing data
- Reviewing deviations from project documents

Once DEQ determines the data meet basic documentation requirements, the data are ready to be analyzed to support WQS attainment decisions (EPA, 2002).

3.8 Data Currency

DEQ requires that data used in making assessment decisions be representative of current conditions; typically, this means data must be less than 10 years old (Makarowski, 2020). If at any time significant changes in sources are documented, the assessor should use best professional judgement (BPJ) to determine which data are appropriate to include in an assessment. The assessor will document the specific changes and identify data that best represent current conditions for use in the selenium aquatic life beneficial use assessment.

4.0 Data Analysis to Support Water Quality Standards Attainment Decisions

This section describes how the data will be prepared and analyzed for assessment. DEQ's preferred approach for completing assessments is to incorporate both water column and multiple fish tissue data types. However, it is possible to complete assessments with only one existing and readily available data type. Because the water column standards are derived from modeling selenium bioaccumulation in fish tissue and reflect criteria that protect the aquatic life beneficial use (ARM 17.30.632), either data type is acceptable to complete assessments.

4.1 Assessment Procedure

The assessment procedure is the same for both steady state and non-steady state conditions. The procedure is as follows:

1. For each AU, gather all current and readily available data.
2. Perform data quality assessments to identify the usable data set.
    a. Note all data excluded from the assessment and justify the exclusion. Document this in each AU's assessment record.
3. For each AU, organize fish tissue data first by year or spawning period (fish tissue only).
    a. Sort fish tissue data by type (egg/ovary, muscle, whole body).
    b. Sort each tissue type by year for muscle and whole body tissues and spawning season for egg/ovary.
    c. Sort fish tissue data types by species.
4. Determine if minimum data requirements (five individual fish) are met for each species.
    a. Calculate the average tissue concentration for each species according to **Section 4.2**.
        i. If composite samples are present in the data set, use weighted averages to calculate fish tissue averages.
5. Compare fish tissue data to the WQS and document any exceedances.
    a. If there are any fish tissue exceedances from an acceptable data set (five or more individual fish), document them in each AU's assessment record.
6. Sort water column data by site, and depth if applicable.
7. Sort water column data by month.
8. Determine if minimum data requirements for calculating 30-day water column averages are met for each month.

    a. Calculate the 30-day average(s) according to **Section 4.3**.
9. Compare monthly average(s) to the WQS and document any exceedances.
    a. If there are any 30-day average exceedances at a site, document them and carry this information forward into each AU's documentation.
10. Proceed to **Section 4.4** and interpret all findings into a decision.

4.2 Calculating Fish Tissue Concentrations

Fish tissue sample results shall be reported as a single value representing an average of individual fish samples or a composite sample (ARM 17.30.632). Only data from the same fish species and tissue type combinations will be averaged during assessments. Egg/ovary averages should only include data collected during each species' spawning period in the same calendar year (**Appendix B**). Muscle and whole body averages should only include data collected in the same calendar year.

4.3 Calculating Water Column 30-Day Averages

Preparing water column data for assessments is largely the same between Lake Koocanusa and the Kootenai River. The exception is where depth measurements exist for Lake Koocanusa. Samples collected at the same site and depth layer (epilimnion, metalimnion, or hypolimnion) can be averaged if they were collected within the same month. Depth layers per site should be averaged only with samples from the same depth layer. All depth layers of Lake Koocanusa must meet the WQS and support beneficial uses.

Each water column data set that meets minimum data requirements (**Section 3.5**) should go through a process to derive a 30-day average. Following this process for each month of available data ensures that all collection timeframes are represented equally, and no timeframe has stronger representation than another. The calculation process is as follows:

1. All data from an AU should be compiled and sorted by site, date and time, and by depth layers (Lake Koocanusa only).
2. Only one result is required to produce a 30-day average. If monthly data requirements are met, proceed to **Step 3**.
3. To derive a 30-day average, all results are averaged per calendar month. The 30-day average can then be compared against the numeric standard and used for the decision process provided in **Section 4.4**.

4.4 Impairment Listing and Delisting

Before determining impairment listings, the assessor must review the current WQS in ARM 17.30.632 to verify if the waterbody being assessed is in steady state or non-steady state. The minimum data requirements described in **Section 3.5** must also be met to make an assessment decision to "list" or "delist" an AU. Once the data have been evaluated against the numeric WQS for selenium through the assessment process, an attainment decision can be made. When assessment confirms that the AU-cause combination is an impairment that is not currently listed, the AU-cause will be "listed" in Montana's impaired waters list. Once listed, AU-cause impairments will remain on the list of impaired waters unless and until a subsequent impairment indicates delisting is appropriate. When assessment confirms that an AU is attaining WQS for selenium, the assessment decision is either "do not list" if the AU-cause combination is not already listed, or "delist" if the AU-cause combination was listed previously.

When the aquatic ecosystem is in steady state and selenium data are available for both fish tissue and the water column, the fish tissue standards supersede the water column standard. "Steady state" means, for the purposes of ARM 17.30.632:

> *“Conditions whereby there are no activities resulting in new, increasing, or changing selenium loads to the lake or river aquatic ecosystem, and selenium concentrations in fish living in the aquatic ecosystem have stabilized”* (ARM 17.30.602.32).

Additionally, when in steady state the fish tissue standards have a hierarchy of importance; for a given species the egg/ovary standard takes precedence over the whole body and/or muscle standards.

When the aquatic ecosystem is in non-steady state, both the fish tissue and water column standards apply (ARM 17.30.632). Moreover, for any individual species, exceedance of the WQS for any tissue type indicates impairment.

Tables 4-1, 4-2, and 4-3 provide the framework for attainment decision-making when listing and/or delisting an AU in both steady state and non-steady state conditions. The columns and rows that display the WQS being attained or exceeded assume all minimum data requirements outlined in **Section 3.5** have been met. “Insufficient Data” indicates that minimum data requirements have not been met.

Table 4-1. Decision-making chart for listing when the system is in steady state.

Steady State		**Water Column**		
		No Exceedance	**Exceeded**	**Insufficient Data**
Fish Tissue	**No Exceedance of any tissue**	Not Impaired	Not Impaired	Not Impaired
	E/O Available and Not Exceeded	Not Impaired	Not Impaired	Not Impaired
	E/O Available and Exceeded	Impaired	Impaired	Impaired
	E/O Unavailable, WB or M Exceeded	Impaired	Impaired	Impaired
	Insufficient Data	Not Impaired	Impaired	Insufficient Information

E/O = egg/ovary, WB = whole body, M = muscle.

Table 4-2. Decision-making chart for listing when the system is in non-steady state.

Non-Steady State		Water Column		
		No Exceedance	**Exceeded**	**Insufficient Data**
Fish Tissue	**No Exceedance**	Not Impaired	Impaired	Not Impaired
	Exceeded	Impaired	Impaired	Impaired
	Insufficient Data	Not Impaired	Impaired	Insufficient Information

Fish tissue includes egg/ovary, whole body, and muscle tissue.

Table 4-3. Decision-making chart for delisting after an AU has been declared impaired.

Steady State or Non-Steady State		Water Column		
		No Exceedance in Three Years	**Any Exceedance in Three Years**	**Insufficient Data**
Fish Tissue	**No Exceedance in Three Years**	Delist	Keep as Listed	Keep as Listed
	Any Exceedance in Three Years	Keep as Listed	Keep as Listed	Keep as Listed
	Insufficient Data	Keep as Listed	Keep as Listed	Keep as Listed

Fish tissue includes egg/ovary, whole body, and muscle tissue.

4.5 Documenting Assessment Decisions and Review

The assessor must document all data and decisions pertaining to selenium impairment and aquatic life use support determinations. Assessment outcomes for individual AUs, including data summaries, impairment decisions, and beneficial use support determinations are documented by assessors using Montana DEQ's WARD system and Clean Water Act Information Center (CWAIC). Assessment decisions are reviewed by the Monitoring and Assessment Section Supervisor and may be reviewed by DEQ's Water Quality Division (WQD) Quality Assurance Manager and managers or staff from other DEQ programs. Impaired waterbodies are included in Montana's biennial Water Quality Integrated Report and list of impaired waters. A public comment period is provided for each of Montana's Integrated Reports.

5.0 Threatened Status

Threatened waters (75-5-103, MCA) are AUs for which sufficient data and information exist to determine that designated uses are being attained, but non-attainment is predicted within the next two Integrated Report cycles (approximately four years). This type of listing should include trend analysis and could also include modeling of sources over time. Waterbody-pollutant combinations that are threatened are reported as causes of impairment, they appear on the 303(d) list of pollutant-impaired waters in need of a TMDL, and the associated use is considered not fully supported (Makarowski, 2020).

If none of the water column or fish tissue standards are exceeded in Lake Koocanusa or the Kootenai River AUs during assessment, then DEQ will reevaluate the data and observable trends in the system. Trends that show imminent exceedances in the near future will trigger a “Threatened” listing for the given AU. Source analysis will also help DEQ accurately define the sources of the potential impairments identified in each waterbody.

6.0 Probable Sources

Probable sources of impairment are the activities, facilities, or conditions that generate the pollutants that prevent AUs from meeting WQS. Two major anthropogenic activities are known to cause increased selenium mobilization and introduction into aquatic systems:

1) mining of metals, minerals, and refinement and use of fossil fuels, and
2) irrigation of selenium-rich soils (EPA, 2021).

Additional source selections are available in the WARD system if needed. BPJ will be used to determine any other significant sources on a site-by-site basis. If water quality data are available that suggest a probable source is likely contributing to impairment, the assessor should check the “Source Confirmed” box in WARD. If probable sources are present in the watershed but are not confirmed, the assessor should check the “Source Not Confirmed” box. If source data exist, they should be incorporated into the data analysis and data matrix within WARD. The assessor may also include a brief description of sources in the overall condition of the waterbody summary in WARD.

7.0 Assessment Documentation

Selenium data collected by DEQ are stored in the Montana Environmental Quality Information System (EQuIS) Water Quality Exchange (MT-eWQX) database and are uploaded regularly to the Water Quality Portal. Assessment outcomes for individual AUs, including data summaries, impairment decisions, and beneficial use support determinations, are documented via DEQ’s CWAIC (available at https://clean-water-act-information-center-mtdeq.hub.arcgis.com).

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APPENDIX A – RECOMMENDED TARGET FISH SPECIES FOR MONITORING

This table is intended as a guide for monitoring design. It includes fish species in Lake Koocanusa and the Kootenai River that have characteristics that make them desirable for monitoring efforts. However, the selenium WQS outlined in **Section 2.0** apply to all fish species. Therefore, data from any fish species must be included in assessments. This table was developed in consultation with MT FWP biologists and using information described in EPA (2021).

Species	Location		Native	Game Species	Known sensitivity to selenium	Known selenium bio-accumulator	Diet
	Lake Koocanusa	Kootenai River					
Rainbow Trout *Oncorhynchus mykiss*	X	X		X	X		Insectivore, piscivore
Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*	X	X	X	X	X		Insectivore
Peamouth *Mylocheilus caurinus*	X	X	X			X	Insectivore
Redside Shiner *Richardsonius balteatus*	X	X	X			X	Insectivore
Mountain Whitefish *Prosopium williamsoni*	X	X	X	X		X	Insectivore
Northern Pikeminnow *Ptychocheilus oregonensis*	X	X	X				Insectivore (juvenile); piscivore (adult)
Longnose Sucker *Catostomus catostomus*	X	X	X				Benthic algae, Insectivore
Largescale Sucker *Catostomus macrocheilus*	X	X	X				Benthic algae, Insectivore
Kokanee Salmon *Oncorhynchus nerka*	X	X		X			Planktivore
Brown Trout *Salmo trutta*	X	X		X	X		Insectivore, piscivore
Burbot *Lota lota*	X	X	X	X			Planktivore (juvenile); piscivore (adult)

Species	Location		Native	Game Species	Known sensitivity to selenium	Known selenium bio-accumulator	Diet
	Lake Koocanusa	Kootenai River					
Columbia Slimy Sculpin *Cottus cognatus*		X	X				Insectivore, piscivore
Rocky Mountain Sculpin *Cottus bondi*		X		X			Insectivore
Torrent Sculpin *Cottus rhotheus*		X	X				Planktivore (juvenile); insectivore, piscivore (adult)
White Sturgeon * *Acipenser transmontanus*		X	X	X	X		Detritivore, molluscivore, insectivore, piscivore
Bull Trout * *Salvelinus confluentus*	X	X	X	X	X		Insectivore (juvenile); piscivore (adult)

*Species listed under the Endangered Species Act (1973) require special authorization to catch and/or handle. https://ecos.fws.gov/ecp/report/species-listings-by-state?stateAbbrev=MT&stateName=Montana&statusCategory=Listed

APPENDIX B – SPAWNING TIMES OF FISH IN LAKE KOOCANUSA AND/OR THE KOOTENAI RIVER

The following table lists the known or expected spawning times for fish in Lake Koocanusa and/or the Kootenai River. It was modified by Jim Dunnigan (FWP Fisheries Biologist) from Skaar (2001) and the Montana Field Guide (https://fieldguide.mt.gov) to display accurate spawning periods for species known to inhabit Lake Koocanusa and/or the Kootenai River.

The code for the table is as follows: **J1, J2, F1, F2,** etc. refer to half month increments (e.g., **J1** = January 1-15, **J2** = January 16-31, **F1** = February 1-14, **F2** = February 15-29, etc.). **S** refers to the spawning period for each species. Spawn timing was based either on area specific observations in the Kootenai drainage (K), statewide periods identified by Skaar (S), or the Montana Field Guide (FG).

Species	J1	J2	F1	F2	M1	M2	A1	A2	M1	M2	J1	J2	J1	J2	A1	A2	S1	S2	O1	O2	N1	N2	D1	D2
White Sturgeon [K]									S	S	S	S	S											
Mtn. Whitefish [K]																		S	S	S	S	S		
Kokanee Salmon [K]																		S	S	S				
Cutthroat Trout [K]							S	S	S	S	S	S	S											
Rainbow Trout [K]					S	S	S	S	S	S	S	S												
Brook Trout [K]																	S	S	S	S				
Bull Trout [K]																	S	S	S					
Lake Trout [S]																			S	S	S	S	S	
Brown Trout [K]																			S	S	S	S	S	S
Redband Trout [K]										S	S	S	S											
Northern Pike [S]					S	S	S	S	S															
Peamouth [K]										S	S	S												
N. Pikeminnow [K]									S	S	S	S	S											
Longnose Dace [S]									S	S	S	S	S	S	S									
Redside Shiner [K]										S	S	S	S	S										

Species	J1	J2	F1	F2	M1	M2	A1	A2	M1	M2	J1	J2	J1	J2	A1	A2	S1	S2	O1	O2	N1	N2	D1	D2
Longnose Sucker [S]						S	S	S	S	S	S	S	S											
Largescale Sucker [K]							S	S	S	S														
Black Bullhead [S]									S	S	S	S	S											
Burbot [S]			S	S	S	S																		
Pumpkinseed [S]										S	S													
Smallmouth Bass [S]									S	S	S	S												
Largemouth Bass [S]									S	S	S	S	S											
Black Crappie [S]									S	S	S	S												
Yellow Perch [K]						S	S	S	S	S	S													
Torrent Sculpin [FG]									S	S	S	S												
Columbia Slimy Sculpin [FG]									S	S	S	S												
Rocky Mountain Sculpin [FG]									S	S	S	S												