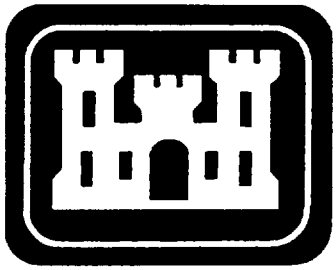

U.S. Army Corps of Engineers®
New England District

FINAL FIELD SAMPLING PLAN
HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

CENTREDALE MANOR RESTORATION SUPERFUND PROJECT SITE
NORTH PROVIDENCE, RHODE ISLAND

CONTRACT NO. DACW33-96-0005
DELIVERY ORDER NO. 0059

HARDING ESE PROJECT NO. 51226, TASK NO. 9

JUNE 1, 2001

Harding ESE
A MACTEC COMPANY

FINAL FIELD SAMPLING PLAN

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

CENTREDALE MANOR RESTORATION SUPERFUND PROJECT SITE NORTH PROVIDENCE, RHODE ISLAND

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) Region I and U.S. Army Corps of Engineers (USACE) are conducting a Human Health Biota Consumption Risk Assessment (HHRA) and a Baseline Ecological Risk Assessment (BERA) for the Centredale Manor Restoration Superfund Site located in North Providence, Rhode Island (Site). A site locus map is provided in Figure 1. This effort is being performed under Contract No. DACW33-96-0005, Delivery Order No. 0059. This Field Sampling Plan (FSP) has been developed to reflect the goals and objectives discussed and agreed upon during meetings with USEPA, USACE, Battelle, and Harding ESE conducted on July 17, November 17, December 4, December 19, 2000, and February 28, 2001, and presented in meeting minutes and other support documents. The FSP was prepared to be consistent with the requirements set forth in the Statement of Work and the Addendum to the Statement of Work prepared by USEPA (USEPA, 2000a and USEPA, 2000b) and has been revised based on comments received from USEPA and USACE dated April 27 and May 8, 2001, respectively. The general approach that will be used to assess human health and ecological risks at the site is presented in the Final Work Plan (Harding ESE, 2001a).

This FSP is divided into two sections: Section 1.0 presents the objectives of the field activities and provides an overview of general site conditions, background information and a summary of previous investigations. Section 2.0 describes the components of general site management as well as the specifics of the field data collection activities. Other supporting information is provided in the appendices.

A Quality Assurance Project Plan (QAPP) has also been prepared for these activities and is provided as a separate document (Battelle, 2001); together the Field Sampling Plan and the QAPP comprise the Sample and Analysis Plan (SAP) for the investigation. A Site Health and Safety Plan, Data Management Plan, and Site Management Plan have also been prepared to support the field investigation and subsequent data analyses.

1.1 WORK ASSIGNMENT OBJECTIVES

The purpose of this work assignment is to provide information on contaminant distribution adjacent to and downstream of the Centredale Manor Site to support USEPA's assessment of human health and ecological risks associated with contaminants in the sediment of the Woonasquatucket River, downgradient impoundments, and associated floodplain habitat. Previous investigations have identified these as areas of concern due to the presence of dioxin and other bioaccumulating compounds.

The FSP presents the approach that will be used to collect additional site data to support the evaluation of baseline risks to human health and ecological receptors. The field work described in this FSP involves collection and analysis of fish and other biota tissue samples (to support both the human health and ecological risk assessments) and macroinvertebrate samples, floodplain invertebrate samples, sediment and floodplain soil samples, and surface water samples (to support the ecological risk assessment). In addition, surveys of indigenous wildlife, fish, benthic macroinvertebrates and floodplain soil fauna will be conducted and sediments will be collected to conduct laboratory toxicity bioassays using aquatic macroinvertebrates. The data collected will be used in the preparation of the HHRA and BERA for the study area.

1.1.1 Potential Human Receptors

Consistent with USEPA objectives, only a single pathway will be evaluated for the HHRA: potential exposure to chemicals of potential concern (COPCs) via ingestion of fish and/or other biota. Contaminants that are present in surface water and aquatic sediments may have bioaccumulated in fish and other biota present in the Woonasquatucket River. These fish and other biota (including turtles and frogs) may be consumed by individuals that catch and/or consume biota from the river. Child, adolescent, and adult consumers may be exposed to COPCs via ingestion of fish and other biota. Both recreational and subsistence anglers/consumers will be evaluated in the HHRA.

1.1.2 Potential Ecological Receptors

Although the primary focus of the BERA will be on the effects of bioaccumulating compounds [particularly dioxins (including HCX), furans, and PCBs] on the ecological health of the Woonasquatucket River, several other classes of COPCs were also identified in the streamlined ecological risk assessment and these will also be evaluated. Of particular note, potential impacts to the macroinvertebrate community associated with the discharge of contaminated groundwater to the Woonasquatucket River in the vicinity of the Site will be a specific focus of the BERA.

In general, aquatic receptors (including invertebrates and both demersal and pelagic fish species) are exposed to COPCs in sediment and surface water via direct contact, direct ingestion, or by consuming prey items that have bioaccumulated COPCs. As discussed above, complete migration pathways, including discharge of site groundwater have resulted in contamination of both sediment and surface water media as well as biota. Semi-aquatic receptors (including mammals, birds, reptiles, and amphibians) may be exposed as a result of incidental ingestion of sediment, consumption of water, or ingestion of contaminated prey. Terrestrial invertebrates and wildlife that prey on these species may be exposed to COPCs in floodplain soil directly or by ingesting contaminated prey.

As depicted in Figure 2, the study area has been segregated into general exposure areas (EA's) (as defined by the four historical impoundments in the Woonasquatucket River) where the nature and magnitude of contaminant exposure is anticipated to differ substantially. The components (i.e., distinctive habitats) found within these EA's include:

- Woonasquatucket River, Centredale Reach (EA1). This is a fast moving shallow river area with high banks and a stony bottom that occurs adjacent to the site.
- Allendale Pond Floodplains (EA1). Areas of the former Allendale Pond that became exposed following the breaching of the dam around 1991. Since that time, the pond bottoms flood occasionally, but are currently vegetated with terrestrial wetland plants, indicating that this area is only inundated with water during flood conditions. The west bank is high and consists of a former railroad bed; Allendale Pond is bordered by residential properties along most of the eastern bank.
- Allendale Pond Channel (EA1). This is a small meandering channel passing through the former Allendale Pond. Water depth is shallow throughout the former Pond area, and the pond bottom is unconsolidated in areas where the depth has recently decreased as a result of the collapse of the remaining portion of the Allendale Dam in spring 2001.
- Woonasquatucket River, Lymansville Reach (EA2). The section of the river between the Allendale Dam and the upper portion of Lymansville Pond. This lotic environment consists of fast moving shallow water with incised banks and a stony bottom. This reach of river passes through a large palustrine wetland.
- Lymansville Pond (EA2). A large impoundment of the Woonasquatucket River below Allendale Pond.
- Manton Pond (EA3). A shallow and narrow impoundment of the Woonasquatucket River downgradient of Lymansville Pond.
- Dyerville Reach (EA4). A reach of the Woonasquatucket River downriver of Manton Pond; site of a former impoundment.

Two areas unimpacted by the Site have been identified as potential reference areas to determine background concentrations of contaminants, and to determine the degree to which other contamination sources may have contributed to contamination identified in the River and adjacent areas. Reference sample collection areas include:

- Woonasquatucket River (upstream of the Site, including Greystone Mill Pond), and
- Assapumpsett Pond and Brook

1.2 SITE BACKGROUND INFORMATION

This section provides a description of the site and a brief summary of the investigations that have been conducted to date.

1.2.1 Site Description

Figure 2 provides an overview of the study area. Two apartment complexes are located on the northern portion of the site. Centredale Manor, located at 2074 Smith Street (Route 44), is a multi-unit apartment complex for elderly adults. The Brook Village apartment complex is located at 2072 Smith Street. The site also consists of reaches of the Woonasquatucket River associated with Allendale Pond, Lymansville Pond, Manton Pond, and Dyerville Pond. The general limits of the site are defined by historical chemical manufacturing operations as well as by areas impacted by these operations. The site is bounded by Route 44 to the north, a former mill raceway and the eastern bank of the Woonasquatucket reach to the east, Dyerville Dam to the south, and the western bank of the Woonasquatucket reach to the west.

Prior to 1936, Centredale Worsted Mills, a woolens-manufacturing plant, occupied the portion of the site located at 2072 and 2074 Smith Street. Circa 1940, Metro Atlantic Chemical Corporation began operations as a chemical manufacturer believed to manufacture hexachlorophene (of which hexachloroxanthene [HCX] is a by-product) and trichlorophenols. Operations at Metro Atlantic Chemical Corporation ceased during the 1960s or early 1970s. Between 1952 and 1969, New England Container Company operated a drum reconditioning facility on a portion of the property. Chemical residues were burned prior to drum reconditioning. In 1972, fire destroyed most property structures. Brook Village was constructed in 1977 and Centredale Manor was constructed in 1982.

Evidence of improper historical waste disposal was discovered during construction of the apartment complexes. Approximately 400 drums and 6,000 cubic yards of soil were removed from the site. Potential chemicals used onsite were identified based on drum labels including: caustics, halogenated solvents, polychlorinated biphenyls (PCBs), and inks. Evidence suggests that contaminants were buried, released directly to the ground, or released directly to the Woonasquatucket River. As a result, contaminants have migrated downstream and have impacted sediments in the Woonasquatucket River, Allendale Pond, Lymansville Pond, Manton Pond, Dyerville Pond, and some floodplain areas associated with these water bodies.

1.2.2 Previous Environmental Investigations

Elevated levels of dioxin were discovered in June 1996 in the Woonasquatucket River during a study conducted by USEPA Narragansett Laboratories and the Providence Urban Initiative Program. Subsequently, elevated concentrations of dioxin and PCBs were identified in sediment in the Woonasquatucket River and downstream impoundments in July 1998 during a study conducted by USEPA. Additional site investigations were performed between 1998 and 2000 to delineate the concentrations of dioxin in soil and sediment. Contaminants detected onsite include: dioxin, PCBs, chlorinated and aromatic volatile organic carbons (VOCs), polycyclic

aromatic hydrocarbons (PAHs), phthalates, and various metals. Further historical information is provided in the Expanded Site Investigation Report prepared by Roy F. Weston, March 1999.

Streamlined human health risk and ecological risk assessments were conducted at Allendale and Lymansville Ponds as part of an Engineering Evaluation/Cost Estimate (EE/CA) performed for the site in September 2000. Further information concerning these preliminary risk assessments are provided in the EE/CA report prepared by Tetra Tech NUS Inc. (2000). The Final Work Plan provides additional details about the human and ecological receptors and exposure pathways to be evaluated in the baseline risk assessments (Harding ESE, 2001a).

1.2.3 Summary of Environmental Conditions

Sampling activities conducted by USEPA and RIDEM revealed elevated polychlorinated dibenzo dioxins and furans (dioxins and furans) in soils and sediments as well as from fish taken from Woonasquatucket River. As mentioned above, other contaminants detected onsite include: PCBs, chlorinated and aromatic VOCs, PAHs, phthalates, and metals. The site was added to the National Priorities List on February 4, 2000. For the Woonasquatucket River, there is currently a fish consumption advisory in place that recommends that people not eat fish, eels, turtles, or plants from the river downstream of the Smithfield Treatment Plant.

Approximately 400 drums and 6,000 cubic yards of soil were removed from the property during construction of the apartment complexes. However, the exact locations of these remediation activities are not known. Temporary caps were installed over heavily contaminated areas near residences. Interim soil caps were placed in the source area in July 2000.

Temporary fencing was erected around areas of contaminated surface soil in January 1999. The temporary fencing was replaced with chain-link fence between May and September 1999 to prevent access to contaminated areas.

Allendale Dam will be reconstructed during the summer of 2001, thus restoring Allendale Pond. For the purposes of the human health and ecological risk assessments, it will be assumed that the flooded condition that will exist after dam renovation is the baseline condition.

1.3 Overview of Field Activities

The investigation field activities scoped under this FSP include the following:

- Mobilization/Demobilization;
- Collection of biological tissue samples;

- Collection of ecological population and community data;
- Collection of additional surface water, sediment and floodplain soil samples; and,
- Investigation-derived waste characterization and disposal (if necessary).

The sampling locations or areas where additional site data will be collected are described in Section 2.0.

2.0 SITE MANAGEMENT/FIELD SAMPLING PLAN

Section 2 is organized as follows:

- Project organization and schedule (Section 2.1).
- Field sampling activities (2.2).
- Field investigation documentation (Section 2.3).
- Quality Control Samples (Section 2.4).
- Equipment decontamination (Section 2.5).
- Control and disposal of investigation derived waste (IDW) (Section 2.6).

2.1 PROJECT ORGANIZATION AND SCHEDULE

This section describes the project organization and schedule, including responsibilities of the personnel involved in performing the work assignment. Key project personnel and their responsibilities are outlined below.

2.1.1 Personnel Responsibilities

Harding ESE field personnel conducting the work outlined in this SAP will consist of a Field Operations Leader (FOL), Site Safety Officer (SSO), and field scientists. The team under the direction of the FOL will perform fieldwork. The FOL will report directly to the Harding ESE Project Manager.

Responsibilities of the FOL include supervising field operations and coordinating daily with the various subcontractors; ensuring that the procedures specified in the Work Plan and SAP are properly implemented; maintaining daily sampling and shipping schedules; and reporting to the Project Manager on a regular basis regarding sampling status and progress of the field activities.

The SSO will be appointed from the Harding/Battelle field team personnel. The SSO will assist in implementing the Health and Safety Plan (Harding ESE, 2001b). The SSO will report directly to the Harding ESE Health and Safety Officer on any health and safety issues. The SSO will also report any hazards, injuries, or decisions to stop work to the FOL whom, in turn, will contact the Harding ESE Project Manager.

2.1.2 Schedule

All fieldwork and sample analysis is separated by task. The estimated schedule for the investigation is shown in Figure 3.

2.1.3 Site Control

The following subsections contain information regarding the control of activities at the site.

2.1.3.1 Site Access

USEPA has negotiated an agreement permitting access to the transmission right-of-way that abuts the western edge of Lymansville Pond and is currently in the process of obtaining boat access agreements for Allendale, Lymansville, and Manton Ponds. Specific directions will be provided when the FSP is finalized. Potential locations that would allow boat access to these three ponds are indicated in Figures 4A – 4C. No other site access issues are anticipated.

2.1.3.2 Utility Clearance and Other Permits

No utility clearances are required for the field investigation activities. Scientific Collector's Permit No. 2001-47 was obtained from RIDFW by EPA. Persons named on the permit are: Don Mason, Michel Jeanneau, Cory Francis, Jason Sieders, Sean Stimmel, and Sandi Sprague (Normandeau Associates); Norman Richardson and Charles Lyman (Harding ESE); Chris Gagon (Battelle); Mike Penko and Robert Davis (USACE); Kenneth Monney (USFWS); Bart Hoskins (Lockheed Martin); and Cornell Rosiu (USEPA).

2.1.3.3 Field Office/Command Post

No single field support location will be established for this investigation as field crews will operate primarily out of support vehicles. The support vehicles will be located in a non-obtrusive area near to the locations being sampled on a given day. The USEPA field trailer that is located at the site will be used as necessary for equipment storage and to prepare samples for shipment.

2.1.3.4 Site Security/Control

Harding ESE will not control access to the study area. Most of the area is state-owned land. The remaining land is privately owned and Harding ESE will only control access to active sampling locations. As directed by the FOL, all removable Harding ESE and subcontractor equipment will be locked in support vehicles and secured at the end of each working day.

2.2 FIELD SAMPLING ACTIVITIES

The field sampling activities consist of the following subtasks:

- Mobilization/Demobilization
- Biota Tissue Sampling
- Field Population and Community Studies
- Sediment Sampling
- Surface Water Sampling
- Floodplain Soil Sampling
- Investigation Derived Waste (IDW) characterization and disposal (if necessary)

Each of these subtasks and the specific data collection activities are described in the following subsections.

2.2.1 Mobilization/Demobilization

This section describes the mobilization of both Harding ESE personnel and Harding ESE subcontractor personnel.

2.2.1.1 Harding ESE Mobilization/Demobilization

Prior to beginning any fieldwork, all field team members will review the Statement of Work (SOW), Work Plan, this FSP, the HASP, and all applicable Standard Operating Procedures (SOPs) identified in Section 2.2 and provided in the appendices of this FSP. In addition, the Project Manager, Office Health and Safety Manager, SSO, FOL, and field scientists will hold a field team orientation meeting prior to beginning the fieldwork to familiarize personnel with the scope of the field activities. All field team members (as listed above), will receive a copy of the FSP prior to the orientation meeting. A record of the fieldwork orientation meeting will be maintained in the project file.

Equipment mobilization may include, but not necessarily be limited to, transporting and preparing the following equipment:

- Sampling and shipping equipment
- Health and safety equipment
- Decontamination equipment
- Subcontractor equipment (to be conducted by the subcontractor).

The FOL will coordinate the Harding ESE mobilization. The FOL will also coordinate any equipment purchases necessary to conduct the field investigation. The equipment of the sampling and health and safety activities will be transported to the site as needed.

2.2.1.2 Subcontractor Mobilization/Demobilization

Subcontractors will be procured for field data collection, analysis of biological field data, and IDW characterization and disposal. Once the procurement process has been completed, a "Notice to Proceed" will be issued to the selected subcontractors to initiate mobilization for each service.

The IDW disposal subcontractor will be responsible for mobilizing and demobilizing the equipment and personnel necessary to perform the work outlined in the specification, including obtaining utility clearance and any other permits required by federal, state, and local authorities.

2.2.2 Biota Tissue Sampling

Biota samples will be collected from several exposure areas (Table 1) to evaluate human health risks associated with eating fish and other biota from the four reaches of the site (Allendale, Lymansville, Manton, and Dyerville Ponds). In addition, biota samples will be collected from the reference areas (Greystone Mill Pond and Assapumpsett Brook). These biota samples will also be used to evaluate potential risks to ecological receptors that ingest fish and other organics that have bioaccumulated site-related compounds in their tissue. The tissue data will be used directly in the BERA to estimate both direct effects to the sampled organisms (using critical body residues [CBR] data) and potential bioaccumulation risks to consumer species as described in the Work Plan, Human Health and Ecological Risk Assessment. Table 2 summarizes the tissue volumes or mass required for each sample type requiring chemical analysis and Table 3 provides an overview of the entire field program indicating the number and distribution of tissue samples, population/community studies, and sediment bioassays.

Three target biota species will be collected. The specific species collected for tissue analysis to support the HHRA and the BERA are based on human consumption patterns, availability of species in the collection areas, and the need to represent different trophic levels in the ecological risk assessment. Analytical results for these three species will be used to estimate exposures in both the human health and ecological risk assessments. The objectives of the ecological risk assessment require that representatives of both demersal and piscivorous categories be included in the sampling program; preliminary target species include white sucker and largemouth bass, respectively (Harding ESE, 2001a). The third target species, focused on meeting requirements for the human health fish consumption assessment is the American eel, with either a frog or turtle

species potential alternate species (Table 4). A total of 172 biota tissue samples will be collected and evaluated in the human health and ecological risk assessments.

The collection of biota for tissue analysis to support the risk assessments will be implemented simultaneously with the fish population and community survey (described in Section 2.2.3.4) that will be completed as part of this FSP. When field activities are implemented, if the target species are not sufficiently available, identified "alternative" species will be selected based on the actual availability of species observed in the river. In addition, if, prior to data collection activities, information is obtained that turtles or frogs are not consumed in the area, or that these taxonomic groups are not abundant within the study area, an alternate fish species will be selected. A contingency plan will be implemented in the field during the fish survey/collection activities to adjust one or more of the target species if (a) one or more of the target species are not present in sufficient quantity in the collection areas, or (b) newly obtained fish consumption information indicates that another species is a more important component of the local diet of human receptors. Prior to initiation of field collection activities, Harding ESE will conduct literature and internet searches to identify consumption patterns, species caught and eaten, potentially exposed populations, angling locations, and food preparation methods for biota. This information will be used to finalize the three target species for the biota consumption risk assessment and provide the basis for development of a contingency plan should the preferred target species not be available in the field. The "preferred" species, as identified in Table 4, will be targeted during field activities. Table 4 also summarizes the more common species that are believed to occur in the Woonasquatucket River watershed (RIDFW, 1995), including bluegill and pumkinseed sunfish, white sucker, large mouth bass, tessellated darter, American eel, fall fish, chain and redfin pickerel, creek chubsucker, yellow bullhead, yellow perch, and carp.

It is assumed that fillet samples will need to be analyzed for one of the fish biota species sampled to support the HHRA depending on how the selected species are consumed. If that species is appropriate for evaluating ecological risks, the offal (i.e., remaining flesh, bones, and internal organs) will also be analyzed and a whole body tissue concentration will be reconstructed by estimating a wet-weight weighted average of the separate fillet and offal analyses. This species would likely be the large mouth bass (i.e., piscivorous species).

In addition to the three tissue types that will be collected to support both the HHRA and BERA, additional tissue samples will be collected specific to the evaluation of ecological risks at the site. These additional tissues include crayfish, emerging macroinvertebrates, earthworms, and various samples collected as part of a swallow population study. The swallow study is not included in this FSP and will be overseen directly by USEPA. Sections 2.2.2.3 through 2.2.2.5 describe the field sampling program for collection of crayfish, emerging macroinvertebrate, and earthworm tissue, respectively.

2.2.2.1 Fish

The detailed technical approach to fish collection is provided in Appendix A, which also includes procedures for conducting the fish community studies (i.e., IBI and ichthyoplankton surveys). Figure 2 depicts the general sampling areas where fish tissue samples will be collected.

Table 1 provides a summary of the number of tissue samples to be collected by exposure/ reference area and the required analyses for those samples. Ten samples of each of the three target biota species will be collected from the Allendale and Lymansville reaches. In the Manton and Dyerville reaches, 3 samples of one species from each reach will be collected. In each reference areas (Greystone Mill Pond and Assapumpsett Brook), 10 samples of each of the three target biota species will be collected. Both muscle (fillet) and offal tissues will be sampled in one of the target fish species, based on typical cooking preparation methods.

Fish samples will be analyzed for SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins/furans (including HCX), percent lipids, and percent moisture (Table 1). A full PCB congener analysis will be conducted on 20 percent of the fish samples.

2.2.2.2 Turtles/Frogs

Turtles or frogs have been identified as potential alternate target species to evaluate consumption exposures in the HHRA. However, as described in Section 2.2.2, the selection of which specific taxonomic groups are included in the tissue sampling program will depend on a review of additional data concerning human consumption patterns in the area and the available of adequate number of individuals. As an alternate, a third fish species (in addition to the two described in Section 2.2.2.1) may be substituted (Table 4).

A total of 10 samples of turtles or frogs would be collected from Allendale Pond, Lymansville Pond, upstream of the CMS site in the Woonasquatucket River and/or in Greystone Mill Pond, and in Assapumpsett Pond. In addition, a duplicate sample will be collected in each of the four areas and a MS/MSD sample collected from both Allendale Pond and Lymansville Pond. Each turtle sample would consist of an individual organism, however, approximately 11-12 frogs would be composited per sample to achieve the required 120 gram sample weight.

If required, specific guidelines for collecting turtles and frogs are provided in Appendices B and C, respectively.

Turtle (or frog) samples will be analyzed for SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins/furans (including HCX), percent lipids, and percent moisture (Table 1). A full PCB congener analysis will be conducted on 20 percent of the samples.

2.2.2.3 Crayfish

Crayfish will be collected in several exposure areas downgradient of the site (Figures 4A and 4B). A total of 11 crayfish samples will be collected from Allendale Pond (3), Lymansville Pond (4), Greystone Mill Pond (3) and Assapumpsett Brook (1) (Table 5) using a combination of dipnets and baited traps. It is anticipated that personnel wearing hip length boots can access most locations. At crayfish sampling locations determined to be inaccessible by wading (i.e., water depths greater than two feet or removed from access points), an open workboat will be used to access sampling locations. Crayfish samples will be collected following the guidance provided in Appendix D.

Table 1 presents the sampling design and analytical requirements for the crayfish samples. Each composite sample will be analyzed for PCBs/pesticides, metals (including methylmercury), dioxins and furans (including HCX), percent lipids, and percent moisture. In addition, a full PCB congener analysis will be conducted for 20 percent of the samples. Specific sampling locations and rationale for each selected location are presented in Table 5.

2.2.2.4 Emerging Macroinvertebrates

Five box-type floating emergence traps will be deployed in each of the following areas: Allendale Pond, Lymansville Pond, and Greystone Mill Pond in the general vicinity of the swallow population study nest boxes (see Figures 4A and 4B). The locations of the emergence traps were selected based on available sediment chemistry and are presented in Table 6. The traps will be used to collect tissue data and to characterize the emerging insect community structure. Sampling will occur following tree swallow egg hatch and prior to collection of nestlings for tissue analysis. Each trap will consist of a 2-meter square structure supporting a conical nylon net. The traps will be inserted in closed foam strips to provide flotation and attached leads allow the traps to be anchored in place. Emerging insects will be sampled every two days using an insect vac and the samples will be chilled to facilitate taxonomic classification, enumeration and preparation of composited tissue samples. These data will be used to supplement data on the macroinvertebrate community productivity as well as to provide tissue analytical data to assess direct effects to macroinvertebrates and to assess contaminant dose exposures to insectivorous birds (e.g., tree swallows) and mammals (e.g., little brown bat).

Appendix E provides the specific guidelines for implementing this field study.

Table 1 presents the sampling design and analytical requirements for the crayfish samples. As indicated in Table 1, a total of 15 emerging insect samples will be collected from Allendale Reach (5), Lymansville Reach (5), and Greystone Mill Pond (5). Specific sampling locations and rationale for each selected location are presented in Table 6.

Each composite sample will be analyzed for PCBs/pesticides, metals (including methylmercury), dioxins and furans (including HCX), percent lipids, and percent moisture. In addition, a full PCB congener analysis will be conducted for 20 percent of the samples.

2.2.2.5 Earthworms

Floodplain invertebrates are directly exposed to COPCs in floodplain soil. These invertebrates provide a forage base for higher trophic level predators; therefore, tissue sampling will be completed to evaluate potential food chain risks to semi-aquatic wildlife receptors that forage in floodplain environments. Earthworms, which will be the focus of this tissue collection activity.

Depending on the availability of adequate tissue mass to conduct the selected chemical analyses, earthworms will be collected at a range of locations where historical data indicate that a concentration range of bioaccumulating compounds are located. Figures 5A and 5B present the sampling locations selected for the collection of earthworm tissue. As indicated in Table 1, a total of 11 earthworm samples will be collected from Allendale Pond (3), Lymansville Pond (4), Greystone Mill Pond (3) and Assapumpsett Brook (1). Specific sampling locations and rationale for each selected location are presented in Table 7.

Table 1 presents the sampling design and analytical requirements for the earthworm samples. Each composite sample will be analyzed for PCBs/pesticides, metals (including methylmercury), dioxins and furans (including HCX), percent lipids, and percent moisture. In addition, a full PCB congener analysis will be conducted for 20 percent of the samples.

A composite soil sample will also be collected at each of the earthworm tissue sampling locations and analyzed for the same chemical parameters listed for the earthworm tissue as well as additional parameters necessary to evaluate community level effects to the soil fauna (see Section 2.2.6).

2.2.2.6 Swallow Nestlings, Stomach Contents, Liver, and Eggs

Field activities associated with the collection of swallow tissue samples are being subcontracted directly by USEPA and are not included in this work assignment.

2.2.3 Field Population and Community Studies

Several surveys will be completed to evaluate the impacts that site-related COPCs may have on invertebrates, fish, and avian populations and/or communities. Population- and community-level studies are focused on evaluating relative population abundance, species richness, and/or

reproductive success. The following sections describe the surveys that will be completed for various ecological receptor groups.

2.2.3.1 Aquatic Macroinvertebrates

The aquatic macroinvertebrate communities in lotic (i.e., riverine) environments downstream of the Site will be surveyed following the multi-habitat approach outlined in Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, 2nd Edition (Barbour et al., 1999). Appendix E presents the specific guidelines that will be employed in the field study.

These data will be used to determine the level of macroinvertebrate community impairment relative to the upstream and reference sampling locations (i.e., above Greystone Mill Pond and Assapumpsett Pond, respectively). At the commencement of the field investigation, the aquatic habitat adjacent to the WWTP will be evaluated to determine whether lotic conditions similar to those found within the study area exist there. If this is not the case, the upstream sampling locations will be moved to the riverine portion of the Woonasquatucket River between Greystone Mill Pond and Route 44 (Figure 4A).

The specific focus of this study is to evaluate the potential effects of discharging groundwater in the reach adjacent to the Site and to assess the potential role that surface water COPCs and nutrients may have on this community. The Smithfield Waste Water Treatment Plant (WWTP) located above Greystone Mill Pond is a known source of nutrients to the Woonasquatucket River (Louis Berger Group, Inc., 2000). Macroinvertebrate sampling areas are targeted to allow discrimination of the effects of the WWTP and groundwater discharge from the Site. Three sampling areas are situated in the reach above Greystone Mill Pond (above, adjacent to, and downstream of the WWTP). Similarly three locations will be sampled in the lotic reach from Route 44 to the lotic/lentic transition area above Allendale Pond. Two samples will be collected in the riverine section of the river below Allendale Pond to assess community recovery and two locations in Assapumpsett Brook to characterize background conditions. Table 8 provides a description and rationale for each of the selected sampling locations.

Surface water samples will be collected at each of the 10 macroinvertebrate community sampling areas and will be used in conjunction with existing sediment data to evaluate the nature of potential stressors to the macroinvertebrate community (see Section 2.2.5). In addition, groundwater analytical data collected as part of the ongoing Groundwater Remedial Investigation and existing vapor diffusion sampler (VDS) data will be evaluated. Figure 4A includes a plot of the VDS results for the Woonasquatucket River, Centredale Reach.

2.2.3.2 Emerging Adult Macroinvertebrates

The abundance and species richness of the insect fauna collected in the emergence traps deployed in Allendale Pond, Lymansville Pond, and Greystone Mill Pond will be determined to assess potential impacts of sediment contamination on the macroinvertebrate community. Emerging insects will be sampled following tree swallow egg hatch and prior to collection of nestlings for tissue analysis. Adult macroinvertebrates will be collected following procedures described in detail in Appendix E. Sample results will be tabulated and total abundance and biomass, abundance of dominant taxa, and species richness estimates (including Shannon-Wiener and Pielou's J estimate of evenness) will be plotted. The null hypothesis that there are no statistical differences in these metrics between the two study areas and the reference area will be tested.

2.2.3.3 Floodplain Soil Fauna

The potential effects of certain COPCs detected in floodplain soils (including SVOCs, pesticides, and metals) on the soil faunal community will be assessed. Three samples will be collected from floodplain sediments/soils from Greystone Mill Pond and Allendale Pond, four locations from Lymansville Pond floodplains, and one sample from Assapumpsett Pond. At each of the 11 biological stations, a standard size plot (size to be determined following an initial pilot study) will be established to demarcate an area for habitat characterization and earthworm collection. The soil infauna in 5 replicate subsamples from each sample plot will be categorized and enumerated and all earthworms within the plot then collected for subsequent tissue sampling along with a composited soil sample for chemical analysis. The substrate and overlying vegetation will be characterized, and macroscopic soil organisms will be collected by soil sieving (Southwood, 1978). A similar effort will be conducted in a comparable reference area of suitable habitat. The following information will be documented:

- relative abundance of other macroscopic life (e.g., larvae or adult forms of invertebrates);
- earthworms weight and total number;
- evidence of cocoons;
- topography of sample area;
- dominant vegetation in area;
- hydrological indicators (depth to standing water; saturated soil conditions, evidence of gleyed conditions or soil mottling); and
- soil classification/profile (based on U.S. Natural Resource Conservation Services [NRCS] mapping units.

Laboratory analysis will include TOC and grain size determination. Results will be compared to identify potential differences among sampling locations (relative to reference areas) that may be related to contaminant exposure. Biomass and total earthworm abundance data will be compared

within each soil classification category and examined for correlations with patterns of contaminant concentrations. Depending upon the number of identified soil categories, the earthworm data may be statistically evaluated (e.g., Kruskall-Wallace) although the number of sample locations will limit statistical power.

2.2.3.4 Fish Community Study

A fish population and community survey will be completed in lotic and lentic (i.e., pond) environments downstream of the Site following the framework of the Index of Biotic Integrity (IBI), as outlined in Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, 2nd Edition (Barbour et al., 1999). The survey will be conducted concurrently with fish tissue sampling activities and the results will inform the selection of specific species for tissue analysis (see Section 2.2.2). Fish will be collected using the techniques outlined in Appendix A, including electroshocking and nets, and placed in live wells prior to collection of population data and possible preparation for tissue analysis. Animals that are not selected for tissue analysis will be returned to the approximate location of capture. Species will be identified, enumerated, length-weight relationships and IBI condition indices (as described in Appendix A) will be measured, and any observations of gross morphological abnormalities (e.g., lesions, and deformities) and the presence of ectoparasites will be noted. Fish scales will be collected to provide age data to evaluate the demographic structure of the fish populations in the study area relative to the reference areas.

Laboratory analytical procedures are presented in the QAPP.

2.2.3.5 Fish Ichthyoplankton Survey

Ichthyoplankton (i.e., larval fish) surveys will be conducted to obtain community measures of species richness and relative abundance that will be used in the effects assessment of the BERA. These surveys will be conducted during three discrete sampling events to be conducted in April, May, and June of 2001. Each pond will be segregated into a number of discrete sampling areas depending on size and data requirements: Allendale Pond (3), Lymansville Pond (4), Greystone Mill Pond (3), and Assapumpsett Pond (1) and three replicate samples will be collected from each segment (Figure 2). Due to the anticipated variability in site conditions, the subcontractor will evaluate conditions in the field (e.g., shallow water depth, presence of snags) prior to selecting a specific sampling methodology. If shallow water conditions preclude the use of a boat in Allendale Pond, a qualitative sampling of the ichthyoplankton using dip nets may be conducted in lieu of the plankton tows.

Surveys will be conducted following the standard operating procedure provided in Appendix A, which are summarized in the following guidelines:

- Prior to sampling, the subcontractor will evaluate the physical conditions of each sampling area and determine appropriate type of tow, gear, and deployment). The towpath for each replicate sample will also be determined.
- The volume of water collected per tow will be measured and the subcontractor will ensure that the volumes collected are consistent across all pond reaches that are quantitatively sampled. It is anticipated that each tow will be approximately 10 minutes in duration; however this may be adjusted following review of site conditions.
- At the completion of the tow, the sample will be transferred to a collection bucket and then to a sample storage container, and sufficient preservative added to ensure that the samples will not deteriorate. Sample identification (see Section 2.3.4) labels will be placed both inside and attached to the outside of the sample container.
- The type of tow, specific gear, and how deployed will be recorded on the sample data form along with date and time sampled, sample identifier, description of tow path, average water depth, and any relevant observations.
- Collect three replicate samples from within the sampling area segment, repeat the last two steps and then move to the next segment or sampling area.

Laboratory analytical procedures will be documented in the QAPP.

2.2.3.6 Swallow Population Study

Field activities associated with the swallow population study are being subcontracted directly by USEPA and not included in this work assignment.

2.2.3.7 Frog Chorus Survey

Field activities associated with the frog chorus survey are being subcontracted directly by USEPA and are not included in this work assignment.

2.2.3.8 Wildlife Survey and Habitat Characterization

Field biologists will routinely document the aquatic, wetland, and upland communities throughout the field program during the conduct of specific sampling tasks. Routine documentation will include recording incidental observations of wildlife, describing dominant vegetation and plant communities, and collecting voucher samples for taxonomically difficult plant species. In addition, field biologists will conduct dedicated field surveys to identify potential wildlife communities that may be present in the study area. Specifically, field surveys will be used to document the occurrence of individual wildlife species, groups of species, and the various habitats. Taxonomic checklists for each major group of wildlife receptors will be used to document the receptors identified during the conduct of the field survey. Information regarding

the presence of rare, threatened, or endangered species that may occur in the study area will be obtained prior to the field surveys from federal and state resource agencies, including USFWS, RIDFW, and the Natural Heritage Program. If responding resource agencies indicate that any species of potential concern are known to or could occur within the study area, the field surveys will specifically target the preferred habitat(s) of the identified taxon or taxa. However, a dedicated search for any identified species is beyond the scope of this field investigation.

Two field technicians will participate in the wildlife surveys over a two-day period. The methods used for wildlife surveys will be reconnaissance-level, habitat-based assessment surveys. They will consist of traveling through the four exposure areas, as well as the upgradient and reference areas, and recording all wildlife species or signs of species that are observed. General statements will be made regarding relative abundance of certain species and the habitats they use within the study area. The presence of specific microhabitats (e.g., undercut riverbanks, downed logs), when encountered, will be documented.

In general, information concerning riverbed substrate, flow rates, water depth, river width, presence and types of macrophytes, local land use, and other features (e.g., riffle/run habitat) will be obtained during a complete transverse of the study area. The adjacent floodplain and upland plant communities will be described floristically and photo-documented. This initial characterization of the ecological communities present within the study area will include both plant and animal communities. Species groups for which initial baseline information is needed include mammals, reptiles and amphibians, birds, and plant communities. The presence of endangered or threatened species and/or their habitats within the study area will also be noted. Incidental observations of foraging or breeding piscivorous, insectivorous, and omnivorous wildlife will be recorded.

Mammals. Field surveys will be conducted to identify potential mammal communities that may be present in the study area. Visual observations will be used to document the occurrence of individual mammal species, groups of species, and the various habitats. The surveys will consist of traveling through the four exposure areas, as well as the upgradient and reference areas, and recording all wildlife species or signs of species (e.g., tracks and scat) that are observed. All occurrences of mammal observations or signs will be recorded whenever traveling in or through the study area. Information on location, species, type of observation, habitat, and activity will be recorded. All observations of mammals will be tabulated by taxon and exposure area.

Reptiles and Amphibians. Field surveys will be conducted to identify the reptile and amphibian species using the riverine, wetland, and upland habitats within the study area. Reconnaissance-level surveys of the reptile and amphibian communities will be conducted using visual encounter surveys, which consist of recording all observations of reptiles and amphibians that occur while traversing the study area. Field surveys of reptiles and amphibians will be ongoing throughout both days. Information on location, species, and habitat will be recorded in the field logbook.

All observations of reptiles and amphibians will be tabulated by taxon and exposure area. Although not a component of this Field Sampling Plan, a frog chorus survey will also be conducted in mid-April, and that information will also be considered in the evaluation of this receptor group.

Birds. Field surveys will be conducted to determine the avian community using the study area. Field surveys consist of general observations of habitat types available within the study area and the visual and auditory observations of birds. When birds are observed, information on numbers of each species, location, habitat type, brood sizes (if applicable), age, and activity will be recorded. Over the two-day survey period, bird observation efforts will occur during typical bird foraging times (the early morning hours [1/2 hour before sunrise to up to four hours after sunrise] and/or dusk). All observations of avifauna will be tabulated by taxon and exposure area.

Plant Communities. Surveys of the plant and natural communities that occur in the study area will be conducted during the two-day survey effort. Species identified during the survey will be documented through voucher specimen and/or photographs. Information concerning location, habitat, phenology, and population size will be collected. Over the two-day survey effort, it is not required that the plant community survey be conducted at a certain time of the day. The survey will occur throughout both days. All observations of plants will be tabulated by taxon and exposure area.

This field survey information will be used to prepare a habitat-based physiognomic map for the study area following the classification systems provided in USFWS (1979) and SAF (1980).

2.2.4 Sediment Sampling

Additional sediment samples will be collected to support the evaluation of potential bioaccumulation into crayfish tissue and to conduct laboratory bioassays.

It is anticipated that personnel in hip length boots can access most locations. At sediment sampling locations determined to be inaccessible by wading (i.e., water depth greater than two feet or removed from access points), an open workboat will be used to access sampling locations.

Sediment samples will be collected following the general guidance of Appendix G and the following guidelines:

- Most aquatic sediment samples will be collected using either an Ekman dredge (shallow areas) or Ponar dredge (deep areas). All sampling devices will be decontaminated prior to use as specified in Section 2.5.

- AVS/SEM samples will be collected from an undisturbed portion of one of the early grabs at each sampling station immediately after the dredge is opened. Care will also be taken during the sample container filling to ensure that the sediment matrix disturbance is minimized (no mixing or blending). AVS/SEM sample containers will be completely filled, leaving no headspace. After filling the AVS/SEM containers, any remaining sediment will be placed into a decontaminated stainless steel mixing bowl.
- Subsequent grabs collected for additional volume for the composite sample will be placed into the stainless steel mixing bowl and a sediment description will be recorded on the field data collection form. A separate stainless steel bowl will be used for each individual sample depth interval.
- The sample will then be thoroughly homogenized by hand mixing using a decontaminated scoop or large mixing spoon. After mixing, the sample will be transferred to the appropriate sample containers.
- The type of sediment sampling device used, penetration depth of the sampler, sample recovery, water depth, sediment description, date and time, sampler names, etc. will be recorded on the sample data form (Appendix G).

All sampling stations will be surveyed during the sampling program using GPS (Global Positioning System) survey equipment capable of sub-meter accuracy. In addition, a wooden stake at the shoreline edge will identify stations. The stake will be labeled with the sample identification number and this information will be recorded in the field logbook.

2.2.4.1 Sediment Sampling at Crayfish Sampling Locations

Surface aquatic sediment composite samples will be collected from a depth interval of 0 to 0. 5 feet below ground surface (bgs) at 11 identified locations where crayfish samples will also be collected (see Figures 4A and 4B). Table 5 presents a summary of the sampling locations within each of the areas where crayfish will be collected.

Appendix G provides the specific guidance on collecting sediments (and see Section 2.2.4). Sediment for the laboratory bioassays will be collected using a gravity corer, Ekman and/or Ponar dredge depending on substrate characteristics and water depth.

Sediment samples will be analyzed for PCBs/pesticides, metals (including methylmercury), dioxins/furans (including HCX), TOC, AVS/SEM, grain size, and percent moisture. In addition, 20 percent of the samples will be analyzed for the complete set of PCB congeners (Table 1).

2.2.4.2 Sediment Bioassays

A total of 8 sediment samples will be collected to conduct the laboratory invertebrate bioassays: 3 samples from both Allendale and Lymansville Ponds and a sample from the Greystone Mill Pond and Assapumpsett Pond. Sample locations are depicted in Figures 4A and 4B and were selected based on the rationale provided in Table 9. Sampling locations were selected to provide a range of exposures to the likely sediment stressors allowing evaluation of patterns of contaminant concentration and observed biological response. A total of 4 liters of sediment will be collected at each sampling location to meet the volume requirements of the bioassay laboratory.

Appendix G provides the specific guidance on collecting sediments (and see Section 2.2.4). Sediment for the laboratory bioassays will be collected using a gravity corer, Ekman and/or Ponar dredge depending on substrate characteristics and water depth. To the extent possible, sampling gear will be consistent across sampling locations to standardize depth of penetration into the bottom substrate. Grab samples that are determined to overpenetrate or are less than one half filled will be rejected and the sample collection activity will be repeated. Sediment samples will be kept on ice (2-4°C) until test commencement. The laboratory bioassay protocols that will be following are provided in the QAPP.

Bioassay sediment samples will be analyzed for SVOCs, PCB/pesticides, metals (including methylmercury), TOC, AVS/SEM, grain size and percent moisture.

2.2.5 Surface Water Sampling

A surface water sample will be collected from each of the 10 sampling areas associated with the aquatic macroinvertebrate community study sampling areas. Sampling locations are presented in Figures 4A and 4B. Surface water grab samples are to be collected from stations co-located with the macroinvertebrate community study. Of these, five will be "reference" locations, three up-stream in the Woonasquatucket River associated with the Smithfield Waste Water Treatment Plant and two in Assapumpsett Brook below the outfall from Assapumpsett Pond. Three samples will be collected in the vicinity of the site and two samples will be collected in the lotic portion of the river below Allendale Pond. Surface water samples will be collected before the aquatic macroinvertebrate community study is conducted and will begin in the most downstream location and proceed upriver. Water samples will be collected using a direct-dip technique as the samples will all be collected in shallow areas. Surface water samples will be collected following the procedures provided in Appendix G and the following guidelines:

- Measure depth of water at the station, being careful not to disturb the riverbed sediment. When possible and when depths appear consistent, the water depth measurement will be

obtained slightly downstream of the planned surface sample location to avoid disturbing the sediments.

- All sampling devices will be decontaminated prior to first used at each station following the procedures specified in Section 2.5.
- The sample collection jar will be held by hand or attached to the end of a pole. The sample collection bottle will be inverted and lowered to the desired depth (one foot above the bottom sediments) and then slowly turned upright to a 45-degree angle with the mouth of the bottle facing upstream. Fill the sample collection bottle.
- Retrieve the sampler and fill the appropriate sample containers.
- Record the pH, specific conductivity, temperature, salinity, turbidity, dissolved oxygen (DO), sampling device used, date and time, name of samplers, etc. of the sample on the field data sheets (Appendix G).
- Preserve total metal samples.
- Stake and GPS survey sample station (as presented below).
- Decontaminate the sampler device before reuse (refer to Section 2.5).

The surface water samples will be analyzed for VOCs, SVOCs, PCB/pesticides, metals, hardness and nutrients (Table 1).

All sampling stations will be surveyed during the sampling program using GPS (Global Positioning System) survey equipment. In addition, a wooden stake at the shoreline edge will identify stations. The stake will be labeled with the sample identification number and this information will be recorded in the field logbook.

2.2.6 Floodplain Soil Sampling

A total of 11 composited floodplain soil samples will be collected to support the evaluation of earthworm tissue analytical results and the soil fauna community study.

Appendix G provides general guidance on the collection of floodplain soil samples. Table 7 provides the rationale for sample location selection.

Floodplain soil samples will be analyzed for SVOCs, PCB/pesticides, metals (including methylmercury), dioxins/furans (including HCX), TOC, grain size, and percent moisture. In addition, 20 percent of the samples will be analyzed for the complete set of PCB congeners (Table 1).

2.2.7 GPS Data Collection Methods

Global Positioning System (GPS) data loggers will be used to establish the vertical and horizontal coordinates of all sample locations. All coordinates will be recorded in the Rhode Island Planar Grid system, with horizontal and vertical coordinates given in feet. Locations will be established with a margin of error of less than three feet.

At each sample location, the GPS logger will be used to establish the location. In order to assure accuracy within the required margin of error, the maximum PDOP permitted for logging should be less than 3.0. Data will be logged at each location for at least one minute, to ensure that enough discrete location measurements are collected to achieve the desired margin of error when averaged. Approximate location and elevation readings will be noted in the logbook for reference at each sample location, and the averaged data will be saved on the GPS instrument to be downloaded and added to the project database.

2.3 Field Investigation Documentation

2.3.1 Logbooks

Logbooks will be maintained throughout the field investigation. The site master log, field logbooks, and field equipment logbooks are briefly described below.

2.3.1.1 Site Master Log

The site master log is the primary field investigation document to be maintained by the FOL. Its primary purpose is to contain within one document the actual field data or references to other field documents that contain a specific description of every activity that has occurred in the field on any given day. Any administrative occurrences, conditions, or activities that have affected the fieldwork will also be recorded. A copy of these reports will be sent to the site managers at the conclusion of the field program. Daily Calibration Data Sheets will be filed as part of the Master Log as well.

2.3.1.2 Field Books

Each field team will maintain separate field books, as necessary, responsible for sampling and support activities. Field books will be sequentially numbered by the user and bound with a hard cover. All entries will be in permanent black ink with changes initialed and dated. In general, these books will contain specific details supporting the tasks performed by the person maintaining the field logbook. Information to be recorded in the field books or on supporting field data forms shall include, but not be limited to the following:

- name and title of author, date and time of entry, and physical/ environmental conditions during the field activity;
- name and titles of field crew, including subcontractors;
- name and titles of site visitors, and time on and off site;
- documentation of health and safety activities;
- sampled media designation (i.e., soil, groundwater);
- sample collection method (i.e., grab or composite);
- number and volume of samples taken;
- description of sampling points;
- date and time of collection;
- sample identification numbers;
- references for maps and photographs of the sampling sites;
- field observations;
- field measurements made (i.e., pH, temperature);
- decontamination procedures;
- instrument calibration; and
- weather conditions.

2.3.1.3 Field Equipment Notebook

The purpose of the field equipment notebook is to document the proper use, maintenance, and calibration of the field testing equipment. Equipment will be inspected and approved by the FOL before being used. A Calibration Data Sheet will be maintained daily for all monitoring instruments used on site; the bound data sheets will comprise the Field Equipment Notebook, which will be incorporated into the Master Log. Information recorded on the data sheets or on separate pages in the notebook will include, but will not be limited to, the following items:

- name and identifying number of the instrument;
- date calibrated;
- calibration points;
- name and title of the calibrator;
- instrument manufacturer;
- lot number;
- expiration date of calibration standards;
- results of the calibration;
- field maintenance; and
- problems encountered/resolution of problems.

2.3.2 Sample Documentation

Solid or liquid phase sample log sheets (Appendix G) will be completed accordingly, for each sample collected. Information recorded will include sample identification, analytes, depth sampled, date and time collected, and other pertinent information. Biological sample logs (as provided in the appendices) will also be completed. Analytical Request Forms (ARFs) and all analytical COC forms will be maintained in a file in the site trailer and copies will be sent to the site managers on a weekly basis when analytical samples are being shipped.

2.3.3 Sample Location Summary

Sample station locations will be surveyed using a Global Positioning system (GPS). All sample site locations will be referenced to the Rhode Island State Plane Coordinate System.

2.3.4 Sample Location Identification System

Each analytical sample collected from the study area will be assigned a unique sample location tracking number. Consistent with the SAP for the Woonasquatucket River Sediment Investigation (Tetra Tech NUS, 1999), the sample location tracking number will consist of a four- to five-segment, alpha-numeric code that identifies the area, sample medium, specific sample location identifier, sample event, sample depth or the quality control (QC) sample designation, if appropriate. Any other pertinent information regarding sample identification will be recorded in the field logbooks or on sample log sheets.

The alphanumeric coding to be used in the sample location numbering system is explained in the following diagram and the subsequent definitions:

AAA - AA - NNNN - NNN - NN

Where "A" represents an alpha character and "N" represents a numeric character.

1. The three alpha character group identifies the area investigated (e.g., "CMS" for Centredale Manor Site). The character groups for the reaches of the river within the boundaries of the site and the upstream and reference areas are provided below:

   River Stations:
   WRC – Woonasquatucket River, Centredale Reach
   CMW – Centredale Manor Wetlands

APC – Allendale Pond Channel
APB – Allendale Pond Bottoms
WRL – Woonasquatucket River, Lymansville Reach
LPX – Lymansville Pond
MAP – Manton Pond
DYP – Dyerville Pond

Reference/Upstream Stations:
RWR – Woonasquatucket River, Upstream Reach
GMP – Greystone Mill Pond
RAB – Assapumpsett Brook, Reference

2. The two alpha character group identifies the matrix sampled as follows:

FP – Floodplain Soil/Sediment
SD – Aquatic Sediment/Soil
SW – Surface Water
CF – Crayfish
EW – Earthworm
EI – Emerging Insects

In addition, a two character alpha group will be established for each of the biota species selected for tissue analysis following initial characterization of the fish fauna and review of consumption patterns (see Section 2.2.2). Target species (with alpha group designation in parentheses) include American eel ("AE"), largemouth bass ("LB"), and turtle ("TT") or frog ("FR"). A unique group designation will be established for any alternate species that is selected.

3. A four numeric character group describing a unique location number identified sequentially. Data collected within site boundaries will use a "4000" series. The "5000" series will be used for upstream and reference areas.

4. A four-digit group stating the depth of the sample collected in feet. As discussed in Section 2.4, sediment samples collected to support the evaluation of uptake to crayfish tissue will be collected from 0 – 0.5 feet and sediment samples collected for the laboratory bioassay will be collected from 0 – 0.5 feet.

5. A two digit round number for that station number "01" for the first sample collected from that location, and "02" for the second sample collected from that location, etc. For example, the sample identifier, LPX-CF-4001-0003-01 represents a crayfish sample collected from Lymansville Pond at location 4001, collected between 0 and 0.5 feet, and it was the first crayfish sample collected at that location.

QC Samples

1. A three alpha character group identifying the area investigated (see above).

2. A two alpha character group will be used to identify QC samples as identified below. This two character group will replace the character group used to identifying the matrix in the primary sample:

   DU = Duplicate
   RB = Rinsate Blank
   FB = Field Blank

3. A six numeric character group describing the date of sample collection and a letter in sequence (A being the first collected that day, B being the second, etc.). For example, WRL-DU-061501A represents the first duplicate sample collected on 15 June 2001.

2.4 QUALITY CONTROL SAMPLES

The quality control (QC) samples that will be collected or generated during the field sampling activities are described below. A detailed discussion of the objectives, procedures, and collection rates for each type of QC sample is provided in the QAPP.

Rinsate Blanks: Rinsate blanks will be collected at a rate of one for ten samples.

Performance Evaluation (PE) Samples: PE samples will be sent to the laboratory at a rate of one for every 20 samples per analysis.

Laboratory Quality Samples: Additional sample volume will be collected at the rate of one in 20 samples per analysis for laboratory quality control.

2.5 CHAIN OF CUSTODY PROCEDURES

Samples collected at the Site will be held under Chain of Custody (COC). COC procedures will be used to ensure that:

- All necessary samples are collected for all scheduled analyses;
- The correct samples are analyzed for requested analyses and traceable to their records;
- Samples are protected from loss and identified if damaged;
- Alteration of samples (e.g., filtration and preservation) is documented;

- A forensic record of sample integrity is established; and
- Sample security is maintained.

COC protocol to be followed by sampling personnel involves the following steps:

- Documenting procedures used and reagents added to samples during sample preparation and preservation;
- Recording sample site identification, field sample number, and specific sample collection procedures on the appropriate forms;
- Using sample labels which contain all information necessary for effective sample tracking; and
- Completing standard field data record forms to establish sample custody in the field before sample shipment.

The COC record is used to document sample-handling information (i.e., sample location, sample identification, and number of containers corresponding to each sample number). The following information is recorded on the COC record:

- Project reference;
- Site identification code, sample identification code, date of collection, time of collection, number and type of sample containers for each analysis, preservation methods, site type, total number of containers for each sample, and sample depth;
- Names of the sampler(s) and the person shipping the samples; and
- Date and time that the samples were delivered for shipping.

2.6 EQUIPMENT DECONTAMINATION

This section provides guidelines for decontamination of equipment used during the field investigation. All decontamination activities will be conducted within an established area within each EA and will be performed under the supervision of the FOL. Personnel decontamination issues will be discussed in the HASP.

2.6.1 Decontamination Procedures

All non-disposable sampling and testing equipment that comes in contact with the sample medium will be decontaminated to prevent cross-contamination between sampling points, as described below:

- Brush to remove gross contamination;
- Potable water and detergent (e.g., Alconox or Liquinox) was and scrub with brush;

- Rinse with potable water;
- Rinse with DIUF water (analyte free);
- Rinse with reagent grade 2-propanol (collect separate from water rinses to minimize solvent IDW volume);
- Rinse with reagent grade hexane (collect separate from water rinses to minimize solvent IDW volume);
- Air dry (to the extent practical) on aluminum foil or in a strainer; and
- Wrap in aluminum foil for transport (or if not being used immediately).

2.7 CONTROL AND DISPOSAL OF INVESTIGATION-DERIVED WASTE (IDW)

Investigation-derived waste generated by the project will be limited to excess sample material and decontamination fluids. All IDW will be stored (on a daily basis) at the Centredale Manor Site trailer until disposal. Sample results from associated soil sampling will be used to characterize this waste to the extent possible. However, the IDW contractor may require additional analysis prior to removal off-site and treatment or disposal.

The personal protective equipment (PPE) waste generated during work will be decontaminated, double-bagged in plastic bags, and disposed of as solid waste in an industrial dumpster at the completion of work.

2.7.1 Segregation of Sediment, Liquids, and Drum Labeling

It is anticipated that IDW will be generated during the sediment sampling and equipment decontamination activities. Harding ESE will segregate sediment and liquids after each sampling event. Sediment and liquids (generated during equipment decontamination) will be places in separate labeled drums. After IDW soil/sediment is drummed and the lid clamped tight, the drum will be marked using a waterproof indelible ink marker; an example follows:

- IDW-CM-01 – (IDW – Centredale Manor – drum #01)
- Date first accumulated: e.g., 9/25/99
- Source(s) of material: Sample ID#
- Volume and type of total material

Drum labeling is necessary to identify materials stored in the drums and to evaluate how the drummed material will be sampled for waste characterization.

2.7.2 Transportation and Disposal Subcontractor

If necessary, a licensed hazardous waste transportation and disposal subcontractor will be required to transport and dispose of any non-hazardous and hazardous waste streams generated during the investigation. The subcontractor will be procured to transport and dispose of IDW waste to approved off-site disposal facilities.

2.7.3 Documentation

On a daily basis, the FOL or designee will document the generation of IDW during the investigative activities to ensure that the IDW is properly containerized and stored at the staging area. Information will be recorded in a bound notebook. Daily records of soil stored in drums will include the following information:

- Drum Identification Number;
- Date first accumulated;
- Source of material;
- Volume of material; and
- Sample Identification Numbers (consistent with sample identifiers described in Section 2.3.4).

2.7.4 Hazardous Waste Manifesting Compliance

The transportation and disposal subcontractor for each shipment of IDW leaving the site will prepare one hazardous waste manifest.

Manifests will be completed for all hazardous wastes disposed off site, and signed by the Harding ESE Site Representative "On Behalf of EPA".

Copies of all documentation of control and disposal of IDW generated by the project will be provided to the U.S. EPA. Copies will also be maintained in the project file located at the Harding ESE Wakefield, Massachusetts office.

GLOSSARY

ARF	Analytical Request Forms
AVS/SEM	acid volatile sulfides/simultaneously extracted metals
BERA	Baseline Ecological Risk Assessment
CBR	Critical Body Residues
COC	Chain of Custody
COPCs	Chemicals of Potential Concern
EA	exposure area
EE/CA	Engineering Evaluation/Cost Estimate
FOL	Field Operations Leader
FSP	Field Sampling Plan
GPS	Global Positioning System
HASP	Health and Safety Plan
HCX	hexachloroxanthene
HHRA	Human Health Biota Consumption Risk Assessment
IBI	Index of Biotic Integrity
IDW	Investigation Derived Waste
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PDOP	Position Dilution of Precision
PE	Performance Evaluation
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
QC	Quality Control
RIDFW	Rhode Island Department of Fish and Wildlife
SAF	Society of American Foresters
SAP	Sample and Analysis Plan
SOPs	Standard Operating Procedures
SOW	Statement of Work

GLOSSARY

SSO	Site Safety Officer
SVOCs	semi-volatile organic carbons
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VDS	vapor diffusion sampler
VOCs	volatile organic carbons
WWTP	Waste Water Treatment Plant

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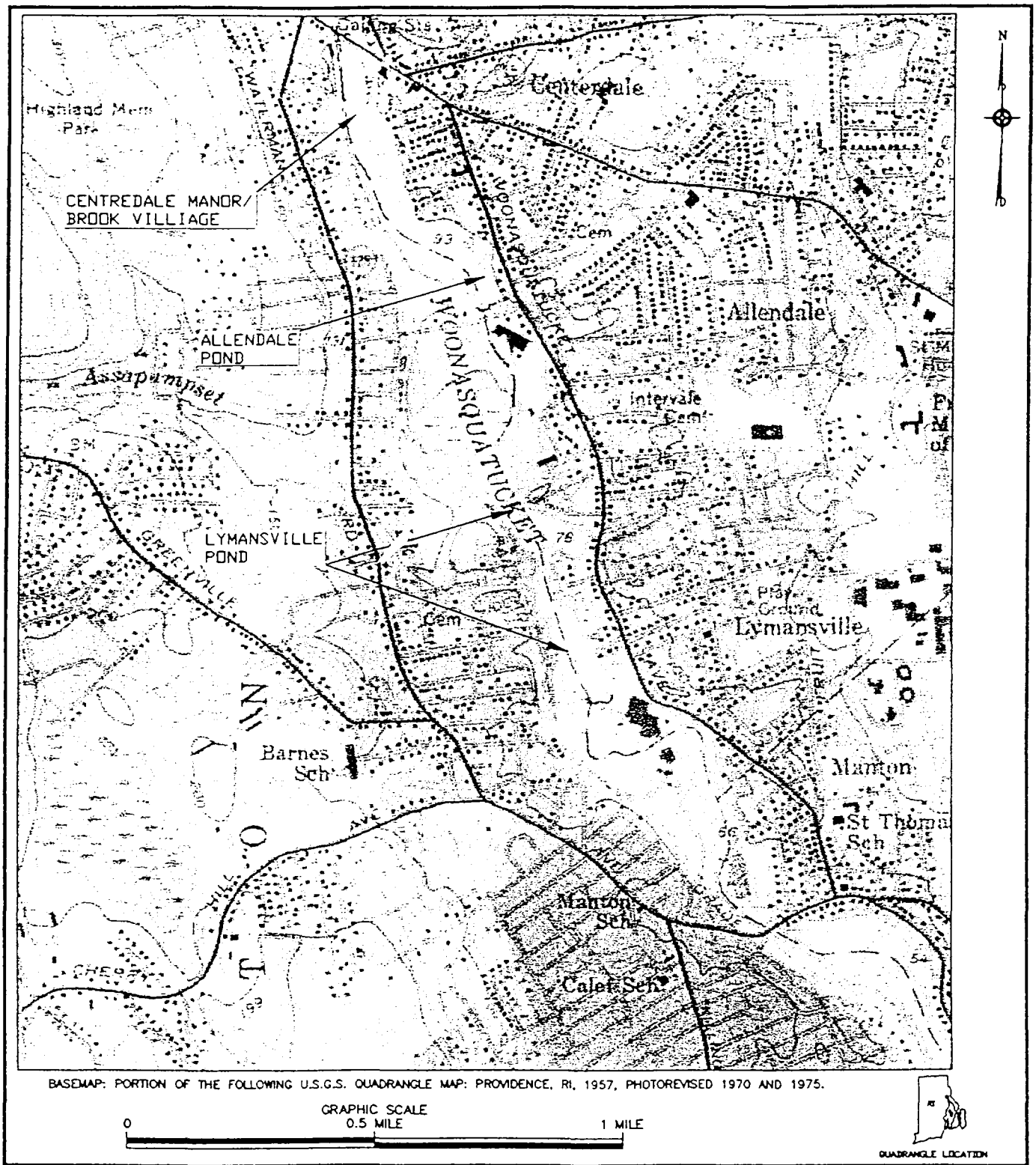
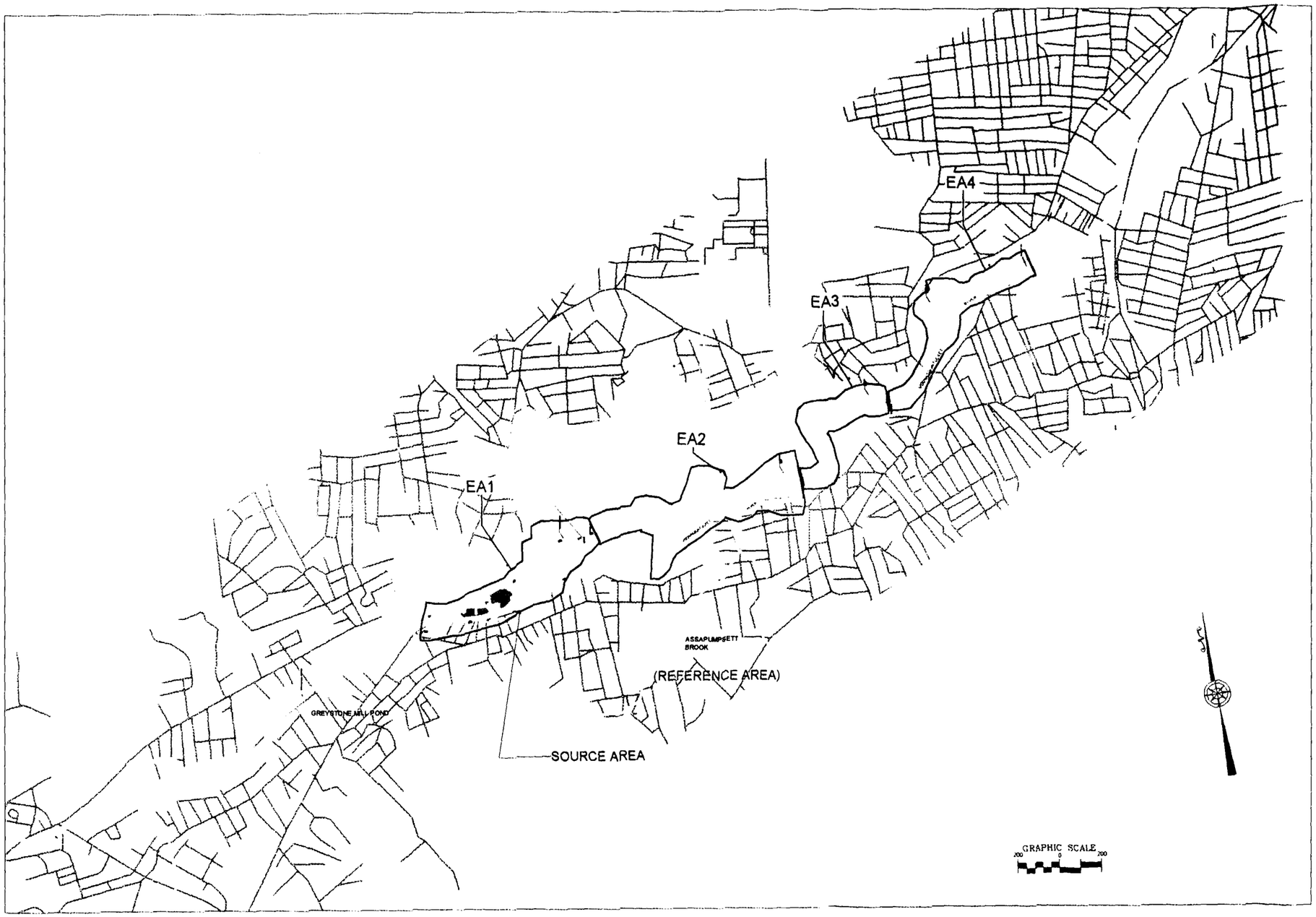


FIGURE 1
SITE LOCATION MAP
CENTREDALE MANOR RESTORATION SITE
NORTH PROVIDENCE, RHODE ISLAND

Harding ESE
A MACTEC COMPANY



LEGEND:

EA = EXPOSURE AREA

= SURFACE WATERS

= APPROXIMATE EXTENT OF EXPOSURE AREAS

* EA1, EA2, EA3, AND EA4 constitute the site.

For the reach of the Woonasquatucket River that constitutes the site (as shown here), the following activities will occur:

- Paired crayfish and aquatic sediment/soil - EA 1, EA 2, Assapumpsett Brook, and Greystone Mill Pond
- Paired earthworm and floodplain soil/sediment - EA 1, EA 2, Assapumpsett Brook, and Greystone Mill Pond
- Fish and other biota (e.g., turtles, frogs) - EA 1, EA 2, Assapumpsett Brook, and Greystone Mill Pond. 1 species of fish at EA 3 and EA 4.
- Emerging insects - EA 1, EA 2, Assapumpsett Brook, and Greystone Mill Pond
- Bioassay sediment - EA 1, EA 2, Assapumpsett Brook, and Greystone Mill Pond
- Species community surveys - All EAs, Assapumpsett Brook, and Greystone Mill Pond

SOURCE: TetraTech

Harding ESE

FIGURE 2
STUDY AREA AND GENERAL EXPOSURE AREAS
CENTERDALE MANOR RESTORATION SITE
NORTH PROVIDENCE, RHODE ISLAND

CENTERDALE2.DWG

Figure 3
Field Investigation Schedule
Centredale Manor Restoration Project Superfund Site

	Task Name	Duration	Start	Finish
1	Notice to Proceed	1 day	Wed 5/16/01	Wed 5/16/01
3				
4	**Task 18. Fish Consumption Information Evaluation**	**27 days**	**Tue 5/1/01**	**Wed 6/6/01**
5	Obtain/Review Information	15 days	Tue 5/1/01	Mon 5/21/01
6	Prepare Summary	1 day	Tue 5/22/01	Tue 5/22/01
7	Finalize Species	1 day	Wed 5/23/01	Wed 5/23/01
8	Finalize Contingency Plan	1 day	Thu 5/24/01	Thu 5/24/01
9	EPA Conference Call/Concurrence	1 day	Fri 5/25/01	Fri 5/25/01
10	Prepare EPA Letter	3 days	Mon 5/28/01	Wed 5/30/01
11	EPA review	5 days	Thu 5/31/01	Wed 6/6/01
12	**Task 21. Field Sampling**	**162 days**	**Tue 4/10/01**	**Wed 11/21/01**
13	Field Prep	1 day	Tue 5/1/01	Tue 5/1/01
14	ELS Fish Sampling	2 days	Tue 4/10/01	Wed 4/11/01
15	Ichthyoplankton survey	2 days	Wed 5/2/01	Thu 5/3/01
16	Frog Chorus (by 5/21/2001 by others)	15 days	Mon 4/23/01	Fri 5/11/01
17				
18	Field Prep	10 days	Thu 5/17/01	Wed 5/30/01
19	Kickoff Meeting	1 day	Thu 5/24/01	Thu 5/24/01
20	Site Reconnaissance	1 day	Thu 5/31/01	Thu 5/31/01
21	Ichthyoplankton Survey (Event II)	2 days	Fri 6/1/01	Mon 6/4/01
22	Fish Tissue Sampling	9 days	Tue 6/5/01	Fri 6/15/01
23	Fish IBI	9 days	Tue 6/5/01	Fri 6/15/01
24	Bioassay Sediment	3 days	Wed 6/27/01	Fri 6/29/01
25	Crayfish and Sediment	3 days	Mon 6/18/01	Wed 6/20/01
26	Surface Water	3 days	Thu 6/21/01	Mon 6/25/01
27	Aquatic Macroinvertebrate (RBP)	4 days	Thu 6/21/01	Tue 6/26/01
28	Earthworms and Floodplain Soil	3 days	Mon 7/2/01	Wed 7/4/01
29	Floodplain Soil and Fauna Survey	3 days	Mon 7/2/01	Wed 7/4/01
30	Emerging Insects	9 days	Fri 6/22/01	Wed 7/4/01
31	Emerging Macroinvertebrates	9 days	Fri 6/22/01	Wed 7/4/01
32	Wildlife and Vegetation	2 days	Thu 7/5/01	Fri 7/6/01
33	Ichthyoplankton Survey (Event III)	2 days	Tue 7/10/01	Wed 7/11/01
34	Swallow Survey (by EPA)	57 days	Wed 5/16/01	Thu 8/2/01
35	Sample Management/Shipping	29 days	Mon 6/4/01	Thu 7/12/01
36	Taxonomic Analysis and Reporting	100 days	Thu 7/5/01	Wed 11/21/01
37	IDW Disposal	30 days	Mon 8/20/01	Fri 9/28/01

Final Field Sampling Plan
June 1, 2001

Task | Progress | Summary | Rolled Up Split | Rolled Up Progress | Project Summary
Split | Milestone | Rolled Up Task | Rolled Up Milestone | External Tasks

Figure 3
Field Investigation Schedule
Centredale Manor Restoration Project Superfund Site

ID	Task Name	Duration	Start
1	Notice to Proceed	1 day	Wed 5/16/01
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27	Aquatic Macroinvertebrate (RBP)	4 days	Thu 6/21/01
28	Earthworms and Floodplain Soil	3 days	Mon 7/2/01
29	Floodplain Soil and Fauna Survey	3 days	Mon 7/2/01
30	Emerging Insects	9 days	Fri 6/22/01
31	Emerging Macroinvertebrates	9 days	Fri 6/22/01
32	Wildlife and Vegetation	2 days	Thu 7/5/01
33	Ichthyoplankton Survey (Event III)	2 days	Tue 7/10/01
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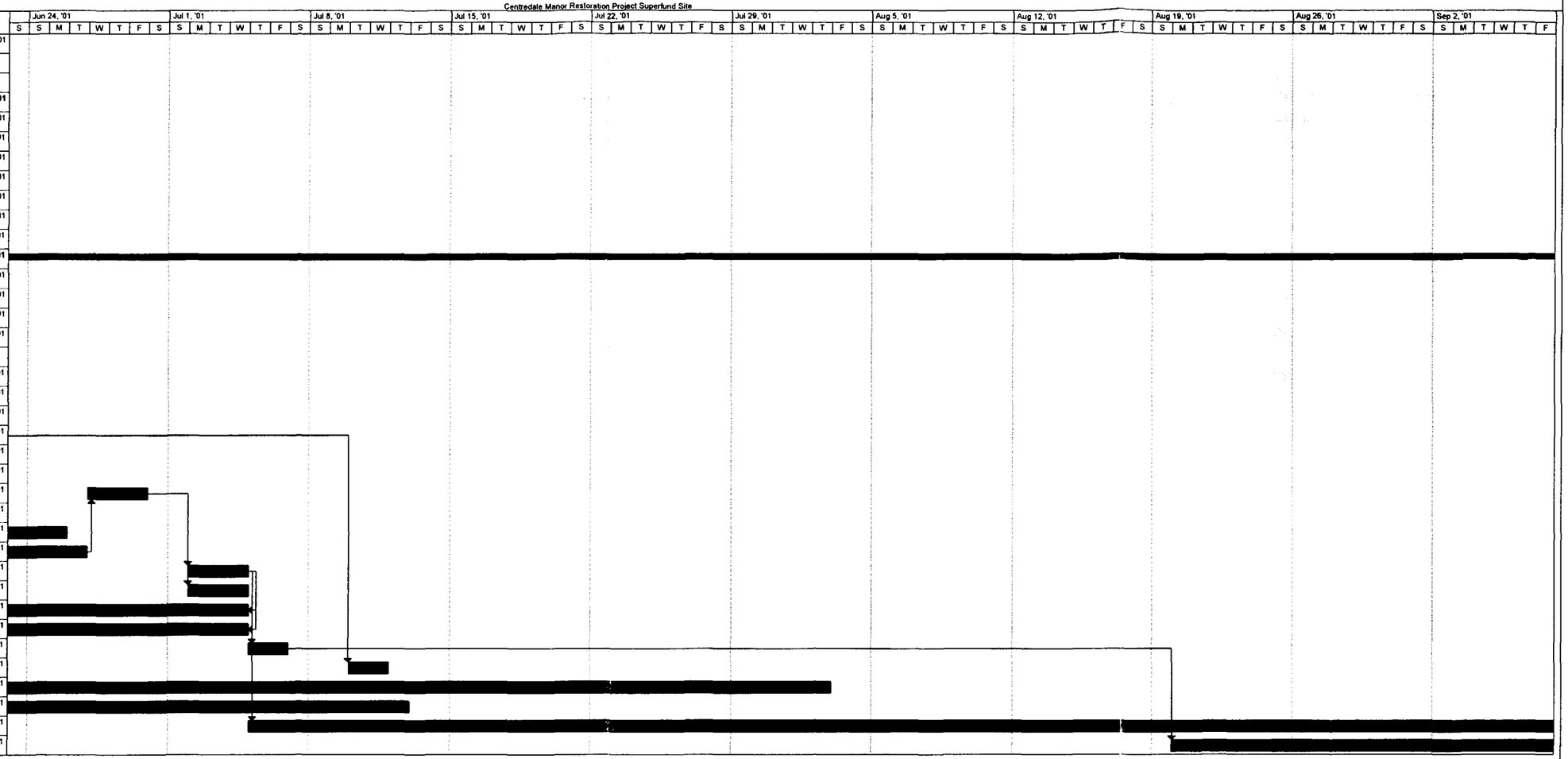

Final Field Sampling Plan
June 1, 2001

Task | Progress | Summary | Rolled Up Split | Rolled Up Progress | Project Summary
Split | Milestone | Rolled Up Task | Rolled Up Milestone | External Tasks

Figure 3
Field Investigation Schedule
Centredale Manor Restoration Project Superfund Site

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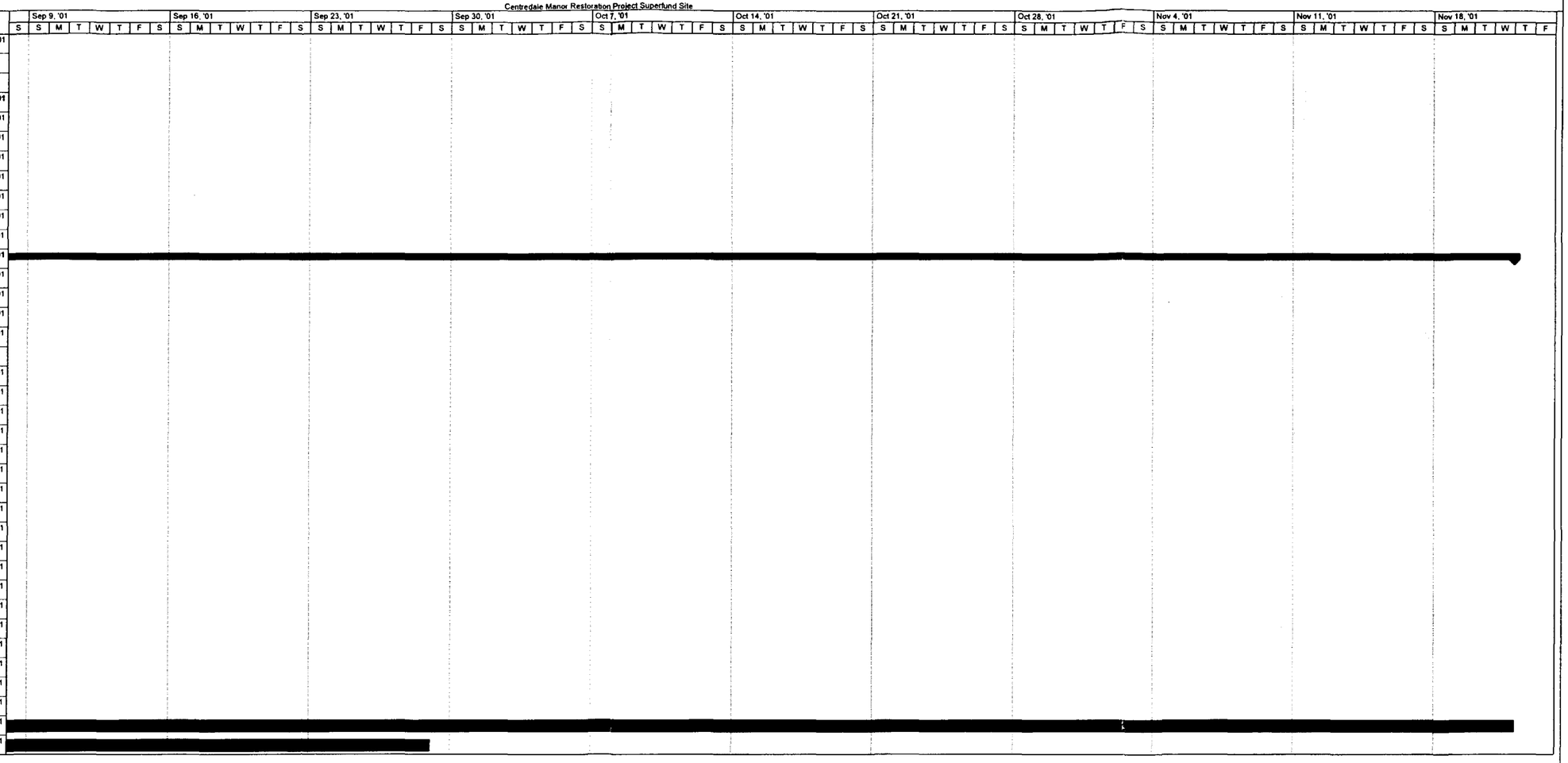

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RWR-CF-5002
RWR-SD-5002
RWR-CF-5001
RWR-SD-5001
CMW-SD-4011(B)
CMW-CF-4001
CMW-SD-4001
CMS-CF-4002
CMS-SD-4002
CMS-EI-4001
CMS-CF-4002(B)
CMS-SD-4002(B)
CMS-EI-4002
CMS-CF-4002(B)
CMS-SD-4002(B)
CMS-EI-4003
APB-SD-4008
APB-SD-4009
APB-SD-4010
APB-EI-4004
APB-CF-4003
APB-SD-4003
APB-EI-4005
ALLENDALE POND
ALLENDALE DAM
A
MAGNETIC
200 0 200 400
SCALE IN FEET

WRC-SW-4003
WRC-SW-4002
WRC-SW-4001
100 0 100 200
SCALE IN FEET

SMITHFIELD SEWAGE TREATMENT PLANT
RWR-SW-5003
RWR-SW-5002
RWR-SW-5001
GMP-EI-5005
GMP-EI-5004
GMP-EI-5003
GMP-EI-5002
GMP-EI-5001
GMP-CF-5003
IN THE GENERAL VICINITY OF SD-35
GREYSTONE MILL POND DAM
GMP-SD-5003
RWR-SW-5003 (B)
RWR-SW-5002 (B)
RWR-SW-5001 (B)
200 0 200 400
SCALE IN FEET

LEGEND:
- PARKING LOT
- BUILDING
- ROAD
- WATER BODY
- RIP RAP
- EXISTING AQUATIC SEDIMENT SAMPLE LOCATION
- EXISTING AQUATIC SOIL SAMPLE LOCATION
- (A) BOAT ACCESS AREA
- NEW SURFACE WATER SAMPLE LOCATION
- NEW AQUATIC SEDIMENT INVERTEBRATE BIOASSAY SAMPLE LOCATION
- NEW EMERGING INSECT SAMPLE LOCATION
- NEW PAIRED CRAYFISH/SEDIMENT SAMPLE LOCATION
- CMS-CF-4002(B) LOCATION ID FOR NEW SAMPLE (B) INDICATES A BACKUP FOR THAT LOCATION
- "CF" - CRAYFISH "EI" - EMERGING INSECT "SD" - AQUATIC SEDIMENT/SOIL

Harding ESE
A MACTEC COMPANY
107 Aubudon Road
Building II, #301
Wakefield, MA 01880
781-245-6606

DRAWN MCR | JOB NUMBER 52123 | APPROVED | DATE | REVISED DATE

FIGURE 4A
AQUATIC AND VAPOR DIFFUSION SAMPLING LOCATIONS
UPSTREAM TO ALLENDALE DAM
CENTREDALE MANOR RESTORATION SITE
NORTH PROVIDENCE, RI

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LEGEND:

- ROAD
- WATER BODY
- EXISTING AQUATIC SEDIMENT SAMPLE LOCATION
- EXISTING AQUATIC SOIL SAMPLE LOCATION
- (A) BOAT ACCESS AREA
- NEW SURFACE WATER SAMPLE LOCATION
- NEW AQUATIC SEDIMENT INVERTEBRATE BIOASSAY SAMPLE LOCATION
- NEW EMERGING INSECT SAMPLE LOCATION
- NEW PAIRED CRAYFISH/SEDIMENT SAMPLE LOCATION
- CMS-CF-4002(B) LOCATION ID FOR NEW SAMPLE (B) INDICATES A BACKUP FOR THAT LOCATION
- "CF" - CRAYFISH
- "EI" - EMERGING INSECT
- "SD" - AQUATIC SEDIMENT/SOIL

200 0 200 400

SCALE IN FEET

Harding ESE
A MACTEC COMPANY
107 Aububon Road
Building II, #301
Wakefield, MA 01880
781-245-6606

DRAWN MCR | JOB NUMBER 52123 | APPROVED | DATE | REVISED DATE

FIGURE 4B
AQUATIC SAMPLING LOCATIONS
IN LYMANSVILLE POND
CENTREDALE MANOR RESTORATION SITE
NORTH PROVIDENCE, RI

Harding ESE
A MACTEC COMPANY

107 Aububon Road
Building II, #301
Wakefield, MA 01880
781-245-6606

DRAWN MCR | JOB NUMBER 52123 | APPROVED | DATE | REVISED DATE

FIGURE 4C
AQUATIC SOIL/SEDIMENT SAMPLING LOCATIONS
IN MANTON AND DYERVILLE PONDS
CENTREDALE MANOR RESTORATION SITE
NORTH PROVIDENCE, RI

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FOR UPSTREAM SEE INSERT A

RCC-FP-3001

RWR-EW-5001
RWR-FP-5001

RCC-FP-3002

CMS-FP-4001
CMS-EW-4001

CMW-FP-4002
CMS-EW-4002

CMW-FP-4003
CMS-EW-4003

CMW-FP-4002 (B)
CMW-EW-4002 (B)

CMS-FP-4003 (B)
CMS-EW-4003 (B)

ALLENDALE POND

ALLENDALE DAM

MAGNETIC

LEGEND:

- PARKING LOT
- BUILDING
- ROAD
- WATER BODY
- RIP RAP
- EXISTING FLOODPLAIN SEDIMENT SAMPLE LOCATION
- EXISTING FLOODPLAIN SOIL SAMPLE LOCATION
- NEW PAIRED EARTHWORM/FLOODPLAIN SOIL SAMPLE LOCATION
- BACKUP SAMPLE LOCATION
- CMW-FP-4002 (B) LOCATION ID FOR NEW SAMPLE (B) INDICATES A BACKUP FOR THAT LOCATION
- "EW" - EARTHWORM
  "FP" - FLOODPLAIN SOIL/SEDIMENT

200 0 200 400
SCALE IN FEET

INSERT A

NOTES:
SD-36 THROUGH SD-39 ARE LOCATED FURTHER UPSTREAM.
SD-37 IS IDENTIFIED AS AN UPSTREAM SAMPLING LOCATION.
RWR-EW-5003 / RWR-FP-5003 LOCATED DOWNSTREAM OF THE UPPER ESMOND DAM.

SMITHFIELD SEWAGE TREATMENT PLANT

GREYSTONE MILL POND DAM

RWR-FP-5002
RWR-EW-5002

Harding ESE
A MACTEC COMPANY

107 Aububon Road
Building II, #301
Wakefield, MA 01880
781-245-6606

DRAWN MCR | JOB NUMBER 52123 | APPROVED | DATE | REVISED DATE

FIGURE 5A
FLOODPLAIN SAMPLING LOCATIONS
UPSTREAM TO ALLENDALE DAM
CENTREDALE MANOR RESTORATION SITE
NORTH PROVIDENCE, RI

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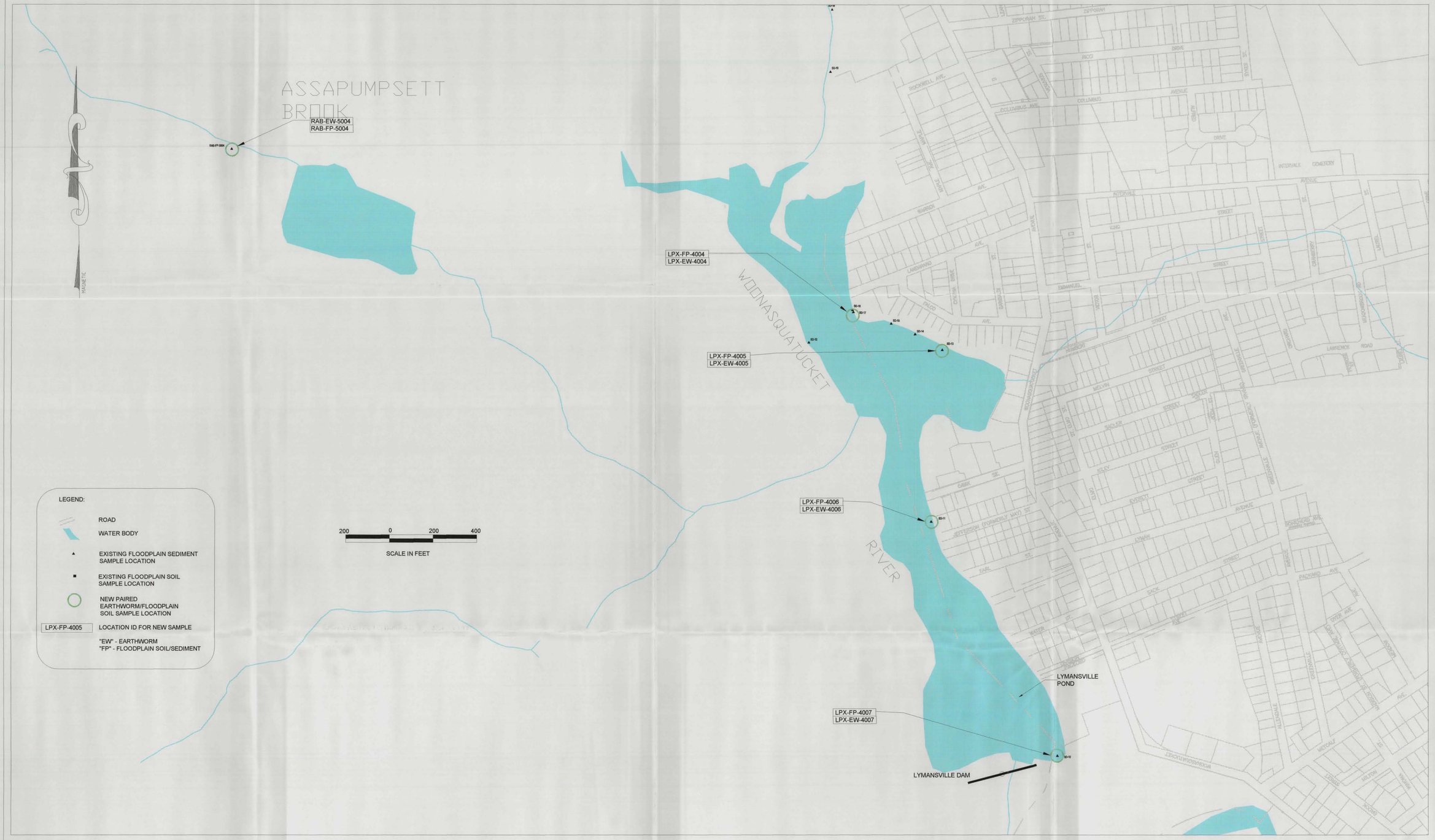

Harding ESE
A MACTEC COMPANY
107 Aububon Road
Building II, #301
Wakefield, MA 01880
781-245-6606

FIGURE 5B
FLOODPLAIN SAMPLING LOCATIONS
LYMANSVILLE POND
CENTREDALE MANOR RESTORATION SITE
NORTH PROVIDENCE, RI

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
MCR	52123			

Table 3

Summary of Biological Data Needs and Sampling Areas

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Study Type	Taxon	Exposure Area				
		Greystone Mill Pond Reach	Assapumpset Brook Reach	Allendale Pond Reach	Lymanville Pond Reach	Manton/ Dyerville Reach
Biological Tissue	Aquatic macroinvertebrates (crayfish)	3	1	3	4	
	Emerging adult macroinvertebrates	5		5	5	
	Earthworms	3	1	3	4	
	Fish – demersal [a]	10	10	10	10	
	Fish – piscivorous [a]	10	10	10	10	6
	Fish – other [a]	10	10	10	10	
Field Population and Community Studies [b]	Aquatic macroinvertebrates	3	2	3	2 [c]	
	Emerging adult macroinvertebrates	5		5	5	
	Floodplain soil fauna	3	1	3	4	
	Fish – IBI	2	1	2	2	
	Ichthyoplankton surveys [d]	3	1	3	4	
	Piscivorous, insectivorous, and omnivorous wildlife	1	1	1	1	1
Toxicity Testing	Aquatic macroinvertebrates	1	1	3	3	

Notes:

[a] Fish species and trophic status to be determined based on fish community survey and risk assessment objectives.
[b] Numbers refer to the number of discrete sampling units within each study reach.
[c] Samples will be collected from the lotic recovery area below Allendale Pond Dam.
[d] Ichthyoplankton surveys will be conducted in April, May, and June and will consist of three replicate plankton tows for each indicated sampling unit.

IBI – Index of Biotic Integrity

Table 4
Identification of Fish and Other Biota to be Collected

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Preferred Target Species	Alternative Species
***Demersal*: White Sucker**	Bullhead Catfish Tesselated Darter Common Carp Fallfish
***Piscivorous*: Largemouth Bass**	Pumpkinseed Bluegill Yellow Perch Redfin Pickerel Chain Pickerel
***Other*: American Eel**	Frog Pumpkinseed Bluegill Turtle Redfin Pickerel Tesselated Darter Fallfish

Notes:
Species will ultimately be selected based on the availability of species observed during field activities and on the results of literature search which will be conducted prior to field activities to help determine likely species consumed from the river and consumption patterns of potential human receptors (see text for additional details).

Table 5

Identification of Samples to be Collected - Paired Crayfish and Aquatic Sediment Samples [a], [b]

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [c]	Location Description [d]	Rationale for Selection
Allendale	CMW-CF-4001 CMW-SD-4001	**WRC-SD-2015** Northing: 280565.742 Easting: 332109.431	At the boundary of the open water and 100-year flood zone; approximately 200 ft southwest of Aldrich Street.	Elevated dioxin (7300 ng/kg 2,3,7,8-TCDD) Elevated HCX (1129 ng/kg) Elevated PCBs (2410 ug/kg total aroclor)
	CMS-CF-4001 (B) CMS-SD-4001 (B)	**CMW-SD-2025** Northing: 280976.495 Easting: 332109.404	At the boundary of the open water and 100-year flood zone; approximately midway between Stephen Street and George Street.	Intermediate dioxin (939 ng/kg 2,3,7,8-TCDD) Intermediate HCX (91 ng/kg) Intermediate/low PCBs (400 ug/kg total aroclor)
	CMS-CF-4002 CMS-SD-4002	**CMS-606** Northing: 280319.58 Easting: 332633.98	Near the boundary of the open water and 100-year flood zone; approximately 650 feet west of Woonasquatucket Avenue at the point about 150 ft north of the intersection of Woonasquatucket and Peach Hill Avenues.	Elevated dioxin (17000 ng/kg 2,3,7,8-TCDD) Elevated PCBs (27000 ug/kg total aroclor)
	CMS-CF-4002 (B) CMS-SD-4002 (B)	**CMS-616** Northing: 280204.16 Easting: 332821.194	At the boundary of the open water and 100-year flood zone; approximately 500 ft west of the intersection of Woonasquatucket Avenue and Peach Hill Avenue.	Elevated dioxin (24000 ng/kg 2,3,7,8-TCDD) Elevated PCBs (9200 ug/kg total aroclor)
	CMS-CF-4002 (B) CMS-SD-4002 (B)	**CMS-607** Northing: 280306.604 Easting: 332731.406	Within the open water of Allendale Pond; approximately 550 feet west of Woonasquatucket Avenue at the point about 150 ft north of the intersection of Woonasquatucket and Peach Hill Avenues.	Elevated dioxin (5300 ng/kg 2,3,7,8-TCDD) Elevated PCBs (28000 ug/kg total aroclor)
	APB-CF-4003 APB-SD-4003	**AD-01** Northing: 279736.83 Easting: 333010.83	Slightly upstream of Allendale Dam; west side of Allendale Pond.	Maximum dioxin (93000 ng/kg 2,3,7,8-TCDD) Elevated PCBs (9100 ug/kg total aroclor)

Table 5

Identification of Samples to be Collected - Paired Crayfish and Aquatic Sediment Samples [a], [b]

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [c]	Location Description [d]	Rationale for Selection
Lymansville	WRL-CF-4004 WRL-SD-4004	**LPX-SD-2046** Northing: 279207.745 Easting: 333266.828	Near the boundary of the open water and 100-year flood zone; approximately 400 ft south of Allendale Way and 500 west of Woonasquatucket Avenue.	Elevated dioxin (7110 ng/kg 2,3,7,8-TCDD) Elevated HCX (733 ng/kg)
	WRL-CF-4004 (B) WRL-SD-4004 (B)	**LPX-SD-2045** Northing: 278050.725 Easting: 333376.194	Within the open water of Lymansville Pond; approximately 125 feet northwest of Warren Avenue.	Elevated dioxin (7610 ng/kg 2,3,7,8-TCDD) Elevated HCX (2692 ng/kg)
	WRL-CF-4005 WRL-SD-4005	**WRL-SD-2041** Northing: 278721.052 Easting: 333397.678	Near the boundary of the open water and 100-year flood zone; approximately 300 ft west (and slightly north) of the intersection of Maple and Rockwell Avenues.	Elevated dioxin (3150 ng/kg 2,3,7,8-TCDD) Elevated HCX (1907 ng/kg)
	WRL-CF-4005 (B) WRL-SD-4005 (B)	**WRL-SD-2043** Northing: 278386.802 Easting: 333382.541	Within the open water of Lymansville Pond; approximately 450 ft west of Maple Avenue (at the point midway between Rockwell and Warren Avenues.	Elevated dioxin (3230 ng/kg 2,3,7,8-TCDD) Elevated HCX (1081 ng/kg)
	LPX-CF-4006 LPX-SD-4006	**LPX-SD-2050** Northing: 276212.587 Easting: 334178.278	Near the boundary of the open water and 100-year flood zone; approximately 150 ft north of Water Street and 250 ft south of Earl Street .	Elevated dioxin (6190 ng/kg 2,3,7,8-TCDD) Elevated/intermediate HCX (549 ng/kg)
	LPX-CF-4007 LPX-SD-4007	**LPX-SD-2052** Northing: 275644.063 Easting: 334420.599	Within the southeasternmost portion of Lymansville Pond; approximately 100 ft north of Lymansville Dam.	Elevated dioxin (4350 ng/kg 2,3,7,8-TCDD) Elevated HCX (5220 ng/kg)

Table 5

Identification of Samples to be Collected - Paired Crayfish and Aquatic Sediment Samples [a], [b]

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [c]	Location Description [d]	Rationale for Selection
Upstream	RWR-CF-5001 RWR-SD-5001	**RCC-SD-3002** Northing: 282889.989 Easting: 331483.109	Approximately 200 ft north of the site on the west side of the river upstream.	Believed to represent typical crayfish habitat.
	RWR-CF-5002 RWR-SD-5002	**RCC-SD-3001** **Northing: 283401.44** **Easting: 31374.92**	Approximately 1000 ft north of the site on the west side of the river upstream.	Believed to represent typical crayfish habitat.
	GMP-CF-5003 GMP-SD-5003	**SD-35** Northing: NA Easting: NA	Immediately upstream of Greystone Mill Pond Dam.	Believed to represent typical crayfish habitat.
Assapumpsett Brook (Reference Area)	RAB-CF-5004 RAB-SD-5004	**RAB-SD-3004** Northing: 278381.97 Easting: 330701.558	Approximately 300 feet west of Assapumpsett Pond and 1700 ft west of Lymansville Pond.	Believed to represent typical crayfish habitat.

Notes:

[a] - For each crayfish sample, at least 120 grams of tissue are required for all appropriate analyses to be performed. Given this, It is expected that a minimum of 15 individuals will be collected to represent a single sample. If tissue is limited, analytical parameters will be prioritized as discussed in Worksheet 9A of the QAPP (Battelle, 2001).

[b] - A sediment sample will be collected at the central location which will be representative of that location and the locations within the 50-foot radius.

[c] - The coordinates provided correspond to coordinates of existing sampling locations. The existing location and the corresponding coordinates are provided. The approximate coordinates for each Sample ID represents the central location where traps will be set. Additional traps will be placed within a 50-foot radius.

[d] - Locations are described using present day conditions as presented in Figures 4A and 4B.

GMP = Greystone Mill Pond

Sample Ids:

"(B)" indicates a backup sample.

"CF" = crayfish

"SD" = aquatic sediment/soil

See the text for discussion of the sample location identification system.

Table 6

Identification of Samples to be Collected - Emerging Insect Samples [a]

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [b]	Location Description [c]	Rationale for Selection
Allendale	CMS-EI-4001	**CMS-606** Northing: 280319.58 Easting: 332633.98	Near the boundary of the open water and 100-year flood zone; approximately 650 feet west of Woonasquatucket Avenue at the point about 150 ft north of the intersection of Woonasquatucket and Peach Hill Avenues.	Elevated dioxin (17000 ng/kg 2,3,7,8-TCDD) Elevated PCBs (27000 ug/kg total aroclor).
	CMS-EI-4002	**CMS-607** Northing: 280306.604 Easting: 332731.406	Within the open water of Allendale Pond; approximately 550 feet west of Woonasquatucket Avenue at the point about 150 ft north of the intersection of Woonasquatucket and Peach Hill Avenues.	Elevated dioxin (5300 ng/kg 2,3,7,8-TCDD) Elevated PCBs (28000 ug/kg total aroclor).
	CMS-EI-4003	**APC-SD-2035** Northing: 279974.28 Easting: 332954.8	At the boundary of the open water and 100-year flood zone; approximately 400 ft west of the intersection of Woonasquatucket Avenue and Allen Avenue.	Within tree swallow foraging area.
	APB-EI-4004	**AD-04** Northing: 279801.31 Easting: 333138.87	Slightly upstream of Allendale Dam; east side of Allendale Pond.	Elevated dioxin (26000 ng/kg 2,3,7,8-TCDD) Elevated PCBs (9100 ug/kg total aroclor).
	APB-EI-4005	**AD-01** Northing: 279736.83 Easting: 333010.83	Slightly upstream of Allendale Dam; west side of Allendale Pond.	Maximum dioxin (93000 ng/kg 2,3,7,8-TCDD) Elevated PCBs (9100 ug/kg total aroclor).
Lymansville	LPX-EI-4006	**LPX-SD-2050** Northing: 276212.587 Easting: 334178.278	Near the boundary of the open water and 100-year flood zone; approximately 150 ft north of Water Street and 250 ft south of Earl Street .	Elevated dioxin (6190 ng/kg 2,3,7,8-TCDD) Elevated/intermediate HCX (549 ng/kg).
	LPX-EI-4007	Does not correspond to an existing location	Approximately 150 ft downstream from **LPX-SD-2050**.	No specific sediment chemistry, but within tree swallow foraging area.
	LPX-EI-4008	Does not correspond to an existing location	Approximately 300 ft downstream from **LPX-SD-2050**.	No specific sediment chemistry, but within tree swallow foraging area.
	LPX-EI-4009	Does not correspond to an existing location	Approximately 450 ft downstream from **LPX-SD-2050**.	No specific sediment chemistry, but within tree swallow foraging area.
	LPX-EI-4010	**LPX-SD-2052** Northing: 275644.063 Easting: 334420.599	Within the southeasternmost portion of Lymansville Pond; approximately 100 ft north of Lymansville Dam and 600 ft downstream of **LPX-SD-2050**.	Elevated dioxin (4350 ng/kg 2,3,7,8-TCDD) Elevated HCX (5220 ng/kg).

Table 6

Identification of Samples to be Collected - Emerging Insect Samples [a]

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [b]	Location Description [c]	Rationale for Selection
Upstream	GMP-EI-5001	Does not correspond to an existing location	Approximately 80 ft upstream of Greystone Mill Pond Dam.	No specific sediment chemistry, but within tree swallow foraging area.
	GMP-EI-5002	Does not correspond to an existing location	Approximately 300 ft upstream of Greystone Mill Pond Dam.	No specific sediment chemistry, but within tree swallow foraging area.
	GMP-EI-5003	Does not correspond to an existing location	Approximately 500 ft upstream of Greystone Mill Pond Dam.	No specific sediment chemistry, but within tree swallow foraging area.
	GMP-EI-5004	Does not correspond to an existing location	Approximately 1800 ft upstream of Greystone Mill Pond Dam.	No specific sediment chemistry, but within tree swallow foraging area.
	GMP-EI-5005	Does not correspond to an existing location	Approximately 2000 ft upstream of Greystone Mill Pond Dam.	No specific sediment chemistry, but within tree swallow foraging area.

Notes:

[a] - Traps will generally be set in tree swallow feeding areas.

[b] - The coordinates provided correspond to coordinates of existing sampling locations. The existing location and the corresponding coordinates are provided.

[c] - Locations are described using present day conditions as presented in Figures 4A and 4B.

GMP = Greystone Mill Pond

Sample Ids:

"(B)" indicates a backup sample.

"EI" = emerging insect

"SD" = aquatic sediment/soil

See the text for discussion of the sample location identification system.

Table 7

Identification of Samples to be Collected - Paired Earthworm and Floodplain Soil/Sediment Samples [a]

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [b]	Location Description [c]	Rationale for Selection
Allendale	CMS-EW-4001 CMS-FP-4001	**CMS-159** Northing: 281321.873 Easting: 332087.304	Near the eastern border of the larger capped area; approximately 40 ft northwest of Redfern Street.	Elevated dioxin (3380 ng/kg 2,3,7,8-TCDD) Elevated PCBs (4100 ug/kg total aroclor) Believed to represent comparable earthworm habitat.
	CMS-EW-4002 CMS-FP-4002	**CMW-FP-2026** Northing: 280854.631 Easting: 332071.138	Within the 100-year flood zone; approximately 300 ft south of the larger capped area and 150 ft west of Stephen Street.	Elevated dioxin (16380 ng/kg 2,3,7,8-TCDD) Elevated HCX (1046 ng/kg) Believed to represent comparable earthworm habitat.
	CMS-EW-4002 (B) CMS-FP-4002 (B)	**CMS-186** Northing: 280911.53 Easting: 331937.68	At the boundary of the open water and 100-year flood zone (on the east side of the open water); approximately 225 ft south of the larger capped area.	Elevated dioxin (33000 ng/kg 2,3,7,8-TCDD) Believed to represent comparable earthworm habitat.
	CMS-EW-4003 CMS-FP-4003	**CMS-023** Northing: 280453.627 Easting: 332109.816	At the boundary of the open water and 100-year flood zone (on the west side of the open water); approximately 700 ft south of the larger capped area.	Elevated dioxin (52000 ng/kg 2,3,7,8-TCDD) Believed to represent comparable earthworm habitat.
	CMS-EW-4003 (B) CMS-FP-4003 (B)	**CMS-025** Northing: 280349.679 Easting: 332293.984	At the boundary of the open water and 100-year flood zone (on the west side of the open water); approximately 850 ft south of the larger capped area.	Elevated dioxin (33000 ng/kg 2,3,7,8-TCDD) Believed to represent comparable earthworm habitat.
Lymansville	LPX-EW-4004 LPX-FP-4004	**SD-10** Northing: NA Easting: NA	Within the southeasternmost portion of Lymansville Pond; along the upstream side of Lymansville Dam.	Intermediate/low dioxin (264 ng/kg 2,3,7,8-TCDD) Low pesticides (6.4 ug/kg) Believed to represent comparable earthworm habitat.
	LPX-EW-4005 LPX-FP-4005	**SD-11** Northing: NA Easting: NA	At the boundary of the open water and 100-year flood zone (on the east side of the open water); located between Oak Street and Jefferson (formerly May) Street.	Intermediate/low dioxin (112 ng/kg 2,3,7,8-TCDD) Low pesticides (42 ug/kg) Believed to represent comparable earthworm habitat.
	LPX-EW-4006 LPX-FP-4006	**SD-13** Northing: NA Easting: NA	East of the open water and approximately 100 ft south of the intersection of Falco Avenue and Cynthia Drive.	Intermediate/low dioxin (161 ng/kg 2,3,7,8-TCDD) Low pesticides (15 ug/kg) Believed to represent comparable earthworm habitat.
	LPX-EW-4007 LPX-FP-4007	**SD-17** Northing: NA Easting: NA	At the boundary of the open water and 100-year flood zone (on the east side of the open water); located approximately 250 ft southwest of the intersection of Falco and Zambarano Avenues.	Intermediate dioxin (611 ng/kg 2,3,7,8-TCDD) Elevated HCX (15478 ng/kg) Low PCBs (58 ug/kg) Low pesticides (29 ug/kg) Believed to represent comparable earthworm habitat.

Table 7

Identification of Samples to be Collected - Paired Earthworm and Floodplain Soil/Sediment Samples [a]

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [b]	Location Description [c]	Rationale for Selection
Upstream	RWR-EW-5001 RWR-FP-5001	**RCC-FP-3002** Northing: 282874.926 Easting: 331523.061	Approximately 200 ft north of the site on the west side of the river upstream.	Believed to represent comparable earthworm habitat.
	RWR-EW-5002 RWR-FP-5002	**SD-33** Northing: NA Easting: NA	Approximately 1600 ft upstream from the site.	Believed to represent comparable earthworm habitat.
	RWR-EW-5003 RWR-FP-5003	**SD-37** Northing: NA Easting: NA	Estimated to be approximately 1200 ft upstream from SD-33, Below Upper Esmond Dam.	Believed to represent comparable earthworm habitat.
Assapumpsett Brook (Reference Area)	RAB-EW-5004 RAB-FP-5004	**RAB-FP-3004** Northing: 278373.65 Easting: 330639.83	Approximately 300 feet west of Assapumpsett Pond and 1700 ft west of Lymansville Pond.	Believed to represent comparable earthworm habitat.

Notes:

[a] - For each earthworm sample, at least 120 grams of tissue are required for all appropriate analyses to be performed. Given this, It is expected that a minimum of 300 individuals will be collected to represent a single sample. If tissue is limited, analytical parameters will be prioritized as discussed in Worksheet 9A of the QAPP (Battelle, 2001).

[b] - The coordinates provided correspond to coordinates of existing sampling locations. The existing location and the corresponding coordinates are provided.

NA = not available in the database. Locations have been approximated on figures.

[c] - Locations are described using present day conditions as presented in Figures 5A and 5B.

Sample Ids:

"(B)" indicates a backup sample.

"EW" = earthworm

"FP" = floodplain soil/sediment

See the text for discussion of the sample location identification system.

Table 8

Identification of Samples to be Collected - Surface Water Samples

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Location Description [a]	Rationale for Selection
Upstream	RWR-SW-5001	Approximately 300 ft downstream of the waste water treatment plant.	Evaluate downstream impacts potentially attributed to WWTP.
	RWR-SW-5001(B)	Approximately 1200 ft south of Greystone Mill Pond Dam.	Evaluate downstream impacts potentially attributed to WWTP.
	RWR-SW-5002	Smithfield waste water treatment plant; approximately 1200 ft north of Greystone Mill Pond	Evaluate impacts potentially attributed to WWTP.
	RWR-SW-5002(B)	Approximately 800 ft south of Greystone Mill Pond Dam.	Evaluate downstream impacts potentially attributed to WWTP.
	RWR-SW-5003	Approximately 300 ft upstream of the waste water treatment plant.	Upstream of WWTP discharge.
	RWR-SW-5003(B)	Approximately 400 ft south of Greystone Mill Pond Dam.	Evaluate downstream impacts potentially attributed to WWTP.
Woonasquatucket River Centredale	WRC-SW-4003	Slightly north of VS-004.	Upstream and outside the area impacted by the site groundwater plume discharge.
	WRC-SW-4002	In the area of VS-013.	Represents area of maximum groundwater discharge
	WRC-SW-4001	Slightly south of VS-061.	Downstream and outside the direct groundwater plume discharge.
Woonasquatucket River Lymansville	WRL-SW-4004	Approximately 50 ft below Allendale Pond	Evaluate potential recovery from the upstream stressors.
	WRL-SW-4005	Approximately 400 ft below Allendale Pond	Evaluate potential recovery from the upstream stressors.
Assapumpsett Brook (Reference Area)	RAB-SW-5004	Approximately 50 ft below outfall of Assappumpsett Pond.	Outside the area of stressors associated with Smithfield sewage treatment plant and the site.
	RAB-SW-5005	Approximately 300 ft upstream of discharge to Lymnasville Pond.	Outside the area of stressors associated with Smithfield sewage treatment plant and the site.

Notes:

[a] - Locations are described using present day conditions as presented in Figures 4A and 4B.

WWTP = waste water treatment plant

Sample Ids:

"SW" = surface water

"VS" = indicates a vapor diffusion sample

See the text for discussion of the sample location identification system.

Table 9

Identification of Samples to be Collected - Aquatic Sediment Invertebrate Bioassay Samples

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [a]	Location Description [b]	Rationale for Selection
Allendale	APB-SD-4008	**APB-SD-2034** Northing: 279920.33 Easting: 332852.89	Approximately 300 ft northwest of Allendale Dam.	Intermediate PAH (14000 ug/kg) Low PCBs (15 ug/kg total aroclor) Low Pesticides (136 ug/kg) Intermediate Cu (195 mg/kg), Pb (350 mg/kg); elevated Zn (711 mg/kg)
	APB-SD-4009	**APB-SD-2037** Northing: 279811.656 Easting: 333198.389	Slightly upstream of Allendale Dam; east side edge of Allendale Pond.	Low PAH (2800 ug/kg) Intermediate PCBs (1200 ug/kg total aroclor) Low Pesticides (133 ug/kg) Elevated Cu (388 mg/kg), Pb (719 mg/kg)
	APB-SD-4010	**AD-04** Northing: 279801.31 Easting: 333138.87	Slightly upstream of Allendale Dam; east side of Allendale Pond.	Elevated PAH (45000 ug/kg) Elevated PCBs (9100 ug/kg total aroclor) Elevated Pesticides (421 ug/kg) Elevated Cr (382 mg/kg), Pb (629 mg/kg), Ag (8.9 mg/kg)
	CMW-SD-4011 (B) (not a backup for any particular sample)	**CMW-SD-2023** Northing: 281151.909 Easting: 332044.124	Approximately 25 ft south of the larger capped area; about midway between and to the west of George and Redfern Streets.	Elevated PAH (38000 ug/kg) PCBs not detected Low Pesticides (23 ug/kg) Elevated Hg (3.6 mg/kg)
Lymansville	LPX-SD-4012	**WRL-SD-2044** Northing: 277759.263 Easting: 333241.540	Approximately 200 ft west of the intersection of Lamsarang and Warren Avenues.	Low PAH (3600 ug/kg) Low PCBs (95 ug/kg total aroclor) Pesticides not detected Elevated Zn (1550 mg/kg)
	LPX-SD-4013	**LPX-SD-2048** Northing: 277276.575 Easting: 334065.444	Within the easternmost portion of Lymansville Pond; approximately 400 ft south west of the intersection of Falco Avenue and Woonasquatucket Avenue.	Intermediate PAH (13000 ug/kg) Low pesticides (63.2 ug/kg) Low PCBs (231 ug/kg total aroclor) Low metals
	LPX-SD-4007 (also collected for crayfish/sediment)	**LPX-SD-2052** Northing: 275644.063 Easting: 334420.599	Within the southeasternmost portion of Lymansville Pond; approximately 100 ft north of Lymansville Dam.	Intermediate PAH (14000 ug/kg) Low pesticides (6.1 ug/kg) Low PCBs (97 ug/kg) Low metals

Table 9

Identification of Samples to be Collected - Aquatic Sediment Invertebrate Bioassay Samples

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [a]	Location Description [b]	Rationale for Selection
	LPX-SD-4014 (B) (not a backup for any particular sample)	**WRL-SD-2042** Northing: 278568.119 Easting: 333471.197	Within the 100-year flood zone north of the open water of Lymansville Pond; approximately 300 ft west of the intersection of Maple Avenue and Rockwell Avenue.	Elevated PAH (36000 ug/kg) Low PCBs (361 ug/kg total aroclor) Low Pesticides (34.4 ug/kg) Low metals

Table 9

Identification of Samples to be Collected - Aquatic Sediment Invertebrate Bioassay Samples

Field Sampling Plan for the Human Health and Ecological Risk Assessments
Centredale Manor Restoration Site
North Providence, Rhode Island

Reach	New Sample Identification	Existing Sample Location and Approximate Northing and Easting Coordinates [a]	Location Description [b]	Rationale for Selection
Upstream	GMP-SD-5003 (also collected for crayfish/sediment)	**SD-35** Northing: NA Easting: NA	Immediately upstream of Greystone Mill Pond Dam.	The analytical results for for upstream floodplain samples indicate that elevated levels of PAHs exist. It is anticipated that constituents would be concentrated within the upstream depositional areas around SD-35.
Assapumpsett Brook (Reference Area)	RAB-SD-5006	**RAB-SD-2069** Northing: 278021.17 Easting: 331464.91	Within the eastern portion of Assapumpsett Pond.	All parameter concentrations look low with slightly elevated PAHs at this location.

Notes:

[a] - The coordinates provided correspond to coordinates of existing sampling locations. The existing location and the corresponding coordinates are provided.

[b] - Locations are described using present day conditions as presented in Figures 4A and 4B.

Sample Ids:

"(B)" indicates a backup sample.

"SD" = aquatic sediment/soil

See the text for discussion of the sample location identification system.

APPENDIX A

FIELD SAMPLING AND ANALYSIS PLAN FOR FISH COLLECTION AND PROCESSING

APPENDIX A
FIELD SAMPLING AND ANALYSIS PLAN
FOR FISH COLLECTION AND PROCESSING

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1.0 INTRODUCTION

1.1 BACKGROUND

Fish are sensitive to both long-term and short-term changes in habitat, sediment, and water quality. While fish are mobile, they frequently spend most of their lives in a defined area, due to their territorial behavior or when the location is subjected to impounding structures that limit fish movement. Thus fish can serve as effective indicators of environmental conditions in that location. The fish community in streams, rivers, and ponds is an important food source for instream consumers, as well as for some bird and mammal species, including man. Fish generally depend on other aquatic sources for their various life functions and area principal component of the aquatic food chain sequence from contaminated sediments and water through benthic macroinvertebrates, to smaller consumers, such as the cyprinids; intermediate consumers, such as the yellow perch and larger sunfish; larger consumers, such as the largemouth bass; and scavengers, such as the bullhead. Each of these may itself be the prey of a higher level consumer, such as an otter, a heron or kingfisher, and ultimately, man. Predation upon fish represents an important transport mechanism for the movement of contaminants from in-stream sediment to terrestrial sources. Because of dioxin contamination in fish, USEPA has established a fish consumption advisory for the Woonasquatucket River within the study area.

Fish community structure and function have been used extensively to evaluate the quality of water resources and characterize causes and sources of impacts in lotic (flowing water) and lentic (standing water) freshwater ecosystems. The individual organisms that make up fish communities respond to both biotic and abiotic environmental variables; therefore, the structure of these communities reflects the integration of the influence of these variables. Biotic variables may include competition, predation, and food availability, whereas abiotic variables may include stream temperature, dissolved oxygen, flow characteristics, and pollutants.

Because of the long-recognized importance of fish community structure in evaluating the health and condition of aquatic habitats, and the importance of fish tissue as a measure of the transport of contaminants through the ecosystem, collection and assessment of fish representing the community in this system is an essential element of the ecological characterization. Fish tissue sampling and community assessment will be conducted to determine if sediment contamination is adversely affecting fish in the study area and accumulating in fish tissue at concentrations detrimental to human and ecological consumers, fish tissue sampling and community assessment is to be conducted.

1.2 OBJECTIVES

The principal objective of the fish collection effort include the following:

- determine the concentrations of various site-related bioaccumulating substances in tissue for use in both human health and ecological risk assessments;
- identify dioxin/furan and PCB congener patterns in a resident fish species for use in designing the fish ELS reproduction study;
- qualitatively assess the status of the fish community throughout the study area and in reference areas; and,

- survey of the ichthyoplankton in the river during three discrete sampling events in May, June, and July of 2001 to obtain additional information.

Fish tissue, whole body samples, and fillet and offal samples will be analyzed for SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins and furans (including HCX), PCB congeners (in 20 percent of the samples), percent lipids, and percent moisture (Table 1). Fish tissue sample collection and analysis will be used to evaluate both ecological and human health endpoints. Fish tissue concentrations will be used to determine potential risks to individuals who may be catching and eating fish in violation of the fish consumption ban, as well as to determine risk to subsistence and recreational anglers in the absence of administrative or institutional controls. Ecological measurement endpoints are the comparison of tissue concentrations to Critical Body Residues (CBRs) from literature and reference area concentrations, and incorporation in food chain models for piscivorous receptors. Tissue analyses will be conducted in accordance with the QAPP (Battelle, 2001).

The fish community studies (including the ichthyoplankton survey), will be conducted to assess potential community level effects potentially attributable to site contamination. Analysis of the data will include calculation of community metrics (i.e., Index of Biological Integrity [IBI], distribution of sensitive fish species, and relative occurrence of species across the sampling areas).

All fish collection will be performed by subcontractor personnel with oversight by a senior Harding ESE scientist.

2.0 STUDY DESIGN

2.1 FIELD SAMPLING

2.1.1 Sample Locations

Fish will be collected from four sampling areas within the study area including Allendale Pond, Lymansville Pond, Manton Pond, and Dyerville Reach (Figures 4A - C). In addition, fish will be obtained from both Greystone Mill Pond and Assapumpsett Brook, which have been designated as reference areas for the study area. Figure 1 in the FSP depicts the general locations of each of these sampling areas.

2.1.2 Target Species

- Largemouth Bass *(Micropterus salmoides)*,
- White Sucker (*Catastomus commersoni*), and
- American Eel (*Anguilla rostrata*).

Other candidate species include:

- Sunfish: pumpkinseed *(Lepomis gibbosus)*, bluegill *(Lepomis macrochirus)* or other.
- Cyprinids: golden shiner (*Notemigonus crysoleucas*), fallfish *(Semotilus corporalis)*, or other.
- Redfin pickerel (*Esox a. americanus*)

2.2 QUALITATIVE FISH SAMPLING

Fish in the Woonasquatucket River study area and in reference areas will be qualitatively sampled to characterize fish communities in terms of species presence and relative abundance. In each area fish will be captured or observed by electrofishing using electroshocking boats or backpacks. All fish sampling will be performed by subcontractor personnel in compliance with their standard operating procedures and safety requirements detailed in Attachments A, B, and C.

Timed electrofishing surveys for qualitatively characterizing fish communities will occur over 30 minute periods within representative areas in each of the above mentioned sampling sites. Starting and ending locations of each timed survey will be plotted on data sheets or located in the field using GPS equipment. During each 30-minute survey all fish that are shocked will be identified to species and enumerated by personnel in the boat. Certain fish may be netted and put into live wells, or buckets, to verify species identification. Additional information collected during each timed survey will include date, location, capture method, weather, crew members, and miscellaneous comments. Data forms will be completed during each timed survey (Attachment D).

2.3 ICHTHYOPLANKTON SURVEY

Larval fish (ichthyoplankton) sampling will be conducted three times from May to July 2001. Samples will be collected using a 0.5-m diameter, 1.5-m long, 363 µm mesh plankton net towed from a boat (Attachment E). On each sampling date, three replicate surface tows will be conducted in each sampling unit from Allendale Pond, Lymansville Pond, Greystone Pond, and Assapumpsett Pond (Table 3).

The volume of water filtered for each sample will be approximately 50 m^3, which will be determined using a General Oceanics Flowmeter mounted in the mouth of the net. Flowmeter readings will be recorded on an ichthyoplankton rough calculation sheet, so that an approximate sample volume can be calculated. The velocity used in this calculation is obtained from the observed number of flowmeter counts per second for each tow, using the General Oceanics graph for the model 2030 flowmeter with standard rotor. If the calculated tow volume is not between 40 and 60 m^3, the tow will be repeated. Each tow should take approximately 10 minutes.

In the event that the conditions within Allendale Pond preclude ichthyoplankton sampling using the approach described above, the fauna located in the confluence of the CMS tailrace should be qualitatively sampled using a dip net. This qualitative sampling should focus on the tailrace area upstream of the confluence with the Woonasquatucket River and include at least two separate sampling areas. A minimum of 30 jabs with the dip net should be collected from each sampling area within the tailrace.

The development of submerged aquatic vegetation (SAV) in shallower portions of some of these water bodies (e.g., Assapumpsett Pond and Greystone Mill Pond) as the season progresses may interfere with the operation of the plankton tow as well. The use of ichthyoplankton traps during the later rounds of the survey may need to be considered. Attachment G presents some devices that have been field tested in other water bodies and could be adapted to supplement or replace the plankton tow methodology.

At each ichthyoplankton sampling locations dissolved oxygen, temperature, pH, and conductivity will be measured at the surface. Samples will be placed individually in a labeled sample container and preserved

with 10% formalin. These samples will be taken to the biological laboratory for sorting, identification, and enumeration of the species present.

2.4 FISH PREPARATION FOR TISSUE ANALYSIS

Fish will be collected in accordance with the methods identified in Attachments A - C by location and retained in live wells containing location-specific water until sample processing is initiated. Fish containers (e.g., live wells) will be labeled with capture location information and aerated to minimize fish mortality before fish processing. All fish retained for potential sample analysis will be enumerated and separated by species and size class. This information will subsequently be used to determine the number of samples and associated IDs. Fish will be sacrificed by cervical separation or sharp blow to the head with a decontaminated steel rod. All fish not retained for analysis will be released at their approximate capture location unharmed after processing.

The following metrics will be recorded for each individual fish included in any sample.

- Total Length (cm) — The greatest dimension of a fish from its anterior-most extremity to the end of the tail fin. For fish with a forked tail, the two lobes should be pressed together, and length of the longest lobe should be recorded.
- Total Weight (g) — Fish will be placed in a pre-weighed decontaminated tray and weighed to the nearest gram.
- Sex (M/F) — When possible (i.e., bass), fish sex will be identified by external morphological characteristics or internal reproductive examination.
- Age — Scale samples will be collected to determine the age of all captured fish. Age will be determined in a laboratory setting at a later date by the designated subcontractor (Attachment F).
- Physical Exam — Gross pathological examination of all fish will be conducted and documented. Special consideration will be give to gross pathological conditions on largemouth bass.

Upon completion of collection of metrics, fish samples will be either submitted for whole body, or fillet and offal analysis depending on the determination of human consumption patterns.

2.4.1 Whole Body Sample Processing

Fish samples for whole body analysis will be rinsed of all debris with deionized water and placed in decontaminated aluminum foil (dull side toward the fish). The sample ID labels will be placed on the outside of the aluminum foil and secured with clear tape. If more than one fish is used for a sample (composite), all fish used for the sample will be placed on one piece of aluminum foil, wrapped and labeled with the appropriate sample ID. To preserve sample integrity, samples will be placed in double resealable plastic bags with a second ID label and placed in either a cooler with dry ice or a suitable freezer until analyzed.

2.4.2 Fillet and Offal Sample Processing (Laboratory)

An initial cut should be made from the dorsal fin to the pelvic fin, just behind the opercular flap. Run the tip of the knife along the dorsal side of the fish, from the initial cut to the caudal fin. Continue making successively deeper cuts, running the knife blade as close to the neural spines and ribs as possible. After the fillet is obtained, remove the skin. Place the skin side of the fillet down on the dissecting tray, hold on to the tail portion of the fillet, and run the knife between the skin and the muscle tissue. Remove any debris from the skinless fillet by rinsing with deionized water.

After a fillet is cleaned, place the sample in a pre-weighed decontaminated tray and record the weight to the nearest gram.

2.4.3 Tissue Analysis

Table 1 provides the required analytical parameters for each tissue sample. Whole body, or depending on the species, fillet and offal, samples will be analyzed for SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins and furans (including HCX), PCB congeners (on 20 percent of the samples), percent lipids, and percent moisture. Tissue analyses will be conducted in accordance with the QAPP.

2.5 SAMPLE SIZE

Ten individual or composite fish samples (depending on adequate tissue mass) of both a demersal and piscivorous fish species will be collected for the aforementioned sample reaches. Approximately 120 grams of fish tissue will be required per sample (whole body, fillet, or offal). Table 2 presents the required tissue mass requirements for each sample.

2.6 DOCUMENTATION

All sample documentation will follow project specific SOPs for field sample ID, data sheet, chain-of-custody, and custody seal procedures.

2.7 DECONTAMINATION

All dissection equipment will be decontaminated following the project-specific SOP for equipment decontamination including detergent/water wash, potable water rinse, hexane rinse, isopropyl alcohol rinse, and deionized water rinse. All aluminum foil will be hexane rinsed prior to use.

At the conclusion of sampling activities in a given area, aquatic weeds should be removed from boats, boat trailers, and other sampling gear to avoid transport of invasive species between water bodies.

2.8 FIELD QUALITY CONTROL SAMPLES

One laboratory duplicate and MS/MSD sample will be collected every 20 samples for samples large enough to produce two-times and three times the minimum required sample mass (i.e., 120 grams). Laboratory duplicate samples will be collected in Allendale and Lymansville Ponds and MS/MSD samples will be collected in Greystone Mill Pond and Assapumpsett Pond (Table 2).

2.9 SAMPLE SHIPPING

Samples should be sent by overnight delivery service (next morning delivery) or hand delivered. Samples should be shipped to:

Attn: Carolyn Suslick Phone: (360) 681-3624
Battelle MSL
1529 Sequim Bay Road
Sequim, WA 98382

Shippers will notify the receiving laboratory that samples are being sent for next-day delivery.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

3.1 DATA QUALITY OBJECTIVES, INDICATORS, AND ASSESSMENT

3.1.1 Data Quality Objectives

The three data quality objectives of the fish collection and evaluation are outlined in Subsection 1.2. To achieve these objectives, the following types of data and specific quality criteria will be required:

- Taxonomic identification of fish to LPIL (lowest practical identification level) - Fish must be identified to the species level whenever possible. When identification to the species level is not possible, the LPIL will be consistent with standard practice for fish. The target species must be identified to species. Fish collected as part of an incidental take should be identified to the species level where possible.

- Enumeration (counts) for each species in each replicate sample - Counts must be made and recorded accurately. Accurate counts are readily achievable in the field.

- Total length (cm) for each fish in each of the target species collected - Total length must be measured accurately in the field using a fish board and recorded accurately. Procedures have been established (Subsection 2.2, above) to ensure that consistent length measurements are taken and recorded.

- Biomass (total weight) for each fish - Total weight must be determined accurately and recorded to 1 g using a calibrated balance designed and intended by the manufacturer to be capable of accurately measuring masses of this magnitude.

- Fillet weight (total fillet weight) for each fish (laboratory) - Fillet weight must be determined accurately and recorded to 1 g using a calibrated balance designed and intended by the manufacturer to be capable of accurately measuring masses of this magnitude. Adherence to the fillet sample processing procedure described in Subsection 2.2.2 is essential.

- Offal weight (total offal weight) for each fish (laboratory) - Offal weight must be determined accurately and recorded to 1 g using a calibrated balance designed and intended by the

manufacturer to be capable of accurately measuring masses of this magnitude. Adherence to the offal sample processing procedure described in Subsection 2.2.2 is essential.

- Age - Collection of scale samples using the accepted procedures is essential. Age determinations will be made in a laboratory setting at a later date by the designated fish subcontractor.

- Physical exam of all fish - Gross pathologies for each fish collected must be accurately recorded.

- Tissue chemistry for bioaccumulating COPCs - Analysis of tissues (whole body, fillet, or offal samples) for chemical constituents must result in data that are consistent in all respects with other contaminant data collected as part of the larger project. Satisfactory results will be ensured by following the quality control specifications for these data as delineated in the project QAPP (Battelle, 2001).

- Qualitative fish community (including ichthyoplankton survey results) data including comparison of the number of fish per species observed per unit effort, relative frequency of fish species, and IBI metrics between sampling areas within the study area and reference locations.

3.1.2 Data Quality Indicators

Data developed in the fish community and tissue analysis components of this study must meet standards of precision, accuracy, completeness, representativeness, comparability, and sensitivity, as defined in the QAPP (Battelle, 2001) that are appropriate to the data quality objectives. Each of these data quality indicators, some of which are not readily quantifiable for fish community data, is discussed below.

Precision is defined as the level of agreement among repeated independent measurements of the same characteristic. The study design includes an increase in the number of replicates to increase the statistical resolution; for this study the number of replicates (up to 10 fish samples per sampling area) is used in this manner. Precision during the fish community evaluation is defined as agreement on species identification and enumeration by multiple personnel involved with collection efforts.

Accuracy is defined as the agreement of a measurement with its true value. For the parameters unique to this study (fish taxonomy and biomass), accuracy is defined as meaning that the fish are correctly identified in each sample, correctly enumerated, and correctly measured for length and weight. Accuracy of these parameters is a function of each fish being processed by eye, and of consistent field sampling techniques. The data generated by this study will also be evaluated for accuracy via comparison with known and/or expected results from similar studies conducted in the Woonasquatucket River or in similar New England systems. For parameters such as tissue contaminants, accuracy is as defined in the QAPP. For the qualitative fish survey, accuracy is defined as the ability to identify the fish species observed by eye, and to generate a reasonable estimate of number of individuals observed in the water during electrofishing. This is constrained by a number of factors including the selective nature of the likelihood of the electrofishing to stun different species, and the ability to accurately estimate number of individuals observed for either small fish or fish that are observed in large numbers instantaneously.

Completeness is defined as the percentage of the planned samples actually collected and processed. Completeness can be evaluated for all components of the fish program. To ensure achieving the planned statistical resolution, it is important that completeness of 100% be achieved for all components of this study with the exception of the tissue residue analyses. For this latter study component, the number of analyses will be determined by the material available for collection; therefore, establishment of an *a priori* completeness goal is not possible. For the qualitative fish survey, completeness will not be 100% because of the known fact that electrofishing will not result in an observation of all fish at a given location. It is expected that there will be a more complete response in the shallow water areas and that completeness will decline with water depth.

Representativeness refers to the degree to which the data accurately reflect the characteristics present at the sampling location at the time of sampling. Representativeness for this study is ensured through establishment of an approved, thorough sampling design and through careful implementation of the sample processing and analytical methods. Specific aspects of representativeness will also be evaluated via comparison with known and/or expected results based on previous investigations of the Woonasquatucket River and other similar systems. Representativeness of the qualitative fish survey will be constrained by the differential response of species to the electrofishing technique. Comparability is a measure of the confidence with which the fish data may be compared to another similar data set. Comparability will be evaluated by examination of the in-station variability in key parameters as determined from the large numbers of replicates to be collected at each location and fish observations to be made. Comparability will also be evaluated for this data set through comparison with the limited historical fish survey data for the Woonasquatucket River and with known characteristics of fish populations in similar stream systems in the Northeast.

Sensitivity, the ability of a measurement technique or instrument to operate at a level sufficient to measure the parameter of interest, is related for fisheries investigations to the ability of the taxonomic analysis to resolve the various fishes into individual species. This data quality indicator will be evaluated by comparing the number of species-specific separations against the number of unresolved larger taxonomic groups. As the number of unresolved groups increase, the community metrics such as species richness and diversity are less able to resolve differences between samples. Sensitivity is applicable and important for the chemistry parameters that will be analyzed as part of the tissue study. For these parameters, the detection limits for chemistry specified in the QAPP will provide appropriate sensitivity for the purpose of providing insight in to factors controlling abundance and distribution of the fish populations.

3.1.3 Data Validation, Verification, and Usability

Procedures for data validation for the chemical and physical data are discussed in various sections of the project QAPP and will be used whenever applicable in this study. For the biological data, usability will be largely determined by three factors: (1) the experience of the senior investigator in establishing that the field sampling was conducted following the SOP and that accuracy and precision were not compromised by an inability to control the sampling procedures in the field; (2) an evaluation of the taxonomic data both within the study area and compared with previous studies in the river and in the New England area; and (3) a direct comparison between the chemistry and similar data developed from co-located samples that have been collected as part of other project components.

The purpose of the remainder of this section of the study plan is to document the measures included in the study to ensure that the standards discussed above are met.

3.2 SAMPLING DESIGN

The rationale for selection of the six locations to be sampled in the fish study is presented in Subsection 2.1.1. The locations are not intended to be representative of the entire river but rather are intended to encompass the range of sediment concentrations of bioaccumulating COPCs, and the associated fish tissue concentrations, in the Allendale, Lymansville, Manton, and Dyerville Ponds; two appropriate reference locations (including the upriver Greystone Mill Pond and the Assapumpsett Brook) will also be sampled.

3.3 SAMPLING METHODOLOGY

3.3.1 Sampling Procedures

Sampling methods, as discussed in Subsections 2.2 and 2.3, were chosen to ensure unbiased (i.e., accurate) samples that will facilitate comparisons with other fish data, both from the Woonasquatucket River and from other areas. All samples will be collected by trained and experienced personnel; senior oversight of all aspects of the sampling and sample processing will further promote comparability and reduce potential bias. Subsamples for tissue chemical analyses will be collected following procedures documented in the project QAPP and will therefore be comparable with procedures followed for all other similar efforts throughout the Field Investigation.

3.3.2 Quality Control Samples

The nature of fish sampling does not allow the incorporation of typical duplicate and blank samples as part of the study design. For community metrics, there is no acceptable method of obtaining such samples in a manner analogous to that for duplicates and blanks collected for chemistry analysis.

Duplicate samples for tissue chemistry will be collected in this study. Quality control of tissue chemistry analyses will be provided by the analysis of field duplicate samples at a rate of approximately 10% of the samples and MS/MSD samples at a rate of approximately 5% of samples collected. Duplicates will be processed in accordance with the QAPP.

3.3.3 Sample Processing and Preservation

Detailed procedures for collection and initial processing of all samples to be collected as part of the fish study are provided in Subsection 2.3. Subsampling, homogenization, and decontamination between samples will follow procedures established in the QAPP. All samples will be held on dry ice and returned to the field laboratory daily and will be either frozen (physical, chemical samples) or preserved (taxonomic samples) at that time. Holding time for physical and chemical samples will follow procedures established in the QAPP; there is no holding time for taxonomic samples.

3.3.4 Training

All sampling will be directed in the field by senior scientists with experience in the collection of fish samples. Supporting staff will receive training from the senior scientist(s) in the overall goals of the study and in techniques to be followed to ensure collection of quality data.

3.4 SAMPLE ANALYSIS

3.4.1 Taxonomy Samples

Processing of taxonomy samples will follow IBI procedures. All samples will be processed by experienced staff who have received specific training in the SOP and whose work is checked periodically by their supervisors and peers. While performing the qualitative fish community survey, any individual for which the identification to species is in question will be captured and either identified and released, or if not definitively identified the individual will be retained for identification in the laboratory. Five percent of the fish will be re-checked by someone other than the original identifier. Corrective action, including reclassification of fish samples and retraining of staff, will be instituted if these QC checks produce unsatisfactory results.

Quality of taxonomic identification will be ensured by maintaining voucher collections and requiring a consensus among all taxonomists at the processing laboratory prior to an identification becoming accepted as a type for the voucher collection. In the event that the taxonomists are unable to agree on an identification, specimens will be sent to a third party for determination.

3.4.2 Physical/Chemical Samples

Samples for tissue chemistry will be processed following procedures and SOPs provided in the QAPP. These samples will be submitted in catalogs (sample delivery groups) and batches with other samples from the larger project and data validation will be performed on a catalog basis in accordance with procedures established and described in the QAPP.

3.5 DATA ANALYSIS AND REPORTING

The overall analytical approach for data generated under this study is described in Subsection 2.4. The study findings will be included in the ecological risk assessment including all data, analyses, and interpretations and will be prepared with specific reference to both the data quality objectives specific to the fish study (see Subsection 3.1.1 above and the QAPP).

4.0 PROCEDURES

4.1 FIELD SAMPLING

4.1.1 Collection of Taxonomy Samples

All fish collection and sampling will be conducted by personnel subcontractor, following the subcontractor SOPs provided as Attachments A through D.

4.1.2 Initial Processing of Fish for Tissue Residue Analysis

Fish preparation for tissue analysis, whole body analyses, and fillet and offal tissue samples will be conducted pursuant to the procedures outlined in Subsection 2.3.

4.2 LABORATORY ANALYSES

4.2.1 Calculation of IBI Metrics

The following metrics will be estimated for each fish community sample to assess species richness and relative health of foraging guilds within the study area (Barbour et al., 1999):

- Total number of fish species
- Number and identity of benthic insectivore species
- Number and identity of pelagic species
- Number and identity of sucker species
- Number and identity of intolerant species
- Proportion of individuals as white sucker
- Proportion of individuals as omnivores
- Proportion of individuals as insectivores
- Proportion of individuals as top carnivores
- Density of individuals
- Proportion of hybrids
- Proportion of individuals with disease, tumors, fin damage, and skeletal anomalies

4.2.2 Age Determination of Fish from Scales of Spines

Attachment F describes the procedures that will be employed to determine the age of captured fish based on collected scales.

5.0 REFERENCES

Battelle, 2001. Quality Assurance Project Plan; Centredale Manor Restoration Project Superfund Site Baseline Risk Assessment, Initial Project Planning, and Support (Task 19-22 QAPP – Field Sampling, Chemical, and Toxicity Testing), May.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling, 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish; Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

ATTACHMENT A

COLLECTION OF FISHES BY ELECTROSHOCKING: BOAT SHOCKER

NORMANDEAU ASSOCIATES INC.-RMC DIVISION

PROCEDURE NO. EF4
Rev. 5 (Mar. 1997)

COLLECTION OF FISHES BY ELECTROFISHING: BOAT SHOCKER

Approved By: _____ _____
Robert W. Blye, Jr. **Date**
Sr. Vice President

Distributed To: _____

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REVISION SHEET

Rev. No.	Page	Section or Paragraph
1	Title page and organizational changes	
2	3	1.0; 2.0; 3.0; 4.0
2	4	5.1; 5.4; 6.0
2	5	7.0
2	6	8.0; 9.1; 9.2
2	7	9.4; 9.6; 10.0
2	8	12.1
3	3	2.0; 4.1
3	4	5.4; 6.0
3	5	6.0 cont'd, 8.1
3	6	9.2; 9.4; 9.7; 10.1
3	7	11.0; 12.0; 13.0
4	3	4.1; 4.4; 5.2
4	4	6.1; 6.2; 6.3; 6.4
4	Attachment II	added
5	Title page updated	
5	3	2.0; 4.1; 4.4; 5.2; 5.3
5	4	5.4; 6.9
5	5	7.2; 9.7; 10.2

COLLECTION OF FISHES BY ELECTROFISHING: BOAT SHOCKER

1.0 PURPOSE

This procedure specifies techniques for collection of fishes by electrofishing with a boat shocker.

2.0 SCOPE

This procedure applies to all Division personnel who collect fishes by boat electrofishing.

3.0 DEFINITIONS

Sampling zone - used to describe the area in which a collection is to be made. Usually the zone consists of a predetermined distance or sampling duration.

4.0 REFERENCES

4.1 *NAI/RMC Documents (current revisions):*

4.1.1 Corporate Health & Safety.

4.1.2 Procedure No. E4, "Identification of Station Locations and Documentation of Samples Collected for Aquatic Work".

4.2 Novotny, D. W., and G. R. Priegel. 1974. Electrofishing boats: improved designs and operational guidelines to increase the effectiveness of boom shockers. Tech. Bull. 73. Dept. Nat. Res., Madison, Wisconsin.

4.3 Smith-Root, Inc. Introduction to electrofishing. Smith-Root, Inc., Vancouver, Washington.

4.4 *Reynolds, J. B. 1996. Electrofishing. pp. 221-254. In L B.R. Murphy and D. W. Willis (eds.). Fisheries Techniques. 2nd edition. Am. Fish. Soc., Bethesda, Maryland.*

5.0 SAFETY PRECAUTIONS

5.1 During electrofishing high voltage electrical current is applied to the water surrounding the boat. Care must be taken to ensure that personnel do not come in contact with this electrical field. Low-voltage safety switches are located at strategic areas in the boat and are used to immediately shut off power should an accident occur. Personnel are to be made aware of safety switch locations and operation.

5.2 *All boat occupants must wear rubber soled (or equivalent insulating) footwear, and electrician's gloves or similar insulating hand covering if in contact with water. A PFD must be worn at all times when on the water.*

5.3 *Because of the use of gas powered motors and generators, danger of fire is present. All personnel will be made aware of the location and operation of the fire extinguisher. Care should also be taken when refilling gasoline tanks while in the boat: SMOKING IS NOT PERMITTED in the boat.*

5.4 *Additional field safety precautions provided in Reference 4.1.1 are to be observed. Handle all preservatives (e.g., isopropanol, formalin) with care. Avoid the use of formalin whenever possible. Wear personal protective gear (i.e., safety glasses, gloves, etc.) and follow other precautions provided on the Material Safety Data Sheets (MSDS) for these materials. See the Project Manager for MSDS sheets, required personal protective gear, and other information regarding safety and other concerns before going afield.*

6.0 APPARATUS

The following equipment (or equivalent), as applicable, are needed:

6.1 Boat (with bow shocking cage) and motor; sufficient in size and properly equipped (see Reference 4.1.1) to safely carry personnel and gear.

6.2 PFD (personal flotation devices, 1 per man + throwable device)

6.3 Electrofishing Apparatus

- Revolving field generator
- Variable voltage pulsator or appropriate electronics
- Anode array(s)
- Cathode array(s) or boat wired to act as cathode
- Flood lights (night) with spare bulbs

6.4 Fish Capturing and Processing Equipment (study specific)

- Scap nets (2 or more)
- Live well or tub(s)
- Dip net
- Measuring board
- Weight scales
- Fish scaling knives and scale envelopes
- Tagging gun with tags
- Fin-clipping equipment
- Fish processing light (night)
- Preservation jars and preservative
- Anesthetizing solution and scalpel (optional)

6.5 Physicochemical instrumentation (study specific)
6.6 Pencils or pen (indelible ink)
6.7 Data sheets/notebooks (see examples - Attachment I and II)
6.8 Sample identification tags
6.9 Applicable local, state, and/or federal collection permits

7.0 STAFF REQUIREMENTS

7.1 Electrofishing operations are to be conducted by experienced personnel or trainees under the direct supervision of experienced personnel. An experienced staff member is to be assigned as biologist-in-charge, who is responsible for the technical and safety aspects of the field crew.

7.2 *The number of personnel and their responsibilities in a field crew are to be tailored to each individual study design. The Project Manager will assign personnel needed for a given study.*

8.0 PRELIMINARY INSTRUCTIONS

8.1 Prior to initiation of each collection, record the necessary physicochemical measurements on the appropriate data sheets.

8.2 Record any miscellaneous information pertinent to the collection of the sample (e.g., results of equipment calibration or meteorological and hydrological conditions).

9.0 INSTRUCTIONS PROPER

9.1 Inspect boat and equipment to ensure proper operation.

9.2 Position boat in the area to be sampled.

9.3 When all personnel are ready to begin a sampling run, turn on flood lights (night) and apply current to the water. Boat operator should understand correct use of on-board electronics so that electric fields having characteristics appropriate to study specifications are applied.

9.4 Begin electrofishing by moving boat into the area to be sampled. Sampling boat should be maneuvered to provide optimum efficiency for existing conditions. Optimum efficiency is determined by the biologist-in-charge.

9.5 As the boat is moved, netters capture stunned fish and retain them until processed.

9.6 Process collected fish per study specifications (e.g., identify, count, measure length, etc.).

9.7 *Release fish in appropriate manner so as to avoid recapture or, if applicable, retain fish for life history studies. If captured fish are to be released, minimize handling and keep in good condition (to the extent reasonably possible) prior to release.*

10.0 QUALITY CONTROL (QC)

10.1 Electrofishing is conducted/supervised by experienced personnel familiar with station locations and trained in sampling, processing, and measurement techniques employed.

10.2 *Physicochemical measurements, instrumentation used, and calibration follow NAI/RMC procedures or manufacturer's instructions (as applicable) for each parameter.*

10.3 Pertinent physicochemical and biological data are recorded on field sheets for each collection.

- These sheets are cross-referenced to retained samples (as applicable) by an identification label placed with each sample. The label identifies the sample by a minimum of date, station and zone, and investigators.

- All sheets are reviewed for completeness, accuracy, and legibility prior to any additional data processing.

11.0 REPORTING

Data generated by this procedure are reported per study specifications.

12.0 RECORDS

The following shall be retained by the responsible laboratory per study specifications or for a period of three (3) years (whichever is longer) following completion of a given study.

12.1 Field data sheets/notebooks

12.2 Calibration/maintenance records for instruments used to measure physicochemical parameters.

12.3 At least one copy of each report generated per Section 11.0.

12.4 Personnel training/retraining records

13.0 ATTACHMENTS

Attachment I - Example field data sheet

Attachment II - Example length frequency form

ATTACHMENT B

COLLECTION OF FISHES BY ELECTROSHOCKING WITH PORTABLE GEARS

REQUEST FOR REVIEW AND APPROVAL OF RMC PROCEDURE NO. **EF5 (Rev. 3):**

"Collection of Fishes by Electrofishing with Portable Gears"

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NORMANDEAU ASSOCIATES INC.-RMC DIVISION

PROCEDURE NO. EF5
Rev. 3 (Mar. 1997)

COLLECTION OF FISHES BY ELECTROFISHING WITH PORTABLE GEAR TYPES

Approved By: _____
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REVISION SHEET

Rev. No.	Page	Section or Paragraph
1	Title page modified, revision sheet added, pages renumbered, and several subsection numbers replaced with dashes.	
1	EF5-4	4.3
1	EF5-5	6.1, 6.3
1	EF5-6	6.5, 6.6
1	EF5-8	9.0, 10.0
2	EF5-4	5.0, 6.1
2	EF5-5	6.2
2	EF5-6	6.5, 7.1, 8.3
2	EF5-7	8.5, 10.0
3	Title page updated	
3	EF5-3	1.0; 2.0; 4.1; 4.2
3	EF5-4	4.4; 4.5; 5.0; 6.0
3	EF5-5	6.3; 6.4; 6.4; 7.0
3	EF5-6	8.2; 8.3; 8.4; 8.7

COLLECTION OF FISHES BY ELECTROFISHING WITH PORTABLE GEAR TYPES

1.0 PURPOSE

The purpose of this procedure is to provide the general techniques for the collection of fishes with three separate but related gears that employ hand-held probes electrified by a portable generating system and are operated by a crew that traverses an aquatic study site by wading.

2.0 SCOPE

Applies to all Division personnel involved in the collection of fishes with gear types described in Section 3.0.

3.0 DEFINITIONS

3.1 **Stream Electrofisher:** A gear type that employs a small 2 to 3 meter pram to float a gasoline powered generator and associated electrical connections.

3.2 **Bank Electrofisher:** A gear type where a gasoline powered generator and associated electrical connections are mounted on a portable frame and carried to and along the water's edge.

3.3 **Backpack Electrofisher:** A gear type consisting of a unitized, self-contained electronic control unit coupled to and powered by a DC battery or miniature gasoline powered generator, mounted on a packframe worn by a crew member.

4.0 REFERENCES

4.1 *Operating Manuals (for currently available portable units):*

- Briggs and Stratton Corp. 1975. Operating and maintenance instructions. Model 80300 to 80492. Briggs and Stratton Corp., Milwaukee, Wisconsin.
- Georator Corporation. 1970. Wiring diagram Model No. 31-002. Georator Corp., Manassas, Virginia.
- Coffelt Electronics Company, Inc. Instruction manual for the variable voltage pulsator backpack electroshocker Model BP-2. Coffelt Electronics Company, Inc., Flagstaff, AZ.

4.2 Electrofishing Techniques

- Novotny, D. W., and G. R. Priegel. 1974. Electrofishing boats: design and operational guidelines to increase the effectiveness of boom shockers. Tech. Bull. No. 73, Dept. Nat. Res., Madison, Wisconsin.
- *Reynolds, J. B. 1996. Electrofishing. pp. 221-254. In L. B.R. Murphy and D. W. Willis (eds.). Fisheries Techniques. 2nd edition. Am. Fish. Soc., Bethesda, Maryland.*
- Smith-Root, Inc. Introduction to Electrofishing. Smith-Root, Inc., Vancouver, Washington.
- Whaley, R. A. 1975. Electrofishing: an evaluation of lethality and physiological consequences. M. S. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

4.3 NAI/RMC Procedure No. E4. Identification of Station Locations and Documentation of Samples Collected for Aquatic Work (current revision).

4.4 *NAI/RMC's Health and Safety document (current revision).*

4.5 *Applicable NAI/RMC's procedures and/or manufacturer's instruction manuals for physicochemical parameter measurements/instrumentation (study specific).*

5.0 SAFETY PRECAUTIONS

Use of extreme caution in the operation of portable electrofishing devices is mandated because personnel, although insulated, are in contact with an electrical field. Insulation is provided by rubberized waders and electrician's gloves, which must be worn. Extreme caution must be exercised when working over slick or uneven substrates. Safety and/or kill switches are located on all gears and personnel are to be briefed on the location and operation of these devices. Personnel in danger of falling should shout their predicament so that other personnel can interrupt the current flow by (1) turning off appropriate safety or kill switches, and (2) raising electrodes from the water. A falling probe handler should attempt to keep the electrode above water or throw it in a direction that will divert the electric field away from his or her location. Personnel shall also be familiar with emergency first-aid procedures for drowning and electric shock victims.

Applicable safety items provided in Reference 4.4 shall be observed and followed at all times. Handle generator gasoline (in approved containers--no smoking when fueling) and all preservatives (e.g., isopropanol, formalin) with care. Avoid the use of formalin whenever possible. Wear personal protective gear (i.e., safety glasses, gloves, etc.) and follow other precautions provided on the Material Safety Data Sheets (MSDS) for these materials. See the Project Manager for MSDS sheets, required personal protective gear (including PFD's, where appropriate), and other information regarding safety and other concerns before going afield.

6.0 APPARATUS

The following equipment (or equivalent) is needed as applicable:

6.1 Stream Electrofisher

- Aluminum, plastic, or rubberized pram.
- Gasoline powered generator.
- Variable voltage pulsator or appropriate electronics.
- Additional fuel in approved container.
- Hand-held anode(s) and cathode with insulated handles or cathode array suspended from the pram.
- Appropriate electrical connections (consult operating manuals or text for wiring diagrams that provide the desired type of electric field).
- Tool kit.

6.2 Bank Electrofisher

In general, similar to stream electrofisher but without the pram. The generator must be equipped with appropriate connections to accommodate the hand-held anodes and the cathode or the cathode may be dangled in the water from a lead.

6.3 **Backpack Electrofisher**

- *Commercial backpack unit (with battery or gasoline powered generator).*
- Appropriate number and kind of electrodes for one, two, or three man operation.
- If gasoline powered generator is used, additional fuel must be carried in approved containers.
- Tool kit.

6.4 **Safety Equipment for All Gears**

- *Rubberized waders for all personnel, and PFD's as applicable.*
- Right and left hand electricians gloves for all personnel.
- Fire extinguisher.
- First-aid kit.

6.5 **Fish Capturing and Handling Equipment** (Study specific but in general consists of the following)

- Dip (scap) nets (long handled shallow nets used to capture and transport stunned fish to a collection container placed on shore or in the pram).
- A sufficient number of containers to allow continuous capture and transfer of fishes from the collection site to the process area.
- In-stream mounted live net to hold large numbers of fish until processed.
- *Applicable local, state, and/or federal collection permits.*

6.6 **Processing and Other Instruments** (Study specific, but may include the following)

- Measuring board.
- Weight scale.
- Scale or spine collecting implements.
- Appropriate field data sheets, scale envelopes, sample identification tags, etc.
- Appropriate tagging or marking materials.
- Physicochemical parameter measuring devices (thermometers, dissolved oxygen meters, pH meter or kits, etc.).

7.0 PERSONNEL

The number of experienced personnel involved with electrofishing operations depends upon the gear type employed, scope of project and field conditions. Personnel involved will be assigned to one or more of the following crew positions, as determined by the Project Manager or biologist-in-charge.

7.1 **Pram and/or generator operator** tows and positions pram, operates generator, keeps
probe leads from tangling, and oversees the electrofishing operation.

7.2 **Probe operator(s)** maneuvers probes to stun fish and captures them in scap nets.

7.3 **Processor(s)** processes fish according to applicable study specifications.

7.4 **Recorder** records data onto appropriate field data sheets or other recording media.

8.0 INSTRUCTIONS

8.1 Inspect all equipment to ensure safe and proper operation of all components.

8.2 *Determine initial position of equipment and crew, and have each crew member verbally acknowledge that he/she is ready to begin.*

8.3 *Start up generator with safety switches in the **OFF** positions, then turn switches to **ON** position, and inspect for proper operation. Keep the anode(s) out of the water until electrical supply is established. For gasoline generator powered units, check probe operation by listening for a decrease in RPM due to load which indicates that the unit is operating. Adjust pulsator for proper electrical output, if appropriate.*

8.4 *Fish by wading upstream, using probes to "sweep" back and forth across the area to be sampled. Movement with bank electrofisher is limited at each site by the length of leads to the hand held electrodes.*

8.5 Pram operator should continue to position pram, keep leads free of snags and debris, transfer stunned fish to collecting tubs, and operate the generator.

8.6 Fish processing may begin on-shore adjacent to the study area if sufficient personnel are available; some studies may designate portable processing equipment whereby processors follow behind the electrofishers. Small crews may need to process fish intermittently or transfer them to a holding area for processing later.

8.7 Measure physicochemical parameters just prior to or after sampling the area for fishes (as appropriate to the parameters required for a given study). Review data sheets for completness and legibility prior to exiting each sampling area.

9.0 QUALITY CONTROL

9.1 Physicochemical and biological measurements and the recording of information is to be conducted according to applicable NAI/RMC procedures and/or client specifications.

9.2 All personnel involved in either stream or bank electrofishing will be experienced in the correct use of required equipment.

9.3 New personnel will complete on-the-job training or demonstrate technical proficiency in order to qualify as "experienced".

10.0 REPORTING AND RECORDS

10.1 All field data, coded forms, analyses, and reports will be retained according to client specifications for the study involved. In lieu of client specifications, records shall be retained for three (3) years following termination of a given study.

10.2 Copies of applicable data forms, study specifications, reports and personnel training records shall be retained by the responsible NAI/RMC office.

ATTACHMENT C

COLLECTION OF FISHES BY TRAP NETS

REQUEST FOR REVIEW AND APPROVAL OF PROCEDURE NO. EF7 (Rev. 3):

"Collection of Zooplankton or Ichthyoplankton with a Plankton Net"

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NORMANDEAU ASSOCIATES INC.-RMC DIVISION

PROCEDURE NO. EF7
Rev. 4 (April 1997)

COLLECTION OF ZOOPLANKTON OR ICHTHYOPLANKTON WITH A PLANKTON NET

Approved By: _____ _____

Robert W. Blye, Jr. **Date**
Sr. Vice President

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REVISION SHEET

Rev. No.	Page	Section or Paragraph
1		Total revision
2	3	2.0
2	4	4.0; 5.0; 6.5
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2	10	14.2
2	Attachments 1, 2, 3	
3	3	2.0; 3.2; 3.6
3	4	3.7; 3.8; 4.0; 6.0
3	6	7.4; 8.2
3	7	9.0
3	8	10.0; 11.2
3	9	12.5
3	Attachment I-III	see specific attachment
3	Attachment IV	added
4	Title page updated	
4	3	2.3
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4	5	6.17; 6.18
4	7	9.1
4	8	10.2

COLLECTION OF ZOOPLANKTON OR ICHTHYOPLANKTON WITH A PLANKTON NET

1.0 PURPOSE

This procedure describes methods for the collection of zooplankton or ichthyoplankton with a plankton net.

2.0 SCOPE

2.1 This procedure is applicable to the collection of zooplankton or ichthyoplankton in marine, estuarine and freshwater environments where:

- a plankton net is utilized directly in the source water (e.g., towed with a boat or suspended in the water column), or
- the source water is diverted into the plankton net (e.g, via portable pump or from an outlet tap).

2.2 This procedure may also be used to collect planktonic macroinvertebrates, including zebra mussel larvae.

2.3 *This procedure applies to Division personnel who use plankton nets in field collections.*

3.0 DEFINITIONS

As used in this procedure:

3.1 **Plankton net** - refers to an open ended net (with mesh size appropriate to the organisms being sampled) mounted on a hard frame.

3.2 **Plankton bucket** - refers to the collection container (usually plastic or stainless steel and with or without mesh netting) attached to the end of the net. Buckets with net panels must have a mesh size equal to or smaller than the corresponding plankton net.

3.3 **Tow** - refers to the manner in which the plankton net is deployed and used in the water to collect a sample.

3.4 **Oblique tow** - refers to a collection made continuously from bottom to top of water column while the sampler is towed by a boat.

3.5 **Horizontal tow** - refers to a collection made at one particular depth in the water column while the sampler is towed by a boat.

3.6 **Integrated tow** - refers to a collection made at several discrete depths in the water column while the sampler is towed by a boat.

3.7 **Stationary tow** - refers to a collection made at one particular depth in the water column

with the sampler deployed from a fixed location (e.g., anchored boat, pillar, railing, etc.). Water flow at the fixed location must be sufficient for proper deployment of the sampler (e.g., power station intake and discharge areas, tailrace of hydro station, swift run or riffle). The stationary tow may be modified to simulate oblique, horizontal, and integrated tows.

3.8 **Pump/Outlet set** - refers to a collection made by pumping or diverting (via outlet tap) source water into the plankton net mounted in or on a boat, over a wet well or drain, off an intake gallery, etc. The pump set may be modified to simulate oblique, horizontal, and integrated tows, as feasible.

4.0 REFERENCES

4.1 *NAI/RMC Corporate Health & Safety document (current revision).*

4.2 Potter, David C. 1978. A circular towing tank for calibrating plankton net flowmeters. Northeast Fisheries Center. National Marine Fisheries Service, Woods Hole, Massachusetts.

5.0 SAFETY PRECAUTIONS

Observe applicable safety precautions provided in Reference 4.1. Safely handle and store preservatives per manufacturer labels and MSDS sheets. Wear personal protective gear (safety glasses, gloves, etc.) when using preservatives. Wear a personal flotation device (PFD) when working on or about water. See the Project Manager for personal protective gear, MSDS sheets, and for other safety and site-specific sampling considerations.

6.0 APPARATUS

The following equipment (or equivalent), as applicable, is needed:

6.1 *Boat and motor; sufficient in size and properly equipped (see Reference 4.1) to safely carry personnel and equipment, and to easily deploy and retrieve nets. The boat must contain one PFD/person plus one throwable device.*

6.2 Winch, boom, and other hardware required to deploy and retrieve the plankton net and to hold it in position for sampling. (Any cable on a winch should be pre-marked for depth determination and of sufficient length to reach desired depths).

6.3 Depressor weights (sufficient in size to adequately position and maintain sampler in the water).

6.4 Plankton net(s) and bucket(s) of appropriate mesh size (study specific).

6.5 Clinometer (or other device to measure cable angle) and angle cosine or depth conversion table.

6.6 Submersible or other pump with sufficient capacity at sampling head.

6.7 Distribution hose and connectors (for pump/outlet sets).

6.8 Flowmeter (calibrated as per Section 14.0).

6.9 Buckets (one pre-measured for volume for pump/outlet sets).

6.10 Sample storage containers, labels and carrier.

6.11 Stop watch or other timing device.

6.12 Generator (for electric pumps used in remote areas).

6.13 Appropriate preservative.

6.14 Field data sheets and notebook.

6.15 Pencil or pen (indelible ink).

6.16 Tool kit, including needle and thread.

6.17 *Water quality instruments and/or kits (for study specific parameter measurements).*

6.18 *Applicable local, state, and federal collection permits.*

7.0 PRE-COLLECTION INFORMATION

The type of tow, gear, and its deployment depends on the objectives of the study and the water body to be sampled. Therefore, the type of tow to be used for each study is determined by the Project Manager prior to actual sampling. The following information for each tow is predetermined and provided to the field staff:

7.1 Oblique or Integrated Tow

- Depth at which tow is started.
- Depths to be sampled during each tow.
- Total time (minutes) per tow and the time each depth is to be sampled, or alternately, the volume of water to be sampled and the volume at each depth.
- Path that net is to be towed (such as circular, parallel to shore, upstream or downstream, or perpendicular to shore).

7.2 Horizontal Tow

- Layer (depth) or layers (such as surface, mid-water, or near bottom) of water to be sampled.
- Total time or volume of water to be collected per tow.
- Path that net is to be towed.

7.3 Stationary Tow

- Layer (depth) or layers (such as surface, mid-water, or near bottom) of water to be sampled.
- Total time or volume of water to be sampled per tow.

7.4 Pump/Outlet Set

- Depth or depths to be sampled for pump collections.
- Total time or volume of water to be sampled (outlet set), or time/volume at depth (pump set).

8.0 PRE-OPERATIONAL INSTRUCTIONS

8.1 Net Tows

- Secure necessary hardware (e.g., tow ropes and associated hardware) to the boom, winch assembly, and the boat or stationary support as applicable.
- Attach plankton net with flowmeter and depressor (when necessary) to the winch cable or towing rope.
- If necessary, lower the net sampler just below the water surface and conduct a preliminary tow to insure that the depresser is so attached to allow proper suspension of the sampler. When towed the sampler should move parallel to the surface for oblique and horizontal tows or remain parallel to the surface and facing upstream into the current for stationary sets. Check flowmeter to insure proper functioning.

8.2 Pump/Outlet Sets

- Secure the net to receive the sampled water and connect distribution hose to the outlet tap or pump, as applicable. The net should be positioned in such a manner that water passing the net is properly drained/discharged (e.g., via an approved floor drain, wet well, or directly back to the source water). **NOTE: Depending on study requirements, and/or the force of flow expected through the net, it may be necessary to partially submerge the net in a bucket of water (or directly in the source water) to prevent/reduce net impingement damage to target organisms during sampling. Consult the responsible Project Manager to determine the need for this collection technique.**
- If using a submersible pump, secure the pump by rope to a fixed structure and use the rope to deploy/retrieve the pump. **NEVER** suspend, raise, or lower the pump by its electric cord. If an extension cord is required use only approved cords and keep the pump to extension cord connection well above the water surface.

- Prior to sample collection, establish a steady flow (from pump or outlet tap) and flush the distribution lines. Then measure the rate (e.g., gal/sec) of flow (average of 3 timed reps using a container/bucket pre-marked for volume). Record the sample flow rate on the field data sheet.

9.0 OPERATIONAL INSTRUCTIONS

9.1 *Determine and record results of the appropriate study specific physicochemical parameter measurements (and applicable instrument calibration/check results)on field data sheet immediately before and/or after sample collection.*

9.2 Securely fasten the collection bucket to the terminal end of the plankton net.

9.3 Proceed with the collection following the instructions given in the appropriate attachment: Attachment I for Oblique Tows, Attachment II for Horizontal Tows, Attachment III for Stationary Tows, or Attachment IV for Pump/Outlet Sets.

9.4 Thoroughly rinse the outside of the net with water to wash collected organisms/material on the inside of the net into the collection bucket. Repeat as necessary to concentrate collected material in the bucket.

9.5 Over an empty container, carefully remove the collection bucket from the net and transfer its contents to a sample storage container. Rinse the collection bucket with either preservative or water and add this material to storage container. If any portion of sample overflowed into the empty catch container, also rinse this material to the storage container. NOTE: If a single storage container is insufficient to hold the entire sample, use as many containers as necessary.

9.6 After the sample and rinses have been placed in the storage container, add preservative as necessary to ensure proper preservation concentration. NOTE: DO NOT use chemical preservatives if "live" samples are to be examined. Contact the Project Manager regarding the type and use of chemical preservatives.

9.7 Unless otherwise instructed by the Project Manager, place a sample identification label inside the storage container. If more than one collection container is needed for a sample, place a duplicate sample identification label in each container and indicate the total number of containers for this collection on each label and on the respective field data sheet.

9.8 Examine the plankton net (and bucket if it contains mesh panels) for damage incurred during the tow/set and either mend all small rips and holes or replace net before the next sample is taken.

9.9 Repeat instructions 9.2 to 9.8 if replicate tows are to be taken.

9.10 Review the field data sheet for completeness and accuracy before proceeding to the next station or leaving the field.

9.11 At the end of the sampling day, cover nets or store nets indoors to prevent deterioration due

to sun exposure.

9.12 Return samples to the laboratory for processing.

10.0 VALID COLLECTIONS

10.1 A plankton net collection is considered valid unless one or more of the following (as applicable) occurs:

- Flowmeter malfunctions.
- Completion of less than 75% of predetermined sampling time or volume, unless excessive clogging of the net occurs, or flow is no longer available (pump/outlet set only).
- Improper deployment of sampler.
- Large holes or rips in the net (>30 mm) or torn mesh in bucket, which occurred during the tow.
- Presence of large amounts of silt, mud, sand, or rocks in sample (i.e., net dragging in bottom substrates).
- Loss of gear, other unavoidable events.

10.2 *Invalid collections are discarded, the net is cleaned and repaired, if necessary, and the tow is repeated, if feasible. If not feasible, document on the data sheet, the reason(s) for the occurrence of any collections that cannot be repeated.*

11.0 CALIBRATION OF FLOWMETERS USED IN NET COLLECTIONS

11.1 Calibrate flowmeters per manufacturer's instructions (if available) or at least once a month per the circular towing tank method described in Reference 4.2. Otherwise, calibrate flowmeters in the field as described below.

11.2 **Field Calibration Method**

- Calibrate flowmeters by towing each flowmeter (equipped with plankton net) over a known distance (at least 50 m) at a constant speed approximately equal to that attained while towing a net. Calibration tows should ideally be done in areas without current. If it is not possible to make calibration tows in still areas, then half of each tow is made with the current and half of each tow against the current.
- Repeat the procedure a minimum of three times for each flow meter being calibrated.
- Record on a data sheet the diameter (circular nets) or length x width (rectangular nets) of the mouth of the net, the distance towed, and number of flowmeter turns for each calibration trial. Also, note existing field conditions (e.g., water temperature and current/patterns, wind/direction, etc.) on the data sheet.

- Calculate the calibration factor (CF), or volume of water sampled per turn, for each flowmeter as instructed by the Project Manager (or designate).

- The frequency for field calibration of flowmeters is study specific.

12.0 QUALITY CONTROL (QC)

12.1 Plankton net collections shall be conducted only by personnel experienced or trained in the appropriate techniques.

12.2 Inspect sampling equipment prior to sampling and before and after each tow to ensure proper function.

12.3 New or repaired flowmeters are calibrated prior to use; all flowmeters are periodically checked during use.

12.4 Physicochemical parameters are measured only with instruments/kits that are properly calibrated per the appropriate procedure/manufacturer instructions for each parameter.

12.5 Review field data sheets for completeness, accuracy, and legibility before leaving the field. These sheets are reviewed again in the laboratory prior to further data processing.

12.6 Each zooplankton and ichthyoplankton collection is consistently numbered for identification. This collection number is provided on the field data sheet, individual identification labels, and any additional sheets or labels, associated with each collection.

13.0 REPORTING

Data generated by this procedure shall be reported per study specifications.

14.0 RECORDS

14.1 The following records shall be retained in the responsible laboratory:

- Study specifications
- Field data sheets
- Flowmeter calibration and monthly check results (as applicable)
- At least one copy of each report generated per Section 13.0
- Personnel training records.

14.2 The above records shall be retained per study specifications. In lieu of such, records will be retained for a period of at least three (3) years following completion of a given study.

15.0 ATTACHMENTS

Attachment I - Instructions for Oblique Tows
Attachment II - Instructions for Horizontal Tows
Attachment III - Instructions for Stationary Tows

Attachment IV - Instructions for Pump/Outlet Sets

ATTACHMENT I

OBLIQUE TOWS - INSTRUCTIONS

1.0 Determine and record the net flowmeter reading on the field data sheet prior to sampler deployment.

2.0 With the boat stopped or, if necessary, with minimal forward speed, lower the plankton sampler into the water to the starting depth. Start the tow and begin timing. Perform either an integrated tow, a continuous oblique tow beginning at the surface, or a continuous oblique tow beginning at the bottom.

3.0 Integrated Tow

3.1 The starting depth is at the water surface with the leading edge of the sampler just below the surface.

3.2 During the timed tow, lower the sampler to the bottom, sampling the specified depths for a proportionate amount of the total sampling time. Example: if the tow duration is 3 minutes and three depths are to be sampled, each depth is sampled for one minute.

3.3 During the tow, maintain a cable angle (e.g., 45 degrees) which produces an even flow of water at the mouth of net.

3.4 Determine the specified sampling depth(s) by deploying a length of cable equal to the desired depth divided by the cosine of the actual towing cable angle (e.g., for a 45 degree towing angle the length of cable deployed is 1.4 longer than desired depth). The sampler is considered to be sampling the bottom (or near bottom) when the depressor is felt to contact and/or drag along the bottom.

3.5 After the tow is completed, the sampler is retrieved with the boat stopped or with minimal forward speed.

3.6 Determine and record the net flowmeter reading after the sampler is retrieved.

3.7 Continue here with Instruction 9.4 in text (p. EF7-7).

4.0 Continuous Oblique Tow (Beginning at Surface)

4.1 The starting depth is at the water surface with the leading edge of the sampler just below the surface.

4.2 During this timed tow, lower the sampler to the bottom at a constant rate so that it samples each portion of the water column for an equal amount of time. The boat speed should be adjusted to maintain the cable at a constant angle (e.g., 45 degrees) from vertical.

4.3 If the sampler reaches the bottom before the tow duration has elapsed, it should be retrieved at a constant rate until the sampler reaches the surface.

ATTACHMENT I (continued)

4.4 Steps 4.2 and 4.3 may be repeated as often as necessary to achieve a sample for the specified tow duration. NOTE: Since a sampling cycle (surface to bottom or bottom to surface) cannot be terminated once it is begun, it is impossible to complete all tows in exactly the same amount of time. However, the specified sampling time can be approximated (±15%) by changes in the rates of cable deployment and retrieval.

4.5 When the sampling cycle has been completed retrieve the sampler. If the cycle terminates with the sampler at the surface, the tow ends when the sampler is lifted from the water. If the cycle ends with the sampler at the bottom, retrieve it to the surface as quickly as possible.

4.6 Determine and record the net flowmeter reading after the sampler is retrieved.

4.7 Continue here with Instruction 9.4 in text (p. EF7-7).

5.0 <u>Continuous Oblique Tow (Beginning at Bottom)</u>

5.1 The starting depth is at the bottom with the sampler lowered until the depressor touches bottom or the appropriate amount of cable is deployed.

5.2 As the boat proceeds forward, additional cable is deployed until the sampler is positioned just off the bottom. When this is achieved, the sampler is retrieved at a constant rate so that it samples each portion of the water column for an equal amount of time. The rate of retrieval should be slow enough to insure that the tow time approximates (±15%) the specified tow duration. Maintain the cable angle during the tow.

5.3 When sampling ends retrieve the sampler, record the flowmeter reading, then continue with Instruction 9.4 in text (p. EF7-7).

ATTACHMENT II

HORIZONTAL TOWS - INSTRUCTIONS

1.0 Determine and record the net flowmeter reading on the field data sheet prior to sampler deployment.

2.0 Deploy the plankton sampler(s) to the desired depth(s) maintaining minimal forward speed.

2.1 Surface tows are made with the leading upper edge of the sampler just under the surface.

2.2 Bottom tows are made with the sampler as close to the bottom as practical.

2.3 Mid-depth tows are taken with the sampler positioned on the cable at the appropriate distance from the water surface (desired sampling depth divided by the cosine of cable angle).

3.0 Begin the tow when sampler is deployed and adjust boat speed to maintain appropriate cable angle.

3.1 If cable angle is unimportant (e.g., surface tow) in assuring proper sampling depth, tow the sampler at a maximum speed which does not produce a detectable pressure wave (<2.5 cm) in front of the sampler.

3.2 If adjustment of boat speed to attain proper cable angle causes the surface net to break water surface or sink too far below surface, lengthen or shorten the surface net tow line until surface net depth is appropriate.

4.0 At the end of the predetermined time period retrieve the sampler(s) as quickly as possible, record the flowmeter reading, then continue here with Instruction 9.4 in text (p. EF7-7).

ATTACHMENT III

STATIONARY TOWS - INSTRUCTIONS

1.0 Determine and record the net flowmeter reading on the field data sheet prior to sampler deployment.

2.0 From a fixed (stationary) location (e.g., anchored boat, gallery railing or post, etc.) lower the sampler to the desired water depth.

2.1 Surface tows are made with the leading upper edge of the sampler just under the surface.

2.2 Bottom tows are made with the sampler as close to the bottom as practical.

2.3 Mid-depth tows are taken with the sampler positioned on the cable at the appropriate distance from the water surface (desired sampling depth divided by the cosine of cable angle).

3.0 Position the sampler with the open end of the net facing upstream into the current. Begin timing the tow when the sampler is positioned.

4.0 At the end of the predetermined time period retrieve the sampler as quickly as possible, record the flowmeter reading, then continue here with Instruction 9.4 in text (p. EF7-7).

ATTACHMENT IV

PUMP/OUTLET SETS - INSTRUCTIONS

1.0 Determine the rate (e.g., liters/sec, gal/sec) of flow (from the pump or outlet tap, as applicable) and record the flow rate on the data sheet.

1.1 If the study specifications require that a certain volume be sampled for each collection, calculate the time needed (based on the pump/outlet tap flow rate) to sample the required volume of water. Record this time on the data sheet, then proceed with the collection per Section 2.0 below.

1.2 If the study specifications require that sampling be conducted for a certain amount of time (e.g., 10, 20, 30 minutes or longer) rather than volume, record the required time on the data sheet, then proceed with the collection per Section 2.0 below.

2.0 With the plankton net/bucket array securely positioned and rate of flow determined, simultaneously direct the sample flow (via hose from pump or outlet tap) into the net and start timing the collection.

3.0 At the end of the timed collection period, terminate flow to the net (remove hose from net, or shut off flow from the pump or outlet, as applicable). Record the actual sampling time if different from that recorded earlier (Instruction 1.1 or 1.2 above). NOTE: If the sample flow from the pump or outlet tap becomes noticeably slower, faster, or uneven during the timed collection, determine and record the flow rate at the end of the collection. If the varying flow condition can be corrected, discard the original sample and repeat the collection. Otherwise, keep the original sample, be sure to record the post-collection flow rate, and inform the Project Manger of the flow conditions.

4.0 Review the field data sheet to ensure that the sample flow rate and sampling time are appropriately recorded, then continue with Instruction 9.4 in text (p. EF7-7).

ATTACHMENT D

FISH SAMPLING FIELD DATA SHEETS

FISH SAMPLING FIELD DATA SHEET (FRONT)

STREAM NAME	LOCATION	
STATION # ______ RIVERMILE ______	STREAM CLASS	
LAT __________ LONG __________	RIVER BASIN	
STORET #	AGENCY	
GEAR	INVESTIGATORS	
FORM COMPLETED BY	DATE ______ TIME ______ AM PM	REASON FOR SURVEY

SAMPLE COLLECTION	**How were the fish captured?** ☐ back pack ☐ tote barge ☐ other ____________ **Block nets used?** ☐ YES ☐ NO **Sampling Duration** Start time ________ End time ________ Duration ________ **Stream width (in meters)** Max________ Mean________
HABITAT TYPES	**Indicate the percentage of each habitat type present** ☐ Riffles____% ☐ Pools____% ☐ Runs____% ☐ Snags____% ☐ Submerged Macrophytes____% ☐ Other ( )____%
GENERAL COMMENTS	

SPECIES	TOTAL (COUNT)	OPTIONAL: LENGTH (mm)/WEIGHT (g) (25 SPECIMEN MAX SUBSAMPLE)					ANOMALIES*							
							D	E	F	L	M	S	T	Z

FISH SAMPLING FIELD DATA SHEET (BACK)

SPECIES	TOTAL (COUNT)	OPTIONAL: LENGTH (mm)/WEIGHT (g) (25 SPECIMEN MAX SUBSAMPLE)					ANOMALIES*							
							D	E	F	L	M	S	T	Z

* **ANOMALY CODES:** D = deformities; E = eroded fins; F = fungus; L = lesions; M = multiple DELT anomalies; S = emaciated; Z = other

FISH SAMPLE LOG-IN SHEET

Date Collected	Collected By	Number of Containers	Preservation	Station #	Stream Name and Location	Date Received by Lab	Lot Number	Date of Completion		
								sorting	mounting	identification

Serial Code Example: F0754001(1)
F = Fish (B = Benthos; P = Periphyton) ■ 0754 = project number ■ 001 = sample number ■ (1) = lot number (e.g., winter 1996 =1; summer 1996 = 2)

ATTACHMENT E

COLLECTION OF ZOOPLANKTON OR ICHTHYOPLANKTON WITH A PLANKTON NET

NORMANDEAU ASSOCIATES INC.-RMC DIVISION

PROCEDURE NO. EF1

Rev. 4

(April 1997)

COLLECTION OF FISH BY TRAP NET

Approved By: _____ _____
Robert W. Blye, Jr. Date
Sr. Vice President

Distributed To: _____

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REQUEST FOR REVIEW AND APPROVAL OF PROCEDURE NO. EF1(Rev. 4):

"COLLECTION OF FISH BY TRAP NET"

Reviewed and Approved By:

Michael J. Hreben III Research Biologist, MREL	Date
George A. Nardacci Manager, MREL	Date
Douglas A. Nieman Principal Biologist, SC	Date
Paul L. Harmon Vice President, NAI/RMC	Date
Eric S. McClellan QA Coordinator, RMC Division	Date
Robert W. Blye, Jr. Sr. Vice President, NAI/RMC	Date

REVISION SHEET

Rev. No.	Page	Section or Paragraph
1	Title page, typographical and organizational changes	
2	Title page, revision sheet added, pages renumbered	
2	EF1-3	1.0;3.1;4.1;5.0
2	EF1-4	7.0;7.2;7.3;8.0;8.2;8.3
2	EF1-5	9.0;10.2;10.4;10.5
2	EF1-6	12.0
3	EF1-3	2.0;4.2;5.0
3	EF1-4	6.2;6.7;6.10;7.2;7.4;8.1
3	EF1-5	8.4;10.5
3	EF1-6	12.1
4	Title page updated	
4	EF1-3	2.0; 4.0; 5.0; 6.0
4	EF1-4	7.1; 7.4; 8.0
4	EF1-5	9.1; 10.2; 12.1

COLLECTION OF FISH BY TRAP NET

1.0 PURPOSE

This procedure specifies the method for collection and disposition of fish by trap net.

2.0 SCOPE

This procedure applies to all Division personnel involved in collection of fish by trap net.

3.0 DEFINITIONS

Trap net -an entrapment device in which fish enter an enclosed area through one or more funnels or V-shaped openings and cannot find a means of escape.

4.0 REFERENCES

4.1 *Hubert, W. A. 1996. Passive capture techniques. Pages 157-192 in B. R. Murphy and D. W. Willis, editors. Fisheries techniques. Second edition. American Fisheries Society, Bethesda, Maryland.*

4.2 *NAI/RMC Corporate Health & Safety document (current revision).*

4.3 *NAI/RMC Procedure No. E4 "Identification of Station Locations and Documentation of Samples Collected for Aquatic Work" (current revision).*

5.0 SAFETY PRECAUTIONS

Appropriate field safety precautions given per Reference 4.2 are to be observed. Wear a PFD when working on the water. When handling preservatives, observe MSDS precautions and wear personal protective gear (safety glasses, gloves, etc.). Transport and keep preservatives in unbreakable leak-proof (e.g. Nalgene) containers. Avoid the use of formalin whenever possible. See the Project Manager for personal protective gear, MSDS sheets, and site-specific safety and other sampling concerns. Trap netting is to be conducted by a minimum of two (2) personnel.

6.0 APPARATUS

The following equipment (or equivalent) as applicable is needed:

6.1 *Boat and motor (sufficient in size to safely carry personnel and equipment, including one PFD/person plus one throwable device).*
6.2 Trap net (of appropriate dimensions and mesh size).
Example - 3'x 50' lead net of 1/2" square mesh attached to a 3' x 6' metal frame connected to two traps with four hoops 3' in diameter.
6.3 *Water quality instrumentation and/or kits (study specific).*
6.4 Measuring board (readable to nearest millimeter).
6.5 Wash tubs.
6.6 *Collection containers (e.g., coolers, jars, plastic bags) and labels.*
6.7 *Preservative (if samples are to be preserved in the field).*

6.8 Field notebook and data sheets.
6.9 Pencil or pen (waterproof ink only).
6.10 Scales for weight determinations.
6.11 *Fish scaling knife and scale envelopes.*
6.12 *Wrist watch.*
6.13 *Applicable local, state, and federal collection permits.*

7.0 INSTRUCTIONS - SETTING NETS

7.1 Generally, set nets near shore and in water less than 8 m deep, unless otherwise specified.

7.2 Tie the lead to shore, then fully extend the lead perpendicular (if frame net) or parallel (if fyke net) to shore (conditions permitting).

7.3 Straighten and tighten the net, lead and/or wings as necessary to avoid rolling and twisting of net.

7.4 *Measure physicochemical parameters (study specific) per the appropriate parameter procedure and record results (including applicable instrument calibration/check results) on the field data sheet for each station sampled. Measure parameters prior to or immediately after nets are set.*

7.5 Review the field data sheet for completeness and legibility before moving to the next station.

8.0 INSTRUCTIONS - RETRIEVING NETS

8.1 *Each net is set for a specified period (typically 12 to 24 hours) before retrieval (consult Project Manager for study specifics). Set and retrieval times should be noted on the appropriate data sheets.* ***NOTE:*** *Nets should be attended at least daily, or more frequently if specified in applicable local, state, or federal permit(s).*

8.2 Measure physicochemical parameters per Instruction 7.4.

8.3 Retrieve the net and transfer any captured fish to a wash tub.

8.4 *Process fish per study requirements (e.g. identify, count, subsample, measure length, weigh, preserve, etc.).* ***NOTE:*** *Minimize handling stress to the extent possible for fishes to be released after processing.*

8.5 *Check field data sheets for completeness and legibility and inspect collection containers (for retained specimens) for proper identification and closure before proceeding to the next station.*

9.0 INVALID COLLECTIONS

9.1 *One or more of the following may invalidate a trap net collection for most quantitative*

purposes. However, use judgement when making invalid determinations (e.g., in estimating species richness, one should consider including a "new" species if caught in an otherwise poor set.

- Vandalism.
- Clogging by debris.
- Collapsed or damaged net.
- Twisted net due to high river flow, wave action or improper set.

- *Failure to retrieve net after the specified set period due to unsafe meteorological, hydrological, other conditions.*

9.2 Document an invalid collection on the appropriate field data sheet.

10.0 QUALITY CONTROL

10.1 Each trap net collection is identified at least by location, date, and time of collection and investigators.

10.2 *Physicochemical parameters are measured only with instruments/kits properly calibrated per the appropriate parameter procedure, or manufacturer's instructions.*

10.3 Trap nets are inspected for damage prior to sampling and repaired or replaced as needed.

10.4 Station locations are identified per Reference 4.3.

10.5 Trap net collections are to be conducted or supervised by personnel trained or experienced in collection and processing techniques.

10.6 Field data sheets are reviewed for completeness and legibility and initialed in the field.

11.0 REPORTING

Data generated by this procedure are reported per client specifications.

12.0 RECORDS

12.1 *The following records are to be retained by the responsible office:*

- *Field data sheets/notebooks.*
- Calibration and maintenance records for instruments used to measure physicochemical parameters.
- Written descriptions of station locations and applicable maps.
- Reports generated per Section 11.0.
- Personnel training.
- *Applicable reference/voucher collection.*

12.2 The above records are retained per client specifications. In lieu of such specification, records will be retained for a period of at least three (3) years following completion of a given study.

ATTACHMENT F

AGE DETERMINATION OF FISH FROM SCALES OR SPINES

REQUEST FOR REVIEW AND APPROVAL OF PROCEDURE NO. EF13 (Rev. 3):

"Age Determination of Fishes from Scales or Spines"

Reviewed and Approved By:

Ray A. Bleistine **Project Biologist, MREL**	**Date**
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Robert W. Blye, Jr. **Sr. Vice President, NAI/RMC**	**Date**

NORMANDEAU ASSOCIATES INC.-RMC DIVISION

PROCEDURE NO. EF13
Rev. 3 (Mar. 1997)

AGE DETERMINATION FROM SCALES OR SPINES

Approved By: _____ _____

Robert W. Blye, Jr. **Date**
Sr. Vice President

Distributed To: _____

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REVISION SHEET

Rev. No.	Page	Section or Paragraph
1		Title page and organizational changes
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2	EF13-3	1.0, 2.0
2	EF13-4	4.0
2	EF13-5	6.2, 7.1.4
2	EF13-8	8.4, 10.0
3		Title page updated
3	EF13-3	2.0, 3.2
3	EF13-4	4.8; 5.4; 6.2; 7.1.3
3	EF13-5	7.1.7; 7.2.8
3	EF13-6	11.0
3		Enclosure 1 added

AGE DETERMINATION OF FISHES FROM SCALES OR SPINES

1.0 PURPOSE

This document describes the procedure for age determination of fishes.

2.0 SCOPE

This procedure applies to all Division personnel who age fish using scales or spines.

3.0 REFERENCES

3.1 Cating, J. P. 1953. Determining age of Atlantic shad from their scales. U. S. Fish. Wildl. Serv. Bull. 54:187-199.

3.2 *Devries, D. R. and R. V. Frie. 1996. Determination of age and growth. Pages 483-512 In B. Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.*

3.3 Judy, M. H. 1961. Validity of age determination from scales of marked American shad. U. S. Fish. Wildl. Serv. Bull. 185:161-169.

3.4 Lagler, K. F. 1966. Freshwater fishery biology. Wm. C. Brown Co., Dubuque, Iowa.

3.5 Marcy, B. C. 1969. Age determinations from scales of Alosa pseudoharengus (Wilson) and Alosa aestivalis Mitchell) in Connecticut waters. Trans. Amer. Fish. Soc. 98(4):622-630.

3.6 Marzolf, R. C. 1955. Use of pectoral spines and vertebrae for determining age and rate of growth of channel catfish. Jour. Wildl. Mgmt. 19(2):243-249.

3.7 Tesch, F. W. 1971. Age and growth. Pages 93123 in Ricker, ed. Methods for the assessment of fish production in freshwater. IBP Handbook No. 3, Blackwell, Oxford.

3.8 Wahtola, C. H. J., and J. B. Owen. 1970. A decalcification technique for sectioning pectoral spines.

4.0 APPARATUS

The following equipment (or equivalent) as applicable is needed:

4.1 Dissecting tools
4.2 Slides (cellulose acetate or glass)
4.3 Vials
4.4 Scale cleansing solution (e.g., 2% KOH)
4.5 Decalcification agent (e.g., HCl solution)
4.6 Scale press
4.7 Scale projector
4.8 *Microfiche reasder*
4.9 Calipers
4.10 Microscope with ocular micrometer

4.11 Petri dish
4.12 Linear measuring device (e.g., ruler)
4.13 Pencil or pen
4.14 Razor blade, scalpel, pocket knife
4.15 Data sheets/scale envelopes

5.0 DEFINITIONS

5.1 **Focus** - the physiological center of scale or spine section.

5.2 **Circuli** - the rings which encircle the focus of a scale that represent growth.

5.3 **Annulus** - marking on scale or spine that indicates a period of growth cessation; normally formed following the period of little or no growth in winter.

5.4 Distal side - the side of the scale far from the point of attachment or origin.

6.0 PRELIMINARY INSTRUCTIONS

6.1 Cross reference field collection information on all data sheets used.

6.2 *Remove scales from most spiny-rayed fish just below the lateral line at the tip of the depressed pectoral fin. Remove scales from most soft-rayed fishes just below the point of insertion of the dorsal fin. (NOTE: Scales on most fish are easily removed using a pocket knife, by "scraping" them off in the same direction ("with the grain") that the scales are oriented on the fish.) Remove pectoral or dorsal spines from catfish. Some species may require different locations. The location where scales or spines are removed is study-specific, and should remain constant throughout a given study.*

7.0 INSTRUCTIONS PROPER

7.1 Scales

7.1.1 Soak dirty scales in a cleansing solution (usually 2% KOH) prior to pressing.

7.1.2 Place uniform, non-regenerated scales (usually 5 to 8) distal side down on a cellulose acetate slide.

7.1.3 *Make permanent impressions using a roller press. NOTE: It is the "rough" side of the scale that will make the impression on the slide.*

7.1.4 Mount very small scales and scales from clupeids on slides with tape or place between two slides.

7.1.5 Examine impressions and mounts using a scale projector.

7.1.6 Identify annuli according to criteria described by Lagler (1966), Tesch (1971), Cating (1953), Judy (1961), and Marcy (1969); or other appropriate reference.

7.1.7 *Assign age based on number of annuli, using nomenclature and conventions as*

described by Devries and Frie (1996) and provided in Enclosure 1.

7.1.8 Make two independent age determinations (two investigators or the same investigator on two separate occasions). Initial and date the age data.

7.1.9 Re-examine scales when independent age determinations differ. Do not use age data for a specimen if age is not agreed upon.

7.1.10 Identify scale(s) to be measured, then measure distance to each annulus and total scale radius (nearest mm) along a line from the focus to the middle of the anterior margin for one scale from each fish (some studies may require additional scale measurements up to five scales from each fish). Make all measurements at the same magnification for a given study.

7.1.11 Record measurements on data sheets.

7.2 Spines

7.2.1 Decalcify spines in a solution of HCl (usually 5%) following the method described by Wahtola and Owen (1970).

7.2.2 Measure spine radii, at base of spine, using a dial caliper prior to sectioning (study specific).

7.2.3 Section spines with a razor blade or scalpel similar to the method described by Wahtola and Owen (1970).

7.2.4 Cut thin sections (usually four) from near the base of the spine. Retain for examination the first four sections that appear "heart-shaped".

7.2.5 Immediately place sections on a glass slide and then cover with a drop of water.

7.2.6 Examine sections using a scale projector or microscope fitted with an ocular micrometer (consistent magnification with species).

7.2.7 Identify annuli according to criteria described by Marzolf (1955), or other appropriate reference.

7.2.8 *Assign age based on number of annuli, using nomenclature and conventions as described by Devries and Frie (1996) and provided in Enclosure 1.*

7.2.9 Make two independent age determinations and re-examine spine sections when independent age determinations differ. Do not use age data for a specimen if agreement is not attained.

7.2.10 Measure distance to each annulus (nearest mm) along a line from the focus to the midpoint of either lobe of the section. Identify spine section(s) measured if permanent mount is made.

7.2.11 Record all age assignments and spine measurements on data sheet.

8.0 QUALITY CONTROL

8.1 All scales and spines and subsequent age data are appropriately identified to insure proper reference to field collection and other processing (e.g., length, weight) information.

8.2 Age determinations are made independently by two investigators or the same investigator on two separate occasions.

8.3 Independent scale or spine readings from the same specimens are not included in study results if a common set of data can not be agreed upon.

8.4 Initials of biologists and date are recorded on age data sheets/scale envelopes.

8.5 Scale samples, scale impressions and portions of spines are retained per study specifications.

9.0 REPORTING

Results of age and growth studies shall be reported per client or study specifications.

10.0 RECORDS

The following records are retained by the responsible laboratory per study specifications. In lieu of such, the records will be retained for a period of at least three (3) years.

10.1 Scale samples, impressions, and spines.

10.2 All age data sheets/scale envelopes.

11.0 ENCLOSURE

1 Box 16.1 Conventions for Age Determinations (from Devries and Frie, 1996; see Reference 3.2)

APPENDIX B

FIELD SAMPLING AND ANALYSIS PLAN FOR TURTLE COLLECTION AND PROCESSING

APPENDIX B
FIELD SAMPLING AND ANALYSIS PLAN
FOR TURTLE COLLECTION AND PROCESSING

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1. BACKGROUND

Inclusion of turtles in the field sampling program will be dependent on additional information concerning human consumption patterns in the area. Several life history characteristics make a turtle species a useful indicator of potential ecological effects of bioaccumulating COPCs in Woonasquatucket River sediments. The turtle is an aquatic species favoring permanent bodies of water. In addition to being in frequent contact with water and sediment, it hibernates in the mud during winter months. The home range of the turtle is small and, due to the elevated fat deposits, turtles have routinely been used as a sentinel species to biomonitor for bioaccumulating substances such as dioxins and PCBs. Thus, turtles may act as indicators of localized contamination.

In addition, diets of turtles are typically varied consisting of aquatic macroinvertebrates, plant material, and decomposing material and some species such as the snapping *turtle (Chelydra serpentina)* are predacious on frogs, fish, and young waterfowl. Anecdotal information indicates that turtles in the Woonasquatucket River watershed are, or have historically, been harvested for human consumption, posing potential human health risks that may require evaluation. The selection of a particular species of turtle would be based on the availability of adequate numbers of organisms within each of the sampling areas as determined during the initial field reconnaissance.

1.2. OBJECTIVES

The principal objective of this study are to:

- Collect turtle from areas of the Woonasquatucket River representing a range of concentrations of bioaccumulating COPCs for tissue residue analysis.
- Provide data on the bioaccumulation of PCBs, dioxins/furans (including HCX), and organochlorine pesticides in the aquatic food web for fate and effects/exposure analysis.

Tissue samples will be analyzed for SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins and furans (including HCX), PCB congeners, percent lipids, and percent moisture. Turtle tissue sample collection and analysis will be used to evaluate both ecological and human health endpoints. Turtle tissue concentrations will be used to determine potential risks to individuals who may be catching and eating turtles in violation of the turtle consumption ban, as well as to determine risk to subsistence and recreational anglers in the absence of administrative or institutional controls. Ecological measurement endpoints are the comparison of tissue concentrations to Critical Body Residues (CBRs) from literature and reference area concentrations, and incorporation in food chain models. Tissue analyses will be conducted in accordance with the QAPP (Battelle, 2001).

All turtle collection and capture will be performed by personnel subcontractor.

2.0 STUDY DESIGN

2.1. FIELD SAMPLING DESIGN

2.1.1. Number of Samples

Four sampling areas are targeted for this component of the field sampling program: Allendale Pond, Lymansville Pond, Greystone Mill Pond, and Assapumpsett Pond. Each adult turtle would comprise a single sample (i.e., adult turtles have adequate tissue mass to meet the mass requirements for the selected analytical parameters) and ten samples will be obtained from each four sampling areas. Additionally, laboratory and matrix spike/matrix spike duplicate samples will be collected at a rate of one in twenty samples.

2.1.2. Sampling Locations

Specific sampling areas will be selected by conducting a field reconnaissance to identify appropriate turtle habitat, followed by a review of available contaminant data to identify habitats both with and without detected contaminant concentrations (for use as site-related and reference sampling areas, respectively). Within the Centredale Manor study area, turtle habitat is expected to exist primarily in the pond areas. These areas have a lower water velocity, which allows deposition of contaminated sediments, as well as growth of submerged and emergent aquatic vegetation favored by turtles. The selected reference areas are Assapumpsett Pond and Greystone Mill Pond. Low level concentrations of PCB and dioxin/furan analytes have been detected in the upstream sampling location.

2.1.3. Collection Methods

Turtles will be sampled primarily using baited traps that will be placed in the sampling locations from a boat or from shore. Traps will be baited with either fish collected from the site or chicken liver and ivory soap. All traps will be place in shallow water, less than 0.5 feet to ensure that captured animals have access to air. Approximately 20 traps will be placed in suitable turtle habitat within each sampling area. Traps will be tethered to wooded stakes and will be checked on a daily basis until all samples have been obtained.

Upon capture, turtles will be given an identification number and returned to the central processing area. If possible, additional turtles at each site will be captured, so that the turtles to be retained for analysis will be of similar weight and sex distribution among the sampled areas. The turtles selected for analysis will be processed immediately.

Processing includes recording sex and other physical metrics (total body weight, age class, carapace length and width). Samples will be euthanized by freezing (Frye, 1994) and a minimum of 48 hours may be required for larger specimens. The specimens will be packaged, and labeled and then held placed on dry ice until shipped. The contract laboratory will remove the carapaces and further process the samples as necessary.

2.2. ANALYTICAL REQUIREMENTS

Table 1 presents a summary of the number of turtle tissue samples to be collected and the corresponding analyses to be undertaken. The minimum volume/mass per sample required to perform all analyses (including laboratory QC) is provided in Table 2. Whole body tissue will be analyzed for the following parameters: SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins and furans including HCX, percent moisture, and percent lipids. PCB congeners will be analyzed for in 8 of the 40 samples. The analytical methods to be used and the desired detection limits are specified in the *Quality Assurance Project Plan* (QAPP) (Battelle, 2001).

3.0 PROCEDURES

3.1. FIELD SAMPLING

1. Working in two-person teams, deploy boat with equipment.

2. Retrieve traps and check for captured animals.

3. Place the turtles captured at each location in a decontaminated 5-gallon polyethylene bucket filled with 2 to 3 inches of river water in the bottom. The lid of each container will be perforated to allow air exchange while the animals are held for processing.

4. After all turtles have been collected from a location, label the bucket lid and side with the location number, date/time, collector's initials, and method of collection.

5. Record a description of the location, date and time, method of collection, name(s) of collector(s), and the number of turtles collected in a field logbook.

6. Mark the exact location that each turtle is collected with a pin flag or flagging, and record it on a map. Return later to record GPS coordinates at each flag point and to sample sediment.

7. Proceed to the next location and collect turtles as above. Return turtles to the central processing area.

8. If turtles are to be held for more than 3 hours, transfer them to coolers fitted with an aerator, and filled with 3 to 6 inches of river water from the same location.

3.2. PROCESSING

3.2.1. Initial Processing

1. Gather and set up equipment for two-person teams. Prepare processing table with clean plastic sheeting. One person records data, while the other processes the turtle.

2. On the data sheet, record the location, date/time of collection, collector's initials, method of collection, and habitat description.

3. Decontaminate two to three pieces of aluminum foil with nitric acid/deionized water/hexane/isopropyl alcohol and air dry.

4. From the first location bucket, remove a turtle while wearing Neoprene gloves and stun it with a sharp blow to the back of head with a decontaminated steel rod. The recommended euthanizing method for turtles is freezing (Frye, 1994) and a minimum of 48 hours or more may be required for large specimens. Sample processors will then tare the scale with the decontaminated aluminum foil, rinse the turtle with deionized water.

5. Weigh the turtle (wet weight including carapace) and record the data to the nearest 0.01g.

6. Measure total carapace length and width and record the data to the nearest 1.0 mm.

7. Identify and record the turtle's age class (juvenile/adult).

8. Identify the sex if possible and record on the data sheet.

9. Inspect the turtle and note any abnormalities or deformities. Record the turtle number on a resealable plastic bag.

3.2.2. Tissue Sample Processing

1. Complete a sample attribute form for each sample to be collected (whole body, duplicate or MS/MSD samples) from the turtle.

2. Label foil with: (1) location, (2) date and time, (3) collector's initials, and (4) weight. The sample should be placed in a resealable plastic bag similarly labeled and immediately placed on dry ice in a cooler.

3. Weigh and label duplicate and MS/MSD samples in the same fashion. These samples should also be labeled either "Duplicate" or "MS/MSD" as appropriate. These samples would require a minimum of 240 g and 360 g tissue mass, respectively.

4. Place it in a resealable plastic bag.

3.2.3. Sample Handling and Shipping

1. When ready to ship, place the samples (wrapped in labeled foil and enclosed in labeled resealable plastic bags) in a large plastic bag into a cooler lined with vermiculite and containing dry ice.

2. Complete a chain-of-custody form listing the contents of each cooler, and place it into a resealable plastic bag. Tape the resealable plastic bag to the inside of the top lid of the cooler, or place it on top of the samples.

3. Seal the cooler with two custody seals, and label the cooler with appropriate shipping labels, including the return address, and laboratory address.

4. Samples will be delivered by courier or overnight delivery to Battelle. Samples should be shipped to:

Attn: Carolynn Suslick
Battelle MSL
1529 Sequim Bay Road
Sequim, WA 98382

Phone: (360) 681-3624

Once received at the laboratory, the samples should be placed in a freezer (<= -20 degrees C) for storage until resection can be performed.

3.2.4. Sample Documentation

All sample documentation will follow project specific SOPs for field sample ID, data sheet, chain-of-custody, and custody seal procedures. Use a field logbook to record the location, date and time, amount of time spent in collecting activities at each area, method of collection, name(s) of collector(s), the number of turtles collected, and any other pertinent information such as problems encountered.

Complete a specimen data sheet for each turtle collected. Specimen data sheets should include: location; date and time of collection; method of collection; collector's initials; total weight, sex, total length, and leg length; and required analyses.

Complete a sample attribute form for each tissue sample. Put the sample number for each sample and the date and processor's initials on the form.

Complete a chain-of-custody form for each cooler of samples shipped to the Battelle laboratory. Provide copies to the task manager, who will retain them in the Harding ESE files.

3.2.5. Decontamination

All sampling equipment will be decontaminated following the project-specific SOP for equipment decontamination including detergent/water wash, potable water rinse, hexane rinse, isopropyl alcohol rinse, and deionized water rinse. All aluminum foil will be hexane rinsed prior to use.

At the conclusion of sampling activities in a given area, aquatic weeds should be removed from boats, boat trailers, and other sampling gear to avoid transport of invasive species between water bodies.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

4.1. DATA QUALITY OBJECTIVES, INDICATORS, AND ASSESSMENT

4.1.1. Data Quality Objectives

The three primary data quality objectives of the turtle collection and tissue analysis were outlined in Subsection 1.2 above. In addition, the turtle program must support and complement applicable data quality objectives established in Subsection 4.1 of the Quality Assurance Project Plan (Battelle, 2001) for the project. To achieve these objectives, the following types of data and specific quality criteria will be required:

- Total Biomass (wet weight) for each specimen: Biomass (wet weight) must be determined accurately in the laboratory following removal of the carapace and recorded to 0.01 g using a calibrated balance of 0.01 g sensitivity.

- Sex for each specimen: Sex should be determined and recorded for each specimen whenever possible. The morphological characteristics that distinguish male and female turtles are obvious to the naked eye; therefore, the use of a low-power microscope or hand lens is not necessary.

- Age class: The age class for each specimen should be determined accurately and recorded whenever possible. Age class will be determined by size and breeding characteristics.

- Total carapace length and width for each specimen: Body length must be determined accurately and recorded to the nearest 0.1 cm (1.0 mm) using a ruler capable of accurately measuring length to 0.1 cm.

- Presence of abnormalities/deformities: Each specimen collected must be examined for gross abnormalities and deformities, including tumors, scars, lesions, or other abnormalities. All observed abnormalities/deformities must be recorded. This morphological examination may be conducted by eye or using a low-power microscope or hand lens.

- Tissue residue concentrations for SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins and furans (including HCX) and PCB congeners: Tissue residue analysis will be conducted on each specimen. Quality control considerations to ensure achievement of DQOs for contaminants will follow in the QAPP (Battelle, 2001).

- Percent moisture and percent lipids: An analysis for percent moisture and percent lipids will be conducted on each tissue sample submitted for tissue residue analysis. Quality control considerations to ensure achievement of DQOs for these parameters will follow in the QAPP (Battelle, 2001).

4.1.2. Data Quality Indicators

Data developed in the turtle study must meet acceptable standards of precision, accuracy, completeness, representativeness, comparability and sensitivity, as defined in Section 15 of the QAPP. Each of these data quality indicators, some of which are not readily quantifiable for the turtle data, is discussed below.

Precision is defined as the level of agreement among repeated independent measurements of the same characteristic. Rather than control and measure precision, the study design includes an increase in the number of samples to obtain sufficient statistical resolution. Precision may also be evaluated by an assessment of the degree to which sample collection procedures are able to ensure collection of consistent sample volumes. For the measurements that are not unique to the turtle study, such as tissue chemistry, precision is evaluated as defined in the QAPP (Battelle, 2001).

Accuracy is defined as the agreement of a measurement with its true value. For the parameters unique to this study (total biomass, carapace length and width, sex determination, and age class determination) accuracy is defined as meaning that each specimen is correctly weighed, correctly measured, and correctly identified. The data generated by this study will be evaluated for accuracy via comparison with known and/or expected results from similar studies conducted in similar biophysical regions. Accuracy is as defined in the QAPP for abiotic parameters, such as sediment contaminants.

Completeness is defined as the percentage of the planned samples actually collected and processed. Completeness can be evaluated for all components of the turtle program. To ensure achieving the planned statistical resolution, it is important that completeness of 100% be achieved for all components of this study.

Representativeness refers to the degree to which the data accurately reflect the characteristics present at the sampling location at the time of sampling. This data quality indicator is addressed through implementation of the sampling design and sample processing methods and will be evaluated via comparison with known and/or expected results.

Comparability is a measure of the confidence with which the turtle data may be compared to another similar data set. Comparability will be evaluated by examination of the intra-site and inter-site (particularly target sites vs. reference sites) variability in key parameters as determined from the group of samples to be collected at each location. Comparability will also be evaluated for this data set through comparison with previous similar turtle studies (if located) and with known characteristics of turtle populations in similar stream systems in the biophysical region.

Sensitivity, the ability of a measurement technique or instrument to operate at a level sufficient to measure the parameter of interest, will be assured for the biological parameters by using scales and measuring devices of appropriate resolution (see sensitivity discussions within each DQO above). The detection limits for chemical analysis specified in the QAPP will provide more than sufficient sensitivity for the purpose of providing insight into factors controlling abundance and distribution of the benthic taxa and populations.

4.1.3. Data Validation, Verification, and Usability

Procedures for data validation for the chemical and physical data are discussed in various sections of the project QAPP and will be used whenever applicable in this study. Usability will be largely be determined by two factors: (1) the experience of the senior investigator in establishing that the field sampling was conducted following the SOP and that accuracy and precision were not compromised by an inability to control the sampling procedures in the field; (2) a direct comparison between the chemistry data and other data developed by the project from similar areas of the river.

The purpose of the remainder of this section of the study plan is to document the measures included in the study to ensure that the standards discussed above are met.

4.2. SAMPLING DESIGN

The rationale for selection of the four locations to be sampled in the turtle study was presented in Subsection 2.1.2 above. The locations are not intended to be representative of the entire river but rather

are intended to encompass the range of sediment contaminant concentrations in the Woonasquatucket River between Allendale Pond and Lymansville Pond where turtle habitat occurs. Two appropriate reference areas were also included to evaluate the potential upstream contribution to the sediment contamination documented for the study area and conditions in a relatively unpolluted reference pond.

Turtle tissue residue concentration data are typically highly variable in nature, and it is necessary to collect adequate numbers of samples to characterize this variability. Ten samples will be collected from each of the two sampling areas within the site as well as at upstream locations at the designated reference location (i.e., Assapumpsett Pond). This number of samples was selected based on the level of resolution would be needed to meet the objectives of this study.

4.3. SAMPLING METHODOLOGY

4.3.1. Sampling Procedures

Sampling methods, as discussed in Subsections 2.1.4 and 3.1, have been selected to ensure that the objectives of the study are met. Note that the stated objectives do not include a characterization of the distribution of turtles in the Woonasquatucket River. As a result, sampling for this study is limited to one species and sampling methodology is biased toward collecting turtles with sufficient mass for tissue analysis. However, detailed information on other turtle species that are observed or trapped will be obtained.

All samples will be collected directly by the highly trained and experienced personnel on this subject to further promote comparability and reduce potential bias through the oversight and use of the professional opinion of the expert. Subsamples for physical and chemical analyses will be collected following procedures documented in the project QAPP, and will therefore be comparable with procedures followed for all other similar samples efforts throughout the Field Investigation.

4.3.2. Quality Control Samples

One laboratory duplicate and MS/MSD sample will be collected every 20 samples for samples large enough to produce two-times and three times the minimum required sample mass (i.e., 120 grams). Laboratory duplicate samples will be collected in Allendale and Lymansville Ponds and MS/MSD samples will be collected in Greystone Mill Pond and Assapumpsett Pond (Table 2).

4.3.3. Sample Processing and Preservation

Detailed procedures for collection and initial processing of all samples to be collected as part of the turtle study are provided in Subsection 3. Decontamination between samples will follow procedures established in the project QAPP (Battelle, 2001). All specimens will be held alive in site water and returned to the field laboratory twice daily. Biological samples will be frozen after processing. The holding time for physical and chemical samples will follow procedures established in the project QAPP.

4.3.4. Training

All sampling will be directed in the field by senior scientists with experience in the collection of turtle samples. Supporting staff will receive training from the senior scientist(s) in the overall goals of the study and in techniques to be followed to ensure collection of quality data.

4.4. SAMPLE ANALYSIS

4.4.1. Biological Samples

The collection of morphometric information and dissection of all samples will be conducted by experienced staff who have received specific training and whose work is checked periodically by their supervisors and peers. Biological samples will be processed following procedures provided in Subsection 3.

4.4.2. Physical/Chemical Samples

Turtle samples collected for tissue chemistry will be processed following procedures and SOPs provided in the project QAPP (Battelle, 2001). These samples will be submitted in catalogs and batches with other samples from the larger project and data validation will be performed on a catalog basis in accordance with procedures established and described in the QAPP.

4.5. DATA ANALYSIS AND REPORTING

The overall analytical approach for data generated under this study is described in Subsection 2.2 above. The findings will be included in the ecological risk assessment including all data, analyses, and interpretations and will be prepared with specific reference to both the data quality objectives specific to the turtle study (Subsection 4.1.1) and Subsection 4.1 of the project QAPP (Battelle, 2001).

5.0 EQUIPMENT LIST

5.1. FIELD

- First aid kit
- 13 medium buckets for collection with lids and holes for ventilation
- 4 all-purpose nylon nets, 12-inch diameter and 5-ft extendable handle
- Indelible markers, duct/labeling tape
- Waders for each field technician
- Life vests
- Oars, anchor, rope for 2 jon boats, trolling motor
- Field logbook

5.2. PROCESSING AREA

- 2 folding tables
- Polyethylene plastic sheets
- 4 boxes of Nitrile gloves

- 4 boxes of gallon-sized resealable plastic bags
- Data sheets
- Pliers, probe, scissors, steel rod
- Knives/scalpels for incision or reproductive examination
- Weighing scale for up to 500 g
- 4 boxes of aluminum foil
- 2 large coolers for freezing samples
- 15 holding coolers, if necessary, with aerators
- Drill for putting hole in side of cooler
- 1 to 2 shipping coolers
- Ice to fill cooler, in plastic resealable plastic bags or free
- Dry ice for shipping
- Gloves for handling dry ice
- Indelible markers (fine and wide)
- Ballpoint pens
- Hexane in rinse bottle
- Nitric acid in rinse bottle
- Isopropyl alcohol in rinse bottle
- Distilled, deionized water in rinse bottle
- Large bucket for decontamination solutions
- Packaging tape
- Laboratory sample labels with unique sample numbers
- QA/QC labels

6.0 REFERENCES

Battelle, 2001. Quality Assurance Project Plan; Centredale Manor Restoration Project Superfund Site Baseline Risk Assessment, Initial Project Planning, and Support (Task 19-22 QAPP – Field Sampling, Chemical, and Toxicity Testing), May.

Frye, F.L., 1994. Reptile Clinician's Handbook: A Compact Clinical and Surgical Reference. Krieger Publishing Company, Malabar, FL.

APPENDIX C

FIELD SAMPLING AND ANALYSIS PLAN FOR FROG COLLECTION AND PROCESSING

APPENDIX C
FIELD SAMPLING AND ANALYSIS PLAN FOR FROG COLLECTION AND PROCESSING

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1. BACKGROUND

Inclusion of frogs, as well as the specific species of frog in the field sampling program will be dependent on additional information concerning human consumption patterns in the area and the results of a frog chorus survey.

Several life history characteristics make the bullfrog *(Rana catesbeiana)* a useful indicator of potential ecological effects of bioaccumulating COPCs in Woonasquatucket River sediments. The bullfrog is an aquatic species favoring permanent bodies of water (DeGraaf and Rudis, 1983; Smith, 1961), including river oxbows (DeGraaf and Rudis, 1983). In addition to being in frequent contact with water and sediment, it hibernates in the mud under water during winter months (Raney, 1940).

The home range of the bullfrog is small. In a study of a New York woodland lake, the average distance traveled in a day during the summer months ranged from 200 to 300 ft (Raney, 1940; Ingram and Raney, 1943). Male bullfrogs defend small territories during breeding season (DeGraaf and Rudis, 1983), which can extend into July in northern states (Smith, 1961). Thus, bullfrogs may act as indicators of localized contamination. In addition, the bulk of the bullfrog diet consists of aquatic insects and crustaceans (Smith, 1961). Bullfrogs are preyed upon by piscivorous birds such as bitterns and herons, by mammals such as raccoon *(Procyon lotor)* and mink *(Mustela vison)*, and by aquatic reptiles such as snakes (Martin et al., 1951). Anecdotal information indicates that frogs in the Woonasquatucket River watershed are harvested for human consumption, posing potential human health risks that may require evaluation.

1.2. OBJECTIVES

The primary objective of this field investigation:

- The whole-body frog tissue concentrations will be determined and used in the fate and effects model and the human health ecological risk assessments.

2.0 STUDY DESIGN

2.1. FIELD SAMPLING DESIGN

2.1.1. Number of Samples

Ten adult bullfrogs samples will be collected from each of four sampling areas (Table 1). The number of bullfrogs sampled per area was determined on the basis of known differences in sediment PCB concentrations between areas within suitable bullfrog habitat.

2.1.2. Sampling Locations

Specific sampling areas will be selected by conducting a field reconnaissance to identify appropriate bullfrog habitat. Within the Centredale Manor study area, bullfrog habitat is expected to exist primarily along pond edge habitat. These areas have a lower water velocity, which allows deposition of

contaminated sediments, as well as growth of submerged and emergent aquatic vegetation favored by bullfrogs. In general, historical data suggests that Allendale Pond sediments have higher bioaccumulating COPC concentrations in sediment than in exposure areas downriver. The selected reference areas are Assapumpsett Pond and Greystone Mill Pond. Low level concentrations of PCB and dioxin/furan analytes have been detected in the upstream sampling location.

2.1.3. Collection Methods

Bullfrog sampling will occur primarily at night. From a boat, a portable spotlight will be shone along the shoreline in order to spot and blind the frogs. Frogs will be netted while blinded. If vegetation is too dense for netting, frogs may be speared using a long-handled gig or fork. Since this method could damage reproductive tissues, or potentially cause cross-contamination with contaminated water or sediment, the gig or fork will be used only if necessary. If the gig or fork method is used, the gig or fork will be decontaminated between captures, and the captured frog will be immediately rinsed with deionized water.

Another method of collecting frogs consists of walking along the edge of the water wearing waders and capturing frogs with a large hand net either on the marsh surface or immediately after they jump in the water. This method is limited to daylight hours for health and safety reasons. As bullfrogs are often more vocal at night, this method will be used only if sufficient numbers of frogs cannot be obtained by spotlighting.

Intensive frog sampling will be conducted during a 1-week period in June (hereafter referred to as the "main sampling period").

Upon capture, bullfrogs will be given an identification number and returned to the central processing area. If possible, additional frogs at each site will be captured, so that the frogs to be retained for analysis will be of similar weight and sex distribution among the sampled areas. The frogs selected for analysis will be processed immediately.

Sample processing includes recording sex and other physical metrics (total body weight, age class, snout vent length, and leg length). Each composite sample will be weighed, packaged, and labeled and then held on dry ice until shipped.

2.2. ANALYTICAL REQUIREMENTS

Table 1 presents a summary of the number of frog tissue samples to be collected and the corresponding analyses to be undertaken. The minimum volume/mass per sample required to perform all analyses (including laboratory QC) is provided in Table 2. Whole body tissue will be analyzed for the following parameters: SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins and furans including HCX, percent moisture, and percent lipids. Twenty percent of each group of samples will be analyzed for the full suite of PCB congeners. The analytical methods to be used and the desired detection limits are specified in the *Quality Assurance Project Plan* (QAPP) (Battelle, 2001). Composite samples from different frogs within each sampling location will be necessary to obtain the required 115 grams/sample required for the selected analyses.

3.0 PROCEDURES

3.1. FIELD SAMPLING

1. Working in two-person teams, deploy boat with equipment.

2. At night a spotlight will be used to spot and blind frogs so they may be captured with a dip net, or if necessary, speared with a gig or fork.

3. Place the frogs captured at each location in a decontaminated 5-gallon polyethylene bucket filled with 2 to 3 inches of river water in the bottom. The lid of each container will be perforated to allow air exchange while the animals are held for processing.

4. After all frogs have been collected from a location, label the bucket lid and side with the location number, date/time, collector's initials, and method of collection.

5. Record a description of the location, date and time, method of collection, name(s) of collector(s), and the number of frogs collected in a field logbook.

6. Mark the exact location that each frog is collected with a pin flag or flagging, and record it on a map. Return later to record GPS coordinates at each flag point and to sample sediment.

7. Proceed to the next location and collect frogs as above. Return frogs to the central processing area.

8. If frogs are to be held for more than 3 hours, transfer them to coolers fitted with an aerator, and filled with 3 to 6 inches of river water from the same location.

3.2. PROCESSING

3.2.1. Initial Processing

1. Gather and set up equipment for two-person teams. Prepare processing table with clean plastic sheeting. One person records data, while the other processes the frog.

2. On the data sheet, record the location, date/time of collection, collector's initials, method of collection, and habitat description.

3. Decontaminate two to three pieces of aluminum foil with nitric acid/deionized water/hexane/isopropyl alcohol and air dry.

4. From the first location bucket, remove a frog while wearing Neoprene gloves and stun it with a sharp blow to the back of head with a decontaminated steel rod. The frog should then be double-pithed to ensure a humane death. This approach is deemed "conditionally acceptable" by the American Veterinary Medical Association Panel on Euthanasia. Sample processors will then tare the scale with the decontaminated aluminum foil, rinse the frog with deionized water, and weigh it.

5. Weigh the frog and record the data to the nearest 0.01g.

6. Measure frog leg length and total length (snout to vent) and record the data to the nearest 1.0 mm.

7. Identify and record the frog's age class (juvenile/adult). Male juveniles are generally less than 85 mm (females 89 mm) in length (Wright and Wright, 1949), and darker gray in color (Smith, 1961).

8. Identify the sex, and record on the data sheet. The following criteria may be used to ascertain sex:

   - Male bullfrogs have a tympanic membrane that is larger than the eye; in females it is as large or smaller than the eye.

   - Male bullfrogs may show stronger mottling near the vent.

   - Male bullfrogs are yellowish below the throat during breeding season, while females are whitish below the throat. This characteristic may not be as useful in June.

   - Males have enlarged thumbpads, which are larger and darker in color than in females.

4. Inspect the frog and note any abnormalities or deformities. Record the frog number on a resealable plastic bag.

3.2.2. Tissue Sample Processing

1. Complete a sample attribute form for each sample to be collected (whole body carcass tissue, duplicate or MS/MSD samples) from the frog.

2. Label foil with: (1) location, (2) date and time, (3) collector's initials, (4) weight, and (5) tissue type. The sample should be placed in a resealable plastic bag similarly labeled and immediately placed on ice in a cooler.

3. Weigh and label duplicate and MS/MSD samples in the same fashion. These samples should also be labeled either "Duplicate" or "MS/MSD" as appropriate. These samples will require a minimum of 240 g and 360 g tissue mass, respectively.

4. Freeze the specimen and place it in a resealable plastic bag.

3.2.3. Sample Handling and Shipping

1. When ready to ship, place the samples (wrapped in labeled foil and enclosed in labeled resealable plastic bags) in a large plastic bag into a cooler lined with vermiculite.

2. Complete a chain-of-custody form listing the contents of each cooler, and place it into a resealable plastic bag. Tape the resealable plastic bag to the inside of the top lid of the cooler, or place it on top of the samples.

3. Seal the cooler with two custody seals, and label the cooler with appropriate shipping labels, including the return address, and laboratory address.

4. Samples will be delivered by courier or overnight delivery to Battelle. Samples should be shipped to:

Attn: Carolynn Suslick
Battelle MSL
1529 Sequim Bay Road
Sequim, WA 98382

Phone: (360) 681-3624

3.2.4. Sample Documentation

Use a field logbook to record the location, date and time, amount of time spent in collecting activities at each area, method of collection, name(s) of collector(s), the number of frogs collected, and any other pertinent information such as problems encountered.

Complete a specimen data sheet for each frog collected. Specimen data sheets should include: location; date and time of collection; method of collection; collector's initials; total weight, sex, total length, and leg length; and analyses.

Complete a sample attribute form for each tissue sample. Put the sample number for each sample and the date and processor's initials on the form.

Complete a chain-of-custody form for each cooler of samples shipped to the Battelle laboratory. Provide copies to the task manager, who will retain them in the Harding ESE files.

3.2.5. Decontamination

All sampling equipment will be decontaminated following the project-specific SOP for equipment decontamination including detergent/water wash, potable water rinse, hexane rinse, isopropyl alcohol rinse, and deionized water rinse. All aluminum foil will be hexane rinsed prior to use.

At the conclusion of sampling activities in a given area, aquatic weeds should be removed from boats, boat trailers, and other sampling gear to avoid transport of invasive species between water bodies.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

4.1. DATA QUALITY OBJECTIVES, INDICATORS, AND ASSESSMENT

4.1.1. Data Quality Objectives

The two primary data quality objectives of the bullfrog collection and tissue analysis were outlined in Subsection 1.2 above. In addition, as part of the larger Supplemental Investigation, the bullfrog program must support and complement applicable data quality objectives established in Subsection 4.1 of the Quality Assurance Project Plan (Battelle, 2001) for the project. To achieve these objectives, the following types of data and specific quality criteria will be required:

- Total Biomass (wet weight) for each specimen: Biomass must be determined accurately and recorded to 0.01 g using a calibrated balance of 0.01 g sensitivity.

- Sex for each specimen: Sex must be determined and recorded for each specimen whenever possible. Sex will be determined by examining the morphological characteristics described in Subsection 3.2.1. The morphological characteristics that distinguish male and female bullfrogs are obvious to the naked eye; therefore, the use of a low-power microscope or hand lens is not necessary.

- Age class: The age class for each specimen must be determined accurately and recorded whenever possible. Age class will be determined by size and breeding characteristics.

- Total body length for each specimen: Body length must be determined accurately and recorded to the nearest 0.1 cm (1.0 mm) using a ruler capable of accurately measuring length to 0.1 cm. Total body length will be measured as snout to vent length for each specimen.

- Leg length for each specimen: Leg length must be determined accurately and recorded to the nearest 0.1 cm using dial calipers capable of accurately measuring length to 1 mm. Leg length will be measured on the right leg. (Note, to assure that the correct leg is measured, orient the frog on its ventral surface, head facing away from investigator.) Leg length will be measured from the top of the knee joint to the bottom of ankle joint.

- Presence of abnormalities/deformities: Each specimen collected must be examined for gross abnormalities and deformities, including tumors, scars, lesions, or other abnormalities. All observed abnormalities/deformities must be recorded. This morphological examination may be conducted by eye or using a low-power microscope or hand lens.

- Tissue residue concentrations for SVOCs, TICs, PCBs/pesticides, metals, methylmercury, dioxins and furans (including HCX) and PCB congeners: Tissue residue analysis will be conducted on each specimen. Quality control considerations to ensure achievement of DQOs for contaminants will follow in the QAPP (Battelle, 2001).

- Percent moisture and percent lipids: An analysis for percent moisture and percent lipids will be conducted on each tissue sample submitted for tissue residue analysis.

4.1.2. Data Quality Indicators

Data developed in the bullfrog study must meet acceptable standards of precision, accuracy, completeness, representativeness, comparability and sensitivity, as defined in Section 15 of the QAPP. Each of these data quality indicators, some of which are not readily quantifiable for the bullfrog data, is discussed below.

Precision is defined as the level of agreement among repeated independent measurements of the same characteristic. Rather than control and measure precision, the study design includes an increase in the number of samples to obtain sufficient statistical resolution. For this study 10 samples per target site and 5 samples per reference site will be collected and processed. Precision may also be evaluated by an

assessment of the degree to which sample collection procedures are able to ensure collection of consistent sample volumes. For the measurements that are not unique to the bullfrog study, such as tissue chemistry, precision is evaluated as defined in the QAPP (Battelle, 2001).

Accuracy is defined as the agreement of a measurement with its true value. For the parameters unique to this study (total biomass, body length, leg length, sex determination, and age class determination) accuracy is defined as meaning that each specimen is correctly weighed, correctly measured, and correctly identified. The data generated by this study will be evaluated for accuracy via comparison with known and/or expected results from similar studies conducted in similar biophysical regions. Accuracy is as defined in the QAPP for abiotic parameters, such as sediment contaminants.

Completeness is defined as the percentage of the planned samples actually collected and processed. Completeness can be evaluated for all components of the bullfrog program. To ensure achieving the planned statistical resolution, it is important that completeness of 100% be achieved for all components of this study.

Representativeness refers to the degree to which the data accurately reflect the characteristics present at the sampling location at the time of sampling. This data quality indicator is addressed through implementation of the sampling design and sample processing methods and will be evaluated via comparison with known and/or expected results.

Comparability is a measure of the confidence with which the bullfrog data may be compared to another similar data set. Comparability will be evaluated by examination of the intra-site and inter-site (particularly target sites vs. reference sites) variability in key parameters as determined from the group of samples to be collected at each location. Comparability will also be evaluated for this data set through comparison with previous similar bullfrog studies (if located) and with known characteristics of bullfrog populations in similar stream systems in the biophysical region.

Sensitivity, the ability of a measurement technique or instrument to operate at a level sufficient to measure the parameter of interest, will be assured for the biological parameters by using scales and measuring devices of appropriate resolution (see sensitivity discussions within each DQO above). The detection limits for chemical analysis specified in the QAPP will provide more than sufficient sensitivity for the purpose of providing insight into factors controlling abundance and distribution of the benthic taxa and populations.

4.1.3. Data Validation, Verification, and Usability

Procedures for data validation for the chemical and physical data are discussed in various sections of the project QAPP and will be used whenever applicable in this study. Usability will be largely be determined by two factors: (1) the experience of the senior investigator in establishing that the field sampling was conducted following the SOP and that accuracy and precision were not compromised by an inability to control the sampling procedures in the field; (2) a direct comparison between the chemistry data and other data developed by the project from similar areas of the river.

The purpose of the remainder of this section of the study plan is to document the measures included in the study to ensure that the standards discussed above are met.

4.2. SAMPLING DESIGN

The rationale for selection of the four locations to be sampled in the bullfrog study was presented in Subsection 2.1.2 above. The locations are not intended to be representative of the entire river but rather are intended to encompass the range of sediment contaminant concentrations in the Woonasquatucket River between Greystone Mill Pond and Lymansville Pond where bullfrog habitat occurs. Two appropriate reference locations with background PCB levels and two "target" sites will be sampled.

Bullfrog tissue residue concentration data are typically highly variable in nature. To achieve acceptable statistical resolution it is necessary to collect large numbers of samples. Data will be collected from 10 locations at each of the target sites as well as at the two reference stations. This number of samples was selected based on the level of resolution would be needed to meet the objectives of this study (see Attachment A).

4.3. SAMPLING METHODOLOGY

4.3.1. Sampling Procedures

Sampling methods, as discussed in Subsections 2.1.4 and 3.1, have been selected to ensure that the objectives of the study are met. Note that the stated objectives do not include a characterization of the distribution of frogs in the Woonasquatucket River. As a result, sampling for this study is limited to one species (bullfrogs) and sampling methodology is biased toward collecting bullfrogs with sufficient mass for tissue analysis.

All samples will be collected directly by the highly trained and experienced personnel on this subject to further promote comparability and reduce potential bias through the oversight and use of the professional opinion of the expert. Subsamples for physical and chemical analyses will be collected following procedures documented in the project QAPP, and will therefore be comparable with procedures followed for all other similar samples efforts throughout the Field Investigation.

4.3.2. Quality Control Samples

One duplicate and MS/MSD sample will be collected every 20 samples for samples large enough to produce two-times and three times the minimum required sample mass (i.e., 120 grams). The results of the analysis of these split samples will be compared for quality control purposes.

4.3.3. Sample Processing and Preservation

Detailed procedures for collection and initial processing of all samples to be collected as part of the bullfrog study are provided in Subsection 3. Decontamination between samples will follow procedures established in the project QAPP (Battelle, 2001). All specimens will be held alive in site water and returned to the field laboratory twice daily. Biological samples will be frozen after processing; sediment samples will be frozen immediately. The holding time for physical and chemical samples will follow procedures established in the project QAPP.

4.3.4. Training

All sampling will be directed in the field by senior scientists with experience in the collection of bullfrog samples. Supporting staff will receive training from the senior scientist(s) in the overall goals of the study and in techniques to be followed to ensure collection of quality data.

4.4. SAMPLE ANALYSIS

4.4.1. Biological Samples

The collection of morphometric information and dissection of all samples will be conducted by experienced staff who have received specific training in the SOP and whose work is checked periodically by their supervisors and peers. Biological samples will be processed following procedures and SOPs provided in Subsection 3.

4.4.2. Physical/Chemical Samples

Samples for tissue chemistry will be processed following procedures and SOPs provided in the project QAPP (Battelle, 2001). These samples will be submitted in catalogs and batches with other samples from the larger project and data validation will be performed on a catalog basis in accordance with procedures established and described in the QAPP.

4.5. DATA ANALYSIS AND REPORTING

The overall analytical approach for data generated under this study is described in Subsection 2.2 above. The findings will be included in the ecological risk assessment including all data, analyses, and interpretations and will be prepared with specific reference to both the data quality objectives specific to the bullfrog study (Subsection 4.1.1) and the project QAPP (Battelle, 2001).

5.0 EQUIPMENT LIST

5.1. FIELD

- First aid kit
- 4 headlamps, 16 AA batteries, extra set of 16 AA batteries
- Spotlights (2) 12-V battery
- 13 medium buckets for collection with lids and holes for ventilation
- 4 all-purpose nylon nets, 12-inch diameter and 5-ft extendable handle
- Indelible markers, duct/labeling tape
- Waders for each field technician
- Life vests
- Oars, anchor, rope for 2 jon boats, trolling motor
- Field logbook

5.2. PROCESSING AREA

- 2 folding tables
- Polyethylene plastic sheets
- 4 boxes of Nitrile gloves

- 4 boxes of gallon-sized resealable plastic bags
- Data sheets
- Pliers, probe, scissors, steel rod
- Knives/scalpels for incision or reproductive examination
- Weighing scale for up to 500 g
- 4 boxes of aluminum foil
- 2 large coolers for freezing samples
- 15 holding coolers, if necessary, with aerators
- Drill for putting hole in side of cooler
- 1 to 2 shipping coolers
- Ice to fill cooler, in plastic resealable plastic bags or free
- Dry ice for shipping
- Gloves for handling dry ice
- Indelible markers (fine and wide)
- Ballpoint pens
- Hexane in rinse bottle
- Nitric acid in rinse bottle
- Isopropyl alcohol in rinse bottle
- Distilled, deionized water in rinse bottle
- Large bucket for decontamination solutions
- Packaging tape
- Laboratory sample labels with unique sample numbers
- QA/QC labels

6.0 REFERENCES

Battelle, 2001. Quality Assurance Project Plan; Centredale Manor Restoration Project Superfund Site Baseline Risk Assessment, Initial Project Planning, and Support (Task 19-22 QAPP – Field Sampling, Chemical, and Toxicity Testing), May.

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APPENDIX D

FIELD SAMPLING AND ANALYSIS PLAN FOR CRAYFISH COLLECTION AND PROCESSING

APPENDIX D
FIELD SAMPLING AND ANALYSIS PLAN
FOR CRAYFISH COLLECTION AND PROCESSING

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1.0 INTRODUCTION

1.1. BACKGROUND

Crayfish, the largest and longest-lived freshwater crustaceans in North America, play an important role in aquatic ecosystems by processing large quantities of organic matter and by feeding directly on carrion (Thorp and Covich, 1991). Crayfish are omnivorous and feed on aquatic vegetation, mollusks, fish, and organic debris (Martin, 1997) and are found in riverine habitat of varying depths (from 1 to 5 ft), substrates (fine sandy silts, organic enriched silts, and gravelly cobbles), and flow regimes (riffles, runs, and pools). Because they eat plants and animals occupying several trophic levels (Thorp and Covich, 1991), they are in a position to potentially bioaccumulate certain contaminants. Crayfish are also prey for large fish, wading birds, frogs, turtles, snakes, raccoons *(Procyon lotor)*, river otters *(Luntra canadensis)*, muskrats *(Ondatra zibethicus)*, and mink *(Mustela vison)* (Martin, 1997).

Because of their life history characteristics, tissue residue bioaccumulating COPC levels of PCBs in crayfish will provide a useful indicator of the potential impacts of on the aquatic food web of the Woonasquatucket River.

1.2. OBJECTIVES

The primary objectives of this study are to:

- Collect crayfish from areas of the Woonasquatucket River representing a range of sediment concentrations of bioaccumulating COPCs for tissue residue analysis.
- Provide data on the bioaccumulation of PCBs, dioxins/furans (including HCX), and organochlorine pesticides in the aquatic food web for fate and effects and exposure models.

2.0 STUDY DESIGN

2.1. FIELD SAMPLING DESIGN

2.1.1. Sampling Locations

A total of four sampling areas will be sampled for this study. Table 5 in the FSP provides a summary of the sampling locations where crayfish tissue will be collected. The selected locations provide a range of concentrations of bioaccumulating compounds in sediment. Alternate (backup) locations are also included in the event that crayfish are not present at the proposed sampling locations. Of the four sampling locations, two sites will be reference locations. Three samples will be collected upstream of the site in Greystone Mill Pond and between Greystone Mill Pond and Route 44, and an additional sample will be collected in the tributary to Assapumpsett Pond (Figure 1). A total of three and four samples will be collected in Allendale and Lymansville Ponds, respectively.

Assuming that each crayfish weighs 10 grams, each sample will consist of a composite of approximately 11-12 individual crayfish (Table 1). An additional crayfish sample will be collected from one sample

location within either Allendale or Lymansville Ponds for duplicate analyses and two additional sample volumes collected from either Assapumpsett Brook or Greystone Mill Pond for the MS/MSD sample analysis.

2.2. ANALYTICAL REQUIREMENTS

2.2.1. Analyses

Each sample will be submitted for analysis of PCBs/pesticides, metals, methylmercury, dioxins and furans (including HCX), PCB congeners, percent lipids, and percent moisture (Table 1). The minimum volume/mass per sample required to perform all analyses (including laboratory QC) is provided in Table 2. In addition, the full suite of PCB congeners will be analyzed in a subset of the samples. Approximately 120 grams of tissue mass are required for the required analyses. The analytical methods and detection limits to be used follow those specified in the *Quality Assurance Project Plan* (QAPP) (Battelle, 2001).

2.2.2. Quality Assurance/Quality Control Samples

One duplicate and MS/MSD sample will be collected every 20 samples for samples large enough to produce two-times and three times the minimum required sample mass (i.e., 120 grams). An additional 240 g of tissue will be required for the MS/MSD analyses, beyond the 120 g required for the original analyses. Thus, the amount of tissue required for original and MS/MSD analyses at a given sampling location is approximately 360 g.

3.0 PROCEDURES

3.1. FIELD SAMPLING

Crayfish will be collected using several methods depending on water depth. In areas where the river is approximately less than 3 feet deep, a seine net or a hand-held net will be used to capture crayfish. In places deeper than 3 feet, baited crayfish traps will be deployed.

3.1.1. Seine Netting, Hand Netting, and Hand Captures

Two-person teams will travel to each sampling location and identify the boundaries of the site using project area maps, which will be marked with survey flagging. Water depths will be reviewed to identify places where there is less than 2 ft of water and seining and hand netting can take place. The seine net will be unfurled and the two-person team will deploy the net in the river, making sure that the bottom of the net skirts the bottom of the river. The sampling area will be systematically fished with the net until the required sample volume is obtained or until no new crayfish are captured. Care will be taken during sampling to minimize habitat disturbance. A similar technique will be used to capture crayfish with the hand-held nets. Captured crayfish will be placed in labeled resealable plastic bags. Bags will be labeled with sampling location, date, time, and collector's initials. Crayfish will be kept in a cooler on wet ice until all locations have been checked and all individuals retrieved. Crayfish will then be transported back to the lab for processing. Repeat visits may be made to each sample area until the required sample volume is obtained.

3.1.2. Trapping

In sample locations where water depth is greater than 3 ft, crayfish will be trapped using wire mesh crayfish traps measuring approximately 18 inches by 12 inches by 8 inches. At each location, three traps will be baited with fish collected from the river within 50 ft of the sampling location. Each trap will be baited with at least 2 ounces of baitfish. The traps will be anchored in the river and marked, and the shoreline at each location will be marked with a flag labeled with the location number. Traps will be deployed during late afternoon hours, and checked daily in morning hours until the sampling objective is achieved, or the decision is made to move the trap due to lack of success. Captured crayfish will be handled as described in Subsection 3.1.1.

3.2. PROCESSING

3.2.1. Initial Processing

Two-person teams will prepare a processing table with clean plastic sheeting and all processing equipment and supplies including aluminum foil rinsed with nitric acid/deionized water/hexane/isopropyl alcohol. Each crayfish will be identified to species and virile crayfish will be kept for processing. Other crayfish will be returned to the site where they were captured, and then released. On the data sheet for each crayfish, the sample location, date and time of collection, initials of collector(s), individual crayfish identification number, identification number, species, sex, weight (g), total length (mm), and carapace length (mm) will be recorded. Length measurements will be collected according to EPA guidance (EPA, 1995). Each individual crayfish will also be inspected for abnormalities or deformities, which will be described on data forms.

3.2.2. Tissue Sample Processing

After morphometric information has been collected for a crayfish, the specimens will be individually wrapped in nitric acid/deionized water/hexane/isopropyl alcohol rinsed aluminum foil. Foil will be labeled with sample identification number, location, date, collector's initials, weight, and tissue type. The foil-wrapped sample will then be placed into a resealable plastic bag, similarly labeled, and then placed immediately on dry ice. Sample attribute forms will be completed for each sample.

3.2.3. Sample Handling and Shipping

Samples will be kept on dry ice while awaiting shipment to the laboratory. When ready to ship, the samples (wrapped in labeled foil and enclosed in labeled resealable plastic bags) will be placed in a large plastic bag and then into a cooler lined with vermiculite. Chain-of-custody forms, listing the contents of each cooler, will be completed and placed into a resealable plastic bag. The resealable plastic bag will be taped to the inside of the top lid of the cooler, or placed on top of the samples. The coolers will be sealed with two custody seals, and labeled with appropriate shipping labels, including the return address, and laboratory address. Samples will be delivered by courier or overnight delivery to the analytical laboratory.

3.2.4. Sample Documentation

Field logbooks will be used to record the location, date and time, collector(s)' names, the number of crayfish collected, and any other pertinent information. Specimen data sheets for each crayfish will be completed to include: location; date and time of collection; method of collection; collector's initials; total weight; sex if known; total length; and analyses. Sample attribute forms will also be completed for each tissue sample, which will include the sample number for each sample and the date and processor's initials on the form. Copies of completed chain-of-custody records for each cooler of samples shipped to the laboratory will be maintained in the Harding ESE project files in Wakefield, MA. Samples should be shipped to:

Attn: Carolynn Suslick
Battelle MSL
1529 Sequim Bay Road
Sequim, WA 98382

Phone: (360) 681-3624

3.2.5. Decontamination

All sampling equipment will be decontaminated following the project-specific SOP for equipment decontamination including detergent/water wash, potable water rinse, hexane rinse, isopropyl alcohol rinse, and deionized water rinse. All aluminum foil will be hexane rinsed prior to use.

At the conclusion of sampling activities in a given area, aquatic weeds should be removed from boats, boat trailers, and other sampling gear to avoid transport of invasive species between water bodies.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

4.1. DATA QUALITY OBJECTIVES, INDICATORS, AND ASSESSMENT

4.1.1. Data Quality Objectives

The two primary data quality objectives of the crayfish programs were outlined in Subsection 1.2 above. In addition, as part of the site investigation, the crayfish program must support and complement applicable data quality objectives established in the Quality Assurance Project Plan (Battelle, 2001) for the project. To achieve these objectives, the following types of data and specific quality criteria will be required:

- Taxonomic identification of crayfish: All collected specimens must be identified to the species level whenever possible using the taxonomic keys for crayfish provided in Smith (1995).

- Biomass (wet weight) for each specimen: Biomass must be determined accurately and recorded to 0.01 g using a calibrated balance capable of accurately measuring weight to .001 g.

- Total body length for each specimen: Body length must be determined accurately and recorded to 1 mm using dial calipers capable of accurately measuring length to 0.1 mm. Body length will be measured from the tip of the rostrum to the end of telson.

- Total carapace length for each specimen: Carapace length must be determined and recorded to 1 mm using dial calipers capable of accurately measuring length to 0.1 mm. The carapace length will be measured from the tip of the rostrum to the end of the cephalothorax.

- Sex for each specimen: Sex must be determined and recorded for each specimen whenever possible. Sex will be determined by examining the morphology of the first pleopod, using a low-power microscope (10X) or hand lens.

- Presence of abnormalities/deformities: Each specimen collected must be examined for gross abnormalities and deformities. This morphological examination will be conducted under a low-power (10X) microscope or hand lens. The morphological examination is limited to determining the presence/absence of gross characteristics (i.e., whether body parts, such as pleopods, are complete, incomplete, or missing). The morphological evaluation will not include a specific examination for tumors and lesions, although these characteristics will be recorded if observed.

- Tissue residue concentrations for bioaccumulating COPCs: Tissue residue analysis will be based on the whole body concentration for crayfish. Quality control considerations to ensure achievement of DQOs for target contaminants will follow the QAPP (Battelle, 2001).

4.1.2. Data Quality Indicators

Data developed in the crayfish study must meet acceptable standards of precision, accuracy, completeness, representativeness, comparability, and sensitivity, as defined in the QAPP (Battelle, 2001). Each of these data quality indicators, some of which are not readily quantifiable for crayfish data, is discussed below.

Precision is defined as the level of agreement among repeated independent measurements of the same characteristic. Rather than control and measure precision, the study design includes a goal for the number of samples to obtain sufficient statistical resolution. Precision may also be evaluated by assessing the degree to which sample collection procedures are consistent among the study sites. For the measurements that are not unique to the crayfish, such as sediment chemistry, precision is evaluated as defined in the QAPP.

Accuracy is defined as the agreement of a measurement with its true value. For the parameters unique to this study (species identification, biomass, total length, and carapace length) accuracy is defined as meaning that all specimens are correctly identified, correctly weighed, and correctly measured. Accuracy of identification is a function of each sample being processed carefully and consistently. The data generated by this study will be evaluated for accuracy via comparison with a results from studies conducted in similar New England systems, if available.

Completeness is defined as the percentage of the planned samples actually collected and processed. Completeness can be evaluated for all components of the crayfish program. To ensure achieving the planned statistical resolution, it would be desirable to achieve 100% completeness. However, other factors such as individual size, scarcity of crayfish in a study area, or analytical budget may preclude achieving the target sample number. A minimum of 8 samples will be considered acceptable for the study.

Representativeness refers to the degree to which the data accurately reflect the characteristics present at the sampling location at the time of sampling. This data quality indicator is addressed through implementation of the sampling design and sample processing methods and will be evaluated via comparison with known and/or expected results.

Comparability is a measure of the confidence with which the crayfish data may be compared to another similar data set. Comparability will be evaluated by examination of the intra-site and inter-site (particularly target sites versus reference sites) variability in key parameters as determined from the replicates to be collected at each location. Comparability will also be evaluated for this data set through comparison with crayfish studies conducted at other sites and with known characteristics of crayfish populations in similar aquatic systems in the biophysical region.

Sensitivity, the ability of a measurement technique or instrument to operate at a level sufficient to measure the parameter of interest, is largely not applicable to the biological parameters. Sensitivity of non-biological parameters is defined in the QAPP (Battelle, 2001).

4.1.3. Data Validation, Verification, and Usability

Procedures for data validation for the chemical and physical data are discussed in various sections of the project QAPP and will be applied whenever applicable in this study. For the biological data, usability will largely be determined by two factors: (1) the experience of the senior investigator in establishing that the field sampling was conducted following the SOP and that accuracy and precision were not compromised by an inability to control the sampling procedures in the field; and (2) a direct comparison between the chemistry data and other data developed by the project from similar areas of the river.

The purpose of the remainder of this section of the study plan is to document the measures included in the study to ensure that the standards discussed above are met.

4.2. SAMPLING DESIGN

The rationale for selection of the four sampling areas in the crayfish study was presented in Subsection 2.1.1 above. The four "target" locations are not intended to be representative of the entire river but rather are intended to assess the impact of the Centredale Manor Site on nearby downstream areas. Two appropriate reference locations believed to be unaffected by the Site will also be sampled.

Crayfish tissue residue concentration data, like other biological parameters, are variable in nature.

4.3. SAMPLING METHODOLOGY

4.3.1. Sampling Procedures

Sampling methods, as discussed in Section 3, have been selected to ensure that the objectives of this study are met. As a result, sampling methods for this study are biased toward collecting larger crayfish (i.e., crayfish with sufficient mass for tissue analyses); however, all crayfish captured will be processed.

All samples will be collected directly by highly trained and experienced personnel to further promote comparability and reduce potential bias through the oversight and the use of the professional opinion of the expert. Subsamples for physical and chemical analyses will be collected following procedures documented in the project QAPP (Battelle, 2001) and will therefore be comparable with procedures followed for all other similar efforts throughout the Field Investigation.

4.3.2. Quality Control Samples

Additional tissue for data duplicate analysis will be conducted for each parameter and a matrix spike/matrix spike duplicate (MS/MSD) sample analysis. Further discussion of duplicate and MS/MSD analyses, including tissue requirements, is presented in Subsection 2.2.2.

4.3.3. Sample Processing and Preservation

Detailed procedures for collection and initial processing of all crayfish samples are provided in Section 3. Decontamination of the processing area between samples will follow procedures established in the project QAPP (Battelle, 2001). All samples will be held on wet ice and returned to the field laboratory twice daily and will be frozen at that time. Holding time for physical and chemical samples will follow procedures established in the project QAPP (Battelle, 2001).

4.3.4. Training

All sampling will be directed in the field by senior scientists with experience in the collection of crayfish samples. Supporting staff will receive training from the senior scientist(s) in the overall goals of the study and in techniques to be followed to ensure collection of quality data.

4.4. SAMPLE ANALYSIS

4.4.1. Biological Samples

The collection of morphometric information for all samples will be conducted by experienced staff who have received specific training in the SOP and whose work is checked periodically by their supervisors and peers. Taxonomy, gross morphology, and sex will be evaluated under low-power (10X) microscope and hand lens; remaining measurements will be made without magnification.

Quality of taxonomic identification will be assured by maintaining voucher collections and requiring a consensus among all taxonomists at the processing laboratory prior to identification becoming accepted as a type for the voucher collection. In the event that the taxonomists are unable to agree on an identification, specimens will be sent to a third-party recognized authority for determination.

4.4.2. Physical/Chemical Samples

Samples for tissue chemistry will be processed following procedures and SOPs provided in the project QAPP (Battelle, 2001). These samples will be submitted in catalogs and batches with other samples from the larger project and data validation will be performed on a catalog basis in accordance with procedures established and described in the QAPP.

4.5. DATA ANALYSIS AND REPORTING

The overall analytical approach for data generated under this study is described in Subsection 2.2 above. The study findings will be included in the ecological risk assessment including all data, analyses, and interpretations and will be prepared with specific reference to both the data quality objectives specific to the crayfish study (Subsection 4.1.1) and the project QAPP (Battelle, 2001).

5.0 EQUIPMENT LIST

5.1. FIELD

- First aid kit
- 18 crayfish traps and anchors for each trap
- Locator flags for traps
- Bait
- Polyethylene plastic sheets for work area at locations
- 2 boxes of Nitrile gloves
- 2 boxes of large gallon-size resealable plastic bags
- Waders, 1 pair per person
- Data sheets for each of 6 locations
- Field logbooks
- 100 ft of ¼-inch nylon rope

5.2. PROCESSING AREA

- Taxonomic keys for crayfish
- 2 folding tables
- Polyethylene plastic sheets
- 4 boxes of Nitrile gloves
- 4 boxes of gallon-sized resealable plastic bags
- Data sheets
- Pliers, probe, scissors, steel rod
- Weighing scale for up to 100 g
- 4 boxes of aluminum foil
- 2 large coolers for freezing samples
- 15 holding coolers, if necessary, with aerators
- Drill for putting hole in side of cooler
- 1 to 2 shipping coolers

- Ice to fill cooler, in plastic resealable plastic bags or free
- Dry ice for shipping
- Gloves for handling dry ice
- Indelible markers (fine and wide)
- Ballpoint pens
- Hexane in rinse bottle
- Nitric acid in rinse bottle
- Isopropyl alcohol in rinse bottle
- Distilled, deionized water in rinse bottle
- Large bucket for decontamination solutions
- Packaging tape
- Laboratory sample labels with unique sample numbers
- QA/QC labels

6.0 REFERENCES

Battelle, 2001. Quality Assurance Project Plan; Centredale Manor Restoration Project Superfund Site Baseline Risk Assessment, Initial Project Planning, and Support (Task 19-22 QAPP – Field Sampling, Chemical, and Toxicity Testing), May.

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Thorp, J.H. and A.P. Covich. 1991. *Ecology and Classification of North American Freshwater Invertebrates.* Academic Press, Inc. San Diego, CA. 911 pp.

APPENDIX E

AQUATIC MACROINVERTEBRATE COLLECTION AND PROCESSING AND COMMUNITY EVALUATION

APPENDIX E
AQUATIC MACROINVERTEBRATE COLLECTION AND PROCESSING AND COMMUNITY EVALUATION

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1.0 INTRODUCTION

1.1. BACKGROUND

The benthic macroinvertebrate community in streams, rivers, and ponds plays a key role in ecosystem functions, such as nutrient cycling and organic matter processing, and is an important food source for instream consumers, as well as for some bird and mammal species. Benthic macroinvertebrates are relatively sedentary organisms that inhabit or depend on bottom sediments or other substrates for their various life functions. Therefore, they are sensitive to both long-term and short-term changes in habitat, sediment, and water quality and, because they spend most of their lives in a single location, can serve as effective indicators of environmental conditions in that location (Davis and Lathrop, 1992).

Benthic macroinvertebrate community structure and function have been used extensively to evaluate the quality of water resources and characterize causes and sources of impacts in lotic (flowing water) and lentic (standing water) freshwater ecosystems. The individual organisms that make up benthic communities respond to both biotic and abiotic environmental variables; therefore, the structure of these communities reflects the integration of the influence of these variables. Biotic variables may include competition, predation, and food availability, whereas abiotic variables may include sediment grain size distribution, temperature, dissolved oxygen, flow characteristics, and pollutants.

Because of the long-recognized importance of benthic community structure in evaluating the health and condition of aquatic habitats, a wide variety of community metrics have been used to capture and represent key community characteristics. Such metrics include species richness, faunal density, evenness, equitability, and diversity. A body of statistical techniques has also been developed to compare these and other metrics across communities. In addition to the normal parametric and non-parametric hypothesis testing tools, there are more subjective techniques that fall under the general headings of classification (cluster analysis) and ordination (factor analysis). Because of the relatively non-motile lifestyle of benthic invertebrates, the tissue residue concentration of contaminants in benthic species is also integrator of levels of chemical contaminants at a particular location. Consumption of contaminated aquatic macroinvertebrates following metamorphosis and adult emergence can be a very significant exposure route for insectivores such as swallows and bat species.

1.2. OBJECTIVES

A focused assessment of the benthic macroinvertebrate community is an important component of the Baseline Ecological Risk Assessment for the Woonasquatucket River. This study has three primary data quality objectives; in addition, all data will also support the DQOs outlined in the Final Quality Assurance Project Plan. The primary objectives of the study are to:

- Evaluate the potential effects of sediment and surface water stressors (particularly VOCs and nutrients), and the Smithfield WWTP effluent on the benthic macroinvertebrate community associated with lotic habitats within the Woonasquatucket River.

- Evaluate the potential effects of sediment contaminants on the abundance and species diversity of adult emerging macroinvertebrates.
- Collect adult macroinvertebrates for tissue analysis to provide one measure of contaminant exposure by tree swallows and other insectivorous wildlife.
- Collect sediment sample to conduct the life cycle toxicity test*using Chironomus tentans* and the 42-day chronic toxicity test using *Hyalella azteca* (see Final Work Plan and detailed specifications presented in the QAPP (Battelle, 2001).

This document provides a detailed discussion of the design for the macroinvertebrate studies and provides background on the rationale for station selection, analysis of biological and chemical samples, and data reduction and presentation.

2.0 STUDY DESIGN

2.1. FIELD SAMPLING

2.1.1. Station Locations

Benthic Macroinvertebrate Community Assessment. Sampling of benthic macroinvertebrates inhabiting lotic habitat will be conducted at 10 locations in the Woonasquatucket River watershed (Figures 4A and 4B). Three reference stations will be established upstream of the Centredale Manor Site, between Route 44 and the Greystone Mill Pond dam. These three locations provide a similar and therefore appropriate habitat unaffected by releases from the Centredale Manor Site to serve as reference areas for riverine habitats associated with the Woonasquatucket River. Two additional reference locations will be established in Assapumpsett Brook. Three investigation locations will be located in the Allendale reach, one above, one adjacent to, and one below the discharge point for VOCs from the Centredale Manor Site. The remaining two sampling locations will be located in the Lymansville reach to evaluate community recovery.

Emerging Macroinvertebrate Community Assessment/Tissue Samples. Five sets of emergence traps will be placed in Allendale Pond, Lymansville Pond, and Greystone Mill Pond to coincide with the swallow population study (Figure 4A and 4B).

Sediment Samples for Laboratory Bioassays. Three sampling locations are located in both Allendale Pond and Lymansville Pond and a single reference sediment will be collected from both Greystone Mill Pond and Assapumpsett Pond (Figures 4A and 4B).

2.1.2. Sampling Site Selection

Benthic Macroinvertebrate Community Assessment. The benthic macroinvertebrate study will focus on suitable riffle/run habitats that are associated with the two primary stressors being evaluated in this study (i.e., VOC-contaminated groundwater in the Woonasquatucket River – Centredale Reach and nutrient enrichment associated with the Smithfield Waste Water Treatment Plant). At each of the 10 locations discussed above, soft bottom sediments will be located by inspection prior to sampling. To the extent practicable in the field, sediment composition and additional habitat characteristics such as flow regime and water depth will be evaluated and

matched to reduce the impact of small-scale variation on differences in benthic community characteristics.

Emerging Macroinvertebrate Community Assessment/Tissue Samples. Sample sites were selected based on a review of historical sediment data exhibiting elevated concentrations of bioaccumulating compounds. Only exposure areas where swallow nest boxes are being deployed in 2001 were included in this study.

Sediment Samples for Laboratory Bioassays. Sediment sampling locations for the laboratory bioassay were selected based on a review of the historical sediment data and exceedances of macroinvertebrate based toxicological benchmarks.

2.1.3. Sampling Procedure

Benthic Macroinvertebrate Community Assessment. The sampling methods described in Barbour et al., 1999 will be followed in each sample reach.

Emerging Macroinvertebrate Community Assessment/Tissue Samples. Emerging aquatic insects will be collected using an approximately 0.5 m diameter funnel emergence trap. The trap will be constructed using a 0.5 m hoop at the bottom and will have a 5-6 cm opening at the top. A 1-liter sample jar will be attached to the top such that the small end of the cone will extend into the jar. As they emerge, aquatic insects will fly upwards through the top opening and become trapped in the sample jar. The sides of the net will be constructed of fine mesh nitex netting. Traps will be tied to PVC pipe that is inserted into the substrate, to anchor the traps in position.

Traps will be cleaned by removing the top of the trap (the jar) and extracting insects using forceps and a suction device (Insect Vac made by Bioquip®). Traps will be cleaned of insects at least every two days during the field study in June 2000 until adequate tissue mass is obtained. Insects will be removed from the traps and chilled until they are processed in the laboratory. A voucher sample of each taxonomic category will be collected, preserved in 70% alcohol, and returned to the laboratory for identification to the lowest practical taxonomic level.

Sediment Samples for Laboratory Bioassays. Sampling procedures presented in Appendix G will be followed at each sampling location.

2.2. TAXONOMY AND BIOMASS DETERMINATION

Preserved macroinvertebrate samples will be sorted in the laboratory using low-power stereoscopic microscopes, and organisms will be identified to Lowest Practical Identification Level (generally genus level, but species identifications will be made when age and condition of the organisms allow) using stereoscopes and compound microscopes as necessary. Species/taxa names and counts will be entered onto laboratory logsheets and subsequently transferred onto electronic spreadsheets for calculation of community summary parameters. All specimens will be appropriately labeled and preserved as a voucher collection.

Biomass (as wet weight) will be measured for each sample of chilled invertebrates in the field prior to sample preparation for subsequent tissue analysis and voucher samples. Biomass will be reported on a catch per unit effort basis.

2.3. DATA REDUCTION AND ANALYSIS

Benthic Macroinvertebrate Community Assessment. Data reduction and analytical procedures are provided in Barbour et al., 1999.

Emerging Macroinvertebrate Community Assessment. The following metrics will be calculated for sampling location:

- Number of individuals (N)
- Total biomass
- Number of species/taxa (S)
- Diversity (Shannon-Wiener H')
- Evenness (Pielou's J')
- Hilsenhoff Biotic Index (HBI) (Hilsenhoff, 1987; Bode, 1988).

Abundance and biomass data will be reported on a catch per unit effort basis. Differences in each of the community parameters among the 10 stations will be tested using techniques presented in Barbour et al., 1999.

Emerging Macroinvertebrate Tissue.Samples. Data reduction and analytical methods are provided in the QAPP (Battelle, 2001).

Analytical Chemistry for Bioassay Sediment Samples. Data reduction and analytical methods are provided in the QAPP (Battelle, 2001).

2.4. DOCUMENTATION

All sample documentation will follow project specific SOPs for field sample ID, data sheet, chain-of-custody, and custody seal procedures.

2.5. DECONTAMINATION

All equipment will be decontaminated following the project-specific SOP for equipment decontamination including detergent/water wash, potable water rinse, hexane rinse, isopropyl alcohol rinse, and deionized water rinse. All aluminum foil will be hexane rinsed prior to use.

At the conclusion of sampling activities in a given area, aquatic weeds should be removed from boats, boat trailers, and other sampling gear to avoid transport of invasive species between water bodies.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

3.1. DATA QUALITY OBJECTIVES, INDICATORS, AND ASSESSMENT

3.1.1. Data Quality Objectives

The primary data quality objectives of the aquatic macroinvertebrate community evaluation are outlined in Subsection 1.2. To achieve these objectives, the following types of data and specific quality criteria will be required:

- Taxonomic identification of aquatic larval, nymphal, or adults organisms to LPIL (lowest practical identification level)—Taxa must be identified to the species level whenever possible. When identification to the species level is not possible, the LPIL will be consistent with standard practice for aquatic taxonomy. Although it is always preferable that each taxon is correctly identified, arriving at the correct name is less important than correctly distinguishing and separating each taxon - community summary parameters such as species richness and diversity are not impacted by incorrect taxonomic names but are affected by inadvertent lumping of taxa. Of equal importance is that the level of taxonomy is consistent for all samples.

- Enumeration (counts) for each taxon within each sampling location —Counts must be made and recorded accurately. Accurate counts are readily achievable in the laboratory - a more important factor in correct enumeration is the collection of consistent volumes in the field sampling effort. Procedures have been established (see Subsection 2.1.4) to ensure that consistent volumes are collected. Care will also be taken in processing samples to ensure that no sample volume is lost.

- Biomass (wet weight, measured in the field, dry weight determined in the analytical laboratory) will be determined for each sample collection (field) and each sample location replicate (laboratory)—Biomass must be determined accurately and recorded to 1 mg (.001 g) using a calibrated balance designed and intended by the manufacturer to be capable of accurately measuring masses of this magnitude. Dry weight biomass estimates will be determined following drying replicate samples to constant weight at 60 degrees C. Accurate determination of biomass is also partly determined by following the field sampling methodologies discussed above.

- Sediment grain size distribution—Quality control considerations to ensure achievement of DQOs for this parameter will follow the QAPP.

3.1.2. Data Quality Indicators

Data developed in the benthic macroinvertebrate study must meet standards of precision, accuracy, completeness, representativeness, comparability and sensitivity, as defined in Section 15 of the QAPP (Battelle, 2001), that are appropriate to the data quality objectives. Each of these data quality indicators, some of which are not readily quantifiable for benthic community data, is discussed below.

Precision is defined as the level of agreement among repeated independent measurements of the same characteristic. Because of the small-scale spatial heterogeneity inherent in benthic communities, it is not possible to take repeated independent measurements of the biological parameters. Rather than control and measure precision, the study design includes an increase in the number of replicates to increase the statistical resolution; for this study the large number of replicates (12) is used in this manner.

Precision may also be evaluated by assessment of the degree to which sample collection procedures are able to ensure collection of consistent sample volumes. For the measurements that are not unique to the benthic macroinvertebrate study, such as sediment chemistry and grain size, precision is evaluated as defined in the QAPP.

Accuracy is defined as the agreement of a measurement with its true value. For the parameters unique to this study (benthic taxonomy and biomass) accuracy is defined as meaning that the taxa are correctly represented and identified in each sample, correctly enumerated, and correctly weighed. Accuracy of sorting and identification are a function of each sample being processed under a microscope rather than by eye, and of consistent field sampling techniques. The data generated by this study will also be evaluated for accuracy via comparison with known and/or expected results from similar studies conducted in the Woonasquatucket River or in similar New England systems. For parameters such as sediment contaminants and sediment grain size, accuracy is as defined in the QAPP.

Completeness is defined as the percentage of the planned samples actually collected and processed. Completeness can be evaluated for all components of the benthic macroinvertebrate program. To ensure achieving the planned statistical resolution, it is important that completeness of 100% be achieved for all components of this study with the exception of the tissue residue analyses. For this latter study component, the number of analyses will be determined by the material available for collection, therefore establishment of an *a priori* completeness goal is not possible (see Subsection 2.1.4).

Representativeness refers to the degree to which the data accurately reflect the characteristics present at the sampling location at the time of sampling. Representativeness for this study is ensured through establishment of an approved through sampling design and through careful implementation of the sample processing and analytical methods. Specific aspects of representativeness will also be evaluated via comparison with known and/or expected results based on previous investigations of the Woonasquatucket River and other similar systems.

Comparability is a measure of the confidence with which the benthic macroinvertebrate data may be compared to another similar data set. Comparability will be evaluated by examination of the in-station variability in key parameters as determined from the large numbers of replicates to be collected at each location. Comparability will also be evaluated for this data set through comparison with previous benthic work in the Woonasquatucket River and with known characteristics of benthic populations in similar stream systems in the Northeast.

Sensitivity, the ability of a measurement technique or instrument to operate at a level sufficient to measure the parameter of interest, is related for benthic invertebrate investigations to the ability of the taxonomic analysis to resolve the various benthic invertebrates into individual species. This data quality indicator will be evaluated by comparing the number of species- specific separations against the number of unresolved larger taxonomic groups. As the number of unresolved groups increase, the community metrics such as species richness and diversity are less able to resolve differences between samples.

3.1.3. Data Validation, Verification, and Usability

Procedures for data validation for the data are discussed in various sections of the project QAPP and will be used whenever applicable in this study. For the biological data, usability will largely be determined by three factors:

(1) The experience of the senior investigator in establishing that the field sampling was conducted following the SOP and that accuracy and precision were not compromised by an inability to control the sampling procedures in the field;

(2) An evaluation of the taxonomic data both within the study and compared with previous studies in the River and in the New England area; and

(3) A direct comparison between the chemistry and grain-size data and similar data developed from co- located samples that have been collected as part of other project components. The purpose of the remainder of this section of the study plan is to document the measures included in the study to ensure that the standards discussed above are met.

3.2. SAMPLING DESIGN

The rationale for selection of the 10 locations to be sampled in the benthic macroinvertebrate study and the 15 locations for collection of emerging adult macroinvertebrates is presented in Subsection 2.1.2. Section 2.1.2 also discusses sample location rationale for the 8 locations where sediment samples will be collected for the laboratory bioassay. The locations are not intended to be representative of the entire river but rather are intended to encompass the range of sediment and surface water stressor concentrations in the Woonasquatucket River.

3.3. SAMPLING METHODOLOGY

3.3.1. Sampling Procedures

Sampling methods, as discussed in Subsection 2.1.4, were chosen to ensure unbiased (i.e., accurate) samples that will facilitate comparisons with other aquatic benthic data, both from the Woonasquatucket River and from other areas. Steps taken to ensure that sampling do not unnecessarily induce bias include: visual inspection of each sample to confirm satisfactory grab penetration, and confirmation of visual similarity of sediment type within a location.

Trained and experienced personnel will collect all samples; senior oversight of all aspects of the sampling and sample processing will further promote comparability and reduce potential bias.

Subsamples for physical and chemical analyses will be collected following procedures documented in the project QAPP and will therefore be comparable with procedures followed for all other similar efforts throughout the Supplemental Investigation.

3.3.2. Quality Control Samples

The nature of aquatic macroinvertebrate sampling does not allow the incorporation of typical duplicate and blank samples as part of the study design. For community metrics, there is no acceptable method of obtaining such samples in a manner analogous to that for duplicates and blanks collected for chemistry analysis. However, it is likely that the collected emerging insect tissue be insufficient to meet these mass requirements in which case the contingency plans identified in Worksheet 9A of the QAPP (Battelle, 2001) will be employed to prioritize analytical parameters. A laboratory duplicate and MS/MSD analysis will be performed sediment samples collected from Lymansville Pond and Assapumpsett Pond, respectively (Table 1).

3.3.3. Sample Processing and Preservation

Detailed procedures for collection and initial processing of all samples to be collected as part of the benthic macroinvertebrate study are provided in Section 4. Subsampling, homogenization, and decontamination between samples will follow procedures established in the QAPP. All samples will be held on wet ice and returned to the field laboratory twice daily and will be preserved at that time. There is no holding time for taxonomic samples.

3.3.4. Training

All sampling will be directed in the field by senior scientists with experience in the collection of aquatic macroinvertebrate samples. Supporting staff will receive training from the senior scientist(s) in the overall goals of the study and in techniques to be followed to ensure collection of quality data.

3.4. SAMPLE ANALYSIS

3.4.1. Benthic Macroinvertebrate Community Assessment

Procedures outlined in Barbour et al., 1999 will be followed.

3.4.2. Emerging Macroinvertebrate Community Assessment

Processing of taxonomy samples will follow procedures established by the subcontractor laboratory. All samples will be processed by experienced staff who have received specific training in the SOP and whose work is checked periodically by their supervisors and peers. Depending on sample volume and other factors, samples will be sorted by eye or under low-power microscopes. Because the possibility of overlooking organisms in the samples processed by microscope is very low, no formal quality control procedures are necessary. For samples processed by eye, 5% of the sample volume will be reviewed by someone other than the original sorter.

Corrective action, including reprocessing of samples and retraining of staff, will be instituted if these QC checks produce unsatisfactory results. Quality of taxonomic identification will be assured by maintaining voucher collections and requiring a consensus among all taxonomists at the processing laboratory prior to an identification becoming accepted as a type for the voucher collection. In the event that the taxonomists are unable to agree on an identification, specimens will be sent to a third party for determination.

3.4.3. Emerging Macroinvertebrate Tissue Analysis

Analysis of composite insect tissue collected from the emergence traps will follow procedures identified in the QAPP (Battelle, 2001).

3.4.4. Sediment Collection for Laboratory Bioassay

Analytical chemistry of the 8 sediment samples collected to support the evaluation of laboratory toxicological results will follow procedures identified in the QAPP (Battelle, 2001).

3.5. DATA ANALYSIS AND REPORTING

The overall analytical approach for data generated under this study is described in Subsection 2.4. The study findings will be included in the ecological risk assessment including all data, analyses, and interpretations, and will be prepared with specific reference to both the data quality objectives specific to the aquatic macroinvertebrate study (see Subsection 2.3.1) and the QAPP.

4.0 PROCEDURES

4.1. FIELD SAMPLING

4.1.1. Benthic Macroinvertebrate Community

Procedures as specified in Barbour et al., (1999) for lotic environments.

4.1.2. Collection of Sediment Bioassay Samples Using the Ponar or Ekman Grab Sampler

See Appendix G for sampling methodology.

5.0 EQUIPMENT LIST

5.1. FIELD

- First aid kit
- 13 medium buckets for collection with lids and holes for ventilation
- 4 all-purpose nylon nets, 12-inch diameter and 5-ft extendable handle
- Indelible markers, duct/labeling tape
- Waders for each field technician

- Life vests
- Oars, anchor, rope for 2 jon boats, trolling motor
- Field logbook

5.2. PROCESSING AREA

- 2 folding tables
- Polyethylene plastic sheets
- 4 boxes of Nitrile gloves
- 4 boxes of gallon-sized resealable plastic bags
- Data sheets
- Pliers, probe, scissors, steel rod
- Weighing scale for up to 500 g
- 4 boxes of aluminum foil
- 1 large cooler for freezing samples
- 1 shipping cooler
- Ice to fill cooler, in plastic resealable plastic bags or free
- Dry ice for shipping
- Gloves for handling dry ice
- Indelible markers (fine and wide)
- Ballpoint pens
- Hexane in rinse bottle
- Nitric acid in rinse bottle
- Isopropyl alcohol in rinse bottle
- Distilled, deionized water in rinse bottle
- Large bucket for decontamination solutions
- Packaging tape
- Laboratory sample labels with unique sample numbers

QA/QC labels

6.0 REFERENCES

Battelle, 2001. Quality Assurance Project Plan; Centredale Manor Restoration Project Superfund Site Baseline Risk Assessment, Initial Project Planning, and Support (Task 19-22 QAPP – Field Sampling, Chemical, and Toxicity Testing), May.

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APPENDIX F

FIELD SAMPLING AND ANALYSIS PLAN FOR SOIL INVERTEBRATE COLLECTION AND PROCESSING

APPENDIX F
FIELD SAMPLING AND ANALYSIS PLAN
FOR SOIL INVERTEBRATECOLLECTION AND PROCESSING

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 BACKGROUND

Soil invertebrates, particularly earthworms, have proven to be useful indicators of the environmental effects of contaminants. Being in nearly constant contact with the soil, soil invertebrates are continually exposed to soil contamination. In addition, they account for the majority of animal biomass in soil, and are preyed upon by a variety of secondary consumers. Thus, soil invertebrates form a pathway by which soil contamination may be passed on to receptors such as short-tailed shrews *(Blarina brevicauda)*, American robin *(Turdus migratorius)*, and American woodcock *(Scolopax minor)* that rely on earthworms for a major portion of their diet.

For the purposes of this Work Plan, soil invertebrates are divided into two separate groups of interest based on their availability to receptors and their degree of exposure to contaminated soils. These two groups consist of: (1) those invertebrates living in the soil itself, as represented by earthworms, and (2) those living primarily in the litter or detritus layer, as represented by adult beetles and other arthropods, hereinafter referred to as litter invertebrates.

Invertebrates will not be sampled from the surface of terrestrial vegetation, since these invertebrates form a relatively small proportion of the diet of American robins and short-tailed shrews. For example, Whittaker and Ferraro (1963) reported that summer short-tailed shrew diets consisted of only 4.3% lepidopteran larvae (found primarily on vegetation), while earthworms, slugs, and snails (found in litter or soil) accounted for over 58.5% of the diet.

Robins may forage on invertebrates in terrestrial vegetation to a larger degree than shrews or woodcock, but these invertebrates are not a dominant item in their diet. For example, Howell (1942) found that lepidopteran larvae accounted for less than 25% of the robin's summer diet based upon stomach content data. In addition, the large proportion of earthworms and similar soft-bodied ground-dwelling invertebrates that robins ingest are likely to be greatly underrepresented in stomach content data because these invertebrates are easily digested (Wheelwright, 1986).

1.2 OBJECTIVES

The principal objectives of this study include:

- Collect representative soil invertebrate samples from floodplain soil/sediment within the study area for analysis of pesticides/PCBs, dioxins/furans, dalapon, metals, PCB congeners, percent lipids, and percent moisture concentrations. Results will be used in the ecological risk assessment to model exposure through the food chain of higher trophic level consumers such as robins, woodcock, and shrews.
- Determine the relationship between earthworm tissue concentrations and corresponding soil concentrations.
- Qualitatively evaluate the relationship between soil fauna community structure and the floodplain soil/sediment contamination.

2.0 STUDY DESIGN

2.1 FIELD SAMPLING DESIGN

2.1.1 Sampling Locations

Soil invertebrates will be collected from four sampling areas, including a reference site with soil and habitat characteristics similar to the contaminated sites. These areas include Greystone Mill Pond, Allendale Pond, Lymansville Pond, and Assapumpsett Pond (Figures 5A and 5B).

All four sampling areas represent suitable habitat for potential ecological receptors (e.g., robins, shrews, woodcock) for which risk will be assessed. Soil chemistry data are also available from these areas, and will be used to select specific collecting locations. In selecting sampling locations for soil invertebrates at each site, particular weight was given to prior analytical results from surficial floodplain soils (0 to 0.5 meters below ground surface [bgs]), since soil invertebrates feeding within this zone are most likely to be preyed upon by the ecological receptors that may be modeled.

2.1.2 Number of Samples

A target goal of 11 earthworm samples is proposed for tissue analysis. Composited earthworm samples (for tissue analysis) and five replicate samples of soil invertebrate fauna (for community analysis) will be collected in each of the four sampling areas.

2.1.3 Collection Methods

2.1.3.1 Field Reconnaissance/Pilot Study

A field reconnaissance and brief pilot study will be conducted prior to sample commencement in order to refine the proposed study design. The primary objectives of the field reconnaissance are to:

- Determine the sampling plot size that will provide sufficient biomass for both earthworm and soil invertebrate community analysis.
- Determine the dominant species of earthworms present in different parts of the study area. (If possible, only the single dominant species of earthworm in the study area will be sampled and analyzed, in order to minimize potential interspecific variation in contaminant uptake or alimentary tract content).
- Evaluate and confirm the usefulness of the different soil invertebrate sampling methods proposed.
- Evaluate plot locations based on existing surface soil contaminant concentrations.

Sample plots will be established within each of the four sampling areas to be compared. A pilot study using an initial plot size of 3 ft^2 by 0.5 ft will be conducted to determine the size of plots required for the collection of sufficient tissue mass for chemical analysis of earthworms. The plot size needed to obtain a minimum of 120 g (wet weight) of earthworm tissue per plot will be determined. Individual plots will be selected on the basis of considerations identified in Subsection 2.1.1.

2.1.3.2 Soil Invertebrate and Soil Sampling

Each plot that is established will be sampled for earthworms according to the following approach. After the plot is delineated with pin flags, soil samples will be collected at five locations in the plot, using a three-inch diameter core sampler to a depth of 4 to 6 inches.

When it is time to sample the plot for earthworms, all surface litter and detritus will be removed. Earthworms will be collected by removing soil from the plot to a depth of approximately 6 inches bgs using a decontaminated shovel, and removing earthworms by hand. If necessary, worms will also be screened from the soil through standard 1/8- to 1/4-inch mesh sieves or through a larger decontaminated screen constructed from 2-inch by 4-inch lumber and 1/4-inch hardware cloth. The earthworm samples will be placed in resealable plastic bags labeled with the sample plot number and transported to a central processing area for processing and taxonomic identification (see Subsection 2.1.4.1).

If sufficient numbers of worms are not located by digging and soil conditions appear suitable, a mustard-based extraction technique may be used (Stair et al., 1995). A mustard/water suspension will be applied to each plot and surfacing earthworms will be collected by hand. The earthworm samples will be placed in resealable plastic bags labeled with the sample plot number and transported to a central processing area for processing and taxonomic identification (see Subsection 2.1.4.1).

Earthworm collection at each plot will continue until at least 120 g (wet weight) of tissue mass is collected, preferably of the same species of earthworm. If sufficient earthworm populations are still not found at a location, the professional judgment of field personnel will be used to determine if sampling at a location should be suspended or if a reduced sample volume will be collected. Additional earthworm samples will be collected from plots for duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples, if possible.

The primary sampling method for litter invertebrates will be hand sampling as necessary. Invertebrates collected from soil samples will be placed in resealable plastic bags labeled with the litter invertebrate sampling plot number and transported to a central processing area. Processing procedures are described in Subsection 2.1.4.

Soil conditions, including soil profile (to 20 inches), conformity to general U.S. Natural Resource Conservation Services [NRCS] mapping units will be described for each sampling plot. Color of each soil horizon will be determined using a Munsell Soil Color Chart and any noticeable odor will be documented. Although hydric soil conditions are often not evident in floodplain soils, hydrological conditions including evidence of soil saturation or standing water; gleyed conditions or soil mottling will also be evaluated.

2.1.4 Invertebrate Field Sample Processing

2.1.4.1 Earthworm Sample Processing

Earthworms will not be depurated prior to processing. Specific processing steps are described in Subsection 3.2.1.

Earthworm processing will consist of:

1. Rinsing the worms with distilled water.

2. Segregating the worms into adult and juvenile age classes.

3. Identifying and segregating the species of the worms.

4. Weighing the worms and recording their individual and combined composite sample weights.

5. Freezing the worms pending shipment to the analytical laboratory.

Each sample will be placed in aluminum foil that has been rinsed with hexane and air dried (dull side toward the sample) and then labeled by plot number. Samples will be frozen in resealable plastic bags at -10 degrees C until they are shipped to the analytical laboratory.

If possible, a single species and size class composite will be submitted for analysis. Efforts will be made to match the composition of any reference samples collected with those collected in contaminated areas. The age and size distribution and species of earthworms collected will be recorded for each composite sample collected.

A representative sample of individuals (i.e., voucher specimens) will also be retained in isopropyl alcohol for subsequent species identification.

2.1.4.2 Soil Invertebrate Community Sample Processing

Invertebrate samples retained for community analysis will be processed as follows. Invertebrates collected from soil samples will be taxonomically identified to order and enumerate. Earthworms collected from these samples will be collected for subsequent tissue analysis. Earthworm samples collected from ensuing weeks will be added to the same bag after taxonomic identification and weighing. Cumulative sample weights will be recorded on sample data sheets; before shipment, the final sample weight will be recorded to ensure sufficient tissue mass is available for analysis. If necessary, the sample may be supplemented with invertebrates collected from the closest sampling plot to form a composite sample.

2.2 ANALYSES

Each composite earthworm and composite soil sample will be submitted to a contract laboratory for analysis of PCBs/pesticides, metals, methylmercury, dioxins/furans (including HCX), percent lipids, and percent moisture. Twenty percent of the samples will also be analyzed for PCB congeners. The floodplain soil/sediment samples will also be analyzed for SVOCs, TOC, and grain size.

The analytical results will be used in the ecological risk assessment to model exposure to higher consumers such as robins, woodcock, and shrews. The results of tissue analyses and co-occurring soil analyses will be used to determine earthworm biological transfer factors.

2.3 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Duplicate analyses will be conducted for each parameter on 5% of the earthworm and soil invertebrate samples. Duplicate samples will be collected from the sample plot location as the original sample; an additional 110 g of tissue will be required for each set of analyses beyond the 110 g required for the original analyses.

A laboratory duplicate and matrix spike/matrix spike duplicate (MS/MSD) sample is required for every 20 samples. Two sample aliquots (i.e., 220 g) will be required for each duplicate sample set and three sample aliquots (i.e., 330 g) will be required for each set of MS/MSD analyses.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

3.1 DATA QUALITY OBJECTIVES, INDICATORS, AND ASSESSMENT

3.1.1 Data Quality Objectives

The two primary data quality objectives of the soil invertebrate evaluation are outlined in Subsection 1.2. To achieve these objectives, the following types of data and specific quality criteria will be required:

- Taxonomic identification of earthworms to LPIL (lowest practical identification level): earthworms must be identified to the species level whenever possible. When identification to the species level is not possible, the LPIL will be consistent with standard practice for invertebrate taxonomy. Of equal importance is that the level of taxonomy is consistent for all samples. Other soil invertebrates will be identified to the level of Order.

- Biomass (wet weight) for each taxon or larger taxonomic group: Biomass must be determined accurately and recorded to 1 mg (.001 g) using a calibrated balance designed and intended by the manufacturer to be capable of accurately measuring masses of this magnitude. Accurate determination of biomass is also partly determined by following the field sampling methodologies discussed above.

- Soil chemistry for selected contaminants: Analysis of soil for chemical constituents must result in data that are consistent in all respects with other sediment/soil contaminant data collected as part of the project. Satisfactory results will be ensured by submitting samples to the same laboratories that are analyzing samples for other components of the program. Quality control specifications for these data are delineated in the QAPP (Battelle, 2001).

- Soil grain size distribution: Quality control considerations to ensure achievement of DQOs for this parameter will follow the QAPP.

- Tissue residue concentrations for PCBs and other contaminants of soil invertebrate samples: Quality control considerations to ensure achievement of DQOs for this parameter will follow the QAPP.

3.1.2 Data Quality Indicators

Data developed in the soil invertebrate study must meet standards of precision, accuracy, completeness, representativeness, comparability and sensitivity, as defined in Section 15 of the QAPP (Battelle, 2001), that are appropriate to the data quality objectives. Each of these data quality indicators, some of which are not readily quantifiable for soil invertebrate data, is discussed below.

Precision is defined as the level of agreement among repeated independent measurements of the same characteristic. Because of the small-scale spatial heterogeneity inherent in soil invertebrate communities, it is not possible to take repeated independent measurements of the biological parameters. Rather than control and measure precision, the study design includes an increase in the number of replicates to increase the statistical resolution; for this study the replicates (5) is used for the soil fauna community analysis in this manner. Precision may also be evaluated by assessment of the degree to which sample collection procedures are able to ensure collection of consistent sample volumes. For the measurements that are not unique to the soil invertebrate study, such as soil chemistry and grain size, precision is evaluated as defined in the QAPP.

Accuracy is defined as the agreement of a measurement with its true value. For the parameters unique to this study (soil invertebrate taxonomy and biomass), accuracy is defined as meaning that the taxa are correctly represented and identified in each sample, and correctly weighed. The data generated by this study will also be evaluated for accuracy via comparison with known and/or expected results from similar studies provided in the literature. For parameters such as soil contaminants and area grain size, accuracy is as defined in the QAPP.

Completeness is defined as the percentage of the planned samples actually collected and processed. Completeness can be evaluated for all components of the soil invertebrate program. To ensure achieving the planned statistical resolution, it is important that completeness of 100% be achieved for all components of this study with the exception of the tissue residue analyses. For this latter study component, the number of analyses will be determined by the material available for collection; therefore, establishment of an *a priori* completeness goal is not possible.

Representativeness refers to the degree to which the data accurately reflect the characteristics present at the sampling location at the time of sampling. Representativeness for this study is ensured through establishment of an approved sampling design and through careful implementation of the sample processing and analytical methods. Specific aspects of representativeness will also be evaluated via comparison with known and/or expected results based on previous investigations of the Centredale Manor area and other similar systems.

Comparability is a measure of the confidence with which the soil invertebrate data may be compared to another similar data set. Comparability will be evaluated by examination of the variability in key parameters as determined from the within sample variability estimate collected at each sample site.

Sensitivity, the ability of a measurement technique or instrument to operate at a level sufficient to measure the parameter of interest, is related for soil invertebrate investigations to the ability of the taxonomic analysis to resolve the various soil invertebrates into individual species and/or orders. Sensitivity is applicable and important for the chemistry parameters that will be analyzed as part of the soil invertebrate study. For these parameters, the detection limits for chemistry and grain-size parameters

specified in the QAPP will provide appropriate sensitivity for the purpose of providing insight into factors controlling abundance and distribution of the soil invertebrate taxa and populations.

3.1.3 Data Validation, Verification, and Usability

Procedures for data validation for the chemical and physical data are discussed in various sections of the project QAPP and will be used whenever applicable in this study. For the biological data, usability will be largely be determined by three factors: (1) the experience of the senior investigator in establishing that the field sampling was conducted following the SOP and that accuracy and precision were not compromised by an inability to control the sampling procedures in the field; (2) an evaluation of the taxonomic data both within the study and compared with information available in the literature; and (3) a direct comparison between the chemistry and grain-size data and similar data developed from co-located samples that have been collected as part of other project components.

The purpose of the remainder of this section of the study plan is to document the measures included in the study to ensure that the standards discussed above are met.

3.2 SAMPLING DESIGN

The rationale for selection of the five locations to be sampled in the soil invertebrate study is presented in Subsection 2.1.1. The locations are not intended to be representative of the entire area but rather are intended to encompass a range of sediment contaminant concentrations typical of the area; one of the locations with near-background contaminant levels will be used as a reference.

Soil invertebrate community data are typically highly variable in nature. To achieve acceptable statistical resolution for earthworms it is necessary to collect replicate numbers of samples from each sampling site. Data will be collected from 5 subsamples at each of 11 sampling locations.

3.3 SAMPLING METHODOLOGY

3.3.1 Sampling Procedures

Sampling methods, as discussed in Subsection 2.1.4, were chosen to ensure unbiased (i.e., accurate) samples that will facilitate comparisons with other soil invertebrate data, both from the Centredale Manor Site and from other areas. Steps taken to ensure that sampling does not unnecessarily induce bias include: visual inspection of each sample to confirm satisfactory collection, and confirmation of visual similarity of soil type within a location. All samples will be collected by trained and experienced personnel; senior oversight of all aspects of the sampling and sample processing will further promote comparability and reduce potential bias. Subsamples for physical and chemical analyses will be collected following procedures documented in the project QAPP (Battelle, 2001) and will therefore be comparable with procedures followed for all other similar efforts in the Site Investigation.

3.3.2 Quality Control Samples

The nature of soil invertebrate sampling does not allow the incorporation of typical duplicate and blank samples as part of the study design. Duplicate and MS/MSD samples for chemistry will collected in this study. Quality control of chemistry analyses will be provided and processed in accordance with the QAPP.

3.3.3 Sample Processing and Preservation

Detailed procedures for collection and initial processing of all samples to be collected as part of the soil invertebrate study are provided in Section 4. Subsampling, homogenization, and decontamination between samples will follow procedures established in the QAPP. All samples will be held on wet ice and returned to the field laboratory daily and will be either refrigerated, frozen (physical, chemical samples), or preserved (taxonomic samples) at that time. Holding time for physical and chemical samples will follow procedures established in the QAPP; there is no holding time for taxonomic samples.

3.3.4 Training

All sampling will be directed in the field by senior scientists with experience in the collection of soil invertebrate samples. Supporting staff will receive training from the senior scientist(s) in the overall goals of the study and in techniques to be followed to ensure collection of quality data.

3.4 SAMPLE ANALYSIS

3.4.1 Taxonomy Samples

Processing of taxonomy samples will follow standard procedures established for both earthworms and other soil invertebrates. All samples will be processed by experienced staff who have received specific training in the SOP and whose work is checked periodically by their supervisors and peers. Depending on sample volume and other factors, samples will be processed by eye or under low-power microscopes.

Quality of taxonomic identification will be ensured by maintaining voucher collections and requiring a consensus among all taxonomists at the processing laboratory prior to an identification becoming accepted as a type for the voucher collection. In the event that the taxonomists are unable to agree on an identification, specimens will be sent to a third party for determination.

3.4.2 Physical/Chemical Samples

Samples for soil grain size, soil chemistry, and tissue chemistry will be processed following procedures and SOPs provided in the QAPP. These samples will be submitted in catalogs (sample delivery groups) and batches with other samples from the larger project and data validation will be performed on a catalog basis in accordance with procedures established and described in the QAPP.

3.5 DATA ANALYSIS AND REPORTING

The overall analytical approach for data generated under this study is described in Subsection 2.4. The study findings will be included in the ecological risk assessment including all data, analyses, and interpretations and will be prepared with specific reference to both the data quality objectives specific to the soil invertebrate study (Subsection 2.3.1, above) and the QAPP (Battelle, 2001).

4.0 PROCEDURES

4.1 FIELD SAMPLING PROCEDURES

Working in two-person teams, identify and mark plot locations using four pin flags (one for each plot corner). The plot area is assumed for planning purposes to be 3 ft^2 by 0.5 ft, but may be adjusted based on the results of the pilot study. Label the flags with a sequential location number, and note the location on a field map and in a bound logbook. Survey the plot location using GPS equipment.

Scrape sufficient leaf litter from the plot area using a decontaminated stainless-steel trowel. Remove five randomly located three inch diameter by four to six inch deep core samples. Each sample will be placed in a labeled sample container, preserved with ten percent formalin, and returned to the laboratory for analysis. The soil sample will be submitted for confirmatory analysis following successful collection of earthworms and other invertebrates from the plot.

If possible, plots should be sampled for earthworms after a heavy precipitation event, when earthworms are closest to the surface. All leaf litter and detritus will be removed from the plot area by hand, while wearing protective gloves. New gloves will be donned before sampling at a new plot to avoid cross contamination of samples. Plots will then be sampled for earthworms. Worms will be removed from the plot by digging to a maximum depth of approximately 0.5 ft with a decontaminated shovel. If sufficient sample mass is not achievable by this method, the soils may be screened using a standard 1/4-inch sieve or equivalent.

An alternative means of sampling earthworms is to apply a mustard/water solution to the ground surface. The solution is prepared by mixing approximately 1 tablespoon of dried mustard to 5 gallons of distilled water. Apply 5 gallons per 1 m 2 of plot area, or until the ground is fully saturated with the solution. Wait until the earthworms surface and collect them from the surface.

Individually rinse each worm with distilled water, using a spray or squeeze bottle. Then place all the worms from the plot into an appropriate precleaned sample container. Label the container with the plot location, the date, time, and collector's initials.

Place the containers in a cooler with ice and transport them to the central processing area.

All sampling equipment will be decontaminated following the project-specific SOP for equipment decontamination, including detergent/water wash, potable water rinse, hexane rinse, isopropyl alcohol rinse, and deionized water rinse.

4.2 SAMPLE PROCESSING PROCEDURES

4.2.1 Earthworm Sample Processing

1. At the central processing area, place earthworms in the refrigerator in their labeled bags until ready to process.

2. Segregate and taxonomically identify earthworm species to determine the dominant species collected within the study area.

3. Once the dominant species is determined, process each container individually. Segregate the species by placing them on decontaminated aluminum foil or paper toweling. Group the largest individuals into a composite sample and weigh the group to ensure that 110 g of tissue are available for analysis. Then weigh each earthworm separately. Record all data on a sample data sheet.

4. Note any external lesions or other abnormalities, such as a "pinched" appearance caused by constriction of the coelom.

5. Place the sample in aluminum foil that has been rinsed with hexane and air-dried (dull side toward the sample), add a label with the sample number, and double bag it using resealable plastic bags. Label the outer bag with the sample number, and place in freezer at -10 °C.

6. Complete a sample attribute form for each sample.

4.2.2 Invertebrate Community Sample Processing

1. At the central processing area, store invertebrates in sampling containers until ready to process.

2. For soil samples from sample plots, pick the invertebrates from the soil litter in each location/container, and segregate live individuals by taxonomic order into decontaminated petri dishes with lids. The lid of the petri dish should be labeled with the sample location number.

3. Taxonomically identify individuals from the soil samples to the level of order, and record the number of individuals per order on a data form for each sample collected. Obtain a wet weight for each order and sample.

4. Wrap samples in decontaminated aluminum foil that has been rinsed with hexane and air dried (dull side toward the sample), and place in resealable plastic bags. Attach a label to each sample indicating the sample number and place in the freezer at -10 °C.

5. Complete a sample attribute form for each sample.

4.2.3 Tissue Sample Handling and Shipping

1. Keep samples in a -10 °C freezer until shipment to the laboratory.

2. When ready to ship, place the samples (wrapped in labeled foil and enclosed in labeled resealable plastic bags) in a large plastic bag into a cooler lined with vermiculite.

3. Complete a chain-of-custody form listing the contents of each cooler, and place it in a resealable plastic bag. Tape the resealable plastic bag to the inside of the top lid of the cooler, or place it on top of the samples.

4. Seal the cooler with two custody seals, and label the cooler with appropriate shipping labels, including the return address, and laboratory address (see below).

5. Samples will be delivered by overnight delivery to Battelle MSL. Earthworm tissue samples should be sent by overnight delivery service (next morning delivery) or hand delivered. Samples should be sent to:

Attn: Carolynn Suslick
Battelle MSL
1529 Sequim Bay Road
Sequim, WA 98382

Phone: (360) 681-3624

4.2.4 Sample Documentation

All sample documentation will follow project-specific SOPs for field sample ID, data sheet, chain-of-custody form, and custody seal procedures.

Use a field logbook to record the location, date and time, amount of time spent in collecting activities at each area, method of collection, name(s) of collector(s), the number of earthworms collected, and any other pertinent information such as problems encountered.

Complete an earthworm specimen data sheet for each location sampled. Specimen data sheets should include location; date and time of collection; method of collection; collector's initials; earthworm species; total weight of earthworm composite sample; and total weight of individual earthworms retained for analysis. Numbers of individuals of other earthworm species collected should also be noted.

An invertebrate community data sheet should also be completed for each location sampled. Data recorded should include the location; date and time of collection; method of collection; collector's initials; species collected and number of each per sample; and weight of the litter invertebrate sample.

Complete a sample attribute form for each tissue sample (earthworm and litter invertebrates). Put the sample number for each sample and the date and processor's initials on the form.

Complete a chain-of-custody form for each cooler of samples shipped to the laboratory. Provide copies to the task manager, who will retain them in the files.

5.0 EQUIPMENT LIST

5.1 FIELD

- First aid kit
- 5-gallon (or equivalent) buckets for litter/detritus collection with lids and holes for ventilation or cheesecloth and rubber bands to secure the cheesecloth to the top of the container
- Plastic buckets (1-gallon or less) for collection of earthworms
- ¼-inch standard soil sieves and/or a 2-ft by 2-ft sieve constructed from hardware, cloth, and 2-inch by 4-inch lumber
- Indelible markers, duct/labeling tape
- Pin flags
- Wooden stakes
- Heavy duty stapler

- Hammer
- Plastic sheeting (or other appropriate material) to use for drift fences
- No. 10 (or similar) cans with covers
- Field logbook
- Rubber gloves
- Resealable plastic bags
- Dry mustard
- Distilled water (5 gallons per 1 m 2 plot) to mix with mustard and pour on sampling plots, if necessary
- GPS receiver
- Wet and dry ice
- Coolers for sample storage and transport
- Soil sampling equipment: stainless-steel trowels, bowls, glassware for soil sample

5.2 PROCESSING AREA

- 2 folding tables
- Polyethylene plastic sheets
- 4 boxes of Nitrile gloves
- 10 boxes of gallon-size resealable plastic bags
- Data sheets
- Four sets of forceps
- 200 plastic petri dishes
- Invertebrate taxonomic keys
- 2 dissecting scopes, each 2X minimum and illuminated
- Weighing scale for up to 100 grams
- 4 boxes of aluminum foil
- 2 large coolers for freezing samples
- 1 to 2 shipping coolers
- Ice to fill cooler, in plastic resealable bags
- Dry ice for shipping
- Gloves for handling dry ice and/or liquid nitrogen
- Indelible markers (fine and wide)
- Ballpoint pens
- Hexane in rinse bottle
- Isopropyl alcohol in rinse bottle
- Distilled, deionized water in rinse bottle
- Large bucket for decontamination solutions
- Packaging tape
- Laboratory sample labels with unique sample numbers
- QA/QC labels

6.0 REFERENCES

Battelle, 2001. Quality Assurance Project Plan; Centredale Manor Restoration Project Superfund Site Baseline Risk Assessment, Initial Project Planning, and Support (Task 19-22 QAPP – Field Sampling, Chemical, and Toxicity Testing), May.

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APPENDIX G

COLLECTION OF SURFACE WATER, AQUATIC SEDIMENT, AND FLOODPLAIN SOIL/SEDIMENT

STANDARD OPERATING PROCEDURES

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Reviewed by:

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Issuing Unit: Harding ESE
SOP No. ND-SWSD-001-00
Date: August 3, 1994

Approved by:

Robin S. Futch, P.G., Technical Director

TITLE: Surface Soil, Surface Water, and Sediment Sampling Procedure

PURPOSE: To establish clear, uniform procedures for surface soil, surface water and sediment sampling that will ensure consistency and quality of samples.

SCOPE: This procedure applies to all surface soil, surface water and sediment sampling activities for laboratory analysis. This procedure is a guideline that must be flexible to accommodate site-specific situations without sacrificing data quality objectives.

REQUIREMENTS: A working knowledge of the sampling equipment to be used is a basic requirement for understanding surface water and sediment sampling procedures.

Familiarity with the environmental regulations of the USEPA and the state in which work is taking place is also required.

Familiarity with the site-specific workplan and health and safety plan (HASP) is required prior to conducting surface water and sediment sampling procedures.

EQUIPMENT: Equipment requirements and specifications for surface water and sediment sampling are as follows:

For Surface Water:

Any equipment used to collect surface water samples is acceptable as long as it does not violate the integrity of the sample and it provides a representative surface water sample.

Actual site-specific conditions and the physical sample location will determine the appropriate equipment required for sample collection. The following list includes several types of equipment typically used for the collection of surface water samples:

- waders (chest-high or waist-high);
- a small boat, raft, or canoe;
- Beta bottle;
- glass beakers or bottles;
- glass or stainless-steel (SS) bucket;
- temperature, specific conductivity, and pH meter;
- personal protective equipment (PPE) as specified in the site-specific HASP;
- appropriate sample containers (from a certified lab) w/ labels and a preservation kit with the appropriate preservatives;
- hard cover field log book, indelible pen, coolers, ice in sealable plastic bags, wide transparent tape, reinforced strapping tape, and chain-of-custody (COC) forms and seals;
- flow meter;
- dissolved oxygen (DO) meter;
- filtration kits;

For Sediment:

Any equipment used to collect sediment samples is acceptable as long as it does not violate the integrity of the sample and it provides a representative sediment sample.

Actual site-specific conditions and the physical sample location will determine the appropriate equipment required for sample collection. The following list includes several types of equipment typically used for the collection of sediment samples:

- Eckman/ponar dredge or grab sampler;
- gravity corer;

- SS Shelby or similar push tubes;
- SS spoons, scoops, or trowels;
- SS hand augers with extensions;
- stainless steel mixing bowls;
- PPE as specified in the site-specific HASP;
- appropriate sample containers (from a certified lab) with labels; and a preservation kit with the appropriate preservatives; and
- hard cover field log book, indelible pen, coolers, ice in sealable plastic bags, wide transparent tape, reinforced strapping tape, and chain of custody papers and seals.

For Surface Soil:

Any equipment used to collect surface soil samples is acceptable as long as it does not violate the integrity of the sample and it provides a representative surface soil sample.

Actual site-specific conditions and the physical sample location will determine the appropriate equipment required for sample collection. The following list includes several types of equipment typically used for the collection of surface soil samples:

- Eckman/ponar dredge or grab sampler;
- gravity corer;
- SS spoons, scoops, or trowels;
- SS hand augers with extensions;
- stainless steel mixing bowls;
- PPE as specified in the site-specific HASP;
- appropriate sample containers (from a certified lab) with labels; and a preservation kit with the appropriate preservatives; and
- hard cover field log book, indelible pen, coolers, ice in sealable plastic bags, wide transparent tape, reinforced strapping tape, and chain of custody papers and seals.

PROCEDURES:

BASIC REQUIREMENTS

Surface water and sediment samples are occasionally taken at the same time to help define the partitioning of contamination between water and sediment. If both water and sediment

are to be collected at a given sample point, the water sample should be collected first. Sample locations are often determined in the field at the time of sampling and should be noted in the field log book.

All sampling equipment must be decontaminated prior to sample collection. During prolonged field events, a designated decontamination area should be set up on site to facilitate repetitive decontamination as required.

SURFACE WATER SAMPLING

The physical location of the sample and site conditions will dictate the type of sampling equipment selected. Several common sampling methods and the corresponding equipment to be used are presented as follows. The appropriate method will be specified in the site-specific sampling and analysis plan (SAP).

Direct Dipping Method

Because of simplicity, when sampling surface water, direct dipping of the sample container into the surface water body is desirable. Steps to follow in using the direct dipping method include:

1. Acquire a small boat or waders. If wading is required always approach the sample location from downstream. Wading may cause bottom deposits to rise and bias the sample and is acceptable only if a current is noticeable.

2. Arrange sample containers in the preferred order of sampling (see Attachment I).

3. Using a small beaker, collect a small water sample and record the temperature, pH, and specific conductivity readings in the field log book.

4. Dip containers such that the top or opening is pointed upstream allowing the sample to be collected directly into the container.

5. Take special care to avoid completely submersing pre-preserved sample containers so that these chemical are not released into the water.

6. Repeat as necessary filling all required sample containers.

7. Preserve sample containers as necessary (see Attachment II).

8. As the sample containers are filled place them in a cooler supplied with ice for packing and shipment.

9. Secure all containers in coolers with adequate bubble wrap and ice so as to maintain a temperature of 4°C during shipment.

10. Complete all required COC and analysis request forms and release samples for shipment.

Beaker and/or Bucket Sampling

Using a large glass beaker or SS bucket to collect surface water samples is similar to direct dipping of sample containers. A stainless-steel bucket can be used in the same manner if the parameters to be analyzed do not preclude it. Steps to be followed include:

1. Acquire a small boat or waders. If wading is required always approach the sample location from downstream. Wading may cause bottom deposits to rise and bias the sample and is acceptable only if a current is noticeable.

2. Arrange sample containers in the preferred order of sampling (see Attachment I).

3. Using a small beaker, collect a small water sample and record the temperature, pH, specific conductivity, and turbidity readings in the field log book.

4. Rinse the beaker/bucket twice with the sample water prior to sample collection.

5. Place the beaker/bucket into the stream to collect sample.

6. Pour sample water into the appropriate prearranged sample containers.

7. Repeat Steps 5 and 6 as necessary filling all required sample containers.

8. Preserve sample containers as necessary (see Attachment II).

9. As the sample containers are filled place them in a cooler supplied with ice for packing and shipment.

10. Secure all containers in coolers with adequate bubble wrap and ice so as to maintain a temperature of 4°C during shipment.

11. Complete all required COC and analysis request forms and release samples for shipment.

SEDIMENT SAMPLING

The physical location of the sample may dictate the type of equipment used. The following outlines several sampling methods and the corresponding equipment to be used. The appropriate method will be specified in the site-specific SAP. To the extent possible, sampling gear will be consistent across sampling locations to standardize depth of penetration into the bottom substrate. Grab samples that are determined to overpenetrate or are less than one half filled will be rejected and the sample collection activity will be repeated.

Eckman/ponar Dredge/Grab Sampler

The Eckman/ponar dredge or grab sampler is a scoop activated by a counter level system. These samplers are only capable of a few centimeters of penetration and the streambed is typically disturbed. The standard Ekman grab sampler has a capacity of 3.5 liters with

dimensions of 150 mm by 150 mm by 150 mm; the Petite Ponar grab sampler has a capacity of 2.4 liters with dimensions of 150 mm by 150 mms.

1. Acquire a small boat or waders. If wading is required always approach the sample location from downstream. Wading may cause bottom deposits to rise and bias the sample and is acceptable only if a current is noticeable.

2. Arrange sample containers in the preferred order of sampling (see Attachment I).

3. Attach required length of nylon cord to the precleaned Eckman/ponar.

4. With jaws open, slowly lower Eckman/ponar through the water to the streambed. Near the bottom take care to minimize bottom disturbances.

5. Upon contact with the bottom release the closing mechanism and allow Eckman/ponar to collect sample.

6. Retrieve Eckman/ponar by pulling it to the surface slowly and allow excess water to drain off.

7. Open Eckman/ponar and place sediment into stainless steel bucket or Pyrex/glass sampling bowl.

8. Composite sample by mixing with a stainless steel spoon and transfer to appropriate sample containers.

9. Repeat Steps 4 through 8 as necessary filling all required sample containers.

10. As the sample containers are filled place them in a cooler supplied with ice for packing and shipment.

11. Secure all containers in coolers with adequate bubble wrap and ice so as to maintain a temperature of 4°C during shipment.

12. Complete all required COC and analysis request forms and release samples for shipment.

Gravity Corer

A gravity corer is a metal tube with a replaceable tapered end on the bottom and a ball or check valve on the top. The ball or valve allows for water to pass through the corer during decent but prevents sludge from washing out during recovery. The use of TeflonÔ sleeves with the corer is an option.

1. Acquire a small boat or waders. If wading is required always approach the sample location from downstream. Wading may cause bottom deposits to rise and bias the sample and is acceptable only if a current is noticeable.

2. Arrange sample containers in the preferred order of sampling (see Attachment I).

3. Attach a precleaned corer to the required length of nylon cord.

4. Secure free end of the line to a stationary support to prevent loss of the sampling device.

5. Allow corer to fall freely through the water to the bottom of the streambed.

6. Allow corer to collect sample and retrieve with a smooth continuous lifting motion.

(If using corer with Teflon sleeves, see Step 7.)

7. Remove tapered end of corer and deposit sample into a precleaned stainless steel bucket or Pyrex/glass sampling bowl.

8. Composite sample by mixing with a stainless steel spoon and transfer to appropriate sample containers.

9. Repeat Steps 5 through 8 as necessary filling all required sample containers.

10. As the sample containers are filled place them in a cooler supplied with ice for packing and shipment.

11. Secure all containers in coolers with adequate bubble wrap and ice so as to maintain a temperature of 4°C during shipment.

12. Complete all required COC and analysis request forms and release samples for shipment.

When using Teflon sleeves with corer:

7A Remove Teflon sleeve from tapered end of corer taking care to minimize sample loss.

8A Cap both ends of the corer sleeve with a Teflon plugs or sheets with rubber stopper.

9A Label the tube with the proper sample ID, site, percent recovery, date, and time.

10A Place the tube in a cooler supplied with ice for packing and shipping.

11A Repeat Steps 5 through 10 for all required analyses.

12A Secure tubes in coolers with adequate bubble wrap and ice so as to maintain a temperature of 4°C during shipment.

13A Complete all required COC and analysis request forms and release samples for shipment.

Direct Push Core

Shelby tubes and most other push tubes commonly consist of Teflon liners in various lengths (1 to 3 feet) and diameters (2 to 4 inches). They can be used as described with the gravity corer and as a stand alone sampling device.

1. Acquire a small boat or waders. If wading is required always approach the sample location from downstream. Wading may cause bottom deposits to rise and bias the sample and is acceptable only if a current is noticeable.

2. Arrange sample containers in the preferred order of sampling (see Attachment I).

3. Place Shelby tube assembly in proper location and drive to desired depth in the sediment using steady hand pressure.

4. Work the tube to loosen the sample twisting, if possible, to shear off the sediment at the base.

5. Carefully pull the tube upward and immediately cap the bottom with a teflon-lined plastic cap.

6. Wipe off the tube walls and rinse with mild Liquinox detergent, or similar to remove excess sediment sticking on the tube.

7. Drain off any excess standing water in the sample tube.

8. Cap the top of the tube with a Teflon-lined cap and tape both ends of the tube as necessary.

9. Label the tube with the proper sample ID, site, length of sample, date, and time.

10. Place the tube in a cooler supplied with ice for packing and shipping.

11. Repeat Steps 3 through 10 for all required analyses.

12. Secure all containers in coolers with adequate bubble wrap and ice so as to maintain a temperature of 4°C during shipment.

13. Complete all required COC and analysis request forms and release samples for shipment.

SHALLOW SOIL SAMPLING

Shallow soil is limited to sampling near the surface. Accurate, representative samples can be collected with this procedure utilizing a shovel, spade or scoop.

1) Carefully remove the top layer of soil to the desired sample depth with a spade or shovel.

2) Using a stainless steel scoop or trowel, collect the desired quantity of soil.

3) Transfer sample into an appropriate sample bottle with a stainless steel lab spoon or equivalent. Check that teflon liner is present in the cap and seal tightly.

4) Label the bottle with the appropriate sample tag, with sampler's initials, date, time, type of sample (grab, composite, etc.), analytical parameter required, site or job I.D., and sampling location I.D. number.

5) Wrap the sample container in bubblewrap and icepacks or equivalent and maintain sample integrity and temperature of 4° C during transportation to the designated laboratory.

6) Complete appropriate documentation including Chain of Custody and analytical request forms.

COMPOSITING OF SOIL AND SEDIMENT SAMPLES –

The key to any statistical sampling plan is the use of the variation within the sample set to test the hypotheses about the population and to determine the reliability of the data set. Compositing provides an excellent estimate of the mean but does not give any information about the variation within the sampling area.

Compositing on Plastic Sheeting -

Compositing can be performed utilizing large plastic sheets in the field. This method works reasonably well for dry materials. If organic chemicals are known to be present, compositing should be performed in a stainless steel bowl. Plastic sheeting, however, is inexpensive and therefore can be discarded after each composite is obtained.

1) Cut plastic to accommodate the volume of material to be composited.
2) Spread plastic out and place samples in the center of the sheet.
3) Separate the heap into four quarters by cutting it pie fashion along two normal diameters. Alternate quarters are retained and the others are laid aside. The pile can be cut with any non-contaminating device such as a clean stainless steel knife or shovel blade.
4) If the remaining quarters are still too large, they may be recombined into a smaller pile and the process repeated
5) The sample is then collected from the remaining pile.
6) Use stainless steel spoon to transfer sample into an appropriate sample container.
7) Check lid for Teflon liner and firmly seal container.
8) Label sample container with appropriate information, including: site identification, sampling location identification, date, time, sampler's initials, and analysis required.

9) Wrap sample container in bubble-wrap or equivalent and place in an appropriate shipping container with ice packs or equivalent to ensure 4° C shipping temperature.

10) Complete appropriate documentation including Chain of Custody and analytical request forms.

Compositing in a Stainless Steel Bowl –

Compositing materials in a stainless steel bowl or equivalent is necessary when organic contaminants are suspected to be present. This procedure can also be performed in the field.

1) Place samples into a precleaned stainless steel bowl.

2) Gently mix materials with a stainless steel spoon or equivalent. Transfer material with stainless steel spoon or equivalent into an appropriate sampling container. Check lid for Teflon liner and firmly seal container.

3) Label sample container with appropriate information, including: site identification, sampling location identification, date, time, sampler's initials, and analysis required.

4) Wrap sample container in bubble-wrap or equivalent and place in an appropriate shipping container with ice packs or equivalent to ensure 4° C shipping temperature.

5) Complete appropriate documentation including Chain of Custody and analytical request forms.

REFERENCES:

Harding ESE, 1993, Comprehensive Quality Assurance Plan.

U.S. Environmental Protection Agency, Region IV, 1991, Standard Operating Procedures and Quality Assurance Manual.

State of Florida Department of Environmental Regulation, 1990, Guidelines for Preparing Quality Assurance Plans.

SOP 010.SSSMP.005.00: Shallow Soil and Sediment Sampling, 1991.

GLOSSARY:

COC: Chain of Custody.

DO: dissolved oxygen.

HASP: Health and Safety Plan. A site-specific HASP is prepared for each Navy CLEAN site. All personnel onsite are required to be familiar with this document.

PPE: personal protection equipment.

SAP: A Sampling and Analysis Plan is generally prepared along with the workplan. The SAP specifies equipment to be used and summarizes the type, frequency, and location of sampling to be accomplished in accordance with the workplan. It is mandatory that all field personnel be familiar with this document.

SS: stainless steel.

SVOC: semivolatile organic compound

USEPA: United States Environmental Protection Agency.

VOC: volatile organic compound.

Workplan: A workplan is prepared for all Harding ESE sites. The work plan summarizes the investigations which will be accomplished and provides guidelines for all aspects of a environmental assessment. It is mandatory that all field personnel be familiar with this document.