Memorandum

To:	Jim Killian, WDNR	Ref. No.:	058505
From:	Glenn Turchan, Julie Charlton/aj/33	Date:	March 8, 2016
CC:	Kim Tucker-Billingslea, GM; Steven Song, Ramboll Environ; Mark Nielsen, Ramboll Environ; Renee Sandvig, Ramboll Environ; Tom Kinney, GHD; Shelly Deitner, GHD		

Re: Revised Sediment Investigation Work Plan
GM Janesville Assembly Plant
1000 General Motors Drive
Janesville, Wisconsin

This Memorandum was prepared on behalf of General Motors, LLC (GM) to present the Revised Sediment Investigation Work Plan (Work Plan) for the GM Janesville Assembly Plant property and buildings located at 1000 General Motors Drive in Janesville, Wisconsin (Site). The Sediment Investigation is being completed as part of the first stage (Stage 1) of a Phase II Environmental Site Assessment (ESA).

The original Work Plan was submitted to the Wisconsin Department of Natural Resources (WDNR) on February 3, 2016. Comments received from WDNR on February 5, 2016 and March 1, 2016 were addressed in response to comments memoranda dated February 17, 2016 and March 3, 2016, respectively, and have been incorporated in to this revised Work Plan.

1. Introduction

Stormwater collected from the main assembly plant property discharges via a NPDES permitted outfall to the Rock River. A sediment investigation will be conducted as part of Stage 1 of the Phase II ESA to evaluate conditions in the Rock River in the vicinity of the stormwater discharge location.

The purpose of this Work Plan is to present the Sediment Investigation Scope of Work (SOW) which will consist of the following:

- Collection of eight sediment cores in the vicinity of the stormwater discharge location north of the Site along the south bank of the Rock River
- Collection of 24 sediment samples for laboratory analysis

GHD Limited
5325 Wall Street Suite 2305 Madison Wisconsin 53718 USA
T 608 249 4545 **F** 608 249 4402 **W** www.ghd.com

2. Sediment Investigation SOW

The Rock River sampling area is presented on Figure 1. Stage 1 of the Sediment Investigation will consist of eight sediment sampling locations in the immediate vicinity of the stormwater discharge location. The sample locations are presented on Figure 2. Additional sampling may be required, in the future, to fully delineate the extent of contamination. Sampling locations may be added upstream and downstream during subsequent stages.

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 Field Method Guideline (FMG) (FMG 6.2 – Sediment Sampling) presented in Attachment A. Sediment cores will be advanced to a depth of 6 feet (ft) below the surface of the riverbed or until refusal is encountered. Cores with less than 6 ft of recovery will be sampled; however, smaller intervals may be accepted based on field conditions. Core will be sub-sectioned into intervals (0 to 0.5 ft, 0.5 to 2 ft, 2 to 6 ft). 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.

At the request of WDNR, a surficial sampler (e.g. van Veen, Ponar, Eckman, or equivalent) or piston corer will be used to collect the top 0 to 6-inch interval in conjunction with the vibracoring equipment until there is sufficient physical logging data to show that there is little to no difference between methods (to be determined during sampling).

A photograph of the vessel is provided in Attachment B. 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 2–6 ft; 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. Homogenize each depth interval using a stainless steel mixing spoon or an electric drill with a stainless steel paddle.
6. 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 C.

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 (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 16 samples, in accordance with the applicable FMG (FMG 6.2 – Sediment Sampling) presented in Attachment A. The data from these samples are intended for use in the assessment of potential human and ecological exposures.

The sediment 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:

- Target Compound List (TCL) Volatile Organic Compounds (VOCs) (including 1,2,4-trimethylbenzene [TMB] and 1,3,5-TMB) by United States Environmental Protection Agency (U.S. EPA) method SW-846 8260
- TCL semi-volatile organic compounds (SVOCs) by U.S. EPA Method SW-846 8270
- Target Analyte List (TAL) Metals (less earth metals) by U.S. EPA Method SW-846 6020/7470
- Polychlorinated biphenyls (PCBs) by U.S. EPA Method SW-846 8082
- Total Organic Carbon (TOC) by the Lloyd Kahn Method

A third sediment sample, which will be a composite sample, will be collected from alternating depth intervals. The composite sediment samples will be submitted for laboratory analysis of Toxicity Characteristic Leaching Procedure (TCLP) Metals by U.S. EPA Method SW-846 1311/6010 in addition to above noted analyses for sediment disposal purposes. It is anticipated that the top two feet of sediment will be less impacted than the deeper interval. However, the samples will include alternating between upper and lower compositing (e.g. half of the locations will be collected at 0 to 24 inches and half of at 0 to 48 inches, or refusal). This information will be used to assess remedial alternatives.

In addition to the above, the sediment sample collected from 0 to 0.5 ft (surface sediment) will also be submitted for laboratory analysis of the following (to support ecological risk assessments):

- Selected parent and alkylated Polycyclic aromatic hydrocarbons (PAHs) by U.S. EPA Method SW-846 8270 selected ion monitoring (**SIM**)
- Acid-volatile sulfide (AVS) by U.S. EPA Method EPA-821-R-100
- Simultaneously extracted metals (SEM) (cadmium, copper, lead, nickel, silver, zinc, and mercury) by U.S. EPA Method SW-846-6010/7470 and EPA-821-R-100
- Methylmercury by U.S. EPA Method EPA 1630
- Black carbon (soot) analysis by the black carbon in soil samples method

The data from these analyses are intended to be used in the assessment of potential ecological exposures.

A summary of the sediment sampling and analysis plan is presented in Table 1. 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).

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.

TCL-SVOC analysis is proposed for all three core intervals (0 to 0.5 ft, 0.5 to 2 ft, and the alternating composite samples [0 to 2 feet and 0 to 4 feet or refusal]) and includes parent PAHs. A list of the compounds included in the TCL-SVOC analysis is provided in Table 2. The selected parent PAH compounds are indicated in yellow under TCL-SVOCs.

Table 2 presents the selected TCL-VOCs, TCL-SVOCs, alkylated PAHs, and metal TALs that will be included in the analysis.

2.1 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. Trip blanks will be submitted with each shipment of samples for VOC analysis. 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 Site 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.
- **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.

A summary of the QA/QC sampling plan is presented in Table 1.

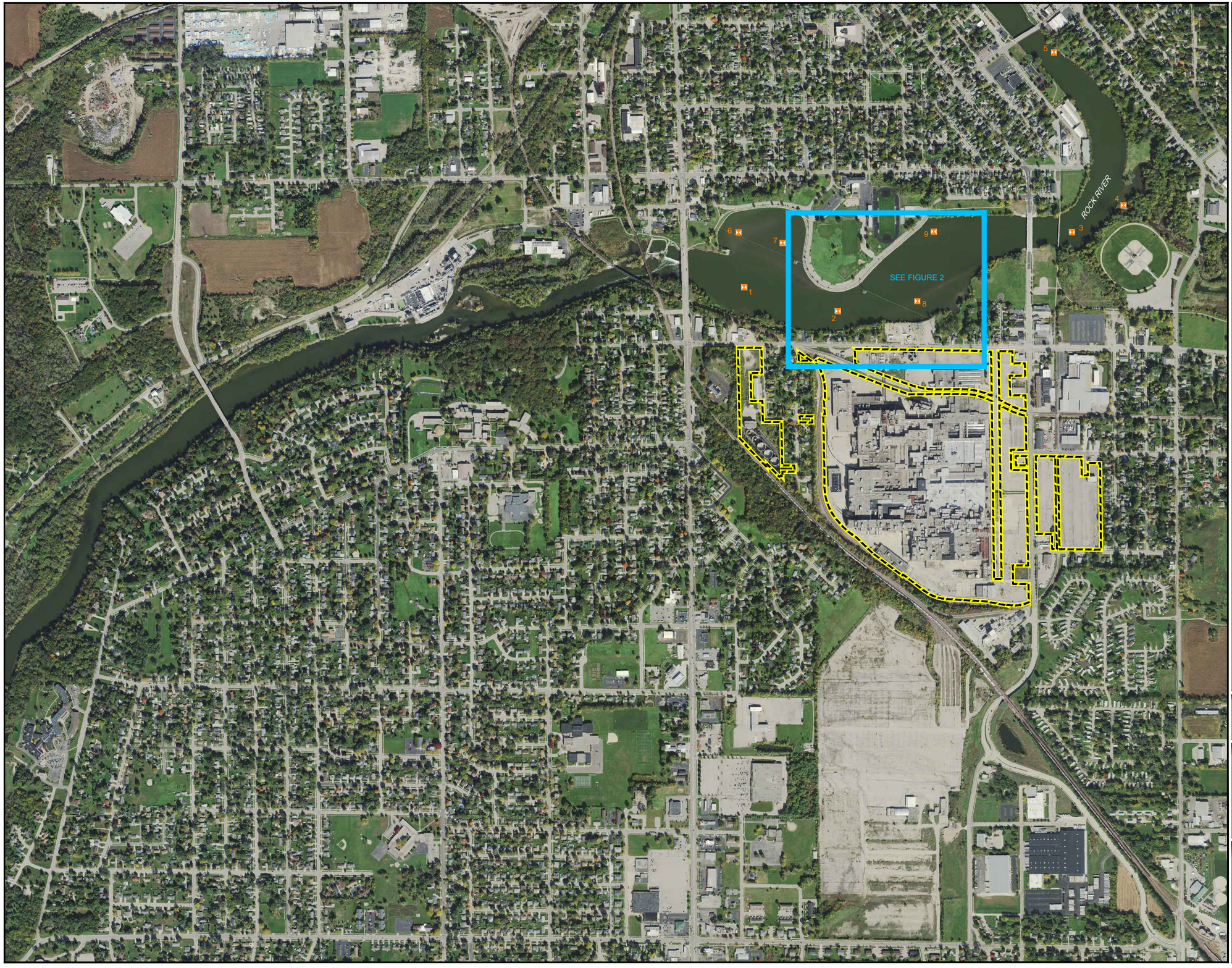
3. Reporting

The Sediment Investigation will be conducted pursuant to the SOW presented in Section 2. A Sediment Sampling Report (Report) presenting the results of the sediment investigation will be prepared. The data evaluation will include a risk-based assessment consistent with prior submittals to the WDNR for this Site. The initial sediment investigation is being conducted in order to characterize the sediment. The resulting data will support a screening-level ecological risk analysis, analogous to Step 3A of U.S. EPA's (1997) Ecological Risk Assessment Guidance for Superfund (i.e., a refinement of preliminary contaminants of concern). Laboratory toxicity testing may be performed at a later date to support the ecological risk assessment, and results will be presented in a separate document. Upon completion of the Sediment 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.

4. Schedule

The Sediment Investigation is scheduled to begin on March 9, 2016 (weather dependent). An appropriate and qualified subcontractor, Normandeau Associates, Inc (Normandeau), located at Suite 101, Building A, 400 Old Reading Pike in Stowe, Pennsylvania, will conduct sediment coring activities. It is anticipated that the Sediment Investigation will take approximately 2 days to complete.

GM /GHD will provided WDNR with a minimum of 24 hour notice prior to commencing any sampling activities.



0 250 500ft

LEGEND

PROPERTY BOUNDARY

1 SEDIMENT SAMPLE LOCATION (INTER-FLUVE, INC - OCTOBER 30, 2015)

SOURCES:

- IMAGERY PROVIDED BY NAIP IMAGERY OF WISCONSIN, 2015 – U.S. DEPARTMENT OF AGRICULTURE (USDA) FARM SERVICE AGENCY, AERIAL PHOTOGRAPHY FIELD OFFICE.
- SEDIMENT SAMPLE LOCATIONS FROM MONTEREY DAM, DRAFT SEDIMENT QUANTITY AND QUALITY REPORT, INTER-FLUVE, INC, OCTOBER 30, 2015.

SCALE VERIFICATION

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

GM JANESVILLE ASSEMBLY PLANT
JANESVILLE, WISCONSIN

ROCK RIVER SAMPLING AREA

GHD

Source Reference:			
Project Manager: J. CHARLTON	Reviewed By: J. CHARLTON	Date: FEBRUARY 2016	
Scale: AS SHOWN	Project №: 58505-01	Report №: MEMO033	Drawing №: figure 1

58505-01(MEMO033)GN-WA001 MAR 7, 2016

0 40 80ft

LEGEND

PROPERTY BOUNDARY

1 SEDIMENT SAMPLE LOCATION (INTER-FLUVE, INC - OCTOBER 30, 2015)

SS-1 PROPOSED SEDIMENT SAMPLE LOCATION

SOURCES:

- IMAGERY PROVIDED BY NAIP IMAGERY OF WISCONSIN, 2015 – U.S. DEPARTMENT OF AGRICULTURE (USDA) FARM SERVICE AGENCY, AERIAL PHOTOGRAPHY FIELD OFFICE.
- SEDIMENT SAMPLE LOCATIONS FROM MONTEREY DAM, DRAFT SEDIMENT QUANTITY AND QUALITY REPORT, INTER-FLUVE, INC, OCTOBER 30, 2015.

SCALE VERIFICATION

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

GM JANESVILLE ASSEMBLY PLANT
JANESVILLE, WISCONSIN

PROPOSED SEDIMENT
SAMPLE LOCATIONS

GHD

Source Reference:			
Project Manager: J. CHARLTON	Reviewed By: J. CHARLTON	Date: FEBRUARY 2016	
Scale: AS SHOWN	Project №: 58505-01	Report №: MEMO033	Drawing №: figure 2

58505-01(MEMO033)GN-WA002 MAR 7, 2016

Table 1

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

Stage 1 Phase II ESA

Proposed Number of Sediment Cores	Figure No.	Proposed Sediment Location No.	Total No. of Samples	Depth Interval(s) Selected for Laboratory Analysis [1]	Analytical Parameters	Quality Control Samples			
						Field Blanks[6]	Field Duplicates	MS/MSD	Trip Blank[7]
8	Figure 2	SS-1 - SS-8	8	0 - 0.5 feet	TCL VOC [3] TCL SVOC TAL Metals [4] PCBs Alkylated PAHs AVS SEM Metals [5] methylmercury TOC black carbon	1/10	1/10	1/20	1/cooler
			8	0.5 - 2 feet	TCL VOC [3] TCL SVOC TAL Metals [4] PCBs TOC	1/10	1/10	1/20	1/cooler
		SS-2, SS-5, SS-6, SS-8	4	0 - 2 feet [2]	TCL VOC [3] TCL SVOC TAL Metals [4] PCBs TOC TCLP Metals	1/10	1/10	1/20	1/cooler
		SS-1, SS-3, SS-4, SS-7	4	0 - 4 feet (or refusal)[2]	TCL VOC [3] TCL SVOC TAL Metals [4] PCBs TOC TCLP Metals	1/10	1/10	1/20	1/cooler
Total Number of Cores	**8**		**Total Number of Sediment Samples**	**24**		**Total Number of Quality Control Samples**	**3**	**3**	**2**	**4**

Notes:

(1) Sediment cores will be advanced until refusal is encountered
(2) Composite sample
(3) Includes reporting 1,2,4-TMB and 1,3,5-TMB.
(4) Excluding the following earth metals: aluminum, calcium, iron, magnesium, potassium, and sodium.
(5) SEM Metals include: cadmium, copper, lead, nickel, silver, zinc, and mercury
(6) 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.
(7) Trip blanks will be submitted with each shipment of samples for VOC analysis.

AVS acid-volatile sulfide
MS/MSD Matrix Spike/Matrix Spike Duplicate
PAHs Polycyclic aromatic hydrocarbons
PCBs polychlorinated biphenyls
PID photoionization detector
SEM simultaneously extracted metals
SVOCs semi-volatile organic compounds
TAL Target Analyte List
TCL Target Compound List
TCLP Toxicity Characteristic Leaching Procedure
TMB trimethylbenzene
TOC Total Organic Carbon
VOCs volatile organic compounds

Table 2

Selected TCL-VOCs, TCL-SVOCs, PAHs, and TAL Metals
GM Janesville Assembly Plant
Janesville, Wisconsin

Parameter	Analytes
Target Compound List (TCL) Volatile Organic Compounds (VOC)	1,1,1-Trichloroethane
	1,1,2,2-Tetrachloroethane
	1,1,2-Trichloroethane
	1,1-Dichloroethane
	1,1-Dichloroethene
	1,2,4-Trichlorobenzene
	1,2,4-Trimethylbenzene
	1,2-Dibromo-3-chloropropane (DBCP)
	1,2-Dibromoethane (Ethylene dibromide)
	1,2-Dichlorobenzene
	1,2-Dichloroethane
	1,2-Dichloropropane
	1,3,5-Trimethylbenzene
	1,3-Dichlorobenzene
	1,4-Dichlorobenzene
	2-Butanone (Methyl ethyl ketone) (MEK)
	2-Hexanone
	4-Methyl-2-pentanone (Methyl isobutyl ketone) (MIBK)
	Acetone
	Benzene
	Bromodichloromethane
	Bromoform
	Bromomethane (Methyl bromide)
	Carbon disulfide
	Carbon tetrachloride
	Chlorobenzene
	Chloroethane
	Chloroform (Trichloromethane)
	Chloromethane (Methyl chloride)
	cis-1,2-Dichloroethene
	cis-1,3-Dichloropropene
	Cyclohexane
	Dibromochloromethane
	Dichlorodifluoromethane (CFC-12)
	Ethylbenzene
	Isopropyl benzene
	Methyl acetate
	Methyl cyclohexane
	Methyl tert butyl ether (MTBE)
	Methylene chloride
	Styrene
	Tetrachloroethene
	Toluene
	trans-1,2-Dichloroethene
	trans-1,3-Dichloropropene
	Trichloroethene
	Trichlorofluoromethane (CFC-11)
	Trifluorotrichloroethane (CFC-113)
	Vinyl chloride
	Xylenes (total)

Table 2

Selected TCL-VOCs, TCL-SVOCs, PAHs, and TAL Metals
GM Janesville Assembly Plant
Janesville, Wisconsin

TCL Semi-Volatile Organic Compounds (SVOC)
PAHs - analyzed in Denver - do not duplicate in TCL list
1,1'-Biphenyl
2,2'-oxibis(1-Chloropropane)
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,4-Dichorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnaphthalene
2-Methylphenol
2-Nitroaniline
2-Nitrophenol
3,3'-Dichlorobenzidine
3-Nitroaniline
4,6-Dinitro-2-methylphenol
4-Bromophenylphenyl ether
4-Chloro-3-methylphenol
4-Chloroaniline
4-Chlorophenyl phenyl ether
4-Methylphenol
4-Nitroaniline
4-Nitrophenol
Acenaphthene
Acenaphthylene
Acetophenone
Anthracene
Atrazine
Benzaldehyde
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(e)pyrene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
bis(2-Chloroethoxy)methane
bis(2-Chloroethyl)ether
bis(2-Ethylhexyl)phthalate
Butylbenzylphthalate
Caprolactam
Carbazole
Chrysene
Dibenz(a,h)anthracene
Dibenzofuran
Diethylphthalate
Dimethylphthalate
di-n-Butylphthalate
di-n-Octylphthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene

Table 2

Selected TCL-VOCs, TCL-SVOCs, PAHs, and TAL Metals
GM Janesville Assembly Plant
Janesville, Wisconsin

TCL Semi-Volatile Organic Compounds (SVOC)	Hexachlorocyclopentadiene
PAHs - analyzed in Denver - do not duplicate in TCL list	Hexachloroethane
	Indeno(1,2,3-cd)pyrene
	Isophorone
	Naphthalene
	Nitrobenzene
	N-Nitroso-di-n-propylamine
	N-Nitrosodiphenylamine (diphenylamine)
	Pentachlorophenol
	Perylene
	Phenanthrene
	Phenol
	Pyrene
Alkalated PAHs to Knoxville lab	
Isotope dilution	C1-benzanthracene/chrysenes
	C1-fluoranthenes/pyrenes
	C1-fluorenes
	C1-naphthalenes
	C1-phenanthrenes/anthracenes
	C2-benzanthracene/chrysenes
	C2-fluorenes
	C2-naphthalenes
	C2-phenanthrenes/anthracenes
	C3-benzanthracene/chrysenes
	C3-fluorenes
	C3-naphthalenes
	C3-phenanthrenes/anthracenes
	C4-benzanthracene/chrysenes
	C4-naphthalenes
	C4-phenanthrenes/anthracenes
TAL Metals (less earth metals)	Antimony
	Arsenic
	Barium
	Beryllium
	Cadmium
	Chromium
	Cobalt
	Copper
	Lead
	Manganese
	Mercury
	Nickel
	Selenium
	Silver
	Thallium
	Vanadium
	Zinc

Attachment A
GM Field Method Guidelines

TABLE OF CONTENTS

Page

SURFACE SEDIMENT

LIST OF FIGURES

Page

REMEDIATION TEAM	FIELD METHOD GUIDELINE NO.: FMG 6.2
REAL ESTATE & FACILITIES	EFFECTIVE DATE: MARCH 14, 2011
GENERAL MOTORS	
REVISION NO.: 0	REVISION DATE:

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

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).

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.

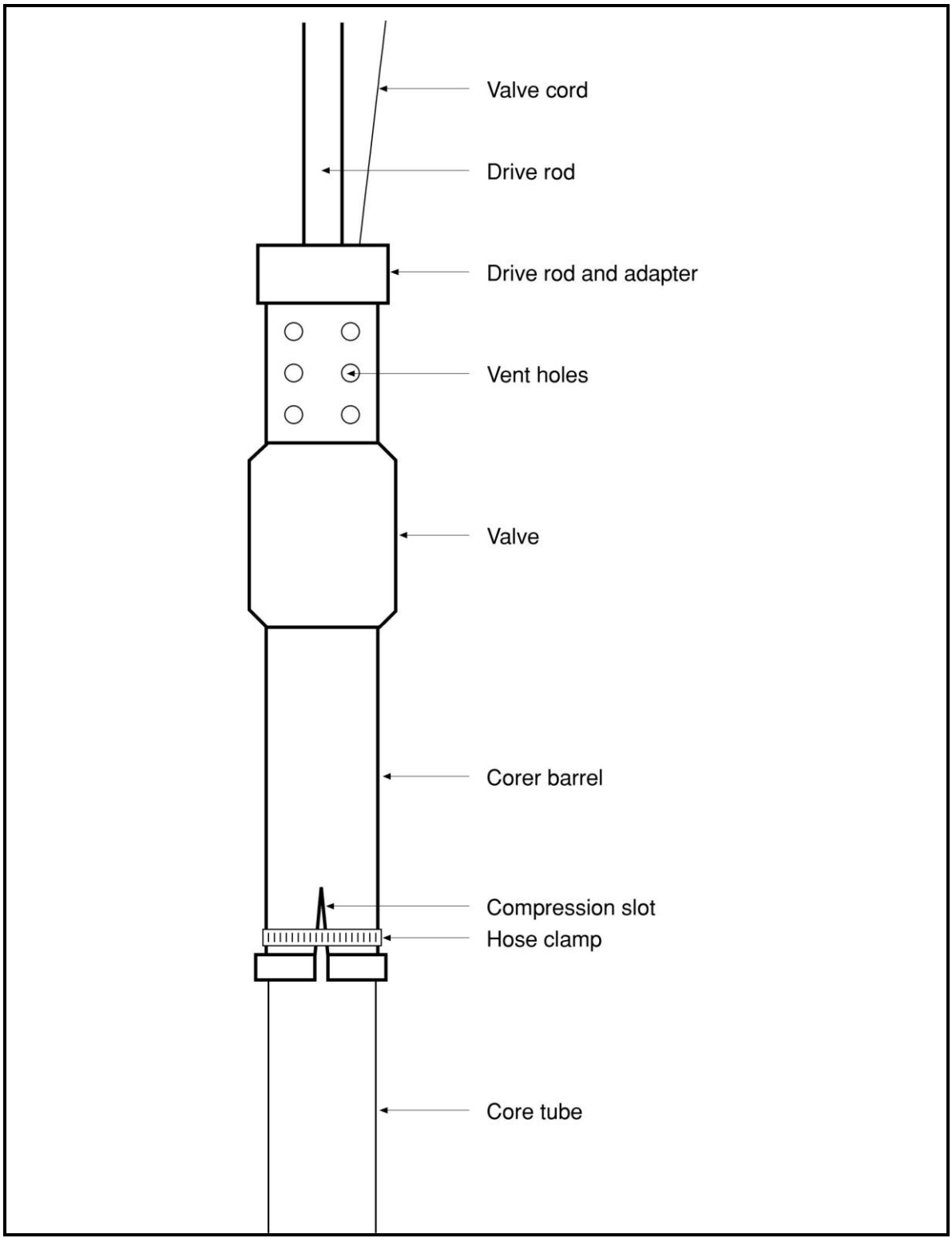


Figure 6.2.C-1 Drive rod check valve corer

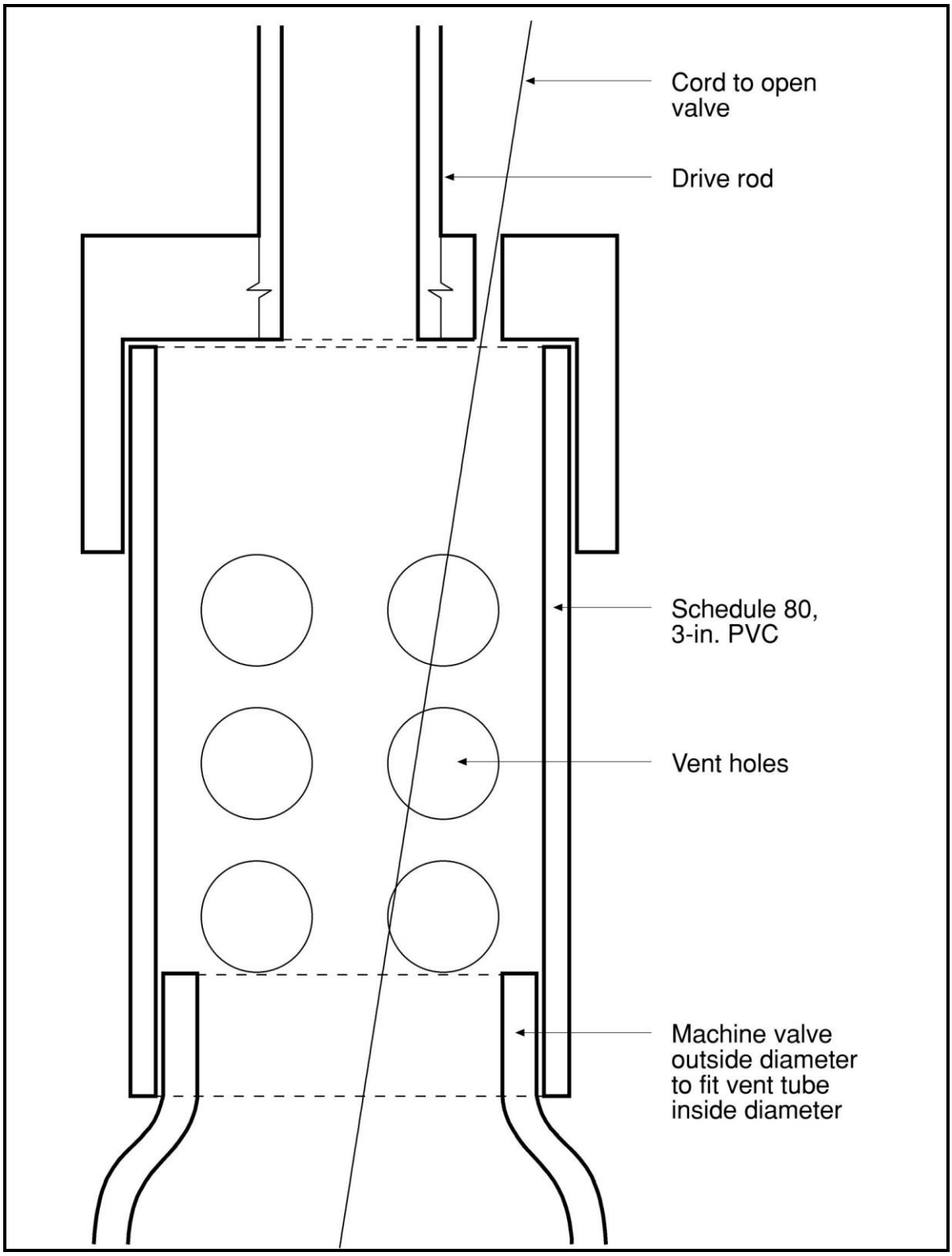


Figure 6.2.C-2 Detail of vent tube

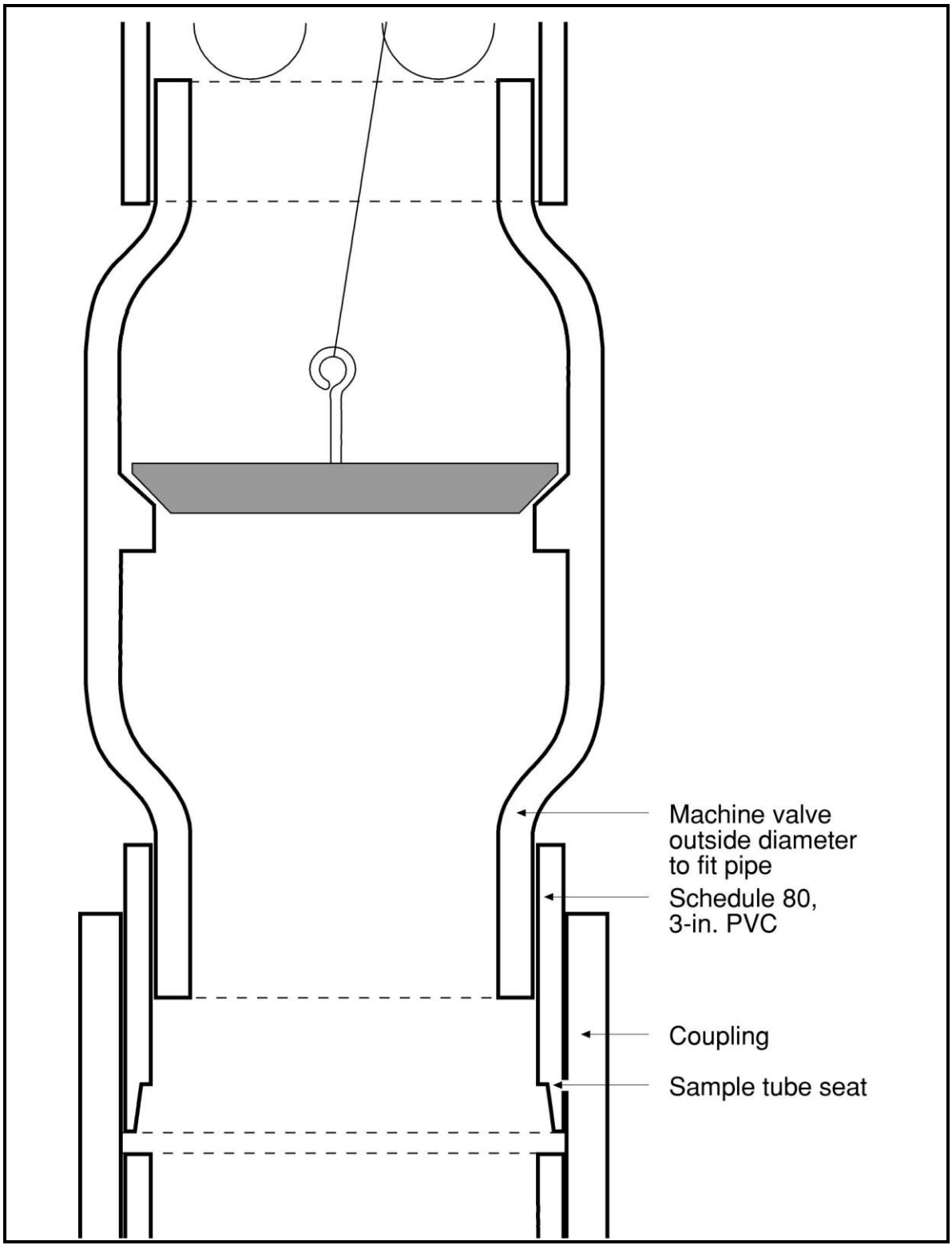


Figure 6.2.C-3 Detail of valve

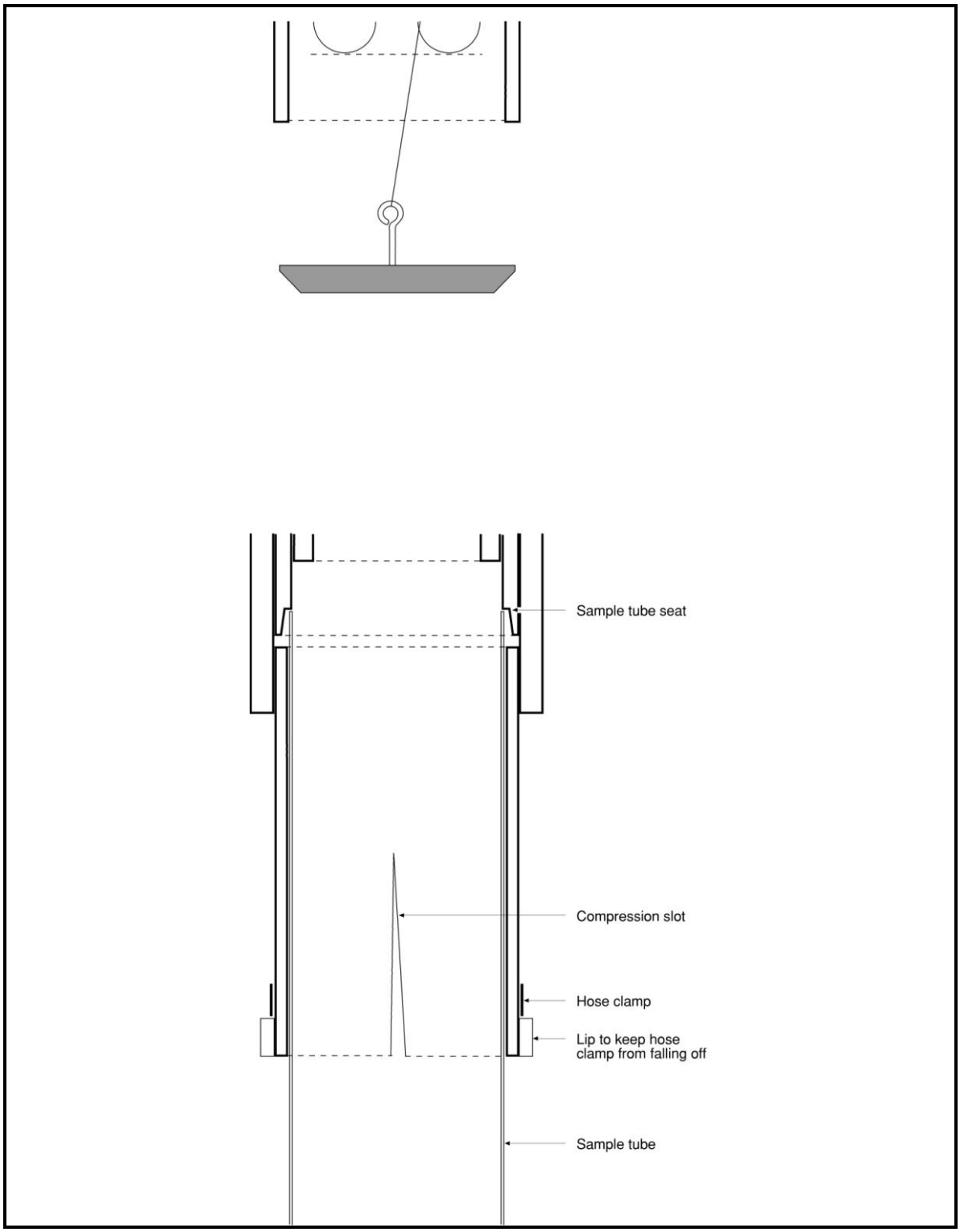


Figure 6.2.C-4 Detail of sample tube holder

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.

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.

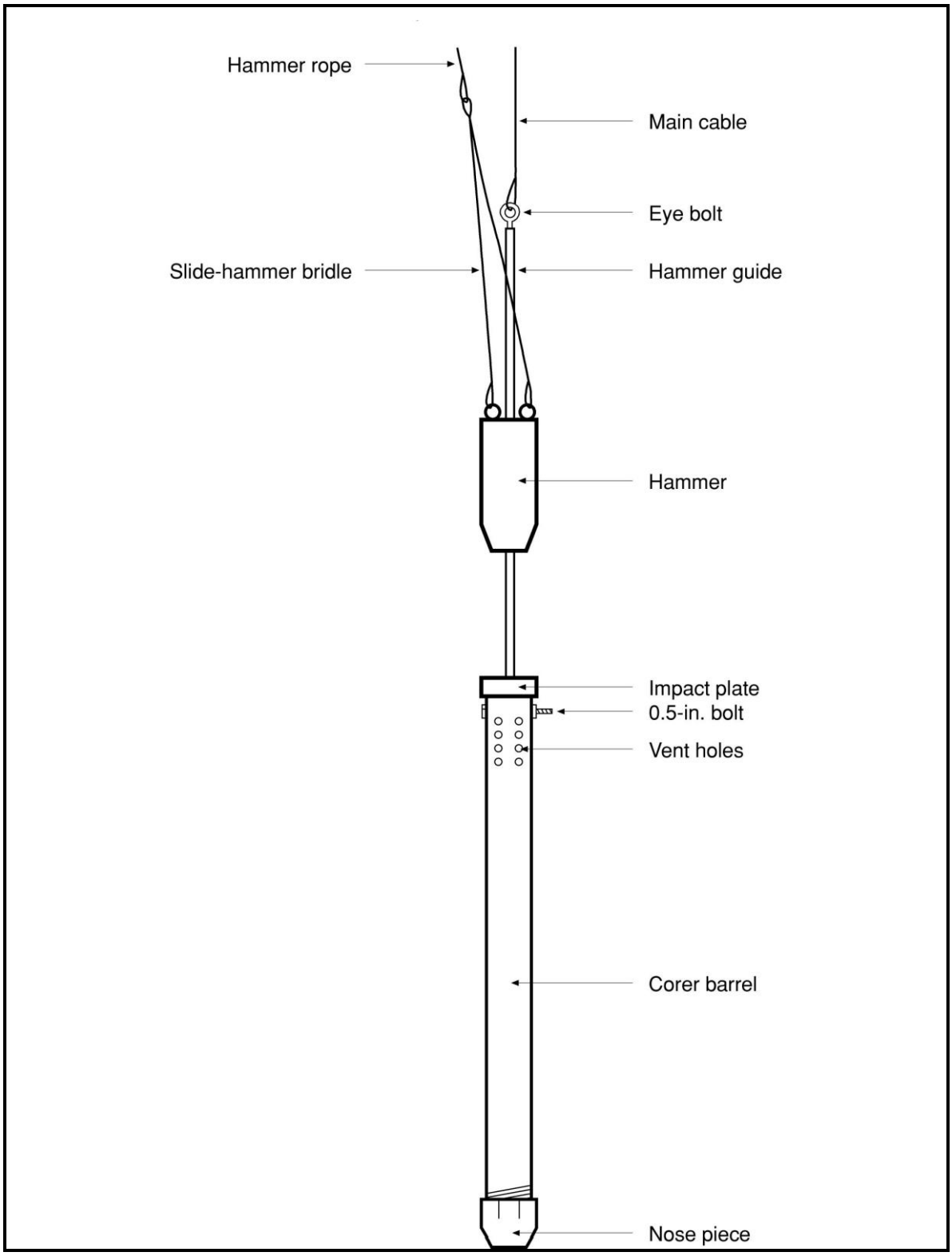


Figure 6.2.D-1 Diagram of slide-hammer corer

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

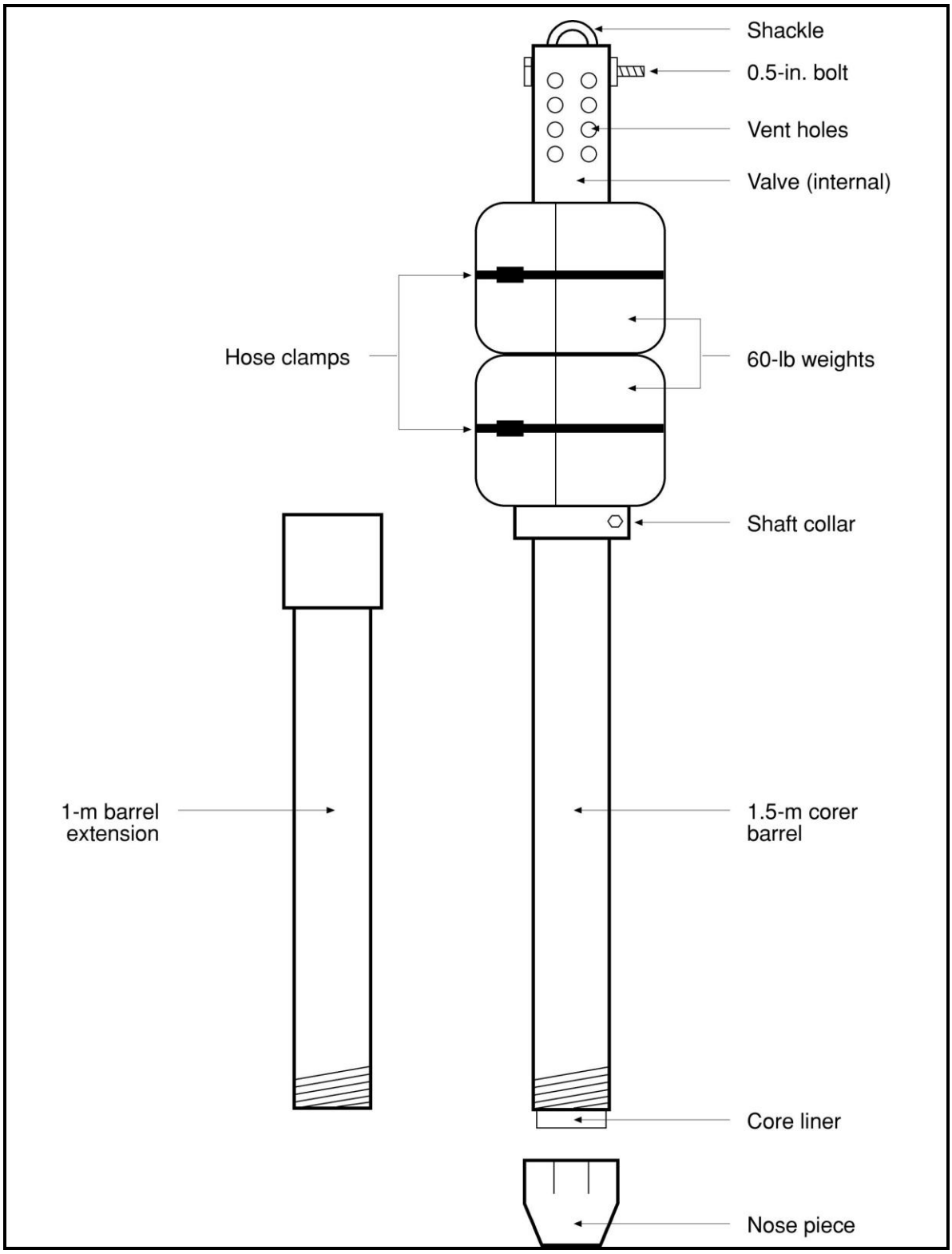


Figure 6.2.D-2 Diagram of 3-inch diameter gravity corer

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:

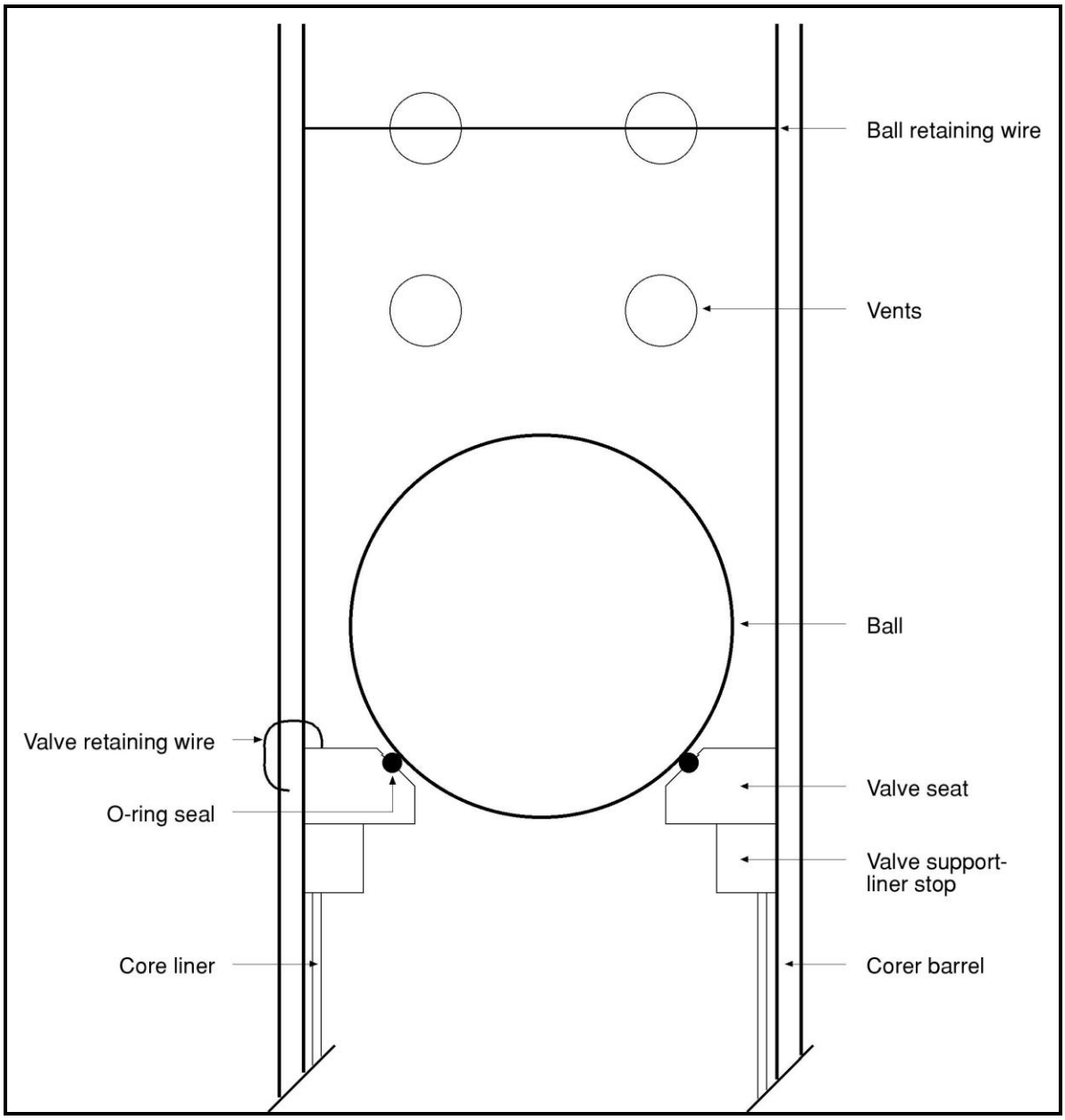


Figure 6.2.D-3 Cross section of ball valve

- **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.

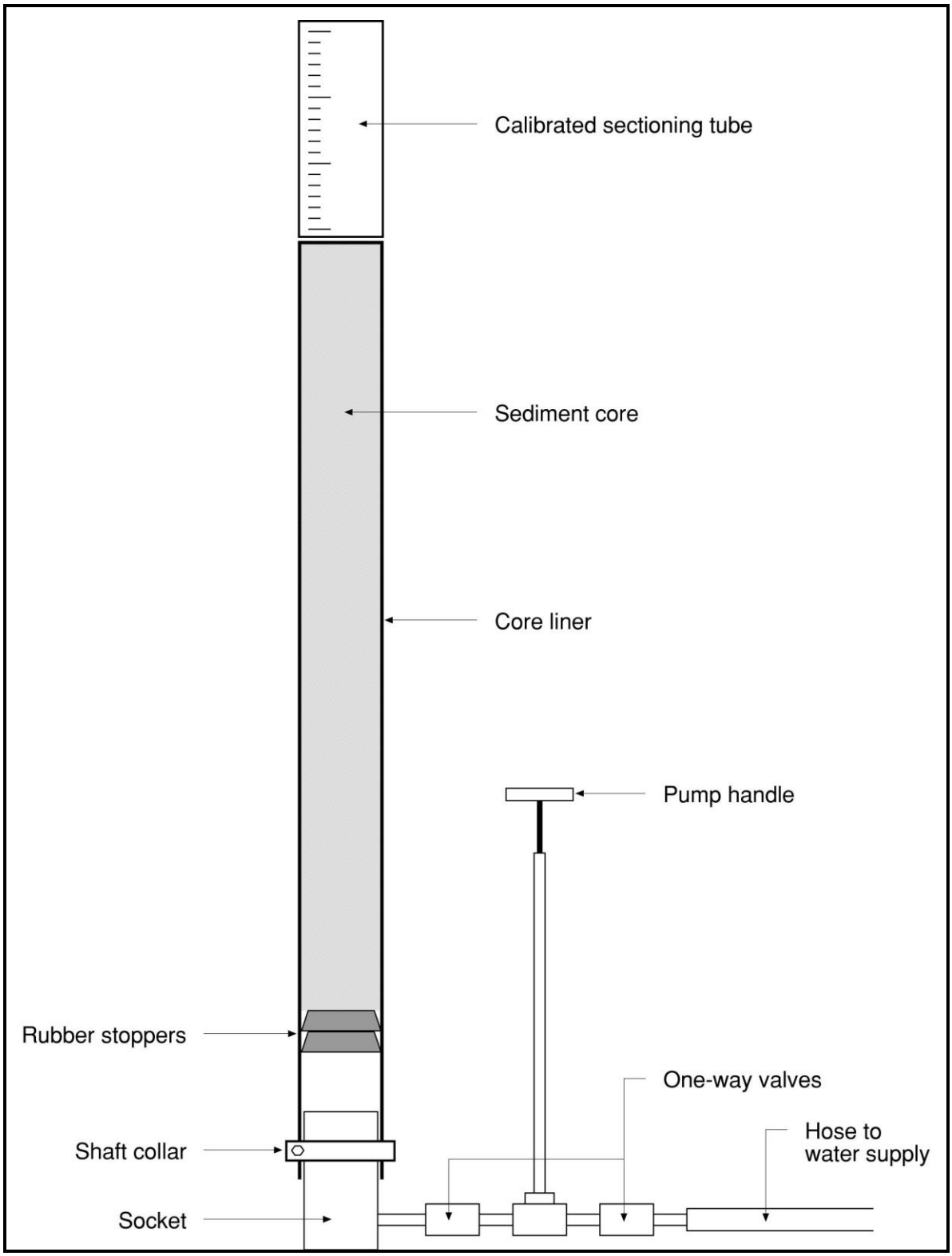


Figure 6.2.D-4 Diagram of core extruder and extrusion tube

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:

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

<u>Field Laboratory Method</u>

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 B
Normandeau Photographs


Johnson


Johnson
40
XDX-0783

Attachment C
Sediment Core Log

VISUAL CLASSIFICATION OF SEDIMENT CORE

Page _____ of _____

Project Name:	**GHD Project No:**
Project Location:	**Date:** / / 2016
Location ID: (N):	**Core Pushed By:** Normandeau Associates, Inc.
(E):	**Core Logged By:**
Core ID:	**Type of Core:** Vibracore
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)