1. Introduction and Scope

This Standard Operating Procedure (SOP) provides operating guidelines and instruction to obtain representative samples while collecting sediment from freshwater environments, including streams, rivers, lakes, as well as marine environments, including intertidal and subtidal zones. Sediment samples can be collected for field screening or laboratory analysis either by hand or specialized equipment.

This SOP forms part of the British Columbia Field Sampling Manual (BCFSM). Additional information on sediment sampling methods, techniques, equipment and information that is critical for planning a sediment sampling program is included in Part D3 – Sediment Sampling, of the BCFSM. The information contained in the BCFSM must be used in conjunction with the information provided in this SOP.

Additionally, SOP D1-01 Field Identification and Classification of Soils, SOP D1-09 Soil Sample Collection and Handling for Volatile Organic Compounds, and SOP D1-10 Soil Sample Collection and Handling for General Organics and Inorganics are relevant to sediment sampling and as such should be reviewed and considered along with the information provided in this SOP.

Additional information is provided in Guidance documents, the Environmental Management Act (EMA) and the Contaminated Sites Regulation (CSR), which are available on the Contaminated Sites webpage at:

https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/contaminated-sites

Sediment sampling conducted within the provincial jurisdiction of BC for regulatory purposes must be carried out with consideration to the EMA, the CSR, Part D3 of the BC Field Sampling Manual, and this document.

2. Principle of the Sampling Method

Sediment sampling methods vary widely depending on the aquatic environment of the site and the objective of the sampling program; however, general field procedures for the collection and handling of sediment samples in the field are relevant for all methods and are addressed in this SOP. These general field procedures provided in this SOP to assist samplers in maintaining the chemical and physical integrity of sediment samples.

General considerations for sediment sample collection include ensuring that sample cross-contamination does not occur, proper chain-of-custody procedures are followed for sample transport, and that sampling procedures and sediment characteristics are clearly and effectively documented.

3. Quality Control

Quality control is provided by careful documentation of field information, proper handling of sample materials and equipment, careful transfer of sediment into sampling containers, decontamination of sampling equipment, homogenization of sediment samples for applicable analyses and documentation of sampling locations. Ensure that the requirements for sample containers, preservation, and holding times (available from laboratory and also the ENV) are understood during preparations and followed in the field. The ENV provides a table that lists sample container requirements for each parameter or parameter suite, required storage temperatures, preservation requirements and holding times. The table is available on their website at:
Quality assurance is provided by submitting an appropriate number of blind field duplicate samples for laboratory analysis; the number of which will depend on the number of field samples submitted. Field duplicates are collected using the same sampling procedure used for the collection of regular or ‘parent’ samples as described below. Sample naming conventions should be developed so the laboratory is unaware of which samples are duplicates. Confirm the number and type(s) of QA samples with the Project Manager. Refer to the BCFSM for specific QA/QC procedures.

Accurate documentation of sampling locations should be referenced by latitude and longitude or UTM coordinates or to an established grid. This allows repeat sampling events to report values for a consistent location. Follow proper sample handling and preparation protocols, as outlined in the BCFSM, for the specific contaminants of concern. Ensure that field notes are legible, recorded in ink (when possible) and complete. Retain all field notes in a project file (including scanned versions in electronic project folder) to ensure that the information reported is accessible, accurate and defensible.

4. Recommended Equipment and Materials

Documents and forms:
- Site plan, results of previous investigations, etc.;
- Sediment sample logs;
- Field book or electronic tablet for logging field notes; and
- Sample submission and chain-of-custody forms.

Field equipment:
- Disposable nitrile gloves;
- Pen, indelible felt marker;
- Flagging tape;
- Laboratory supplied sample jars/vials, appropriate for the contaminants of concern, pre-labelled;
- Sealable bags;
- Cooler and ice or freezer packs;
- Handheld global positioning system device (GPS; especially important if sampling locations cannot be physically marked [e.g., marine sediment sampling]);
- Field screening instrument (if required), appropriate for the contaminants of concern and with appropriate calibration equipment;
- Sediment sampling equipment (see below);
- Mixing and spoons (for mixing sediment samples);
- Laboratory detergent (e.g. Alconox™ or Liquinox™) and water solution or solvents [as necessary]);
- Distilled water in squeeze bottle dispensers; and
- Paper towels.

Sediment sampling equipment:
- Sampling by hand: scoop, spoon or trowel
- Grab sampler (e.g., Eckman grab sampler, Ponar grab sampler)
- Core sampler (e.g., hand corer, gravity core sampler, piston core sampler, vibracore sampler)

The types of sediment sampling equipment listed above is not complete; other, less common sediment sampling techniques are included in Part D3 of the BCFSM but are not included in this SOP. The selection of appropriate sediment sampling equipment will be dependent upon the sampling design, depth of sediment desired for characterization, and site-specific conditions, including water depth, current and sediment properties. Part D3 of the BCFSM outlines these site-specific conditions and additional considerations that should be evaluated when selecting sediment sampling equipment for a given site and sampling program. The following section outlines sampling considerations for all methods of sediment sample collection and is designed to ensure that the sediment
sample collected is representative of what is present at the sampling location and target depth.

## 5. Sampling Considerations

### Sampling by Hand: Scoop, Spoon or Trowel

- If sediments are not inundated at the time of sampling (e.g., intertidal sediment sampling when the tide is out, stream sediment sampling in low flow conditions) or if the surface water body is shallow (wadeable), the simplest way to collect a sediment sample is by using a stainless steel scoop, spoon, or trowel. Dry sediments can be accessed directly.

- Wading: If sediments are submerged at a wadeable depth, a sample can be collected by wading into the surface water body while facing into the current (upstream) and scooping sediment from the required depth of sediment. Care must be taken to minimize the loss of fine-grained sediments during sampling and sample retrieval.

- Bank/Platform Sampling: In surface water bodies that are too deep to wade into but are less than 3 m deep, a scoop or spoon attached to a piece of conduit can be used from a bank or platform, with care taken to minimize the loss of fine-grained sediments during sampling and retrieval.

### Grab Samplers

- Grab samplers are used to sample surficial sediments, typically silts and clays, but also sands and gravels although recovery of these coarse-grained sediments may not be complete.

- Free, vertical clearance is required to use any grab sampler. Grab samplers are to be securely attached to ropes, and are lowered vertically from a sampling platform such as a boat, or bridge, to the surface of the substrate being sampled. Depending on the weight of the sampler and the depth of the aquatic environment to be sampled, a winch and/or crane system may be required to assist in the sampler’s deployment and retrieval.

- Prior to deployment, the grab sampler must be set to enable triggering once it contacts the sediment.

- The sampler must be lowered slowly through the water column to prevent premature closure.

- The trigger mechanism used to close the grab sampler is sampler-dependent. Some grab samplers close automatically in response to a reduction of tension in the deployment line (when the sampler contacts the sediments), while others may employ a messenger-trigger system. The operating instructions provided by the manufacturer for the grab sampler should be reviewed prior to use.

### Core Samplers

- Core samplers are used to sample vertical columns of sediment. Core samples are especially useful in determining the historical deposition of sediment and contaminants as they preserve sequential sediment layering. Core samplers minimize the loss of material at the sediment-water interface. A wide array of coring devices is available, ranging from hand-driven push tubes to electronic vibracore samplers.

- Manually-deployed push tubes are used in shallow, wadeable waters, or for diver-collected samples. The tube should be approximately 30 cm in length to sample recently deposited sediments at depths of 20 cm or less. A tube of approximately 5 cm in diameter is typically deployed. It is important to note that soft and semi-consolidated sediments such as mud and clay have a greater adherence to the inside of the
tube, while coarse or unconsolidated sediments may be difficult to sample without the use of a core catcher or end cap. When wading to obtain a sample, the sample should be retrieved while facing upstream to prevent sediment disturbance while the sample is being obtained.

- Gravity corers, piston corers and vibracorers are typically deployed and retrieved from a barge platform or large vessel, by professionals trained in the operation of such equipment. As a result, specific considerations and procedures for these specialized corers are not provided in this SOP.

- Sediment cores, collected using any of the above-listed devices, can be subject to spreading or compaction as they are driven into the sediment; both of these processes affect the physical integrity of the core sample. Spreading occurs when sediment is pushed to the side as the core barrel advances into the sediment. Compaction occurs when the sediment is pushed downward as the core barrel advances. One or both of these processes may have occurred if a core barrel is known to have been advanced 3 m into the sediment, but there is only 2.5 m of sediment in the core barrel.

- Core barrel liners can be used in any/all of the above-listed devices. Core barrel liners can be made of stainless steel, glass, Teflon®, polyvinyl chloride (PVC) or carbon steel. The material of the core liner should be selected based on the potential contaminants of concern under evaluation at a given site. Teflon® or plastic is preferred to glass, as they are less likely to break and result in sample loss and/or personal injury. Stainless steel barrels are also acceptable, and provide a better cutting edge and greater strength than plastic or Teflon®. Teflon® and glass liners reduce the likelihood of interference due to metals contaminants from core barrels, cutting heads, etc.

6. Procedures

The sediment sampling procedures outlined below assume that the sampling program and logistics associated with the selected sampling method (e.g., renting appropriate equipment, hiring trained vessel operators, etc.) are complete. Guidance for the planning stage of sediment sampling programs is provided in Part D3 of the BCFSM and should be referenced in conjunction with this SOP.

Procedures associated with sediment sampling in freshwater or marine environments, regardless of the sampling methods/equipment employed, are as follows:

1) Obtain authorization from the owner for site access, if needed, and confirm that physical access to the site is possible.

2) Confirm the accuracy of the existing site plan and or keep sufficient notes so that a site plan can be developed or used to amend an existing site plan. Observe and evaluate the water body to be sampled. Confirm that the assumptions made during the sampling program planning stage such as water depth, current speed, sediment grain size, etc. were accurate and that the equipment and methods available/selected for sediment sampling are appropriate and safe for the site’s current conditions.

3) As part of field preparations thoroughly decontaminate all sampling equipment. Scrub the equipment with tap water followed by an adequate rinse with de-ionized water. If the sampling equipment was last used in sediments containing grease or hydrocarbons or if the equipment exhibits an oily film, a mild detergent (e.g., Alconox®) water
solution should be used followed by a very thorough rinse with deionized water.

4) Prepare and calibrate any field screening instruments, if required.

5) Select the first sampling location or navigate to a predetermined sampling location. Begin collecting samples in the suspected “cleanest” area of the site, and proceed to the more contaminated areas (if relevant/applicable). For sediment quality monitoring begin collecting samples downstream working your way to the most upstream location of the reach.

6) The selected sampling locations should contain sufficient sediment for sampling. Avoid rocky areas or areas of bedrock. If possible, mark each sampling location; sampling locations along streams and small rivers, can be marked with flagging tape secured to shoreline vegetation. Marking tape provides easy reference and enables efficient relocation of a sampling location if the site is to be revisited during the sampling program. Ensure that GPS coordinates are collected and recorded at each sampling location.

7) Consult with the project manager to determine or confirm the appropriate sampling method. When the sample/s has been collected field observations of sediment samples and vapour readings should be recorded in a field notebook. If the sample requires homogenization, observations regarding the sediment should be recorded prior to homogenization and again following homogenization. Document site conditions and key observations; include a photo of the sediment sample and a photo of the sampling location.

**Sampling by hand:**

a) Using a scoop, spoon or trowel, scoop sediment to a predetermined sampling depth (e.g., 0-5 cm, as outlined in the sediment sampling program plan).

b) If the sediments being sampled are submerged, retrieve the scoop, spoon, or trowel slowly through the water column, to minimize the effect of turbulence which can result in the loss of fine-grained surface sediments.

c) A consistent and predetermined sediment volume should be retrieved from each sampling location, targeting sediment from the same sampling depth, to ensure the sample material represents the parent material. Ensure that sufficient sediment is obtained for the selected laboratory analyses including duplicates where required.

d) Place the retrieved sediments into a container such as a shallow pan or a mixing bowl. Excess water may be carefully decanted from the container. Immediately record, in the field log book, observations regarding the appearance of the sediment; be sure to include texture, colour, odour, presence of biota, presence of detritus, and the depth of sediment sampled.

e) With a clean spatula or spoon, either remove the top portion of the sediment (when this is outlined by the study design), or thoroughly stir the sediment to homogenize. Place aliquots of the homogenized sediment into pre-labelled laboratory supplied sediment sample bottle/s as needed.

f) Place the samples directly into a cooler containing ice packs.

**Sampling with a grab sampler:**

a) Set the grab sampling device with the jaws cocked open. Great care should be taken while setting the jaws of the sampler to avoid an accidental closure which could result in serious injuries. Follow the operational instructions provided by the manufacturer of the device to ensure effective deployment and retrieval of the sampling device and optimal sediment sample recovery.

b) Ensure that a rope is securely fastened to the sampler and that the other end of the rope is tied off to the sampling platform (e.g., bridge or boat) to prevent device loss.
c) Slowly lower the sampler over the upstream side of the bridge or boat until it is resting on the sediment; the weight of the sampler is adequate to penetrate soft sediments. At this point, the slackening of the line will activate the mechanism that releases the jaws of Ponar and Petersen grabs. When using an Ekman grab sampler a messenger must be sent down to ‘trip’ the release mechanism.

d) Retrieve the sampler slowly to minimize the effect of turbulence that can result in a loss of surface sediments.

e) Place a container, such as a shallow pan or a mixing bowl, beneath the sampler as soon as it is at the sampling platform. View the sediment sample through the device's top mount screens or flaps to confirm that a complete sample has been retrieved. Note: If the jaws were not closed completely, the sample must be discarded.

f) Gently open the jaws of the grab sampler and in a controlled manner allow the sediments to empty into the container. A selection of one or more layers can be obtained if this is a goal of the sampling plan. For example, a sample of surface sediments (1 - 2 cm) can be obtained by carefully scooping off the top undisturbed layers while exposing deeper sediment material. In some lakes, a grab sample to a depth of 10 - 15 cm is typical and the vertical heterogeneity found within that grab sample may represent many years of lake or watershed changes.

g) If discrete samples from a layer are desired those samples can be obtained from that segregated layer. If a bulk sample or replicate samples are required the full contents of the sampler or the target layer must be thoroughly mixed to create a homogenous matrix. Once mixed the sediment can be transferred into the appropriate sample containers.

**Sampling with a core sampler:**

The following protocol is intended to provide general methods for gravity core sampling. This protocol assumes that any large coring equipment such as gravity corers, piston corers and vibracorers will be deployed from a large vessel or barge and would be operated by trained professionals. For this reason the specifics of core sampling methods regarding large equipment types are not included however a description of core processing techniques and considerations is provided below.

a) Open the valve and set the trigger mechanism (Figure 2). Ensure the rope is securely fastened to the corer and attach the other end of the rope to the sampling platform (e.g., to bridge or to boat).

b) Lower the corer to approximately 5 m above an area of undisturbed sediments and then allow it to fall freely into the sediments. Note that the drop depth may vary with sampler size, weight, and sediment type. Sufficiently heavy corers can simply be lowered into the sediment to avoid any disturbance caused by impact.

c) Send the messenger down to release the trigger mechanism.

d) Carefully retrieve the sampler and place a stopper into the bottom opening before removing the corer from the water to prevent loss of the sample.

e) Remove the liner from the corer and stopper the upper end. Store erect. Repeat steps a through d to obtain replicate cores; each of which should be at least 0.5 m in length.

f) Core processing typically takes place onshore, but can be carried out on the sampling platform if space...
and time permits. When the cores are ready for processing carefully siphon off most of the water that overlay the sediments in the core tube; leave a small amount of water at the sediment-water interface. Take care to not disturb the sediment-water interface.

g) Make careful measurements of the total length of the core and precise points to the nearest millimetre of any layers of sediment that appear to be different. Note any changes in stratigraphy, such as colour and texture. Note that core processing considerations and techniques related to larger cores are described below.

h) A rubber stopper is inserted into the lower end of the corer to form a watertight seal inside the liner. The core is then gently and slowly forced upward to the top of the tube. Some advanced corers come equipped with this stopper allowing the increment of each sediment slice to be adjusted.

i) As the sediment core is extruded, carefully cut slices of the sediment core to a thickness of approximately one cm or more using clean spatulas placing each slice into pre-labelled laboratory supplied sample bottles. A core slicer greatly assists in this operation, but good samples can be obtained without this aid when done carefully.

When core samplers are obtained using large gravity corers, piston corers, or vibracorers, trained equipment operators will remove the sediment core from the equipment; typically, the sediment core will be in a liner. Core sample recovery is highly dependent on the drillers’ technique and experience, and sediment conditions at the site. After the core barrel is advanced to the limit of the run, the core barrel and extensions are withdrawn from the hole. Typically, the recovered sediment core is collected from the core barrel in the liner material. Cores may be processed on the sampling platform or vessel, if space permits, or may be retained for evaluation later, on shore.

The following points should be considered when processing a large sediment core for sampling:

- As a result of the drilling technique, the outer surface of the core may be smeared or disturbed, and stratigraphic detail may be obscured. As such, the core should be split longitudinally to expose a fresh surface for logging.

- Sediment cores should be logged in accordance with SOP D1-01. The exposed core should be photographed, with markers placed along the core to identify the depth at the top and bottom of the core run. Be sure to include the borehole number and the project number in the photo.

- Consideration should be given to collecting samples at changes in stratigraphy (as inferred from changes in drilling action or cuttings), or at predetermined depths ([e.g., continuous, every 0.75 m (2.5 ft) or 1.5 m (5 ft)].

- Samples for laboratory or headspace analysis may be collected directly from the recovered core. Laboratory and headspace samples should be collected from the inner portion of the core where possible to minimize the possibility of including contamination which may be present on the outer surface of the core sample from shallower soils or liquids co-recovered in the core run.

- Information specific to this method of drilling which should also be recorded include the length of run and the length of core recovered. During extrusion, the core will have a tendency to compress or lengthen and logging of the core should account for this.

- Where 100% core recovery is not achieved, an opinion should be made of the depth interval from which the missing sediment is located. Core recovery should be recorded on the sediment core log. In some cases this may be obvious, for instance drilling
from a dense material into a softer material may result in spreading or compaction, rather than recovery.

8) Homogenize the sediment sample. Sediment samples must be thoroughly mixed to ensure that any given sub-sample is representative of the sampled sediment at that particular location and depth. For samples that are to be analyzed for organics, the spatula/spoon and mixing container must not be plastic and the container must be a glass bottle provided by the laboratory. For samples that are to be analyzed for metals, the spatula/spoon must not be metallic. Note that samples collected for analysis of volatile organic compounds, should not be homogenized. If homogenization is occurring in a mixing bowl, adequate mixing can be achieved by stirring the material in a circular fashion, reversing direction and occasionally turning the material over. Repeat several times until the sample is well-mixed.

9) Samples for non-volatile compounds should be collected according to SOP D1-10, and samples obtained for analysis of volatile organic compounds should be collected according to SOP D1-09.

10) For field screening, split the sample or collect a replicate sample from each sampling depth. In either case place the sediment in a sealable plastic bag and conduct vapour screening in accordance with SOP D1-02.

11) Fill the pre-labelled sample containers provided by the laboratory and secure the caps tightly. Clean the threads on the container and the lid to ensure a tight seal when closed. Complete sample labelling by including date and time of sampling, as well as confirmation of requested analyses and any sample preservation (if required) on the label. Ensure appropriate sample labelling information is included.

12) Decontaminate the sampling equipment between each sample collection. Wipe visible sediment with paper towel and thoroughly rinse any residual materials with potable or preferably, distilled water; pat dry with clean paper towel. If the equipment encountered grease, oil or petroleum hydrocarbons a mild detergent should be used for the decontamination process. Whenever a detergent is used for decontamination a rigorous rinse is required to mitigate the potential of phosphate compound residues. For larger equipment, the sampling devices may be cleaned with high pressure steam. Sampling devices should be visually inspected for cleanliness after washing.

13) Typically, any unused sample material is returned to the location from where the sample is collected. If the sediment is known or suspected to be contaminated or where sensitive water uses exist immediately downstream the material should be stored for appropriate disposal.

14) Complete the sample submission and chain-of-custody form.

15) Dispose of all wastes including in-field rinsate, liquids, used gloves and materials, in an appropriate manner. Always leave the site in a tidy condition.

16) At the completion of sampling, note equipment rental(s) and/or materials consumption as necessary. Return all equipment to the person or company responsible for the equipment.

7. References


