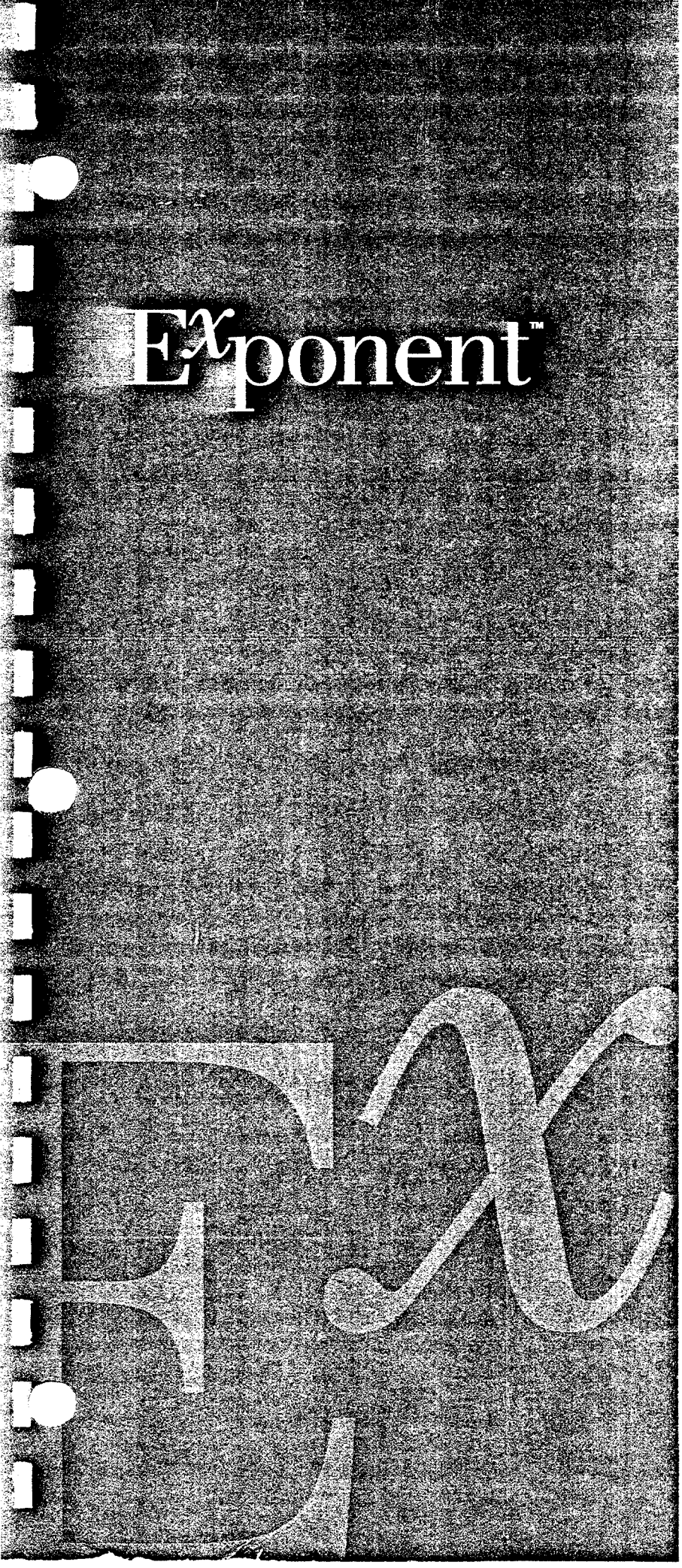

Field Sampling Plan for Analysis of Food-Web Structure of the Upper Hudson River, Spring 1998

Prepared for

General Electric Company
Albany, New York

309378

Exponent™

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October 1998

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ACRONYMS AND ABBREVIATIONS

BMI	benthic macroinvertebrate(s)
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
GE	General Electric Company
HSP	health and safety plan
NYSDEC	New York State Department of Environmental Conservation
PCB	polychlorinated biphenyl
PMI	phytophilous macroinvertebrate(s)
QAPP	quality assurance project plan
QA/QC	quality assurance and quality control
SOP	standard operating procedure
TOC	total organic carbon
USGS	U.S. Geological Survey

1. INTRODUCTION

Exponent has been retained by the General Electric Company (GE) to collect and analyze fish stomach contents and benthic and phytophilous macroinvertebrates (BMI and PMI) to better understand trends in polychlorinated biphenyl (PCB) concentrations in the tissue of largemouth bass (*Micropterus salmoides*), brown bullhead (*Ictalurus nebulosus*), and pumpkinseed (*Lepomis macrochirus*). These species are collected and analyzed each year by the New York State Department of Environmental Conservation (NYSDEC) as part of its program for monitoring PCBs in Hudson River fish. As part of this program, samples of the stomach contents of these and other fish and samples of BMI and PMI communities were collected concurrent with the collection of fish for PCB analysis by NYSDEC during September of 1997. The details of the study design for the program initiated in September 1997 are provided in PTI (1997).

Typically, largemouth bass and brown bullhead are collected by NYSDEC during the spring for analysis of PCBs. Much of the 1997 program is being repeated to coincide with the NYSDEC spring collection period. A major difference is that submerged aquatic vegetation is minimal in the spring and, therefore, PMI should make up a relatively small fraction of the fishes' diet. The investigation to be conducted in the spring of 1998 is designed to characterize and compare the food webs of the fish collected by NYSDEC for analysis of PCBs through collection and taxonomic analysis of BMI communities, PMI communities, and stomach contents of largemouth bass and brown bullhead at Griffin Island and Coveville. Two species of forage fish that have been found in the stomachs of largemouth bass and bullhead will also be collected and their stomach contents will be analyzed so that the food web will be more fully described.

This field sampling plan (FSP) describes the fieldwork required to complete this effort in the spring of 1998. An overview of the spring 1998 study design is presented in Section 2 of this document. Sample collection methods and analyses to be performed are described in Section 3, *Sediment Sampling;* Section 4, *PMI Sampling;* Section 5, *Fish Sampling;* Section 6, *Invertebrate and Plant Biomass Sampling;* Section 7, *Sampling Logistics;* and Section 8, *Analytical and Testing Methods*. Section 9 presents data analysis and reporting procedures.

Sample collection and analysis procedures used in this study follow current guidelines of the U.S. Environmental Protection Agency (EPA). The usability of the data and the comparability of the data to results of other studies will depend on the implementation of rigorous, standardized quality assurance and quality control (QA/QC) measures. The quality assurance project plan (QAPP) for the testing laboratories is provided in

Appendix A, and the health and safety plan (HSP) is provided in Appendix B. Standard operating procedures (SOPs) are provided in Appendix C and include the following:

- SOP 2—Sample Packaging and Shipping
- SOP 4—Field Documentation
- SOP 5—Sample Custody
- SOP 6B—Preparation of Field Quality Control Samples—Sediment
- SOP 51—Station Positioning
- SOP 101—Decontamination of Equipment—Sediments
- SOP 102—Preservation and Handling of Samples
- SOP 104—Sediment Coring Procedures Using Slide-Hammer and Gravity Corers.

Example field data forms are provided in Appendix D.

2. SPRING 1998 STUDY DESIGN

The historical database of PCBs in fish from the NYSDEC monitoring program for the Upper Hudson River includes PCB concentrations in fish representing both spring and fall conditions. The trophic relationships of those fish targeted in the spring are likely to be different than those of fish collected in the late summer because of the differences in habitat conditions between the two seasons. Subsurface aquatic habitats in September include the dense growth of *Vallisneria americana* and *Trapa natans* in large areas of the Upper Hudson River. In the spring, habitats include large areas of open sediments where *Vallisneria* and *Trapa* are undeveloped but dominate later in the season, and some patches of other vegetation types. In May, some development of *Potomogeton* and *Myriophyllum* species is expected, but the spatial extent of these areas is expected to be less than that of *Trapa* and *Vallisneria* later in the season. Data describing food-web conditions during the spring are needed to calibrate the bioaccumulation models being developed by GE and EPA.

The spring 1998 investigation is designed to characterize the trophic relationships of fish species targeted by NYSDEC for analysis of PCBs by determining the source of foods of targeted fish species (i.e., largemouth bass and brown bullhead) and their prey, and the relative contribution of BMI and PMI to the diets of the target fish species.

The studies outlined in this FSP will 1) support validation of assumptions of the PCB bioaccumulation model, and 2) provide additional data to evaluate qualitatively whether PCB transfer to higher trophic levels occurs through sediment food webs (i.e., based on BMI).

The spring 1998 investigation consists of the following six study elements:

- **BMI Community Analysis**—This work element will include collection of BMI for taxonomic identification and enumeration and collection of surface sediment samples for determination of total organic carbon (TOC) content and grain size distribution. Stations will be located at Griffin Island (Figure 1), and in the cove or adjacent main stem at Coveville (Figure 2). Sampling stations at Griffin Island will be located as close as possible to the locations of samples collected in September of 1997. Water depth, approximate distance to shore, and distance to aquatic vegetation bed (if present) will be measured at each sampling station. All invertebrate samples will be preserved in formalin and shipped to Aquatic Resources Center in Franklin, Tennessee, for taxonomic analysis. All sediment samples collected for conventional analysis and archiving will be stored at 4°C and shipped

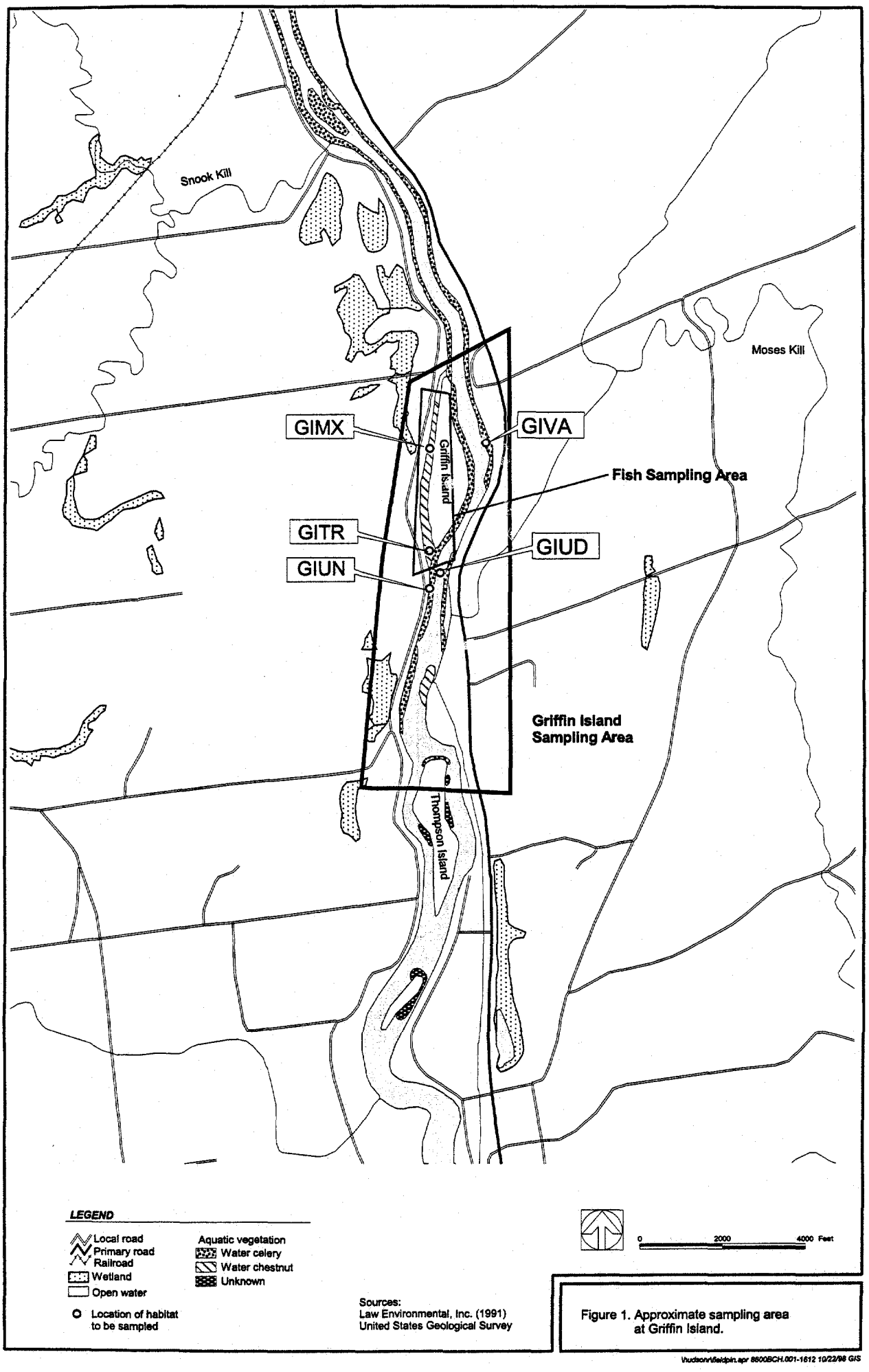

Figure 1. Approximate sampling area at Griffin Island.

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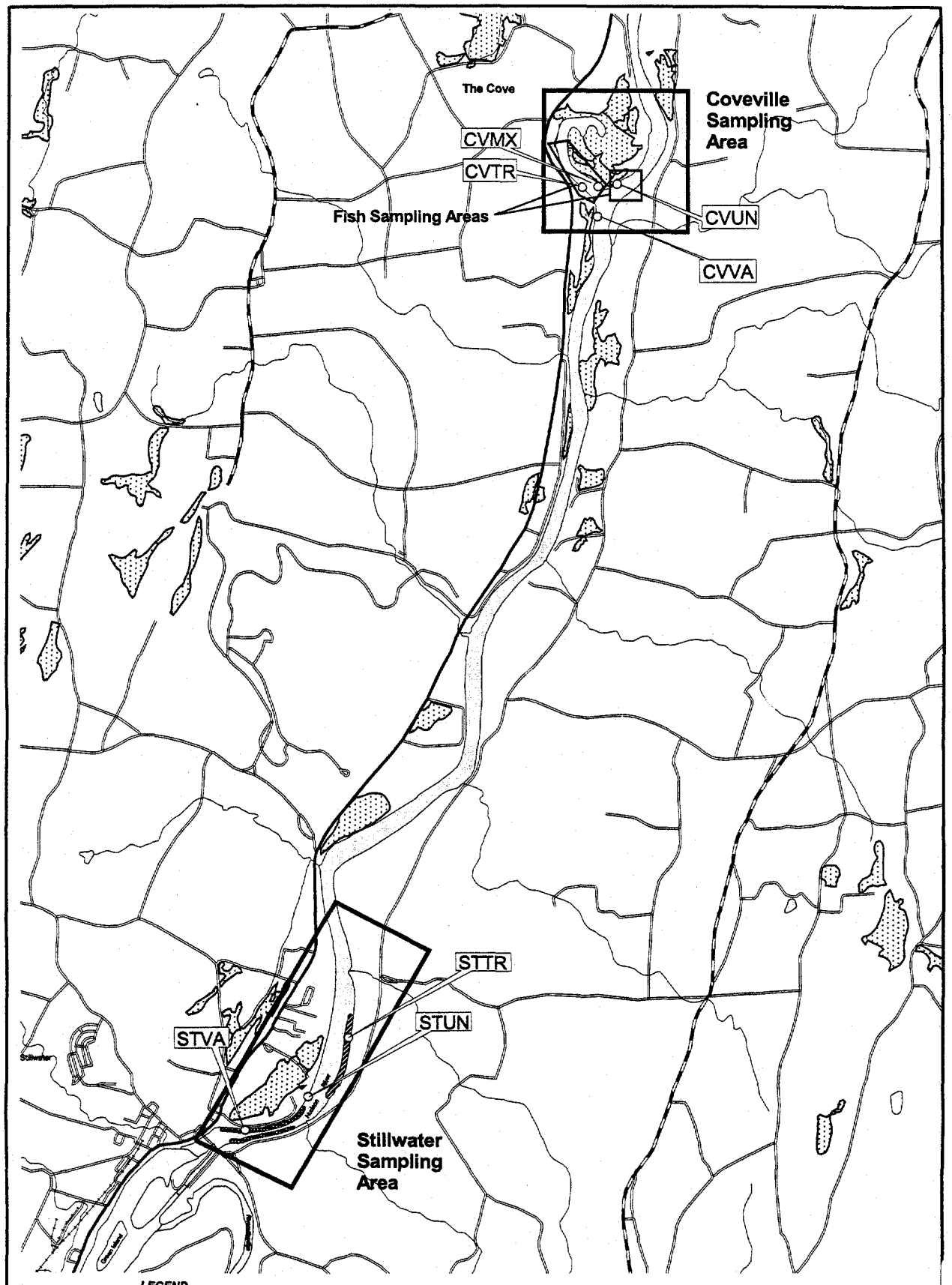

Figure 2. Approximate sampling areas in the Coveville and Stillwater regions.

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at the same temperature to Columbia Analytical Services in Kelso, Washington, for analysis.

- **PMI Community Analysis**—PMI will be collected for taxonomic analysis from plant communities that are present in the river at the time of sampling. A Plexiglas® box sampler will be used to collect quantitative samples of aquatic vegetation and associated macroinvertebrates. Stations will be located at Griffin Island (Figure 1) and in the cove or adjacent main stem at Coveville (Figure 2). The biomass of tissue of submerged aquatic plants associated with the invertebrates collected in the quantitative sampler will be measured. All samples will be preserved in formalin and shipped to Aquatic Resources Center for taxonomic analysis and determination of the dry weight biomass of associated vegetation.

- **Analysis of Stomach Contents of Largemouth Bass and Brown Bullhead**—NYSDEC will collect largemouth bass, brown bullhead, and other species (yellow perch, white perch, and carp) for analysis of PCBs concurrent with Exponent's sampling activities. In addition, the U.S. Geological Survey (USGS) will collect blood samples for analysis of vitellogenin and liver samples for histopathologic analysis. The USGS also will measure gonad weights, and evaluate fish health. All fish will be collected using a boat electroshocker to be operated by personnel designated by NYSDEC or USGS. Exponent will collect the stomach contents of only largemouth bass and bullhead that have been electroshocked by NYSDEC and USGS. Electroshocker transects will be located at Griffin Island (Figure 1) and in the vicinity of Coveville (Figure 2). The weight and length of all fish that are captured will be recorded, and their stomach contents will be removed and preserved for analysis. Stomach contents will be removed by evacuating the stomach using an acrylic tube. The stomach contents will be preserved in formalin, and the fish will be preserved by NYSDEC for PCB analysis. All stomach samples will be shipped to the Aquatic Resources Center in Franklin, Tennessee, for taxonomic analysis. The team of field personnel provided by Exponent to collect fish stomach contents will be available to support activities of NYSDEC and USGS. Extraction of fish stomach contents and collection of forage fish (described below) will be the first priority of the Exponent team.

- **Analysis of Stomach Contents of Forage Fish**—Additional forage fish will be collected from each of the two areas of the river in which fish are collected for PCB analysis (i.e., Griffin Island [Figure 1] and Coveville [Figure 2]). Collection of forage fish will be opportunistic, and samples will consist of the first 15 fish of each of two forage fish species that are shocked incidentally by NYSDEC and USGS in a given area during sampling for their targeted species. The species, weight, and length of each forage fish will be recorded. The

abdominal cavity of each fish will be slit, the gastrointestinal tract will be injected with 10 percent formalin, and the entire fish will be preserved in formalin. All forage fish samples will be shipped to Aquatic Resources Center for taxonomic analysis.

- **Determination of Mean Invertebrate Biomass**—Benthic, phytophilous, and planktonic invertebrates will be collected for determination of the mean biomass of general taxonomic categories. Benthic sampling stations will be located at Griffin Island (Figure 1) and Stillwater (Figure 2). Phytophilous and planktonic invertebrate sampling stations will be located at the Griffin Island (Figure 1) and Coveville sampling areas (Figure 2). All invertebrate samples will be preserved in formalin and shipped to Aquatic Resources Center in Franklin, Tennessee. Samples will be sorted into 14 taxonomic groups and dry weight biomass will be determined for each taxonomic group.

- **Determination of Vegetation Biomass**—Where submerged aquatic vegetation is well developed and associated PMI are sampled, the plant biomass per 0.1 m^2 will be measured. Plant biomass stations will be located at PMI community sample stations at Griffin Island and at Coveville. Plant biomass samples will be preserved in plastic bags at 4° C and shipped to the Aquatic Resources Center for measurement of dry weight biomass.

The anticipated schedule for the various investigations is presented in Table 1. The total number of stations and samples for each analysis is provided in Table 2.

TABLE 1. SCHEDULE FOR FIELD ACTIVITIES

Field Activity	Date
Sediment Sampling	
Griffin Island	May 21, 22, and 26
Coveville	May 27–28
Stillwater	May 18–20
Collection of Fish for Stomach Contents Analysis[a]	
Griffin Island	May 18–19
Coveville	May 20–21
Collection of PMI	
Griffin Island	May 23
Coveville	May 23
Collection of Plant Biomass	
Griffin Island	June 14
Coveville	June 14

[a] Largemouth bass and bullhead for stomach contents analysis and forage fish for stomach content analysis will be collected concurrently.

TABLE 2. SUMMARY OF SAMPLES TO BE COLLECTED FOR THE BMI COMMUNITY ANALYSIS, ANALYSIS OF STOMACH CONTENTS, AND BIOMASS DETERMINATIONS

BMI and PMI Community Analysis

	Griffin Island					Coveville				Stillwater			
	Vallisneria	*Trapa*	Mixed Vegetation	Unvegetated	Deep Unvegetated	*Vallisneria*	*Trapa*	Mixed Vegetation	Unvegetated	*Vallisneria*	*Trapa*	Unvegetated	Total Samples
BMI taxonomy	9	9	9	9	9	9	9	9	9	9[a]	9[a]	9[a]	108
Sediment chemistry (TOC, grain size, archive)	3	3	3	1	1	3	3	3	1	3[a]	3[a]	1[a]	30[b]
PMI taxonomy and vegetation biomass	--	--	6	--	--	--	--	6	--	--	--	--	12
Vegetation biomass per quadrat	--	--	6	--	--	--	--	6	--	--	--	--	12

Largemouth Bass and Bullhead for Stomach Contents Analysis

	Griffin Island	Coveville	Stillwater	Total Samples
Largemouth bass stomach contents[c]	20[e]	20	--	30
Brown bullhead stomach contents	20[e]	20	--	30

Forage Fish for Stomach Contents Analysis

	Griffin Island	Coveville	Stillwater	Total Samples
Forage fish stomachs[d]	30	30	--	60

Biomass Determinations

	Griffin Island					Coveville				Stillwater			
	Vallisneria	*Trapa*	Mixed Vegetation	Unvegetated	Deep Unvegetated	*Vallisneria*	*Trapa*	Mixed Vegetation	Unvegetated	*Vallisneria*	*Trapa*	Unvegetated	Total Samples
Benthic macroinvertebrates	2	2	--	2	--	--	--	--	--	2	2	2	12

	Griffin Island	Coveville	Stillwater	Total Samples
Phytophilous macroinvertebrates	1	1	--	2
Planktonic macroinvertebrates	1	1	--	2

Note: BMI - benthic macroinvertebrates
TOC - total organic carbon

Footnotes on following page.

TABLE 2. (cont.)

[a] Benthic macroinvertebrate samples and sediment samples from Stillwater will be archived and analyzed only on an as-needed basis.

[b] Excludes field duplicate samples. Two field duplicates for laboratory quality assurance will be collected at stations that will be determined in the field.

[c] Yellow bullhead may be used as a substitute if the number of brown bullhead is insufficient.

[d] Specific fish species to be sampled will be determined in the field.

[e] A maximum of 20 stomach content samples will be collected. The exact number of samples will depend on fish availability.

3. SEDIMENT SAMPLING

This section describes station locations and sample types and presents detailed procedures for sediment sample collection. Procedures are included for the following tasks:

- Collecting sediment samples
- Processing samples to ensure proper subsampling of each matrix
- Cleaning equipment, work surfaces, and sampling implements prior to sampling between stations.

Sample handling and shipping details are described in Section 6, *Sampling Logistics*.

3.1 STATION LOCATIONS AND SAMPLE TYPES

Sediment samples will be collected from three areas of the Hudson River (i.e., Griffin Island [Figure 1], Coveville [Figure 2], and Stillwater [Figure 2]). Sediment and the associated BMI community will be collected from four kinds of aquatic habitats (*Vallisneria americana, Trapa natans*, mixed vegetation and unvegetated) in each of these areas of the river. In addition, sediment and the associated BMI community will be collected from one station at a deep, unvegetated area near Griffin Island (Figure 1). All of the sediment samples will be collected consistent with EPA protocols (U.S. EPA 1986a).

The number and type of sediment samples to be collected during spring 1998 are summarized below:

- **Sediment Chemistry Samples**—Three composite sediment samples (0–6 in.) will be collected from each of 8 stations and one composite sediment sample will be collected at 4 stations in the Hudson River for analysis of TOC and grain size distribution (Table 2). Field duplicate samples for chemistry analyses will be collected from 2 of the stations.
- **BMI Samples**—Nine sediment samples will be collected from each of 12 stations in the Hudson River for BMI analysis (Table 2).
- **Archive Samples**—A subsample from each sediment chemistry sample will be archived for possible future chemical analyses.

3.2 SAMPLING PROCEDURES

Surface sediment samples (0–6 in. sediment horizon) will be collected for the BMI community survey and for analysis of TOC and grain size distribution at 12 stations in the Hudson River. Sediment samples will be collected using a 3-in. diameter gravity-assisted corer in accordance with standard methods used by U.S. EPA (1986a). Before sampling begins at a station, the core tubes and all other sampling equipment that will come in contact with the sample will be scrubbed with Alconox® and rinsed with site water; any metal components of the corer that will come in contact with the sample will be rinsed with acetone; and the core tubes and any sampling equipment that will come in contact with the sample will then be rinsed with hexane, air-dried, and rinsed with distilled/deionized water. The acetone and hexane rinsates will be collected in a container, and the small volume collected will be allowed to evaporate.

After a sediment sample is retrieved and judged to be acceptable (see discussion below), the overlying water will be siphoned off of the samples collected for chemical analysis, and the upper 6 in. of sediment will be collected in accordance with U.S. EPA (1986a) guidelines. Stainless-steel spatulas and spoons may be used to collect the sediment. A stainless-steel ruler will be used to ensure that the sampling criterion for adequate penetration depth is met and that the correct amount (i.e., 6 in.) of sediment has been removed.

At each sampling station, a minimum of three core samples will be collected. The surface (top 6 in.) sediment will be collected from each core. For BMI samples, each core will be processed individually. For chemical analyses, the sediment from three cores will be composited to achieve a sample more representative of average surface sediment characteristics at a given station. The sediment core samples at each station will be composited in a stainless-steel bowl and covered with aluminum foil until a sufficient volume of sediment is collected. Sediment in the bowl will then be mixed using a large stainless-steel spoon to achieve a uniform texture and color before subsamples are taken and transferred to precleaned glass containers with Teflon®-lined lids.

Material collected in the corer will be evaluated for acceptability according to whether the following criteria are met:

- The corer is not overfilled
- Overlying water is present
- The overlying water is not excessively turbid
- The sediment surface is relatively undisturbed
- A sediment penetration depth of at least 7 in. is attained.

The chief scientist will evaluate all samples collected. If a sample fails to meet the above criteria, it could be rejected and discarded away from the station. Rejected cores will be

extruded immediately to minimize the period of contact with the core liner. Liners that contained a rejected core may be used again at the same station after washing with site water to remove adhering sediments. If the specified penetration depth is not achieved after three or more attempts, the chief scientist may decide to relocate the station slightly. Aboard the sampling vessel, the sediment will be extruded upward from the coring tube using PVC pipes pressed against the bottom of a rubber stopper inserted into the tube's lower end; the overlying water will be allowed to drain slowly over the top of the tube. When the sediment surface reaches the top of the tube, a sample transfer container (open at both ends) will be placed over the top of the tube, and the sediment will be extruded upward into the sample container. When the top 6 in. of the sediment core is in the sample container, the container will be slid away from the coring tube, thereby slicing the top 6 in. off the sediment core. The sediment will be either transferred into a 0.5 μm sieve for processing the BMI sample or transferred to a stainless-steel bowl for compositing and subsampling for the chemical analyses.

4. PHYTOPHILOUS MACROINVERTEBRATE SAMPLING

Six PMI samples will be collected in mixed vegetation at each of two areas (Griffin Island [Figure 1] and Coveville [Figure 2]) using Plexiglas® box samplers. The box sampler has a 6 L volume (30 × 20 × 10 cm) and consists of two rectangle halves hinged together on one side. Clasp latches allow locked closure of the box during sampling and the seal is lined with closed-pore Neoprene. There is a drainage tube at one end of the box.

The collection of PMI samples requires selection of an aquatic vegetation patch that represents the typical density of the vegetation type as estimated visually. The completely open box sampler will be submerged in that area with the drainage tube facing skyward. The box sampler will be kept open until its top is 2–6 in. below the surface. The box halves will be closed and the latches will be locked. If divers are available, they will cut the vegetation stems from around the outside seal of the box sampler before bringing it up to the boat. Without diver assistance, the box sampler must be raised far enough out of the water to reach around the box with a cutting instrument and remove dangling vegetation. On the boat, the water will be drained from the box through an 80-μm sieve. The organisms will be rinsed from the sieve into a sample bottle. The outside of the box sampler will be rinsed to remove clinging organisms and vegetation. The vegetation inside the box sampler will be placed inside the sample jar and the box sampler insides will be rinsed through the 80-μm sieve to catch remaining organisms. Once the sieve is rinsed again into the sample bottle, 10 percent formalin will be added to the full bottle volume.

5. FISH SAMPLING

Fish will be captured with electroshockers for analysis of stomach contents as described below. This section also describes procedures for fish stomach collection. Sample handling and shipping requirements are described in Section 6, *Sampling Logistics*. Sample handling procedures and analysis of fish tissue, fish condition, and blood samples will be performed by NYSDEC and USGS personnel and are not discussed in this FSP.

5.1 COLLECTION OF LARGEMOUTH BASS AND BROWN BULLHEAD STOMACH CONTENTS

The two selected species (i.e., largemouth bass and brown bullhead) will be collected using a boat electroshocker. The electroshocker will be operated only by USGS or NYSDEC personnel. Electroshocking will occur in the Griffin Island (Figure 1) and Coveville (Figure 2) sections of the Hudson River. A total of 20 largemouth bass and 20 brown bullhead (Table 2) will be targeted for collection at Griffin Island and at Coveville. If collection above this target number is possible in a given sampling area, up to 10 additional specimens will be processed for stomach content analysis. Fish to be used for stomach content analysis will be collected concurrently with the fish tissue, condition observations, and blood samples that NYSDEC will collect for its PCB trends monitoring program.

Stomach contents of the selected species will be collected as follows:

- **Largemouth Bass**—Only bass greater than 30.5 cm in length will be collected for PCB and stomach content analyses.
- **Brown Bullhead**—Only bullhead greater than 20 cm in length will be collected for PCB and stomach content analyses.

The species, weight, and length of all fish will be recorded. Fish stomach contents will be removed by evacuating the stomach using an acrylic tube. Stomach contents will be removed after the USGS has taken a blood sample. The stomach contents will be preserved in formalin as individual samples, and the carcass will be provided to NYSDEC and USGS personnel onboard the sampling vessel for additional dissection and preservation on ice for shipment to the laboratory for PCB analysis.

5.2 COLLECTION OF FORAGE FISH STOMACH CONTENTS

Forage fish that are shocked incidental to the electroshocking conducted for the PCB target species will be collected in each area sampled (i.e., Griffin Island [Figure 1],

Coveville [Figure 2]). The sampling will be opportunistic and will consist of the first 15 fish of each of two forage fish species that are captured. A total of 60 forage fish will be collected for analysis of stomach contents (Table 2). Each forage fish will be identified, weighed, and measured for length. The body cavity of each fish will be slit and the gastrointestinal tract will be injected with formalin, before immersing the fish body in formalin, to ensure that the contents of the stomachs are preserved immediately. Each fish will be preserved and shipped individually and will be labeled as an individual sample. These fish will not be analyzed for PCBs.

The species of forage fish to be collected will be determined based on field observations of the species most abundant in the stomachs of bass and in the environment. To maximize compatibility with data collected in September 1997, juvenile yellow perch, spottail shiners, and logperch will be collected if they are present.

6. BIOMASS SAMPLES

Procedures for collection of BMI, PMI, and planktonic invertebrate samples and submerged aquatic plants for biomass determination are presented in this section.

For the invertebrates, a general representation of major taxonomic classes will be targeted for mean biomass determination and collected using sediment cores, D-ring nets, or plankton tows (Table 3). Major taxa groups were determined from analysis of fish stomach content samples collected during the September 1997 sampling event. The sampling objective is to collect a sufficient number of organisms so that 5 replicates of 10 individuals per taxonomic group (50 individuals per group for zooplankton) will be available for analysis of biomass. Plankton tow and D-ring net collections will be conducted at the Griffin Island and Coveville sampling areas. These collections will be inspected in the field to determine the total number of collections required to meet the sampling objective. BMI will be collected from six sediment cores from the Griffin Island and Stillwater sampling areas including two cores each in the three habitat types. An additional sediment core will be collected in the deep unvegetated habitat at Griffin Island. The total number of benthic samples will not exceed 12. Collecting these organisms for biomass determination may occur at any one of the sampling areas.

Vegetation biomass per unit area is a necessary measure for converting PMI densities per gram of vegetation biomass to macroinvertebrate density per unit area. This conversion allows comparison of the phytophilous and BMI densities. The sampling objective is to remove submerged aquatic vegetation from within 0.1 m^2 quadrats in the mixed vegetation habitats that will be sampled for PMI. Six quadrats will be sampled in the Griffin Island and Coveville sampling areas. A total of 12 quadrat samples will be collected.

6.1 COLLECTION OF BENTHIC MACROINVERTEBRATES

BMI biomass samples will be collected using the method described in Section 3. Decontamination procedures will not be conducted between samples for biomass determination. Samples will be processed using a 500-μm sieve and washed of sediment. A minimum of two cores will be collected in each of the three habitats (*Trapa*, *Vallisneria*, and unvegetated) at both Stillwater and Griffin Island during the first 3 days of the field sampling at each area.

6.2 COLLECTION OF PHYTOPHILOUS MACROINVERTEBRATES

The fish sampling team will use a D-ring net to collect PMI samples from existing vegetation beds for biomass determination. Collections from multiple sweeps will be sieved

TABLE 3. GENERAL TAXONOMIC GROUPS AND ASSOCIATED SAMPLE COLLECTION METHODS

Taxonomic Group	Collection Method
Dragonflies	D-ring net
Cladocera	Plankton tow
Ceacidotea	Core
Caddisflies	Core
Damselflies	D-ring net
Ostracods	D-ring net
Amphipods	Core
Cyclopoid copepods	Plankton tow
Bryozoa	Core and D-ring net
Hexagenia	Core
Chironomids	Core
Gastropods	D-ring net
Ancylids	Core
Bivalves	Core

at 80 μm and inspected in the field to ensure adequate collection of target organisms. Samples will be preserved and shipped in 10 percent formalin.

6.3 COLLECTION OF PLANKTON

Planktonic organisms will be collected using a plankton tow net (63 μm mesh) pulled for 2 minutes in the middle of the water column. The duration of the plankton tows will be determined by biomass that is available. Plankton collected in the net will be sieved at 80 μm, examined to estimate the quantity of target taxa and then transferred to 3–5 percent formalin for shipment to the taxonomic laboratory.

6.4 COLLECTION OF SUBMERGED AQUATIC PLANTS

All submerged aquatic vegetation will be removed from within 0.1 m^2 quadrats and placed in a Ziploc® bag. All stems will be cut within the quadrat at approximately 2 cm from the sediment surface. Samples will be placed immediately on ice and shipped at 4°C to the laboratory for total biomass determination.

7. SAMPLING LOGISTICS

7.1 VESSEL OPERATION AND NAVIGATION

The sampling vessels used during the field effort will be provided by O'Brien & Gere (for the sediment sampling) and by NYSDEC and Ichthyological Associates (for the fish sampling). Station positions for the sediment sampling will be recorded using a differential global positioning system capable of locating the survey vessel with an absolute accuracy of ±2 m and a repeatable accuracy of ±1 m. The positioning system used for this sampling effort will provide latitude and longitude coordinates for the station locations. Repositioning at stations sampled in September 1997 will be based on the coordinates recorded during that sampling event (Table 4). Water depth and approximate distance to shore will be noted, and all sample locations will be documented.

7.2 SAMPLE IDENTIFIERS

Sample identifiers will be established before field sampling begins and assigned to each sample as it is collected. Sample identifiers consist of codes designed to fulfill three purposes: 1) to identify related samples (i.e., replicates) to ensure proper data analysis and interpretation, 2) to obscure the relationships among samples so that laboratory analysis will be unbiased by presumed similarities between samples, and 3) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. To accomplish these purposes, each container is assigned a sample identifier, a sample number, and a tag number. These codes and their uses are described below:

- **Sample Number**—The sample number is an arbitrary number assigned to each sediment and stomach content sample collected. Each field replicate of a given type will have a different sample number, and the sample numbers of related field replicates will not necessarily have any shared content. The sample number appears on the sample containers, the chain-of-custody forms, and the sample analysis request forms.

- **Tag Number**—A different sample tag number is attached to each sample container. If the amount of material (i.e., everything associated with a single sample number) is too large for a single container, each container will have the same sample number and a different sample tag. A sample will also be split between containers if a different preservation technique is used for each container (i.e., because different analyses will be conducted, such as sediment chemistry vs. BMI).

TABLE 4. WATER DEPTHS AND STATE PLANE COORDINATES FOR STATIONS SAMPLED IN SEPTEMBER 1997

Station ID[a]	State Plane Coordinates X-Coordinate	State Plane Coordinates Y-Coordinate	Depth (ft)	Adjusted Depth (ft)
GITR	699705.1105	1168155.6495		
A			4.2	4.5
B			4.0	4.3
C			5.0	6.3
GIVA	701090.0960	1170857.2798		
A			4.9	5.2
B			4.9	6.3
C			4.1	5.7
GIUN	699754.7812	1167240.7794		
A			3.8	5.3
B			5.0	6.3
C			4.3	5.6
GIUD	699801.2003	1167516.5999		
A			15.0	16.3
STTR	688664.4735	1075779.0654		
A			3.5	4.9
B			3.5	5.0
C			3.5	4.6
STVA	684261.1171	1071720.1160		
A			2.4	3.7
B			2.7	4.0
C			3.1	4.4
STUN	686956.5396	1073210.3898		
A			3.6	4.9
B			4.3	5.6
C			5.0	6.4

[a] Station IDs are coded as follows:

The first two letters designate the area

- GI - Griffin Island
- ST - Stillwater
- TI - northern Thompson Island Pool

The second two letters designate habitat type

- TR - *Trapa natans*
- VA - *Vallisneria americana*
- UD - unvegetated deep water
- UN - unvegetated

The fifth letter designates the station.

The sample tag number will appear on the chain-of-custody and sample analysis request forms. Tag numbers are used by laboratories only to confirm that they have received all of the containers that were filled and shipped. Data are reported by sample number.

Sample numbers will be assigned sequentially in the field; sample tags will be preprinted with tag numbers.

All sample containers will be provided by the laboratory or will be purchased from scientific suppliers and prepared in accordance with U.S. EPA guidelines (U.S. EPA 1986a) prior to field operations. Sample containers will be kept closed until use. As they are collected, samples will be fully labeled, recorded in the field notebook along with other pertinent collection data, and returned to coolers as soon as possible (if appropriate). Immediately after they are filled, all sample containers containing sediment for chemical analysis will be placed on ice in a cooler at 4°C. For those sediment samples that will be frozen (i.e., archive samples), sufficient headspace will be left in each jar to accommodate expansion during freezing. Samples to be preserved in formalin will be stored in coolers at ambient temperature.

Sediment samples for all chemical analyses (i.e., TOC content and grain size) will be shipped on ice (4°C) to the testing laboratory (Columbia Analytical Services) and will be stored at 4°C until analysis and final disposition of the samples. All field samples, except archive chemical samples, will be analyzed as soon as possible after receipt at the laboratory. Maximum sample holding times are stipulated in Table 5 and in the QAPP (Appendix A). All sediment chemistry samples will be placed in an outer plastic bag to avoid cross contamination should breakage occur. The archived samples will be held frozen at the laboratory pending a decision on whether to perform possible future additional chemical analyses within the specified holding time for frozen samples.

Sediment samples for BMI analysis and fish stomach content samples will be preserved in formalin and will be shipped to the testing laboratory (Aquatic Resources). All field samples will be analyzed as soon as possible after receipt at the laboratory. All BMI and fish stomach content samples will be placed in an outer plastic bag to minimize sample loss should breakage occur.

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 the testing laboratories. Information on the labels will be checked against field logbook entries, and samples will be re-counted. Samples will be shipped or sent by courier to arrive at the participating laboratories as soon as possible after collection.

Samples in glass containers that are shipped or sent by courier will be packed in bubble-wrap plastic to prevent breakage. All samples will be shipped with chain-of-custody seals placed across the cooler lids. A combined chain-of-custody/sample analysis request form will be enclosed in each cooler with the samples, and it will be signed at the testing

TABLE 5. SAMPLE PRESERVATION AND HANDLING PROCEDURES

Analyte	Approximate Laboratory Subsample[a]	Container	Preservation and Handling	Maximum Holding Times
Total organic carbon	1 g	500-mL wide mouth glass jar; Teflon®-lined lid	Keep in dark; cool (4°C)	1 year
Grain size distribution	225 g	500-mL wide mouth glass jar; Teflon®-lined lid	Keep in dark; cool (4°C)	1 year
Fish species identification	Whole fish	2 to 8 oz. high density polyethylene jar	10 percent formalin solution; ambient temperature	Not established
Taxonomic identification of stomach contents	Whole stomach	2 to 8 oz. high density polyethylene jar	10 percent formalin solution; ambient temperature[b]	Not established
Benthic macroinvertebrate assemblages	NA	1-L polyethylene jar	10 percent formalin solution; ambient temperature[b]	Not established
Phytophilous macroinvertebrate assemblages	NA	1-L polyethylene jar	10 percent formalin solution; ambient temperature[b]	Not established
Benthic macroinvertebrate biomass	NA	1-L polyethylene jar	10 percent formalin solution; ambient temperature[b]	Not established
Phytophilous and planktonic macroinvertebrate biomass	NA	1-L polyethylene jar	10 percent formalin solution; ambient temperature[b]	Not established
Vegetation biomass	NA	Ziploc® bag	Keep in dark; cool (4°C)	Not established

Note: NA - not applicable

[a] Sample volumes listed are the optimum amounts that should be used to conduct the target analyses to achieve the detection limit goals. However, the sample volume that will be used at the laboratory may vary if a limited amount of sample is collected or if smaller amounts are necessary because of elevated concentrations of target analytes.

[b] Prior to storage, the laboratory will transfer the samples to 70 percent ethyl alcohol.

laboratory receipt. A copy of the signed form will be returned to Exponent and filed in the project file. Sample packaging and shipping requirements are described in SOP 2, *Sample Packaging and Shipping* (Appendix C).

7.3 DOCUMENTATION

The integrity of each sample must be maintained throughout the study, from the time of collection to the point of data reporting. Proper record-keeping and chain-of-custody procedures will be implemented to allow samples to be traced from collection to final disposition. Exponent's chief scientist for each team is responsible for properly completing all logbooks and forms. Station and sample logs must be completed at the time the observations are made. Chain-of-custody and sample analysis request forms will be completed and signed before the end of each sampling day and before the samples pass from the control of the chief scientist. Chain-of-custody forms will be signed at each additional point of transfer of samples between the field and the laboratory and within the laboratory. Copies of all forms will be retained by Exponent.

Various logs and forms required to adequately identify and catalog station and sample information include the following:

- **Field Notebook**—A bound, waterproof field notebook with consecutively numbered pages will be completed for this sampling event. All daily field activities will be documented in indelible ink in this notebook. At a minimum, Exponent's chief scientist will record the following information daily in the field notebook:
  - Date and time of entry (24-hour clock)
  - Project name and location
  - Project number
  - Time and duration of daily sampling activities
  - Weather conditions
  - Station name, date, gear, water depth, approximate distance to shore, and station location coordinates
  - Sample type (i.e., sediment or fish stomach content), sample number, and sample tag number
  - Sediment type, color, and odor for sediment samples
  - Fish species, length, and weight for fish stomach content samples
  - Variations, if any, from specified sampling protocols and reasons for deviations

- Name of person making entries and other field personnel
- Onsite visitors, if any.

- **Chain-of-Custody Form**—The sample and tag numbers of each sample container will be recorded on a chain-of-custody form. The chain-of-custody form will also identify the sample collection date and time, the type of sample, the project, and the chief scientist. The chain-of-custody form will be sent to the laboratory along with the sample. Chain-of-custody forms will be completed in triplicate and one copy will be retained by the chief scientist.

- **Sample Analysis Request Form**—Each set of samples sent to a laboratory will be accompanied by a sample analysis request form. The sample analysis request form will identify samples by sample number and sample tag. For each sample tag, the sample analysis request form will identify the preservative or other sample pretreatment applied and the analyses to be conducted by referencing a list of specific analytes or the statement of work for the laboratory. One copy of this form will be retained by the chief scientist, and the original form will accompany the shipment. A combined chain-of-custody and sample analysis request form will be used.

- **Sample Label and Custody Seal**—A sample label will be completed for each sample. Sample containers will be labeled at the time of sampling with the following information: sample number, site name, sampling date and time, sampling personnel, preservative (if appropriate), and tag number. A custody seal will be placed across the lid of the cooler prior to shipping.

Appendix D contains examples of the various forms that are used to record information at each sampling location.

7.4 SAMPLING SCHEDULE

The spring 1998 sampling event is anticipated to begin on Monday, May 18, 1998, pending approval of this FSP. In the interim, sampling equipment and personnel will be mobilized. Sediment sampling is estimated to require 10–14 days at the site (depending on the difficulty of obtaining adequate sediment samples at all stations). Fish sampling is estimated to require 6 days at the site. The sequence of sample collection will be arranged to maximize efficiency while minimizing potential cross-sample contamination. The schedule also will be arranged to minimize health and safety concerns that may occur between the two sampling teams (i.e., metal coring tubes being used by sediment sampling team and electroshocking gear being used by the fish sampling team). The actual sequence in which the stations will be visited will be determined in the field by Exponent's chief scientist.

7.5 SAMPLING SAFETY

Safety hazards are associated with the equipment and supplies that will be used, as well as with the general rigors of work on the water. The HSP is provided in Appendix B; its purpose is to identify potential hazards, institute procedures for minimizing those hazards, document the proper responses in case of accident and injury, and make this information known to all shipboard personnel. Before sampling begins, a health and safety briefing will be held.

To ensure safe and efficient shipboard operations, the chief scientists will be designated the safety officers responsible for all shipboard operations for their respective sampling teams. The duties of the health and safety officers will include evaluating hazardous conditions, ensuring compliance with safety precautions, and suspending shipboard operations if necessary. A halt to or suspension of operations can also be dictated by the vessel operator.

7.5.1 Hazards

Hazards encountered during sampling are generally classified as either chemical or physical. Chemical hazards are associated primarily with the materials used to clean sampling gear. Physical hazards are associated with the gear and conditions of work on the water.

7.5.1.1 Chemical Hazards

When sampling stations during the survey, the field team should be prepared to encounter concentrations of chemicals that pose a hazard to human health. If excessive odor, non-aqueous liquids, or organic enrichment is observed during field operations, the sampling plan will be reassessed. Precautionary steps may include artificially ventilating the rear deck or the area where samples are being preserved with formalin, instituting suitable protective measures for the crew, or relocating or eliminating the sampling station.

Acetone and hexane will be used to clean the metal sediment sampling equipment. Both are clear, colorless, volatile solvents with strong odors. Acetone and hexane will be used only on the open deck, and personnel must wear protective gloves when handling these liquids.

Material safety data sheets for acetone and hexane are included in the HSP (Appendix B).

7.5.1.2 Physical Hazards

Gear deployment and retrieval present hazards because of the weight and length of the sampling gear and its suspension above the deck. While gear deployment hazards are expected to be minimal, there are physical hazards associated with the sediment corer.

During sampling gear retrieval, at least one crew member will watch for the sampling gear to appear at the sediment surface and alert the sampling personnel on deck. Failure to observe the sampling gear as it is coming out of the water could result in possible injury to the sampling personnel. The cutting ring of the core tube is very sharp and must be handled with extreme care.

Lines, hoses, and mud on the deck present tripping, slipping, and falling hazards. Every crew member will be instructed to keep the working surface of the deck clear and clean by coiling hoses and lines and rinsing accumulations of mud from the deck. In addition, all crew members will remain aware of locations of sampling gear at all times.

A drowning hazard exists for shipboard personnel working on the water primarily from tripping (discussed above) or excessively rough weather. Flotation vests will be worn by all personnel on deck.

Fatigue presents a hazard when working on the water and can be compounded by the motion of the vessel, exposure, or hypothermia. Personnel will monitor their own conditions and capabilities and are responsible for taking appropriate measures to relieve fatigue or exposure. Exponent's chief scientist may also direct any member of the crew to cease working.

7.5.2 Safe Work Practices

Precautions for handling chemicals include wearing gloves, restricting chemical use to the deck, storing and dispensing chemicals from narrow-mouth bottles or squirt bottles, and exercising care in use. Solvent rinsate from sampling gear will be collected in a container so excess solvent is not spilled on the deck. The presence of wakes or other disturbances will be noted to avoid spills.

All crew members will wear hard hats when working on the rear deck. Work gloves will be available but not required (impermeable gloves are required when using acetone or hexane). Flotation vests will be worn by all personnel on deck.

During gear deployment and retrieval, personnel should pay close attention to the position of the gear, the motion of the boat, obstructions on the deck that could impede their mobility, and actual or potential fouling of the gear.

Weather conditions will be monitored by the chief scientist and vessel operator. The vessel will be supplied with emergency flotation equipment and fire extinguishers. Each

crew member will be required to wear clothing appropriate for the weather to minimize the hazards of exposure and hypothermia.

7.5.3 Emergency Planning

If an emergency or accident occurs during sampling, the chief scientist and vessel operator will determine the appropriate response. They will assess the severity of the incident and, if appropriate, contact emergency assistance. The vessel operator is responsible for moving the boat into position to receive emergency aid, if necessary. A basic first-aid kit will be kept onboard to treat minor cuts or scrapes. All field personnel have received first-aid and CPR training. All accidents must be reported to the chief scientist and will be recorded in the field notebook. Contact information for local emergency services, hospitals, and ambulance services will be onboard the vessel in a location known to and accessible to all personnel. Emergency contact information is provided in the HSP (Appendix B).

8. ANALYTICAL AND TESTING METHODS

Analytical and testing procedures will be completed in accordance with requirements specified in the selected methods.

8.1 CHEMICAL ANALYSES

Procedures for each chemical analysis are summarized in the QAPP (Appendix A). Samples will be analyzed in accordance with U.S. EPA (1986b,c), or other EPA-approved or recommended methods when available. Analyses will include all associated QA/QC procedures recommended in each method.

For sediment chemistry samples, the laboratory will assume that the entire sample submitted for analysis is representative material. To avoid substance losses, any overlying water in sediment samples received from the field will be mixed into the sample before removing a subsample for analysis.

8.2 TAXONOMIC ANALYSES OF BENTHIC AND PHYTOPHILOUS MACROINVERTEBRATES AND FISH STOMACH CONTENTS

All PMI and BMI samples will be sieved using a 500 μm sieve in the laboratory. Organisms will be identified to the lowest taxonomic level possible, the target being species level, and the number of individuals of each species will be recorded for each BMI, PMI, and stomach sample analyzed. All taxonomic identifications will be made by qualified taxonomists using binocular-dissecting or compound microscopes. If possible, at least two literature sources will be used for each species identification. Moreover, each species identification will be verified by a taxonomic expert or checked against a reference specimen from a verified reference collection.

8.3 PHYTOPHILOUS, PLANKTONIC, AND BENTHIC MACROINVERTEBRATE BIOMASS

PMI and BMI samples for biomass determinations will be sieved using a 500 μm sieve in the laboratory. Plankton samples for biomass determinations will be sieved using a 250 μm sieve in the laboratory. Samples for phytophilous, planktonic, and BMI biomass determinations will be sorted into 14 taxonomic groups (Table 3). Organisms in each taxonomic group will be sorted into 5 replicates, each containing 10 individuals (50 individuals per replicate for cladocerans and copepods). Dry weight biomass will be determined for the 5 replicates in each taxonomic group. All taxonomic identifications will be made by a qualified taxonomist using binocular-dissecting or compound

microscopes. If possible, at least two literature sources will be used for each species identification. Each species identification will be verified by a taxonomic expert or checked against a reference specimen from a verified collection.

8.4 VEGETATION BIOMASS

Two determinations of plant biomass will be made. The biomass of plant tissue that is included in quantitative PMI samples will be determined, and the biomass per unit area of river bottom will be determined. The dry weight biomass will be determined for both of these sample types according to the SOP provided by Exponent (Attachment 1).

9. DATA ANALYSIS AND REPORTING

9.1 DATA ANALYSIS

At the request of GE, analysis of data collected during the spring of 1998 will deferred.

9.2 DATA REPORTING

The BMI and PMI community, biomass and stomach content data will be reported in a data report approximately 1 month following receipt of all results from analytical laboratories. It is anticipated that draft data reports will be submitted to GE in early September 1998. Original laboratory results will be provided as appendices to the report.

10. REFERENCES

PTI. 1997. Ecological value and food web structure of aquatic communities in the Upper Hudson River: Study plan. PTI Environmental Services, Bellevue, WA.

U.S. EPA. 1986a. General QA/QC considerations for collecting environmental samples in Puget Sound. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

U.S. EPA. 1986b. Recommended protocols for measuring conventional sediment variables in Puget Sound. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

U.S. EPA. 1986c. Test methods for evaluating solid waste. Volumes 1A and 1B: Laboratory manual physical/chemical methods. SW-847. Third Edition. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

Appendix A

Quality Assurance Project Plan

QUALITY ASSURANCE PROJECT PLAN

Prepared by: Exponent
July 1998

Prepared for: General Electric Company

Approvals:

General Electric Company Project Manager

Exponent Project Manager

Exponent Quality Assurance Coordinator

CONTENTS

309420

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
GE	General Electric Company
LCS	laboratory control sample
PCB	polychlorinated biphenyl
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
RPD	relative percent difference
RSD	relative standard deviation
SDG	sample delivery group
SOP	standard operating procedure
SOW	statement of work
TOC	total organic carbon

1. PROJECT DESCRIPTION

This quality assurance project plan (QAPP) describes the quality assurance and quality control (QA/QC) procedures used to support the analytical data generated for this investigation. These QA/QC procedures ensure that the data generated during the site investigation represent actual field conditions and meet the project's data quality objectives (DQOs) for precision, accuracy, and completeness. This QAPP was developed using guidance provided by U.S. EPA (1987, 1989). If additional field sampling or analysis activities are needed in the future, related QA/QC activities will be described in an addendum to this QAPP.

A description of the study site can be found in the field sampling plan (FSP). The rationale for the current sampling specifications, scheduled dates for the field investigation, and the intended end use of the data acquired from this investigation are also described in the FSP.

As discussed in the main text of the study plan and the FSP, fish, macroinvertebrates, aquatic vegetation, and sediment samples will be collected as part of the ecological investigation. Biological analyses to be performed on the fish samples will include identification of the species of fish collected and the taxonomic identification of fish stomach contents. For sediment samples, chemical analyses will be performed for total organic carbon (TOC) and grain size distribution. Biological analyses to be performed on the macroinvertebrate samples will include identification and enumeration of benthic and phytophilous macroinvertebrate assemblages, and biomass determination of benthic, phytophilous, and planktonic macroinvertebrates and aquatic vegetation.

TOC concentrations and grain size distribution will be determined using standard analysis techniques consistent with applicable EPA test methods and other laboratory methods cited in this QAPP. Biological analyses will be conducted according to test methods cited in this QAPP.

2. PROJECT ORGANIZATION AND RESPONSIBILITIES

The quality assurance organization for this project and the individuals responsible for ensuring the quality of field and laboratory operations and the data collected are provided below. These personnel have the following responsibilities:

Personnel	Responsibilities
Project Manager and Site Coordinator (John Haggard, GE)	Overall responsibility for site activities. Oversee all program activities to ensure compliance, perform technical oversight and consultation on major quality assurance problems, and provide final approval of all necessary actions and adjustments for activities to accomplish project objectives.
Exponent Project Manager (Robert Pastorok)	Oversee project activities to ensure appropriate quality control review, provide technical oversight, and implement necessary actions and adjustments for activities to accomplish project objectives.
Chemistry Quality Assurance Coordinator (Adam Bonin, Exponent)	Provide technical quality assurance assistance; develop, prepare, and review QAPP; coordinate with project laboratory; oversee quality assurance activities to ensure compliance with QAPP; track submittal and analysis of samples to the laboratory and ensure delivery of data; monitor field investigations; and prepare and submit quality assurance reports.
Biology Quality Assurance Coordinator (Jenée Colton, Exponent)	Provide technical quality assurance assistance; develop, prepare, and review biological components of the QAPP; coordinate with project laboratory; oversee quality assurance activities to ensure compliance with QAPP; track submittal and analysis of samples to the laboratory and ensure delivery of data; monitor field investigations; and prepare and submit quality assurance reports.
Laboratory Project Managers and Quality Assurance Officer	Ensure that sample receipt and custody records are properly handled, data are reported within specified turnaround times, instruments are calibrated and maintained as specified, internal quality control measures and analytical methods are performed as required, corrective actions are taken, the quality assurance coordinator is notified when problems occur, and data and quality assurance information are reported.

A laboratory project manager and a quality assurance coordinator, as described above, will be identified at each contract laboratory to ensure that appropriate procedures are followed during sample analysis and preparation of the data packages. The laboratory quality assurance officer will be identified before submittal of samples.

As an additional quality control measure, negotiated contracts between Exponent and the laboratory will include a statement of work (SOW) that specifies the following items:

- Summary of analyses, including:
  - A scope of services that lists all variables for analysis
  - The total number of field samples and laboratory quality assurance samples for each sample matrix and analysis requested, the per-analysis price, and the total cost of the analytical service provided
- Sample delivery and storage requirements, including:
  - Method of delivery, schedule of sample delivery, and person responsible for notifying the laboratory of any changes in the schedule
  - Requirements for physical storage of samples, holding times (consistent with this QAPP), and chain-of-custody procedures
- Turnaround time from date of sample receipt to submittal of complete data deliverables, including penalties for late delivery
- Deliverable requirements, including supporting documentation and specification of electronic data files
- Analytical methods to be followed, including any modification from standard procedures (all procedural changes require prior approval by the quality assurance coordinator)
- QA/QC requirements, including acceptance of the DQOs specified in this QAPP and performance evaluation testing requirements
- Progress report requirements and notice of laboratory and data auditing rights of Exponent
- Responsibilities for payment for acceptable analyses, including the requirement that all invoices be approved by the quality assurance coordinator.

Copies of the SOW for each laboratory will be provided to all quality assurance reviewers to assist in the review of data returned by the laboratories. The laboratories are required to have written quality assurance manuals. The laboratory quality assurance manuals should include a description of the laboratory organization, personnel, and responsibilities; facilities and equipment; analytical methods; and routine procedures for sample custody, quality assurance, and data handling. The laboratories must provide the manuals to Exponent, if requested for review.

No changes in the QAPP procedures will be permitted without written justification and a detailed explanation of the intended change. All changes are subject to approval by the quality assurance coordinator. A description of all changes, with justification, will be included in applicable quality assurance or data reports generated for this project.

3. QUALITY ASSURANCE OBJECTIVES AND SAMPLING STRATEGY

The primary quality assurance objective for this investigation is to obtain data of known and acceptable quality and representative of the conditions present at the site. The production of valid and acceptable data begins with setting explicit DQOs (U.S. EPA 1987) for the project before collecting field samples and measurement data.

3.1 DATA QUALITY OBJECTIVES

DQOs for measurement data are usually expressed in terms of accuracy (bias and precision), completeness, representativeness, and comparability. These characteristics are defined as follows:

- **Bias**—The degree of conformity of a measurement, X, with an accepted reference value, T, expressed as a percentage of a ratio, $X/T \times 100$. Bias is quantified by the analysis of matrix spike samples and reference materials. Bias is one component of the accuracy of measurements.
- **Precision**—A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is expressed in terms of the relative standard deviation (RSD) for three or more measurements or relative percent difference (RPD) for two measurements. Precision is calculated from laboratory and field duplicate measurements. Precision is the second component of the accuracy of measurements.
- **Completeness**—The ratio of the number of valid measurements compared to the number of expected measurements, expressed as a percentage. Field and analytical data may be specified at different completeness levels.
- **Representativeness**—The degree to which data accurately and precisely represent the true value of a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness of field and laboratory data is attained through consistent methods of data collection, including field methods, sampling procedures, sample preservation and handling, and analytical procedures. Equipment must be properly maintained and calibrated against known standards before each use.

- **Comparability**—The confidence with which one data set can be compared with another. All sediment data for this site investigation will be obtained using consistent analytical methods to ensure comparability of results within the study, and every reasonable effort will be made to maintain comparability with other studies completed at the site. Comparability of data is attained by following established protocols for collecting and analyzing samples and recording field and laboratory data in consistent units.

Quantitative DQOs for this project, including method reporting limits, bias, precision, and completeness, are presented in Table 1. Attainment of these DQOs will ensure that the data are of appropriate quality for their intended uses. Data that do not meet target DQOs will be qualified during data validation, and their limitations will be noted in the QA/QC report for the project, as discussed in Section 14 of this QAPP.

To confirm that project DQOs for precision and accuracy are achieved, analytical results for both field and laboratory quality control samples will be evaluated, as discussed in the sections below. The equations used to assess precision, accuracy, and completeness, as well as the techniques used to determine the reported instrument detection limits for each method, are listed in Section 12 of this QAPP.

3.2 FIELD OPERATIONS

The field sampling strategy for obtaining data that meet the project objectives is described in the FSP. To ensure that field samples and quantitative field measurements represent the media collected and the conditions being measured, sample collection and measurement methods will follow documented standard operating procedures (SOPs) contained in the FSP. Quality control samples collected in the field will include duplicate sediment samples (i.e., colocated samples). Duplicate field samples will be collected to determine analyte variability, a measure of representativeness and precision. Equipment rinsate blanks will not be collected because the sediment samples will be archived frozen at –20°C for up to 1 year before analysis. Reference material samples may be submitted at a later date, before beginning analysis of the archived sediment samples. Field quality control samples are discussed in greater detail in Section 9.2 of this QAPP.

3.3 LABORATORY OPERATIONS

In the laboratory, quality control samples for chemical analyses will include matrix spike samples, laboratory duplicate samples, laboratory control samples (LCSs), and method blanks, as well as other quality control samples and procedures as required by the individual methods. Laboratory quality control samples are discussed in greater detail in Section 9.1 of this QAPP.

TABLE 1. SUMMARY OF DATA QUALITY OBJECTIVES

Analysis	Method Reference	Matrix	Units	Method Reporting Limits[a]	Bias (percent)[b]	Precision (RPD)[b]	Completeness
Chemical							
Total organic carbon	ASTM Method D4129-82 (1989)	Sediment	percent	0.05	75–125	±25	95
Grain size distribution	ASTM Method D422 (1989)	Sediment	percent	0.1	NA	±35	95
Biological							
Fish species identification	NA	Fish	species	--	--	--	100
Taxonomic identification of stomach contents	NA	Fish	species	--	--	--	100
Benthic macroinvertebrate assemblages	NA	Sediment	family and species	--	--	--	100
Phytophilous macroinvertebrate assemblages	NA	Aquatic vegetation	family and species	--	--	--	100
Vegetation biomass	NA	Aquatic vegetation	grams	--	--	--	100

Note: ASTM - American Society for Testing and Materials
EPA - U.S. Environmental Protection Agency
NA - not applicable
RPD - relative percent difference
SOW - *statement of work*

[a] The method reporting limits listed are expressed on a wet weight basis. Elevated method reporting limits may be reported if dilutions are required.

[b] The values listed for bias and precision are the ranges listed per the referenced method, or what can routinely be achieved by an analytical laboratory.

4. SAMPLING PROCEDURES

The overall quality of the data collected during an environmental study depends largely on the quality of the field sampling activities. The following QA/QC procedures for sample collection and handling are further specified and documented in the FSP.

4.1 SAMPLE HANDLING AND PRESERVATION

Sample container, preservation, and handling requirements, as well as the sample mass or volume required by the laboratory for each analysis, are summarized in Table 2. New ICHEM® 300 Series Superanalyzed® sample containers or equivalent, with certificates of analysis, will be provided by the analytical laboratory for all sediment sample analyses. Sample containers will be kept closed until used. As they are collected, samples will be fully labeled, recorded in the field logbook along with other pertinent data, and placed in coolers as soon as possible. Field duplicates will be clearly identified on the sample log forms, but will be submitted to the laboratory as blind samples whenever possible.

The following additional criteria will be implemented for the field samples to ensure that data represent environmental conditions, are comparable to existing data from the site, and address detection limits commensurate with the intended uses of the data:

- Whenever feasible, sample size will be sufficient to allow attainment of target detection limits and analysis of laboratory quality control samples
- All subsamples will be taken from well-homogenized samples
- Subsamples will be placed in appropriate containers and held under appropriate conditions (Table 2) to avoid sample contamination or analyte loss.

A complete record of stations, samples, and events will be maintained, as described in the FSP, throughout the field effort for this site investigation. Any modifications to the field sampling procedures described in the QAPP or FSP will be documented and justified in the field notebooks and will be identified as a change from the intended method in subsequent project reports. Major modifications to the sampling strategy or collection procedures must be approved in advance by the project manager and the quality assurance coordinator, in consultation with GE.

TABLE 2. SAMPLE PRESERVATION AND HANDLING PROCEDURES

Analyte	Approximate Laboratory Subsample[a]	Container	Preservation and Handling	Maximum Holding Times
Total organic carbon	1 g	500-mL wide mouth glass jar; Teflon®-lined lid	Keep in dark; cool (4°C)	1 year
Grain size distribution	225 g	500-mL wide mouth glass jar; Teflon®-lined lid	Keep in dark; cool (4°C)	1 year
Fish species identification	Whole fish	2 to 8 oz. high density polyethylene jar	10 percent formalin solution; ambient temperature	not established
Taxonomic identification of stomach contents	Whole stomach	2 to 8 oz. high density polyethylene jar	10 percent formalin solution; ambient temperature[b]	not established
Benthic macroinvertebrate assemblages	NA	1-L polyethylene jar	10 percent formalin solution; ambient temperature[b]	not established
Phytophilous macroinvertebrate assemblages	NA	1-L polyethylene jar	10 percent formalin solution; ambient temperature[b]	not established
Benthic macroinvertebrate biomass	NA	1-L polyethylene jar	10 percent formalin solution; ambient temperature[b]	not established
Phytophilous and planktonic macroinvertebrate biomass	NA	1-L polyethylene jar	10 percent formalin solution; ambient temperature[b]	not established
Vegetation biomass from quadrats	NA	1-gal Ziploc® bag	Keep in dark; cool (4°C)	not established

Note: NA - not applicable

[a] Sample volumes listed are the optimum amounts that should be used to conduct the target analyses to achieve the detection limit goals. However, the sample volume that will be used at the laboratory may vary if a limited amount of sample is collected or if smaller amounts are necessary because of elevated concentrations of target analytes.

[b] Prior to storage, the laboratory will transfer the samples to 70 percent ethyl alcohol.

5. SAMPLE CUSTODY

The possession and proper handling of samples must be documented so that sample custody and handling are traceable from the time of sample collection until the analytical data are accepted, or until reanalysis, if required.

5.1 FIELD SAMPLING OPERATIONS

An important aspect of sample custody is thorough record-keeping. Procedures for establishing sample locations and preparing samples are specified in the FSP (Exponent 1998b) and in appropriate SOPs. A sample label and a chain-of-custody form will be completed for each sample. Examples of a sample label and a custody seal are included in Appendix D. At the time of sample collection, sample containers will be labeled with the following information:

- Sample number
- Site name
- Sampling date and time
- Sampling personnel
- Preservative, if appropriate.

This information will also be recorded on the sample log forms at the time of collection. At the end of each day and before shipping or storage, chain-of-custody forms will be completed by a designated sample custodian for all samples using the form shown in Appendix D. Finally, information on the sample labels will be rechecked and verified against sample log form entries and chain-of-custody forms. Any necessary changes to the chain-of-custody forms, sample container labels, or field log forms will be made by striking out the error with one line and reentering the correct information. The new entries will be initialed and dated.

5.2 SHIPPING

All samples will be accompanied by a chain-of-custody form. Examples of the chain-of-custody are provided in Appendix D. Copies of all forms will be retained by the quality assurance coordinator.

Before samples for chemical analysis or archive are shipped, sample containers will be placed in plastic bags, wrapped in bubble-wrap, securely packed inside the shipping coolers, and placed on "blue ice" or ice. The original chain-of-custody and sample analysis request forms will be enclosed in a plastic bag and taped to the inside lid of the cooler. The cooler will be taped closed by wrapping fiber tape completely around it. Any required shipping labels will be attached to the cooler, and the cooler will be sealed with two custody seals on adjacent sides of the lid. Packaging will conform to U.S. Department of Transportation regulations. Shipping procedures for environmental samples are described in the FSP.

The designated sample custodian will be responsible for sample custody and appropriate sample storage before shipment, as well as for shipping samples in a manner that meets all holding time requirements. The sample custodian will also contact the laboratory and the quality assurance coordinator to notify them of the sample shipment.

5.3 LABORATORY OPERATIONS

The quality assurance officer at each laboratory will verify receipt of each sample shipment and will contact the quality assurance coordinator to provide notification that all samples were received and to relay any concerns or observations regarding sample integrity or documentation. The quality assurance officer at each laboratory will be responsible for ensuring that laboratory chain-of-custody forms and other tracking records are completed upon receipt of the samples and are maintained through all stages of laboratory sample processing and analysis. The sample tracking records must show the date of sample preparation and the date of instrument analysis for each analytical procedure. These records will be used to determine compliance with holding time requirements.

6. CALIBRATION PROCEDURES AND FREQUENCY

Initial and continuing calibration procedures for laboratory instruments will be completed consistent with the cited analytical method for each chemical analysis (Table 1). These method descriptions specify the required acceptance criteria for initial and continuing calibration and state the conditions where recalibration is necessary.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology or other documented, reliable, commercial sources. At the laboratory, standards are validated before use to verify their accuracy (e.g., by comparison with an independent standard). Reagents are examined for purity by performing method blank analyses.

7. ANALYTICAL PROCEDURES

Chemical and biological analysis methods to be used during this investigation are referenced in Table 1. These methods will be performed by laboratories with established protocols and quality assurance procedures that meet or exceed applicable EPA guidelines. Samples will be analyzed using EPA-approved or recommended methods when available and will include all associated QA/QC procedures recommended in each method.

Target method reporting limits are summarized in Table 1 for each method and sample type. These method reporting limits were obtained from the cited analytical methods or from the current laboratory-derived method reporting limits. The actual method reporting limits attained during this site investigation may be elevated with respect to theoretical reporting limits if interferences due to the sample matrices are encountered or if limited material is available for analysis.

The analyses that will be performed for the investigation are described in the following sections.

7.1 CHEMICAL ANALYSES

Chemical analyses will be conducted on sediment samples. The laboratory will assume that the entire sample submitted for analysis is representative material. To avoid substance losses, any overlying water in sediment samples received from the field will be mixed into the sample before removal of a subsample for analysis. Data for sediment samples will be reported as dry weight.

7.1.1 Total Organic Carbon

Analysis for TOC in sediment samples may be conducted at a later date. After the sediment samples are collected, they will be archived frozen at –20°C for up to 1 year. If the sediment samples are analyzed for TOC, the analysis will be performed using a combustion technique as described in American Society for Testing and Materials (ASTM) method D4129-82 (ASTM 1989).

7.1.2 Grain Size Distribution

Analyses for grain size distribution in sediment samples may be conducted at a later date. After the sediment samples are collected, they will be archived at 4°C for up to 1 year. If the sediment samples are analyzed for grain size distribution, the analyses will be completed

using the wet sieve and hydrometer technique described in ASTM Method D422 (ASTM 1989).

7.2 BIOLOGICAL ANALYSES

Biological analyses will be conducted on fish and sediment samples. The laboratory will assume that the entire sample submitted for analysis will be representative material.

7.2.1 Fish Species Identification

Species level identification will be performed on all fish samples as they are collected. The length and weight of each fish will be recorded prior to evacuation of the fish stomach contents.

7.2.2 Taxonomic Identification of Fish Stomach Contents

The stomach contents of fish or whole fish, of a limited size, collected in the field will be shipped in 10 percent formalin in plastic vials to the laboratory. Upon receipt of samples, the laboratory will weigh the whole fish samples and remove all stomach contents from those samples. The isolated stomachs and the stomach contents from the whole fish samples will be sorted and identified by the laboratory. The laboratory will identify all stomach contents to the lowest taxonomic level possible and create a reference collection of mounted chironomids and any additional specimens for which a reference sample is not available. All taxonomic identifications will be made by qualified taxonomists whose resumes will be provided to Exponent prior to their participation. For incomplete specimens, only the anterior or posterior ends shall be enumerated, depending upon the taxon. All identifications will be made using binocular-dissecting or compound microscopes. If possible, at least two literature sources will be used for each species identification. Moreover, each species identification will be verified by a taxonomic expert who is approved by Exponent or checked against a reference specimen from a verified reference collection. In addition, the laboratory will provide quality assurance samples of fish stomach contents that will be evaluated in another laboratory. The primary laboratory will send 10 samples of fish stomach contents to the second laboratory for a quality assurance check of the taxonomic identifications.

7.2.3 Taxonomic Identification of Benthic Macroinvertebrate Assemblages

Samples of benthic macroinvertebrate assemblages will be collected with a 3-in. diameter core and shipped whole to the laboratory for sorting, rinsing, processing, and enumeration. The laboratory will identify all benthic macroinvertebrates to the lowest practical taxonomic level, with species level as the target. All samples collected in the field by Exponent will be preserved in formalin and shipped to the laboratory, where

sample sorting and taxonomic analyses will be conducted. The laboratory will transfer the samples from formalin to 70-percent ethyl alcohol prior to storage.

7.2.4 Taxonomic Identification of Phytophilous Macroinvertebrates Assemblages

Phytophilous macroinvertebrate assemblages will be collected using a box sampler. Aquatic vegetation collected inside the box sampler will be included in the sample bottles. The macroinvertebrates and vegetation will be shipped whole to the laboratory for sorting, identification, and enumeration. Dry weight biomass will be determined for the aquatic vegetation in each sample.

The laboratory will identify all benthic macroinvertebrates to the lowest practical taxonomic level, with species level as the target. All samples collected in the field by Exponent will be preserved in formalin and shipped to the laboratory, where sample sorting and taxonomic analyses will be conducted. The laboratory will transfer the samples from formalin to 70-percent ethyl alcohol prior to storage.

7.2.5 Benthic, Phytophilous, and Planktonic Macroinvertebrate Biomass Determination

Benthic, phytophilous, and planktonic macroinvertebrates will be collected using a sediment core, D-ring net, and plankton tow net, respectively. These macroinvertebrates will be preserved in formalin and shipped to the laboratory for sorting and biomass determination.

7.2.6 Determination of Plant Biomass

Samples of submerged aquatic plants will be collected by cutting all stems within a 0.1 m^2 quadrat approximately 2 cm from the sediment surface and placing associated plant material in a plastic Ziploc® bag. Bags of plant tissue will be stored in a cooler at 4°C and shipped to ARC for determination of dry weight biomass.

8. DATA VALIDATION, REDUCTION, AND REPORTING

The procedures used for data reduction and reporting are provided below.

8.1 DATA VALIDATION

For every set of 20 or fewer samples of a similar matrix analyzed by each analytical method, the laboratory will submit a complete data package containing the following data and supporting information:

- A cover letter discussing the analytical procedures used and problems encountered during sample analysis (if any)
- A sample log listing the identifying sample numbers and corresponding laboratory numbers (if applicable) for all samples included in the data package
- Chain-of-custody forms for all samples included in the data package
- Analyte concentrations (on a dry weight basis for sediment samples) with reporting units identified
- The original laboratory data, bench sheets, and instrument printouts for all analyses and samples, including all laboratory quality control samples and blanks
- Final dilution volumes, sample sizes, wet-to-dry ratios, and any other information and formulas required to derive the final reported sample concentration from the original laboratory data
- Final analyte results with appropriate concentration units for all natural samples, field quality control samples, and laboratory quality control samples (i.e., laboratory method blanks, LCSs, and matrix spike samples)
- Instrument detection limits for each analyte in each package
- A summary form indicating which method blanks are associated with each batch of samples for every analysis
- Summarized recovery and/or RPD results for all laboratory QA/QC checks, including laboratory spike samples, calibration check samples,

surrogate compounds, laboratory duplicate samples, method blanks, and LCSs for each analysis

- Appropriate laboratory data qualification codes and their definitions
- Summary forms for all initial and continuing instrument calibrations, including the exact concentrations of the calibration standards and the acceptable linear calibration ranges for each instrument used. Some measure of the linearity of the initial calibration curve must also be determined and reported, as specified in the method.

The laboratory will perform internal quality assurance checks on the reported data before submitting the data packages to the environmental consultant for review. The laboratory will correct any transcription or computation errors identified during this quality assurance check. Close contact with the laboratory will be maintained so that any quality issues can be resolved in a timely manner.

Exponent will be responsible for final review and validation of the analytical data, overall data management, and final interpretation of the results. An EPA Level 3 data validation review will be conducted for the chemical analyses. For the TOC and grain size distribution analyses, data qualifiers will be applied when the quality control results are outside the project DQOs. The data validation procedures summarized below will be performed for all analyses:

- Review chain-of-custody documentation to verify completeness of the sample set for each data package submitted
- Verify that holding time requirements were met
- Review the reported laboratory quality control information to verify the initial and continuing calibration information and that results for laboratory quality control samples, including laboratory blanks, laboratory duplicate samples, matrix spike samples, LCSs, and other quality control measures, were reported and are within target required control limits and DQOs for the project
- Evaluate the results of the field quality control samples
- Assess the impact of laboratory and field quality control results and assign any necessary data qualifiers.

8.2 DATA REDUCTION

The laboratory will perform data reduction as specified in the referenced analytical methods and submit a complete data package with full documentation for all chemical analyses. The laboratory project manager is responsible for reviewing the laboratory data packages

and checking data reduction before submittal to Exponent. The laboratory will correct any transcription or computation errors identified during this review.

General equations used to determine precision and accuracy are included in Section 12 of this QAPP. The methods used to identify and treat laboratory quality control outliers are specified in the method SOWs and SOPs and in the data validation guidelines.

8.3 DATA REPORTING

Computerized systems will be used to record, store, and sort the technical data to support the site investigation. The data record will include a unique sample code, station ID, sample type (matrix), analyte, analyte concentration, and concentration units. Automated data handling increases data integrity by reducing errors, omissions, and ambiguities that can be introduced by manual procedures. In addition, automated procedures will be used by a contract laboratory to capture and summarize analytical results. In this case, electronic data files can be imported directly from the laboratory to the environmental consultant's database, minimizing both data entry effort and opportunities for error. The laboratory will be responsible for internal checks on data reporting and will correct errors identified during the quality assurance review.

9. INTERNAL QUALITY CONTROL

This section summarizes the field QA/QC procedures and those used in the laboratory to verify the validity of the sediment data. These quality control checks reveal information about the sample collection techniques, analytical methodology, instrument performance, bias and precision of the reported results, and possible sources of contamination or interferences due to the sample matrix.

9.1 LABORATORY QUALITY CONTROL

Each analytical protocol used in this site investigation will include specific instructions for analysis of quality control samples and completion of quality control procedures during sample analysis. These quality control samples and procedures will verify that the instrument is calibrated properly, that it remains in calibration throughout the analytical sequence, that sample preparation procedures have been effective, and that contaminants have not been introduced into the samples. Additional quality control samples are used to identify and quantify positive or negative interference caused by the sample matrix. The following laboratory quality control procedures are required for most chemical analyses:

- **Calibration Verification**—Initial calibration of instruments will be performed at the start of the project or sample run, as required, and when any ongoing calibration does not meet control criteria. The number of points used in the initial calibration is defined in each analytical method. Continuing calibration will be performed as specified in the analytical methods used to track instrument performance. If a continuing calibration does not meet control limits, analysis of project samples will be suspended until the source of the control failure is either eliminated or reduced to within control specifications. Any project samples analyzed while an instrument is outside of control limits will be reanalyzed.

- **Method Blanks**—Method blanks are used to assess possible laboratory contamination of samples associated with all stages of preparation and analysis of samples and extracts. The laboratory will not apply blank corrections to the original data. A minimum of 1 method blank will be analyzed for every sample analysis group (sample delivery group [SDG]), or for every 20 samples, whichever is more frequent.

- **Matrix Spike Samples**—Matrix spike samples are analyzed to assess the matrix effects on the accuracy of analytical measurements. For organic analyses, duplicate matrix spike samples are used to assess both accuracy and precision. For applicable conventional analyses (e.g.,

TOC), a minimum of 1 matrix spike will be analyzed for each SDG or for every 20 samples, whichever is more frequent.

- **Laboratory Control Samples**—When required by the referenced method, LCSs will be used as checks on overall method performance. A minimum of 1 LCS will be analyzed for all applicable analyses for every SDG or for every 20 samples, whichever is more frequent. The source of the LCS must be included in the data package.

- **Laboratory Duplicates and Triplicates**—Laboratory duplicate and triplicate analyses are indicators of laboratory precision. Duplicate sample analyses will be completed for TOC determinations. For grain size distribution determinations, a triplicate analysis will be completed. Duplicate and triplicate sample analyses, as applicable, will be analyzed for every SDG, or for every 20 samples, whichever is more frequent.

9.2 FIELD QUALITY CONTROL

Field quality control samples will be collected only for sediment samples. Duplicate field samples (i.e., colocated samples) will be analyzed to assess the variability of concentrations at a location to provide an indication of the representativeness and precision.

Equipment rinsate blanks will not be collected during sediment sampling because the associated sediment samples to be collected will be archived frozen at –20°C for up to 1 year before analysis. Reference material samples may be submitted at a later date, before analysis of archived sediment samples.

10. QUALITY ASSURANCE PERFORMANCE AND SYSTEM AUDITS

Performance and system audits for sampling and analysis operations will not be conducted unless required as a result of nonconformance. Such audits would be conducted by the quality assurance coordinator and would consist of onsite reviews for the following activities:

- Field activities (documentation and record-keeping, sampling methods including collection of field quality control samples, sample handling, and shipment)
- Laboratory analyses (documentation and record-keeping, analytical methods, and implementation of laboratory quality assurance manual procedures).

Performance audits may be conducted before and during sample collection, documentation, and shipment, as well as during sample analysis and data reduction at the laboratory.

System audits may include, but are not limited to, the following components:

- Field and laboratory personnel, facilities, and equipment
- Chain-of-custody procedures and records
- Instrument calibration, maintenance procedures, and records
- Standards preparation, verification procedures, and records
- Documentation of analytical methods
- Sample storage conditions
- Data reduction, processing, and reporting procedures
- Documentation control procedures.

All personnel engaged in sampling and analysis tasks will have appropriate training and required certifications. The laboratory must have written procedures addressing internal QA/QC, which may be requested for review by Exponent. Performance audit samples will be used during the project, if necessary, to identify problems affecting data quality that may occur during sample processing, transfer, or analysis.

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11. PREVENTIVE MAINTENANCE PROCEDURES AND SCHEDULES

Preventive maintenance of laboratory instruments is essential if project resources are to be used in a cost-effective manner. Preventive maintenance will take two forms: 1) a schedule of preventive maintenance activities to minimize downtime and ensure the accuracy of measurement systems and 2) availability of critical spare parts and backup systems and equipment. These maintenance procedures will be documented in field and laboratory notebooks.

Each analytical instrument will have a dedicated logbook or notebook in which calibration and maintenance are recorded. Balances will be calibrated for each use and certified according to International Standards Organization requirements annually. All field and laboratory meters will be calibrated using these standards daily or before use. Calibrated backup meters will be taken into the field for use in the event of breakdown.

The laboratory quality assurance coordinators will be responsible for ensuring that routine preventive maintenance is performed and documented for each analytical instrument used and that spare parts or additional instruments are available in case of instrument breakdown or failure.

12. SPECIFIC ROUTINE PROCEDURES USED IN DATA QUALITY ASSESSMENT

Routine procedures used to measure bias and precision for this project are described in Section 9 (*Internal Quality Control*) of this QAPP. The laboratory will verify that quality control measures were performed at the required frequencies and that quality control results met control limits defined in method descriptions or by project DQOs. The equations used to verify that project DQOs were met for each quality control measure are summarized below.

12.1 DUPLICATE ANALYSIS

Precision for duplicate chemical analyses will be calculated as the RPD:

$$RPD = \frac{\text{abs}\left[D_1 - D_2\right]}{\left(D_1 + D_2\right)/2} \times 100$$

where:

D_1 = sample value

D_2 = duplicate sample value.

For three or more measurements, the RSD will be calculated as follows:

$$RSD = \frac{\text{standard deviation}}{\text{mean}} \times 100$$

12.2 MATRIX SPIKE RECOVERIES

The bias of matrix spike recoveries will be calculated as the ratio of the observed value to the known spiked quantity:

$$\text{Percent recovery} = \frac{\text{spike sample result} - \text{sample result}}{\text{spike added}} \times 100$$

12.3 LABORATORY CONTROL SAMPLES

The bias of LCSs will be calculated as the ratio of the observed value to the known spiked quantity:

$$\text{Percent recovery} = \frac{\text{measured concentration}}{\text{concentration added}} \times 100$$

12.4 COMPLETENESS

Completeness may be calculated for each set of data by dividing the number of valid measurements (all measurements except rejected data) actually obtained by the number of valid measurements planned:

$$\text{Completeness} = \frac{\text{valid data points obtained}}{\text{total data points planned}} \times 100$$

To be considered complete, the data set must also contain all quality control check analyses that verify precision and accuracy of results.

12.5 DETECTION AND QUANTIFICATION LIMIT

The detection limit of the instrument and sample preparation process is defined as "the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte is greater than zero" (40 CFR 136B). In other words, it is the point at which qualitative, not quantitative, identification can be made. The limit of detection is based on the variability of the blank response for the complete analytical procedure (Keith et al. 1983) or the variability of the signal-to-background response in a processed sample when there is no detectable blank response (Kirchmer 1988). In practice, the limit of detection is defined as 3 times the standard deviation of the blank or background response, adjusted for the amount of sample typically extracted and the final extract volume of the method.

Best professional judgment is used to adjust the limit of detection upward in cases where high instrument precision (i.e., low variability) results in a calculated limit of detection and equivalent instrument response lower than the absolute sensitivity of the analytical instrument. When there is no blank response for analyses by non-isotope dilution techniques, the limit of detection can be estimated based on the multiplication (by τ) of the standard deviation of low-level matrix spike responses.

The practical quantification limit is the minimum concentration of an analyte that can be measured and reliably reported (i.e., reported without qualification as an estimated quantity) for samples without substantial matrix interferences. The practical quantification

limit is based on the lowest concentration used to establish the initial calibration curve, the weight of sample typically analyzed, and the final extract volume of that method. The practical quantification limit can be greater than or equal to the limit of detection and may be influenced by factors such as sample size, dilution, and matrix interferences.

13. CORRECTIVE ACTIONS

Although the entire quality assurance program is designed and implemented to avoid problems, it also serves to identify unexpected or unavoidable problems that may be encountered during sample collection and analysis. An important part of any quality assurance program is a well-defined, effective policy for correcting these problems once they have been identified.

13.1 SHORT-TERM CORRECTIVE ACTION

Short-term corrective actions fall into two categories: 1) handling of analytical instrument or field equipment malfunctions and 2) handling of nonconformance or noncompliance with the quality assurance requirements established for the project.

During field operations and sampling procedures, the field supervisor will be responsible for correcting equipment malfunctions. Acceptable equipment operating parameters and control limits are specified in the operating instructions and SOPs. If any piece of equipment fails to meet established quality control criteria or cannot be properly repaired, it will be replaced. All equipment malfunctions and subsequent corrective measures will be documented in the field logbook.

The laboratory project managers are responsible for ensuring that laboratory results comply with project QA/QC requirements and that all analytical instruments and laboratory equipment are properly maintained. Acceptable instrument operating parameters, control limits for quality control results, and required corrective actions are specified in Sections 3, 4, 5, and 7 of this QAPP. The control limit specifications are designed to help analysts or field supervisors detect the need for corrective action. Often an analyst's experience will be most valuable in identifying suspicious data or malfunctioning equipment. Immediate corrective action must be taken by the laboratory if any phase of the sample preparation and analysis process is considered suspect. Any corrective actions will be noted in the laboratory notebooks.

13.2 LONG-TERM CORRECTIVE ACTION

In addition to short-term corrective actions taken by field and laboratory personnel, a mechanism is required to address long-term, systemic corrective actions. The need for long-term corrective action may be identified by an overview of compliance with standard quality control procedures, control charts, and performance or system audits. Any quality control problem that cannot be solved by immediate corrective action falls into this

long-term category. This system will be used to ensure that the condition is reported to the person who is responsible for the corrective action and follow-up plan.

The specific corrective actions necessary will vary, depending on the nature of the problem; however, the essential steps in the closed-loop, long-term corrective action system are as follows:

1. Identify the problem
2. Assign responsibility for investigating the problem
3. Investigate and determine the cause of the problem
4. Determine a corrective action to eliminate the problem
5. Establish responsibility for implementing the corrective action, and implement the corrective action
6. Verify that the corrective action has eliminated the problem
7. Document the complete process of establishing and implementing the corrective action in a project memorandum that specifies the problem areas requiring corrective action and how they were detected, the individual initiating corrective action, the samples concerned, the acceptable data range, the measures taken to correct the problems, and the individual approving corrective action.

Corrective action documentation will be routinely reviewed by the quality assurance coordinator, who has the authority to enforce necessary corrective measures. In addition, laboratory contracts and analysis SOWs drafted by Exponent specify performance standards tied to the QAPP requirements for DQOs. These performance standards must be satisfactorily met for payment of invoices.

14. QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality assurance reports will be prepared in conjunction with data reports for this field investigation. Reports summarizing field activities will contain copies of, or references to, the following items:

- Summary of site locations and sampling conditions
- Sample log forms, completed at the time of sample collection, that document station locations, date and time of collection, and pertinent field observations
- Chain-of-custody forms
- Corrective action reports documenting any problems encountered during field activities and corrective actions taken
- System and performance audit reports completed during the investigation
- A summary of any changes made to documented procedures and the rationale for the changes.

Complete QA/QC reports may be written for the project data. If written, the reports will summarize the results of the data quality review and note any significant quality assurance problems that were encountered. If written, the reports will include the following items:

- Executive summary of overall data quality and recommendations for data use and limitations
- Description of sample collection and shipping, including chain-of-custody and holding time documentation
- Description of analytical methods and detection limits
- Description of data reporting
- Description of completeness relative to QAPP objectives
- Description of initial and continuing calibration results
- Description of precision relative to QAPP objectives, including results for field and laboratory replicate analyses

- Description of accuracy relative to QAPP objectives, including results of reference material analyses and matrix spikes
- Description of results for field and laboratory blanks and implications for data quality of any blank contamination
- Identification of all cases where DQOs were not met and summary of the significance of these deviations.

Whenever possible, the QA/QC reports will include a discussion of the magnitude and direction of any bias to the project data that may be indicated by laboratory or field quality control results. Implications for usability of qualified data will be discussed, as applicable.

15. REFERENCES

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Appendix B

Health and Safety Plan

Exponent

HEALTH AND SAFETY PLAN

Site Name: Upper Hudson River Superfund Site

Proposed Activity: Sampling of sediment, invertebrates, and fish in river

Prepared by: Jenée Colton Date: April 14,1998

Reviewed by: Greg Bawden Date: April 14,1998

1. INTRODUCTION

This site-specific health and safety plan establishes procedures and practices to protect employees of Exponent and its subcontractors from potential hazards posed by field activities at the Hudson River. In this health and safety plan, measures are provided to minimize potential exposures, accidents, and physical injuries that may occur during daily onsite activities and adverse conditions. Contingency arrangements are also provided for emergency situations.

2. DISCLAIMER

Exponent cannot guarantee the health or safety of any person entering this site. Because of the potentially hazardous nature of this site and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at this site. The health and safety guidelines in this plan were prepared specifically for this site and should not be used on any other site without prior evaluation by trained health and safety personnel.

3. SITE DESCRIPTION

Site name: Upper Hudson River Superfund Site, New York

Site location or address: Eastern New York State at Stillwater, Coveville, and between Thompson Island Dam and Fort Edward (see attached site map Figures 1, 2, and 3)

Owners/tenants: Many - client is General Electric Co. (GE)

Current site use: The Hudson River is used for transportation, recreation, and habitat.

Past site use (if different): _____

Designated hazardous waste site: Yes (federal, state, other) Federal

Industrial facility _____ Spill _____ Other PCB-contaminated

Active _____ Inactive X river sediments resulting from discontinued industrial discharge

Topography: Floodplain

Name of and distance to nearest surface water body: The site is a large river.

Surrounding land use/nearest population: Land uses along the Hudson River include agricultural, residential, forest, and urban. Closest towns are Saratoga Springs and Troy.

Site access: Field sampling will be conducted from two boats. One will be operated by O'Brien & Gere (pontoon) and one by Ichthyological Associates. Boats will be launched from the West River Road Marina, McDonald's Oil Co, and Coveville Marina.

Nearest drinking water/sanitary facilities: Drinking water will be carried onboard the boats. Nearby service stations or other public facilities will be used for sanitation.

Nearest telephone (list number if possible): Three cellular phones will be used onsite. Phones will be connected through Cellular One. Phone numbers were not available when plan was prepared.

All buried utilities must be located prior to drilling or excavating at the site. List procedures to be used to locate utilities or indicate that no subsurface excavation or sampling will occur:

Underground facilities office in New York will be notified of our activities and sampling locations prior to arrival. They will notify all local utilities, who will then contact Exponent regarding utility line locations, and the local utilities will field-mark them.

Underground facilities: (800) 962-7962

Site map attached: Yes

4. PROJECT PERSONNEL

	Name/Affiliation	Work Telephone	Home Telephone
Project manager	Rob Pastorok/Exponent	(425) 643-9803	(425) 486-4063
Field coordinator	Jane Sexton/Exponent	(425) 643-9803	(206) 782-1754
Site safety officer	Jane Sexton /Exponent	(425) 643-9803	(206) 782-1754
	Jenée Colton (alternate)	(425) 643-9803	(206) 729-9327
Field personnel	Steve Truchon/Exponent	(781) 466-6681	(603) 654-6620
	Cristin Corless/Exponent	(781) 466-6681	(617) 736-9193
	Adam Bonin/Exponent	(503) 636-4338	(503) 286-5792
Facility contact	John Haggard/GE	(518) 458-6619	unknown
Client contact (if different)	same		

5. WORK PROPOSED

Description of proposed work: May14–31, 1998: Jennifer Sampson will be onsite only May 18–19 for reconnaissance and to meet with New York State Department of Environmental Conservation (NYSDEC) staff. J. Sexton, C. Corless, A. Bonin will use a corer to collect sediment and benthic macroinvertebrate samples on May 18–31. S. Truchon and J. Colton will work with Rusty Woods of Ichthyological Associates to collect plankton and macroinvertebrate samples and stomach contents from fish collected by NYSDEC staff on May 18–23. During this time, J. Colton will also assist U.S. Geological Survey staff in fish necropsies. Night collection of fish may be performed by NYSDEC staff depending on success rate

during daylight hours. In the event of night collection by NYSDEC, S. Truchon and J. Colton would remove stomach contents from fish collected by NYSDEC. No chemical analysis will be performed onsite. All samples except whole fish and sediment samples for chemical and physical analyses will be preserved in 10 percent formalin. All work involves possible contact with PCB-contaminated sediment. J. Sexton will be using a differential global positioning system on the boat during period when sediment samples are collected.

Proposed work dates: May 14–31, 1998

Subcontractors Name	Task	Contact	Telephone
Ichthyological Associates	Remove stomach contents of fish; operate boat	Kurt Jirka	(607) 533-8801
O'Brien & Gere (under separate contract with GE)	Operate boat	Bill Ayling	(315) 437-6100

6. HAZARD EVALUATION

Potentially hazardous chemicals known or suspected to be onsite (include preservatives and decontamination chemicals):

Chemical of Concern	Concentration (observed or expected)	Medium	OSHA PEL	OSHA STEL	OSHA IDLH	Odor Threshold	IP(eV)	Carcinogen or Other Hazard
PCB Aroclor®	<1–3,000 ppm	sediment	0.5 mg/m^3	none	5 mg/m^3	none	unknown	SC
Formalin	10 percent	liquid	0.75 ppm	2 ppm	20 ppm	0.83–1.0 ppm	10.88 for formaldehyde	SC
Hexane	100 percent	liquid	500 ppm vacated PEL is 50	none	1,100 ppm	130 ppm	10.18	CNS,PNS
Acetone	100 percent	liquid	1,000 ppm vacated PEL is 750 ppm	none	2,500 ppm	13–100 ppm	9.69	

Footnotes on following page.

Note: CNS - central nervous system
IP(eV) - ionization potential in electron volts
PCB - polychlorinated biphenyl
PEL - permissible exposure level
PNS - peripheral nervous system
SC - suspected carcinogen
STEL - short-term exposure level

Potential chemical exposure routes at the site:	Known	Possible	Unlikely
Inhalation	X (formalin, hexane, acetone)	X (PCB)	

	Known	Possible	Unlikely
Ingestion	X (formalin, hexane, acetone)	X (PCB)	
Skin absorption	X (formalin, hexane, acetone)	X (PCB)	
Skin contact	X (formalin, hexane, acetone)	X (PCB)	
Eye contact	X (formalin, hexane, acetone)	X (PCB)	
Chemical characteristics:			
Corrosive			X
Ignitable		X (formaldehyde gas, acetone, hexane)	X
Reactive			X
Volatile		X (formalin, acetone, hexane)	X
Radioactive			X
Explosive			X
Biological agent			X
Particulates or fibers			X

If known or likely, describe: Acetone is flammable and an irritant to skin and eyes. Formaldehyde gas from formalin is flammable. Formalin vapors are hazardous to eyes. Formalin is hazardous to skin and internally if swallowed. PCBs could potentially pose a hazard if they become airborne (i.e., dried sediment).

Possible physical hazards present during site activities:

	Yes	No	Proposed Safety Procedure
Uneven terrain/tripping	X		Use caution on river banks; wear closed-toe shoes. Be aware of very slippery rocks.
Heat stress	X		Drink water frequently in hot weather; take work breaks. Refer to heat stress SOP.
Cold/hypothermia	X		Stay dry; get out of wet clothes in cold weather. Keep warm clothes on vessel.
Drowning	X		Wear life jackets in boats and when wading in >2 ft of water; do not work alone in or near water; keep visual contact with all workers in your group.
Falling objects		X	

	Yes	No	Proposed Safety Procedure
Noise		X	
Excavations		X	
Scaffolding		X	
Heavy equipment		X	
Material handling	X		Use proper lifting technique; ask for assistance.
Compressed air equipment		X	
Confined spaces		X	
Adverse weather	X		Stop work and take cover when storms (including electrical) approach; monitor wind speed.
Biohazard		X	
Plant/animal hazards	X		Look before stepping; avoid walking through heavy brush; refer to procedures for ticks and chiggers; be aware of poison ivy.
Other			

Note: If confined space entry is required, personnel must first obtain a confined space entry permit.

Potential physical hazards posed by proposed site activities:

Activity	Potential Hazard
Sediment sampling	Drowning; cold; adverse weather
Sample preservation	Drowning; cold; heat stress; adverse weather
Fish collection	Drowning; cold; adverse weather
Fish dissection	Drowning; cold; adverse weather; accidental cuts

7. PERSONAL PROTECTIVE EQUIPMENT

Based on the hazards identified above, the following personal protective equipment will be required for the following site activities (specify both an initial level of protection and a more protective level of protection in the event conditions should change):

	Level of Protection	
	Initial	Contingency
Reconnaissance	D (gloves required when handling sediment-contaminated equipment)	MD
Fish dissection/handling	D (double layer gloves)	MD
Fish sampling (Electrofish)	D	none

	Level of Protection	
	Initial	Contingency
Sediment sampling	MD	D
Sample preservation	C	MD
Sample packaging/other handling	D	MD
Other activities (list)		

Each level of protection will incorporate the following equipment (specify type of coveralls, boots, gloves, respiratory cartridges or other protection, safety glasses, hard hat, and hearing protection):

Level D: [X] Long pants and shirt or work coveralls. Hard hat, light weight gloves, eye and hearing protection as needed.

Modified D: [X] Same as Level D with addition of either coated rain gear or polylam coveralls for all work except beneath waders, where uncoated tyvek may be worn. Neoprene, nitrile or silvershield gloves should be used according to type of chemical exposure (see Table 1).

Level C: [X] Same as Level D with full air-purifying respirator with a GMF filter or cartridge for MSA (or appropriate brand filter), and neoprene, nitrile, or silvershield gloves (chosen according to type of chemical exposure; see Table 1).

Note: Project personnel are not permitted to deviate from the specified levels of protection without the prior approval of the site safety officer or Exponent Environmental Group health and safety officer.

TABLE 1. PERSONAL PROTECTIVE EQUIPMENT TYPE BY EXPOSURE

Type of Exposure	Coveralls	Gloves
PCB-contaminated sediment (direct contact)	Coated rain gear or polylam	Neoprene with nitrile inner lining
Formalin (preservation)	Coated rain gear or polylam	Neoprene
Acetone/hexane (decon)	Coated rain gear or polylam	Silvershield
Light sediment work (indirect contact [i.e., under waders])	Uncoated tyvek	Neoprene with nitrile inner lining
River water	Neoprene waders	Neoprene with nitrile inner lining

8. SAFETY EQUIPMENT

The following safety equipment will be onsite during the proposed field activities:

First Aid Kit (mandatory, including adhesive bandaids, gauze, tape, gloves, CPR shield, triangle bandage) (check additional items required for the site)

- [X] Emergency blanket
- [X] Insect repellent
- [X] Sunscreen
- [X] Other: Calamine lotion, Antibiotic cream, Aspirin

Other (check the items required for this project)

- [X] Eyewash
- [X] Drinking water
- [X] Stopwatch for monitoring heart rate
- [X] Thermoscan thermometer for heat stress monitoring
- [ ] Fit test supplies
- [X] Fire extinguisher
- [ ] Windsock
- [X] Other: PFDs, personal night lights (to attach to PFDs) as appropriate

9. SITE CONTROL

Describe location and designation of each zone:

Exclusion zone: The river, its sediments, and the boats are the exclusion zone.

Contamination/reduction zone: This zone will be a designated area on or near the riverbank.

Support zone: Any other upland areas.

Describe controls to be used to prevent entry by unauthorized persons:

No unauthorized persons will be allowed on boats. Any shore operations will be conducted away from high-traffic areas with regular surveillance for and verbal warnings to curious public.

10. AIR MONITORING

Based on conditions reported during previous sampling event, air monitoring will not be required.

11. DECONTAMINATION

To prevent the distribution of contaminants outside the exclusion zone or cross-contamination of samples, the following procedures will be used to decontaminate sampling equipment:

Mud and/or sediment must be washed off all equipment at the sample location by using river water. Equipment that cannot be thoroughly decontaminated and comes into contact with potentially contaminated sediments will be washed and either saved for future use at the site or disposed.

To prevent the distribution of contaminants outside the exclusion zone and personal exposure to chemicals, vehicles will not be allowed inside the exclusion zone. If vehicles are required in the exclusion zone (e.g., drill rigs), the following procedures will be used to prevent contamination or decontaminate the vehicles:

Only boats will be used inside the exclusion zone. Polyethylene sheeting may be used to limit contamination to specific areas in the boat. Mud will be washed off the boat and trailer before it is removed from the exclusion zone.

To minimize or prevent personal exposure to hazardous materials, all personnel working in the exclusion zone and contamination reduction zones will comply with the following decontamination procedures:

Mud or sediment will be washed off boots and protective clothing at the sample location. Waders and work boots will not be worn in hotels and offices. Field personnel will promptly shower after returning to the hotel at the end of day.

Decontamination equipment required onsite will include the following:

Brushes and/or buckets, garbage bags. Protective clothing (after washing off of gross mud) will be bagged up for disposal as solid waste.

Decontamination wastewater and contaminated materials will be disposed of in the following manner:

No wastewater will be collected, except for decontamination chemicals, which will be collected for disposal. Contaminated washwater will be returned to the river at the sampling location. All sediment-contaminated clothing and equipment (after rinsing at river site) will be contained in bags and disposed of as solid waste.

The following personal hygiene practices will be used:

- Long hair will be secured away from the face so it does not interfere with any activities.
- All personnel leaving potentially contaminated areas will wash their hands and faces before entering any clean areas or eating areas.
- Personnel leaving potentially contaminated areas will shower (including washing hair) and change to clean clothing as soon as possible after leaving the site.
- No person will eat, drink, or chew gum or tobacco in potentially contaminated areas. Drink containers and drinking of replacement fluids for heat stress control will be permitted only in areas that are free from contamination. Smoking is prohibited in all areas of the site because of the potential for contaminating samples and for health and safety reasons.

12. SPILL CONTAINMENT

Provisions must be made for spill containment at any site where bulk liquids will be handled.

Will the proposed fieldwork include the handling of bulk liquids, oil, or chemicals (other than water)? Yes _____ No X

If yes, describe spill containment provisions for the site: _____

13. SHIPMENT OF RESTRICTED ARTICLES

Federal laws and international guidelines place restrictions on what materials may be shipped by passenger and cargo aircraft. In the course of this field investigation, the following items will be shipped to and from the site in the following manner:

Item	Hazardous Constituent	Quantity	Packaging	How Shipped
All samples	<10 percent formalin solution	19 L	Packed in bottles in coolers sealed with duct tape; samples in plastic/glass bottles	Fed. Express - regular shipping with <10 percent formalin
Solvents (name)	Hexane, acetone	1 gal each	Inside plastic bottle sleeve	Obtained locally, transported by field vehicle
Preservatives (name)	Formalin (10 percent)	19 L	Inside plastic cubitainers	Obtained locally, transported by field vehicle
Other: _____				

14. MEDICAL MONITORING

OSHA requires medical monitoring for personnel potentially exposed to chemical hazards in concentrations exceeding the PEL for more than 30 days per year and for personnel who must use respiratory protection for more than 30 days per year. Exponent requires medical monitoring for all employees potentially exposed to chemical hazards.

Will personnel working at this site be enrolled in a medical monitoring program? Yes X No _____

15. HEALTH AND SAFETY TRAINING

State and federal laws establish training requirements for workers at uncontrolled hazardous waste sites (including areas where accumulations of hazardous waste create a threat to the health and safety of an individual, the environment, or both).

Exponent and subcontractor personnel will be required to complete the following training requirements:

Duties	No Special Training[a]	24-hour	40-hour	Supervisor	First Aid/CPR	Boating	Other
Exponent Personnel							
Jennifer Sampson			X				
Jane Sexton			X	X	X		
Cristin Corless			X				
Adam Bonin			X		X		
Jenée Colton			X		X		
Steve Truchon			X		X		
Subcontractors							
Ichthyological Associates		X					

[a] Provide explanation or justification:

O'Brien & Gere will operate boats under separate contract with GE.

16. SITE SAFETY MEETINGS

Site safety meetings must be held before beginning new tasks or when new staff enter a site. Site safety meetings should be held at least once a week and may be held daily, if needed. Attendance and topics covered must be documented.

17. FACILITY SAFETY PROCEDURES

The client or facility operators require that the following procedures be followed for all personnel at the site:

None

18. EMERGENCY PLANNING

In case of fire, spill, or other emergency affecting the site, all affected personnel must immediately evacuate the work area and report to the site safety officer at a predetermined location. Field personnel must also immediately notify facility or community emergency response providers unless facility personnel have already initiated this notification.

Designated assembly point: At parked vehicles or boat ramp

In case of injury, field personnel should take reasonable precautions to protect the victim from further harm and notify local or facility emergency services. In remote areas, it will be necessary to have first aid-trained personnel on the field team.

Emergency medical care will be provided by:

- [X] Local emergency medical provider (i.e., fire department)
- [ ] Facility emergency medical provider
- [X] First aid-trained field staff (for remote areas only)

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Fire	various	911	No
Police	various	911	No
Ambulance	various	911	No
Hospital	Saratoga Hospital	(518) 587-3222	
Site phone	Cellular		

Directions to hospital: 211 Church St. Saratoga Springs, NY. US 87 south to Exit 15. Turn right at light onto Rte 50. Go through four lights and take right at 5th onto Church St. Hospital is on right after two lights.

Corporate Resources	Name	Work Telephone	Home Telephone
Exponent Environmental Group health and safety manager	Greg Bawden	(425) 643-9803	(425) 788-0436
Medical consultant	Dr. Petrie	(206) 242-3651	

In case of serious injuries, death, or other emergency, the Exponent Environmental Group health and safety manager must be notified immediately. To contact the Exponent Environmental Group health and safety manager (or delegate), try calling Greg Bawden at the work and home numbers listed above. If no response, call the emergency pager (206) 996-1480. If no response, call Larry Marx at (425) 643-9803 or (425) 643-6019 or (360) 378-3778.

Other Resources	Agency Name/Location	Telephone
Local OSHA office	US OSHA, Syracuse	(315) 451-0808

19. DOCUMENTATION

	Attached	In File	Not Applicable
Site safety acknowledgment forms	X		
OSHA or equivalent state poster	X		
Site safety meeting minutes	X		
Accident/incident report form		X	
Heat stress monitoring form	X		
Confined space entry permit			X

	Attached	In File	Not Applicable
Confined space entry checklist			X
Air monitoring record			X
Air sampling record			X
Diving plan			X
Site map	X		
Work plan		X	
Material safety data sheets (formalin, hexane, acetone)	X		
Hospital route	X		
Health and safety training records	X		
Heat stress standard operating procedure	X		
Confined space entry information			X
Equipment standard operating procedures (list below)			X
Other:			

20. LIST OF ATTACHMENTS

Attachment B-1. Site Maps and Hospital Route

Figure 1. PCB concentrations in sediments, Thompson Island Pool region
Figure 2. PCB concentrations in sediments, Coveville region
Figure 3. PCB concentrations in sediments, Stillwater region
Figure 4. Route to hospital

Attachment B-2. Regulatory Notices and Health and Safety Training Records

OSHA Job Safety and Health Protection Notice
Exponent's Health and Safety Training and Medical Status Report for 9/98

Attachment B-3. Forms

Site Safety Meeting Minutes
Heat Stress Monitoring Form

Attachment B-4. Standard Operating Procedures

SOP 420 Heat Stress Prevention and Monitoring

Attachment B-5. Material Safety Data Sheets

MSDS for acetone
MSDS for formalin
MSDS for hexane

Exponent

HEALTH AND SAFETY PLAN CONSENT AGREEMENT

I have reviewed the health and safety plan prepared by Exponent, dated April 14, 1998, for the Upper Hudson River site fieldwork. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines while an employee of Exponent or its subcontractors.

Employee signature	Firm	Date
Employee signature	Firm	Date
Employee signature	Firm	Date
Employee signature	Firm	Date
Employee signature	Firm	Date
Employee signature	Firm	Date
Employee signature	Firm	Date
Employee signature	Firm	Date

Attachment B-1

Site Maps and Hospital Route

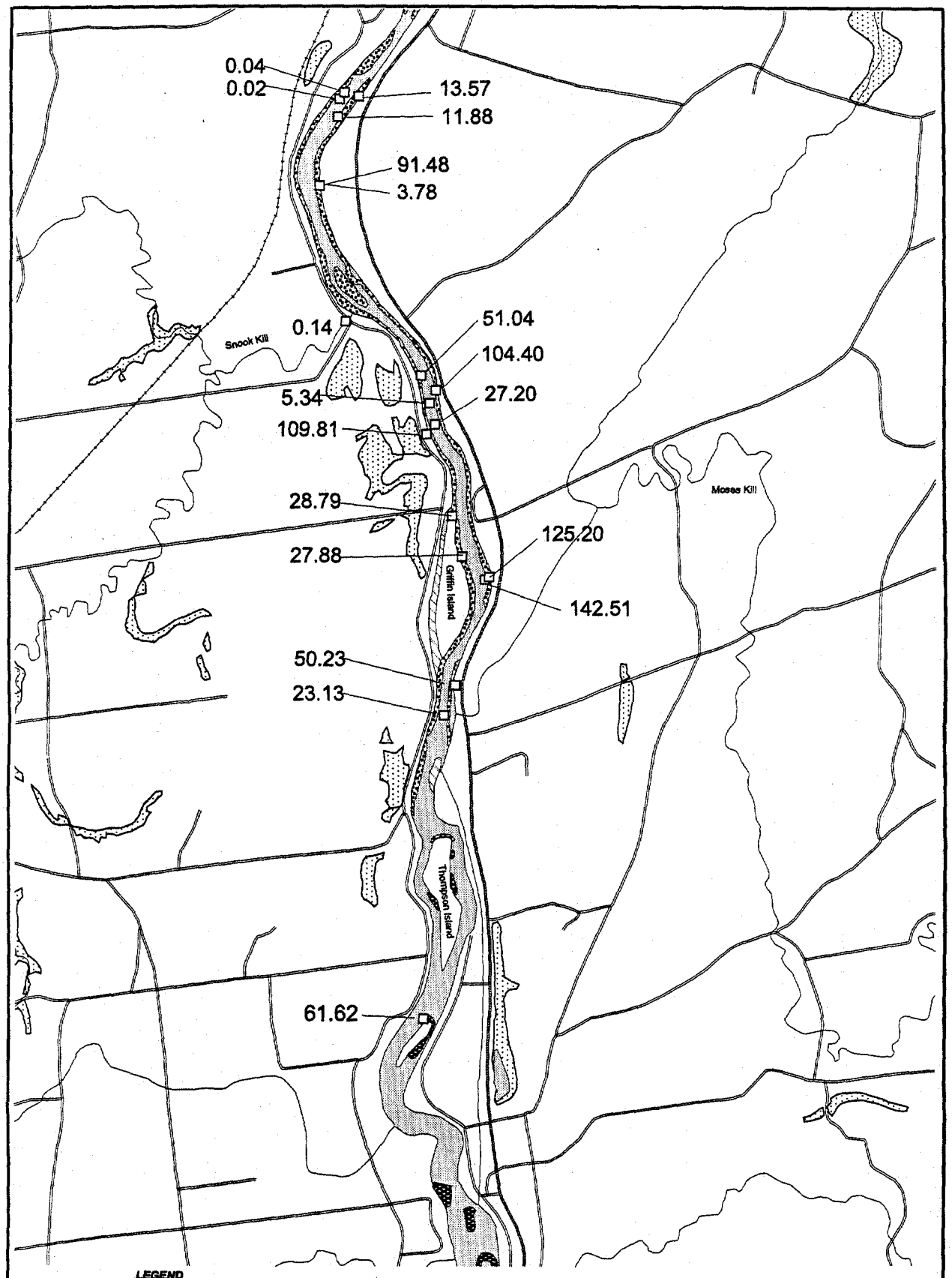

Figure 1. PCB concentrations in sediments, Thompson Island Pool region.

8600BCH.001-1812 10/02/98 GIS

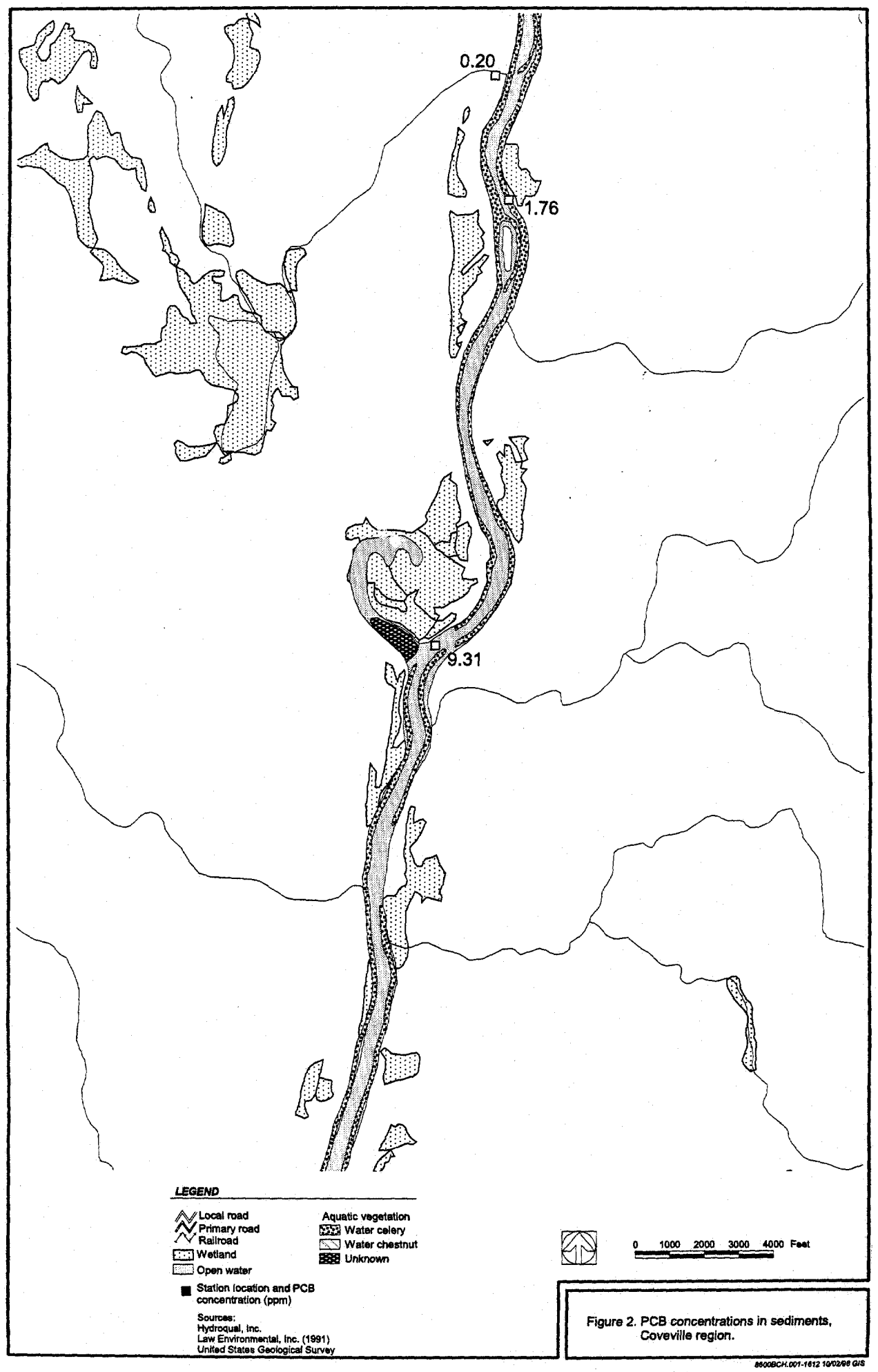

Figure 2. PCB concentrations in sediments, Coveville region.

8600BCH.001-1612 10/02/98 GIS

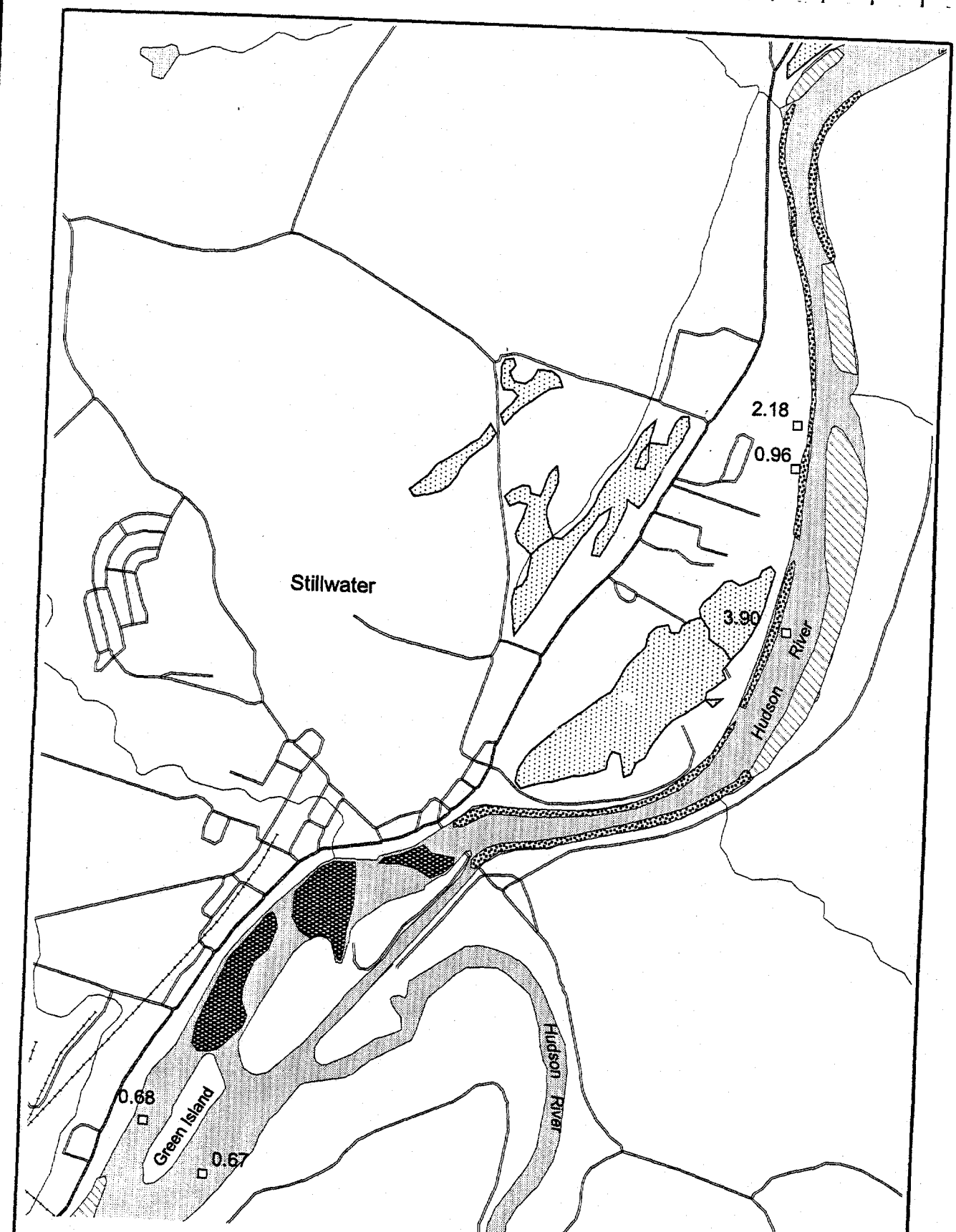

Figure 3. PCB concentrations in sediments, Stillwater region.

8600BCH.001-1612 10/02/98 GIS

309470

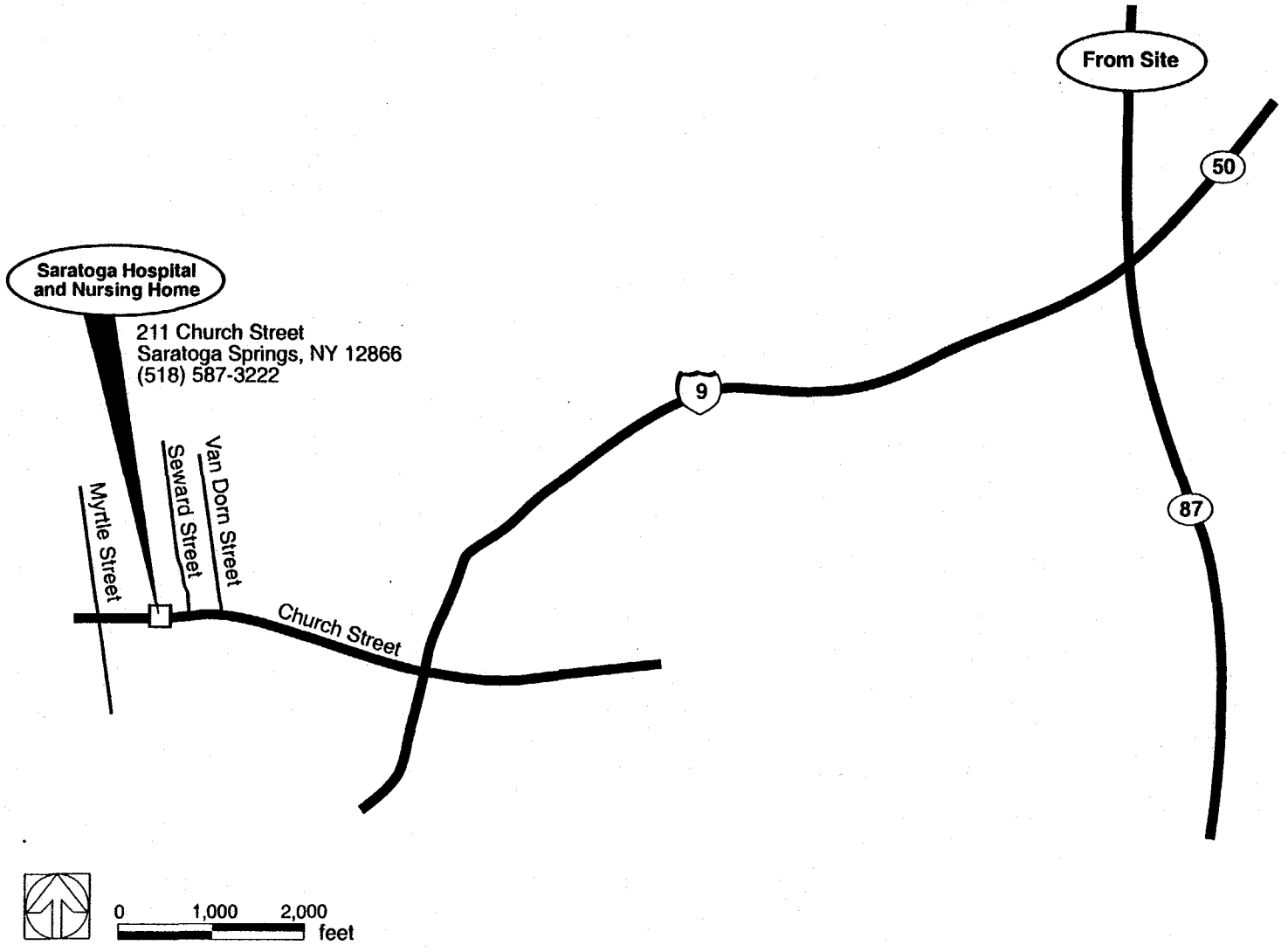

Figure 4. Route to hospital.

Attachment B-2

Regulatory Notices and Health and Safety Training Records

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Provisions of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discriminatory action.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 for each nonserious violation. Penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

There are also provisions for criminal penalties. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of up to $250,000 (or $500,000 if the employer is a corporation), or by imprisonment for up to six months, or both. A second conviction of an employer doubles the possible term of imprisonment.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

OSHA has published Safety and Health Program Management Guidelines to assist employers in establishing or perfecting programs to prevent or control employee exposure to workplace hazards. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free assistance in identifying and correcting hazards and in improving safety and health management is available to employers, without citation or penalty, through OSHA-supported programs in each State. These programs are usually administered by the State Labor or Health department or a State university.

Posting Instructions

Employers in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or facsimile) in a conspicuous place where notices to employees are customarily posted.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta	(404) 347-3573
Boston	(617) 565-7164
Chicago	(312) 353-2220
Dallas	(214) 767-4731
Denver	(303) 844-3061
Kansas City	(816) 426-5861
New York	(212) 337-2378
Philadelphia	(215) 596-1201
San Francisco	(415) 744-6670
Seattle	(206) 442-5930

Elizabeth Dole

Elizabeth Dole, Secretary of Labor

Washington, D.C.
1989 (Revised)
OSHA 2203

U.S. Department of Labor

Occupational Safety and Health Administration

309473

EXPONENT's HEALTH & SAFETY TRAINING & MEDICAL STATUS

DATE: Sept 28, 1998

	OSHA			MSHA								
Name	40-Hour Training	8-Hour Refresher	Supervisory Training	8-Hour Refresher	Fit Test	CPR	First Aid	Other Training	Date	Physical	Date	Status
BELLEVUE												
Barrick, R.			10/19/88							WIOMC*	Aug-87	INACTIVE
Becker, S.	1/27/89	5/7/98	12/21/93		1/18/96					WIOMC*	Sep-91	Reserve
Bigham, G.			10/19/88			12/5/95						INACTIVE
Booth, P.	6/3/87	2/23/98	5/5/93		10/30/92	12/7/95	12/7/95			WIOMC*	May-97	ACTIVE
Boyce, C.			4/30/96									
Bryant, M.	11/7/85	6/25/98	11/6/87		8/6/98	5/9/95		Excavation & Trenching	5/20/92	Virginia Mason*	Oct-97	Reserve
Butcher, M.	3/28/97	6/25/98			1/28/98	12/5/95				Virginia Mason*	Apr-97	Reserve
Colton, J.	6/13/97		5/7/98		1/28/98					Virginia Mason*	Aug-98	ACTIVE
Doran, S.	4/6/93	6/25/98	4/30/96		6/5/97	1/2/98	1/15/97			Virginia Mason*	Sep-98	ACTIVE
Gard, N.	6/4/91	2/23/98	4/30/96		8/6/98		12/7/95	Basic First Aid		Virginia Mason*	Sep-96	ACTIVE
Goode, D.	6/25/88	2/23/98			8/6/98	12/5/95				WIOMC*	Feb-93	Reserve
Jacobs, L.	6/3/87	2/23/98	12/21/93		8/6/98	10/19/94	10/19/94			WIOMC*	Apr-97	ACTIVE
Marx, L.	10/1/82	10/11/88	10/19/88		5/13/91					WIOMC*	Sep-87	RESERVE
McNair, C.	7/10/98				9/9/98					Virginia Mason*	Aug-98	ACTIVE
McCrone, L.	9/13/91	2/23/98	12/21/93		8/6/98	10/19/94	9/24/97			Virginia Mason*	Dec-96	ACTIVE
Mellott, R.	3/25/94	2/23/98	4/30/96		8/6/98	12/7/95	12/7/95			WIOMC*	Sep-98	ACTIVE
Moore, M.	12/15/93	5/7/98	4/30/96		8/6/98							Reserve
Nimmo, N.	1/20/93	7/1/97	4/30/96		1/18/96	1/15/97	1/15/97	Asbestos Super Cont	9/16/95	Virginia Mason	Mar-97	M-ACTIVE
Nimmo (Cont)								Building Inspector	8/6/97			
Noftsker, C.	11/16/96	12/15/97			1/28/98					Virginia Mason*	Sep-98	ACTIVE
Oard, J.	11/14/97				2/6/98							
Pastorok, R.		8/29/95	6/30/93		7/21/93							INACTIVE
Perry, M.		2/23/98										
Redd, T.	4/14/94	5/7/98			0/00/00					Virginia Mason*	Sep-96	ACTIVE
Sampson, J.	5/25/91	6/25/98			7/25/97	0/00/00	0/00/00			Virginia Mason	Apr-97	ACTIVE
Severn, S.	12/20/96	6/25/98			6/5/97							
Sexton, J.	6/10/91	2/23/98	12/21/93		8/6/98	1/15/97	1/15/97	Drug Screen	8/14/98	Virginia Mason	Jul-98	ACTIVE
Shields, W.			11/1/89		11/1/89	2/1/85	2/1/85			WIOMC*	Mar-90	INACTIVE
Yost, L.	11/4/89	2/23/98	5/5/93		8/6/98	6/22/93	5/16/92			WIOMC*	Dec-90	RESERVE

EXPONENT's HEALTH & SAFETY TRAINING & MEDICAL STATUS

DATE: Sept 28, 1998

	OSHA			MSHA								
Name	40-Hour Training	8-Hour Refresher	Supervisory Training	8-Hour Refresher	Fit Test	CPR	First Aid	Other Training	Date	Physical	Date	Status
BOULDER												
Arbuckle, S.	4/29/94	6/24/98	8/22/95	6/24/98	4/30/98					Meadows Medical*	Jan-98	M-ACTIVE
Atkins, D.	4/29/94	4/30/98		4/30/98	0/00/00	10/22/96	10/22/96			Meadows Medical	Oct-96	M-ACTIVE
Barron, M.	6/14/96	4/30/98		4/30/98	4/30/98	10/22/96	10/22/96			Meadows Medical*	Sep-97	M-ACTIVE
Dole, S.		4/25/97										
Fink, M.	12/14/90	11/4/97			0/00/00	10/22/96	10/22/96			Meadows Medical*	Oct-97	ACTIVE
Hogue, C.	9/13/91	11/4/97	12/21/93		1/18/96					WIOMC*	Sep-91	RESERVE
Hook, G.	1/14/91	4/30/98			4/30/98							
Kempton, H.	6/3/88	4/30/98		4/30/98	4/30/98	6/17/97		Level B Update	2/10/88	Meadows Medical*	Sep-96	M-ACTIVE
Kempton (cont)												
Liegeois, A.					1/18/96	0/00/00						
Locke, W.	6/30/95	4/30/98		4/30/98	1/5/98	10/22/96	10/22/96			Meadows Medical*	Sep-96	M-ACTIVE
MacDonald, A.	3/31/89	4/30/98	5/5/93	4/30/98	4/30/98	5/10/96	10/19/94			Meadows Medical*	Sep-98	ACTIVE
Martin,T.	4/5/96	4/30/98		4/30/98	4/30/98	10/22/96	10/22/96			Meadows Medical*	Oct-96	M-ACTIVE
Metzger, J.	12/13/93	6/24/98		6/24/98	4/30/98	6/17/97				Meadows Medical*	Oct-97	M-ACTIVE
Murdock, M.	12/14/89	9/11/96			0/00/00	10/22/96	10/22/96			Meadows Medical*	Oct-96	ACTIVE
Nelson, J.	5/6/94	11/4/97			0/00	10/22/96	10/22/96			Meadows Medical*	Oct-97	ACTIVE
Nicholson, A.	10/11/92	4/30/98	6/25/93	4/30/98	4/30/98	6/17/97				Meadows Medical	Nov-96	M-ACTIVE
Peterson, J.	1/13/95	4/25/97			0/00/00					ProMed	Sep-95	RESERVE
Peterson, L.	6/28/91	4/30/98	5/26/93	4/30/98	4/30/98	10/22/96	10/22/96			Meadows Medical*	Aug-97	M-ACTIVE
Pliessing, C.										Meadows Medical*	May-98	ACTIVE
Ruby, M.	2/8/91	4/25/97	6/25/93		9/7/93	10/1/95	10/1/95			Meadows Medical*	Sep-96	ACTIVE
Ryon, T.	9/18/89	11/4/97			0/00/00					Meadows Medical	Oct-97	ACTIVE
Salatas, J.										Meadows Medical	Oct-97	ACTIVE
Schmeising, L.	6/26/87	2/27/92		4/30/98	4/30/98							
Sueker, J.										Meadows Medical*	Sep-97	ACTIVE
Travers, C.	2/8/91	4/30/98	6/25/93	4/30/98	8/18/95	3/16/96	4/1/93			Meadows Medical*	Oct-95	M-ACTIVE

EXPONENT's HEALTH & SAFETY TRAINING & MEDICAL STATUS

DATE: Sept 28, 1998

	OSHA			MSHA								
Name	40-Hour Training	8-Hour Refresher	Supervisory Training	8-Hour Refresher	Fit Test	CPR	First Aid	Other Training	Date	Physical	Date	Status
LAKE OSWEGO												
Axelrod, R.	5/8/87	6/4/98	3/28/94		12/18/96	6/4/98	6/25/97			Thompson*	Dec-96	ACTIVE
Barnett, S.	2/28/92	6/4/98	3/28/94		5/21/98	6/4/98	7/20/94			Thompson*(P)	Nov-97	ACTIVE
Bonin, A.	10/25/96	6/4/98		12/16/97	11/7/96	6/4/98	6/25/97			Thompson*	Nov-97	M-ACTIVE
Boykin, C.	3/11/94	6/4/98		12/16/97	12/17/96	6/4/98	6/25/97			Thompson**	Feb-98	M-ACTIVE
Chase, M.	9/13/91	7/11/95			5/17/93	3/31/92	3/31/92			Thompson*	Sep-94	RESERVE
Cooley, U.	9/13/91	6/4/98			5/21/98	6/4/98		Confined Space Entry	12/12/95	Thompson*	Jun-98	ACTIVE
Jones, L.	11/18/88	6/4/98	3/28/94		5/21/98	11/29/95				Thompson*	Apr-95	RESERVE
Livermore, D.	12/12/87	6/4/98	10/20/93		5/21/98	11/29/95	3/31/92			Thompson* (P)	Nov-96	ACTIVE
Paul, J.	6/19/87	6/4/98	4/30/96	12/16/97	5/21/98	6/4/98	12/17/96	Excavation Safety	5/23/96	Thompson*	Oct-97	M-ACTIVE
Peek, D.	9/14/90	9/19/91			5/17/93					WIOMC	Aug-90	RESERVE
Whitson, M.	2/13/87	6/4/98	10/20/93		5/21/98					Thompson* (P)	Nov-96	ACTIVE

EXPONENT's HEALTH & SAFETY TRAINING & MEDICAL STATUS

DATE: Sept 28, 1998

	OSHA			MSHA								
Name	40-Hour Training	8-Hour Refresher	Supervisory Training	8-Hour Refresher	Fit Test	CPR	First Aid	Other Training	Date	Physical	Date	Status
BOSTON												
Conner, K.	12/15/93											
Corless, C.	7/25/97	9/3/97			3/12/98	3/12/98				Health Resources*	Jul-97	ACTIVE
Craven, V.	8/8/97									Health Resources*	Apr-98	ACTIVE
Dean, J.		2/23/98										
DiMaro, D.		2/23/98			3/12/98	3/12/98				Health Resources*	Apr-98	ACTIVE
Murphy, S.		2/23/98										
Hansen, L.	9/22/95	9/3/97	3/20/96		3/12/98	3/12/98				Health Resources*	Jun-97	ACTIVE
Iannuzzi, T.	2/9/90	2/23/98										
Langseth, D.	8/5/88	9/3/97	3/2/89		3/9/98					Health Resources*	Mar-97	RESERVE
Ludwig, D.	10/9/87	2/23/98			0/00/00							
Rothrock, J	4/18/97	3/17/98				4/1/97	4/1/97					
Dodd, T	2/19/95	2/6/98				12/14/96	12/14/96					
Truchon, S.	4/5/91	9/3/97		5/13/95	3/12/98	3/12/98				Health Resources*	Jul-97	ACTIVE
Wallin, J.	2/27/98	2/23/98										
Wilson, N.		2/23/98										

Note: Physicals required annually, however, physicals may be delayed for up to 1 year (for a total of 2 years) for persons with no field activity since their last physical; first aid training valid for 3 years; CPR valid for 1 year; fit test valid for 1 year, 8-HR training for 1 year (can do supervisor training instead)

STATUS: ACTIVE-ready for site work (40 hour training, refresher course, fit test and physical up to date).

M ACTIVE-cleared for mine site (has completed OSHA 40 hr. & OSHA 8 hr. refresher and MSHA 8 hr. refresher)

INACTIVE-needs training and baseline medical (not 40 hour trained).

RESERVE-could be activated for field work if necessary but will need updated training and medical within 30 days of being activated (40 hour trained, but other requirements not current). This category also includes personnel who are fully trained but area subject to tother temporary restriction or limitation.

(P) Preliminary Work Clearance

NON-HAZ-field support or lab, not cleared for field work at "uncontrolled hazardous waste site".

* Medical fit/unfit form available

** Possible field work limitations due to medical restrictions

Attachment B-3

Forms

Exponent

SITE SAFETY MEETING MINUTES

Site Name _____ Contract No. _____

Meeting Location _____

Meeting Date _____ Time _____ Conducted By _____

Pre-fieldwork Orientation _____ Weekly Site Meeting _____ Other _____

Subjects Discussed _____

Safety Officer Comments _____

Name and Signature of Participating Personnel (list company name if subcontractor)

Note: Attach additional pages if necessary. Send this form to the Exponent Environmental Group health and safety officer. Copies will be placed in the appropriate project files.

Exponent

HEAT STRESS MONITORING RECORD

Project Title/Number _____

Site Name/Location _____ Date_____

Time Work Started _____ Initial Temperature _____ ☐F° ☐C°

Adjusted temperature at hour: [= Ambient air temp + (13 x % sunshine)]
% sunshine = estimate based on: 100% = no cloud cover, distinct shadows; 0% = no shadows

Time								
Adjusted temp (___°)								

	TIME [1]					
NAME	HR/TEMP [2]					ACTION TAKEN [3]

1. Time of break
2. Heart rate/oral temperature
3. i.e., break lengthened, cool vests worn, etc.

Data collected by _____ _____
Print name *Signature*

Monitoring Guidelines:

1. Heart rate — monitor the radial pulse (wrist) as soon as possible at the beginning of the test period.

   If the rate exceeds 110 beats per minutes, shorten the next work cycle by one-third and keep the rest period the same.

   If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third.

2. Oral temperature — use a clinical thermometer for 3 minutes under the tongue to measure oral temperature immediately following the work period (before drinking).

   If the temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.

   If oral temperature still exceeds 99.6°F (37.6°C), at the beginning of the next rest period, shorten the following work cycle by one-third.

   If the temperature exceeds 100.6°F (38.1°C), do not permit the worker to wear an impermeable garment.

Attachment B-4

Standard Operating Procedures

STANDARD OPERATING PROCEDURE

HEAT STRESS PREVENTION AND MONITORING
SOP 420

INTRODUCTION

Heat stress poses a serious threat to the health of workers conducting hazardous material or chemical investigations at industrial and other facilities. This threat is increased for workers wearing chemical protective clothing or personal protective equipment (PPE) because the impermeable clothing does not allow sweat to evaporate and cool the body. Depending on ambient conditions, the work being performed, and other factors, heat stress may affect workers at temperatures as low as 70°F (adjusted for humidity and sunlight; see *Monitoring for Heat Stress*, below) and can occur rapidly, with workers suffering acute symptoms in less than 15 minutes. Even relatively minor symptoms of heat stress can result in impaired functional ability, threatening the safety of the worker and his or her companions. Thus, heat stress can present as great a health risk to workers as chemical hazards or traditional physical hazards such as falling objects and confined spaces. This SOP presents information on heat-related illnesses, factors that influence heat stress, monitoring for heat stress, and heat stress prevention.

HEAT-RELATED ILLNESSES

A common factor in heat-related illnesses is the failure of the worker to recognize the symptoms of heat stress. All personnel should become familiar with the symptoms of heat stress and appropriate first aid precautionary measures.

Table 420-1 provides information on the types of heat-related disorders and procedures for treating them. Heat stress can result in minor symptoms such as heat rash, heat cramps, discomfort, and drowsiness. Prolonged heat stress can result in more severe effects, such as heat exhaustion and heat stroke. Heat rash is a relatively minor form of early heat stress that results from prolonged contact with wet clothing. Heat rash can be prevented by allowing the skin to dry completely during rest periods and by showering as soon as possible at the end of the work day. Although heat cramps and drowsiness are generally of minor concern, these symptoms may also result in impaired functional ability, which in turn may threaten the safety of the individual and coworkers.

TABLE 420-1. HEAT DISORDERS

Disorder	Cause	Signs	Treatment
Heat rash	Heavy sweating, drinking large volumes of water without replacing salt loss	Profuse tiny raised vesicles, prickly skin	Remove from source of heat; allow skin to dry completely during rest periods; shower as soon as possible after work day
Heat syncope	Lack of acclimatization, pooling of blood in the legs	Fainting while standing, immobile in heat	Remove to cooler area
Heat cramps	Heavy sweating, drinking large volumes of water without replacing salt loss	Painful spasms of muscles used during work; cool, moist skin	Provide fluids that replace salts and protein; allow 1–3 days of rest, depending on the severity of the attack
Heat exhaustion	Sustained exertion in heat, lack of acclimatization, failure to replace water and/or salt	Fatigue, nausea, headache, moist and clammy skin, pale complexion, delirium, diarrhea, cramps	Remove to cooler area; provide cool water and salted fruit or protein drinks
Heat stroke	Sustained exertion in heat, excessive exposure to heat, lack of physical fitness, alcoholism and drug abuse, dehydration, cardiovascular disease	Headache; rapid pulse; dizziness; nausea; confusion; convulsions; flushed, dry skin; high body temperature; loss of consciousness; coma	Call emergency medical services (often 911) immediately; place the worker in a cool, shady area; remove their clothing, then sprinkle their entire body with cool water; also cool by fanning; treat for shock

Heat cramps, heat syncope, heat exhaustion, and heat stroke all result from excessive loss of body fluids and electrolytes. The symptom of heat cramps is spasms in the abdomen or limbs. Heat syncope is a pooling of blood in the lower extremities, which may result in fainting when the worker stands up suddenly or has been immobile. Heat exhaustion, caused by more severe dehydration, has the following symptoms: pale, clammy skin; profuse sweating; weakness; headache; and nausea. Heat stroke (sometimes called sunstroke) is a life-threatening condition that occurs when the body's temperature-regulating system no longer functions properly. Heat stroke requires immediate medical attention. Symptoms of heat stroke include hot, dry skin; a high fever (often 106°F or more); dizziness; nausea; rapid pulse; and unconsciousness. Brain damage and death may follow if the body temperature is not reduced.

Workers must learn to recognize that dizziness, nausea, headaches, skin rashes, muscle cramps, and pale or clammy skin are symptoms of heat stress and act promptly when suffering these symptoms. Workers may not realize the risk they face by ignoring these symptoms and staying in the work area until overcome by heat stress or suffer other injuries of heat stress-related impairment. Critical factors in the prevention of heat stress include a proper work regimen and the intake of adequate replacement fluids and electrolytes.

FACTORS INFLUENCING HEAT STRESS

Many factors determine an individual's susceptibility to heat stress. Environmental factors include the ambient temperature, humidity, and presence or absence of cooling breezes or shade. The nature of the work being performed, including the level of physical activity, the degree of permeability and the number of layers of protective clothing, and the time of day that the work is being performed affects the level of heat stress.

Some workers are predisposed towards suffering heat stress. Factors that could increase a worker's susceptibility to heat stress include degree of physical fitness, lack of acclimatization, age, dehydration, obesity, alcohol and drug use, infection, sunburn, diarrhea, and chronic disease.

Workers who have acclimated to working in hot climates or in PPE will be less likely to suffer heat stress. Acclimated individuals typically have lower heart rates and body temperatures than nonacclimated workers. Acclimated workers also sweat sooner and more profusely than those not acclimated to high temperatures or the use of PPE (acclimated individuals may sweat more profusely when wearing PPE than nonacclimated workers, thus increasing their risk of dehydration). The National Institute of Occupational Safety and Health (NIOSH) recommends a progressive 6-day regimen to allow a worker to acclimate to work in a hot environment, especially when wearing PPE (this program begins with 50-percent exposure, then lengthens the staying time by 10 percent each subsequent day). A individual's capacity to work in hot environments generally decreases with age. According to NIOSH, however, an older person in peak physical condition may

have a greater work capacity than a less fit, younger worker. Thus, physical fitness is a more significant factor than age when determining an individual's work capacity. Weight is usually a significant factor when determining the ability of an individual to work in a heated environment because overweight people have a lower surface area to mass ratio and, thus, can not dissipate heat as well as slimmer people. Weight is not as significant a factor when wearing PPE, as the impermeable garments impede the dissipation of body heat regardless of the individual's weight.

MONITORING FOR HEAT STRESS

To ensure the safety of workers wearing impermeable or semipermeable encapsulating PPE, NIOSH recommends that heat stress monitoring be implemented at temperatures above 70°F, using an "adjusted temperature." The adjusted temperature is calculated by determining the ambient temperature (using a standard thermometer, shielded from heat) and adding the total of 13 × the percentage of sunshine (complete overcast = 0 percent sunshine and no cloud cover = 100 percent sunshine). For example, for an ambient temperature of 80°F and 80 percent sunshine, the adjusted temperature would be 90.4°F (80+[13×0.80]=90.4). The effect of heat stress on the body may be monitored using the techniques described below. Recommended intervals for physiological monitoring when wearing permeable or impermeable work clothes are shown in Table 420-2.

Heart Rate

To monitor the effect of heat stress on the worker using the heart rate method, the worker must measure his or her heart rate over a 30-second period as soon as possible at the beginning of each rest break. The pulse should be taken at the radial (wrist) artery, not the carotid (neck) artery. When monitoring heart rate, the following guidelines apply:

- If the worker's heart rate does not exceed 110 beats/minute, proceed as before
- If the worker's heart rate exceeds 110 beats/minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same
- If the worker's heart rate exceeds 110 beats/minute at the beginning of the next rest period, shorten the next work cycle by another one-third.

Exponent recommends the use of heart rate monitoring as the minimum heat stress monitoring technique.

TABLE 420-2. SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS[a]

Adjusted Air Temperature[b]	Normal Work Ensemble[c]	Impermeable Ensemble
90°F or above (32.2°C)	After each 45 minutes of work	After each 15 minutes of work
87.5°–90°F (30.8°–32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°–87.5°F (28.1°–30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°–82.5°F (25.3°–28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°–77.5°F (22.5°–25.3°C)	After each 150 minutes of work	After each 120 minutes of work

Source: NIOSH (1985).

[a] For work level of 250 kilocalories/hour (moderate work activity).

[b] Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 × percent sunshine). Measure air temperature (ta) with a standard, mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent of time the sun is not covered by clouds that are thick enough to produce a shadow (100 percent sunshine = no cloud cover and sharp, distinct shadows; 0 percent sunshine = no shadows).

[c] A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

Oral Temperature

To monitor the effect of heat stress on the worker using the oral temperature method, the worker should use a clinical thermometer (3 minutes under the tongue) at the end of each work period, but before taking a drink. When monitoring oral temperature, the following guidelines apply:

- If the oral temperature does not exceed 99.6°F, no action is needed
- If the oral temperature exceeds 99.6°F at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same
- If the oral temperature exceeds 99.6°F at the beginning of the next rest period, shorten the following work period by one-third
- If the oral temperature exceeds 100.6°F at the beginning of any rest period, the worker should not be permitted to wear impermeable clothing.

Body Water Loss

To monitor the effect of heat stress on workers by measuring body water loss, the workers must weigh themselves with a scale accurate to within 0.25 lb at the beginning and end of each work day. Their weight for the beginning and the end of the work shift should be taken while wearing similar clothing or, for greatest accuracy, when nude. Fluctuations in weight (between the beginning of the shift and end of the shift) indicate the gain or loss of body fluids, thus revealing if fluid replenishment has been effective. Body weight loss in a work day should not exceed 1.5 percent of total body weight. Where such weight losses occur, more attention should be given to fluid replacement during subsequent work shifts.

Electronic Monitors

Electronic monitors that constantly monitor a worker's heart rate and core temperature have recently been developed. These devices utilize sensors that are held in place on the worker's chest with an elastic band and are programmed to account for the worker's age and type of protective clothing. The worker's heart rate and core temperature are monitored, and lights illuminate on a small pad (worn on the outside of the PPE) to indicate one of the following conditions: the worker may continue as before, the worker has only a limited amount of work time left, or the worker should exit the work area immediately. These devices also include audible alarms and can be set to download heat stress data to a printer at the end of a shift.

Other electronic monitors are designed to measure adjusted (ambient) temperatures and can be programmed to account for the level of worker activity and type of protective clothing. These devices can calculate stay times (the amount of time the workers in the area may remain in that area at the current activity levels) and can also log conditions encountered. These devices do not actually monitor the effects of heat stress on the workers, but may be used to implement heat stress prevention measures.

HEAT STRESS PREVENTION

Several means are available to decrease or prevent the effects of heat stress.

An effective means of preventing heat stress is to schedule work in the cool parts of day—early mornings, evenings, or at night. If the heat source is mechanical (e.g., caused by a power plant or production equipment), it may be possible to schedule the work during hours when the facility is inoperative.

Engineering methods may be used to cool workers regardless of the time of day. These methods frequently involve the use of cool vests (ice packs worn under PPE in a special vest), circulating air (often associated with powered air-purifying respirators that utilize hoods rather than sealed facepieces), or in extreme cases, circulating liquids through specially designed suits. Other engineering controls to prevent heat stress include erecting a shelter to protect workers from direct sunlight or the circulation of air through the workplace. In some instances, deluge showers can be constructed within the exclusion zone or in the decontamination area that allow workers wearing fully encapsulating PPE to stand under a shower of cold water. The deluge shower is an efficient means of providing relief to the worker without requiring the worker to proceed through decontamination and exit from the work area.

A critical element in an effective heat stress prevention program is to ensure that workers maintain a normal level of fluids within their bodies. To prevent heat-related illness, the worker's intake of fluids must approximate the amount of fluid lost (e.g., the worker must drink 8 oz of water for every 8 oz decrease in body weight). The sensation of thirst is not a reliable indicator of fluid loss. When heavy sweating occurs, it is essential that workers increase their fluid intake. The following guidelines may be useful:

- Provide fluid replenishment beverages at the work site, cooled to 50–60°F (appropriate beverages include water and diluted fruit juices or Gatorade®)
- Have workers drink 16 oz of fluid prior to working in a hot environment
- Encourage workers to drink 8–16 oz of liquids every 15–20 minutes, or at each rest break. NIOSH recommends that workers consume a total of 1–1.5 gal of fluids/day, although a greater quantity may be required.

Scheduling rest periods to break up work periods is essential to prevent heat-related illnesses. It is difficult to establish a rigid schedule that spells out the staying time and rest breaks based on temperature alone because other factors, such as the level of physical activity and the type of protective equipment, play a significant role in determining an individual's susceptibility to heat stress. The recommended course of action is to use the guidelines for physiological monitoring provided in Table 420-2 to schedule the initial work period, then vary the length of the break and the next work period based on the physiological responses of individual workers to the work load. If the workers are engaged in strenuous activities, are not acclimated to the work environment, or are not in peak physical condition, the work interval should be shortened significantly, and monitoring continued.

INDIVIDUAL RESPONSIBILITIES

In preventing heat stress, it is essential that the individual monitor his or her own symptoms and promptly take steps to remedy any signs of heat stress. Such steps include notifying coworkers of his or her condition and taking whatever measures may be necessary to alleviate the symptoms by taking a break, increasing the intake of fluids, instituting environmental controls (such as the use of cool vests or circulating air), assuming less strenuous duties, or implementing appropriate first-aid procedures as indicated in Table 420-1. No field monitoring program can substitute for the individual's sense of their own health and physical limits.

REFERENCES

NIOSH. 1985. Occupational safety and health guidance manual for hazardous waste site activities. Prepared by the National Institute for Occupational Safety and Health, Occupational Safety and Health Administration, U.S. Coast Guard, and U.S. Environmental Protection Agency. U.S. Department of Human and Health Services, Public Health Service, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Washington, DC.

Attachment B-5

Material Safety Data Sheets

J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865
M A T E R I A L S A F E T Y D A T A S H E E T
24-HOUR EMERGENCY TELEPHONE -- (908) 859-2151
CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8802

EFFECTIVE: 02/22/96 ISSUED: 03/26/96

MALLINCKRODT BAKER, INC., 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME: ACETONE
COMMON SYNONYMS: DIMETHYL KETONE; 2-PROPANONE; DIMETHYL KETAL
CHEMICAL FAMILY: KETONES
FORMULA: (CH3)2CO
FORMULA WT.: 58.08
CAS NO.: 67-64-1
NIOSH/RTECS NO.: AL3150000
PRODUCT USE: LABORATORY REAGENT
PRODUCT CODES: 9007,9254,9004,5356,9015,9002,A134,9009,9001,9008,9006,9010
9005,5580,9125,5805

PRECAUTIONARY LABELING

BAKER SAF-T-DATA* SYSTEM

HEALTH	-	1	SLIGHT
FLAMMABILITY	-	4	EXTREME (FLAMMABLE)
REACTIVITY	-	2	MODERATE
CONTACT	-	1	SLIGHT

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

U.S. PRECAUTIONARY LABELING

DANGER
EXTREMELY FLAMMABLE. HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM. KEEP AWAY FROM HEAT, SPARKS AND FLAME. KEEP CONTAINER CLOSED. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING. AVOID BREATHING VAPOR. AVOID CONTACT WITH EYES, SKIN AND CLOTHING.

INTERNATIONAL LABELING

HIGHLY FLAMMABLE.
KEEP CONTAINER IN A WELL-VENTILATED PLACE. KEEP AWAY FROM SOURCES OF IGNITION - NO SMOKING. DO NOT BREATHE VAPOR. TAKE PRECAUTIONARY MEASURES AGAINST STATIC DISCHARGES.

CONTINUED ON PAGE: 2

PRECAUTIONARY LABELING (CONTINUED)

SAF-T-DATA* STORAGE COLOR CODE: RED (FLAMMABLE)

SECTION II - COMPONENTS

COMPONENT	CAS NO.	WEIGHT %	OSHA/PEL	ACGIH/TLV
ACETONE	67-64-1	99-100	750 PPM	750 PPM

SECTION III - PHYSICAL DATA

BOILING POINT: 56 C (132 F) (AT 760 MM HG)

VAPOR PRESSURE (MMHG): 184 (20 C)

MELTING POINT: -95 C (-139 F) (AT 760 MM HG)

VAPOR DENSITY (AIR=1): 2.0

SPECIFIC GRAVITY: 0.79 (H2O=1)

EVAPORATION RATE: 7.7 (BUTYL ACETATE = 1)

SOLUBILITY(H2O): COMPLETE (100%)

% VOLATILES BY VOLUME: 100 (21 C)

PH: N/A

ODOR THRESHOLD (P.P.M.): 100

PHYSICAL STATE: LIQUID

COEFFICIENT WATER/OIL DISTRIBUTION: N/A

APPEARANCE & ODOR: CLEAR, COLORLESS LIQUID. SWEET ODOR.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (CLOSED CUP): -17 C (0 F)

NFPA 704M RATING: 1-3-0

AUTOIGNITION TEMPERATURE: 464 C (869 F)

FLAMMABLE LIMITS: UPPER - 13.0 % LOWER - 2.2 %

CONTINUED ON PAGE: 3

SECTION IV - FIRE AND EXPLOSION HAZARD DATA (CONTINUED)

FIRE EXTINGUISHING MEDIA
USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE.)

SPECIAL FIRE-FIGHTING PROCEDURES
FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

UNUSUAL FIRE & EXPLOSION HAZARDS
VAPORS MAY FLOW ALONG SURFACES TO DISTANT IGNITION SOURCES AND FLASH BACK. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE. THIS MATERIAL MAY PRODUCE A FLOATING FIRE HAZARD.

TOXIC GASES PRODUCED
CARBON MONOXIDE, CARBON DIOXIDE

EXPLOSION DATA-SENSITIVITY TO MECHANICAL IMPACT
NONE IDENTIFIED.

EXPLOSION DATA-SENSITIVITY TO STATIC DISCHARGE
YES.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE (TLV/TWA): 1780 MG/M3 (750 PPM)

SHORT-TERM EXPOSURE LIMIT (STEL): 2400 MG/M3 (1000 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 1780 MG/M3 (750 PPM)

TOXICITY OF COMPONENTS

ORAL RAT LD50 FOR ACETONE	5800 MG/KG
ORAL MOUSE LD50 FOR ACETONE	3000 MG/KG
INTRAPERITONEAL MOUSE LD50 FOR ACETONE	1297 MG/KG
SKIN RABBIT LD50 FOR ACETONE	20 G/KG

CONTINUED ON PAGE: 4

SECTION V - HEALTH HAZARD DATA (CONTINUED)

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

CARCINOGENICITY
NONE IDENTIFIED.

REPRODUCTIVE EFFECTS
NONE IDENTIFIED.

EFFECTS OF OVEREXPOSURE

INHALATION: INHALATION OF VAPORS IRRITATES THE RESPIRATORY TRACT. MAY CAUSE COUGHING, DIZZINESS, DULLNESS, AND HEADACHE. HIGHER CONCENTRATIONS CAN PRODUCE CENTRAL NERVOUS SYSTEM DEPRESSION, NARCOSIS, AND UNCONSCIOUSNESS.

SKIN CONTACT: IRRITATING DUE TO DEFATTING ACTION ON SKIN. MAY CAUSE REDNESS, PAIN, DRYING AND CRACKING OF THE SKIN.

EYE CONTACT: VAPORS ARE IRRITATING TO THE EYES. SPLASHES MAY CAUSE SEVERE IRRITATION, WITH STINGING, TEARING, REDNESS AND PAIN.

SKIN ABSORPTION: MAY OCCUR

INGESTION: SWALLOWING SMALL AMOUNTS IS NOT LIKELY TO PRODUCE HARMFUL EFFECTS. LARGER AMOUNTS MAY PRODUCE LIVER AND KIDNEY DAMAGE AND NARCOTIC EFFECTS WITH OTHER SYMPTOMS PARALLELING THOSE FROM INHALATION EXPOSURE.

CHRONIC EFFECTS: PROLONGED OR REPEATED SKIN CONTACT MAY PRODUCE SEVERE IRRITATION OR DERMATITIS.

TARGET ORGANS
RESPIRATORY TRACT, EYES, SKIN, CENTRAL NERVOUS SYSTEM

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
USE OF ALCOHOLIC BEVERAGES ENHANCES TOXIC EFFECTS. EXPOSURE MAY INCREASE THE TOXIC POTENTIAL OF CHLORINATED HYDROCARBONS, SUCH AS CHLOROFORM, TRICHLOROETHANE.

PRIMARY ROUTES OF ENTRY
INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT

CONTINUED ON PAGE: 5

SECTION V - HEALTH HAZARD DATA (CONTINUED)

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: ASPIRATION HAZARD. IF SWALLOWED, DO NOT INDUCE VOMITING GIVE LARGE QUANTITIES OF WATER OR MILK IF AVAILABLE. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

INHALATION: IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

SKIN CONTACT: IN CASE OF CONTACT, IMMEDIATELY FLUSH SKIN WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. IN ALL CASES CALL A PHYSICIAN.

EYE CONTACT: IN CASE OF EYE CONTACT, IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. GET MEDICAL ATTENTION IF SYMPTOMS OCCUR.

SARA/TITLE III HAZARD CATEGORIES AND LISTS

ACUTE: YES CHRONIC: NO FLAMMABILITY: YES PRESSURE: NO REACTIVITY: NO

EXTREMELY HAZARDOUS SUBSTANCE: NO
CERCLA HAZARDOUS SUBSTANCE: YES CONTAINS ACETONE (RQ = 5000 LBS)
SARA 313 TOXIC CHEMICALS: NO
GENERIC CLASS: GENERIC CLASS REMOVED FROM CFR: 7/1/91
TSCA INVENTORY: YES

SECTION VI - REACTIVITY DATA

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, FLAME, OTHER SOURCES OF IGNITION

INCOMPATIBLES: STRONG OXIDIZING AGENTS, STRONG BASES, HALOGEN ACIDS AND HALOGEN COMPOUNDS, CAUSTICS, AMINES AND AMMONIA, CHLORINE AND CHLORINE COMPOUNDS, STRONG ACIDS, ESP. SULFURIC, NITRIC, HYDROCHLORIC

DECOMPOSITION PRODUCTS: CARBON MONOXIDE, CARBON DIOXIDE

CONTINUED ON PAGE: 6

SECTION VII - SPILL & DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

VENTILATE AREA OF LEAK OR SPILL. REMOVE ALL SOURCES OF IGNITION. WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AS SPECIFIED IN SECTION VIII. ISOLATE HAZARD AREA. KEEP UNNECESSARY AND UNPROTECTED PERSONNEL FROM ENTERING. CONTAIN AND RECOVER LIQUID WHEN POSSIBLE. USE NON-SPARKING TOOLS AND EQUIPMENT. COLLECT LIQUID IN AN APPROPRIATE CONTAINER OR ABSORB WITH AN INERT MATERIAL (E.G., VERMICULITE, DRY SAND, EARTH), AND PLACE IN A CHEMICAL WASTE CONTAINER. DO NOT USE COMBUSTIBLE MATERIALS, SUCH AS SAW DUST. DO NOT FLUSH TO SEWER

J. T. BAKER SOLUSORB(R) SOLVENT ADSORBENT IS RECOMMENDED FOR SPILLS OF THIS PRODUCT.

DISPOSAL PROCEDURE

WHATEVER CANNOT BE SAVED FOR RECOVERY OR RECYCLING SHOULD BE HANDLED AS HAZARDOUS WASTE AND SENT TO A RCRA APPROVED WASTE FACILITY. PROCESSING, USE OR CONTAMINATION OF THIS PRODUCT MAY CHANGE THE WASTE MANAGEMENT OPTIONS. STATE AND LOCAL DISPOSAL REGULATIONS MAY DIFFER FROM FEDERAL DISPOSAL REGULATIONS. U.S. REGULATIONS REQUIRE REPORTING SPILLS AND RELEASES TO SOIL, WATER AND AIR IN EXCESS OF REPORTABLE QUANTITIES. THE TOLL-FREE NUMBER FOR THE U.S. COAST GUARD NATIONAL RESPONSE CENTER IS (800) 424-8802.

EPA HAZARDOUS WASTE NUMBER: U002 (TOXIC WASTE)

SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT

VENTILATION: A SYSTEM OF LOCAL AND/OR GENERAL EXHAUST IS RECOMMENDED TO KEEP EMPLOYEE EXPOSURES BELOW THE AIRBORNE EXPOSURE LIMITS. LOCAL EXHAUST VENTILATION IS GENERALLY PREFERRED BECAUSE IT CAN CONTROL THE EMISSIONS OF THE CONTAMINANT AT ITS SOURCE, PREVENTING DISPERSION OF IT INTO THE GENERAL WORK AREA. PLEASE REFER TO THE ACGIH DOCUMENT, "INDUSTRIAL VENTILATION, A MANUAL OF RECOMMENDED PRACTICES," MOST RECENT EDITION, FOR DETAILS.

RESPIRATORY PROTECTION: IF THE EXPOSURE LIMIT IS EXCEEDED, AN ORGANIC VAPOR RESPIRATOR MAY BE WORN FOR UP TO TEN TIMES THE EXPOSURE LIMIT. FOR EMERGENCIES OR INSTANCES WHERE THE EXPOSURE LEVELS ARE NOT KNOWN, USE A POSITIVE-PRESSURE, AIR-SUPPLIED RESPIRATOR. WARNING: AIR-PURIFYING RESPIRATORS DO NOT PROTECT WORKERS IN

CONTINUED ON PAGE: 7

SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT (CONTINUED)

OXYGEN-DEFICIENT ATMOSPHERES.

EYE/SKIN PROTECTION: USE CHEMICAL SAFETY GOGGLES AND/OR FULL FACE SHIELD WHERE SPLASHING IS POSSIBLE. MAINTAIN EYE WASH FOUNTAIN AND QUICK-DRENCH FACILITIES IN WORK AREA.

WEAR IMPERVIOUS PROTECTIVE CLOTHING, INCLUDING BOOTS, GLOVES, LAB COAT, APRON OR COVERALLS, AS APPROPRIATE, TO PREVENT SKIN CONTACT.

SECTION IX - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA* STORAGE COLOR CODE: RED (FLAMMABLE)

STORAGE REQUIREMENTS
PROTECT AGAINST PHYSICAL DAMAGE. STORE IN A COOL, DRY WELL-VENTILATED LOCATION, AWAY FROM ANY AREA WHERE THE FIRE HAZARD MAY BE ACUTE. OUTSIDE OR DETACHED STORAGE IS PREFERRED. SEPARATE FROM OXIDIZING MATERIALS. CONTAINERS SHOULD BE BONDED AND GROUNDED FOR TRANSFERS TO AVOID STATIC SPARKS. STORAGE AND USE AREAS SHOULD BE NO SMOKING AREAS. USE NON-SPARKING TYPE TOOLS AND EQUIPMENT.

SPECIAL PRECAUTIONS
CONTAINERS OF THIS MATERIAL MAY BE HAZARDOUS WHEN EMPTY SINCE THEY RETAIN PRODUCT RESIDUES (VAPORS, LIQUID); OBSERVE ALL WARNINGS AND PRECAUTIONS LISTED FOR THE PRODUCT.

SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME: ACETONE
HAZARD CLASS: 3
UN/NA: UN1090 REPORTABLE QUANTITY: 5000 LBS. PACKAGING GROUP: II
LABELS: 3 FLAMMABLE LIQUID
REGULATORY REFERENCES: 49CFR 172.101

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SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION (CONTINUED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME: ACETONE
HAZARD CLASS: 3.1 I.M.O. PAGE: 3102
UN: UN1090 MARINE POLLUTANTS: NO PACKAGING GROUP: II
LABELS: 3 FLAMMABLE LIQUID
REGULATORY REFERENCES: 49CFR PART 176; IMDG CODE

AIR (I.C.A.O.)

PROPER SHIPPING NAME: ACETONE
HAZARD CLASS: 3
UN: UN1090 PACKAGING GROUP: II
LABELS: 3 FLAMMABLE LIQUID
REGULATORY REFERENCES: 49CFR PART 175; ICAO=== WE BELIEVE THE TRANSPORTATION DATA AND REFERENCES CONTAINED HEREIN TO BE FACTUAL AND THE OPINION OF QUALIFIED EXPERTS. THE DATA IS MEANT AS A GUIDE TO THE OVERALL CLASSIFICATION OF THE PRODUCT AND IS NOT PACKAGE SIZE SPECIFIC, NOR SHOULD IT BE TAKEN AS A WARRANTY OR REPRESENTATION FOR WHICH THE COMPANY ASSUMES LEGAL RESPONSIBILITY.=== THE INFORMATION IS OFFERED SOLELY FOR YOUR CONSIDERATION, INVESTIGATION, AND VERIFICATION. ANY USE OF THE INFORMATION MUST BE DETERMINED BY THE USER TO BE IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE, AND LOCAL LAWS AND REGULATIONS. SEE SHIPPER REQUIREMENTS 49CFR 171.2, CERTIFICATION 172.204, AND EMPLOYEE TRAINING 49 CFR 173.1(8).

U.S. CUSTOMS HARMONIZATION NUMBER: 29141100008

NOTE: WHEN HANDLING LIQUID PRODUCTS, SECONDARY PROTECTIVE CONTAINERS MUST BE USED FOR CARRYING.
-N/A = NOT APPLICABLE, OR NOT AVAILABLE; -N/E = NOT ESTABLISHED

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NOTE: CHEMTREC, CANUTEC AND NATIONAL RESPONSE CENTER EMERGENCY TELEPHONE NUMBERS ARE TO BE USED ONLY IN THE EVENT OF CHEMICAL EMERGENCIES INVOLVING A SPILL, LEAK, FIRE, EXPOSURE, OR ACCIDENT INVOLVING CHEMICALS. ALL NON-EMERGENCY QUESTIONS SHOULD BE DIRECTED TO CUSTOMER SERVICE (1-800-JTBAKER) FOR ASSISTANCE.

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APPROVED BY QUALITY ASSURANCE DEPARTMENT.

-- LAST PAGE --
"ISSUED BY VWR 05/02/96"

MATERIAL SAFETY DATA SHEET

EM SCIENCE

11. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MANUFACTURER.....:

EM SCIENCE
A DIVISION OF EM INDUSTRIES
P.O. BOX 70
480 DEMOCRAT RD.
GIBBSTOWN, N.J. 08027

PREPARATION DATE.: 11/20/95
DATE MSDS PRINTED.: DEC 18, 1995

INFORMATION PHONE NUMBER.: 609-423-6300
HOURS: MON. TO FRI. 8:30-5
CHEMTREC EMERGENCY NUMBER: 800-424-9300
HOURS: 24 HRS A DAY

CATALOG NUMBER(S):
HX0295 HX0302

PRODUCT NAME.....:
HEXANE
SYNONYMS.....:
HEXANES
CHEMICAL FAMILY..:
ALIPHATIC HYDROCARBON
FORMULA.....:
C6H14

MOLECULAR WEIGHT.:
86.18

12. COMPOSITION / INFORMATION ON INGREDIENTS

COMPONENT	CAS #	APPR %
HEXANE	110-54-3	95-99%

ALSO CONTAINS METHYL PENTANES 0-5% CAS# UNKNOWN. MAY CONTAIN TRACE LEVELS BENZENE (0.0002%) CAS# 71-43-2.
BENZENE HAS BEEN FOUND TO CAUSE CANCER.
NOTIFICATION OF CARCINOGENIC INGREDIENTS IN QUANTITY LESS THAN 0.1% IS NOT REQUIRED UNDER FEDERAL HAZARD COMMUNICATION LAW.

13. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
EXTREMELY FLAMMABLE LIQUID AND VAPOR.
HARMFUL IF INHALED OR SWALLOWED.

MAY CAUSE DAMAGE TO KIDNEYS, NERVES, AND RESPIRATORY SYSTEM.
IRRITATING TO SKIN, EYES AND MUCOUS MEMBRANES.

APPEARANCE.....:
CLEAR, COLORLESS LIQUID

POTENTIAL HEALTH EFFECTS (ACUTE AND CHRONIC)

SYMPTOMS OF EXPOSURE:
TOXIC BY INGESTION AND INHALATION.
VAPOR INHALATION CAUSES IRRITATION OF NASAL AND RESPIRATORY PASSAGES, HEADACHE, DIZZINESS, NAUSEA, CENTRAL NERVOUS SYSTEM DEPRESSION.
N-HEXANE IS NEUROTOXIC. CHRONIC OVEREXPOSURE CAN CAUSE SEVERE NERVE DAMAGE. MAINLY RESPONSIBLE FOR THE (CHRONIC) TOXICITY IS THE METABOLITE 2,5-HEXANDION. IN HUMANS, THIS DIKETONE IS FORMED AS A MAIN METABOLITE, WHICH THE RAT MOSTLY METABOLIZES TO 2-HEXANOL. CONSEQUENTLY THE LD50 VALUE OF THE RAT WITH 28710 MG/KG IS NOT SUITABLE FOR THE TOXICITY IN HUMANS. IN THE RAT, A NEUROTOXIC EFFECT SHOWS UP ONLY ABOVE A CONCENTRATION OF 200 ML/CU.M., WHILE THE HUMAN ORGANISM CAN REACT WITH PLYNEUROPATIC SYMPTOMS AT 100 ML/CU.M.
CAUSES IRRITATION ON CONTACT WITH SKIN OR EYES.
MAY CAUSE DAMAGE TO KIDNEYS AND/OR LIVER.

MEDICAL COND. AGGRAVATED BY EXPOSURE:
KIDNEY, LIVER, RESPIRATORY AND CNS CONDITIONS

ROUTES OF ENTRY.....:
INHALATION, INGESTION OR SKIN CONTACT.

CARCINOGENICITY.....:
THE MATERIAL IS NOT LISTED (IARC, NTP, OSHA) AS CANCER CAUSING AGENT.
MAY CONTAIN TRACE BENZENE (SEE SECTION TWO).

4. FIRST AID MEASURES

EMERGENCY FIRST AID:
GET MEDICAL ASSISTANCE FOR ALL CASES OF OVEREXPOSURE.
SKIN: IMMEDIATELY FLUSH THOROUGHLY WITH LARGE AMOUNTS OF WATER.
EYES: IMMEDIATELY FLUSH THOROUGHLY WITH WATER FOR AT LEAST 15 MINUTES.
INHALATION: REMOVE TO FRESH AIR; GIVE ARTIFICIAL RESPIRATION IF BREATHING HAS STOPPED.
INGESTION: DO NOT INDUCE VOMITING; GET IMMEDIATE MEDICAL ATTENTION.

5. FIRE FIGHTING MEASURES

FLASH POINT (F).....: -7F (CC)
FLAMMABLE LIMITS LEL (%).: 1.20
FLAMMABLE LIMITS UEL (%).: 7.50
EXTINGUISHING MEDIA.....:
DAM, DRY CHEMICAL, OR CO2

FIRE FIGHTING PROCEDURES.:
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING.

FIRE & EXPLOSION HAZARDS.:
DANGEROUS FIRE AND EXPLOSIVE HAZARD.
VAPOR CAN TRAVEL DISTANCES TO IGNITION SOURCE AND FLASH BACK.

6. ACCIDENTAL RELEASE MEASURES

SPILL RESPONSE:
EVACUATE THE AREA OF ALL UNNECESSARY PERSONNEL.
WEAR SUITABLE PROTECTIVE EQUIPMENT LISTED UNDER EXPOSURE / PERSONAL PROTECTION.
ELIMINATE ANY IGNITION SOURCES UNTIL THE AREA IS DETERMINED TO BE FREE FROM EXPLOSION OR FIRE HAZARDS.
CONTAIN THE RELEASE AND ELIMINATE ITS SOURCE, IF THIS CAN BE DONE WITHOUT RISK.
TAKE UP AND CONTAINERIZE FOR PROPER DISPOSAL AS DESCRIBED UNDER DISPOSAL.
COMPLY WITH FEDERAL, STATE, AND LOCAL REGULATIONS ON REPORTING RELEASES. REFER TO REGULATORY INFORMATION FOR REPORTABLE QUANTITY AND OTHER REGULATORY DATA.
EM SCIENCE RECOMMENDS SPILL-X ABSORBENT AGENTS FOR VARIOUS TYPES OF SPILLS. ADDITIONAL INFORMATION ON THE SPILL-X PRODUCTS CAN BE PROVIDED THROUGH THE EM SCIENCE TECHNICAL SERVICE DEPARTMENT (609) 354-9200.
THE FOLLOWING EM SCIENCE SPILL-X ABSORBENT IS RECOMMENDED FOR THIS PRODUCT:

SX0863 SOLVENT SPILL TREATMENT KIT

7. HANDLING AND STORAGE

HANDLING & STORAGE:
KEEP CONTAINER CLOSED.
STORE IN A COOL, DRY AREA AWAY FROM IGNITION SOURCES AND OXIDIZERS.
DO NOT BREATH VAPOR OR MIST.
ELECTRICALLY GROUND ALL EQUIPMENT WHEN HANDLING THIS PRODUCT.
RETAINED RESIDUE MAY MAKE EMPTY CONTAINERS HAZARDOUS; USE CAUTION!
DO NOT GET IN EYES, ON SKIN, OR ON CLOTHING.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT:

VENTILATION, RESPIRATORY PROTECTION, PROTECTIVE CLOTHING, EYE PROTECTION
RESPIRATORY PROTECTION: IF WORKPLACE EXPOSURE LIMIT(S) OF PRODUCT
OR ANY COMPONENT IS EXCEEDED (SEE TLV/PEL), A NIOSH/MSHA APPROVED
AIR SUPPLIED RESPIRATOR IS ADVISED IN ABSENCE OF PROPER
ENVIRONMENTAL CONTROL. OSHA REGULATIONS ALSO PERMIT OTHER
NIOSH/MSHA RESPIRATORS (NEGATIVE PRESSURE TYPE) UNDER SPECIFIED
CONDITIONS (SEE YOUR SAFETY EQUIPMENT SUPPLIER). ENGINEERING
AND/OR ADMINISTRATIVE CONTROLS SHOULD BE IMPLEMENTED TO REDUCE
EXPOSURE.
MATERIAL SHOULD BE HANDLED OR TRANSFERRED IN AN APPROVED FUME
HOOD OR WITH ADEQUATE VENTILATION.
PROTECTIVE GLOVES SHOULD BE WORN TO PREVENT SKIN CONTACT
(NITRILE OR EQUIVALENT)
SAFETY GLASSES WITH SIDE SHIELDS SHOULD BE WORN AT ALL TIMES.

WORK / HYGENIC PRACTICES:
WASH THOROUGHLY AFTER HANDLING.
DO NOT TAKE INTERNALLY.
EYE WASH AND SAFETY EQUIPMENT SHOULD BE READILY AVAILABLE.

EXPOSURE GUIDELINES

OSHA - PEL:

	TWA		STEL		CL		
COMPONENT	PPM	MG/M3	PPM	MG/M3	PPM	MG/M3	SKIN
HEXANE	50	180					

ACGIH - TLV:

	TWA		STEL		CL		
COMPONENT	PPM	MG/M3	PPM	MG/M3	PPM	MG/M3	SKIN
HEXANE	50	176					

9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT (C 760 MMHG).: 65C
MELTING POINT (C).....: -95C
SPECIFIC GRAVITY (H20 = 1).: 0.6603
VAPOR PRESSURE (MM HG).....: 125 20C
PERCENT VOLATILE BY VOL (%): 100%
VAPOR DENSITY (AIR = 1).....: 3.0
EVAPORATION RATE (BUAC = 1): 9.0
SOLUBILITY IN WATER (%).....: SLIGHT
APPEARANCE.....:

SIGMA CHEMICAL -- F5134 (STOCK#:HT201) FORMALIN SOLUTION 10%,
MATERIAL SAFETY DATA SHEET
NSN: 6550012262925
Manufacturer's CAGE: 21076
Part No. Indicator: A
Part Number/Trade Name: F5134 (STOCK#:HT201) FORMALIN SOLUTION 10%,
NEUTRAL BUFFERED

General Information

Company's Name: SIGMA CHEMICAL COMPANY
Company's Street: 3050 SPRUCE ST
Company's P. O. Box: 14508
Company's City: ST. LOUIS
Company's State: MO
Company's Country: US
Company's Zip Code: 63178
Company's Emerg Ph #: 314-771-5765
Company's Info Ph #: 800-325-3010/FAX 800-325-5052
Distributor/Vendor # 1: ALDRICH CHEMICAL CO INC./SUB OF SIGMA-AL
Distributor/Vendor # 1 Cage: 60928
Distributor/Vendor # 2: FLUKA CHEMICAL CORP (516-467-0980)
Distributor/Vendor # 2 Cage: 63181
Record No. For Safety Entry: 004
Tot Safety Entries This Stk#: 004
Status: SE
Date MSDS Prepared: 01OCT94
Safety Data Review Date: 03MAY96
Supply Item Manager: KX
MSDS Serial Number: BYVXJ
Specification Number: UNKNOWN
Hazard Characteristic Code: T6
Unit Of Issue: BG
Unit Of Issue Container Qty: UNKNOWN
Type Of Container: BAG
Net Unit Weight: UNKNOWN

Ingredients/Identity Information

Physical/Chemical Characteristics

Appearance And Odor: LIQUID.
Boiling Point: 121F,49C
Vapor Pressure (MM Hg/70 F): 25
Vapor Density (Air=1): 1.02
Specific Gravity: 1.000
Solubility In Water: WATER--SOLUBLE

Fire and Explosion Hazard Data

Flash Point: 185F,85C
Flash Point Method: CC
Lower Explosive Limit: 7.0
Upper Explosive Limit: 73
Extinguishing Media: WATER MAY BE EFFECTIVE FOR COOLING BUT MAY NOT EFFECT EXTINGUISHMENT.CARBON DIOXIDE,DRY CHEM POWDER OR APPROPRIATE FOAM.
Special Fire Fighting Proc: WEAR SELF-CONTAINED BREATHING APPARATUS & PROTECTIVE CLOTHING TO PREVENT CONTACT W/SKIN/EYES.USE WATERSPRAY TO COOL

FIRE-EXPO CONTAINERS.
Unusual Fire And Expl Hazrds: COMBUSTIBLE LIQ.EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

Reactivity Data

Cond To Avoid (Stability): NONE SPECIFIED BY MANUFACTURER.
Materials To Avoid: ANILINE,PHENOL,ISOCYANATES,ANHYDRIDES,STRONG ACIDS, STRONG BASES.RXS VIOLENTYL W/STRONG OXIDIZING AGENTS.
Hazardous Decomp Products: THERM DECOMPOSITION MAY PRODUCE TOXIC FUMES OF PHOSPHORUS OXIDES &/OR PHOSPHINE.CARBON MONOXIDE AND CARBON DIOXIDE
Conditions To Avoid (Poly): NONE SPECIFIED BY MANUFACTURER.

Health Hazard Data

LD50-LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: MAY BE FATAL IF INHAL/INGEST/ABSORBED THRU SKIN.CAUSES SEVERE EYE IRRIT.MATL IRRIT TO MUC MEMBRANES & UPPER RESP TRACT.MAY CAUSE ALLERGIC RESP & SKIN RXS.EXPO CAN CAUSE:COUGHING,CHEST PAINS,DIFFICULTY IN BREATH.PULM EDEMA.EFFECTS MAY BE DELAYED.GI DISTURBANCES.CONTAINS METHANOL,FATAL/CAUSE BLINDNESS,CAN'T BE MADE UNPOI
Carcinogenicity - NTP: YES
Carcinogenicity - IARC: YES
Carcinogenicity - OSHA: YES
Explanation Carcinogenicity: CONTAINS Formaldehyde [50-00-0] WHICH IS LISTED BY NTP AND IARC AND REGULATED BY OSHA AS A CARCINOGEN.
Signs/Symptoms Of Overexp: SEVERE EYE IRRIT, MUC MEMBRANE/UPPER RESP TRACT/GI TRACT IRRIT. ALLERGIC RESP/SKIN REACTIONS. COUGHING, CHEST PAINS, DIFFICULTY IN BREATHING,PULM EDEMA. FATAL, CAUSEL BLINDNESS. MAY ALTER GENETIC MATERIAL.
Med Cond Aggravated By Exp: NONE SPECIFIED BY MANUFACTURER. TARGET ORGANS:EYE, KIDNEYS.
Emergency/First Aid Proc: IN CASE OF CONTACT IMMED LFUSH EYE/SKIN W/ COPIOUS AMTS OF WATER FOR @LEAST 15MINS WHILE REMOVING CONTMAIN CLOTH/ SHOES.ASSURE ADEQUATE FLUSHING OF EYES BY SEPARATING EYELIDS W/FINGERS.IF INHALED REMOVE TO FRESH AIR.NOT BREATH GIVE ART RESP.BREATHING DIFFICULT GIVE OXYGEN.IF SWALLOWED,WASH OUT MOUTH W/WATER PROVIDED PERSON IS CONSC. CALL PHYSICIAN.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: EVACUATE AREA.WEAR SELF-CONTAINED BREATHING APPARATUS,RUBB BOOTS,HEAVY RUBB GLOVES.ABSORB ON SAND/VERMICULITE.PLACE IN CLSD CNTNRS FOR DISPOSAL.VENTILATE AREA.WASH SPILL SITE AFT MATL PICKUP IS COMPLETE.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Method: DISSOLVE/MIX W/COMBUST SOLVT & BURN IN CHEM INCINERATOR EQUIPPED W/AFTBURNER/SCRUBBER.OBSERVE ALL FED/STATE/LOC ENVIRO REGS. CONTAINS CHEM SUBJ TO SARA SEC 313 TITLE III SARA REPORITNG REQMTS.
Precautions-Handling/Storing: USE ONLY IN CHEMICAL FUME HOOD.DO NOT BREATH VAP.DO NOT GET IN EYE/SKIN/CLOTH.AVOID PROLONGED/REPEATED EXPO.READILY ABSORBED THRU SKIN.HIGHLY TOXIC.
Other Precautions: KEEP TIGHTLY CLSD.STORE IN COOL,DRY PLACE.CARCINOGEN, SEVERE EYE IRRIT,SENSITIZER,LACHRYMATOR,MUTAGEN.

Control Measures

Respiratory Protection: WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR.
Ventilation: USE ONLY IN CHEMICAL FUME HOOD.
Protective Gloves: CHEM-RESISTANT GLOVES.
Eye Protection: SAFETY GOGGLES
Other Protective Equipment: PROTECTIVE CLOTHING.SAFETY SHOWER,EYEBATH.
Work Hygienic Practices: DISCARD CONTAMINATED CLOTHING/SHOES.WASH THOROUGHLY AFT HNDLG.
Suppl. Safety & Health Data: PER TIR:ITEM CANCELLED DTD 93274 W/O REPLACEMENT.

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Transportation Data

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Trans Data Review Date: 96124
IMO PSN Code: HLZ
IMO Proper Shipping Name: FORMALDEHYDE SOLUTION,
IMO Regulations Page Number: 8176-1
IMO UN Number: 2209
IMO UN Class: 8
IMO Subsidiary Risk Label: -
IATA PSN Code: MKR
IATA UN ID Number: 1198
IATA Proper Shipping Name: FORMALDEHYDE SOLUTION, FLAMMABLE
IATA UN Class: 3
IATA Subsidiary Risk Class: 8
IATA Label: FLAMMABLE LIQUID & CORROSIVE
AFI PSN Code: MKR
AFI Prop. Shipping Name: FORMALDEHYDE SOLUTIONS
AFI Class: 3
AFI ID Number: UN1198
AFI Pack Group: III
AFI Label: 8 *
AFI Basic Pac Ref: A7.3
Additional Trans Data: PER MSDS:TRANSP INFO CONTACT SIGMA CHEMICAL CO.

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Disposal Data

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Label Data

==========

Label Required: YES
Technical Review Date: 03MAY96
Label Status: F
Common Name: F5134 (STOCK#:HT201) FORMALIN SOLUTION 10%, NEUTRAL BUFFERED
Chronic Hazard: YES
Signal Word: DANGER!
Acute Health Hazard-Severe: X
Contact Hazard-Severe: X
Fire Hazard-Moderate: X
Reactivity Hazard-None: X
Special Hazard Precautions: HIGHLY TOXIC,MAY CAUSE CANCER,HERITABLE GENETIC DMG.TOXIC BY INHAL/SKIN CONTACT/INGEST.MAY CAUE SENSITIZATION BY INHAL/SKIN CONTACT.CAUSES IRRIT.LACHRYMATOR.TARGET ORGANS:EYE/KIDNEYS. 1STAID:IN CASE OF CONTACT IMMED LFUSH EYE/SKIN W/COPIOUS AMTS OF WATER FOR @LEAST 15MINS WHILE REMOVING CONTMAIN CLOTH/SHOES.ASSURE ADEQUATE FLUSHING OF EYES BY SEPARATING EYELIDS W/FINGERS.IF INHALED REMOVE TO FRESH AIR.NOT BREATH GIVE ART RESP.BREATHING DIFFICULT GIVE OXYGEN.IF SWALLOWED,WASH OUT MOUTH W/WATER PROVIDED PERSON IS CONSC.CALL PHYSICIAN.CONTAINS METHANOL, CAN'T BE MADE UNPOISON.FIRE:CARBON DIOXIDE,DRY CHEM POWDER,APPROPRIATE FOAM.

Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: SIGMA CHEMICAL COMPANY
Label Street: 3050 SPRUCE ST
Label P.O. Box: 14508
Label City: ST. LOUIS
Label State: MO
Label Zip Code: 63178
Label Country: US
Label Emergency Number: 314-771-5765

CHAIN OF CUSTODY RECORD/SAMPLE ANALYSIS REQUEST FORM

Page ___ of ___

Project:
(Name and Number)

Exponent Contact: _____ Office: ____

Ship to: _____

_____

_____

Lab Contact/Phone: _____

Samplers:

Exponent
Environmental Group

Bellevue,WA (425) 643-9803
Portland, OR (503) 636-4338
Boulder, CO (303) 444-7270
Boston, MA (781) 466-6681
Washington, D.C. (301) 577-7830
Atlanta, GA (770) 419-9909

Sample No.	Tag No.	Date	Time	Matrix	Analyses Requested						Extra Container	Archive	Remarks

Matrix Code: GW - Groundwater SL - Soil SD - Sediment SW - Surface water
OTHER - Please identify codes _____

Priority: ☐ Normal ☐ Rush Rush time period _____

Shipped via: ☐ FedEx/UPS ☐ Courier Other_____

Condition of Samples Upon Receipt: _____

Custody Seal Intact: ☐ Yes ☐ No ☐ None

Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____
(Signature) (Signature)

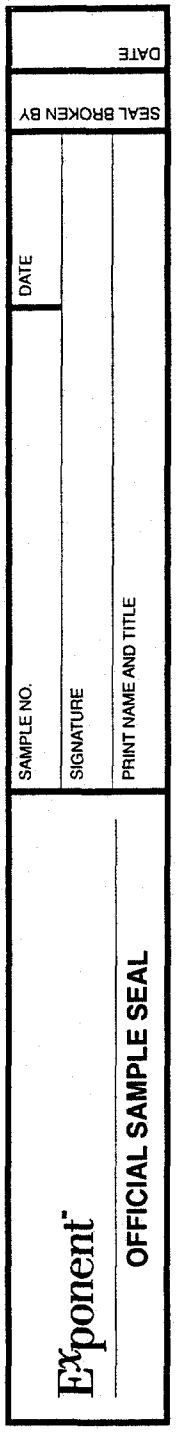
Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____
(Signature) (Signature)

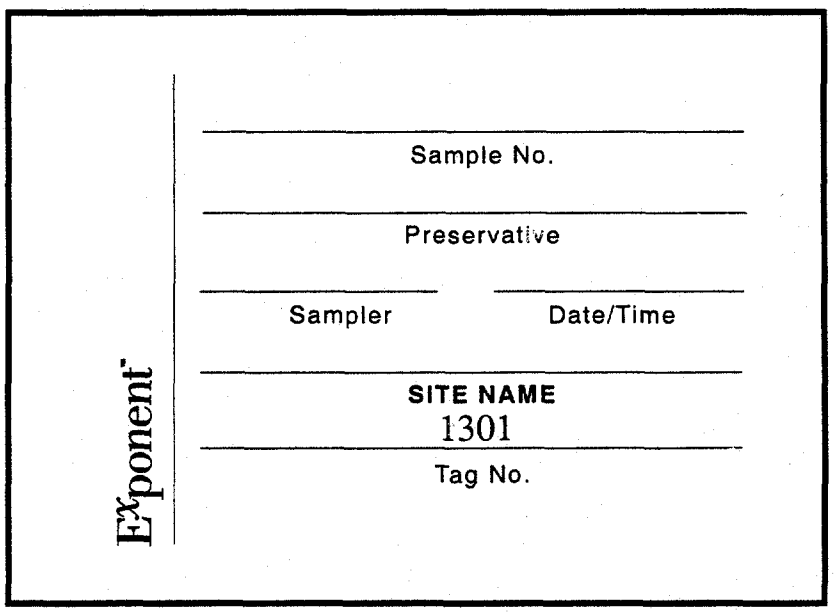
Distribution: White and Yellow Copies - Accompany Shipment; Pink Copy - Project File

309508

Example chain of custody/sample analysis request form.

CBCH-16-12 04/23/98 WA





Example label and chain-of-custody seal.

CLEAR, COLORLESS LIQUID

STABILITY AND REACTIVITY

STABILITY.....: YES

HAZARDOUS POLYMERIZATION:
DOES NOT OCCUR

HAZARDOUS DECOMPOSITION.:
COX

CONDITIONS TO AVOID.....:
HEAT; CONTACT WITH IGNITION SOURCES.

MATERIALS TO AVOID.....:
( ) WATER
( ) ACIDS
( ) BASES
( ) CORROSIVES
(X) OXIDIZERS
( ) OTHER :

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA:

IHL-HMN TCLO: 5000 PPM/10M
ORL-RAT LD50: 28710 MG/KG
(SEE SECTION 3 - SYMPTOMS OF EXPOSURE)

TOXICOLOGICAL FINDINGS:
TESTS ON LABORATORY ANIMALS INDICATE MATERIAL MAY PRODUCE ADVERSE MUTAGENIC AND REPRODUCTIVE EFFECTS.
CITED IN REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS)

12. DISPOSAL CONSIDERATIONS

EPA WASTE NUMBERS: D001
TREATMENT:
INCINERATION, FUELS BLENDING OR RECYCLE. CONTACT YOUR LOCAL PERMITTED WASTE DISPOSAL SITE (TSD) FOR PERMISSIBLE TREATMENT SITES.
ALWAYS CONTACT A PERMITTED WASTE DISPOSER (TSD) TO ASSURE COMPLIANCE WITH ALL CURRENT LOCAL, STATE AND FEDERAL REGULATIONS.

13. TRANSPORT INFORMATION

DOT PROPER SHIPPING NAME...:
HEXANE

DOT ID NUMBER.....:
UN1208

14. REGULATORY INFORMATION

TSCA STATEMENT .....:
THE CAS NUMBER OF THIS PRODUCT IS LISTED ON THE TSCA INVENTORY.

COMPONENT	SARA EHS (302)	SARA EHS TPQ (LBS)	CERCLA RQ (LBS)
HEXANE			5000

COMPONENT	OSHA FLOOR LIST	SARA 313	DEMINIMIS FOR SARA 313 (%)
HEXANE	Y	Y	1.0

OTHER INFORMATION

COMMENTS:
NONE

NFPA HAZARD RATINGS:
HEALTH : 1
FLAMMABILITY : 3
REACTIVITY : 0
SPECIAL HAZARDS :

REVISION HISTORY:
01/04/89 06/28/89 03/01/91 06/23/93 01/25/94 03/06/95 09/08/95

I = REVISED SECTION
N/A = NOT AVAILABLE
N/E = NONE ESTABLISHED

THE STATEMENTS CONTAINED HEREIN ARE OFFERED FOR INFORMATIONAL PURPOSES ONLY AND ARE BASED UPON TECHNICAL DATA THAT EM SCIENCE BELIEVES TO BE ACCURATE. IT IS INTENDED FOR USE ONLY BY PERSONS HAVING THE NECESSARY TECHNICAL SKILL AND AT THEIR OWN DESCRETION AND RISK. SINCE CONDITIONS AND MANNER OF USE ARE OUTSIDE OUR CONTROL, WE MAKE NO WARRANTY, EXPRESS

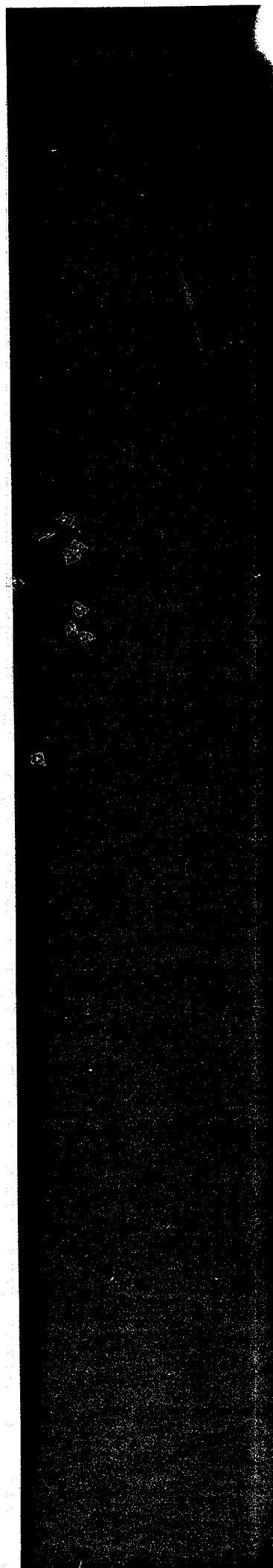
OR IMPLIED, OF MERCHANTABILITY, FITNESS OR OTHERWISE.

Appendix C

Standard Operating Procedures

SOP 2

Sample Packaging and Shipping



Note: SOP 4 cited within.

STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING AND SHIPPING
SOP 2

Specific requirements for sample packaging and shipping must be followed to ensure the proper transfer and documentation of environmental samples collected during field operations. Procedures for the careful and consistent transfer of samples from the field to the laboratory are outlined herein.

EQUIPMENT REQUIRED

Specific equipment or supplies necessary to properly pack and ship environmental samples include the following:

- Ice in sealed bags or blue ice
- Sealable airtight bags
- Plastic garbage bags
- Coolers
- Bubble wrap
- Fiber reinforced packing tape
- Scissors
- Chain-of-custody seals
- Airbills for overnight shipment
- Chain-of-custody record/sample analysis request forms.

PROCEDURE

The following steps should be followed to ensure the proper transfer of samples from the field to the laboratories:

1. Appropriately document all samples using the proper logbooks (see SOP 4) and chain-of-custody/sample analysis request forms (example provided in Attachment 2-1).

2. Make sure all applicable laboratory quality control sample designations have been made on the sample analysis request forms. Samples that will be archived for future possible analysis should be clearly identified on the sample analysis request form. Such samples should also be labeled on the sample analysis request form as "Do Not Analyze: Hold and archive for possible future analysis" because some laboratories interpret "archive" as meaning to continue holding the residual sample after analysis.

3. Notify the laboratory contact and the project QA/QC coordinator that samples will be shipped and the estimated arrival time. Send copies of all chain-of-custody record/sample analysis request forms to the QA/QC coordinator.

4. Clean the outside of all dirty sample containers to remove any residual material that may lead to cross-contamination.

5. Check sample containers against the chain-of-custody record to ensure all samples intended for shipment are accounted for.

6. Store each sample container in a sealable bag that allows the sample label (example provided in Attachment 2-1) to be read. Volatile organic analyte (VOA) vials for a single sample must be encased in bubble wrap before being sealed in bags.

7. Choose the appropriate size cooler (or coolers) and line with bubble wrap and a plastic garbage bag.

8. Fill the cooler with the samples, separating glass containers with bubble wrap and allowing room for ice to keep the samples cold. Add enough ice or blue ice to keep the samples refrigerated overnight. Ice should be enclosed in sealable plastic bags to prevent leakage. Avoid separating the samples from the ice with excess bubble wrap because it will insulate the containers from the ice. After all samples and ice have been added to the cooler, use bubble wrap to fill any empty space to keep the samples from shifting during transport.

9. Remember to consolidate any VOA samples in a single cooler, and ship them with a trip blank if the quality assurance project plan calls for one.

10. After all the samples are packed, close the plastic garbage bag and fasten it with a chain-of-custody seal (example provided in Attachment 2-1).

11. Store the signed chain-of-custody records/sample analysis request forms in a sealable bag and tape them to the inside of the cooler lid. Fill out the sample analysis request as described in SOP 5, and retain the back copy of the form for the project records prior to sealing the cooler.

12. After the cooler is sufficiently packed to prevent shifting of the containers, close the lid and seal it shut using fiber reinforced packing tape. Also, if the cooler has a drain at the bottom, it should be taped shut.

13. As security against unauthorized handling of the samples, apply one or two chain-of-custody seals across the opening of the cooler lid. Be sure the seals are properly affixed to the cooler so they are not removed during shipment.

14. Label the cooler with destination and return addresses, and add other appropriate stickers, such as "This End Up," "Fragile," and "Handle With Care."

15. If an overnight courier is used, fill out the airbill as required and fasten it to the top of the cooler. The identification number sticker should be taped to the lid, because tracking problems can occur if a sticker is removed during shipment.

Attachment 2-1

Example Chain-of-Custody Record/Sample Analysis Request Form, and Label and Custody Seal

SOP 4

Field Documentation

Note: SOP 5 cited within.

STANDARD OPERATING PROCEDURE

FIELD DOCUMENTATION
SOP 4

All information relevant to field operations must be properly documented to ensure that activities are accounted for and can be reconstructed from written records. Several types of logbooks will be used for this purpose and should be consistently used by field crews (e.g., field logbooks, sample logbooks, field data logbooks). Logbooks will be labeled on the cover with the project name, dates of field work, survey name, and the Exponent contract number. Each logbook will have a unique document control number assigned by the data management coordinator.

The information recorded in each logbook should be written in indelible ink. All corrections should consist of a single line-out deletion, followed by the author's initials and the date. When all pages in a logbook are used, copies will be made and kept in the field office, and the original will be sent to the project data management coordinator to be placed in the Exponent library. No bound logbooks should be discarded, even if they are illegible or contain inaccuracies that require a replacement document. When not in use, all logbooks will be stored in the field office.

FIELD LOGBOOKS

The purpose of the field logbook is to document events that occur in the field to the extent that someone not present at the site can reconstruct the activity without relying on the memory of the field crew. A bound logbook with consecutively numbered pages will be used for each survey element. The author will initial and date entries at the end of each day, and a line will be drawn through the remainder of the page. The logbooks, at a minimum, must contain the following information:

1. A purpose and description of the field task
2. The time and date the field work began
3. The location and description of the work area, including sketches, map references, and photographs, if appropriate
4. The names and titles of field personnel and anyone present during the field work, including the times they are present

5. The name, agency, and telephone number of any field contacts
6. The meteorological conditions at the beginning of the field work and any changes that occur throughout the day, including the approximate time of the change
7. Details of the field work performed, with a description of any deviations from the sampling and analysis plan or field methods
8. All field measurements made (unless a specific logbook is available for this purpose), including the time of measurement
9. Any field results not appearing in the field data logbook
10. Personnel and equipment decontamination procedures
11. References to other logbooks used to record information (e.g., station log, sample log, health and safety log)
12. Deviations from the sampling and analysis plan.

SAMPLE LOGBOOKS

Each sampling element requires a unique sample logbook, which will be used to record the relevant sample information. For instructions regarding proper use of sample identifiers, sampling personnel should consult the project data management coordinator or field sampling plan. The project sample logbooks require the following information:

1. Sampling station number and description
2. Date and time of sample collection
3. Method of locating sampling site and the coordinates
4. Location characteristics, such as water depth and sample depth
5. Sampling method
6. Sample identifier information, such as sample ID, sample number and tag number, field replicate ID, and subsample ID
7. Sample volume
8. Sample analysis and identification of any quality control samples
9. Any observations or comments relevant to the sampling procedure, including suspected chemical concentration (low-level, moderate, or high-level), deviations from the sampling and analysis plan, and information regarding split samples

10. Information regarding photographs taken

11. Names of all sampling personnel.

SAMPLE LABELS

Sample labels are designed to uniquely identify each container that is used for a sample. Field crews will be provided with preprinted sample labels (also known as tags), which must be affixed to each sample container used. The labels should be filled out at the time the samples are collected and should consist of the following information:

1. Sample number
2. General category of analytes (primarily for identification purposes); the laboratory will follow instructions on the sample analysis request form (see SOP 5 for example) provided with the samples
3. Date and time sample is collected
4. Initials of the samplers
5. Preservatives used, if any
6. A unique tag number (preprinted on the tag) consisting of six digits, used to identify individual containers.

FIELD DATA LOGBOOKS

The purpose of the field data logbooks is to record data that are measured during field activities. They are organized to allow methodical and consistent entry of information by field crews. Field data logbooks to be used on a project include a field observation logbook for pH, conductivity, dissolved oxygen, and temperature measurements; a stream flow measurement logbook; and a site safety monitoring logbook for organic vapor and H_2S measurements. These logbooks typically contain space for the following information:

1. Station identification and location
2. Date and time of measurements
3. Field personnel
4. Measurements and calculations.

PHOTOGRAPHS

Photographs will be taken of field activities using a camera-lens system with a perspective similar to the naked eye. Photographs should include a measured scale in the picture, when practical. Telephoto or wide-angle shots will not be used because they cannot be used in enforcement proceedings. The following items should be recorded in the field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photograph, and the general direction faced
2. A brief description of the subject and the field work portrayed in the picture
3. The sequential number of the photograph and the roll number on which it is contained.

The slides or prints and associated negatives will be placed in task files in the field office after the film is developed. Any supporting documentation from the field logbooks will be photocopied and placed in the task files to accompany the slides or prints.

SOP 5

Sample Custody

Note: SOPs 2 and 4 cited within.

STANDARD OPERATING PROCEDURE

SAMPLE CUSTODY
SOP 5

A stringent, established program of sample chain-of-custody will be followed during sample storage and shipping activities to account for each sample. The procedure outlined herein will be used in conjunction with SOP 4, which covers the use of sample logbooks, and SOP 2, which covers sample packaging and shipping. Chain-of-custody record/ sample analysis request forms (Attachment 5-1) ensure that samples are traceable from the time of collection through processing and analysis until final disposition. A sample is considered to be in a person's custody if any of the following criteria are met:

1. The sample is in the person's possession
2. The sample is in the person's view after being in possession
3. The sample is in the person's possession and is being transferred to a designated secure area
4. The sample has been locked up to prevent tampering after it was in the person's possession.

PROCEDURE

The chain-of-custody record portion of the form is the most critical because it documents sample possession from the time of collection through the final disposition of the sample. The sample analysis request portion of the form provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped.

The chain-of-custody record/sample analysis request form will be completed after each field collection activity and before the samples are shipped to the laboratory. Sampling personnel are responsible for the care and custody of the samples until they are shipped. When transferring possession of the samples, the individuals relinquishing and receiving the samples must sign the chain-of-custody record/sample analysis request form(s), indicating the time and date that the transfer occurs. Copies of the forms will be made and kept by Exponent, and the originals will be included with the samples in the transfer container. The following guidelines will be followed to ensure consistent shipping procedures and to maintain the integrity of the samples:

1. Each chain-of-custody record/sample analysis request form contains a line where all sampling personnel will sign. The person who relinquishes custody of the samples must sign this form. Samplers' signatures not on the chain-of-custody record/sample analysis request form should be entered in the field logbook.

2. The chain-of custody record/sample analysis request form should not be signed until the information has been checked for inaccuracies by the lead sampler. All changes should be made by drawing a single line through the incorrect entry and initialing and dating it. Revised entries should be made in the space below the entries. On the handwritten chain-of custody record/sample analysis request forms, spaces remaining at the bottom of the page after corrections are made should be marked out with single lines. This procedure will preclude any unauthorized additions.

3. At the bottom of each chain-of custody record/sample analysis request form is a space for the signatures of the persons relinquishing and receiving the samples and the time and date that the transfer occurred. The time that the samples were relinquished should match exactly the time they were received by another party. Under no circumstances should there be any time when custody of the samples is undocumented.

4. If samples are sent by a courier not affiliated with the laboratory, such as Federal Express or UPS, the name of the courier should be entered in the "received by" block. The time of transfer should be as close to the actual drop-off time as possible. After the chain-of custody record/ sample analysis request forms are signed and copied, they should be sealed inside the transfer container.

5. If errors are found after the shipment has left the custody of Exponent personnel, a corrected version of the forms must be made and sent to all relevant parties. Minor errors can be rectified by making the change on a copy of the original with a brief explanation and signature. The person who makes the changes should appear on the chain-of custody record/sample analysis request form as a sampler. Errors in the signature block may require a letter of explanation.

6. Samples that are archived internally at Exponent should be accompanied by a chain-of custody record/sample analysis request form. While samples remain in Exponent's custody before being shipped, all containers will be kept securely locked to preclude tampering with the samples.

Attachment 5-1

Example Chain-of-Custody Record/Sample Analysis Request Form

CHAIN OF CUSTODY RECORD/SAMPLE ANALYSIS REQUEST FORM

Page ___ of ___

Project:
(Name and Number)

Exponent Contact: _____ Office: ____

Ship to: _____

_____

_____

Lab Contact/Phone: _____

Samplers:

Exponent
Environmental Group

Bellevue,WA (425) 643-9803
Portland, OR (503) 636-4338
Boulder, CO (303) 444-7270
Boston, MA (781) 466-6681
Washington, D.C. (301) 577-7830
Atlanta, GA (770) 419-9909

Sample No.	Tag No.	Date	Time	Matrix	Analyses Requested						Extra Container	Archive	Remarks

Matrix Code: GW - Groundwater SL - Soil SD - Sediment SW - Surface water
OTHER - Please identify codes _____

Priority: ☐ Normal ☐ Rush Rush time period _____

Shipped via: ☐ FedEx/UPS ☐ Courier Other_____

Condition of Samples Upon Receipt: _____

Custody Seal Intact: ☐ Yes ☐ No ☐ None

Relinquished by: _____ (Signature) Date/Time: _____ Received by: _____ (Signature) Date/Time: _____

Relinquished by: _____ (Signature) Date/Time: _____ Received by: _____ (Signature) Date/Time: _____

Distribution: White and Yellow Copies - Accompany Shipment; Pink Copy - Project File

309528

Example chain of custody/sample analysis request form.

SOP 6B

Preparation of Field Quality Control Samples—Sediment

309529

Note: SOPs 2, 5, 71B, and 104 cited within.

STANDARD OPERATING PROCEDURE

PREPARATION OF FIELD QUALITY CONTROL SAMPLES—SEDIMENT SOP 6B

This SOP describes the purpose, preparation, and collection frequency of equipment rinsate blanks, replicate samples, trip blanks, and reference materials for solid matrices.

As part of the QA/QC program, all field quality control samples will be sent blind to the laboratories. To accomplish this, the samples will be sent in the same form as regular samples, including all containers, sample numbers, and analytes. The sample ID for field quality control samples should allow data management and data validation staff to identify them as such. Under no circumstances should the laboratory be allowed to use reference materials, rinsate blanks, or trip blanks for matrix spike and matrix spike duplicate analysis. The laboratory should be instructed to contact the project QA/QC coordinator when a laboratory quality control sample is not specified on the sample analysis request form for a sample digestion group so that one can be assigned.

All field quality control samples will be packaged and shipped with other samples in accordance with procedures outlined in SOP 2, *Sample Packaging and Shipping*. Sample custody will be maintained in accordance with procedures outlined in SOP 5, *Sample Custody*.

Field quality control samples will be prepared at least once per sampling event, and certain types will be prepared more often at predetermined frequencies. If the number of samples taken does not equal an integer multiple of the intervals specified in this SOP, the number of field quality control samples is specified by the next higher multiple. For example, if a frequency of 1 quality control sample per 20 is indicated and 28 samples are collected, 2 quality control samples will be prepared. The text below describes the preparation and frequency of field quality control samples required for sediment sampling activities.

EQUIPMENT RINSATE BLANKS

Equipment rinsate blanks will be used to help identify possible contamination from the sampling environment or from improperly decontaminated sampling equipment. Equipment rinsate blanks will be prepared by processing a representative amount of laboratory deionized water through the decontaminated sample collection equipment, then

transferring the water to the appropriate sample containers and adding any necessary preservatives. Because the matrix for rinsate blanks is water, rather than solids, bottle types and volumes should be coordinated with the laboratory. Equipment rinsate blanks will be prepared for sediment core sampling and analyzed for all inorganic, organic, and conventional analytes at least once per sampling event. The actual number of equipment rinsate blanks prepared during an event will be determined on a case-by-case basis by the project QA/QC coordinator.

Sediment collected with the gravity corer comes in contact with the polycarbonate tube that holds the sample and the stainless-steel bowl used for homogenizing the sediment sections. To prepare the equipment rinsate blank, the core tube and stainless-steel bowl will be decontaminated and allowed to air-dry as specified in SOP 104, *Sediment Coring Procedures Using Slide Hammer and Gravity Corers*. The procedure will likely require two people to be done effectively. One person should hold the polycarbonate tube at an angle above the stainless-steel bowl. While this person slowly turns the tube, the second person pours deionized water through the tube into the bowl. When the bowl is one-half full, the sample bottles will be filled with the water and preserved as necessary. The process will be repeated until all sample bottles are filled. When finished, the ends of the tube will be capped and the bowl covered with aluminum foil (dull side down) for use at the next station.

FIELD TRIPLICATE SAMPLES

Field triplicate samples are co-located samples collected in an identical manner over a minimum period of time to provide a measure of the analytical precision (field and laboratory) variance, including variance resulting from sample heterogeneity. Field triplicates will consist of three samples (one sample and two replicates) collected consecutively at the same location and placed in different bottles for separate analysis. Each replicate will have a unique sample number to distinguish it from the others. The three samples will be sent to the laboratory and analyzed for identical chemical parameters but will not be distinguishable by the laboratory as being replicates. Field triplicates will be collected for sediment core and surface sediment sampling at a minimum frequency of 1 per 50 samples or once per sampling event, whichever is more frequent.

TRIP BLANKS

Trip blanks will be used to help identify cross-contamination in the shipment of aqueous samples for analyzing volatile organic compounds (VOCs) only. Trip blanks will be prepared in the field office by pouring deionized water into two 40-mL VOC vials and tightly closing the lids. Each vial will be inverted and tapped lightly to ensure that no air bubbles exist.

The blanks will be transported unopened to and from the field in the cooler with the VOC samples. One trip blank will be sent with each shipment of samples for analyzing VOCs for sediment core and surface sediment sampling.

REFERENCE MATERIALS

Reference materials are materials of known composition that have been prepared by and obtained from EPA-approved sources and that have undergone multilaboratory analyses using a standard method. Reference material samples provide a measure of analytical performance and/or analytical method bias of the laboratory. Several reference materials may be required to cover all analytical parameters. Reference materials will be prepared for sediment core and surface sediment sampling at a minimum frequency of 1 per 50 samples or once per sampling event, whichever is more frequent. Details on preparation of the reference materials can be found in SOP 71B, *Preparation of Reference Materials—Sediment*.

SOP 51

Station Positioning

STANDARD OPERATING PROCEDURE

STATION POSITIONING
SOP 51

This SOP describes the equipment and procedures used to position sampling vessels and locate sampling stations.

EQUIPMENT REQUIRED

The locations of sampling stations will be surveyed in the field using one of the following four positioning systems:

- LORAN receiver (King 7000)
- Electronic distance measuring (EDM) system (Nikon NTD2-EDM)
- Global positioning system (GPS) (Magellan 5000)
- Range-range microwave positioning system (Del Norte 540).

Selection of the appropriate positioning system for a particular survey is based on the degree of accuracy required, as discussed below for each system.

LORAN RECEIVER

The LORAN receiver can be used to locate an approximate position, with a repeatable accuracy that varies from 20 to 30 m, depending on the weather and the geometry of the receiver within the LORAN station network. To use the LORAN receiver, the boat operator positions the boat at the target station and the chief scientist observes and records the LORAN reading at that station. A position fix is obtained by reading the time difference (TD) displayed from two LORAN stations or by switching the receiver to the "lat-long" display and comparing the displayed latitude-longitude to the preplotted coordinates for a particular station.

ELECTRONIC DISTANCE MEASURING SYSTEM

The EDM system can achieve an absolute and repeatable positioning accuracy ranging from less than 1 m to 5 km. Required equipment includes a range reflector and two marine band VHF radio-telephones. The following procedures are used for locating and documenting the position of a sampling station:

1. From the sampling vessel, collect a sample at the sampling station and deploy a buoy at the station.
2. Notify the surveyors by radio that positioning of the buoys is required.
3. Locate the sampling vessel (or motorized dingy) at the station and hold the survey prism directly above the sampling station buoy.
4. Radio the surveyor with the sampling station number.
5. Confirm the station number with the surveyor, who will read and record the range and azimuth displayed on the EDM.

GLOBAL POSITIONING SYSTEM

Accuracy requirements for reconnaissance surveys allow the use of a portable GPS receiver. The geographic and repeatable accuracy of a hand-held GPS receiver is approximately 15 m. The United States government, however, has decided not to provide this full level of accuracy to non-military GPS users. GPS signals are intentionally degraded to provide varying levels of accuracy over time. This results in an accuracy of 50 m, 50 percent of the time, and 100 m, 95 percent of the time. Accuracy can be increased by averaging fixes taken at a single location at several points in time. The only equipment required for the GPS positioning system is the GPS receiver and a spare set of AA batteries. The following procedures are used for locating and documenting the position of a sampling station:

1. Enter the latitude and longitude of the sampling station into the GPS receiver.
2. Program the GPS receiver to display the range and distance to the sampling station, and steer the boat to the station.
3. When the boat arrives at the sampling station, deploy the sampler and a buoy labeled with the number of the sampling station.
4. Hold the GPS receiver over the station buoy and record the latitude and longitude of the station in the field logbook.

RANGE-RANGE MICROWAVE POSITIONING SYSTEM

The range-range microwave positioning system uses radio beacons, located onshore, that respond to interrogations from the survey vessel's navigation system. The distance from the survey vessel to each of the beacons can be determined based on the travel time interval between the interrogation from the shipboard system and the response from the shore stations. The microwave system transmits on the line of sight. Therefore, the practicable range of the system is limited by the height of the beacons. The position information is updated every second with a position repeatability of ±1 m. A minimum of three beacons (usually four) are used during the survey. All positioning data are recorded on disk and printed by the vessel's navigation acquisition system. The angles of intersection between adjacent shoreline stations must be greater than 30° and less than 150° to maintain an absolute position accuracy of about 1.5 m for each range used to compute a fix.

The required equipment includes four shore beacons with two 12-V batteries wired in series, a ship-board receive-transmit beacon, and an HP 2000 personal computer with the navigation software. The following procedures are used to position the vessel:

1. Calibrate the navigation beacons on survey control points.
2. Compare the ranges on the receiver to the calculated range between the two control points and adjust the calibration if necessary.
3. Install the receive-transmit beacon and the navigation acquisition system onboard the survey vessel.
4. Deploy the shore beacons on the shoreline stations.
5. Enter the coordinates of the sampling stations and/or track lines into the shipboard computer.
6. Navigate the vessel in accordance with the graphics display on the computer CRT screen.

SOP 101

Decontamination of Equipment—Sediments

Note: SOP 6B cited within.

STANDARD OPERATING PROCEDURE

DECONTAMINATION OF EQUIPMENT—SEDIMENTS SOP 101

To prevent potential cross contamination of samples, all reusable sediment sampling equipment will be decontaminated before each use. A decontamination station will be set up onsite in a clean location, upwind of actual sampling locations. Decontaminated equipment will be stored away from areas that may cause recontamination, and rinsate blanks will be collected according to SOP 6B, *Preparation of Field Quality Control Samples—Sediment*. When handling decontamination chemicals, field personnel will follow all relevant procedures outlined in the site health and safety plan.

EQUIPMENT REQUIRED

Equipment required for decontamination includes the following:

- Plastic brushes
- Extension arm for cleaning core liners
- Squirt bottles
- 5-gal plastic bucket(s)
- Tap water or site water
- Alconox® or similar industrial detergent
- Acetone (for organic contaminants)
- Hexane (for organic contaminants)
- 0.1 normal nitric acid (HNO_3) for inorganic contaminants
- Sealable waste containers equipped with a funnel
- Aluminum foil
- Core liner caps or plastic wrap and rubber bands.

DECONTAMINATION PROCEDURES

Potential sources of contamination of samples include the stainless-steel equipment used to prepare the samples (e.g., bowls, spoons, spatulas), the polycarbonate core liners and extruding tube, and the sampler. The following steps should be followed to properly clean all equipment that comes into contact with the samples:

1. Rinse the equipment thoroughly with tap or site water to remove most of the remaining sediment. This step should be performed onsite for all equipment, including core liners that will not be used again until the next day of sampling. Pieces that do not need to be used again that day may be set aside and thoroughly cleaned in the field laboratory at the end of the day.

2. Pour a small amount of concentrated industrial detergent into a 5-gal bucket and fill it with tap or site water.

3. Scrub the equipment in the detergent solution using a plastic brush with rigid bristles. For the polycarbonate core liners, use a brush attached to an extension to reach the entire inside of the liners, scrubbing with a back-and-forth motion. Be sure to clean the outside of core liners, bowls, and other pieces that may be covered with sediment.

4. Rinse the equipment with tap or site water and set aside to drain.

5. Wash the equipment with acetone from a squirt bottle, and let the excess solvent drain into a waste container equipped with a funnel. Acetone acts primarily as a drying agent, but it also works as a solvent for some organic contamination. Core liners must be held over the waste container and turned slowly to be effectively cleaned. The sample apparatus may be turned on its side and opened to be washed more effectively. Set the equipment in a clean location and allow it to air dry.

6. Rinse the air-dried equipment with hexane from a squirt bottle, and let the excess solvent drain into the waste container. The opening of the squirt bottle may need to be widened to allow enough solvent to run through the core liners without evaporating. Hexane acts as the primary organic solvent, but it is insoluble with water. If water beading occurs, it may mean that the equipment was not thoroughly rinsed with acetone. When the equipment has been thoroughly washed with hexane, set it in a clean location and allow the hexane to evaporate before using it for sampling.

7. If inorganic compounds are being sampled, rinse the equipment a final time with clean water, 0.1 normal nitric acid, and water.

8. Wrap small stainless-steel items in aluminum foil (dull side facing the cleaned area) after decontamination is completed. Seal the polycarbonate core liners at both ends with either core caps or cellophane plastic and rubber bands.

9. When not in use, keep the waste solvent container closed and store in a secure area. The waste should be transferred to empty solvent bottles and disposed of at a licensed facility.

SOP 102

Preservation and Handling of Samples

STANDARD OPERATING PROCEDURE

PRESERVATION AND HANDLING OF SAMPLES
SOP 102

This SOP defines bottle types and preservation and handling techniques for environmental samples. All bottles will be precleaned and provided by either a supply house or a subcontracted laboratory.

If preservatives are added before the bottles are brought into the field, each bottle must be marked to identify the preservative. Preserved bottles must be closed tightly and kept upright during storage. Test bottles will be prepared for each sampling site to determine the volume of preservative to use.

Immediately after collection, samples will be placed in coolers on ice. To ensure that bottles are kept at the proper temperature when stored onsite, each refrigerator must be monitored with its own thermometer. Daily readings will be recorded in a logbook to be kept near the refrigerators.

Preservation and handling guidelines for site analytes are provided in Table 102-1. Analytes with similar bottle and preservative requirements will be analyzed from the same container when possible.

TABLE 102-1. RECOMMENDED PRESERVATION AND HANDLING PROCEDURES FOR SAMPLES[a]

Analyte	Matrix	Container	Preservation and Handling	Holding Time (from date of collection)
Acid-volatile sulfides	Solids	HDPE	Fill bottle, leaving no headspace Store samples in the dark at –20°C	14 days
Alkalinity	Water	HDPE	Store samples at 4°C	14 days
Ambrosia pollen	Solids	HDPE	Store samples at 4°C	No specific holding time
Ammonia-nitrogen	Water	HDPE	Preserve with 1:1 sulfuric acid (H_2SO_4) to a pH of 2 or less Store samples at 4°C	28 days
Carbon dioxide	Water	HDPE	Fill bottle, leaving no headspace Store samples at 4°C	1 day, but analysis should be performed onsite when possible
Carbonate	Solids	HDPE	Store samples at 4°C	28 days
Chloride	Solids	HDPE	Store samples at 4°C	28 days
	Water	HDPE	Store samples at 4°C	28 days
Grain size	Solids	HDPE	Store samples at 4°C	28 days
Lead-210 and cesium-137	Solids	HDPE	Store samples at 4°C	365 days
Mercury species[b]	Solids	HDPE	Store samples at 4°C	28 days
	Water	TFE® bottle and lid	Fill bottle, leaving no headspace Store samples at 4°C	28 days, but analyze samples as soon as possible after collection
	Tissue	Sealed polyethylene bag	Eviscerate; store samples below –10 °C	28 days, but analyze samples as soon as possible after collection
Percent lipids	Tissue	Aluminum foil; sealed polyethylene bag	Store samples at –20 °C[c]	360 days[d]
Percent moisture	Solids	HDPE	Store samples at 4°C	No specific holding time
Polychlorinated biphenyls	Solids	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days[e]
	Tissue	Sealed polyethylene bag	Eviscerate, store samples at –20 °C	360 days
Polycyclic aromatic hydrocarbons	Solids	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days[e]

TABLE 102-1. (cont.)

Analyte	Matrix	Container	Preservation and Handling	Holding Time (from date of collection)
TAL and site metals and cyanide (except mercury)	Solids	HDPE	Store samples at 4°C	180 days
	Water	HDPE	Preserve with 1:1 nitric acid (HNO_3) to a pH of 2 or less Store samples at 4°C	180 days
	Tissue	Aluminum foil; sealed polyethylene bag	Eviscerate; store samples at 4°C	180 days; CN: 14 days
TCL pesticides and polychlorinated biphenyls	Solids	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days*
	Water	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days*
	Tissue	Aluminum foil; sealed polyethylene bag	Eviscerate; store samples at 4°C	7 days*
TCL and site semivolatile organic compounds	Solids	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days*
	Water	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days*
	Tissue	Aluminum foil; sealed polyethylene bag	Eviscerate; store samples at 4°C	7 days*
TCL and site volatile organic compounds	Solids	Glass, with TFE®-lined lid	Fill bottle, leaving no headspace Store samples in the dark at 4°C	7 days
	Water	40-mL glass vial with TFE®-lined septum	Fill bottle, leaving no headspace Invert and tap vial to ensure no air bubbles are present Store samples in the dark at 4°C	7 days
	Tissue	Aluminum foil; sealed polyethylene bag	Eviscerate; store samples at 4°C	7 days
Total inorganic carbon	Solids	HDPE	Store samples in the dark at 4°C	28 days

TABLE 102-1. (cont.)

Analyte	Matrix	Container	Preservation and Handling	Holding Time (from date of collection)
	Water	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	28 days
Total and dissolved organic carbon	Solids	HDPE	Store samples in the dark at 4°C	28 days
	Water	Glass, with TFE®-lined lid	Preserve with 1:1 sulfuric acid (H_2SO_4) to a pH of 2 or less Store samples in the dark at 4°C	28 days
Total sulfate	Solids	HDPE	Fill bottle, leaving no headspace Store samples in the dark at –20 °C	28 days
	Water	HDPE	Store samples at 4°C	28 days
Total sulfide	Solids	HDPE	Fill bottle, leaving no headspace Store samples in the dark at –20 °C	7 days
	Water	HDPE	Preserve with 4 mL 2N zinc acetate per liter of sample, and NaOH to a pH of 9 or greater Store samples at 4°C	7 days
Total suspended solids	Water	HDPE	Store samples at 4°C	7 days

Note: HDPE - high-density polyethylene
TAL - target analyte list
TCL - target compound list

[a] For more information, see the project quality assurance project plan or laboratory statements of work.

[b] Sampling for mercury and handling containers requires extreme care to avoid contaminating the samples.

[c] Samples that will also be analyzed for Contract Laboratory Program target list analytes will be stored at 4°C.

[d] Samples that will also be analyzed for Contract Laboratory Program target list analytes must be analyzed within 7 days.

[e] Samples must be analyzed within 40 days of extraction.

SOP 104

Sediment Coring Procedures Using Slide-Hammer and Gravity Corers

309546

STANDARD OPERATING PROCEDURES

SEDIMENT CORING PROCEDURES USING SLIDE-HAMMER AND GRAVITY CORERS SOP 104

This SOP 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-in. outside diameter tubing with a 1/16-in. 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. Prior to 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 lb of static weight if a gravity corer were used. The slide-hammer corer is illustrated in Figure 104-1. 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-ft tripod, a power winch, and a hole in the floor centered below the tripod. Because the coring is typically done in shallow water, it is necessary to anchor the boat 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

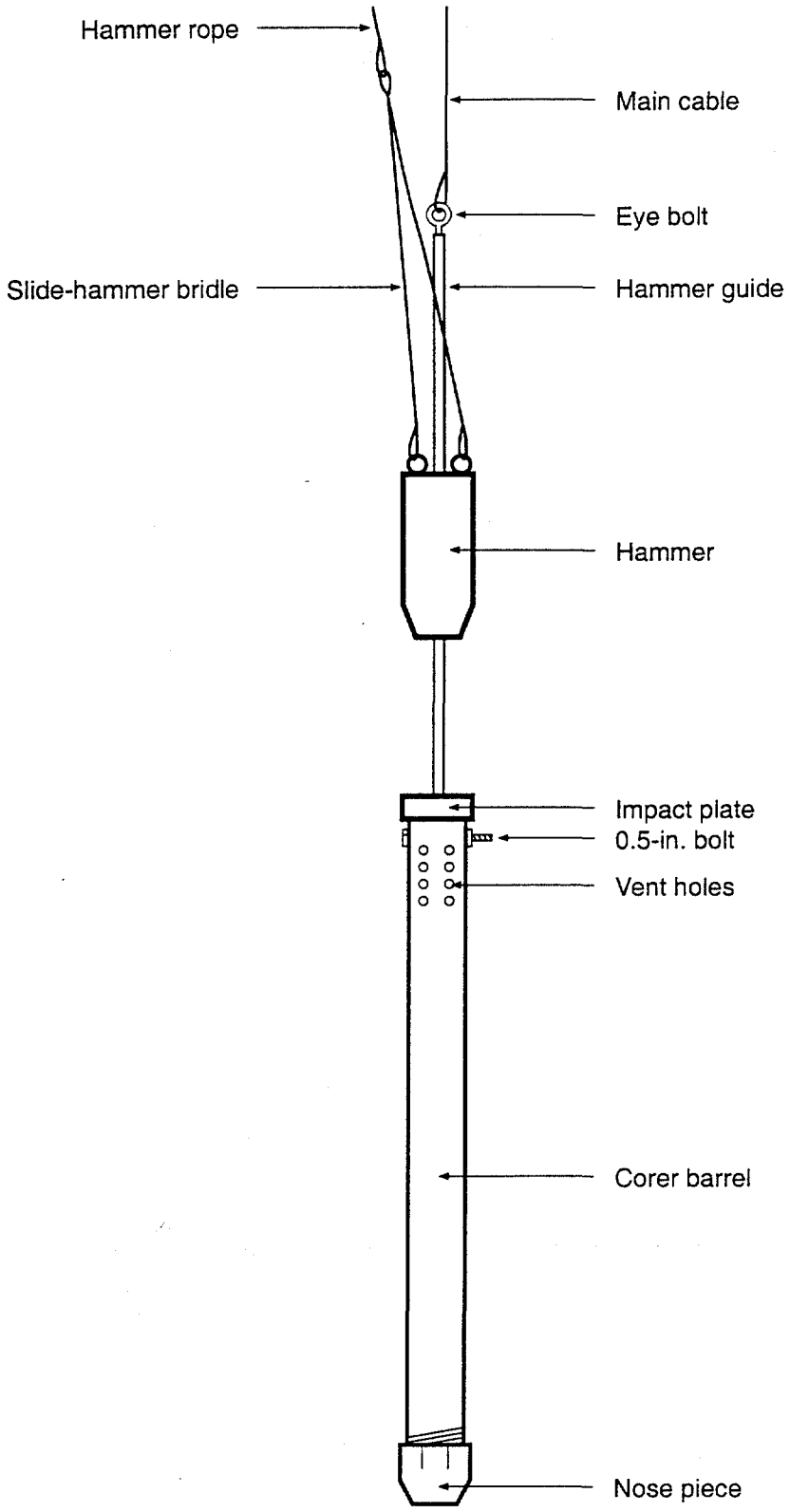


Figure 104-1. Diagram of slide-hammer corer.

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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-in. diameter bolt. Inspect the bolt periodically for wear near the cap and 3.5 in. 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 in. in diameter so it is easy to hold by hand.

4. Insert the 3-in. outside diameter polycarbonate liner into the corer barrel, making sure that about 0.75 in. 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.

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 ft 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 15–20 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 in. 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-in. 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. With 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-in. bolt, and connect the main cable to the shackle.

11. Lift the corer about 1 ft with the main cable. With one person holding 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 the *Sample Extrusion and Sectioning* section.

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 ft of water. However, it may be used in shallower waters if the sediment is soft. The gravity corer is illustrated in Figure 104-2.

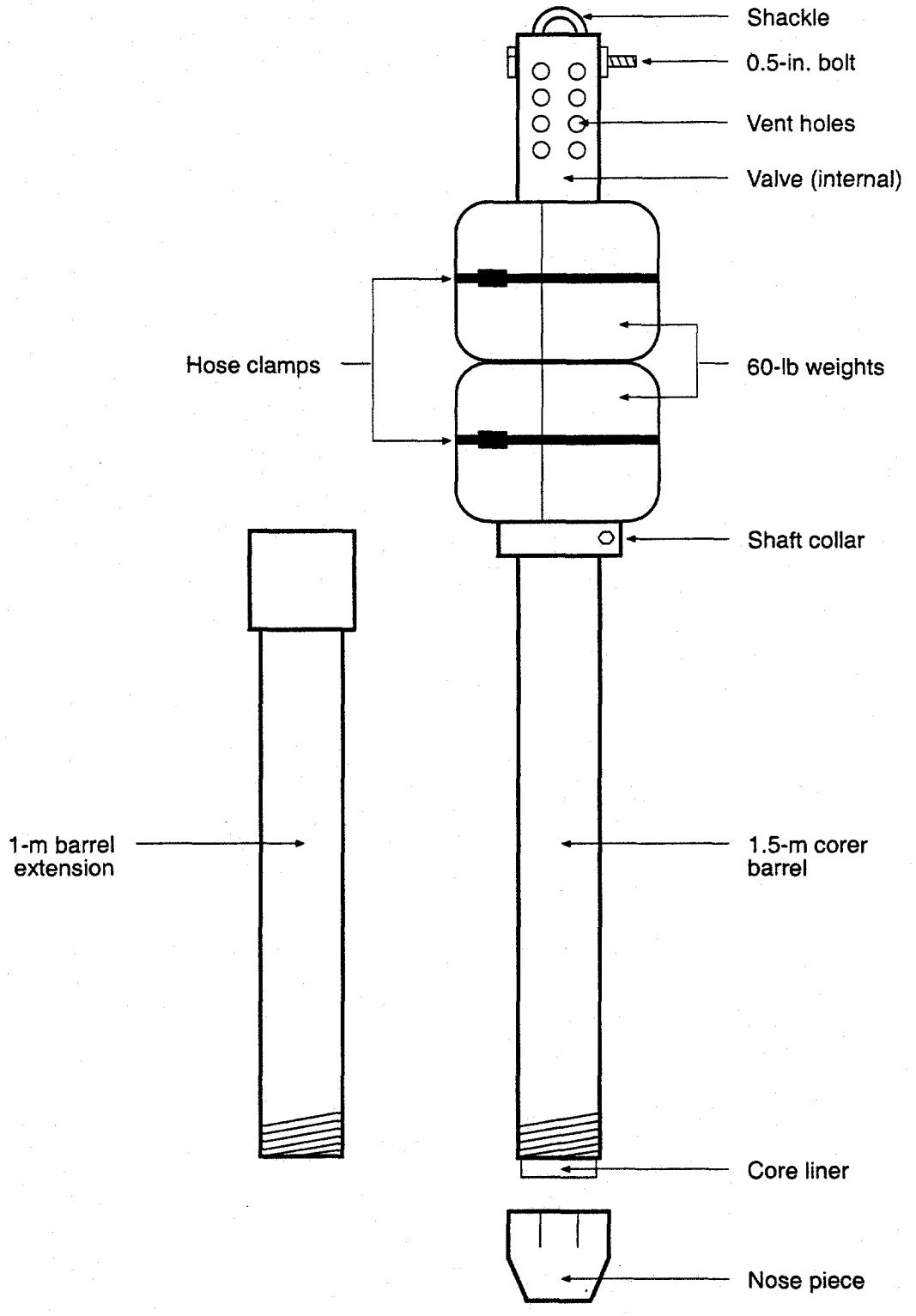

Figure 104-2. Diagram of 3-in. diameter gravity corer.

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The weight can be adjusted using any combination of six 60-lb weights and one 30-lb 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 in. 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 in. 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 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-in. 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 ft above the sediment, then reduce the rate to about 1 ft/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 ft/second. As soon as the nose clears the water surface, stop retrieval, push a double rubber stopper up into the corer, and 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.

   Lift the corer about 1 ft 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.

6. 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.

7. Process the sample as described in the *Sample Extrusion and Sectioning* section.

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 in Figure 104-3. To clean the valve, remove the 0.5-in. 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 the majority of 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:

- **Inadequate Penetration**—Add more weight to the corer or pound it in farther.

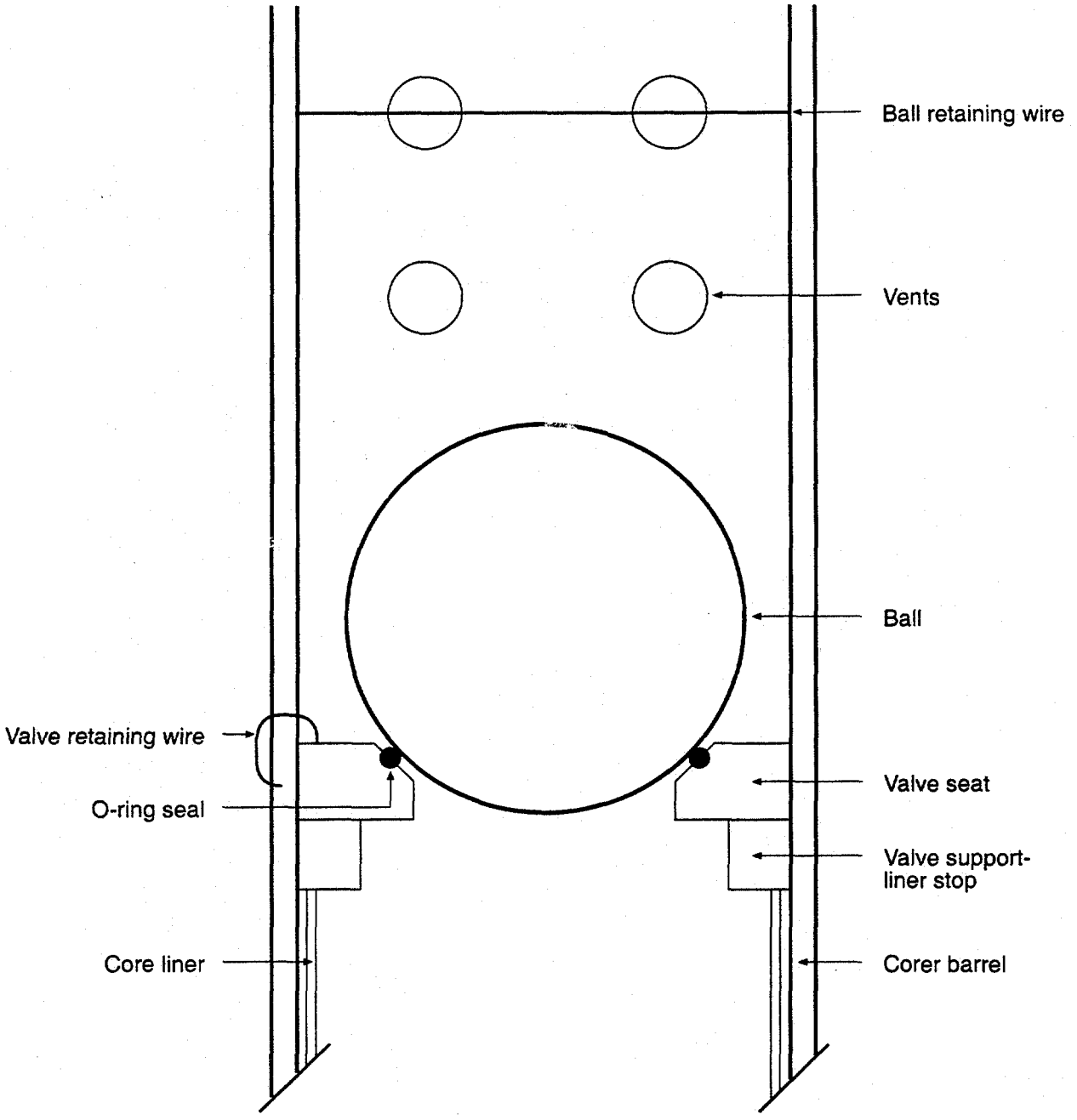

Figure 104-3. Cross section of ball valve.

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- **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 in Figure 104-4. The extruder can be used for 2- to 3-in.-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 in. of sample per pump. With one person holding the liner steady,

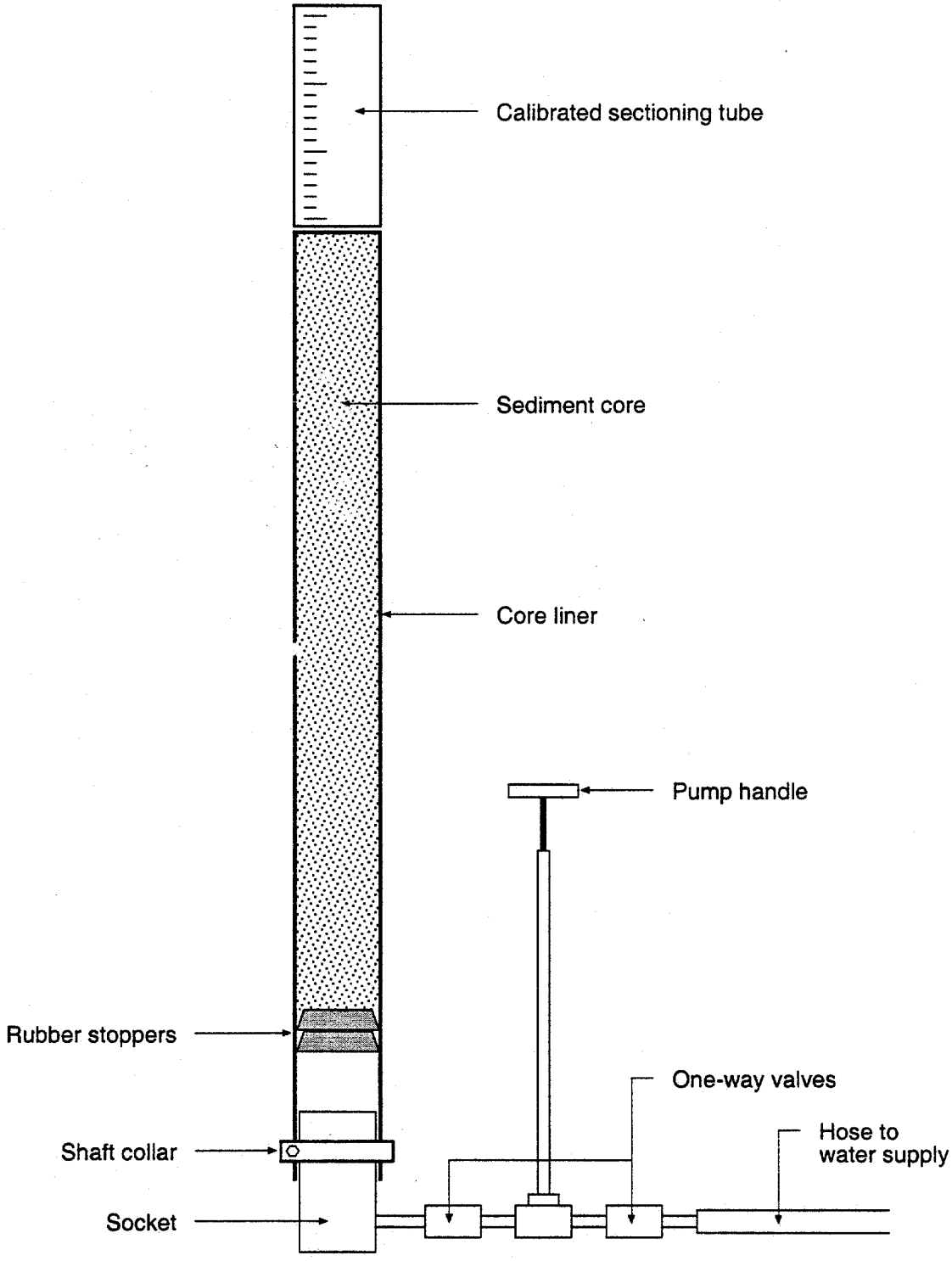

Figure 104-4. Diagram of core extruder and extrusion tube.

309556

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 sample into the mixing bowl.

4. Repeat Step 3 until the lowest desired depth is collected. Pump the remainder of the sample out of the liner along with the rubber stoppers.

Notes

1. The eyebolt at the top of the hammer guide may become unscrewed from the pounding vibrations and should be checked at each station prior to 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 there are no leaks. 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, with the tension increasing. 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.

Appendix D

Example Forms

Example label and chain-of-custody seal.

Exponent

OFFICIAL SAMPLE SEAL

SAMPLE NO.	DATE	SEAL BROKEN BY	DATE
SIGNATURE			
PRINT NAME AND TITLE			

Exponent

Sample No.

Preservative

Sampler Date/Time

SITE NAME
1301

Tag No.

CBCH-16-12 04/23/98 WA

3095S9

CHAIN OF CUSTODY RECORD/SAMPLE ANALYSIS REQUEST FORM

Page ___ of ___

Project:
(Name and Number)

Exponent Contact: _____ Office: ____

Ship to: _____

_____

_____

Lab Contact/Phone: _____

Samplers:

Exponent
Environmental Group

Bellevue,WA (425) 643-9803
Portland, OR (503) 636-4338
Boulder, CO (303) 444-7270
Boston, MA (781) 466-6681
Washington, D.C. (301) 577-7830
Atlanta, GA (770) 419-9909

Sample No.	Tag No.	Date	Time	Matrix	Analyses Requested						Extra Container	Archive	Remarks

Matrix Code: GW - Groundwater SL - Soil SD - Sediment SW - Surface water
OTHER - Please identify codes _____

Priority: ☐ Normal ☐ Rush Rush time period _____

Shipped via: ☐ FedEx/UPS ☐ Courier Other_____

Condition of Samples Upon Receipt: _____

Custody Seal Intact: ☐ Yes ☐ No ☐ None

Relinquished by: _____ (Signature) Date/Time: _____ Received by: _____ (Signature) Date/Time: _____

Relinquished by: _____ (Signature) Date/Time: _____ Received by: _____ (Signature) Date/Time: _____

Distribution: White and Yellow Copies - Accompany Shipment; Pink Copy - Project File

309560

Example chain of custody/sample analysis request form.

CBCH-16-12 04/23/98 WA

Exponent

STATION/SAMPLE LOG

CRUISE: _____ STATION: _____ DATE: _____ GEAR: _____

Time	Water Depth ( )	Sample		Penetration Depth (cm)	
		Sample No.	Tag No.		

TEXTURE:	Cobble	Gravel	Sand	Silt	Clay	Organic
COLOR:	Black	Brown		Grey	Green	
ODOR:	Normal	Sewage	H_2S	Petroleum	None	

COMMENTS:

PHOTO: Roll _____ No: _____ INITIALS: _____

Example station/sample log.