Memorandum

September 9, 2016

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Subject: **Supplemental Rock River (Mile 178.5 to 180.5) Investigation**
GM Janesville Assembly Plant
1000 General Motors Drive
Janesville, Wisconsin

This Memorandum was prepared by GHD Services Inc. (GHD) (with input from Ramboll-Environ and Exponent) on behalf of General Motors, LLC (GM) to present the Supplemental Rock River (Mile 178.5 to 180.5 as the Study Area) Investigation Work Plan (Work Plan). This Work Plan is being presented to augment the previously completed Sediment Investigation (GHD, May 2016) and is intended to fill data gaps necessary to complete quantitative human health and ecological risk assessments for the sediment in the vicinity of Outfall 010 and other outfalls (identified as City West Outfall, City Northeast Outfall 1, City Northeast Outfall 2 for the purposes of this Work Plan) that collect storm water runoff from the former GM Janesville Assembly Plant located at 1000 General Motors Drive in Janesville, Wisconsin (Site). The major components of this investigation are to:

- Characterize sediment interstitial water (porewater), surface water, aquatic biota tissue, and complete benthic invertebrate toxicity testing in the vicinity of the outfalls (GM Outfall 010, City West Outfall, City Northeast Outfall 1 and 2) from the Site and upstream reference locations.
- Further characterize the extent of the contaminants in the Rock River sediment in the vicinity of the outfalls from the Site, upstream of these outfalls at reference locations, and within the impoundment area and embayment upstream of the Monterey Dam (Mile 178.5).

1. Introduction

The Rock River is part of the Lower Rock River drainage basin, covering over 3,700 square miles (Wisconsin Department of Natural Resources [WDNR], 2016). The segment of the Rock River near the Site flows from east to west and is approximately 400 feet (ft) to 800 ft wide. The Monterey Dam, constructed in 1855, is located approximately one quarter mile downstream of the Site, and consists of two spillways. The City of

Janesville (City) is currently considering whether to repair the Monterey Dam or remove the dam and its associated spillways. The Study Area between Mile 178.5 and Mile 180.5 is presented on Figure 1. Figure 1 defines the nomenclature to describe the Study Area's outfalls and dams.

In general, dams act as sediment traps, limiting the transport of coarse sediment and creating areas where fine material can fall out of suspension resulting in the accumulation of sediment (Inter-Fluve, Inc, 2015). Sediment has been deposited upstream of the Monterey Dam, most notably in a relatively large impoundment area (including the embayment area) located on the north side of the Rock River, just upstream of the Monterey Dam as well as in the area where the Rock River turns to the west just upstream of the Site (Figure 1) (Inter-Fluve, Inc, 2015).

Upstream of the Site, the Rock River flows through a mix of towns and agricultural areas, including the City of Janesville. Potential sources of pollutants to the Rock River and its sediment include agricultural runoff, storm water discharges, treated municipal and industrial wastewater discharges, and legacy contamination (Inter-Fluve, Inc. 2015). Potential sources of polycyclic aromatic hydrocarbons (PAHs), mercury, and polychlorinated biphenyls (PCBs) to surface water and sediment include airborne deposition, municipal and industrial waste waters, urban storm water runoff, runoff from coal storage areas, and road runoff (Agency for Toxic Substances and Disease Registry [ATSDR] 1995; 1999; 2000).

In March 2016, GM conducted a Sediment Investigation to characterize sediment in the vicinity of the GM Outfall 010 to the Rock River. GM Outfall 010 collects storm water from the main assembly plant property at the Site. In addition, the storm water system at the Site feeds into the City's storm sewers and discharges to the Rock River potentially though the City West Outfall and the City Northeast Outfall 1 and 2 (see Figure 1). The Sediment Investigation consisted of the collection of eight sediment cores in the vicinity of GM Outfall 010 along the south bank (left bank) of the Rock River. Three sediment samples from each of the eight locations (plus 3 duplicate samples for quality control purposes) were submitted for laboratory analyses. The results of the sediment samples were generally consistent with the findings from the sampling conducted on behalf of the City in the vicinity of the GM Outfall 010 by Inter-Fluve, Inc (2015).

The sediment thickness and type within the Rock River between mile 178.5 and 180.5 were previously characterized by Inter-Fluve, Inc (2015). Sediment thickness within the impoundment ranged from 0 to 9 ft, but the majority of the area surveyed (approximately 70 percent) had a sediment thickness of less than 2 ft. The main channel bed was comprised primarily of gravel and cobbles with deposits of loose gravel and medium to coarse sand, that in general were less than 2 ft thick. Areas of the river outside of the main channel contained 2 to 9 ft of deposited fine sand, silts, and organic material (Inter-Fluve, Inc, 2015). During the Sediment Investigation sediment samples obtained within the immediate vicinity of the GM Outfall 010 consisted mainly of silt (75 percent of locations).

A screening-level evaluation of the sediment data was performed to assess the degree to which the sediment concentrations may pose a human health or ecological risk.

For human and ecological exposures, a potential for unacceptable risk could not be ruled out during the screening level evaluation given the high degree of conservatism necessary for such evaluations and the fact that some of the highest concentrations are located at the northern edge of the area that was sampled (e.g., PAHs at locations SS-5, SS-7, and SS-9) (see Figures 1 and 2). The Sediment Investigation

recommended additional sampling to characterize the extent and identify the potential sources of the sediment concentrations within the area where sediment/soil exposures may occur. This Supplemental Rock River (Mile 178.5 to 180.5) Investigation will further characterize the extent and identify the potential sources of contaminants in Rock River sediment in the vicinity of the GM outfalls, upstream of the Site, and within the impoundment and embayment areas upstream of the Monterey Dam.

In addition to sediment characterization, this investigation will address specific data needs identified from the human health and ecological risk screening analyses, as follows:

- Concentrations of chemicals of interest in surface water, to better characterize water-related exposures for humans and fish.
- Concentrations of PCBs and mercury[1] in fish tissue potentially consumed by humans.
- Concentrations of metals (cadmium, copper, lead, mercury, and zinc), PAHs, and PCBs in fish and aquatic invertebrates tissue potentially consumed by wildlife.
- Sediment toxicity to benthic invertebrates.
- Bioavailability of PAHs and mercury in sediment to sediment invertebrates through porewater analysis.

Further, certain additional geophysical data will be collected to help support the City's evaluation of the Monterey Dam removal options. These geophysical parameters are intended to support analyses of sediment stability or erosion potential in the event that the City decides to remove the Monterey Dam.

The purpose of this Work Plan is to present the Supplemental Rock River (Mile 178.5 to 180.5) Investigation Scope of Work (SOW) which consists of the following:

- Collection of seven surface water samples in the vicinity of the GM Outfall 010, impoundment area, and upstream of the Site to characterize surface water.
- Collection of 49 sediment cores in the vicinity of the GM outfalls, within the impoundment and embayment areas, and upstream of the Site to fully delineate the extent and potential sources of contamination identified in the previously completed Sediment Investigation.
- Collection of 11 sediment porewater samples in the vicinity of the GM outfalls and upstream reference locations to further evaluate sediment toxicity to benthic invertebrates.
- Collection of aquatic biota samples in the vicinity of the GM outfalls to characterize the concentration of bio-accumulative compounds (e.g., PAHs, PCBs, and select metals) in prey species.
- Collection of 11 sediment samples in the vicinity of the GM outfalls and upstream reference locations to further evaluate sediment toxicity to benthic invertebrates through benthic invertebrate toxicity testing.

The SOW and methodology associated with each of the tasks identified above are discussed in the subsequent sections.

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[1] Mercury concentrations in fish were predicted to be below risk thresholds, based on modeling from sediment methylmercury concentrations (GHD, 2016). The proposed sampling is intended to confirm the modeled fish tissue mercury levels.

2. Surface Water Investigation SOW

The Supplemental Rock River Investigation Study Area is presented on Figure 1. The surface water investigation will consist of the collection of seven surface water samples in the vicinity of the GM Outfall 010, the impoundment area, and upstream reference locations to characterize surface water (see Figures 2 and 3). The rationale for each proposed surface water sample location is presented in Table 1.

Surface water sampling will be conducted in accordance with the applicable GM Field Method Guideline (FMG) (FMG 6.3 – Surface Water Sampling) presented in Attachment A.1.

Surface water sampling for organic analytes will be conducted with a reusable stainless steel sampling device commonly referred to as a "bomb" sampler. The bomb sampler will be lowered from the sampling vessel from mid-depth of the water column and opened to collect the sample. The bomb assembly will then be retrieved and the sample decanted to the appropriate sample containers. The bomb will then be lowered back to the interval to collect an additional sample from the same location and interval until enough sample volume has been retrieved to fulfill the sample volume requirements and collect field measurements.

Surface water samples for inorganic analyses will be collected using a peristaltic pump with sample tubing attached to a rod made of appropriate inert material. The sample tubing will be affixed with straps to the rod and lowered to the same depths as used for the bulk sample with the "bomb". The sample will then be pumped with the peristaltic pump through sample tubing directly into sample containers. Following collection of the total metals surface water samples the sample for filtered metals analysis will be collected using a 0.45 micron filter on the end of the tubing with the filtered water collected directly into the sample container. Sampling for inorganic constituents will be performed following the bomb sampling.

All equipment must be thoroughly decontaminated.

The general procedure for collecting surface water samples is as follows:

1. Maneuver the sampling vessel to the proposed sampling location using Differential Global Positioning System (DGPS) and R8 Global Navigation Satellite System (GNSS) Real Time Kinematic (RTK) Global Positioning System (GPS) and deploy a marker buoy at the location; record the water depth using a lead line or calibrated fathometer.
2. Collect equipment blank samples on the frequency shown in Table 1, using distilled/deionized water in a decontaminated sample bomb to fill a full set of sample containers.
3. Collect the water samples for organic constituents from mid-depth of the water column using the sample bomb.
4. Ensure the bomb sampler has been decontaminated and is in the closed position.
5. Guide the sampler overboard until it is clear of the vessel.
6. Lower the sampler through the water column with the suspension cable keeping the cable attached to the trigger of the plunger relaxed. When the desired sample depth is reached (mid-depth of the water column), open the sampler by pulling the trigger cable taut to allow the reservoir chamber to fill with liquid.

7. Allow the trigger cable to go slack to close the sampler and retrieve the sampler with the suspension cable.
8. Position the sampler over the appropriate sampling jar.
9. Transfer the sample to the pre-cleaned and pre-labeled sampling jars by pulling the trigger cable to open the sampler. Store samples in coolers with ice or ice packs until samples are dispatched under chain or custody to the analytical laboratory.
10. After collection of the samples for organic constituents, collect samples for the inorganic constituents using a peristaltic pump. Fix new sample tubing to the rod at appropriate intervals to ensure that it will not snag on subsurface materials and that the open end of the tubing can be positioned at the desired depths.
11. Pump water from mid-depth of the water column, corresponding to the depths collected using the bomb. Direct water into containers for total inorganic analyses. The surface water sample will be collected from mid-depth during this sampling.
12. After collection of the unfiltered inorganic samples, connect the sample tubing to the peristaltic pump with a 0.45 micron filter on the discharge end of the pump tubing to collect the sample for filtered metals analysis.
13. Run the peristaltic pump to produce the filtered water sample and collect the filtrate into the pre-preserved sample container.
14. Place the container in a cooler with proper labeling and discard the sample tubing.
15. In the field log book, describe surface water characteristics. Record the GPS coordinates of each sample location. Note the elevation of the Rock River and the depth below water surface for each sample collected. Complete the field form for surface water sample collection (see Attachment B.1).
16. Decontaminate the sampler, and ensure all logbook entries are complete.
17. Field duplicate samples will be collected at the rate of one for each 20 or fewer investigative samples.

The surface water samples will be submitted for laboratory analysis of the following by the methods indicated in accordance with section s. NR 716.13, Wis. Adm. Code:

- Selected parent PAHs by United States Environmental Protection Agency (U.S. EPA) Method SW-846 8270.
- Target Analyte List (TAL) Metals (less earth metals) by U.S. EPA Method SW-846 6020/7470 in both filtered and unfiltered water samples.
- PCBs by U.S. EPA Method SW-846 8082.
- Hardness by U.S. EPA Method 2340C-1997.

Table 2 presents the selected parent PAHs and TAL metals that will be included in the analysis.

A summary of the Quality Assurance/Quality Control (QA/QC) sampling plan for surface water is presented in Table 1.

3. Sediment Investigation SOW

The SOW for the sediment investigation will consist of the following (see Figures 2 and 3 for sample locations):

- Task 1: Collection of eight sediment cores (SS-10 to SS-17) in the vicinity of the GM Outfall 010 located north of the Site along the south bank of the Rock River to fully delineate the extent and potential sources of contamination identified in the Sediment Investigation. Collection of nine sediment cores (SS-18 to SS-26) in the vicinity of the City West Outfall and City Northeast Outfall 1 and 2 to characterize sediment in the vicinity of these two outfalls.
- Task 2: Collection of seven sediment cores (SS-27 to SS-33) in the impoundment area upstream of the Dam, to characterize sediment.
- Task 3: Collection of eight sediment cores (SS-34 to SS-41) in the embayment area located on the north side of the Rock River upstream of the Monterey Dam, to characterize sediment.
- Task 4: Collection of 17 reference sediment cores to assess sediment concentrations of target parameters in the Rock River. The downstream reference sediment samples (SS-42 and SS-43), collected just upstream of the Monterey Dam, will be used to characterize sediment immediately above the Monterey Dam that reflects inputs from multiple sources. The upstream reference sediment samples (SS-44 to SS-60), collected from the vicinity of the Centerway Dam (also known as the Janesville Central Dam), the West Racine Street Bridge, Monterey Park, and Jeffris Park will be used to assess reference levels of pollutants transported through the Rock River. Although 17 samples have been proposed, sediment samples will only be analyzed from a proposed sample location if visual field screening of the sediment indicates that the sediment has similar physical characteristics to the sediment previously identified in the vicinity of GM Outfall 010 (fine sand with silt and organics [Inter-Fluve, Inc, 2015]) up to a maximum of 10 samples. The field screening will consist of a visual analysis for grain-size and apparent presence of organic material. All additional sediment cores will be held in case analysis is required at a later date.
- Additional sediment cores will be collected and frozen at the lab from SS-12, SS-15, SS-17, SS-25, SS-37, SS-39, SS-49, SS-50, SS-51, SS-53, and SS-59 for possible forensic analysis.

The rationale for each proposed sediment sample location is presented in Table 3.

A core processing area will be established on shore prior to commencing field activities. An experienced GHD geologist will be on Site to process and log the sediment cores. The contractor will transport the cores from the sample location to the core processing area. Cores will remain in a vertical position while being transported to the processing area.

A trailerable coring vessel will be utilized for sediment collection activities. The coring vessel will be positioned at each sampling location using a sub-meter DGPS with either spuds or by anchoring. All sample

points will be located using sub-meter DGPS and R8 GNSS RTK GPS and coordinates provided to WDNR (referenced to NAVD88 vertical datum). The coring vessel requires 2 to 2.5 feet of water to float and 4 feet to run its engine. Water depths will be recorded using both a lead line and a calibrated fathometer. The coring vessel is outfitted with an A-Frame, electric winch, generator, and all necessary sediment collection tools. Sediment cores will be collected from each location using a Rossfelder® or PVL submersible vibracore unit. Additional sampling devices such as a van Veen sampler, Ekman and a Piston corer will be on hand to be used if necessary. Sampling will be conducted in accordance with the applicable GM FMG (FMG 6.2 – Sediment Sampling) presented in Attachment A.2. Sediment cores will be advanced until refusal is encountered. The core will be sub-sectioned into intervals (0 to 0.5 ft, 0.5 to 2 ft, 2 ft to refusal). Penetration depth and depth of core recovery will be recorded at each sample location. This will allow for determination of percent recovery (as measured by length divided by penetration length) and sediment thickness at each location.

A piston corer will be used to collect the top 0 to 6-inch interval in conjunction with the vibracoring equipment.

A photograph of the vessel is provided in Attachment C. Note that should unfavorable weather conditions prevent usage of the coring barge described above (e.g., frozen surface, heavy ice flows, or shallow water depths) a non-motorized barge will be utilized. The portable barge will be floated out to the sample locations and cores will be collected using a portable manually driven vibracore.

Field Procedures. Sediment core samples will be collected using an electrically powered vibracorer which is lowered through the water column under winch control and penetrates the sediment by means of its weight and powered vibration.

The following steps outline the procedures for using a vibracorer in the field:

1. Maneuver the sampling vessel to the proposed sampling location using DGPS and R8 GNSS RTK GPS and deploy a marker buoy at the location; record the water depth using a lead line or calibrated fathometer.
2. Check to ensure that the clear, semi-rigid cellulose acetate butyrate (CAB) disposable tubing is securely fastened to the powerhead of the vibracorer.
3. Insert a disposable core catcher into the end of the barrel so that the catcher fingers will extend into the tubing, and then screw the cutter head onto the bottom of the core barrel until the shoulder snugs against the end of the tubing. Tighten the cutter head with a spanner or strap wrench.
4. Start the electrical generator, but **DO NOT** yet energize the corer.
5. Signal the winch operator to hoist the corer and swing it over the stern or side of the vessel at the marked sampling location. Reposition the vessel if necessary. Record the water depth using a lead line or calibrated fathometer.
6. Signal the winch operator to lower the corer through the water column. Determine the depth of the corer in the water column and track its subsequent penetration into the sediment by either marking the winch line in 1 ft increments or by attaching a flexible tape measure to the powerhead.

7. When the cutter head is within approximately 10 ft of the bottom, energize the corer by actuating the circuit breaker on the generator control panel.
8. Slow the descent speed of the corer in order to determine when the core nose enters the sediment. Maintain tension on the winch line throughout the coring process to keep the corer from toppling over. The worker monitoring the penetration of the corer into the sediment will signal the winch operator when to pay out more line.
9. If refusal is encountered or if the measured distance to the tip of the core nose indicates that project depth has been reached, stop paying out line and de-energize the corer. Do not power down the generator. Refusal is indicated by less than 6 inches of penetration in a given 30-second interval.
10. Signal the winch operator to bring the winch line taut. Maneuver the boom or the boat until the winch pulley is directly above the corer, as indicated by the winch line being as close to true vertical as possible.
11. Record the position of the actual coring location. The navigation antenna may be mounted on the winch boom near the pulley to place it directly over the corer.
12. Signal the winch operator to retrieve the corer. If the corer is stuck in the bottom, energize the power head while maintaining tension on the winch line. To reduce the risk of losing sediment from the core barrel, de-energize the corer as soon as it shows any sign of vertical movement. As soon as retrieval of the corer is underway, power down the generator. Swing the corer over the deck and lower it to a holding rack. Note and record the length of smearing on the outside of the core barrel, which gives an indication of the amount of penetration.
13. Use a spanner or strap wrench to unscrew the cutter head and remove it. The catcher may stay inside the cutter head or remain attached to sediment inside the tubing. Retain any sediment in the cutter head and core catcher for examination and possible use.
14. Remove the disposable catcher, if necessary, and immediately cap the bottom end of the core tubing with a plastic cap. Secure the bottom cap with duct tape. Immediately cap the top of the core liner.
15. If the core is to be cut into sections, draw a mark on the outside of the core liner where the cut will be made to cut off the bottommost section. Apply duct tape and use a permanent marker to mark the sections on both sides of the location of the future cut. Mark arrows pointing toward the top end of the core, write the core ID, write date and time, and indicate the depth interval spanned by the sections in terms of feet below mudline.
16. Cut the core at the section boundary using power shears loaded with a decontaminated blade. Another person will be at the ready to immediately cap both the exposed ends and secure with duct tape.
17. Repeat the cutting procedure if more sections need to be cut.
18. Remove the cap from the top end of the top-most section and drain the water. Draining may be accomplished by drilling a hole through the core liner just above the top of the sediment or by gently

tipping the section to empty the water out the top. Care must be taken to avoid loss of sediments during decanting, particularly "soupy" sediments with high water content.

19. After decanting, cut off the excess plastic tubing, cap the end at the sediment interface, and secure the cap with duct tape.
20. Evaluate the appearance and length of the core sample by examination through the clear plastic core tubing. Note any stratigraphic intervals or other salient features on the core collection log sheet.
21. Store the core sections at 4°C (±2°C) in a refrigerator or iced cooler for subsampling and further processing (see below).
22. Complete any additional entries on the coring field form.

Core Acceptance Criteria. Acceptance criteria for sediment core samples are as follows:

- The core penetrated to target depth.
- The core did not suffer significant sample-induced compaction or loss of material (i.e., recovery greater than 60 percent, as measured by recovery length divided by penetration length).
- Cored material did not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube.
- There are no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core tube, which may have resulted in an incomplete and biased core section.

If sample acceptance criteria are not achieved, the sample will be rejected and a repeated deployment will be made within 20 ft of the original location. If redeployment does not result in an acceptable sample according to these criteria, the Project Manager will be contacted to discuss relocating the proposed core sample.

Core Processing. The following steps outline the general procedures to be followed when cores are split, logged, and subsampled for laboratory analysis.

1. All equipment coming into contact with sediment will be decontaminated before use with each sample to avoid cross contamination.
2. Cut the core tubing longitudinally on opposite sides using power shears. Pull away the top half of the core tubing to expose the sediment sample.
3. Log and describe the sediment on a core log form according to standard ASTM soil description procedures. Core logs should include:
    a. Visual grain size classification
    b. Color
    c. Consistency (stiffness or denseness)
    d. Odor
    e. Presence of debris

f. Presence of biological activity (e.g., detritus, shells tubes, bioturbation, live or dead organisms)

g. Presence of oil sheen

h. Any other unusual or distinguishing characteristics

4. After the sediment description is complete, subsample the core into intervals (0-0.5 ft, 0.5-2 ft, and 2 ft to refusal; based on in situ conditions). The ex situ core intervals will be corrected for compaction, and therefore may be somewhat less than these intervals in actual length.
5. A sediment sample for simultaneously extracted metals (SEM) and acid-volatile sulfide (AVS) will be obtained via a discrete grab prior to sample homogenization described below.
6. Homogenize each depth interval using a stainless steel mixing spoon or an electric drill with a stainless steel paddle.
7. Collect samples of the homogenized sediment as appropriate for chemical analysis. Label sample jars and place them in refrigerators or coolers with blue ice to maintain sediment at 4°C until dispatched under chain of custody to the appropriate laboratory. Samples designated for archiving will be frozen for possible future analysis.

A field form will be completed at each sample location that will include: sample coordinates; weather; wind conditions; water depth; penetration depth; depth of core recovery; and ASTM soil description. See Attachment B.2.

Each sediment core will be field screened for grain-size distribution in accordance with the applicable FMG (FMG 6.2 – Sediment Sampling) presented in Attachment A.2 (as applicable).

At each location, one sample will be selected for laboratory analysis from the sediment depth intervals of 0 (riverbed surface) to 0.5 ft and 0.5 to 2 ft, for a total of 92 samples, in accordance with the applicable FMG (FMG 6.2 – Sediment Sampling) presented in Attachment A.2. Additional samples will be collected from surface sediment (0 to 0.5 ft) collected for benthic invertebrate toxicity testing, as described in Section 4.2. The data from these samples are intended for use in the assessment of potential human and ecological exposures.

All sediment samples selected for chemical analysis (i.e., all samples except the upstream samples deemed physically different than those collected downstream) will be submitted for laboratory analysis of the following by the methods indicated in accordance with section s. NR 716.13, Wis. Adm. Code:

- TAL Metals (less earth metals) by U.S. EPA Method SW-846 6020/7471
- PCB Aroclors by U.S. EPA Method SW-846 8082
- Total Organic Carbon (TOC) by the Lloyd Kahn Method

In addition, certain chemical and physical analyses will be performed on subsets of the sediment samples, as follows:

- All surface and subsurface sediment samples will be analyzed for grain size analysis using the Sieve Method (ASTM D422). Grain size analysis using the Sieve Method (ASTM D422, with hydrometer) will be analyzed in sediment samples selected for toxicity testing; see section 4.2.
- All surface and subsurface sediment samples will be analyzed for selected parent and alkylated PAHs by U.S. EPA Method SW-846 8270. However, if there is evidence of subsurface strata presenting a sheen, high PID reading, petroleum or tar odors, or tar like appearance, an additional sediment sample will be taken from the observed stratum. Any additional sediment samples will be analyzed for selected parent and alkylated PAHs by U.S. EPA Method SW-846 8270.
- SEM (cadmium, copper, lead, nickel, silver, zinc) by U.S. EPA Method SW-846-6010/7470 and AVS by U.S. EPA Method EPA-821-R-100 will be analyzed in all surface sediment samples collected adjacent to or downstream of GM outfalls (i.e., at and downstream of sample location SS-27).
- Hexavalent chromium by U.S. EPA Method 7196A will be analyzed in all upstream surface samples where SEM metals are not analyzed (see above) to provide information on chromium speciation.
- Methylmercury by U.S. EPA Method EPA 1630 will be analyzed in surface sediment samples from locations at and downstream of location SS-27.
- Black carbon (soot) analysis by the black carbon in soil samples method will be analyzed in surface sediment samples from locations at and downstream of location SS-27.
- Pyrethroid pesticides by U.S. EPA 8270D(M) TQ will be analyzed in sediment samples selected for toxicity testing; see Section 4.2 (Eurofins Calscience).
- Additional sediment for laboratory porewater extraction for parent and alkylated PAH analysis will also be collected at sediment toxicity test sample locations; see Section 4.2.

In addition to the analysis above, the following data will be collected as part of the Study Area SOW to support analyses of sediment stability or erosion potential in the event that the City decides to remove the Monterey Dam:

- Bathymetric survey extending between the Monterey Dam upstream to the Centerway Dam (as required)[2]
- Existing topographic survey of the Rock River extending between the Monterey Dam upstream to the Centerway Dam within the Study Area (e.g. City, County, USGS, etc.).
- Bed material characteristics (as required) (Review with GHD sediment transport modelling experts)
  - Total Solids and Water Content (ASTM D2216)
  - Bulk Density-dry (ASTM D2937)
  - Grain Size Distribution (ASTM D422, with hydrometer)

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[2] GM will request that the City provide the Inter Fluve Inc (2015) bathymetry data in a database. Additional bathymetry data, including flow rates, will be collected, as required.

- Atterberg Limits (ASTM D4318)
- Field Vane Shear Test (field method) (ASTM D2573)
- Direct Shear Testing (ASTM D3080)

To fully characterize the bed material, sediment sample cores will extend to the pre-dam bed level, determined based on a review of historic records, and characterize different depositional horizons. Following a review of the entire sediment collection, bed material characteristics will be completed at up to three locations for each type of sediment to get characteristics representative of different depositional environments extending to the depth of refusal. The proposed bed material characteristic tests will be completed where the sediment material is suitable (e.g., appropriate grain size for the Atterberg Limits testing).

A summary of the sediment sampling and analysis plan is presented in Table 3. Sediment samples will be placed in laboratory-supplied containers and shipped under standard chain-of-custody (COC) protocol for analysis of the parameters listed above on a two-week turn-around time (TAT). However, note that expedited turnaround will be requested for selected parameters in candidate toxicity test samples; see Section 4.2.

The selected PAH compounds (parent and alkylated) will be reported individually as well as a summation of the individual parent PAHs reported as Total PAH.

Table 2 presents the selected parent PAHs, alkylated PAHs, PCB Aroclors, and TAL metal that will be included in the analysis.

A summary of the QA/QC sampling plan is presented in Table 3.

4. Benthic Invertebrate Sediment Toxicity Testing SOW

The study design for sediment toxicity testing includes the following components:

- Collection of sediment from 8 candidate toxicity testing locations adjacent to and downstream of GM Outfall 010, as well as 3 upstream reference locations.
- Placement of in situ passive diffusion samplers (peepers) for porewater collection at these 11 locations.
- Expedited analysis of TAL metals and priority pollutant PAHs from the 8 adjacent/downstream sediment samples, followed by selection of 5 of these samples for toxicity testing.
- Chronic sediment toxicity testing using the amphipod *Hyalella azteca* and the midge *Chironomus dilutes.*
- Analyses of sediment from toxicity test locations for the remaining target analytes.
- Laboratory extraction of sediment porewater followed by analysis of dissolved concentrations of parent and alkylated PAHs.
- Retrieval of peepers from final sediment toxicity test locations, followed by analyses of collected porewater for total mercury and methylmercury.

The rationale for these study elements and methods for their implementation are given in the subsections below.

4.1 Surface Sediment Sampling Methods

Surface (i.e., 0 – 6 inches below ground surface [bgs]) sediment will be collected from 8 candidate toxicity test locations adjacent to and downstream of GM Outfall 010 and from 3 of 4 upstream depositional areas that will act as reference locations (Figures 2 and 3). Precise sediment sample locations will be determined in the field, with the goal of collecting sediment from locations with similar substrate characteristics, to limit potential variation in toxicity test responses related to physical conditions such as grain size distribution and organic content (proposed locations are identified on Figures 2 and 3). Ultimately, toxicity testing will be performed on 5 adjacent/downstream sediment samples and 3 upstream sediment samples (see Section 4.2.1). The selection of sample locations for toxicity testing will be based on: (1) field observations of physical similarity of sediments, for upstream locations, and (2) expedited analysis of selected parameters for adjacent/downstream locations. This approach is intended to improve the likelihood of obtaining a representative gradient of chemical concentrations in the toxicity test data set, which will maximize the ability to apply the results of the sediment toxicity testing to locations for which only chemical concentrations are available.

Sediment samples will be collected sequentially from downstream to upstream. Prior to sediment collection at each location, water quality measurements will be taken at mid-depth of the water column using a multi-parameter meter, taking care not to disturb the sediment layer. Surface sediment will be collected from each location using a petite Ponar sampler. Any free water will be carefully decanted to avoid loss of fine material.

Multiple grab samples from within each sampling location will be composited to satisfy total sample volume requirements, including the volume necessary for toxicity testing, chemical analyses of bulk sediment, and porewater extraction for PAH analysis. Samples for the porewater PAH analysis will be collected from a discrete grab, prior to sediment homogenization described below. Sediment from all grab samples taken from a single location will be placed in a bowl or bucket and mixed until it is visually observed to be homogeneous; excessive mixing will be avoided to maximize sample integrity. Visible plant material (roots, shoots, leaves) and rocks will be removed prior to filling sample containers. Sample containers will be packed as full as possible to minimize empty head space. A field duplicate and laboratory QC sample will be collected at a predetermined sampling location.

Surface sediment samples will be labelled immediately after collection. The information on the sample label will include the project name, sample identification, sample date and time, and the analyses requested. Samples will be placed immediately in wet ice. Under appropriate chain-of-custody procedures, samples will be shipped via overnight courier in wet ice.

4.2 Whole-Sediment Chemical Analyses

4.2.1 Expedited Chemical Analyses

The 8 candidate adjacent/downstream sediment samples will be analyzed for TAL metals and priority pollutant (parent) PAHs on an expedited basis, with a 5-day TAT. The analytical results will be reviewed, and 5 samples will be selected for toxicity testing. The toxicity test samples will be selected with the goal of providing representative concentration gradients (including the highest available concentrations) for total PAHs and for TAL metals.

4.2.2 Standard Chemical Analyses

The 3 upstream sediment samples from toxicity test locations will be analyzed for TAL metals on a standard TAT.

All 8 sediment samples selected for toxicity testing (i.e., 5 adjacent/downstream samples and 3 upstream samples) will be analyzed on a standard turnaround basis for the following parameters:

- AVS/SEM U.S. EPA Method EPA-821-R-100 and SW-846-6010/7470
- Methylmercury by U.S. EPA Method EPA 1630
- Parent and alkylated PAHs U.S. EPA Method SW-846 8270
- PCB Aroclors by U.S. EPA Method SW-846 8082
- Pyrethroid pesticides by U.S. EPA 8270D(M) TQ
- TOC by the Lloyd Kahn Method
- Black carbon by the black carbon in soil samples method
- Grain size analysis by the Sieve Method (ASTM D422, with hydrometer)

Pyrethroid pesticides are included because they have been identified as a widespread cause of observed sediment toxicity in urban and rural areas nationally (Kemble et al., 2013). Although pyrethroid pesticides, if present, are not expected to be Site-related, their analysis will help identify or rule out this potential cause of toxicity in Rock River sediments.

4.3 Porewater Collection and Analysis

Sediment porewater will be collected using different methods for analyses of PAHs and mercury, as described below.

4.3.1 PAH Analysis

Porewater for PAH analysis will be extracted from sediment samples at the laboratory using centrifugation followed by alum flocculation and extraction of the PAHs using solid phase microextraction (SPME) (ATSM Method D7363-13 and U.S. EPA Method 8272). The analysis will include parent and alkylated PAHs, as summarized in Table 2, by U.S. EPA Method SW-846 8270 SIM. Centrifugation is considered an appropriate porewater extraction method for PAH analysis based on extensive validation of this approach as a basis for exposure-response evaluations at PAH-contaminated sites (McDonough et al., 2010).

4.3.2 Mercury Analyses

Porewater for mercury analysis will be collected using peepers. This approach is preferred for analyses of metals (including mercury), to minimize sampling artifacts that may be associated with centrifugation.

Peepers will consist of a passive diffusion bag placed within a perforated push point casing. The diffusion bag consists of a semi-permeable membrane (0.45 µm polysulfone) filled with deionized water that allows dissolved mercury to diffuse into the sampler, providing an estimate of the time-averaged concentration of mercury in sediment porewater. Before deployment, the casing will be acid leached in 5 percent (v/v) HCl and rinsed by soaking in de-ionized water. The assembled peepers will be deoxygenated by nitrogen purging for at least 24 hours.

The push point casing with the diffusion bag will be installed into the biologically active zone of river bed sediment. Specifically, the peepers will be installed into the sediment at a depth of approximately 6 inches at all 11 candidate toxicity test locations (i.e., 8 adjacent/downstream and 3 upstream). The peepers will be buried within the sediment to allow the surrounding interstitial water to infiltrate the sampler. If the sediment is soft, the peepers will be pressed into the sediment by hand (if wadeable) or with a weighted frame. An underwater camera will be used to verify that the peepers are placed appropriately. The peepers will be connected with leader lines attached to the shoreline, if possible, to facilitate retrieval. If attachment to the shoreline is not possible, the leader lines will be attached to floating buoys to identify their locations. GPS coordinates will also be recorded. Concentration equilibrium between the porewater and the sampler generally requires approximately 4 weeks.

Peepers will be retrieved after the specified equilibration time. Porewater will be analyzed only for those locations selected for sediment toxicity testing; peepers from the remaining locations will be discarded. Once on-shore, the peepers retrieved from toxicity test locations will be rinsed immediately with deionized water, the membranes covering cells will be perforated with acid-washed pipette tips, and the porewater will be collected in pre-cleaned sample containers and stored on ice until shipment to the laboratory. Porewater collected from the peepers will be analyzed for total mercury and methylmercury. Peepers are designed to collect sediment porewater and dissolved contaminants therein. Therefore, the analytical results will be considered to represent dissolved concentrations.

4.4 Benthic Invertebrate Toxicity Testing

Toxicity tests will be conducted on 8 sediment samples, including 5 adjacent/downstream samples and 3 upstream samples. Ramboll Environ's Aquatic Toxicity personnel will conduct the sediment toxicity testing; contact information is:

Brian Hester
Ramboll Environ: Port Gamble Environmental Laboratory
4770 NE View Drive
PO Box 216
Port Gamble, WA 98364

The following sediment toxicity tests will be performed:

Test	Method
Hyalella azteca 42-d Test for measuring the effects of sediment-associated contaminants on survival, growth, and reproduction	U.S. EPA 600/R-99/064 Test Method 100.4
Chironomus dilutus 20-day survival and growth (no reproductive endpoint)	U.S. EPA 600/R-99/064 Abbreviated Test Method 100.5

The toxicity tests will be implemented as static renewal bioassays. The toxicity test procedures include analysis of porewater ammonia and pH. Appropriate laboratory controls and reference toxicant tests will be utilized to assess the viability of test organisms and testing conditions.

For *Hyalella azteca*, the sediment exposure starts with 7- to 8-d-old amphipods. On Day 28, the amphipods are isolated from the sediment and placed in water-only chambers where reproduction is measured on Days 35 and 42. Typically, amphipods are first in amplexus at about Day 21 to 28 with release of the first brood between Day 28 to 42. Endpoints measured include survival (Days 28, 35 and 42), growth (as dry weight measured on Day 28 and 42), and reproduction (number of young/female produced from Day 28 to 42). The amphipod tests will be conducted with a minimum of 12 replicates per sample and 10 organisms per replicate. Test acceptability is determined by a minimum mean control survival of 80 percent on Day 28.

For *Chironomus dilutus*, the sediment exposure starts with <24 hour old larvae. On Day 20, the replicate chambers will be sacrificed, and survival and ash-free dry weight will be recorded. The midge tests will be conducted using up to 16 replicates per sample and 12 organisms per replicate. Test acceptability is determined based on the average size of *C. tentans* in the control sediment, which must be at least 0.6 mg/surviving organism as dry weight or 0.48 mg/surviving organism as ash free dry weight.

Explicit details regarding specific testing conditions can be found in U.S. EPA (2000).

5. Aquatic Biota Tissue Investigation SOW

The aquatic biota tissue investigation will consist of the collection of invertebrate and fish samples to characterize the concentrations of bioaccumulative compounds (e.g., PAHs, PCBs, and select metals) in wildlife prey species and in fish potentially consumed by humans.

5.1 Benthic Invertebrate Tissue Investigation SOW

Benthic invertebrate tissue samples will be co-located with sediment samples and collected after the collection of sediment for chemical and/or toxicity analysis. Sampling efforts will be focused on obtaining invertebrate tissue samples from at least three priority locations: one from depositional areas upstream of the Site, one near the Site, and one from the embayment area upstream of the Monterey Dam and across the river from the Site.

Samples will be collected using a variety of methods at each sampling location to increase the likelihood for success in obtaining an adequate mass of tissue for analysis. The success of each sampling method varies

by the particular type of organisms, habitat, and water depth present at each sampling location. Invertebrates collected for tissue analysis will be obtained from baited minnow traps, ponar sampling of sediment followed by sieving, and potentially nets (kick, sweep, or dip netting, if conditions permit). The Field Team Leader and/or the Project Manager will determine which sampling method(s) are appropriate for each individual location.

It is possible that target specimens for benthic invertebrate tissue samples will be either absent from a proposed sampling location or present in insufficient numbers or volume to satisfy analytical requirements. Therefore, at the discretion of the Field Leader and/or the Project Manager, final locations and number of biota tissue samples will be determined in the field based on availability of target organisms. Reasonable efforts will be made to obtain the required minimum biota tissue sample volume, allowing a maximum sampling time of 12 person-hours (i.e., 6 hours for a 2-person team) per sample location.

Invertebrate samples for tissue analysis will consist of a representative composite of the collected taxa, sufficient to satisfy a sample required for the analyses summarized below (approximately 50 g). The mass of the composite benthic invertebrate sample(s) will be determined in the field. Any individual specimens not used for this sampling effort will be released at the sampling location from which the individual was collected. Habitat disturbance during sampling will be minimized to the extent possible. Sediment will be removed from the specimens by rinsing with analyte-free deionized water. The composite sample will be wrapped in aluminum foil (dull side against the sample) and placed into a small, plastic zip-top bag, labelled with project name, sample identification, sample date and time, and the analyses requested. Samples will be placed immediately on wet or dry ice and held in a freezer, if possible, until shipping. Under appropriate COC procedures, samples will be shipped via overnight courier in wet ice to TestAmerica.

Benthic invertebrate tissue samples will be analyzed for metals, PAHs, and PCBs at TestAmerica. In the case that an insufficient amount of tissue is collected to support all chemical analyses, metals (cadmium, copper, lead, zinc) will have the highest priority for analyses, followed by PAHs, methylmercury, total mercury, and lastly PCBs. The prioritization of analyses reflects that cadmium, copper, lead, and zinc do not biomagnify through the food web, and PAHs are metabolized in fish. Therefore, invertebrate tissue is the worst-case exposure pathway for these metals, whereas PCB and mercury concentrations will likely be higher in fish tissue.

Benthic invertebrate tissue samples will be submitted for laboratory analysis in the order of priority presented below, following the indicated methods:

- Selected metals (cadmium, copper, lead, and zinc) by U.S. EPA Method SW-846 6020
- Parent PAHs by U.S. EPA Method SW-846 8270
- Methylmercury by U.S. EPA Method 1630
- Mercury (total) by U.S. EPA Method 1631
- PCB Aroclors by U.S. EPA Method 8020
- Lipid Content by U.S. EPA Method 1980

Table 2 presents the selected parent and alkylated PAHs and PCB Aroclors that will be included in the analysis.

5.2 Fish Tissue Investigation SOW

Fish will be collected for tissue constituent analysis to investigate trophic transfer potential of Site-related constituents via the food chain. Potential transfers of Site-related constituents may result in exposures to higher-trophic-level wildlife and to humans through consumption of fish from the area. Prior to collecting fish samples, a Scientific Collectors Permit or Research License Application and Authorization (Form 9400-379)[3] will be obtained from the WDNR.

5.2.1 Prey-Size Fish

The Rock River provides habitat for fish, which serve as a prey base for wildlife. Elevated concentrations of metals, PAHs, and PCBs were found in Rock River sediments. Piscivorous birds and mammals may be exposed to these chemicals while consuming fish from the River. To evaluate the potential risk posed by chemicals in fish to wildlife that consume them, five to eight whole body composites of prey-size fish will be collected for chemical analysis from the impoundment area upstream of the Monterey Dam (i.e., in the vicinity of and downstream of GM outfalls). Each composite sample should consist of at least 5 individual fish (more individuals may be needed to reach minimum sample size for very small fish). In addition, five to eight whole body composite samples of prey-size fish for chemical analysis will be collected upstream of the Centerway Dam. All samples will be placed on ice immediately until transfer to the analytical laboratory.

Composite samples will be assembled in the field based on species, collection location, and fish body size. Examples of target species include: common shiner (*Luxilus cornutus*), dace species (*Rhinichthys atratulus, Rhinichthys cateractae*), sunfishes (bluegill [*Lepomis macrochirus* Rafinesque], pumpkinseed [*Lepomis gibbosus* (Linnaeus)], and crappies [*Pomoxis* spp.]). Benthivores or bottom fish, such as brown bullhead (*Ameiurus nebulosus*) may be collected, if prey-size individuals are available, because of their close association with sediments. Upon availability in the field other species may be collected that represent forage fish, including benthivorous fish that wildlife may consume.

The small fish composite samples will be analyzed for the following using the indicated methods:

- Select metals (cadmium, copper, lead and zinc) by U.S. EPA Methods 6020
- Mercury (total) by U.S. EPA Method 1631
- PCB Aroclors by U.S. EPA Method 8020
- Lipid content by U.S. EPA Method 1980
- Total Solids by U.S. EPA Method 160.3

In addition, parent PAHs (U.S. EPA Method 8270) will be analyzed in a subset of whole fish composite samples to ensure consideration of PAH exposure to piscivorous wildlife from fish gut contents (i.e., the

3 http://dnr.wi.gov/files/PDF/forms/9400/9400-379.pdf

whole fish samples will naturally include gut contents). Table 2 presents the selected parent PAHs and PCB Aroclors that will be included in the analysis.

5.2.2 Game Fish

Fillets of game fish will be collected to assess potential risk to humans via fish ingestion. In addition, to support analyses of risks to the fish themselves, the complete carcasses remaining after fillet preparation will be retained for analysis. Both fillet and carcass samples will be weighed, which will permit calculation of the corresponding whole-body concentrations.

Game fish sampling will target catfish and bass, if present in sufficient numbers. Catfish, especially channel catfish (*Ictalurus punctatus*), are popular sport fish and are likely to be present due to the suitability of habitat conditions in the impounded area. Largemouth bass (*Micropterus salmoides*) and/or smallmouth bass (*M. dolomieu*) will also be sampled, if present in sufficient numbers. These bass species have high site fidelity (i.e., a small home range) and thus are more likely than other species to reflect localized sediment exposures. However, habitat conditions in the impounded area may not be favorable for bass, due to sparse instream cover (e.g., log jams, root wads, boulders). If the target bass species are not present, then an alternative game fish species will be selected based on availability (e.g., walleye [*Sander vitreus*], sauger [*Sander canadensis*], and/or northern pike [*Esox lucius*]).

Game fish will be collected from the same sampling areas as prey fish (i.e., the impounded area upstream of the Monterey Dam and the area upstream of the Centerway Dam). Sampling will target at least 8 catfish and 8 bass (or alternative species) from the impounded area, if available. In the upstream area, sampling will proceed from the Centerway Dam and will continue upstream until at least 8 individuals of each target species are obtained, in order to characterize background conditions.

Game fish samples will be analyzed as individual fish (i.e., not composited). Game fish samples will be filleted in the field. Cutting boards will be covered with a piece of aluminum foil, dull side facing up. Skin will be left on the fillets of all species except catfish, which is consistent with WDNR's fish advisory program. The fillets will be analyzed for total mercury, PCB Aroclors, and lipid content; all testing will be consistent with the WDNR's fish advisory program. Field collection and laboratory methods for fish samples are discussed below.

Game fish fillets and carcasses will be analyzed for the following using the indicated methods:

- Mercury (total) by U.S. EPA Method 1631
- PCB Aroclors by U.S. EPA Method 8020
- Lipid content by U.S. EPA Method 1980
- Total Solids by U.S. EPA Method 160.3

Table 2 presents the selected parent and alkylated PAHs and PCB Aroclors that will be included in the analysis.

5.2.3 Fish Collection Methods

Fish will be collected using standard fish collection techniques (e.g., seine and gill nets, traps, and electrofishing) in accordance with the applicable GM FMG (FMG 6.7 – Fish and Crayfish Collection) presented in Attachment A.3. Each gear deployment event will constitute a sample station. Data will be recorded on a sample log sheet at each sample station and will include the station name, date, gear used, electrofishing effort, netting effort, location, global GPS data, and qualitative information on water quality or habitat.

Vital statistics such as species, length, weight, and general observations will be recorded, and digital photos will be taken as appropriate. Each sample retained will be assigned a sample number. Fish sample collection forms will include client name, site name, sample identification number, sampling location, species, physical characteristics of the sampling station, date and time, names of field personnel, and a checklist to record any observed gross physical abnormalities (see Attachment B.3).

For prey species, minimum sample weight to be collected for tissue samples will be 25 g, as required. For game fish samples, sample size will be predicated on size limits established for recreational fishing. Fish samples will be wrapped in aluminum foil (dull side against the sample) and placed in Ziploc®-type bags and stored on ice for overnight courier shipment to the analytical laboratory (TestAmerica). As field personnel process samples, they will label the sample containers and record sample identifiers and numbers in the field notebook, along with other pertinent collection data. Chain-of-custody and sample analysis request forms will be completed and signed at the end of the day and shipped with the samples to TestAmerica.

A sample label will be completed for each sample and placed on the outside of each sample Ziploc®-type bag. All sample label entries will be made with indelible ink. Sample containers will be labeled at the time of sampling with the following information: sample number, site name, sample location designation, sampling date and time, sampling personnel, preservative (if appropriate), and tag number.

If shipping is required, the samples will be shipped by express overnight service. All packaging, marking, labeling, and shipping of samples will comply with the regulations promulgated by the U.S. Department of Transportation in 49 CFR 171–177. Samples will be transported and shipped in a manner that protects both the integrity of the samples and the safety of the handlers. It is anticipated that the samples collected from this site will be classified as low-hazard materials. All samples will be packaged securely in plastic coolers containing enough ice to ensure that they remain cool throughout shipping and handling.

In addition to primary field samples, one laboratory duplicate per 20 samples, and one MS/MSD sample per 20 samples will be analyzed for the target analytes.

6. Quality Assurance/Quality Control (QA/QC)

QA/QC sampling includes equipment blanks, field duplicates, matrix spike/matrix spike duplicate (MS/MSD). Equipment blanks will be collected at a frequency of 1 per 10 sediment samples collected, at a minimum of 1 per day. Field duplicates will be collected at a frequency of 1 per 10 sediment samples collected. MS/MSD samples will be submitted at a frequency of 1 per 20 sediment samples collected. It should be noted, temperature blanks are not required as samples will be shipped on ice. The following is a brief discussion

defining each type of field derived QC sample that will be collected during the Supplemental Rock River (Mile 178.5 to 180.5) Investigation.

- **Equipment Blanks** - Equipment field blanks are defined as QA/QC samples used to determine if cleaning procedures are effective and adequate. Equipment field blanks are prepared by collecting laboratory distilled de-ionized water which has been "run through" or "poured over" the cleaned sample collection equipment. If dedicated, new sampling devices are used; an equipment blank is not required.
- **Field Duplicates** - Field duplicates will be collected and submitted to assess the potential for laboratory data inconsistency and the adequacy of the sampling and handling procedures. A duplicate sample is collected from the same source utilizing identical collection procedures and typically submitted "blind" to the laboratory by providing a false identification number. The sampling key to ensure proper sample identification must be submitted to the appropriate personnel to enable completion of the QA/QC review process. It should be noted that field duplicates are not always required for solid samples (e.g., fish fillets, etc.). It may be possible to homogenize a solid sample and collect a "split" sample, as required.
- **Laboratory QA/QC Sample Volumes** – MS/MSD sample volumes are additional sample aliquots provided to the laboratory to evaluate the accuracy and precision of the sample preparation and analysis technique. Typically, three times the normal sample aliquot is required to conduct MS/MSD procedures. Sample collection is identical to the technique described for collection of field duplicates. Sample labeling identifies the respective sample location and each additional container that is labeled as the "MS/MSD" volume.

7. Sequencing of Sample Collection

Careful sequencing of sample collection is necessary to ensure collection of samples that are representative of ambient environmental conditions and to minimize the potential for collection of unrepresentative samples and cross-contamination between samples and sample locations. The following considerations/actions will be taken in the final staging of the sampling event:

- Fish will be collected for tissue constituent analysis by electrofishing. The timing of the fish collection is independent of the sample collection of other environmental media (e.g., surface water, sediment, and benthic invertebrate tissue)
- Samples will be collected beginning at the locations furthest downstream and proceeding upstream.
- Within a given sampling area, as applicable, environmental media will generally be collected in the following order to maintain sample integrity: (1) collect surface water, (2) collect sediment, (3) collect benthic invertebrates, and (4) install peepers for porewater collection.

8. Reporting

The Supplemental Rock River (Mile 178.5 to 180.5) Investigation will be conducted pursuant to the SOW presented in Sections 2 to 5. A Supplemental Rock River (Mile 178.5 to 180.5) Investigation Report (Report) presenting the results of the surface water, sediment, sediment porewater, benthic invertebrate toxicity

testing, and aquatic biota tissue investigation will be prepared. The data evaluation will include a risk-based assessment consistent with prior submittals to the WDNR for this Site. The resulting data will support updated human health and ecological risk assessments. Upon completion of the Supplemental Rock River (Mile 178.5 to 180.5) Investigation, it will be determined if further investigation and/or delineation is required. The proposed SOW for any supplemental investigations will be presented in the Report.

9. Schedule

The Supplemental Rock River (Mile 178.5 to 180.5) Investigation is scheduled to begin the week of September 19th and continue through mid-November (weather dependent). GHD plans to implement the Work Plan beginning the week of September 19th due to the time required for the porewater peepers to reach equilibrium with the sediment (4 weeks).

An appropriate and qualified subcontractor, Normandeau Associates, Inc. (Normandeau), located at Suite 101, Building A, 400 Old Reading Pike in Stowe, Pennsylvania, will conduct surface water sampling, sediment coring activities, and aquatic biota sampling.

It is anticipated that the Supplemental Rock River (Mile 178.5 to 180.5) Investigation will take approximately 6 to 8 weeks to complete.

GM/GHD will provide WDNR with a minimum of 72 hour notice prior to commencing any sampling activities.

10. References

ATSDR. 1995. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. August.

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U.S. EPA. 2000. Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders. Memorandum from Simon, Ted. W., Ph.D., Office of Technical Services. http://risk.lsd.ornl.gov/homepage/ecoproc2.pdf.

U.S. EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. EPA 600/R-99/064.

U.S. EPA. 2003. Procedures for the Derivation of Equilibrium-Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Polycyclic Aromatic Hydrocarbon (PAH) Mixtures. EPA-600-R-02-013. U.S. Environmental Protection Agency, Office of Science and Technology and Office of Research and Development.

WDNR. 2016. Lower Rock River Basin. http://dnr.wi.gov/water/basin/lowerrock/. Accessed April 21, 2016.

LEGEND

- PROPERTY BOUNDARY
- 1 — APPROXIMATE SEDIMENT SAMPLE LOCATION (INTER-FLUVE, INC - OCTOBER 30, 2015)
- SS-1 — APPROXIMATE STAGE 1 SEDIMENT INVESTIGATION SAMPLE LOCATION (NORMANDEAU ASSOCIATES, INC. MARCH 9 AND 10, 2016)
- MAJOR OUTFALL
- OTHER STORMWATER OUTFALL

SOURCES:
- IMAGERY PROVIDED BY NAIP IMAGERY OF WISCONSIN, 2015 – U.S. DEPARTMENT OF AGRICULTURE (USDA) FARM SERVICE AGENCY, AERIAL PHOTOGRAPHY FIELD OFFICE (WISCRS-ROCK COUNTY FEET).
- SEDIMENT SAMPLE LOCATIONS FROM MONTEREY DAM SEDIMENT ANALYSIS SEDIMENT ANALYSIS EXHIBIT , INTER-FLUVE, INC, DECEMBER 9, 2015.
- MAJOR OUTFALL LOCATIONS FROM CITY OF JANESVILLE STORM SEWER SYSTEM PERMIT MAP - 2016.
- OTHER STORMWATER OUTFALL LOCATIONS FROM CITY OF JANESVILLE WEB MAPPING APPLICATION, GEOCORTEX VIEWER FOR HTML5, AVAILABLE AT: HTTP:GIS.CI.JANESVILLE.WI.US/HTML5VIEWER/INDEX.HTML?VIEWER=JANESVILLE

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

GM JANESVILLE ASSEMBLY PLANT
JANESVILLE, WISCONSIN

ROCK RIVER INVESTIGATION
SAMPLING AREA

GHD

Source Reference:			
Project Manager: J.C.	Reviewed By: N.K.	Date: SEPTEMBER 2016	
Scale: AS SHOWN	Project №: 58505-01	Report №: MEMO045	Drawing №: figure 1

58505-01(MEMO045)GN-WA001 SEP 8, 2016

EMBAYMENT

SS-36 SS-39 SS-38 SS-41 SS-35 SS-40 SS-37

W-3 SS-43 SS-42 T-8 SS-33 SS-34

MONTEREY DAM
(RIVER MILE 178.4)

IMPOUNDMENT AREA

SS-32 SS-25 T-6 T-7 SS-24 SS-26 T-5

CITY WEST OUTFALL

SS-47 T-9 W-4 SS-45 SS-44 SS-48 SS-46

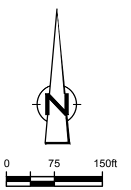
ROCK RIVER

SS-27 SS-31 SS-30 SS-28 SS-19 SS-18 SS-20 SS-13 SS-11 SS-29 SS-14 SS-22 SS-15 SS-12 SS-23 SS-21 SS-16 W-1 SS-10 SS-17 T-3 SS-3 W-2 T-4 T-2 T-1 SS-7 SS-5 SS-4 SS-1 SS-8 SS-9 SS-6 SS-2

CITY NORTHEAST
OUTFALL 2

CITY NORTHEAST
OUTFALL 1

GM OUTFALL 010



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LEGEND

- PROPERTY BOUNDARY
- 1 — APPROXIMATE SEDIMENT SAMPLE LOCATION (INTER-FLUVE, INC - OCTOBER 30, 2015)
- SS-1 — APPROXIMATE STAGE 1 SEDIMENT INVESTIGATION SAMPLE LOCATION (NORMANDEAU ASSOCIATES, INC. MARCH 9 AND 10, 2016)
- MAJOR OUTFALL
- OTHER STORMWATER OUTFALL
- SS-10 — PROPOSED SEDIMENT SAMPLE LOCATION
- W-10 — PROPOSED SURFACE WATER SAMPLE LOCATION
- T-1 — PROPOSED SEDIMENT TOXICITY TESTING SAMPLE LOCATION

SOURCES:

- IMAGERY PROVIDED BY NAIP IMAGERY OF WISCONSIN, 2015 – U.S. DEPARTMENT OF AGRICULTURE (USDA) FARM SERVICE AGENCY, AERIAL PHOTOGRAPHY FIELD OFFICE (WISCRS-ROCK COUNTY FEET).
- SEDIMENT SAMPLE LOCATIONS FROM MONTEREY DAM SEDIMENT ANALYSIS SEDIMENT ANALYSIS EXHIBIT , INTER-FLUVE, INC, DECEMBER 9, 2015.
- MAJOR OUTFALL LOCATIONS FROM CITY OF JANESVILLE STORM SEWER SYSTEM PERMIT MAP - 2016.
- OTHER STORMWATER OUTFALL LOCATIONS FROM CITY OF JANESVILLE WEB MAPPING APPLICATION, GEOCORTEX VIEWER FOR HTML5, AVAILABLE AT: HTTP:GIS.CI.JANESVILLE.WI.US/HTML5VIEWER/INDEX.HTML?VIEWER=JANESVILLE

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

GM JANESVILLE ASSEMBLY PLANT
JANESVILLE, WISCONSIN

PROPOSED SAMPLE LOCATIONS
WITHIN THE IMPOUNDMENT AREA

Source Reference:

Project Manager: J.C.	Reviewed By: N.K.	Date: SEPTEMBER 2016	
Scale: AS SHOWN	Project No: 58505-01	Report No: MEMO045	Drawing No: figure 2

58505-01(MEMO045)GN-WA002 SEP 8, 2016

LEGEND

- PROPERTY BOUNDARY
- 1 APPROXIMATE SEDIMENT SAMPLE LOCATION (INTER-FLUVE, INC - OCTOBER 30, 2015)
- SS-1 APPROXIMATE STAGE 1 SEDIMENT INVESTIGATION SAMPLE LOCATION (NORMANDEAU ASSOCIATES, INC. MARCH 9 AND 10, 2016)
- MAJOR OUTFALL
- OTHER STORMWATER OUTFALL
- PROPOSED SEDIMENT SAMPLE LOCATION
- PROPOSED SURFACE WATER SAMPLE LOCATION
- PROPOSED SEDIMENT TOXICITY TESTING SAMPLE LOCATION

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

GM JANESVILLE ASSEMBLY PLANT
JANESVILLE, WISCONSIN

PROPOSED SAMPLE LOCATIONS
UPSTREAM OF GM JANESVILLE ASSEMBLY PLANT

GHD

Source Reference:

Project Manager:	Reviewed By:	Date:	
J.C.	N.K.	SEPTEMBER 2016	
Scale:	Project Nº:	Report Nº:	Drawing Nº:
AS SHOWN	58505-01	MEMO045	figure 3

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Table 1

Surface Water Sampling and Analysis Plan
GM Janesville Assembly Plant
Janesville, Wisconsin

Proposed Surface Water Sample Location No.	Figure No.	Number of Surface Water Samples	Location of Proposed Sample (Upgradient/ Downgradient)	Location of Proposed Sample	Rationale for Proposed Surface Water Sample Location	Analytical Parameters	Quality Control Samples		
							Field Blanks[1]	Field Duplicates	MS/MSD
W-1 and W-2	Figure 2	2	Downgradient	GM Janesville Assembly Plant	Characterize surface water in the vicinity of GM Outfall 010	Parent PAHs TAL Metals [2] PCB Aroclors Hardness	1/20	1/20	1/20
W-3	Figure 2	1	Downgradient	Reference	To assess surface water concentrations in the Rock River downstream of the GM Janesville Assembly Site.				
W-4 to W-7	Figure 2/3	4	Upgradient	Reference	To assess surface water concentrations in the Rock River upstream of the GM Janesville Assembly Site. The upstream reference samples will be used to assess levels of pollutants transported in the Rock River surface water.				
	Total Number of Surface Water Samples	7				**Total Number of Quality Control Samples**	**1**	**1**	**1**

Notes:

(1) Field blank samples will not be required if dedicated or disposable sampling equipment is used. Field blanks are required at a minimum of one per day.
(2) Excluding the following earth metals: aluminum, calcium, iron, magnesium, potassium, and sodium.
PAHs Polycyclic aromatic hydrocarbons
PCBs Polychlorinated biphenyls
TAL Target Analyte List

Table 2

Selected PAHs, PCB Aroclors, and TAL Metals
GM Janesville Assembly Plant
Janesville, Wisconsin

Parameter	Analytes	
Parent Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthene	Chrysene
	Acenaphthylene	Dibenz(a,h)anthracene
	Anthracene	Fluoranthene
	Benzo(a)anthracene	Fluorene
	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene
	Benzo(b)fluoranthene	Naphthalene
	Benzo(e)pyrene	Perylene
	Benzo(g,h,i)perylene	Phenanthrene
	Benzo(k)fluoranthene	Pyrene
Alkalated PAHs (to Knoxville lab) Isotope Dilution	C1-benzanthracene/chrysenes	C2-phenanthrenes/anthracenes
	C1-fluoranthenes/pyrenes	C3-benzanthracene/chrysenes
	C1-fluorenes	C3-fluorenes
	C1-naphthalenes	C3-naphthalenes
	C1-phenanthrenes/anthracenes	C3-phenanthrenes/anthracenes
	C2-benzanthracene/chrysenes	C4-benzanthracene/chrysenes
	C2-fluorenes	C4-naphthalenes
	C2-naphthalenes	C4-phenanthrenes/anthracenes
Polychlorinated Biphenyl (PCB) Aroclors	Aroclor-1016 (PCB-1016)	Aroclor-1254 (PCB-1254)
	Aroclor-1221 (PCB-1221)	Aroclor-1260 (PCB-1260)
	Aroclor-1232 (PCB-1232)	Aroclor-1262 (PCB-1262)
	Aroclor-1242 (PCB-1242)	Aroclor-1268 (PCB-1268)
	Aroclor-1248 (PCB-1248)	
TAL Metals (less earth metals)	Antimony	Manganese
	Arsenic	Mercury
	Barium	Nickel
	Beryllium	Selenium
	Cadmium	Silver
	Chromium	Thallium
	Cobalt	Vanadium
	Copper	Zinc
	Lead	

Table 3

Sediment Sampling and Analysis Plan
GM Janesville Assembly Plant
Janesville, Wisconsin

Task	Proposed Number of Sediment Cores	Figure No.	Proposed Sediment Location No.	Location of Proposed Sample (Upgradient/ Downgradient)	Location of Proposed Sample	Rationale for Proposed Sediment Sample Location	Total No. of Samples	Depth Interval(s) Selected for Laboratory Analysis [1]	Analytical Parameters	Quality Control Samples		
										Field Blanks[2]	Field Duplicates	MS/MSD
1	8	Figure 2	SS-10 - SS-17	Downgradient	GM Janesville Assembly Plant	Delineate the extent and sources of contamination identified in the Stage I Sediment Investigation	8	0 - 0.5 feet	PAHs PCB Aroclors AVS Methylmercury Black carbon TAL Metals [3] Alkylated PAHs SEM Metals [4] TOC Grain size analysis	1/10	1/10	1/20
							8	0.5 - 2 feet	PAHs TAL Metals [3] TOC Alkylated PAHs [5] PCB Aroclors Grain size analysis	1/10	1/10	1/20
1	9	Figure 2	SS-18 - SS-26	Downgradient	GM Janesville Assembly Plant	Characterize sediment in the vicinity of the City of Janesville west outfall and City of Janesville northeast outfall	9	0 - 0.5 feet	PAHs PCB Aroclors AVS Methylmercury Black carbon TAL Metals [3] Alkylated PAHs SEM Metals [4] TOC Grain size analysis	1/10	1/10	1/20
							9	0.5 - 2 feet	PAHs TAL Metals [3] TOC Alylated PAHs [5] PCB Aroclors Grain size analysis	1/10	1/10	1/20
2	7	Figure 2	SS-27 - SS-33	Downgradient	Impoundment	Characterize sediment in the impoundment area located upstream of the Monterey Dam	9	0 - 0.5 feet	PAHs PCB Aroclors AVS Methylmercury Black carbon TAL Metals [3] Alkylated PAHs SEM Metals [4] TOC Grain size analysis	1/10	1/10	1/20
							9	0.5 - 2 feet	PAHs TAL Metals [3] TOC Alkylated PAHs [5] PCB Aroclors Grain size analysis	1/10	1/10	1/20
3	6	Figure 2	SS-34 - SS-41	Downgradient	Embayment	Characterize sediment in the embayment area located on the north side of the Rock River upstream of the Monterey Dam	6	0 - 0.5 feet	PAHs PCB Aroclors AVS Methylmercury Black carbon TAL Metals [3] Alkylated PAHs SEM Metals [4] TOC Grain size analysis	1/10	1/10	1/20
							6	0.5 - 2 feet	PAHs TAL Metals [3] TOC Alkylated PAHs [5] PCB Aroclors Grain size analysis	1/10	1/10	1/20
4	2	Figure 2	SS-42 and SS-43	Downgradient	Reference	To assess sediment levels in the Rock River. The downstream reference sediment samples (SS-42 and SS-43) will be used to characterize sediment immediately above the Monterey Dam that reflects inputs from multiple sources.	4	0 - 0.5 feet	PAHs PCB Aroclors AVS Methylmercury Black carbon TAL Metals [3] Alkylated PAHs SEM Metals [4] TOC Grain size analysis	1/10	1/10	1/20
							4	0.5 - 2 feet	PAHs TAL Metals [3] TOC Alkylated PAHs [5] PCB Aroclors Grain size analysis	1/10	1/10	1/20
4	17	Figure 2/3	SS-44 to SS-60	Upgradient	Reference	To assess reference sediment levels in the Rock River. The upstream reference samples will be used to assess reference levels of pollutants transported through the Rock River. Sediment samples will only be analyzed from a proposed sample location if field screening of the sediment indicates that the sediment has similar physical characteristics to the sediment previously identified in the vicinity of GM Outfall 010 (fine sand with silt and organics), up to a total of ten sediment samples. Additional samples will be held in case they are required.	10	0 - 0.5 feet	PAHs Alkylated PAHs Hexavalent Chromium TAL Metals [3] PCB Aroclors TOC	1/10	1/10	1/20
							10	0.5 - 2 feet	PAHs TAL Metals [3] TOC Alkylated PAHs [5] PCB Aroclors Grain size analysis	1/10	1/10	1/20
	Total Number of Cores		**49**			**Total Number of Sediment Samples**	**92**		**Total Number of Quality Control Samples**	**10**	**10**	**5**

Notes:

(1) Sediment cores will be advanced until refusal is encountered
(2) Field blank samples will not be required if dedicated or disposable sampling equipment is used. Field blanks are required at a minimum of one per day.
(3) Excluding the following earth metals: aluminum, calcium, iron, magnesium, potassium, and sodium.
(4) SEM Metals include: cadmium, copper, lead, nickel, silver, and zinc
(5) Alkylated PAHs will be analyzed in subsurface sediment (0.5 - 2 feet) based on field observations.

AVS Acid-volatile sulfide
MS/MSD Matrix Spike/Matrix Spike Duplicate
PAHs Polycyclic aromatic hydrocarbons
PCB Polychlorinated biphenyl
SEM Simultaneously extracted metals
TAL Target Analyte List
TOC Total Organic Carbon

Attachment A
GM Field Method Guidelines (FMGs)

Attachment A.1
GM FMG 6.3 – Surface Water Sampling

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REMEDIATION TEAM	FIELD METHOD GUIDELINE NO.: FMG 6.3
REAL ESTATE & FACILITIES	EFFECTIVE DATE: MARCH 14, 2011
GENERAL MOTORS	
REVISION NO.: 0	REVISION DATE:

SURFACE WATER

INTRODUCTION

Surface water sampling locations for water quality studies may be selected based on many factors, including: study objectives; the location of point source discharges, non-point source discharges and tributaries; the presence of structures (bridges, dams, etc.), and accessibility.

PROCEDURES REFERENCED

- FMG 9.0 - Equipment Decontamination.

PROCEDURAL GUIDELINES

Before any sampling is conducted, the first requirement is to consider suitable sampling locations. Bridges and piers are normally good choices for surface water sampling since they provide access and permit water sampling at any point across the width of the water body. Sampling locations should be selected in accordance with the Work Plan and discussed with the Project Manager.

Wading for water samples in lakes, ponds, and slow-moving rivers and streams must be done with caution since bottom deposits are easily disturbed. Samples must be collected without entrained suspended sediments. All surface water samples are to be collected commencing with the most downstream sample to avoid sediment interference with other samples. A life vest and safety line will be worn in all cases where footing is unstable or where water is fast moving or over 3 feet (0.85 m) in depth. A second person may also be required for most of the sampling scenarios.

Prior to entering select areas it may be necessary to acquire property access permission from the land owner. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Rivers, Streams, and Creeks

Surface water samples should usually be collected in areas of the surface water body that are representative of the surface water body conditions. Representative samples can usually be collected in portions of the surface water body that have a uniform cross section and flow rate. Since mixing is influenced by turbulence and water velocity, the selection of a site immediately downstream of a riffle area (e.g., fast flow zone) will ensure good vertical mixing. These locations are also likely areas for deposition of sediment since the greatest deposition occurs where stream velocity slows.

A site that is clear of immediate point sources (e.g., tributaries and industrial and municipal effluents) is preferred for the collection of surface water samples unless the sampling is being performed to assess these sources.

Tributaries should be sampled as near the mouth as is feasible. However, it is important to select the sample location taking into consideration the impact that the downstream receiving water body has on the tributary flow and sediments. The downstream water body may change the water quality (salinity), temperature, or turbidity in the tributary near its mouth.

Sediment samples shall be collected along a cross-section of a river or stream in order to adequately characterize the bed material or as described in the Work Plan. A common procedure is to sample at quarter points along the cross-section of the sampling site selected. Samples may be composited as described in the Work Plan. Samples of dissimilar composition should not be combined.

In some instances sediment sampling may be performed along the shore only; depending upon the study needs.

Lakes, Ponds, and Impoundments

The water in lakes, ponds, and impoundments has a much greater tendency to stratify than water in rivers and streams. The lack of mixing may require that more samples be obtained. An extreme turbidity difference may occur where a highly turbid river enters a lake. Therefore, each layer of the stratified water column may need to be considered separately. Stratification is caused by water temperature differences; the cooler, heavier water is beneath the warmer water.

Sample selection also should adequately represent the conditions of the lagoon or settling pond. Attention must be given to identify intakes and outflows within the lagoon or settling pond which may provide biased sample representation. Sample locations with adjacent structures (i.e., banks, piers, etc.) may also provide biased samples within active lagoons or settling ponds, as the potential for boundary flow and eddies exist.

The number of water sampling sites on a lake, pond, or impoundment will vary with the purpose of the investigation, as well as the size and shape of the basin. In ponds and small impoundments, a single sample should be collected at the deepest point. In naturally formed ponds, the deepest point is usually near the center. In impoundments the deepest point is usually near the dam.

In lakes and larger impoundments, several subsamples may be composited to form a single sample. These vertical sampling locations are often taken along a grid.

In lakes with irregular shape, with several bays and coves that are protected from the wind, additional samples may be needed to represent water quality at various points in the lake. Additional samples may be taken where discharges, tributaries, and other such factors are suspected of influencing water quality.

When collecting sediment samples in lakes, ponds, and reservoirs, samples should be collected at approximately the center of the water body or as directed by the Work Plan. This is also the case for reservoirs that are formed by the impoundment of rivers or streams. The coarse grained sediments are deposited near the headwaters of the reservoir, and the fine grained sediments near the center. The shape, inflow pattern, and circulation must be considered when selecting sediment sampling sites in lakes and reservoirs.

In all instances, the sampling locations should be properly documented with field notes and photographs, as appropriate.

Sampling Techniques

Any equipment or sampling technique(s) used to collect a sample is acceptable as long as it provides a sample which is representative of the stream being sampled and is consistent with the Work Plan. Typically sample aliquots are collected from the area of concern directly, or a compositing approach is considered using a plastic bucket to collect a representative sample, then individual aliquots are collected from the sample bucket.

When collecting surface water samples, direct dipping of the sample container into the stream is acceptable unless the sample bottles contain preservatives. If the bottles are preserved, then precleaned unpreserved bottles should be used to collect the sample. The water sample should then be transferred to the appropriate preserved bottles. When collecting samples, submerse the inverted bottle to the desired sample depth and then tilt the opening of the bottle upstream to fill. When composting across a stream and/or water channel is typically performed using a pre-rinsed 1 to 2 L plastic bottle collecting sub-samples for final mixing sample aliquot collection. Volatile organic compounds (VOCs) must not be collected from the compositing bucket and are sampled directly from the stream cross section.

Wading may cause bottom sediment deposits to be re-suspended and therefore could result in a biased sample. Wading is acceptable if the stream has a noticeable current and the samples are collected directly into the bottle while pointed upstream. If the stream is too deep to wade or if the sample must be collected from more than one water depth, additional sampling equipment will be required. Samples should be collected approximately 6 inches (15 cm) below the surface with the sample bottles completely submerged. This will keep floating debris from entering the sample bottles. Floating debris could result in unrepresentative analytical data.

Sample collection when the flow depth is minimal (i.e., <1 inch (<2.5 cm)) will require special consideration to prevent sediment disturbance. Sampling might be conducted with a container then transferred to the appropriate glassware, or collection may be permissible with a peristaltic pump using a 'fixed' suction line, secured to prevent sediment collection. A small excavation in the stream bed to create a 'sump' for sample collection may be permissible but should be prepared well in advance of the sample collection event to allow sediment settlement.

Teflon bailers may be used for surface water sampling if it is not necessary to collect a sample at a specified interval. A top-loading bailer with a bottom check-valve is sufficient for many studies. As the bailer is lowered through the water, water is continually displaced through the bailer until a desired depth is reached, at which point the bailer is removed. This technique is not suitable where strong currents are encountered (because the ball may not seat effectively), or where a discrete sample at a specific depth is required.

If discrete samples are required from a specific depth, and the parameters to be measured do not require a Teflon-coated sampler, a standard Kemmerer, or Van Dorn sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends of the sampler open while being lowered in a vertical position to allow for passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In each case, a messenger is sent down a rope when the sampler is at the required depth to cause the stoppers to close the cylinder. The sampler is then raised to the surface. Water is removed through a valve to fill respective sample bottles. Dissolved oxygen (DO) sample bottles can be properly filled by allowing overflow using a rubber tube attached to the valve. When performing multiple depth sampling, care should be taken not to stir up the bottom sediment.

A glass beaker or stainless steel scoop may be used to collect samples if the parameters to be analyzed are not interfered with. The beaker or scoop should be rinsed three times with the sample water prior to collection of the sample. All field equipment should follow standard cleaning procedures.

EQUIPMENT/MATERIALS

- Sampling device [plastic bucket, pump, depth integrated sampler (D15)].
- Flow measurement device (velocity meter, survey equipment, measuring tape).
- Sampling materials (sample containers, log book, cooler, chain-of-custody).
- Camera.
- Work Plan.
- Health and Safety Plan.

REFERENCES

ASTM D4841 - Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents

ASTM D4581 - Guide for Measurement of Morphologic Characteristics of Surface Water Bodies

ASTM D5906 - Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths

ASTM D5073 - Practice for Depth Measurement of Surface Water

ASTM D5413 - Test Methods for Measurement of Water Levels in Open-Water Bodies

Greenberg, A.E., R.R. Trussell, and C.S. Clesceri (eds). 1985. Standard methods for the examination of water and wastewater. 16th Edition. American Public Health Association, Washington, DC. p. 37.

Attachment A.2
GM FMG 6.2 – Sediment Sampling

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SURFACE SEDIMENT

A. SURFACE SEDIMENT SAMPLING USING AN EKMAN GRAB SAMPLER - INTRODUCTION

This section describes the procedures used to collect surface sediment with an Ekman grab sampler. Surface sediment is typically analyzed for various physical and chemical variables. For the purposes of this section, surface sediment is defined as the upper 10 cm of the sediment column but may vary given the sampling interval specified in the study design.

A stainless steel Ekman grab sampler is capable of collecting acceptable samples from a variety of soft substrates, such as silt, silt mixed with clay, and silt mixed with some sand. The Ekman grab sampler has two doors on top to allow easy access to the sediment for visual characterization and sampling of surface sediments. The procedures for collecting surface sediment samples using the Ekman grab sampler are described below.

PROCEDURAL GUIDELINES

Decontamination

Before each station is sampled, decontaminate the inner surfaces of the grab sampler and all stainless steel sample compositing equipment. Sediment sampling and compositing equipment will be decontaminated using the following general sequence: site water rinse, Alconox scrub and rinse, site water rinse, solvent rinse (if applicable for a specific project) with acetone and hexane (respectively), and a final site water rinse. Equipment used for compositing the sediment samples will follow the same basic decontamination sequence except that the final rinse will be with laboratory-grade distilled/deionized water. If there is a significant lapse of time between decontamination of the sediment sampling and compositing equipment and collection of the sample, then the decontaminated sediment sampling and compositing equipment will be protected from additional contamination by wrapping it in foil (with the dull side of the foil touching the equipment) and placing it in clean bags for transport, if necessary.

All solvent rinsates will be collected into a bucket or tub and allowed to evaporate over the course of the day. Any rinsate that has not evaporated by the end of the sampling event will be containerized and disposed of in accordance with federal regulations.

Grab Sampler Deployment

1. If the water depth is less than 9 feet, attach the grab sampler to the metal handles. If the water depth is greater than 9 feet, use the rope to deploy the grab sampler.
2. Place the grab sampler on a decontaminated surface and open it.
3. Ensure that the two release wires are securely placed around the release pins.
4. Lower the sampler through the water column at a slow and steady speed.
5. Allow the grab sampler to contact the bottom gently, with only its weight being used to force it into the sediments. The sampler should never be allowed to "free fall" to the bottom because this may result in premature triggering, an excessive wake, or improper orientation upon contact with the bottom.
6. Deploy trigger weight (i.e., messenger) to release the doors on the bottom of the grab sampler.

Grab Retrieval

1. After the grab sampler has rested on the bottom for approximately 5 seconds, begin retrieving it at a slow and steady rate.
2. After the grab sampler breaks the water surface, gently lower it into a clean, flat-bottomed container, while maintaining the grab sampler in an upright position.
3. Open the doors on the top of the grab sampler, and inspect the sample for acceptability. The following acceptability criteria should be satisfied:
    - The sampler is not overfilled with sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.
    - Overlying water is present (indicating minimal leakage).
    - The overlying water is not excessively turbid (indicating minimal disturbance or winnowing).
    - The sediment surface is relatively undisturbed.
    - The desired penetration depth is achieved.

If a sample fails to meet the above criteria, it will be rejected and discarded away from the station.

Penetration depth should be determined by placing a decontaminated stainless steel ruler against the center of the inside edge of the opening on the top of one side of the grab sampler and extending it into the grab sampler until it is almost in contact with the top of the sample. The penetration depth is determined by the difference between that measurement and the total depth of the grab sampler.

Sample Removal and Processing

1. For acceptable samples, remove the overlying water by slowly siphoning it off near one or more sides of the grab sampler. Ensure that the siphon does not contact the sediments or that fine grained suspended sediment is not siphoned off. If sediment is suspended in the overlying water, do not proceed with siphoning until the sediment is allowed sufficient time to settle.
2. After the overlying water is removed, characterize the sample as specified in the study design. Characteristics that are often recorded include:
    - Sediment type (e.g., silt, sand).
    - Texture (e.g., fine-grain, coarse, poorly sorted sand).
    - Color.
    - Approximate percentage of moisture.
    - Biological structures (e.g., chironomids, tubes, macrophytes).
    - Approximate percentage of biological structures.
    - Presence of debris (e.g., twigs, leaves).
    - Approximate percentage of organic debris.
    - Presence of shells.
    - Approximate percentage of shells.
    - Stratification, if any.
    - Presence of a sheen.
    - Odor (e.g., hydrogen sulfide, oil, creosote).
3. After the sample is characterized, remove the top 10 cm using a stainless steel spoon (see site-specific study design for project-specific sampling interval). Unrepresentative material (e.g., large shells, stones, leaves, twigs) should be carefully removed without touching the sediment sample under the supervision of the chief scientist and noted on the field logbook.
4. Remove subsamples for analysis of unstable constituents (e.g., volatile organic compounds, acid-volatile sulfides), and place them directly into sample containers without homogenization.
5. Transfer the remaining surface sediment to a stainless steel mixing bowl or pot for homogenization. Additional grab samples may be required to collect the volume of sediment specified in the study design. The mixing bowl should be covered with aluminum foil (dull side down) while additional grab samples are being collected to prevent sample contamination (e.g., from precipitation, splashing water, falling leaves).
6. After a sufficient volume of surface sediment from a grab is collected (i.e., 0 to 10 cm), move away from the station, open the jaws of the grab sampler, and allow the remainder

of the sediment sample to fall out of the grab sampler. Discard this material away from the station, and rinse away any sediment adhering to the inside of the grab sampler. The grab sampler is now ready for additional sampling at the same station or decontamination before sampling at a new station.

7. After a sufficient volume of sediment is transferred to the mixing bowl, homogenize the contents of the bowl using stainless steel spoons until the texture and color of the sediment appears to be uniform.
8. After the sample is homogenized, distribute subsamples to the various containers specified in the study design and preserve the samples as specified in the study design.

EQUIPMENT/MATERIALS

- Stainless steel Ekman grab sampler (typically 0.25 feet^2) with handle and rope.
- Trigger weight (i.e., messenger).
- Teflon® or polyethylene siphon.
- Flat-bottomed container (e.g., dish pan).
- Stainless steel ruler.
- Stainless steel spoons.
- Stainless steel mixing bowl or pot.
- Scrub brush.
- Squirt bottles (for solvents).
- Alconox® (laboratory detergent).
- Acetone and hexane (if applicable for a specific project).

B. SURFACE SEDIMENT SAMPLING USING A MODIFIED VAN VEEN GRAB SAMPLER - INTRODUCTION

This section describes the procedures used to collect surface sediment with a modified van Veen grab sampler. Surface sediment is typically analyzed for various physical and chemical variables. For the purposes of this section, surface sediment is defined as the upper 10 cm of the sediment column.

A modified stainless steel van Veen grab sampler is capable of collecting acceptable samples from a variety of substrates, such as mud, sand, gravel, and pebbles (APHA 1989). The modified van Veen grab sampler incorporates several design improvements over the traditional van Veen grab sampler that improve the quality of the sediment samples. The modified grab sampler has

two doors on top to allow easy access to the sediment for visual characterization and subsampling of surface sediments. The interiors of the doors are made of screens to minimize the bow wake and the resulting disturbance of the sediment surface when the grab sampler is lowered to the bottom. Rubber flaps cover each screen as the grab sampler is retrieved to prevent disturbing the sediment sample as it is raised through the water column. The arms of the modified grab sampler are lengthened and arced to provide a stronger seal when the grab sampler is closed, thereby minimizing sample leakage when the grab sample is retrieved. Finally, the modified grab sampler has four detachable, epoxy-coated lead weights that allow the weight and penetration of the grab sampler to be optimized with respect to the kind of sediment being sampled.

PROCEDURAL GUIDELINES

Decontamination

Before each station is sampled, decontaminate the inner surfaces of the grab sampler and all stainless steel sample compositing equipment. Sediment sampling and compositing equipment will be decontaminated using the following general sequence: site water rinse, Alconox scrub and rinse, site water rinse, solvent rinse with acetone and hexane (respectively), and a final site water rinse. Equipment used for compositing the sediment samples will follow the same basic decontamination sequence except that the final rinse will be with laboratory-grade distilled/ deionized water. If there is a significant lapse of time between decontamination of the sample compositing equipment and collection of the sample, then the decontaminated compositing equipment will be protected from additional contamination by wrapping it in foil (with the dull side of the foil touching the equipment) and, if necessary, placing it in clean bags for transport.

All solvent rinsates will be collected into a bucket or tub and allowed to evaporate over the course of the day. Any rinsate that has not evaporated by the end of the sampling event will be containerized and disposed of in accordance with federal regulations.

Grab Sampler Deployment

1. Attach the grab sampler to the hydrowire with a swivel. The swivel minimizes the twisting forces on the sampler during deployment and ensures that proper contact is made with the bottom. For safety, the hydrowire, swivel, and all shackles should have a load capacity at least three times the weight of a full sampler.
2. Place the grab sampler on the sample collection table, and open it.
3. Ensure that the two release chains and the two retrieval chains are hanging free and are not wrapped around the arms of the sampler.
4. Attach the ring of the release chains to the release mechanism, and insert the safety pin to prevent the mechanism from being activated prematurely.

5. Start the winch, raise the release mechanism and the sampler, and swing it outboard.
6. Remove the safety pin from the trigger, and lower the sampler through the water column at a slow and steady speed (e.g., 30 cm/second).
7. Allow the grab sampler to contact the bottom gently, with only its weight being used to force it into the sediments. The sampler should never be allowed to "free fall" to the bottom because this may result in premature triggering, an excessive bow wake, or improper orientation upon contact with the bottom.
8. Allow approximately 60 cm of slack in the hydrowire after contact with the bottom is made to ensure that the release mechanism is activated.

Grab Retrieval

1. After the grab sampler has rested on the bottom for approximately 5 seconds, begin retrieving it at a slow and steady rate (e.g., 30 cm/second).
2. Ensure that the sampling vessel is not headed into any waves before the sampler breaks the water surface to minimize vessel rolling and potential sample disturbance.
3. After the grab sampler breaks the water surface and is raised above the height of the sample collection table, swing the grab sampler inboard, and gently lower it onto the table, maintaining tension on the hydrowire to prevent the grab sampler from rolling when it contacts the table.
4. When the grab sampler contacts the table, insert wedges under both jaws so that the grab sampler will be held in an upright position when tension on the hydrowire is relaxed.
5. Relax the tension on the hydrowire, and remove the release and retrieval chains from the surface of the grab sampler.
6. Open the doors on the top of the grab sampler, and inspect the sample for acceptability. The following acceptability criteria should be satisfied:
    - The sampler is not overfilled with sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.
    - Overlying water is present (indicating minimal leakage).
    - The overlying water is not excessively turbid (indicating minimal disturbance or winnowing).
    - The sediment surface is relatively undisturbed.
    - The desired penetration depth is achieved.

If a sample fails to meet the above criteria, it will be rejected and discarded away from the station.

Penetration depth should be determined by placing a decontaminated stainless steel ruler against the center of the inside edge of the opening on the top of one side of the grab sampler and

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extending it into the grab sampler until it contacts the top of the sample. The penetration depth is determined by the difference between that measurement and the total depth of the grab sampler.

Sample Removal and Processing

1. For acceptable samples, remove the overlying water by slowly siphoning it off near one or more sides of the grab sampler. Ensure that the siphon does not contact the sediments or that fine grained suspended sediment is not siphoned off. If sediment is suspended in the overlying water, do not proceed with siphoning until the sediment is allowed sufficient time to settle.
2. After the overlying water is removed, characterize the sample as specified in the study design. Characteristics that are often recorded include:
   - Sediment type (e.g., silt, sand).
   - Texture (e.g., fine-grain, coarse, poorly sorted sand).
   - Color.
   - Approximate percentage of moisture.
   - Biological structures (e.g., chironomids, tubes, macrophytes).
   - Approximate percentage of biological structures.
   - Presence of debris (e.g., twigs, leaves).
   - Approximate percentage of organic debris.
   - Presence of shells.
   - Approximate percentage of shells.
   - Stratification, if any.
   - Presence of a sheen.
   - Odor (e.g., hydrogen sulfide, oil, creosote).
3. After the sample is characterized, remove the top 10 cm using a stainless steel spatula or spoon. Unrepresentative material (e.g., large shells, stones) should be carefully removed without touching the sediment sample under the supervision of the chief scientist and noted on the field logbook.
4. Remove subsamples for analysis of unstable constituents (e.g., volatile organic compounds, acid-volatile sulfides), and place them directly into sample containers without homogenization.
5. Transfer the remaining surface sediment to a stainless steel mixing bowl for homogenization. Additional grab samples may be required to collect the volume of sediment specified in the study design. The mixing bowl should be covered with aluminum foil while additional samples are being collected to prevent sample contamination (e.g., from precipitation, splashing water).

6. After the surface sediment for a sample is collected, move the sampling vessel away from the station, open the jaws of the grab sampler, attach the ring of the deployment chains to the release mechanism, insert the safety pin, start the winch, raise the grab sampler, and allow the remainder of the sediment sample to fall onto the sample collection table. Discard this material away from the station, and rinse away any sediment adhering to the inside of the grab sampler. The grab sampler is now ready for additional sampling at the same station or decontamination before sampling at a new station.
7. After a sufficient volume of sediment is transferred to the mixing bowl, homogenize the contents of the bowl using stainless steel spoons until the texture and color of the sediment appears to be uniform.
8. After the sample is homogenized, distribute subsamples to the various containers specified in the study design and preserve the samples as specified in the study design.

EQUIPMENT/MATERIALS

- Stainless steel van Veen grab sampler (typically 0.06 m^2 or 0.1 m^2).
- Winch and hydrowire (with load capacities ≥3 times the weight of a full sampler).
- Sample collection table.
- Teflon® or polyethylene siphon (inner diameter = 1.27 cm, length = 60–90 cm).
- Stainless steel ruler.
- Stainless steel spatulas.
- Stainless steel spoons.
- Stainless steel mixing bowl or pot.
- Scrub brush.
- Squirt bottles (for solvents).
- Alconox® (laboratory detergent).
- Acetone and hexane (if applicable for a specific project).
- Socket and crescent wrenches (for adding or removing the detachable weights of the grab sampler).
- Water pump and hose (for rinsing the grab sampler, sampling utensils, and sample collection table).

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C. SEDIMENT CORING USING A DRIVE ROD CHECK VALVE CORER - INTRODUCTION

This section describes the procedure for collecting sediment core samples using a drive rod check valve corer. The drive rod check valve corer is designed for collecting short cores (<60 cm) in water less than about 30 feet deep. The corer is lowered through the water column and then driven into the sediment using drive rods. This corer has the advantage over gravity corers in that the drive rods allow up to 200 pounds of driving force to be used without having to handle or lift a heavy weight.

PROCEDURAL GUIDELINES

The sample is held in the core tube with the suction provided by a check valve at the top of the corer. Unlike free-floating check valves, this valve is actuated from the boat using a cord. As the corer is lowered, the valve is held open so water flows freely through the corer as it approaches the sediment, thus reducing the wake that can disrupt the surficial sediments. Because it is not a piston-type corer, some compaction of the sample will occur depending on the sediment type and core length. The internal cross-sectional area of the 3-inch diameter corer is 39 cm^2, which yields about 2 g of dry solids per centimeter of sample thickness at a porosity of 98 percent and about 15 g of solids per centimeter of thickness at a porosity of 85 percent.

There are five basic steps to collecting sediment with this corer:

1. Prepare the corer.
2. Measure the water depth.
3. Drive the corer.
4. Retrieve the corer.
5. Remove the core.

When reading instructions, refer to Figures 6.2.C-1, 6.2.C-2, 6.2.C-3, and 6.2.C-4.

Preliminary Considerations

It is best to work from a platform that is anchored and will not drift. This setup helps to prevent collecting a poor quality sample and damaging the equipment. A platform with a low free-board, such as a pontoon boat, is best.

Core tubes can vary in length from about 70 to 200 cm. The core tube should be about 50 cm longer than the sample length needed to provide for overlying water and errors in the depth driven. It is desirable to have about 20 to 30 cm of water overlying the sediment in the core tube.

The overlying water provides a buffer that reduces agitation of the surficial sediments when handling the core tube. The corer should be pushed into the sediments deeper than the length of core needed. If the sediments are soft, it is possible to overpenetrate and run the sediment–water interface up into the valve. A long core tube will help prevent such an occurrence. For the tube to retain the sample, the minimum sample length is about three to four times the diameter depending on the sediment type.

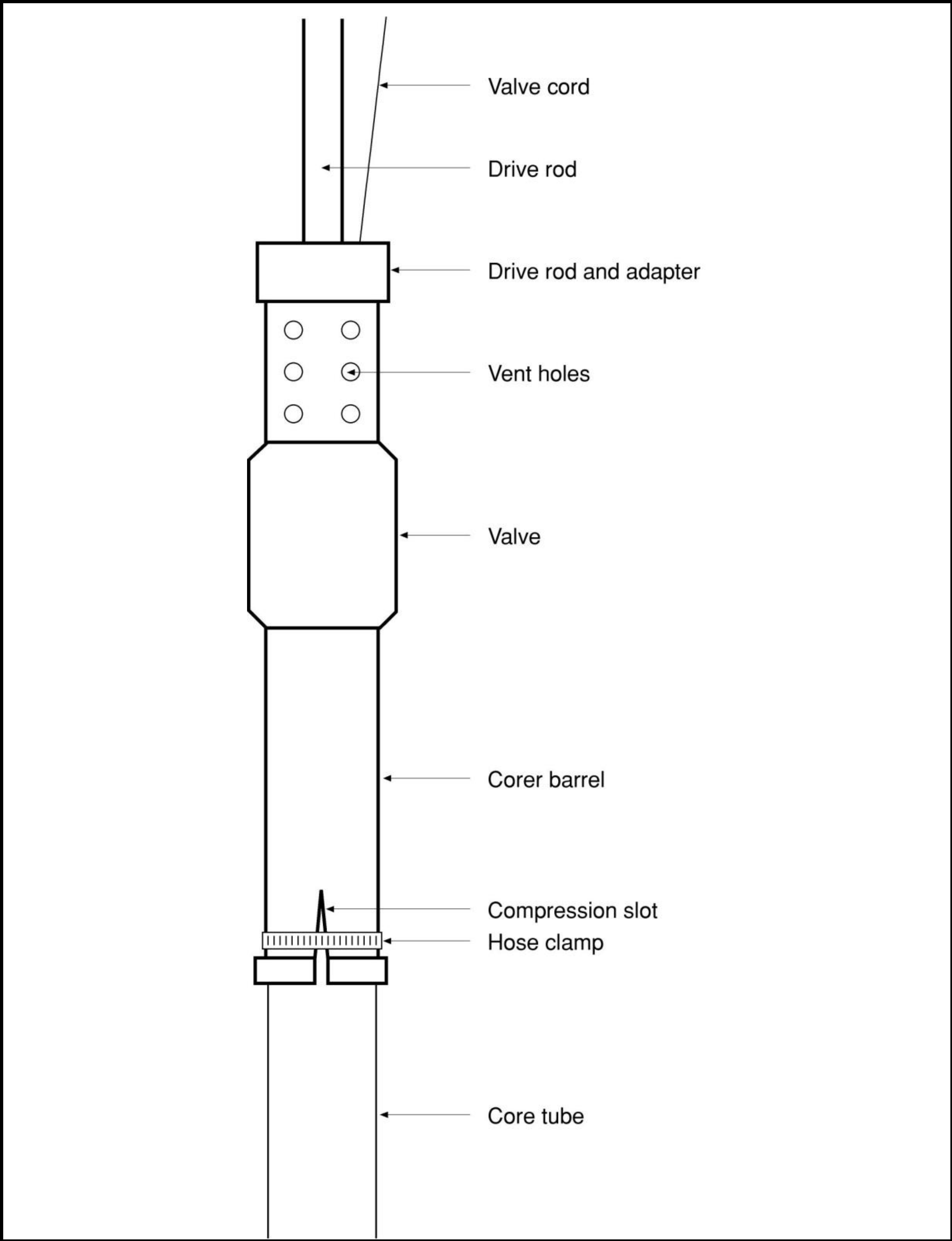

Figure 6.2.C-1 Drive rod check valve corer

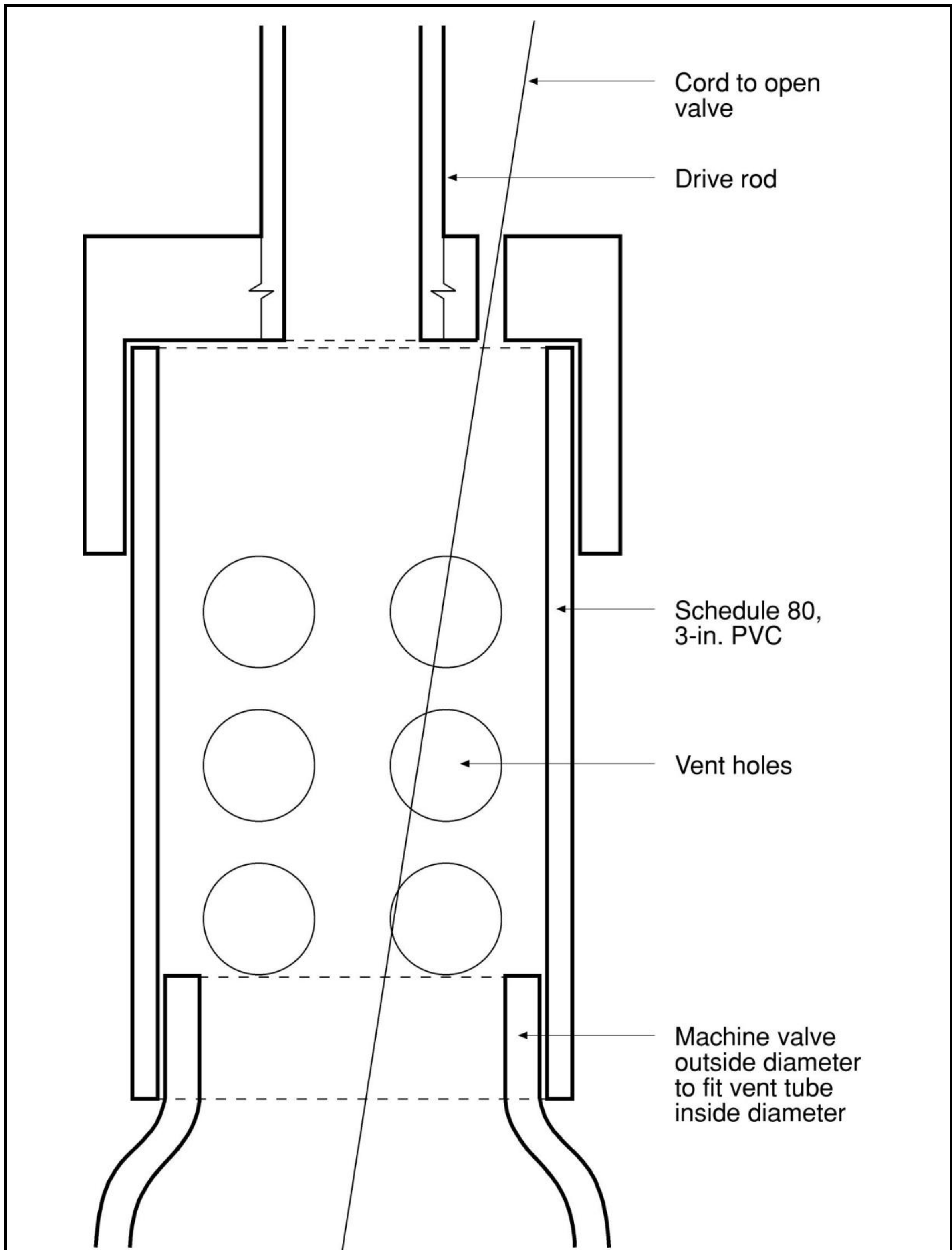

Figure 6.2.C-2 Detail of vent tube

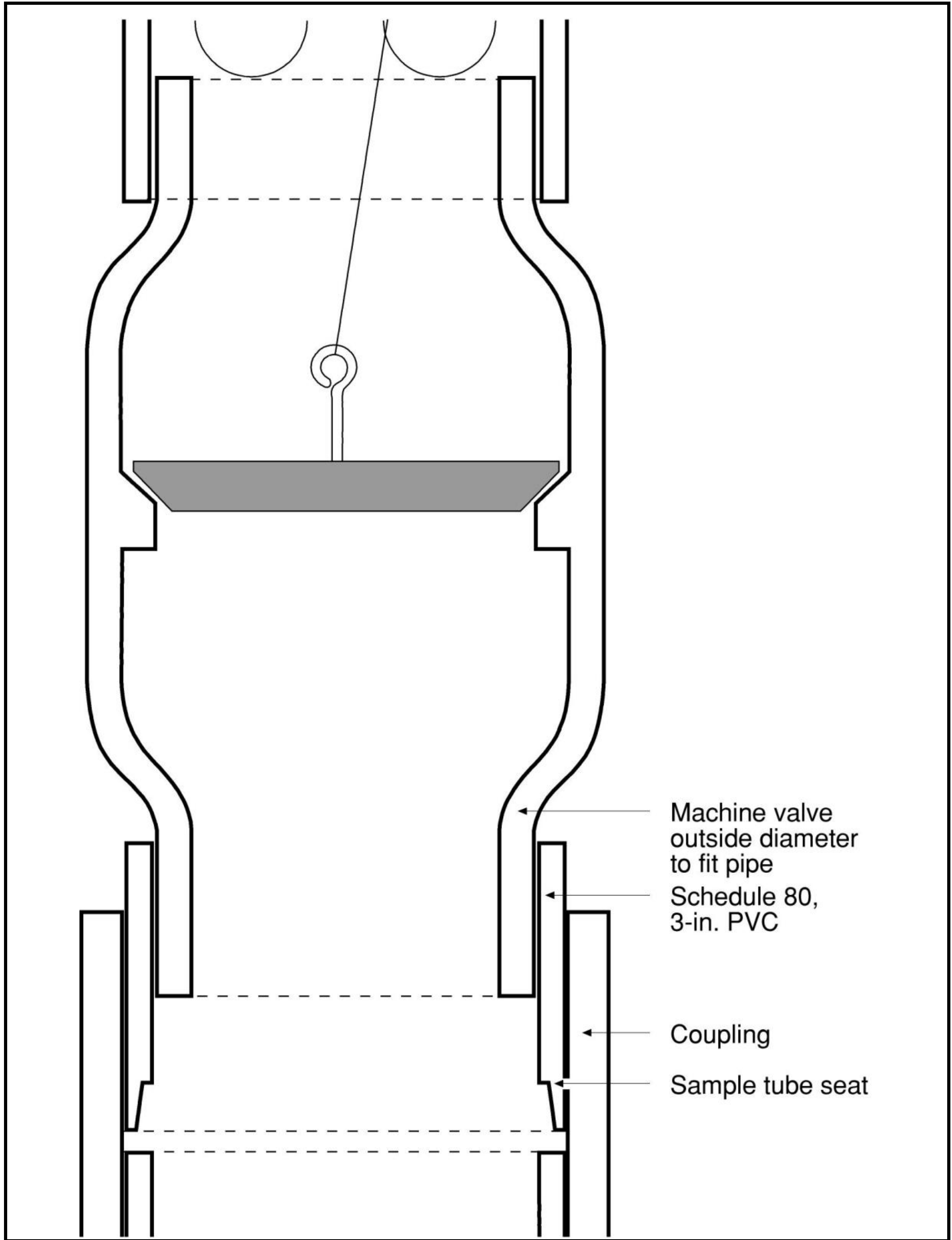

Figure 6.2.C-3 Detail of valve

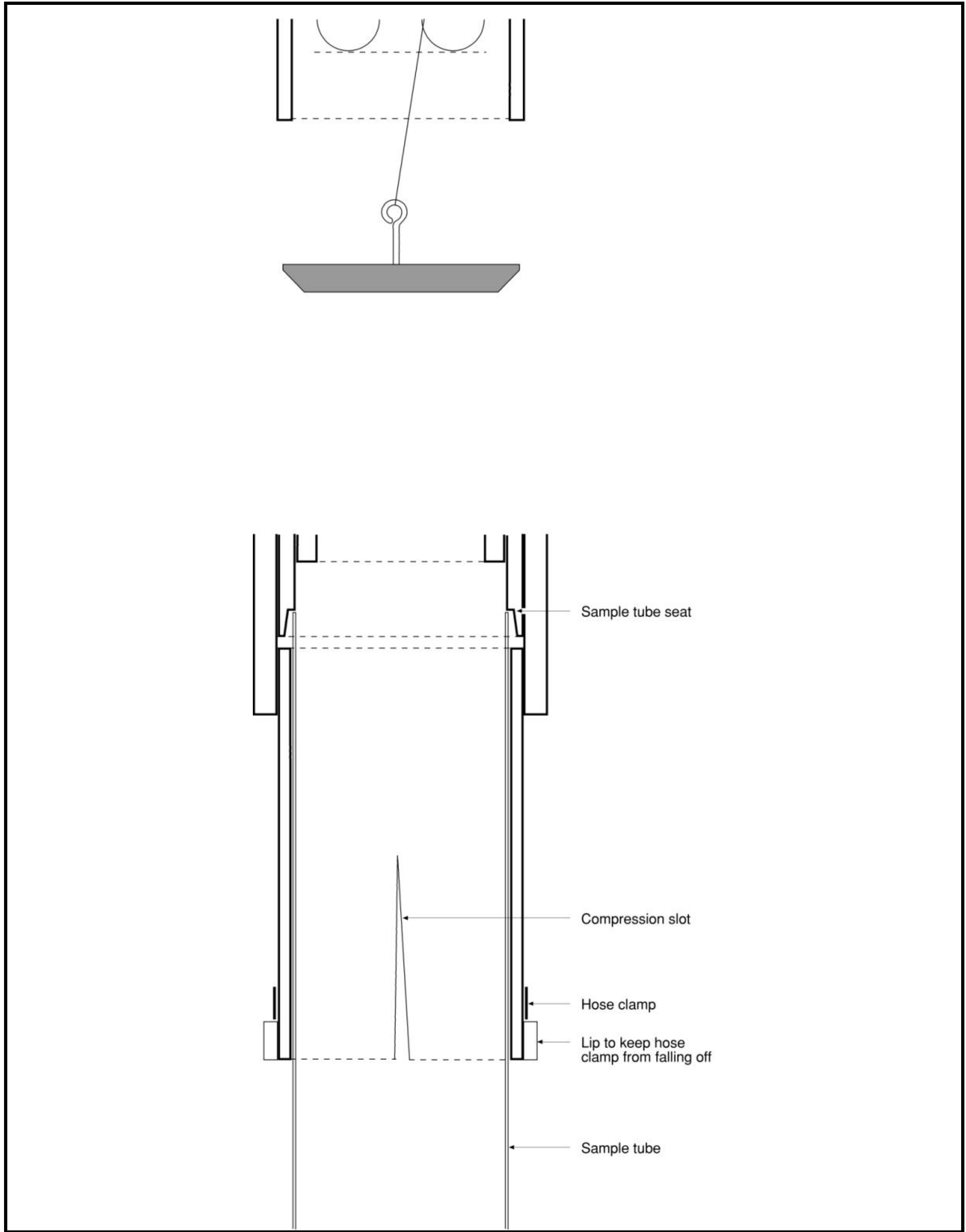

Figure 6.2.C-4 Detail of sample tube holder

Instructions

1. **Prepare the Corer—**Before using the corer, inspect it for worn or broken parts, and repair as necessary.

   1.1 Clean the corer; sandy material in particular can foul the valve and other seals. If the corer has been used in a sandy area, sand caught on the seat might prevent the valve from sealing. To clean the valve, run or spray water through it while repeatedly opening and closing the valve. Test the valve for leaks by releasing the valve cord and pouring water into the top of the corer and watching for leakage. No more than about 1 mL per minute should leak.

   1.2 Insert a core tube into the corer barrel and push it in until you feel the top end of the tube contact the sealing ring at the top of the corer barrel. To seat the tube, push it hard for about a tenth of an inch; you will feel it seat into position. If the bottom edge of the core tube is beveled to improve cutting action, make sure the tube is not upside down. Tighten the hose clamp at the bottom of the barrel so that the core tube cannot be rotated by hand within the corer barrel. Make sure that the drive rod is tightly screwed into the adapter.

2. **Measure the Water Depth** — Measure the water depth to within about a foot of the true depth, using a weighted measuring tape or sonar.

   You will need to know the depth so you can attach the correct length of drive rods and so you can determine how close the corer is to the sediment as it is being lowered.

3. **Drive the Corer**

   3.1 While keeping the valve open with the valve line, lower the corer and keep adding drive rods until the corer is near the sediment. Only a couple pounds of lifting force is required to keep the valve open, so do not lift too hard on the valve line. With the corer and drive rods hanging vertically, lower the corer slowly until you feel it contact the sediment, and then with one smooth motion, push the corer into the sediment. Be careful to push vertically on the corer. If the platform moves laterally and the drive rods are at an angle, attempting to drive the corer may damage it.

   3.2 After the corer is driven to the desired depth, release the valve cord so the valve closes.

4. **Retrieve the Corer—**After the valve is closed, the corer can be retrieved; retrieval is best done with two people.

   4.1 Lift steadily on the drive rods until you feel the corer break loose from the sediments. As the corer approaches the water surface, have a rubber stopper ready to place in the bottom of the core tube. If the sediments are sandy and the samples tend to erode from the bottom of the tube as it is lifted through the water column, it may be necessary to keep the corer submerged just below the surface while another person reaches underwater and places the stopper in the tube. If sampling

is performed from a large boat that has a lot of free-board, it may be necessary to have someone near the water level on a skiff to insert the stopper. While the corer is being lifted onboard, support the rubber stopper so it and the sample do not fall out.

4.2 After the corer is onboard, seat the stopper so it is entirely inside the core tube by placing a second stopper on the deck and pushing the corer down on top of it. Keep the corer vertical at all times to prevent the sample from shifting, and avoid rapid movements that can disrupt the interface.

5. **Remove the Core**

5.1 As a second person holds the corer vertical and keeps the valve open, loosen the hose clamp at the bottom of the core barrel and hold the bottom of the core tube firmly against the deck.

5.2 While holding the core tube, have the second person lift the corer off the tube. If the tube is seated very firmly in the barrel from the force of driving the corer, twist the barrel slightly while lifting it off the tube to break it loose. It is best to rotate the barrel, not the core tube, because when it breaks loose, the rapid rotation of the core tube may disrupt the sediment–water interface. As the core barrel is lifted off the tube, the water in the valve assembly will spill. Before moving or lifting the core tube, seal the top of the core tube with a test plug. The core is now ready to be extruded and sectioned.

5.3 If possible, extrude and section the sample immediately in accordance with FMG 6.2.D - Sediment Coring Procedures Using Slide-Hammer and Gravity Corers. Immediate extrusion and sectioning is essential if the sample is to be analyzed for redox-sensitive elements. Oxygen diffuses through the polycarbonate core tube and oxidizes ferrous iron in the pore water. This process is fairly rapid, and an orange iron oxide precipitate will visibly form on the inside walls of the core tube within a day. There is some evidence that this oxidation does not extend more than a couple millimeters into the sample. If the sample cannot be extruded immediately, keep it cool and out of the sun by refrigerating it or wrapping it with aluminum foil.

Troubleshooting

Problem 1: The Corer is Not Retaining the Sample

There are two possible causes to this problem. One is that the sediments are sandy and not cohesive so they do not stick to the core tube walls or themselves. As a result, the core erodes from the bottom as it is lifted through the water. This problem can be solved in several ways.

- Drive the corer deeper into the sediments, where there may be a more cohesive layer. It is not unusual for a fine grained cohesive layer to lie below coarser layers.

- Place a stopper in the bottom of the tube as soon as possible using one of two methods: 1) use a rod that holds the stopper in the correct position, maneuver the rod below the tube, and lift it up to insert the stopper, or 2) have a diver insert the stopper.
- Use a smaller diameter corer so there is relatively more cohesion of the sediment with the walls.

The second possible cause is a leak in the suction of the corer that allows the whole core to start slipping out of the core tube. There are two places where the suction can be lost: the valve, and the seat between the core barrel and the core tube. Inspect and clean both the valve and the seat, and check that the valve is not stuck in the open position.

Problem 2: The Sediment Interface is Not Distinct

There are several possible causes to this problem. One is that the bottom end of the core tube was moving horizontally when it first contacted the sediments. Further evidence of this cause is if the sediment interface is tilted. In this case, make sure the platform is not moving and that the corer and drive rods are allowed to hang vertically just before driving the corer. Another common cause is the formation of gas bubbles in the sediments of productive or eutrophic systems. When a corer is pushed into this type of sediment, bubbles are released that entrain and resuspend sediment. There is no easy solution to this problem other than to let the resuspended sediment settle before processing the sample. Another possible cause is rough handling of the sample.

Problem 3: The Core is Compacted

Little can be done to prevent compaction other than to use a piston corer. However, the amount of compaction can be quantified. One easy method is to apply Velcro® tape to the outside of the corer barrel and determine the depth of penetration by noting where sediment is caught in the Velcro®.

D. SEDIMENT CORING PROCEDURES USING SLIDE-HAMMER AND GRAVITY CORERS - INTRODUCTION

This section describes the procedure for collecting and processing sediment core samples using slide-hammer and gravity corers. These corers can be used for sampling both coarse, consolidated sediment and fine grained, cohesive sediment. The same corer barrel is adapted for use as either a slide-hammer or gravity corer by changing a few parts. In both coring methods, heavy weights are supported overhead by ropes or cables and pulleys. Therefore, hardhats are required in the vicinity of the equipment. Sample processing using a hydraulic extruder is also described.

PROCEDURAL GUIDELINES

Both corers rely on a one-way valve at the top of the corer that allows water to pass through the corer while being lowered and provides suction to prevent the sample from slipping out while being raised. The corers use 3-inch outside diameter tubing with a 1/16-inch wall thickness. The main corer barrel accepts liners that are 150 cm long and can be used for cores of up to about 140 cm long. Cores up to 3 m in length can be collected by adding 1 m and 1.5 m barrel extensions. Before use, the corer should be inspected for worn and damaged parts and should be cleaned.

Slide-Hammer Coring

This coring method uses a slide hammer that pounds the corer into the sediment with repeated impacts. This method is most useful in nearshore zones where the sediment is difficult to penetrate and would require more than 500 pounds of static weight if a gravity corer were used. The slide-hammer corer is illustrated on Figure 6.2.D-1. The slide-hammer corer uses one cable for lowering and retrieving the corer and one rope for actuating the hammer. The slide hammer works best when the hammer is heavier than the rest of the corer so, before use, all of the weights should be removed from the corer. The following procedures are based on using the corer aboard a pontoon boat equipped with a 12-foot tripod, a power winch, and a hole in the floor centered below the tripod. Because the coring is typically done in shallow water, the boat must be anchored with at least three anchors so the boat will not drift.

1. With the corer laying flat on the boat, screw the hammer guide onto the impact plate, slide the hammer onto the hammer guide, and screw the eyebolt onto the top of the hammer guide (see Note 1). Run the main cable and the hammer rope through the appropriate pulleys. Attach the main retrieval line to the eyebolt. Caution: When handling the slide-hammer assembly, be careful to keep hands away from the area where the hammer slides to avoid injury.
2. After the ball and valve are cleaned, align the holes in the top of the corer and impact plate, and attach the impact plate to the top of the corer with the 0.5-inch diameter bolt. Inspect the bolt periodically for wear near the cap and 3.5 inches from the cap.
3. Attach the two thimbles at the ends of the slide-hammer bridle to the two eyebolts at the top of the hammer with small carabiniers, and secure the middle thimble to the hammer rope. The hammer rope should be at least 0.5 inch in diameter so it is easy to hold by hand.
4. Insert the 3-inch outside diameter polycarbonate liner into the corer barrel, making sure that about 0.75 inch protrudes out the end (see Note 2). Wrap the threads on the corer with Teflon® plumber's tape, and screw the nose piece onto the barrel by hand until it is as tight as possible.

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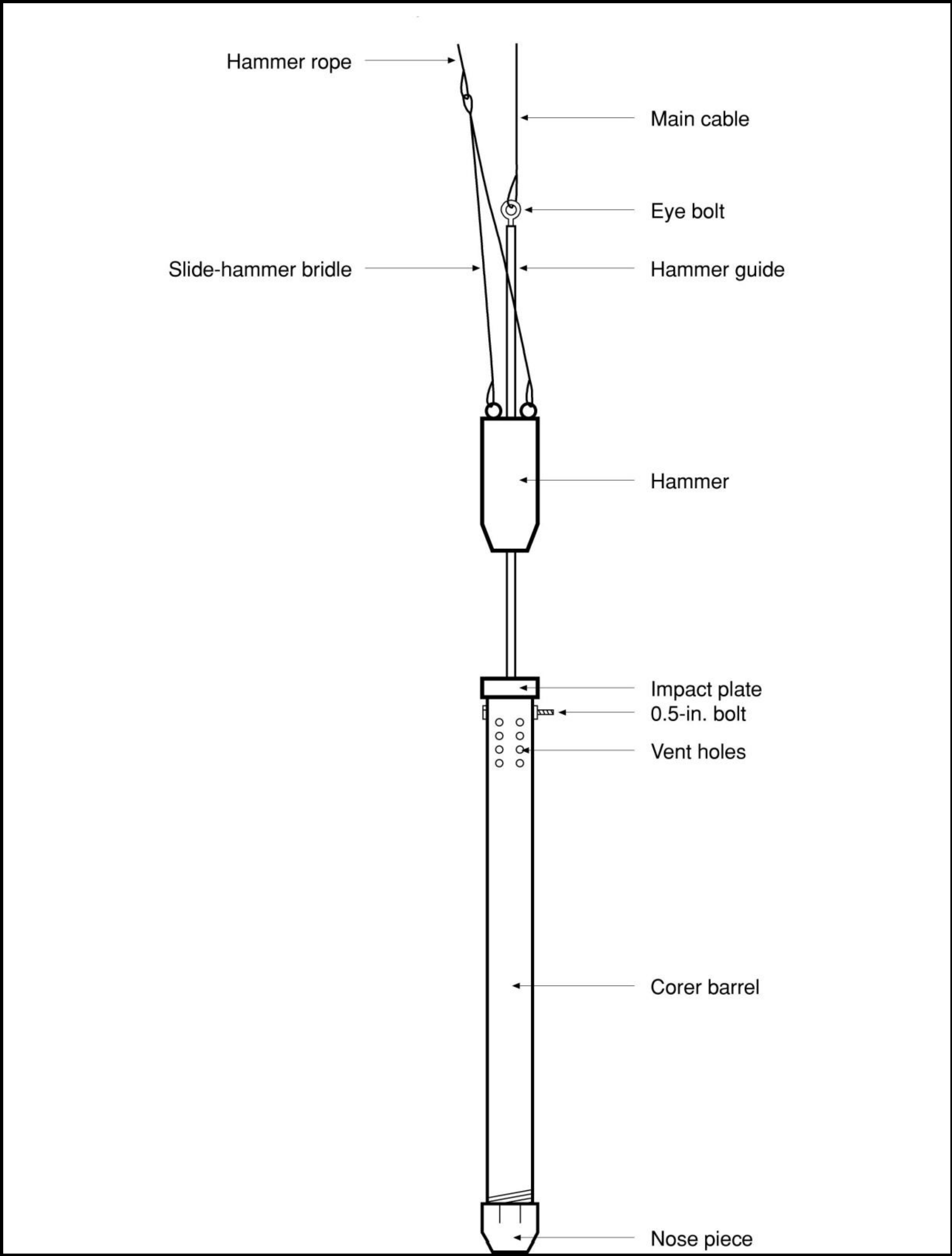

Figure 6.2.D-1 Diagram of slide-hammer corer

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5. Slide the hammer down to the impact plate, being careful to keep hands free from the path of the hammer, and raise the corer to the vertical position using the main retrieval cable.

6. Lower the corer and let out the hammer rope at the same rate. As the corer is being lowered, valve popping can be heard as water displaces air inside the corer. Continue lowering the corer slowly until the nose piece contacts the sediment. Keep tension on the main retrieval cable, measure the length of the core needed from the water surface upward, and mark this point on the main cable with a piece of tape.

7. With just enough tension on the main retrieval cable to keep the corer vertical but still allow the cable to be let out at a rate of a few inches per impact, lift the hammer about 4 feet, and release the rope. Caution: Before releasing the hammer rope, be sure that no one is standing on the rope or that the rope is not caught on anything.

8. Repeat Step 7 until the piece of tape is slightly below the water. When lifting the hammer, be careful not to lift so fast and high that it hits the eyebolt at the top of the hammer guide and hammers the corer back out of the sediment. Depending on how much the sediment core is compacted, it may be necessary to pound the corer until the tape is well below the water surface. Penetration should be stopped before the headspace between the sediment-water interface and the valve is less than about 15 to 20 cm.

9. When the corer has been pounded to the necessary depth, start retrieving the corer slowly at first until it is free of the sediment, and then more rapidly until the nose piece is above the water. Slow the rate of retrieval until the nose piece clears the deck, and stop when there is 6 inches of clearance. Have two bolted rubber stoppers on top of one single stopper next to the hole in the deck and lower the corer onto the rubber stoppers until they are completely inside the nose piece. Caution: When guiding the corer onto the stopper, keep hands away from the area between the nose piece and the deck.

10. Cover the hole and tie-off the hammer rope to a cleat. With two people supporting the corer in a vertical position, release some, but not all, tension on the main retrieval cable. Disconnect the impact plate from the corer by removing the 0.5-inch bolt. Increase tension on the main retrieval line until the impact plate is free of the corer. Caution: When the impact plate is free of the corer, it is able to swing so it should be stabilized immediately. This can be a problem when the boat is rocking. While maintaining tension on the main cable, untie the hammer rope, and lower the slide hammer assembly to the deck. Connect the shackle to the top of the corer with the 0.5-inch bolt, and connect the main cable to the shackle.

11. Lift the corer about 1 foot with the main cable. While one person holds the corer barrel so it does not turn, unscrew the nose piece slowly. When it is unscrewed, be prepared to support the weight of the liner and sample by holding the nose piece and the stoppers from the bottom, then lower the nose piece and liner to the deck. While stabilizing the liner and corer, lift the corer until it is free of the liner. Lower the corer onto the deck, and cover the hole. For cores 1.5 m and longer, see Note 3.

12. Remove the nose piece from the liner by pushing down and rocking it slowly from side to side. The single stopper will come off with the nose piece, but the others should remain in place. Watch carefully that the other stoppers do not slip. In moving the liner with the sample, always support the liner from the bottom so the stoppers cannot slip.
13. Process the sample as described in *Sample Extrusion and Sectioning*.

Gravity Coring

This method uses gravity to force the corer into the sediment. It is designed for use in soft sediment that is typically found in more than 20 feet of water. However, it may be used in shallower waters if the sediment is soft. The gravity corer is illustrated on Figure 6.2.D-2. The weight can be adjusted using any combination of six 60-pound weights and one 30-pound weight (in addition to the barrel, which weighs 10 lb/ft) to achieve the necessary penetration. This gravity corer is not designed for free-fall into the sediment. Because gravity coring is much faster than slide-hammer coring and water depths are usually greater, boat drift is not a problem, and anchoring is not necessary.

1. With the corer laying on the deck, insert the liner into the corer barrel until it contacts the bottom of the valve seat; about 0.75 inch of liner should protrude from the corer barrel. Wrap the threads with Teflon® plumber's tape where the nose piece screws in. Screw on the nose piece, making sure the liner seats on the lowest shoulder inside the nose piece (about 1 inch from the bottom edge of the nose piece). Tighten as much as possible by hand.
2. Add the appropriate amount of weight to the corer and secure it with a hose clamp. Slide the weights upward until the top of the top weight is a few inches below the vent holes. Slide the shaft collar upwards until it contacts the bottom of the bottom weight, and tighten it so it will not slip when it supports all the weights. It is a good idea to wrap a few layers of duct tape right below the shaft collar so that if it slips, it will become wedged on the tape.
3. Attach the shackle to the top of the corer with the 0.5-inch bolt, and connect the retrieval cable to the shackle.
4. While supporting the corer so that it does not swing freely, raise it with the winch. Watch the weights to see that they do not slip. Lower the corer at any rate that is practical until the nose is about 10 feet above the sediment, then reduce the rate to about 1 feet/second. This reduces the shock wave preceding the corer and helps retrieve a good interface. Let the line go slack for about 5 seconds (see Note 4).
5. Pull the corer slowly at first to break it loose from the sediment. Raise the corer up through the water column at a rate that is practical until the top of the corer approaches the surface, then slow the retrieval rate to about 1 feet/second. As soon as the nose clears the water surface, stop retrieval, push a double rubber stopper up into the corer, and

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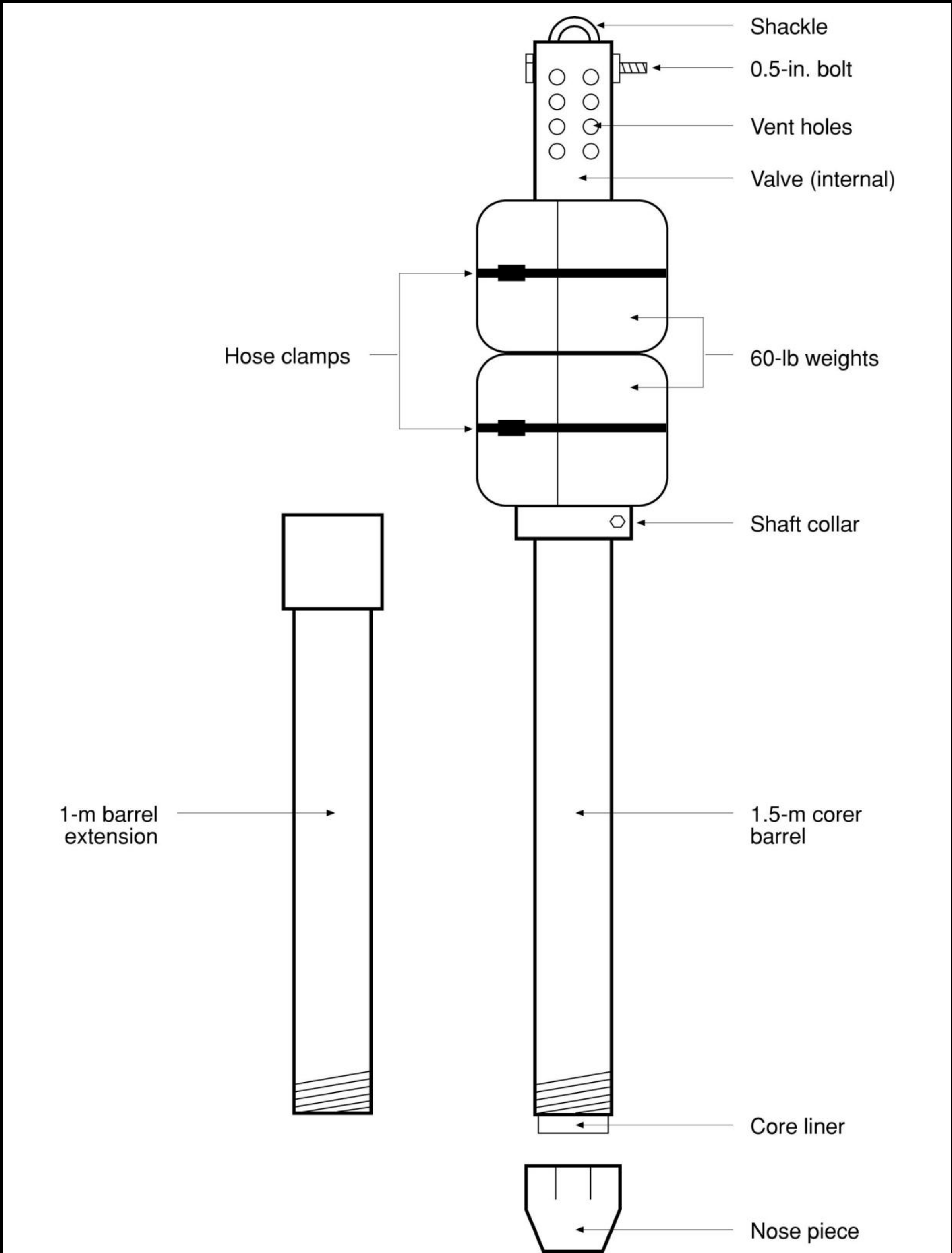

Figure 6.2.D-2 Diagram of 3-inch diameter gravity corer

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support the stoppers so they are not pushed out by the sample. Have another stopper ready on the deck. Raise the corer, and lower it onto the other stopper to push the double stopper further into the liner. Caution: When guiding the corer onto the stopper, keep hands away from the area between the nose piece and the deck.

6. Lift the corer about 1 feet with the main cable. With one person holding the corer barrel so that it does not turn, unscrew the nose piece slowly. When it is unscrewed, be prepared to support the weight of the liner and sample by holding the nose piece and the stoppers from the bottom, then lower the nose piece and liner to the deck. While stabilizing the liner and corer, lift the corer until it is free of the liner. Lower the corer onto the deck, and cover the hole. For cores 1.5 m and longer, see Note 3.
7. Remove the nose piece from the liner by pushing down and rocking it slowly from side to side. The single stopper will come off with the nose piece, but the others should remain in place. Watch carefully that the other stoppers do not slip. In moving the liner with the sample, always support the liner from the bottom so the stoppers cannot slip.
8. Process the sample as described in *Sample Extrusion and Sectioning*.

Maintenance and Troubleshooting

Cleaning the Ball Valve

The ball valve should be cleaned 1) at a minimum on each day of sampling, 2) if there is evidence that sediment entered the valve, and 3) whenever coring is conducted in nearshore zones where the sediment is sandy. A diagram of the valve is shown on Figure 6.2.D-3. To clean the valve, remove the 0.5-inch bolt from the top of the corer barrel and disconnect the impact plate or the shackle. Before removing the thin ball retaining wire, make sure the ball cannot roll overboard. Then remove the wire, reach in the corer, and remove the ball. Inspect the ball for materials or scratches that may prevent seating or sealing. Wipe off the ball with a paper towel, and place it in a clean place. Do not drop the ball because this will scratch the surface and prevent the ball from seating properly. Also, be careful not to damage the O-ring seal by placing any tools in the valve assembly. Wash out the valve with a hose to remove most of the dirt. Using a paper towel, reach inside the top of the corer, wipe off the valve seat, and inspect the towel for dirt. Take a small quantity of Vaseline® (about the volume of a typical pencil eraser), and rub it on the ball. If the valve needs to be replaced, remove the two valve retaining wires, and slide the valve out.

Insufficient Sample

The corer may not collect enough sample because of 1) inadequate penetration, 2) good penetration but too much compaction, or 3) adequate penetration but loss of sample during retrieval. Solutions to these problems are as follows:

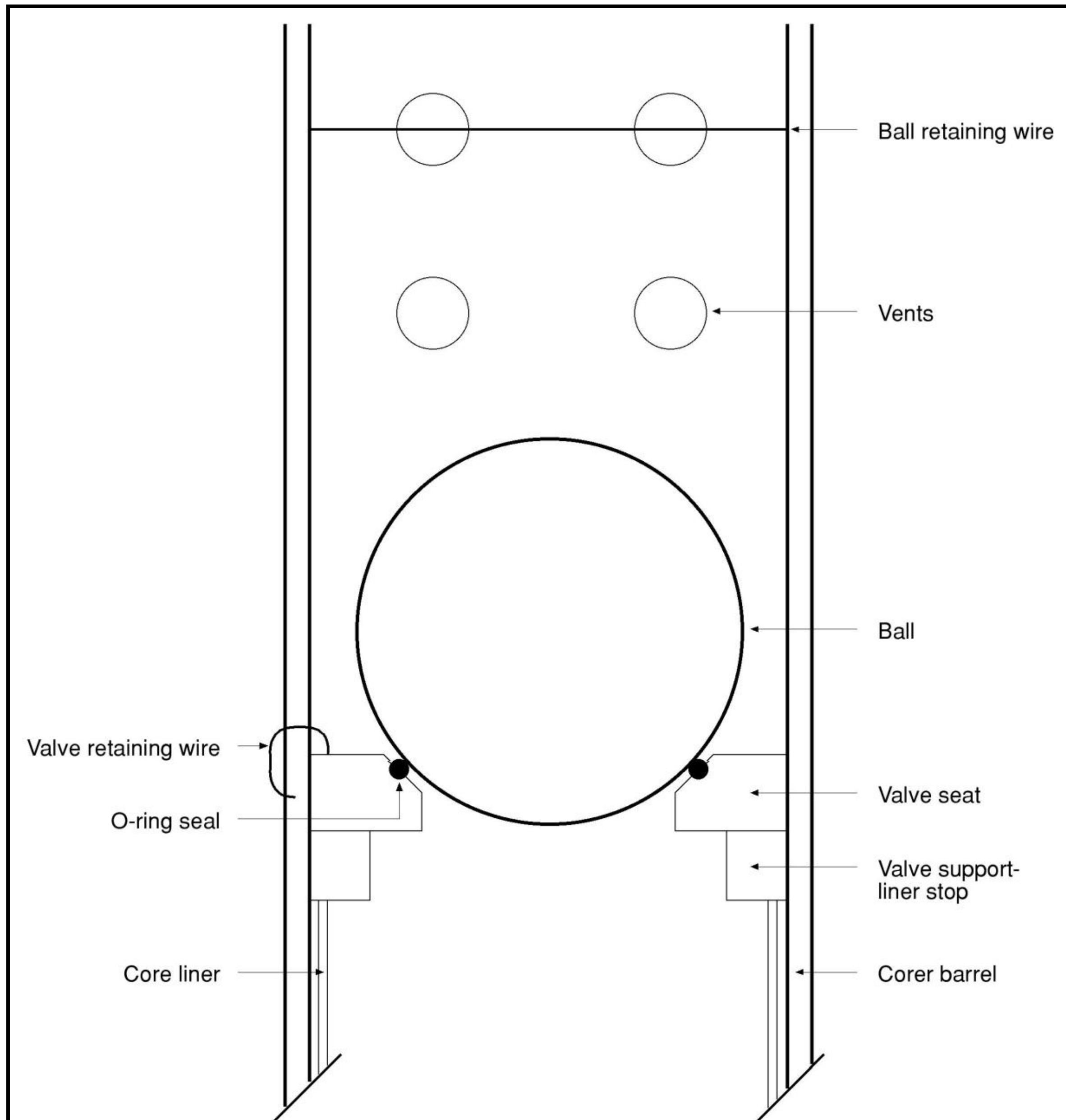

Figure 6.2.D-3 Cross section of ball valve

- **Inadequate Penetration—**Add more weight to the corer, or pound it in farther.
- **Too Much Compaction—**Add an extension and more weight to get more penetration.
- **Loss of Sample During Retrieval—**Sample slipping out the bottom of the corer is caused by a loss of suction. There are several places at which suction can be lost: the valve seat, the valve assembly, the nose piece, and couplings between the barrel and extensions. To reduce sample loss, clean the valve seat/O-ring, and grease the ball as described above. Make sure

the valve assembly is sealed. Use Teflon® plumber's tape on the threads and duct tape on the outside of the couplings and nose piece.

Penetration of the corer can be measured by putting white Velcro® tape on the outside of the corer. Velcro® tape can also be used on the inside of the liner during testing to see how far up inside the liner the interface moves, how much sample slips out the bottom, and how much compaction occurs.

Sample Extrusion and Sectioning

Sediment samples are extruded from the core liner using a hydraulic or mechanical extruder and are cut into desired section thicknesses using a calibrated sectioning tube. A diagram of the hydraulic extruder and sectioning apparatus is shown on Figure 6.2.D-4. The extruder can be used for 2- to 3-inch diameter cores and can be used vertically or horizontally.

1. With no core liner attached to the extruder, submerge the inlet hose of the extruder in a bucket of water or overboard into the lake. Pump water through the system rapidly to clear all air out of the hose, valves, pump, and socket. Observe the water coming out of the socket and pump until no air bubbles come out.
2. Rinse grit from the bottom of the core liner so that the liner will slip smoothly onto the socket. With the shaft collar loosened and already around the socket, lift the core liner onto the socket, and push it down onto the socket with a twisting motion. While holding the liner down, pump water through the socket slowly to remove air bubbles at the base of the rubber stoppers. While still holding the liner down, slip the shaft collar up and around the liner, and tighten it very tightly with the hexagonal wrench. Push gently on the pump to check for leaks. Pump until the sediment-water interface is level with the top of the core liner.
3. Place the calibrated sectioning tube on the top of the liner. Hold it down so it seats firmly on the liner, and pump until the desired sample thickness is extruded into the tube. The extruder will extrude about 1 inch of sample per pump. While one person holds the liner steady, another person holds the sectioning tube and cuts the extruded sample by inserting the semicircular cutter between the liner and the tube. Cut the core and slide (do not lift) the cutter and the tube horizontally off the top of the liner. Hold the cutter and tube firmly together. Invert the tube, and slide the cutter out to discharge the sample into the mixing bowl.
4. Repeat Step 3 until the lowest desired depth of sample is collected. Pump the rest of the sample out of the liner with the rubber stoppers.

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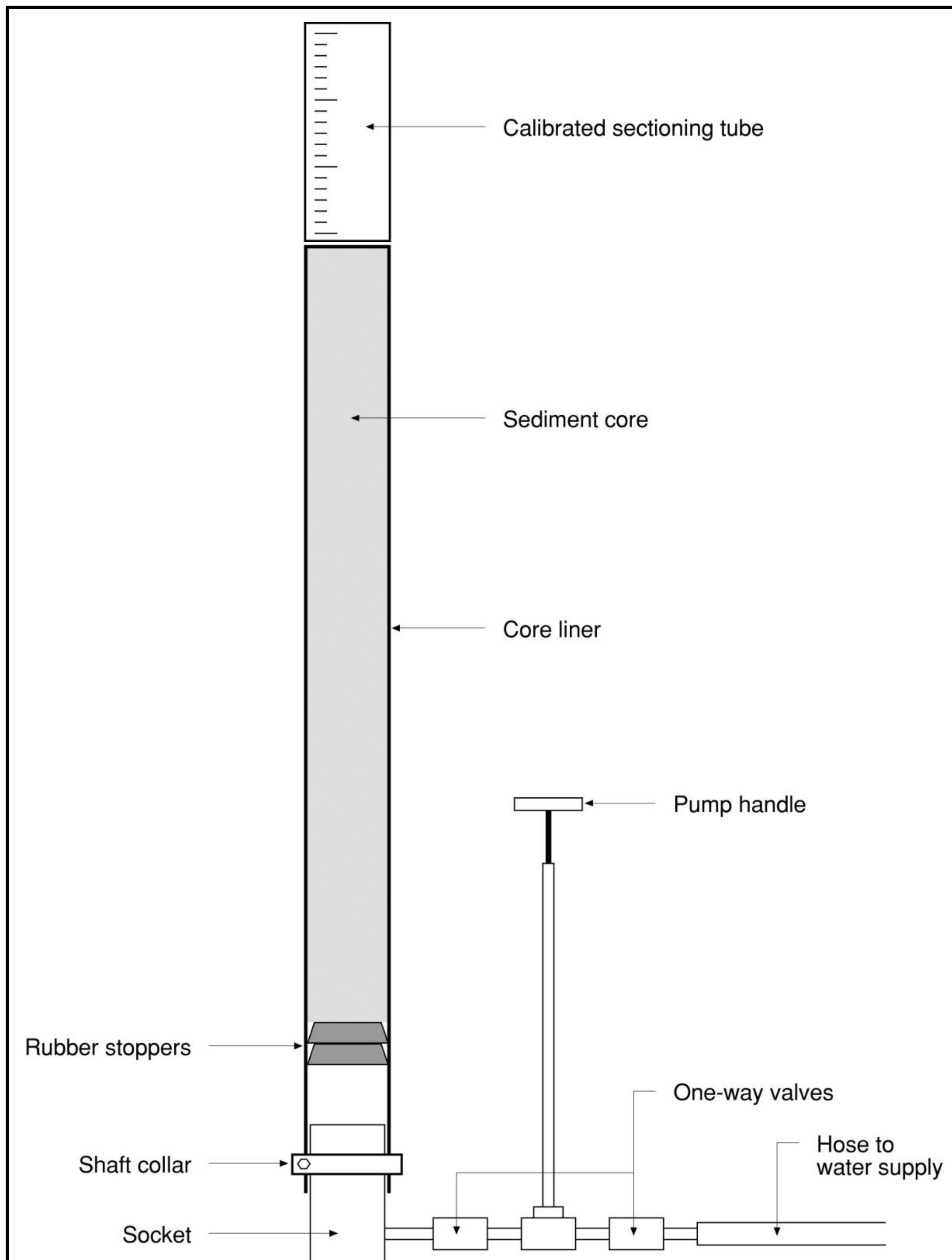

Figure 6.2.D-4 Diagram of core extruder and extrusion tube

Note:

1. *The eyebolt at the top of the hammer guide may become unscrewed because of the pounding vibrations and should be checked at each station before coring.*
2. *For long cores that require more than one piece of liner, butt the ends of the two pieces of liner squarely together and tape them securely so no leaks occur. Do not use too many layers of tape or the liner will not fit into the barrel.*
3. *For cores 1.5 m and longer, the tripod is not tall enough to lift the corer so that the barrel will clear the top edge of the liner when removing the liner. To remove the liner in this case, upon unscrewing the nose piece, lower the nose piece and liner into a pail that has a rope securely tied to the handle. While the corer is raised by the winch, lower the pail through the hole in the deck and into the water (if necessary) until the top edge of the liner clears the bottom edge of the barrel. Then lift it back onto the deck.*
4. *If the sediment is too hard for the amount of weight on the corer, and the corer does not penetrate significantly, the corer will contact the bottom, tip over, and fall sideways. When this happens, the line will initially go slack, then quickly snap to the side as the tension increases. In this case, try doubling the weight; if this does not work, try using the slide hammer.*
5. *Periodically check the water level in the bucket. If air gets into the system, pumping becomes less efficient. At the end of each day, unscrew the cap at the top of the pump, lift the pump handle to remove it, wipe the O-rings with a paper towel, and grease the O-rings with Vaseline®. Avoid using water with coarse particles because they may interfere with proper valve function.*

E. DETERMINATION OF GRAIN SIZE DISTRIBUTION IN SEDIMENT - INTRODUCTION

PROCEDURAL GUIDELINES

Field Screening

Grain-size distribution in sediment is measured in the field because the information is needed to direct further sampling. This procedure provides a gross field measurement of percent fines in a sediment sample. This field measurement is not intended to take the place of grain size distribution analysis in the laboratory, but to aid in directing collection of toxicity test samples and reference samples, which can be dependent upon percent fines. Equipment required to perform this field measurement includes:

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After collecting a sediment sample, perform the following procedures:

1. Thoroughly rinse the sieve and all other equipment and visually inspect to ensure that no sediment or other detritus is present.
2. Collect a sediment aliquot from the grab sampler in the 50 mL cup, ensuring that exactly 50 mL is collected by "shaving" excess sediment from the top of the cup and rinsing any sediment off the sides of the cup.
3. Transfer the sediment aliquot from the 50 mL cup to the sieve using the spoon. Thoroughly rinse the cup and the spoon into the sieve with water to ensure that the entire aliquot has been transferred.
4. Gently rinse the sieve with running water and observe the stream of water coming from the bottom of the sieve. During this step, the fines are being rinsed away. Rinse until the stream of water appears clear, indicating that all fines have passed through the sieve. Gently rinse the remaining sediment to one side of the sieve.
5. Place the plastic funnel into the 100 mL graduated cylinder and position the lip of the sieve over the funnel. Using the squirt bottle, rinse the sediment into the graduated cylinder, directing the stream of water through the back of the sieve. Continue rinsing until all sediment has been transferred to the graduated cylinder. If needed, rinse any sediment that may have adhered to the funnel. The rinse water should not overflow the graduated cylinder. If it appears that the graduated cylinder will overflow before all sediment has been transferred, discard the sample and repeat the entire procedure.
6. Allow the sediment to settle completely in the graduated cylinder and record the amount of sediment present. This measurement represents the volume retained. Also record any turbidity observed in the overlying water.

The volume retained (in mL), subtracted from the original 50 mL aliquot, provides the volume that passed through the sieve, or volume of fines in 50 mL of sample. Multiplying this difference by 2 gives the volume of fines in 100 mL, or percent fines. The formula can be stated as:

Percent fines = (50 mL – Volume Retained in mL) × 2

Field Laboratory Method

1. Weigh approximately 100 g of the dried sediment.
2. Sieve the sediment material to <100 μm using a stainless steel sieve.
3. Determine the weights of the >100- and 100 μm size fractions.
4. Determine the sand/silt/clay fractions by the pipette method (Day 1965).

Contract Laboratory Method

Analysis for grain size distribution will be completed using the wet sieve and hydrometer technique described in ASTM Method D422 (ASTM 1998).

Quality Assurance and Quality Control

Quality assurance and quality control samples will consist of duplicates (1 in 20).

EQUIPMENT/MATERIALS

- USA Standard Testing Sieve #230 (63 μm opening).
- 50 mL measuring cup.
- 100 mL graduated cylinder.
- Small plastic funnel.
- Teaspoon.
- Squirt bottle filled with water.

REFERENCES

APHA. 1989. Standard methods for the examination of water and waste water. Seventeenth Edition. Prepared and published by American Public Health Association, the American Water Works Association, and the Water Pollutant Control Federation.

Day, P.R. 1965. Particle fractionation and particle-size analysis. pp. 545–566. In: Methods of Soil Analysis. C.A. Black (ed). American Society of Agronomy, Incook of ASTM Standards. American Society for Testing and Materials, West Conshohocken, PA.

Attachment A.3
GM FMG 6.7 – Fish and Crayfish Collection

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FISH/CRAYFISH COLLECTION

A. FISH COLLECTION PROCEDURES USING A SEINE NET - INTRODUCTION

This section discusses the sampling of fishes by use of a seine net.

PROCEDURAL GUIDELINES

A seine net is used as an active sampling device to capture fish along a segment of shallow shoreline by encircling them. Each encircling effort or sweep of shoreline with the net is referred to as a "haul". The number of hauls and number of fish collected in each haul can be documented to yield quantitative (i.e., catch-per-unit-effort) information as a standard method of reporting fisheries seine data. Sampling by seine net is generally most effective in areas with smooth substrate and few underwater obstructions. A seine net consists of a length of mesh fabric, usually made of nylon or polyester, vertically suspended between a float line on top and a weighted lead line at the bottom. Seine nets can be obtained from commercial net vendors in a variety of dimensions and mesh sizes. Seine nets commonly used for fisheries work have mesh sizes that range from 1/16 inch to 4 inch Specific seine dimensions are selectively used by stream investigators depending on the needs of the fish survey, fish sizes, or life stages of the fish sought.

Each end of the net is fastened to a metal or wooden pole referred to as a braille. Seine nets can be constructed with an extended bag at the center that aids in the entrapment of fish during the seine haul.

<u>Sampling Procedures</u>

1. Mark off the segment of shoreline to be sampled.
2. Hold the inner end of the seine at the beginning of the shoreline sampling segment.
3. Carry the other end of the seine into the water perpendicular to the shore (a second person is needed to complete this task). When sampling areas are difficult or dangerous to wade in, or when a very long seine (e.g., for seining an ocean beach) is deployed, a boat can be used to manipulate the outer end of the seine. When using a boat, one person should hold the seine pole while a second person rows the boat. Alternatively, the shoreward end of

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the seine can be tethered to a fixed object on the shore while the boat maneuvers the outer end of the seine.

4. Extend the seine away from shore until it is fully extended or until the water becomes too deep to maneuver the outer end of the net. Ideally, the water depth to be sampled is no deeper than the mesh wall on the seine net. If an extra bag is sewn into the seine net, make sure the bag is extended out behind the seine.
5. With the first person pulling the inner seine pole from shore and the second person pulling the outer pole in the water, drag the seine parallel to the shoreline for the length of the sampling segment. Make sure the lead line drags along the substrate so that fish cannot escape under the net.
6. If necessary, a third person can follow behind the seine as it is being pulled to free the net from any snags that are encountered.
7. When the end of the sampling segment is reached, swing the outer end of the seine shoreward and continue moving (sweeping) the seine toward shore until both ends meet at the shoreline.
8. Pull the remainder of the seine toward shore, making sure that the lead line drags along the substrate.
9. Check the net for fish after the entire seine is brought onto the shore.
10. Transfer the captured individuals to collection buckets.
11. Process the fish in accordance with study design specifications and FMG 6.7.E - Fish Processing Procedures.
12. If replicate shoreline segments are to be sampled, repeat Steps 1 to 10 for each replicate segment.
13. If a quantitative analysis of the fish community is being conducted (i.e., catch-per-unit-effort, total enumeration, or mark-recapture), it is recommended that the upper and lower boundaries of the stream segment be blocked by nets of the same mesh as the seine net. These nets should be strung across the channel, ensuring that the bottom of the net contacts the sediments so fish cannot move out of the stream segment being sampled.

EQUIPMENT/MATERIALS

- Seine net.
- Brailles.
- Hip boots or chest waders.
- Life jackets.
- Collection buckets or sample containers.
- Boat (for difficult access).

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• Tape measure or hip chain.

B. FISH COLLECTION PROCEDURES USING AN ELECTROSHOCKER - INTRODUCTION

This section discusses the sampling of fishes by use of an electrofishing device referred to as an "electroshocker".

PROCEDURAL GUIDELINES

An electroshocker is an active fish collection device that sends an electric current through the water, temporarily stunning or directing the movements of fish. Stunned fish are collected by using a dip net. Because an electric current is generated during sampling, several precautions must be taken when using an electroshocker to avoid being electrocuted. Electroshocking should not be conducted without knowledge of the safety procedures described below. All equipment should be maintained and operated according to the manufacturer's instructions.

Basic procedures for using electroshockers are described below. One of four general electroshocker configurations can be used for fish collections. A backpack-mounted electroshocker is used in shallow streams where wading is safe. A pram shocker is used when wading in small and medium sized shallow streams. The pram is a small barge-mounted electrofishing unit that allows one or more fish collectors to work simultaneously without the encumbrance of backpack-mounted units. A bankside shocker offers alternative sampling flexibility in that it can be stationed along an embankment and deployed throughout small or medium-size streams by the use of handheld electrodes with extended conductor cables. Pram and bankside shockers offer more power output than backpack shockers and, as such, potentially pose higher risks. A boat electroshocker is used along shorelines of deeper or open waters where wading is not possible or safe.

Safety Precautions

Electrofishing is hazardous work. The following safety precautions must be taken when using an electroshocker:

1. Never electrofish alone. The buddy system must always be enforced.
2. Ensure that all persons in the sampling crew wear proper sampling attire.
3. Ensure that all members of an electrofishing crew understand the system they are using and the risks involved. Before a field operation begins, new crew members should

receive orientation on equipment and procedures. At least one member of the electrofishing crew must have CPR and first aid training.

4. Ensure that people, livestock, or pets are not in the water either upstream or downstream from the sampling site.
5. Do not use the electroshocker during an electrical storm or periods of heavy rainfall.
6. Limit the number of sampling crew to maximize safety through increased freedom of movement on deck or in the stream and to reduce confusion.
7. Make sure that the person-in-charge has ultimate control of the power source.
8. Never reach into the water with hands or feet for any reason while the electrosystem is operating..
9. Turn off the electroshocker immediately if a person falls into the water. All sampling crew must know how to turn off the electroshocker.
10. When electroshocking in streams, proceed upstream at a slow pace. Do not chase the fish.
11. With the exception of standard shoreline fish community surveys, do not shock constantly; it is preferable to shock for a few seconds, stop shocking while continuing to move, and then begin shocking again.

Operating the Electroshocker

1. Mark off the stream segment to be sampled, if applicable to the needs of the study.
2. Set up the electroshocking equipment according to the manufacturer's instructions. Each electroshocker configuration has unique setup procedures.
3. Have all members of the sampling crew put on appropriate attire (e.g., gloves, chest waders, etc.).
4. Designate one person as the operator of the electroshocker (i.e., the "shocker").
5. Adjust the voltage and ampere settings to the appropriate levels for the conductivity and velocity of the water that will be sampled and the size range of the target fish. This decision is deferred to the experienced operator.
6. If so equipped, adjust the setting for the electroshocker timer to zero before each electroshocking effort to document "on-time" electrofishing effort.
7. Have the crew members that will collect the shocked fish (i.e., the "dip-netters") stand by with dip nets.
8. If sampling a small stream, have all sampling crew members enter the water at the downstream end of the survey stream segment.
9. In small streams, have the crew face upstream while the "shocker" begins moving the anode through the water by extending it in an upstream direction and then pulling it away from fish cover or back in a downstream direction. At the same time, have the

"dip-netters" position themselves slightly downstream on either side of the "shocker" to capture the shocked fish and transfer them to collection buckets.

10. Have the sampling crew proceed in an upstream direction while electrofishing available fish micro-habitats until the end of the sampling segment is reached or until a pre-determined sampling time is expended. If electroshocking from a boat, the dip netters will position themselves at the handrail on the bow, from which point they can safely net the stunned fish.
11. Where quantitative fish data is not required, sample distances and times may be limited only by the needs of the survey.
12. When the end of the sampling segment is reached, record the number of electroshocker seconds elapsed during sampling plus the number of fish collected during that period.
13. Process the fish according to study design specifications and the procedures described in FMG 6.7.E - Fish Processing Procedures.
14. If replicate stream segments will be sampled, repeat Steps 1 to 13 for each replicate.

EQUIPMENT/MATERIALS

- Electroshocker unit (backpack, pram, bankside, boat).
- Hip boots or chest waders (if wading).
- Rubber gloves.
- Personal floatation device.
- Dip nets.
- Buckets.

C. FISH COLLECTION PROCEDURES USING GILL NETS AND TRAMMEL NETS - INTRODUCTION

This section discusses the sampling of fishes by use of gill nets and trammel nets.

PROCEDURAL GUIDELINES

Gill nets and trammel nets are typically used as passive sampling devices to capture fish as they swim through the water column, generally in shallow water. A gill net consists of a single wall of multi- or mono-filament nylon mesh netting vertically suspended between a float line on top and a weighted lead line at the bottom. Fish are captured in a gill net when they swim into the mesh and their bodies and gill coverings become entangled. A trammel net consists of an inner

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wall of a smaller fixed-size mesh with an outer wall on either side made of larger fixed-size mesh. A trammel net entraps fish, especially larger bodied fish, by catching them inside a pocket of small-mesh net which is pushed through an opening of the larger outer mesh by the fishes own movement.

To keep nets in a vertical orientation, especially in areas where strong water currents are present, anchors are attached to the ends of the lead line, and the ends of the float line are tied to small buoys. The lengths of the anchor and buoy lines can be adjusted so that the net is suspended at a target water depth. Gill nets and trammel nets are frequently used to fish in relatively shallow water with the lead line lying on the substrates. A gill net typically has a uniform mesh size and it is fish-size selective. However, the gill net can be composed of multiple panels with each panel a different mesh size, in which case it is referred to as an "experimental mesh" gill net. These types of nets are effective at sampling a broader range of fish body sizes than a traditional gill net.

Setting the Gill Net

1. Attach anchors to both ends of the lead line, and attach buoys to both ends of the float line with extension lines, if needed.
2. Stack the gill net in a large container by placing the end with the larger mesh size in the tub first (if the net has variable mesh sizes) and coiling the rest of the net into the tub. This step facilitates setting the net. Alternatively, the net can be "flaked-out" onto an open bow for easy deployment.
3. Beginning close to or on the shore, remove the outer end of the net from the storage bucket, and drop the anchor (attached to the lead line) and buoy (attached to the float line) over the bow of the boat. Adjust the buoy line so that the buoy is floating and the line is relatively taut. Allow plenty of extra line where tidal amplitudes fluctuate several feet.
4. Begin to set the net by slowly backing the boat away from shore.
5. Carefully let out (pay-out) the remainder of the net as the boat is moving backwards, shaking out any tangles.
6. Once the inner end of the net is reached, stop the boat, and pull on the net until it is taut.
7. Drop the anchor (attached to the lead line) overboard.
8. If setting a suspended gill net, pull on the float line to make sure the net is taut. Drop the buoy that is attached to the float line into the water. Adjust the buoy line so that the buoy is floating and the line is relatively taut.
9. Allow the gill net to fish for the prescribed sampling period (e.g., 1 to 24 hours).

Retrieving the Net

1. Start at the deeper end of the net, and retrieve the buoy and anchor.

2. Begin pulling the net on board the boat and stacking it in coils in the storage bucket as the boat moves toward the shoreward end of the net.
3. As fish are encountered in the net, remove them by lifting the mesh over their opercula (gill coverings) and sliding it off their bodies. The mesh is frequently extremely tight around the fish's body and may require the use of a net pick, toe-nail clippers, or knife to free the fish.
4. Transfer the captured fish to collection buckets.
5. Process the fish in accordance with study design specifications and FMG 6.7.E - Fish Processing Procedures.
6. If sampling will continue at the collection site, the net can be reset in the original manner.
7. If the objective is to capture live fish, gill nets must be checked about every 4 hours or sooner depending on conditions and the presence of fish-eating predators. If gill nets are left in place overnight, many fish will be dead, and depending on the type of aquatic habitat being sampled, many may be partially eaten by turtles or crabs.
8. In many aquatic habitats, turtles or other animals including water fowl, small diving mammals, and various invertebrates may become entangled in the gill net. Most species can be removed with a low likelihood of harm to the researcher. However, snapping turtles should be approached with extreme caution; it may be advisable to cut the mesh around the turtle to free it from the net.

Gill nets can also be used as an active collection device, by using the net as a large seine. When used as a large seine, one end of the net is held or fastened to a structure on the shoreline at the start point. The other end is taken downstream until the net is nearly extended, then across the channel and up the far bank to above the start point. The end of the net is then brought back to the first bank and returned to the start point. At this time, both persons slowly pull in the gill net, now functioning as a large seine. If the net becomes snagged, it will be necessary for one person to follow back in the boat along the net to free the net. This method is successful in obtaining a large number of fish from many taxa at one time.

EQUIPMENT/MATERIALS

- Gill or trammel net.
- Net containers (large plastic tubs or trash cans).
- Buoys, floats, or jugs.
- Anchors (traditional, bricks, concrete blocks, etc.).
- Small diameter line.
- Collection buckets.
- Boat.

- Gill net pick or pocket knife, scissors, or large toe-nail clippers (for cutting mesh) if needed.

D. FISH COLLECTION PROCEDURES USING FISH TRAPS - INTRODUCTION

This section discusses the sampling of fishes by use of traps including trap nets, hoop nets, and minnow traps.

PROCEDURAL GUIDELINES

SAMPLE COLLECTION USING A TRAP NET OR HOOP NET

Trap nets and hoop nets are used as passive sampling devices to capture fish as they swim along the shoreline. Although the nets can be set in different configurations to sample deeper open waters as well. Trap nets are particularly effective in capturing several migratory species. A trap net consists of a leader (wall of mesh fabric) and a series of hoops or compartments that entrap fish after they pass through a series of funnels or openings. Panels of mesh referred to as "wings" can be added to either side of the openings on these traps and serve to guide otherwise passing fishes into the net funnels. The net is commonly set perpendicular to the shore with its mouth facing the shoreline. When fish encounter the leader or wings, they are directed into the mouth of the net. As fish move through the series of hoops or compartments, escape becomes increasingly difficult. Fish may be attracted to the net by other fish that are already captured in it. Bait may be added to trap nets and hoop nets to attract species such as catfish.

Setting the Net

1. Bait the inside of the last compartment of the net if catfish or other bottom feeders are desired.
2. Anchor the shoreward end of the leader near the shoreline, or attach it to the shoreline by tying it to a fixed object onshore (e.g., a tree, a root, etc.).
3. Extend the leader line out into the water and perpendicular to shore until it is taut.
4. Extend each wing at a 45 to 90° angle to the leader line. This step can be done either by boat or by wading, depending on water depth and substrate characteristics.
5. Anchor the lower ends of both wings with anchors, and attach buoys to the upper ends of the wings. Adjust the buoy lines so that the buoys are floating and the lines are relatively taut.
6. Extend the hoops of the trap away from shore in line with the leader line, and pull on the end of the net until all of the hoops are upright.

7. Close the back end (cod end) of the net with a piece of line.
8. Attach an anchor to the end of the net to keep it submerged, and attach a buoy to the anchor to mark the location of the end of the net.
9. Allow the net to soak for the prescribed sampling period (e.g., 24 to 48 hours).

Retrieving the Net

1. Arrive at the buoy at the end of the net, snag the buoy line with a boat hook, and pull the buoy and its anchor into the boat.
2. Retrieve the hoops in sequence while moving toward shore.
3. Starting at the mouth of the net, shake the captured fish into the closed end of the net.
4. Once all captured fish are in the back end of the net, empty them into the collection buckets.
5. Process the fish according to study design specifications and FMG 6.7.E - Fish Processing Procedures.
6. If sampling will continue at the collection site, reset the net according to Steps 5 to 8 of the above procedures for setting a net.

SAMPLE COLLECTION BY USING A MINNOW TRAP

A minnow trap is used as a passive sampling device to capture juvenile fish as well as the adult individuals of small fish species. Minnow traps can also be effective in capturing crayfish and tadpoles. Fish are captured when they swim into the trap through a funnel-shaped opening that makes escape difficult. The trap is generally set in shallow nearshore areas and should have a buoy attached to facilitate retrieval. Multiple traps can also be strung together with line to facilitate retrieval. The trap can be deployed with bait inside to attract fish or without bait. Fish may be attracted to the trap by other fish that are already captured in it.

Setting the Minnow Trap

1. Attach a buoy to the trap with enough line to ensure that the line will remain slack at the highest water level expected for the period of deployment. If sufficient line is not used, the buoy can reduce the negative buoyancy of the trap, allowing the trap to be moved by waves or currents. The use of an excessive length of line should also be avoided because it will increase the probability of the line becoming snagged as it is moved around by waves or currents.
2. Assemble the trap. If bait will be used, the trap can be baited at this time.
3. Deploy the trap at the sampling station by lowering it over the side of the boat, making sure that it does not get tangled in the buoy line. If a string of traps will be deployed,

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attach the trap to the next one in the sequence before deploying it. Buoys do not need to be attached to any of the additional traps.

4. After the trap is placed on the bottom, adjust the length of the buoy line on the basis of the considerations discussed in Step 1. If a string of traps is used, move the boat to the prescribed location of each additional trap in sequence, and deploy each of those traps.
5. Allow the trap to soak for the prescribed sampling period (e.g., 24 to 48 hours).
6. If the minnow traps are being set from the shoreline, tie a long piece of rope onto the trap, and lower the minnow trap out into the stream channel, or place it at the edge of habitat along the shoreline or adjacent to habitat structure (e.g., a downed tree limb).
7. Secure the end of the line to a structure on the shoreline, and use surveyor flagging to mark where the line is tied.
8. If motorized boats are expected to traverse the channel, fasten a buoy to the trap with a length of line sufficient to allow the buoy to float above the trap. Ensure a sufficient amount of line is attached to keep the buoy afloat during high water conditions.

Retrieving the Minnow Trap

1. Arrive at the buoy attached to the trap, and snag the buoy line by using a boat hook or similar device.
2. Pull the trap to the water surface by using the buoy line, and bring the trap onboard the boat.
3. Open the trap, and transfer the captured fish to the collection buckets. If a string of traps is used, proceed to the next trap in sequence, and follow Steps 2 and 3.
4. Process the fish according to study design specifications and FMG 6.7.E - Fish Processing Procedures.
5. If sampling will continue at the collection site, reset the trap according to Steps 3 to 5 of the above procedures for setting a minnow trap.
6. In habitats influenced by tidal flux, check minnow traps before low tide is reached because the trap may become exposed during low tides, leading to mortality of the organisms in the trap or serving as an attractant to other wildlife.

EQUIPMENT/MATERIALS

Sample Collection Using a Trap Net or Hoop Net

- Trap net or hoop net.
- Buoys.
- Anchors (traditional, bricks, or concrete blocks, etc.).

- Line.
- Boat hook.
- Collection buckets.
- Boat.

Sample Collection Using a Minnow Trap

- Minnow trap(s).
- Buoy(s) or surveyor flagging.
- Line.
- Boat hook.
- Boat.

E. FISH PROCESSING PROCEDURES - INTRODUCTION

This section discusses the procedures for making biological measurements of individual fish and for resecting fillets from individual fish for analysis of chemical concentrations in edible muscle tissue.

PROCEDURAL GUIDELINES

Biological Measurements/Observations

The biological measurements and observations commonly made of individual fish include length, weight, gender, reproductive condition, presence or absence of physical anomalies, parasites, or disease, and age using scales or hard body parts.

Length and Weight Measurements and Other Observations

Length and weight measurements should be made on unpreserved fish as soon as possible after collection. Preservation techniques such as freezing and fixation with formalin and ethanol can alter length and weight measurements relative to the values that would be found for unpreserved individuals immediately after capture. The procedure described below for measuring length addresses total length (i.e., the distance from the most anterior part of the fish to the tip of the longest caudal fin ray):

1. Examine each fish for signs of physical anomalies, disease, or external parasites. Examples of physical anomalies include eroded fins, missing eyes, scoliosis or other body

or mouth deformities, and skin lesions. Examples of disease symptoms include hemorrhagic sores, skin fungi, or grossly undernourished body condition. Examples of external parasites include attached leeches or worms, or cysts embedded in the skin or fin membranes. Detailed observations should be noted on appropriate data sheets for each fish examined. Note the location of the anomalies (i.e., caudal fin, left mandible).

2. Place each fish on the measuring board, with its head touching the wall of the board and its side resting along the ruler of the board. Do not squeeze the head of the fish against the wall of the board.
3. Push the caudal fin together, and record the measurement for the longest part of the fin to the specified accuracy (e.g., the nearest 1.0 mm).
4. Place the balance tray on the analytical balance, and press TARE. Wait for a reading of 0.0 g.
5. Place the fish in the balance tray.
6. Allow the weight reading to stabilize, and record the weight to the specified accuracy (e.g., 1.0 g).

Fish Filleting Procedures

Fish are commonly filleted to resect edible muscle tissue for analysis of chemical concentrations. The filleting process is the same one used by fishermen to remove edible muscle tissue from fish. The results of the chemical analyses are therefore directly related to the tissue that is frequently consumed by humans. Filleting should occur after length and weight measurements and other observations have been recorded for each fish, as follows:

1. Decontaminate all filleting equipment (filleting knife, scaler, fillet board) with Alconox®, methanol, and hexane, in sequence. After the hexane rinse, allow the equipment to air dry.
2. Cover the cutting board with a piece of aluminum foil, dull side facing up.
3. Place each fish on its side on the fillet board.
4. Remove all scales from the caudal fin to the head. Do not remove the skin from fish that are commonly eaten with the skin attached to the fillet. For species that are commonly skinned before eating (e.g., catfish), remove the skin from the entire fish by cutting the skin around the head and peeling it off with pliers.
5. Make a cut along the ventral midline of the fish from the vent to the base of the jaw.
6. Make a diagonal cut from the base of the cranium, following just behind the gill to the ventral side just behind the pectoral fin.
7. Remove the flesh and rib cage from each side of the fish by cutting from the cranium along the spine and dorsal fin to the caudal fin. Leave the ribs attached to the main fillet. When removing the fillet, it is common to leave the fatty "belly" meat on the fish carcass.

Consult specific project study plans regarding inclusion of belly meat or rib bones with the fillet portions because this procedural requirement may vary among agencies.

8. Wrap the fillets in aluminum foil with the dull side facing the tissue.
9. Label the wrapped sample according to job-specific study plan instructions.
10. Place the labeled, wrapped sample in a labeled Ziploc® bag, and preserve as indicated in the project-specific study plan.

Determination of Gender and Reproductive State

1. After filleting each fish, examine the gonads, and determine whether they are ovaries or testes. Record the gender of the fish.
2. Identify the reproductive state of the gonads according to the following scale:
   - **Stage I -** Ovaries are wine-colored and shaped like torpedoes, and no eggs are visible; testes are small, flat, whitish in color, and cling closely to the spine.
   - **Stage II -** Ovaries resemble those in Stage I, except that small black (but color may vary) eggs are visible to the naked eye; testes are swollen and milky in appearance.
   - **Stage III -** Ovaries are somewhat swollen and yellowish in color; testes are large, lobed, and freely emit a milky liquid.
   - **Stage IV -** Ovaries are greatly swollen, their texture resembles tapioca, and the largest eggs are transparent and more than 1 mm in diameter; testes are slack and contain an abundance of connective tissue.
   - **Stage V -** Ovaries are slack and contain only a matrix and a few residual eggs.

Age Determination

The age of fish is commonly determined by counting the number of annual check marks (i.e., annuli) on hard structures such as scales, spines, otoliths, vertebrae, and opercular bones. The procedures described below are based on the use of scales for age determination. If otoliths, opercular bones, or vertebrae are required for age analysis, follow procedures specified in Nielsen et al. (1983) or as otherwise indicated in the project-specific work plan.

1. Only personnel experienced in the process of fish-scale age determinations should be assigned to this task. At least one experienced peer should validate age determinations.
2. Before collecting scales for age determinations, remove mucous, dirt, and epidermis from the area by gently wiping the side of the fish in the direction of the tail with a blunt-edged knife.
3. Remove about 20 scales from the left side of each fish from areas suitable for the particular species being aged. Consult standardized methods manuals or experienced fisheries workers to obtain this information. Removal must be done carefully. Blunt

forceps or a knife tip may be very useful for this task. Be careful not to break the margins of the scales or scratch the surfaces. Scales that are broken or irregularly shaped should be discarded.

4. Transfer fish scales to a labeled coin envelope for later age determination. For bullheads and catfishes, remove the dorsal spine for age determination instead of the scales. If otoliths, opercular bones, or vertebrae are required for age analysis, follow procedures specified in Nielson et al. (1983) or as otherwise indicated in the project-specific work plan.
5. A scale sample number should be included on the coin envelope for each fish sampled. The sample number should cross reference vital data for each fish including information such as species, length, weight, sex, date, location, and project number.
6. Scales should be inspected and cleaned before mounting them for microscopic viewing. If mucus, skin pigments, or dirt is present on the scale, soak them in water for about two hours, and scrub off any remaining deposits with a small brush or piece of cloth after the soaking period. Retain the best 5 to 10 scales for mounting and viewing.
7. Mount the viewing scales between two microscope slides, making sure that the scales do not overlap.
8. Project the mounted scales with a microprojector (microfiche reader) and identify the scale(s) that have a complete set of rings emanating outward from their center. The microprojector should provide an enlarged image to about 50 times the natural size of the scale.
9. The number of annual rings (annuli) on each scale are counted. Each "true" annulus represents one year of growth. Care must be taken not to misinterpret "false" annuli, "split" annuli, checks, crowded annuli, or accessory rings. An important consideration for aging fish via scale marks is to understand the time of annulus formation which can vary with latitude, spawning, migration, and feeding habits of the sampled fish population as well as with environmental data and water temperature range.
10. Scale and age data are recorded on Figure 6.7.E-1 - Scale Analysis Summary Sheet. The scale analyst must sign and date the sample control sheet.

Exponent™

Scale Analysis Summary Sheet

Project Name:________________________

Project Number:______________________

Water Body:_________________________

Sample No.	Date Collected	Location	Species	Length (mm)	Weight (g)	Sex	Age	Remark

Analyst:________________________ Date:________

Witness:________________________ Date:________

Figure 6.7.E-1 Scale analysis summary sheet

EQUIPMENT/MATERIALS

- Measuring board.
- Analytical balance.
- Stainless-steel filleting knife.
- Skinning pliers (if needed for removing catfish skins).
- Blunt-point forceps.
- Fish scale-remover ("scaler").
- Fillet board.
- Microprojector.
- Coin envelopes.
- Aluminum foil.
- Ziploc® bags.
- Disposable nitrile gloves.
- Alconox®.
- Hexane.
- Methanol.
- Collection buckets.

F. CRAYFISH COLLECTION PROCEDURES - INTRODUCTION

This section discusses collection of crayfish by use of kick-nets and crayfish traps and the procedures for processing captured crayfish.

PROCEDURAL GUIDELINES

Sampling can be conducted at day or night. Crayfish can be caught by passive or active means. A passive technique entails the baiting of crayfish traps which are placed in the water during the day and left to fish overnight. If more intensive (active) methods are required, kick-nets can be deployed in shallow streams to seek out crayfish. When working in small streams, if electrofishing gear is available, crayfish may be incidentally collected along with fish. Night sampling in shallow water is often the most productive approach because a number of species venture out of their burrows or out from other cover at night. Captured crayfish should be handled with care because of their pinchers.

Collection With Kick-Net

Kick-net sampling is an active method of sampling benthic organisms by vigorously kicking and disturbing bottom sediments and catching the dislodged organisms with an aquatic net. Kick-net sampling is most effective in shallow streams (<1 m deep) with substrates of rock, rubble, or gravel in the riffle/run areas with light to moderate currents.

1. The kick-net is positioned in the stream about 0.5 m downstream.
2. The stream bottom including stones and debris is vigorously disturbed by foot so that the dislodged organisms are carried by the current into the net.
3. Sampling can be continued for a specified time and for a specified distance in the stream if standard effort is required.
4. The preferred line of sampling is a diagonal transect of the stream.
5. The net contents are emptied into a pan of stream water.
6. Crayfish are removed from the net and washed with water from the stream being sampled then placed in collection bucket. Other benthic macroinvertebrates are removed from the net and discarded into the stream.
7. The net is vigorously rinsed in the stream between sample efforts.

Collection With Crayfish Trap

Crayfish traps provide a passive means of collecting crayfish. The use of bait (usually some type of meat) attracts scavenging crayfish into the traps. Traps can be deployed in shallow or deep water. An experienced biologist should determine how to most efficiently bait and deploy the traps for the habitats being investigated. Crayfish traps are commonly identical to minnow traps used to catch small fish. The funnel shaped entrance of a minnow trap should be widened beyond the factory dimension to accommodate the capture of larger crayfish. Traps can be set individually with a line and a float or in a series with several traps attached to a single line and float.

Deployment of Crayfish Traps

1. Determine the number of sample locations to be sampled.
2. Bait and assemble each two-piece trap by using the hinges provided around the rim of each trap.
3. Attach a buoy (small visible float) to the trap to aid in retrieval of the trap at a later time.
4. Deploy the trap at the sampling station by lowering it into the water (or over the side of the boat), making sure that it does not get tangled in the buoy line. If a series of traps will be deployed, attach the trap to the next one in the sequence before deploying it. Floats do not need to be attached to any of the additional traps.

5. Allow the trap to soak for the prescribed sampling period (e.g., 24 hours).
6. If the traps are being set from the shoreline, tie a long piece of rope onto the trap and lower the trap at the edge of the habitat along the shoreline.
7. Secure the end of the line to a structure on the shoreline, and use surveyor flagging to mark where the line is tied.

<u>Retrieving the Crayfish Trap</u>

The trap will be retrieved and the crayfish collected as follows:

1. Arrive at the buoy attached to the trap, and snag the buoy line with a boat hook if using a boat to retrieve the traps.
2. Pull the trap to the water surface by using the buoy line, and bring the trap onboard the boat or onto shore if wading.
3. Open the trap and transfer the captured crayfish into the collection buckets. If a string of traps is used, proceed to the next trap in sequence, and follow Steps 2 and 3.
4. Process the crayfish for length, weight, and enumeration according to study design specifications.
5. If sampling will continue at the collection site, reset the trap according to Steps 3 to 5 of the above procedures for setting a crayfish trap.

<u>Crayfish Length and Weight Measurements</u>

The following measurements and preparations for shipping shall be made:

1. Place each crayfish on a measuring board, and record its total length to the nearest millimeter from the tip of its rostrum to the end of the telsun (central tail section or uropod).
2. Place a balance tray on an analytical scale, and press TARE. Wait for a reading of 0.0 g.
3. Place the crayfish in the balance tray.
4. Allow the weight reading to stabilize, and record the weight to the specified accuracy (e.g., 1.0 g).
5. Record measurements on a field collection log.
6. Place crayfish in decontaminated 8-ounce glass jars or into aluminum foil with the dull side facing the sample.
7. Label jars or foil packets with an adhesive label.
8. Labeled sample containers should be placed in a clean plastic outer bag and stored on dry ice or wet ice pending shipment to the laboratory for tissue analysis. Frozen crayfish in

glass jars may be transferred to double polyethylene bags to avoid breakage during shipment and storage.

9. If required sample sizes are greater than the mass of individual organisms, the composition of any composite samples should be noted in the field notebook (number of organisms, species, if possible).
10. Sample preparation and analysis, problems encountered, and corrective action taken during sample collection, preparation, and delivery shall be recorded in the field notebook.

Quality Control

At no time should organisms that are found dead in traps or that are known to have been caught more than 24 hours before collection be retained for analysis. Checking traps on a daily basis is required.

EQUIPMENT/MATERIALS

Collection With Kick-Net

- Hip boots or chest waders.
- Kick-net with a mesh opening size less than 2 mm^2.
- Sample collection pan or bucket.
- Measuring board.
- 8-ounce glass jars or aluminum foil.
- Cooler with ice.
- Adhesive labels.
- Space pen and field collection logs.

Collection With Crayfish Trap

- Minnow/crayfish traps.
- Bait (cheese whey, beef or pork, chicken parts, fish, peanut butter, or other suitable baits).
- Chest waders or rubber boots (if deployed in wading conditions).
- Sample collection pan or bucket.
- Measuring board.
- Small floats or surveyor flagging.
- Boat hook.

- Twine.
- 8-ounce glass jars or aluminum foil.
- Cooler with ice.
- Adhesive labels.
- Space pen and field collection logs.

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Attachment B
Field Data Sheets

Attachment B.1
Surface Water Sampling

FIELD DATA SHEET - SURFACE WATER SAMPLING

Project Name:
GHD Project #:
Site Name:
Task #:
City: **State:**
Date: / /

Sample Event:

FIELD TEAM

Field Team Leader: ____________________ Boat Captain: ____________________
Field Crew: ____________________ Arrival/Departure Times: ____________________
Field Crew:

CONDITIONS

Pool Elevation (ft. msl): ________________
Weather: *Clear* *Cloudy* *Rain* *Other* _________ Air Temperature________________
Water Conditions ______________________________ Wind Conditions (Speed/Direction) ________________

SAMPLE ID and FIELD DATA

Station ID #: ____________________ Sample Depth __________
Sample ID# ____________________ Sampling Device __________
Sample Type: Surface Water Unfiltered:________________ Filtered: ______________
Water Depth (ft): ____________ pH (SU): ________ Turbidity (NTU): __________
ORP (meV):______________ Conductivity (mmho/cm): ________ H^2O Temp. (^0C): __________
Observations:______________ ____

Laboratory Analyses (√):

Hardness ________________ TAL Metals ________ Field Dup. ____________
PCBs: ___________________ PAHs: ________ MS/MSD ____________

DGPS DATA

Operator: ____________________ Coordinate Units: Lat/Lon US Survey Feet
File Name: ____________________ Datum: *NAD1983* *Y* *N* *Other* ____________
Lat / N: ____________________ Proj.: ____________________
Lon / E: ____________________ GPS Serial #: ____________________________
PDOP: ____________________

COMMENTS / NOTES

Preparer's Initial:

Attachment B.2
Sediment Core Log

VISUAL CLASSIFICATION OF SEDIMENT CORE

GHD

Page ______ of ______

Project Name:

GHD Project No:

Project Location:

Date: / / 2016

Location ID: (N):

(E):

Core Pushed By:

Core Logged By:

Core ID:

Type of Core:

Water Depth/Elevation of Core:

Diameter of Core:

Cored Length:

Other:

Core Recovery:

No. of Attempts:

PID (PPM)	PID Interval (ft)	Sample Interval (ft)	Sample Number	Classification and Remarks (Soil Type, Main/Secondary Components, Density, Consistency, Color, Moisture Content, Odor, and Supplemental Descriptions)

Attachment B.3
Fish Collection Log Sheet

FISH COLLECTION LOG SHEET

GHD

Page ______ of ______

Project Name:

GHD Project No:

Project Location:

Date: / / 2016 **Time:**

Station Location: (N): ______ (E): ______

Station ID:

Field Personnel:

Collection Method:

Physical Characteristics of the Sampling Station:

Species	Fish No.	Length (mm)	Weight (g)	Age	Sex (M/F/U)	Reproductive Condition	Sample No.	Parasites/Deformities/Lesions/Comments

Attachment C
Normandeau Photographs

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Johnson

Johnson 40
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