West Virginia Selenium Chronic Aquatic Life Criteria Implementation[1]

Overview of WV Selenium Aquatic Life Criterion

West Virginia's 2016 revised aquatic life criterion for selenium is a multi-part criterion consisting of both water column concentration and fish tissue concentrations, organized in a hierarchy depending on tissue type, with egg/ovary concentration taking precedence over fish whole body or fillet concentration, which in turn takes precedence over the selenium water column concentration.

In order to develop protective permit limits for selenium, a bioaccumulation factor for specific water bodies may be obtained using selenium fish tissue concentration along with water column selenium information. This information can be used to determine a water column concentration that will be protective of that particular population of fish. Fish egg/ovary concentration is the best indicator of potential adverse effects on fish reproduction, and as such, any concentration of fish egg/ovary tissue obtained by following the procedures outlined in this implementation document take precedence over any other fish tissue or water column concentration.

Oftentimes, fish egg/ovary samples are difficult to obtain due to limited times of year for collection, asynchronous spawning, and insufficient fish size. Because of this, fish whole body or muscle tissue collection is also acceptable. Whether egg/ovary tissue, muscle tissue, or whole body fish tissue is obtained, the tissue's selenium concentration compared to water column concentration may be used to calculate a protective water column concentration.

There is an exception to this hierarchy, and it is in regards to selenium being added to a water that previously had no significant source of selenium. In this case, selenium in fish tissue must be allowed to come to equilibrium with the water column before fish tissue concentration would be allowed to override water column concentration. When a selenium input changes, causing the water column concentration to increase or decrease, the fish tissue will not immediately reflect the changed water chemistry. Because of this, when any major changes in water column selenium concentration occur, a minimum of six months must be allowed before fish tissue may be sampled for use in this criterion.

[1] *Note: In light of the changing nature of policy concerns addressed herein, as well as limited data in these early stages of bioaccumulation factor development, this document is intended to be dynamic, and will likely be modified in the future as more is learned about bioaccumulation factors in various waterbody types and regions in West Virginia.*

West Virginia aquatic life criterion for selenium:

PARAMETER	B1, B4 (warmwater fisheries & wetlands)		B2 (trout waters)	
	ACUTE[1]	CHRON[2]	ACUTE[1]	CHRON[2]
8.27 Selenium (ug/l) Water Column Concentration [f]		5		5
8.27.1 Selenium (ug/g) [g] (based on instantaneous measurement) 8.0 ug/g Fish Whole-Body Concentration or 11.3 ug/g Fish Muscle (skinless, boneless fillet)		X		X
8.27.2 Selenium (ug/g) Fish Egg/Ovary Concentration [h] (based on instantaneous measurement)		15.8		15.8

[1] One hour average concentration not to be exceeded more than once every three years on the average, unless otherwise noted.

[2] Four-day average concentration not to be exceeded more than once every three years on the average, unless otherwise noted.

[f] Water column values take precedence over fish tissue values when new inputs of selenium occur in waters previously unimpacted by selenium, until equilibrium is reached between the water column and fish tissue.

[g] Overrides any water column concentration when water concentrations and either fish whole body or fish muscle (skinless, boneless fillet) are measured, except in situations described in footnote [f]

[h] Overrides any fish whole-body, fish muscle (skinless, boneless fillet), or water column concentration when fish egg/ovary concentrations are measured, except in situations described in footnote [f]

Implementation Procedures for Selenium Chronic Aquatic Life Criterion

Sampling Plan

- Plans for sampling shall be submitted to DEP for review and approval before commencing any sampling for the purposes of establishing a bioaccumulation factor

Data Collection – Water Column and Fish Tissue

- Water column average concentration will be established using recent and reliable data. At least 12 months of twice monthly data for existing sites (using data no older than 2 years) and a minimum of 6 months twice monthly data for new sites is required.
- Water column data will be collected at the same location as fish tissue sampling unless an established instream station is proximate and receives no additional inputs or dilution. Separate water and fish sampling sites shall be justified in the sampling plan and must receive prior approval from DEP.

Stream (Lotic) Fish Collection

- Stream fishes will be collected by standard electroshocking methods in accordance with U.S. EPA Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters (USEPA 1993).
- Minimum sampling reach surveyed will be 100 meters
- All fish collected must be identified, counted and reported, regardless of desired sampling matrices; fish not retained for analysis will be released back into surveyed reach
- Fish tissue sampling location will be as close as practicable to the source of selenium input. Details and deviations from this should be explained in the sampling plan.
- Fish tissue sampling location will be at the same location where water concentration data has been collected unless separate water and fish sampling sites are justified in the sampling plan and receive prior approval from DEP.

Lake (Lentic) Fish Collection

- In lentic waters fish will be collected by gill nets, hook and line, or electroshocking methods according to U.S. EPA Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters (USEPA 1993).
- All fish collected must be identified, counted and reported. Fish not retained for analysis will be released back into surveyed reach.

Collection and storage

- Field sampling shall not commence prior to obtaining appropriate scientific collection permits from West Virginia Division of Natural Resources (WVDNR). State and Federally Listed Threatened and Endangered Species, if present, must be protected using collection methods approved by WVDNR and the United States Fish and Wildlife Service (USFWS).
- If collected, egg/ovary collections for the initial bioaccumulation factor determination should be taken during Spring spawning season (March 1 to June 15).
- Fish muscle tissue and whole body collections for the initial bioaccumulation factor determination should be timed to avoid immediate post spawning influence on selenium concentration (USEPA 2016).
- Fish tissue collections for established permits shall be repeated before permit reissuance to verify the initial bioaccumulation factor (BAF), but no sooner than 3 years from the previous BAF determination.

- Specimens retained for analysis will be measured, weighed, composited by species (see below), labeled, double-bagged, and iced to 4 °C in transit to storage.
- Specimens will be stored at <0°C in preparation for laboratory tissue analysis.

Target Species

Target species groups must be adhered to irrespective of preferred sample matrix. If available target species do not permit use of desired matrix, the tissue matrix type analyzed must be adjusted to match available specimens.

Target species not used for tissue analysis should be enumerated, weighed, and measured.

Minnow group. Creek chubs and western blacknose dace are the most common and abundant fish in small streams in the southern coalfields of West Virginia, and there is much existing selenium tissue data from these species. The expectation is that they will be found at most sampling locations.

Therefore, for the sake of consistency and improved ability for DEP to interpret resulting data, the applicant should target the most abundant two minnow species found at the sampling location for collection and tissue analysis.

For situations where only one or neither of the preferred target minnows are the most abundant species at the sampling location, the most abundant of the following fish can be utilized to obtain 2 minnow species composites: central stoneroller; bluntnose minnow; striped shiner; rosyface shiner; river chub; or silverjaw minnow.

If only one of the listed minnow species is available, the applicant should attempt to collect a minimum of 6 individuals to create 2 composite samples, the results of which will be averaged together. (Two 5-fish composites are preferred)

Fillet samples should only be collected from species that are definitively large enough to yield fillets of adequate size for tissue analysis. Species such as blacknose dace, bluntnose minnow, rosyface shiner, silverjaw minnow, or similar-sized species are not appropriate for collection of fillet samples.

Sunfish group. If bluegill (or other *Lepomis* spp. or rock bass) are resident in the proposed fish collection site, the applicant should analyze a composite sample of the sunfish species in addition to the minnow group composite samples.

If none of the expected taxa are available in the stream being sampled, contact DEP for further guidance.

The applicant shall submit all fish tissue or egg/ovary data analyzed to the DEP for evaluation.

Sample Specifications

- Whether using egg/ovary, whole body or muscle tissue, composite samples shall be used
- Composite sample specifications:
    - 3 to 5 individuals of the same species
    - If >5 individuals of a species are collected, the collection shall be split to provide a replicate sample for that species
    - Individuals for composite samples should be combined before analysis
    - Fish used should be adults and of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual
    - Collected no more than 1 week apart
    - Collected in the same reach (for lotic waters)

- Collected within the boundaries of the lake (for lentic waters)
- Minimum analytical mass of 5g, though samplers should make every attempt to achieve 10g for whole body or muscle analyses (5g plus 5g in case of sample loss), and a minimum of 1g for egg/ovary analyses

Analysis of Tissue Sample

- Samples shall be prepared by use of EPA Laboratory Analysis Method 3052, Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices (USEPA, 1996), EPA Laboratory Analysis Method 3050B Acid Digestion of Sediments, Sludges and Soils or by EPA Laboratory Analysis Method 200.3 Sample Preparation Procedure for Spectrochemical Determination of Total Recoverable Elements in Biological Tissue.

- Samples may be analyzed by selenium animal tissue analysis methods, such as:

Method	Technique	Method Detection Limit
EPA Method 6010 C	Inductively Coupled Plasma – Atomic Emission Mass Spectroscopy	5 mg/kg
EPA Method 6020A	Inductively Coupled Plasma - Mass Spectrometry	0.2 mg/kg
EPA Method 7742	Atomic Absorption, Borohydride Reduction	0.05 mg/kg
USGS I-9020-05	Inductively Coupled Plasma - Mass Spectrometry	0.008 µg/g

- Samples may also be solubilized and analyzed by analyses of selenium in water, such as:

Method	Technique	Method Detection Limit
APH Standard Method 3114 B (2009) or 3114 C (2009)	Hydride generation atomic absorption spectrometry (HG-AAS)	2 µg/L
APH Standard Method 3113 (B) (2009)	Electrothermal atomic absorption spectrometry	2 µg/l
EPA Method 200.8, Rev 5.4 (1998)	Inductively coupled plasma mass spectrometry (ICP-MS)	7.9 µg/L
EPA Method 200.9, Rev.2.2 (1994)	Stabilized temperature graphite furnace atomic absorption (STGF-AA)	0.6 µg/L

Data Submittal

All water quality and fish tissue analyses for the study will be reported, at a minimum the following information will be included:

- Sample ID
- Sample type (whole body, muscle core, egg/ovary)
- Collection location
- Collection date
- Individual water quality selenium results from the collection or location reported in micrograms per liter (µg/L) (minimum 12-month period for existing sites, 6 months for newly established sites, maximum 24 months from fish tissue collection date)
- Fish information (species, length, weight, number in composite)
- total homogenous sample volume
- Tissue selenium concentration of total recoverable selenium in units of micrograms per gram of dry weight (µg/g dw)
- Field collection forms with fish survey results and individual lengths and weights for target species
- Final WVDEP-approved fish tissue study plan
- Protective Selenium Water Column Concentration Calculator with appropriately calculated water column concentration for each final study location
- Laboratory results forms for fish tissue and water column analyses

Application in NPDES permitting

- Species-specific bioaccumulation factors based on selenium tissue concentrations for use in permitting will be calculated with the following equation:

$$\text{Bioaccumulation Factor (BAF) (L/kg)} = \frac{\text{Tissue Concentration (mg/kg) dry weight}}{\text{Average Water Column Concentration (mg/L)}}$$

$$\text{Protective Water Column Concentration (mg/L)} = \frac{\text{Se Fish Tissue Criterion (mg/kg)}}{\text{BAF (L/kg)}}$$

- The lowest protective water column concentration resulting from species-specific bioaccumulation factors will be used to derive permit limits.

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