REPORT

USACE CHESAPEAKE BAY OYSTER RECOVERY, MD AND VA INITIAL SCREENING OF OYSTER REEFS CONSTRUCTED USING ALTERNATE SUBSTRATE

Prepared for

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February 2012

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LIST OF ABBREVIATIONS, ACRONYMS, AND UNITS

BOF	blast oxygen furnace
ºC	degrees Celsius
CBF	Chesapeake Bay Foundation
COC	Chain of Custody
DGPS	Differential Global Positioning System
DO	Dissolved Oxygen
EA	EA Engineering, Science, and Technology
EPA	Environmental Protection Agency
ºF	degrees Fahrenheit
FSP	Field Sampling Plan
HNO_3	Nitric Acid
in.	inch
L.O.I.	Loss on Ignition
m^2	square meters
mm	millimeter
MDE	Maryland Department of the Environment
MDL	Method Detection Limit
MDNR	Maryland Department of Natural Resources
MG/KG	Micrograms per Kilogram
mg/L	Milligrams per Liter
ORP	Oyster Recovery Partnership
ppm	parts per million
PVC	Polyvinyl chloride
QC	Quality Control
RL	Reporting Limit
TAL	Target analyte list
TAT	Turn-around-time
ug/L	Micrograms per Liter
USACE	United States Army Corps of Engineers
WQC	Water Quality Criteria
YSI	Yellow Springs Instruments

EXECUTIVE SUMMARY

The United States Army Corps of Engineers – Baltimore District (USACE-Baltimore) and its non-federal sponsor, Maryland Department of Natural Resources (MDNR) are permitted to construct oyster reef habitat using alternate substrates. Reefs have been constructed in two tributaries in the Maryland section of the Chesapeake Bay using alternative substrates. Multiple reefs were constructed in Mill Hill by MDNR and 13.4 acres of oyster reef habitat were constructed by the USACE in the Severn River. This project investigated eight Mill Hill sites and six separate Severn River sites.

The eight Mill Hill sites consisted of the following substrate planting combinations:

- MH-1: 6 in. (thickness of planting or depth) shell (3 in. fines and 3 in. shell)
- MH-2: 3in. shell on a 6 in. slag base
- MH-3: 3 in. shell on a 6 in. stone base
- MH-4: 3 in. shell on a 6 in. concrete rubble base
- MH-5: 6 in. recycled concrete
- MH-6: 6 in. slag
- MH-7: 6 in. stone
- MH-8: Oyster shell reference site

The six Severn River sites consisted of the following substrate planting combinations:

- Wade 2-2: concrete, stone, and slag
- Wade 2-3: slag
- Wade 2-4: concrete
- Wade 2-5: stone
- Weems Upper: stone with oyster shell veneer
- Weems Creek Upper: recovered oyster shell (reference site)

EA Engineering, Science, and Technology, Inc. (EA) was contracted by the USACE-Baltimore District to perform metals analysis and an initial screening of oysters growing on various alternate substrates and reef habitats.

The objectives of this study were to perform an initial screening of the oyster reefs and describe their present state; characterize the composition of the steel slag in comparison to its initial composition (assumed to be that of Grubb et al. 2010); perform a qualitative survey of the habitat and ecological community on the reefs; collect specific oyster, water quality, and sediment data at each site; and quantify metal concentrations in oyster tissues, sediments, and water.

Initial slag and water chemical surveys were performed in December 2010 (Mill Hill) and March 2011 (Severn River). Steel slag was sampled from five points in each planting, totaling about 1 pound of slag per site, at MH-2 and MH-6 (Mill Hill) and Wade 2-3 (Severn River). Water samples for metal concentration analysis were collected at the same time.

Oyster reef screening was performed in September 2011 (Mill Hill) and October 2011 (Severn River). At each planting site divers collected all accessible live oysters and provided them to onboard crew for individual size measurements, weighing, and counting of living and box

oysters. From each site divers and the onboard crew collected as close to 200 grams of wet oyster tissue as possible, site water from approximately 6 to 12 inches above the center of each planting, and a five-point composite sediment sample. Visual inspection by divers was performed at each site.

Oyster tissue samples, water samples, and sediment samples were submitted to Test America for Target Analyte List (TAL) analysis. The TAL analysis included the following analytes: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, and cyanide. A total of 40 oyster tissue samples (5 per site), 9 water samples (1 per site and a field blank), and 8 sediment samples (1 per site) were collected from the Mill Hill sites for TAL analysis. A total of 30 oyster tissue samples (5 per site), 7 water samples (1 per site and a field blank), and 6 sediment samples (1 per site) were collected from the Severn River sites for TAL analysis.

To investigate the reef communities at the Severn River, sampling trays were deployed in the following four Severn River sites: Wade 2-3, Wade 2-4, Wade 2-5, and WU. Trays were deployed in May 2011 and collected in September 2011. Upon collection of trays, organisms from each tray were identified and counted.

Metal concentrations from MH-6 and Wade 2-3 were comparable to those of Grubb et al. 2010. Metal concentrations from MH-2 were lower than those of Grubb et al. 2010.

At Mill Hill dissolved oxygen (DO) averaged 7.90 mg/L, salinity 7.90 ppm, pH 8.43, and temperature 21.98 °C. At the Severn River sites DO averaged 7.74 mg/L, salinity 4.78 ppm, and temperature 18.07 °C. The pH meter was malfunctioning and measurements are not available for the Severn River sites.

Oysters collected in all Mill Hill sites ranged from 70.82 mm to 137 mm individual length, and average oyster length per site ranged from 73.43 mm to 98.32 mm. Oyster box to live ratio ranged from 2 box: 1 live to 1 box: 5 live. Blue crabs, mud crabs, anemones, and jelly fish were present in several Mill Hill sites. Fish, mainly gobies, were present in three Mill Hill sites (MH-4, MH-5, and MH7). One Mill Hill site had extensive mussel coverage (MH-6).

Oysters collected in Severn River sites were clumped and smaller than 3 inches, thus individual measurements were not possible. The number of oysters collected in Severn River sites ranged from 167 to 200. Blue crabs were present in two Severn River sites (Wade 2-2 and Wade 2-3). Two Severn River sites had low visibility (Wade 2-4 and Wade 2-5), and two sites had sedimentation present in the substrate (Weems Creek Upper and Wade 2-4).

Ribbed mussels and mud crabs were among the most common organisms found in the trays recovered from the Severn River plantings. Gobies were the most abundant fish collected in all trays. Other commonly found organisms included grass shrimp, barnacles, marine worms, and false dark mussels. The trays in Wade 2-4 had the highest number of benthic organisms, the highest oyster abundance, and the highest fish abundance among all the sites.

1.0 PROJECT OVERVIEW

The United States Army Corps of Engineers – Baltimore District (USACE-Baltimore) and its non-federal sponsor, Maryland Department of Natural Resources (MDNR) are permitted to construct oyster reef habitat using alternate substrates. Reefs have been constructed in two tributaries in the Maryland section of the Chesapeake Bay using alternative substrates, multiple reefs at Mill Hill in Eastern Bay in 2002 (Figure 1-1) and the Severn River in 2009 (Figure 1-2). The reefs in Mill Hill were constructed by MDNR. In 2009, USACE constructed 13.4 acres of oyster reef habitat in the Severn River between the U.S. 50 and Route 450 bridges using oyster shell, stone, concrete, and steel slag on four reefs: Wade, Weems Upper, Traces Hollow, and Peach Orchard (Figure 1-2). The Mill Hill sites and four separate Severn River plantings [Wade, the planting at Weems Upper, and a Chesapeake Bay Foundation (CBF)] planting were investigated by this project.

The composition of the weathered slag in the Severn River and Mill Hill plantings were evaluated to determine if exposure to the estuarine environment has an effect on the metals content of the planted slag. X-ray fluorescence (XRF) was used to determine the bulk composition of the slag. XRF were performed in the laboratory on a composite sample that was collected, pulverized, and homogenized from a five-point sample within each of the reefs restored using slag.

The steel slag placed in the Severn River was produced at the Severstal Steel Mill, operated by Phoenix Services, at Sparrows Point in Baltimore, MD. It is also believed that the material placed at Mill Hill in 2002 would have been from Sparrows Point as this is the regional source of steel slag. According to communications with Phoenix Services, it is reasonable to assume that the composition of the steel slag produced at the facility has not changed since the Mill Hill planting in 2002. Therefore, the bulk composition of steel slag published by Grubb et al. (2010) represents the original composition of the slag prior to placement and was used to compare the composition of the weathered slag at both sites. Analyses were performed so that results can be compared with those presented in Grubb et al. (2010).

In 2002, Maryland Department of Natural Resources (MDNR) constructed seven substrate plantings at the Mill Hill sanctuary using the combinations of substrate shown below:

- 6 in. (thickness of planting or depth) shell (3 in. fines and 3 in. shell)
- 3in. shell on a 6 in. slag base
- 3 in. shell on a 6 in. stone base
- 3 in. shell on a 6 in. concrete rubble base
- 6 in. recycled concrete
- 6 in. slag
- 6 in. stone

Figure 1-1 provides a map of the Mill Hill Sanctuary and various oyster plantings that have been completed since 2000. This site was monitored in 2003 by MDNR for growth, density, oyster mortality, spat-set, and disease. Concrete (32 oysters/m^2) and slag (44 oysters/m^2) attracted more larvae, or at least resulted in more spat surviving on it, than stone, shell, concrete with shell, reef balls, slag with shell, or stone with shell (<1 to 15 oysters/m^2).MDNR Fall Survey data shows

continued presence of oysters on the Mill Hill Sanctuary (adjacent areas to the alternate substrate plantings, but within the Mill Hill Sanctuary).

EA Engineering, Science, and Technology, Inc. (EA) was contracted by the USACE-Baltimore District to perform metals analysis and an initial screening of oysters growing on various alternate substrates and reef habitats.

1.1 PROJECT PURPOSE AND OBJECTIVES

The purpose of this project was to conduct initial screening of oyster reefs restored using alternate substrates. The initial contaminant screening focused on further characterizing the steel slag used to construct oyster reefs and characterizing the oysters growing on the reefs.

Specific objectives of the initial screening study were to:

- Perform an initial screening of oyster reefs constructed of alternate substrates to include a description of their present state and obtain a sample of the substrate;
- Characterize the composition of steel slag exposed to the estuarine environment;
- Perform a qualitative survey of the habitat and ecological community that has developed at the restored sites at Mill Hill and a semi-quantitative screening at the Severn River sites;
- Collect specific data at each site including oyster size, oyster and spat density, oyster mortality, water quality, water depth of each reef, and videography and photography of each reef, and
- Quantify concentrations of metals in oyster tissue.

1.2 PROJECT LOCATION

Distinct plantings have been constructed in two tributaries of the Chesapeake Bay; seven distinct plantings were constructed at Mill Hill in Eastern Bay near Kent Island, Maryland (Figure 1-1), and eleven distinct plantings were constructed in the Severn River near Annapolis, Maryland, between the Route 50 and Route 450 bridges (Figure 1-2). For the initial screening, seven locations plus an oyster shell reef (a total of eight locations) were sampled at Mill Hill and five of the plantings plus an oyster shell reef (a total of six locations) were sampled in the Severn River. Table 1-1 lists the site location coordinates, site ID, and substrate types for the Mill Hill site and Table 1-2 lists the site location coordinates, site ID, and substrate types for the Severn River site.

1.3 ANALYTICAL TESTING

Target analytes, target detection limits, and methodologies were in accordance with U.S. Environmental Protection Agency (EPA) guidance (2000) and Maryland Department of the Environment (MDE) standard operating procedures (2009). Analytical testing was conducted by

TestAmerica Pittsburgh and testing of steel slag samples was conducted by CTLGroup Laboratories. The list of target analytes, target detection limits, methodologies, and sample holding times are derived from the following guidance documents:

- Maryland Department of the Environment (MDE). 2009. *Standard Operating Procedures for Fish and Shellfish Collection and Analysis.* Draft.

- U.S. Environmental Protection Agency (EPA). 2000. *National Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis.* Third Edition. Office of Water. EPA 823-B-00-007.

The Target Analyte List (TAL) analysis for oyster tissue included the following analytes: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, and cyanide.

Steel slag samples were analyzed using XRF to determine bulk composition of the slag.

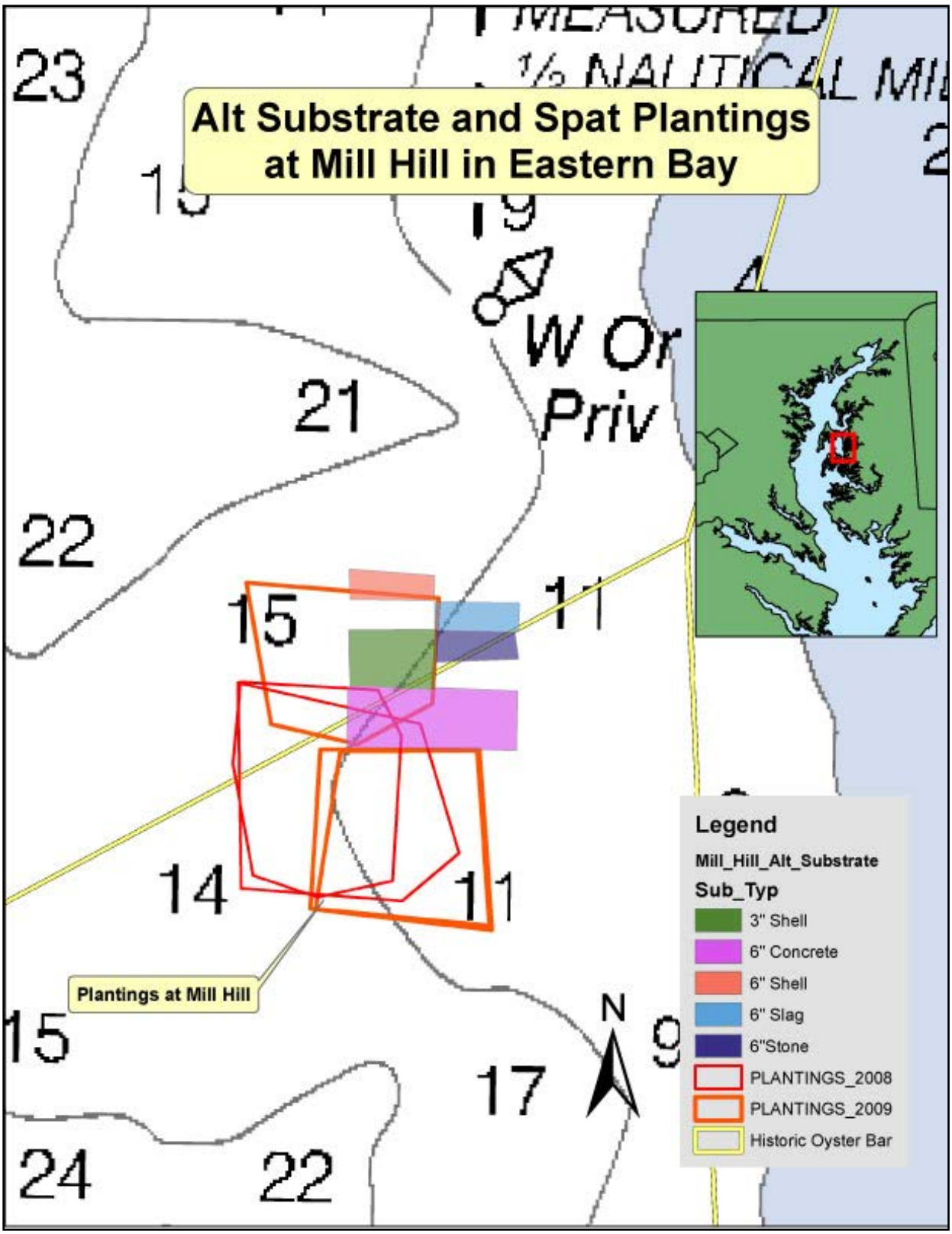

Figure 1-1. Oyster Reefs Located at Mill Hill, Eastern Bay, Maryland

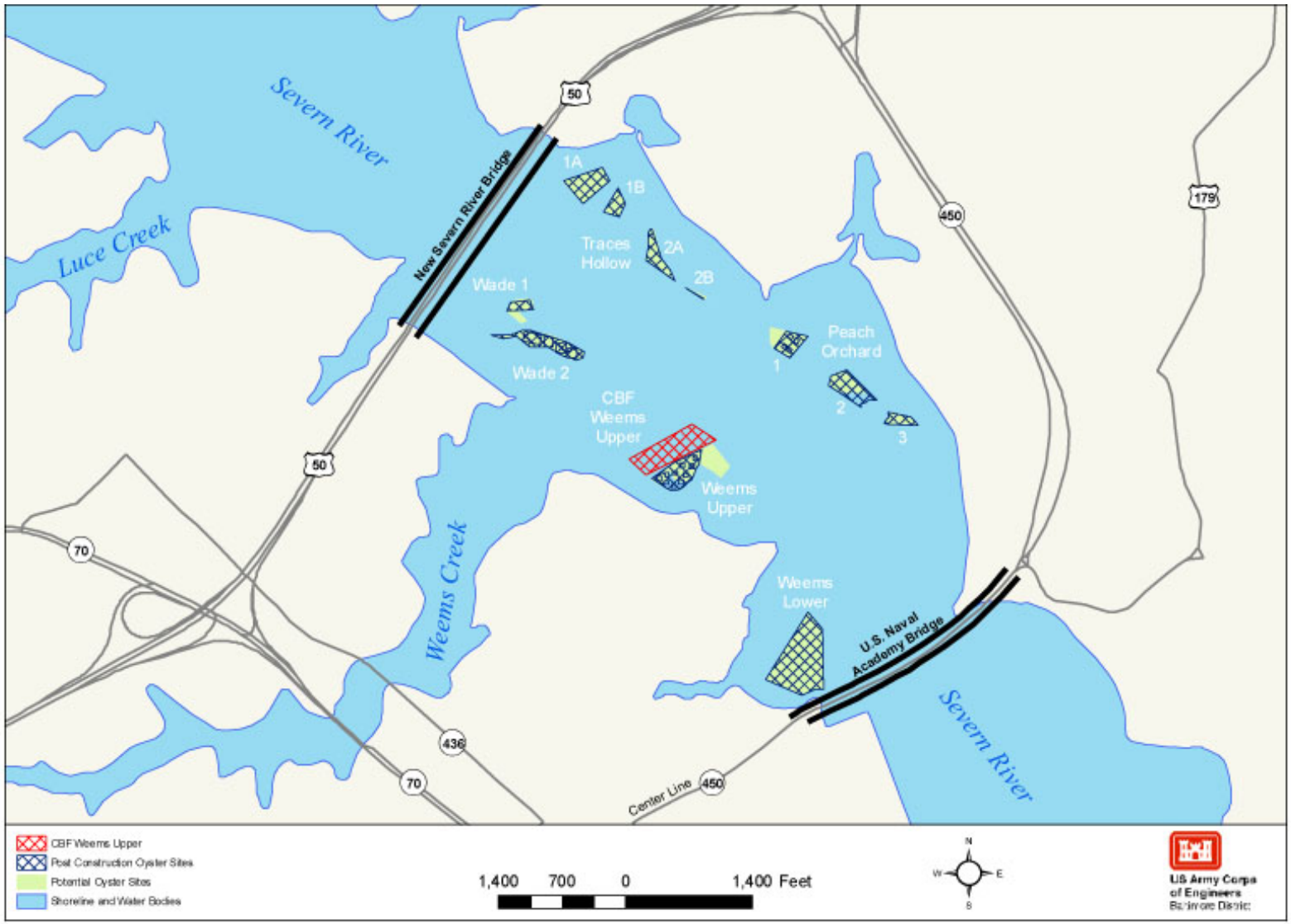

Figure 1-2. Oyster Reefs Located in Severn River, Maryland

TABLE 1-1. SAMPLE LOCATIONS AT MILL HILL

Location ID	Substrate	Size (acres)	Planting Number	Latitude	Longitude
MH-1	6" oyster shell (3"fines, 3"shell)	1	1	38^{0}54.520’	76^{0}13.000’
			2	38^0 54.518’	76^{0}12.924’
			3	38^{0}54.499’	76^{0}13.001’
			4	38^{0}54.499’	76^{0}12.925’
MH-2	3"shell with 6” slag base	1	1	38^{0}54.499’	76^{0}13.001’
			2	38^{0}54.499’	76^{0}12.925’
			3	38^{0}54.478’	76^{0}13.001’
			4	38^{0}54.479’	76^{0}12.923’
MH-3	3"shell with 6” stone base	1	1	38^{0}54.478’	76^{0}13.001’
			2	38^{0}54.479’	76^{0}12.923’
			3	38^{0}54.458’	76^{0}13.001’
			4	38^{0}54.458’	76^{0}12.923’
MH-4	3"shell with 6” concrete rubble base	1	1	38^{0}54.458’	76^{0}13.001’
			2	38^{0}54.458’	76^{0}12.923’
			3	38^{0}54.439’	76^{0}12.999’
			4	38^{0}54.438’	76^{0}12.924’
MH-5	6"recycled concrete	4.5	1	38^{0}54.438’	76^{0}13.001’
			2	38^{0}54.438’	76^{0}12.924’
			3	38^{0}54.438’	76^{0}12.849’
			4	38^{0}54.395’	76^{0}13.002’
			5	38^{0}54.395’	76^{0}12.924’
			6	38^{0}54.394’	76^{0}12.848’
MH-6	6" slag	1	1	38^{0}54.498’	76^{0}12.924’
			2	38^{0}54.498’	76^{0}12.847’
			3	38^{0}54.479’	76^{0}12.924’
			4	38^{0}54.479’	76^{0}12.848’
MH-7	6" stone	1	1	38^{0}54.479’	76^{0}12.929’
			2	38^{0}54.479’	76^{0}12.851’
			3	38^{0}54.457’	76^{0}12.923’
			4	38^{0}54.459’	76^{0}12.846’
MH-8	Oyster shell (reference)				

TABLE 1-2. SAMPLE LOCATIONS IN SEVERN RIVER

Location ID	Reef Name	Substrate	Size (acres)	Planting Number	Latitude	Longitude
W2-2	Wade 2-2	concrete, stone, and slag	0.5	1	39^{0}0.162181’	76^{0}30.092999’
				2	39^{0}0.179640’	76^{0}30.087240’
				3	39^{0}0.187680’	76^{0}30.127439’
				4	39^{0}0.157680’	76^{0}30.083399’
				5	39^{0}0.157919’	76^{0}30.061859’
W2-3	Wade 2-3	slag	0.25	1	39^{0}0.175980’	76^{0}30.062221’
				2	39^{0}0.176644’	76^{0}30.083836’
				3	39^{0}0.165361’	76^{0}30.054899’
				4	39^{0}0.147300’	76^{0}30.054540’
				5	39^{0}0.147600’	76^{0}30.033000’
W2-4	Wade 2-4	concrete	0.25	1	39^{0}0.165660’	76^{0}30.033420’
				2	39^{0}0.136920’	76^{0}30.028020’
				3	39^{0}0.154981’	76^{0}30.028379’
				4	39^{0}0.155281’	76^{0}30.006839’
				5	39^{0}0.137220’	76^{0}30.006480’
W2-5	Wade 2-5	stone	0.25	1	39^{0}0.136920’	76^{0}30.028020’
				2	39^{0}0.163800’	76^{0}29.556481’
				3	39^{0}0.191280’	76^{0}29.557320’
				4	39^{0}0.174540’	76^{0}29.470140’
				5	39^{0}0.135121’	76^{0}29.512319’
				6	39^{0}0.163800’	76^{0}29.556481’
WU	Weems Upper	stone with oyster shell veneer	2.7	1	38^{0}59.916766’	76^{0}29.835171’
				2	38^{0}59.945521’	76^{0}29.782680’
				3	38^{0}59.968857’	76^{0}29.718556’
				4	38^{0}59.943487’	76^{0}29.724225’
				5	38^{0}59.936220’	76^{0}29.730780’
				6	38^{0}59.915940’	76^{0}29.741220’
				7	38^{0}59.911440’	76^{0}29.749319’
				8	38^{0}59.902602’	76^{0}29.760893’
				9	38^{0}59.897442’	76^{0}29.769779’
				10	38^{0}59.894440’	76^{0}29.779831’
				11	38^{0}59.895269’	76^{0}29.790290’
				12	38^{0}59.899084’	76^{0}29.800857’
				13	38^{0}59.916766’	76^{0}29.835171’
WCU	Weem's Creek Upper	recovered oyster shell	5	1	39^{0}0.016000’	76^{0}29.740000’
				2	38^{0}59.986000’	76^{0}29.685000’
				3	38^{0}59.923000’	76^{0}29.847000’
				4	38^{0}59.951000’	76^{0}29.888000’

2.0 PROJECT ORGANIZATION AND PERSONNEL

The project team was organized to provide professional expertise in each of the major components necessary for the completion of the project. A project team organization chart and the project team contact information are provided in Figure 2-1.

The Field Team consisted of personnel from University of Maryland and a representative of EA Engineering, Science, and Technology, Inc. The University of Maryland was responsible for vessel operations and sample collection. EA was responsible for equipment decontamination, site water collection, homogenization and compositing of samples, labeling and packing of samples, transport of samples to appropriate testing laboratories, and direct coordination with analytical laboratories.

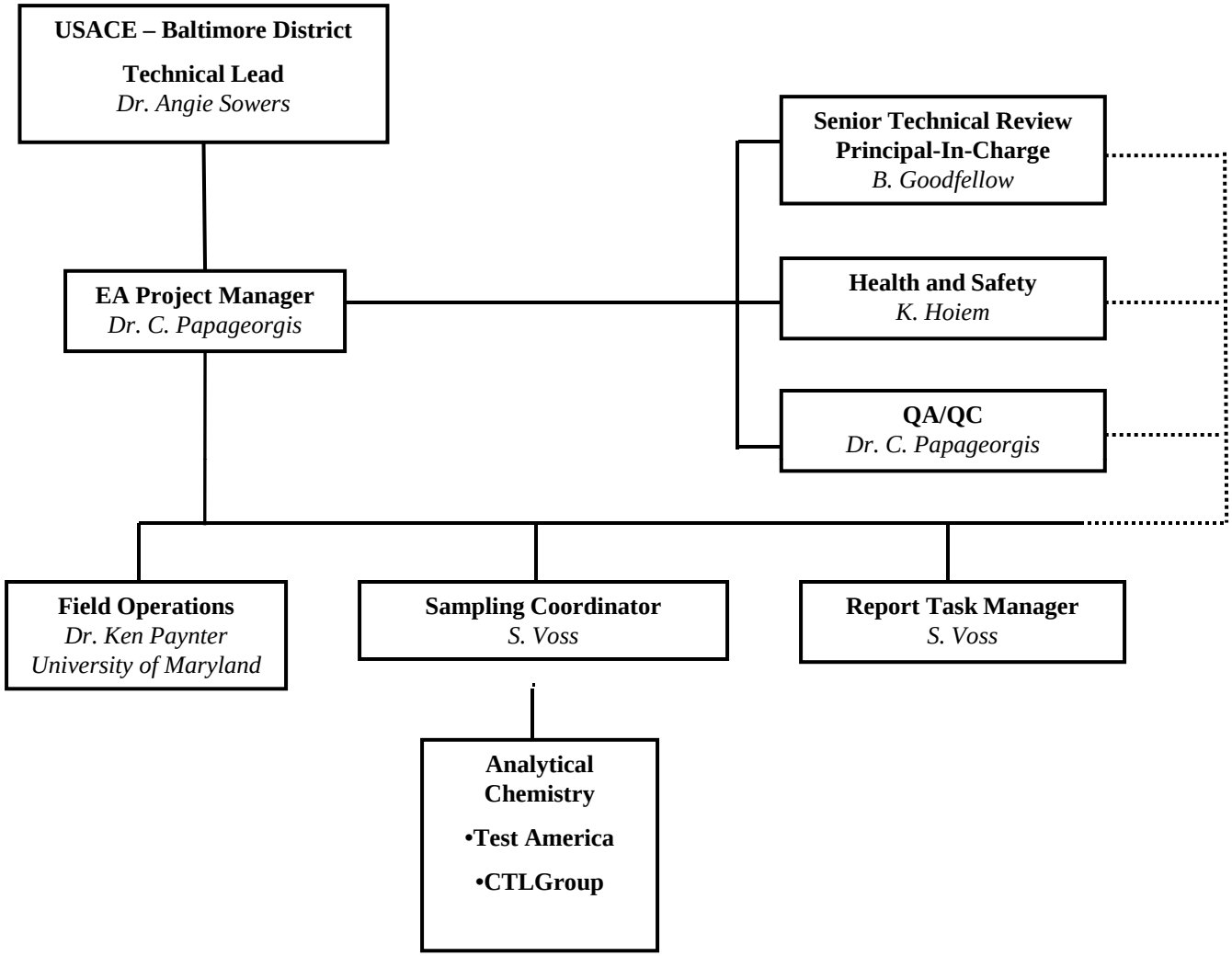

FIGURE 2-1. PROJECT TEAM ORGANIZATION
USACE Chesapeake Bay Oyster Recovery Project – Initial Screening of Oyster Reefs

3.0 FIELD ACTIVITIES

The field investigation consisted of an initial screening of oyster reefs, characterization of the composition of steel slag exposed to the estuarine environment, and a qualitative survey of the habitat and ecological community developed at the restored sites. Work was conducted in accordance with the Field Sample Guide (Appendix A) (EA 2011).

3.1 SAMPLING OBJECTIVES

The general objectives of the field sampling and sample processing include:

- Evaluation of steel slag composition from 2 locations (plantings) at Mill Hill and 1 location in the Severn River (Wade 2-3).
- Screening of seven substrate locations and a reference site at Mill Hill.
- Screening of five substrate locations and a reference site in the Severn River.
- *In situ* water quality measurements at each sampling location.
- Submittal of steel slag samples to CTLGroup Laboratories for composition analysis.
- Submittal of oyster tissue samples to TestAmerica for Target Analyte List (TAL) analysis.
- Submittal of water samples for each location for TAL analysis.
- Submittal of sediment sample for each location for TAL analysis.
- Videography and photography at each location.

Table 3-1 presents a summary of the data collected in each task and an inventory of the samples analyzed by Test America and CTLGroup. Table 3-2 lists the method detection limits for sediment, water, and tissue analyses by Test America.

3.2 SAMPLING LOCATION DETERMINATION

Sample locations were provided by USACE-Baltimore. Coordinates (latitude and longitudes) are provided in Table 1-1 (Mill Hill) and Table 1-2 (Severn River). Sampling locations were located in the field using a Differential Global Positioning System (DGPS).

3.3 SAMPLE VOLUME REQUIREMENTS

A minimum mass of 200 grams of wet tissue was required per sample for oyster tissue TAL analysis. Steel slag sample analysis required 1 pound of slag per sample.

3.4 *IN SITU* WATER QUALITY MEASUREMENTS

Water quality measurements were recorded *in situ* at each sampling location using an YSI water quality probe. Water temperature, salinity, dissolved oxygen, and pH were recorded at the bottom of the water column at each sampling location 6 inches to 12 inches above the reef. The pH meter was malfunctioning and pH measures from the Severn River are not available. The following parameters were recorded in the field log book:

- Location number
- Sampling data and time
- Water temperature [degrees Celsius (ºC)]
- Salinity (parts per thousand)
- Dissolved oxygen (milligrams per liter)
- pH

3.5 SAMPLE COLLECTION, STORAGE, AND TRANSPORT

3.5.1 Initial Slag and Water Chemical Survey

Steel slag was sampled from five points within each of the slag plantings at Mill Hill (2 plantings) and at Wade 2-3 in the Severn. The five points were randomly distributed across the planting, but representative of the planting. For each planting, the five samples were pulverized and homogenized into one composite sample for XRF in order to determine the bulk composition of the slag. Approximately 1 pound of slag was collected and submitted to CTL Group Laboratory for analysis at each planting. Water samples for TAL analysis were collected in each of the planting sites. Sampling in Mill Hill was performed on December 2010 and in the Severn River on March 2011.

3.5.2 Mill Hill Oyster Reef Screening

Sampling was performed at each of the seven substrate plantings study sites (MH-1 through MH-7) as well as an adjacent site (MH-Reference) that has been restored using oyster shell by Oyster Recovery Partnership (ORP) (Figure 1-1). Table 1-1 provides the coordinates of the seven Mill Hill plantings, size, and substrate type. Sampling was performed in the Fall of 2011 (September 2011).

On reefs constructed with alternate substrate, traditional harvesting gear cannot be used due to potential damage to the gear. Sampling was undertaken while water temperatures remained above 50° F (10° C). Divers collected enough oysters to recover about 200 grams of wet tissue. The number of oysters collected ranged from about 20-60 depending on oyster lengths at each site. All oysters collected were provided to the onboard crew for size measurement of oysters and counting of living and box oysters. All oysters collected were retained for tissue analysis. The length of all oysters was measured according to standard practices, and living and dead oysters enumerated.

As close to 200 grams of wet tissues from oysters were collected at each of the sampling sites. For TAL analysis, the full soft tissue body of collected oysters was homogenized into one composite sample for each sampling site. The oysters were prepared for analysis and preserved according to the requirements of the analyzing laboratory and in compliance with EPA guidance (EPA 2000) and Maryland Department of the Environment standard operating procedures (MDE 2009). For all samples, the number of oysters collected and the weight and length of each oyster was recorded.

Substrate type was recorded at each location and a representative sample retained to confirm bottom type. Sample size occupied a double-bagged quart-size plastic zip top bag, with as much air removed as possible. For plantings restored using slag, the bottom sample was collected in addition to the slag sample collected for *Section 3.5.1 Slag Composition*.

All samples were preserved according to Table 6-8 in the EPA National Guidance (EPA 2000). Sample handling, processing, and chain of custody was conducted according to Section 7 in the EPA National Guidance (EPA 2000).

3.5.3 Severn River Oyster Reef Screening

Sampling was performed at four study sites at Wade#2 (Wade 2-2 through Wade 2-5), and an additional study site at Weems Upper (WU). A recovered oyster shell reef was used as a reference site, Weems Creek Upper (WCU). Sampling was performed in the Fall of 2011 (October 2011). Figure 1-2 shows the locations of the Severn River plantings and Table 1-2 provides coordinates, size, and substrate type of each site.

At each planting samples were collected by divers (traditional harvesting gear may be damaged on reefs constructed with alternate substrates). Sampling was undertaken while water temperatures remain above 50° F (10° C). Divers collected enough oysters to recover about 200 grams of wet tissue. All oysters collected in the Severn River sites were less than 3 inches in length. In order to collect as close as possible to 200 grams of wet tissue, divers collected over 100 oysters per site. All oysters collected were retained for tissue analysis. Due to the small size of oysters in Severn River sites, individual size measurements and counting of living and box oysters were not feasible.

As close as possible to 200 grams of wet tissues from oysters were collected at each of the sampling sites. For TAL analysis, the full soft tissue body of collected oysters was homogenized into one composite sample for each sampling site. The oysters were prepared for analysis and preserved according to the requirements of the analyzing laboratory and in compliance with EPA guidance (EPA 2000) and Maryland Department of the Environment standard operating procedures (MDE 2009). For all samples, the number of oysters collected for a sample and the weight of wet tissue of collected oysters was recorded.

Substrate type was recorded and a representative sample retained to confirm bottom type. Sample size occupied a double-bagged quart-size plastic zip top bag, with as much air removed as possible. For plantings restored using slag, the bottom sample was collected in addition to the sample collected for *Section 3.5.1 Slag Composition*.

All samples were preserved according to Table 6-8 in the EPA National Guidance (EPA 2000). Sample handling, processing, and chain of custody was conducted according to Section 7 in the EPA National Guidance (EPA 2000).

3.5.4 Site Water (TAL Analysis)

Site water was collected at the center of each planting for TAL analysis at the bottom of the water column approximately 6 to 12 in above the reef. Eight site water samples were collected at the Mill Hill plantings and 6 site water samples were collected at the Severn River plantings. Site water samples were kept at 4°C and shipped to Test America laboratory for analysis. A field blank with distilled water was prepared for each river.

3.5.5 Sediment Samples (TAL Analysis)

A five-point composite sediment sample was collected for TAL analysis at each of the eight Mill Hill plantings and six Severn River plantings. For the slag plantings, the five sampling points for sediment collection were co-located with sites where slag was collected per *Section 3.5.1*. Composites were produced by homogenizing the five separate grab samples in a stainless-steel bowl and placing the sediment in a pre-cleaned, laboratory container. The five-points of sediment collection were co-located with sites where slag was collected per *Section 3.5.1*. Composite sediment samples were kept at 4°C and shipped to Test America laboratory for analysis.

3.5.6 Qualitative Description of Reef Community

A visual inspection by divers was performed at all sites in both Mill Hill and the Severn River in order to characterize the reef community at each reef.

Observations on organisms present at the site, nekton species seen using the reef, type of cover on the substrate, water visibility, depth of sedimentation and a general description of the reef site were made at both locations by divers.

3.5.7 Severn River Plantings

Sampling trays were used to investigate the Severn River oyster reef communities. Four trays measuring 56 cm^2 were placed approximately 3 meters apart from one another on each of the following study sites: Wade 2-3 (slag), Wade 2-4 (concrete), Wade 2-5 (stone), and WU (stone with oyster shell veneer). Four plastic trays were placed within each of the sites and filled with existing site substrate. Oysters were planted at the sites September and August of 2010. Substrate was placed in trays regardless of presence or absence of oysters on substrate. Sampling trays were deployed in the Spring of 2011 (May 2011) and collected in the Fall 2011 (September 2011). Upon collection of trays organisms were identified and counted from each sample tray. Fouling organisms such as barnacles were described as a percent cover of the shell or substrate rather than enumerated.

3.6 EQUIPMENT DECONTAMINATION PROCEDURES

Equipment that came into direct contact with sediment during sampling was decontaminated prior to deployment in the field and between each sampling location to minimize cross-contamination. This included the Ponar grab sampler and stainless steel processing equipment (spoons, knives, bowls, etc.). While performing the decontamination procedure, phthalate-free nitrile gloves were used to prevent phthalate contamination of the sampling equipment or the samples.

The decontamination procedure is described below:

1. Rinse equipment using site water
2. Rinse with 10 percent nitric acid (HNO_3)
3. Rinse with distilled or de-ionized water
4. Rinse with methanol followed by hexane
5. Rinse with distilled or de-ionized water
6. Air dry (in area not adjacent to the decontamination area)

Waste liquids were contained during decontamination procedures and transferred to EA's facility in Sparks, Maryland for proper disposal.

TABLE 3-1. SUMMARY OF TASKS AND ANALYTICAL SAMPLE INVENTORY

Task/ Media Samples for Analytical Laboratory	Slag	Tissue	Water	Substrate
Task 1 Slag Composition				
2 sites Mill Hill ; 5 sampling points each to make composites; choose 3 for Task 2	2			
1 site Severn Wade2-5; five sampling points to make composite ; choose 5 random locations for Task 3	1			
Compare weathered slag with Grubb et al (2010)				
Total samples for XRF Analysis	**3**			
Task 2 Screening of Mill Hill				
Seven sites plus reference site				
3 samples per site; size, #spat, living and box oysters, substrate type; length; tissue		24		
Tissue replicates (1 sample per site in triplicate)		16		
Water			8	
Sediment/substrate representative sample retained to confirm bottom type				
Five point composite sediment sample				8
Field Data-Dissolved oxygen, temperature, pH, salinity at 6-12"above reef, depth to reef				
Videography; still photos				
Field Blank			1	
Total Samples for TAL analysis Task 2		**40**	**9**	**8**
Task 3 Screening of Severn River Reefs 2011				
Wade #2-2, 2-3, 2-4, 2-5; Weems Upper (5 sites)				
Reference CBF/ORP Site At Weems Upper				
3 samples per site; size, #spat, living and box oysters, substrate type; length; tissue		18		
Tissue replicates (1 sample per site in triplicate)		12		
Sediment/substrate representative sample retained to confirm bottom type				
Water			6	
Sediment				6
Field Data-Dissolved oxygen, temperature, pH, salinity at 6-12"above reef, depth to reef				
Videography; still photos				
Field Blank			1	
Total Samples for TAL analysisTask 2		**30**	**7**	**6**
Task 4A Qualitative Description of Mill Hill 2010				
Qualitative estimates of coverage of quadrat samples by diver				
Record of organisms present for 1 sample on each of 8 plantings				
General description (coverage by fouling organisms, visibility, sedimentation, nekton species)				
Task 4B Qualitative Description of Severn Sites 2011				
Total of Four (4) sampling trays placed on Wade 2-3, 2-4, 2-5, and Weems Upper; organisms from trays to be identified and counted				
General description (coverage by fouling organisms, visibility, sedimentation, nekton species)				

TABLE 3-2. METHOD DETECTION LIMITS (MDL) FOR SEDIMENT, WATER, AND TISSUE ANALYSES

Sediment

TAL Metals (Method 6020)

Compound	RL	Units	MDL	Units
Aluminum	3	mg/kg	0.2849	mg/kg
Antimony	0.2	mg/kg	0.0026	mg/kg
Arsenic	0.1	mg/kg	0.0181	mg/kg
Barium	1	mg/kg	0.0107	mg/kg
Beryllium	0.1	mg/kg	0.0075	mg/kg
Cadmium	0.1	mg/kg	0.007	mg/kg
Calcium	10	mg/kg	1.326	mg/kg
Chromium	0.2	mg/kg	0.0061	mg/kg
Cobalt	0.05	mg/kg	0.0015	mg/kg
Copper	0.2	mg/kg	0.033	mg/kg
Iron	5	mg/kg	0.3539	mg/kg
Lead	0.1	mg/kg	0.0038	mg/kg
Magnesium	10	mg/kg	0.187	mg/kg
Manganese	0.05	mg/kg	0.0103	mg/kg
Nickel	0.1	mg/kg	0.0113	mg/kg
Potassium	10	mg/kg	1.3583	mg/kg
Selenium	0.5	mg/kg	0.0502	mg/kg
Silver	0.1	mg/kg	0.0039	mg/kg
Sodium	10	mg/kg	1.369	mg/kg
Thallium	0.1	mg/kg	0.002	mg/kg
Vanadium	0.1	mg/kg	0.0079	mg/kg
Zinc	0.5	mg/kg	0.0648	mg/kg

Mercury 7471A

Compound	RL	Units	MDL	Units
Mercury	0.033	mg/kg	0.0109	mg/kg

Total Cyanide 9012A

Compound	RL	Units	MDL	Units
Total Cyanide	0.5	mg/kg	0.0968	mg/kg

Water

TAL Metals (Method 6020)

Compound	RL	Units	MDL	Units
Aluminum	30	ug/L	2.5662	ug/L
Antimony	2	ug/L	0.0187	ug/L
Arsenic	1	ug/L	0.2908	ug/L
Barium	10	ug/L	0.098	ug/L
Beryllium	1	ug/L	0.0367	ug/L
Cadmium	1	ug/L	0.1144	ug/L
Calcium	100	ug/L	2.8374	ug/L
Chromium	2	ug/L	0.5433	ug/L
Cobalt	0.5	ug/L	0.0263	ug/L
Copper	2	ug/L	0.2443	ug/L
Iron	50	ug/L	6.0901	ug/L
Lead	1	ug/L	0.0192	ug/L
Magnesium	100	ug/L	1.1665	ug/L
Manganese	0.5	ug/L	0.0389	ug/L
Nickel	1	ug/L	0.1749	ug/L
Potassium	100	ug/L	5.823	ug/L
Selenium	5	ug/L	0.4216	ug/L
Silver	1	ug/L	0.0362	ug/L
Sodium	100	ug/L	3.8135	ug/L
Thallium	1	ug/L	0.0152	ug/L
Vanadium	1	ug/L	0.0824	ug/L
Zinc	5	ug/L	0.9609	ug/L

Mercury 7470A

Compound	RL	Units	MDL	Units
Mercury	0.2	ug/L	0.0384	ug/L

Total Solids 2540G

Compound	RL	Units	MDL	Units
Total Solids	10	mg/L	10	mg/L

Total Cyanide 9012A

Compound	RL	Units	MDL	Units
Total Cyanide	10	ug/L	1.5	ug/L

Tissues

TAL Metals (Method 6020)

Compound	RL	Units	MDL	Units
Aluminum	3	mg/kg	0.236	mg/kg
Antimony	0.2	mg/kg	0.0033	mg/kg
Arsenic	0.1	mg/kg	0.0165	mg/kg
Barium	1	mg/kg	0.0077	mg/kg
Beryllium	0.1	mg/kg	0.0037	mg/kg
Cadmium	0.1	mg/kg	0.0091	mg/kg
Calcium	10	mg/kg	1.7787	mg/kg
Chromium	0.2	mg/kg	0.008	mg/kg
Cobalt	0.05	mg/kg	0.0025	mg/kg
Copper	0.2	mg/kg	0.0085	mg/kg
Iron	5	mg/kg	0.2887	mg/kg
Lead	0.1	mg/kg	0.0034	mg/kg
Magnesium	10	mg/kg	0.3794	mg/kg
Manganese	0.05	mg/kg	0.0145	mg/kg
Nickel	0.1	mg/kg	0.0068	mg/kg
Potassium	10	mg/kg	0.9931	mg/kg
Selenium	0.5	mg/kg	0.0406	mg/kg
Silver	0.1	mg/kg	0.0024	mg/kg
Sodium	10	mg/kg	0.7241	mg/kg
Thallium	0.1	mg/kg	0.002	mg/kg
Vanadium	0.1	mg/kg	0.0058	mg/kg
Zinc	0.5	mg/kg	0.0117	mg/kg

Mercury 7471A

Compound	RL	Units	MDL	Units
Mercury	0.033	mg/kg	0.0109	mg/kg

4.0 SAMPLE CHAIN-OF-CUSTODY AND DOCUMENTATION

Field notes were recorded in a permanently bound, dedicated field logbook. A log of sampling activities, location, and water depths was recorded in the log in indelible ink. In addition, in situ water quality measurements were recorded at each sampling location using an electronic water quality monitoring instrument.

Personnel names, local weather conditions, and other information that may impact the field sampling program were also recorded. Similar appropriate information was recorded in the logbook as samples were processed and submitted to the laboratories for analyses. Each page of the logbook is numbered and dated by the personnel entering information. Copies of the logbooks are found in Appendix B.

Divers Trip Reports were submitted by the University of Maryland and contain trip details such as trip length, location, dates, weather conditions, personnel involved and the description of work that occurred during dive trips (Appendix B). Dive plans submitted to the University of Maryland Environmental Safety Division of Administrative Affairs and USACE are available in Appendix C.

Samples collected in the field were documented on a chain-of-custody (COC) available in Appendix D.

5.0 SAMPLE PACKING AND SHIPPING

Slag, site water, oyster tissue, and field blank samples were stored in ice-filled coolers on the work platform until the end of each sampling day. Samples for analytical testing were packaged in bubble wrap, secured individually in ziplock bags, placed in an ice-filled cooler, and shipped via overnight express to TestAmerica and CTL Group laboratories.

Site water, oyster tissue, sediment samples, and field blank samples for chemical analysis were sent directly to the following address:

TestAmerica–Pittsburgh
301 Alpha Drive
Pittsburgh, PA. 15238
(412) 963-7058
Attn: Sample Management

Slag samples submitted for chemical analyses were shipped directly to the following address:

CTL Group
5400 Old Orchard Road
Skokie, IL 60077-1030
(847) 965-7500
Attn: Scott Nettles

6.0 RESULTS

6.1 INITIAL SLAG AND WATER CHEMICAL SURVEY

6.1.1 Chemical Composition of Slag

The testing laboratory used for the slag chemical composition was the same used by Grubb et al. 2010. The results of the two Mill Hill sites (MH-2 and MH-6), the Severn sample (Wade 2-3), Grubb et al. (2010) slag sample, and Phoenix BOF sample are provided in Table 6-1. Concentrations of all analytes from MH-6 and Wade 2-3 are comparable to those of Grubb et al. (2010) and Phoenix BOF. Concentrations of analytes from MH-2 are lower than those of Grubb et al. (2010) and Phoenix FBO. MH-2 site was 3" shell with a 6" slag base.

6.1.2 Metal Concentrations in Water

Of the 24 tested metals, 20 were detected in the sample water collected at Mill Hill. Beryllium, Cadmium, Silver, and total Cyanide were not detected in any of the samples collected at Mill Hill. Of the 24 tested metals, 17 were detected in the sample water collected at the Severn River. Beryllium, Cadmium, Chromium, Silver, Thallium, Vanadium, and Mercury were not detected in the sample collected at the Severn River (Table 6-2).

6.2 OYSTER REEF QUANTITATIVE SURVEY

6.2.1 Water Quality

Mill Hill

Water samples were collected on September 2011. Dissolved Oxygen (DO) averaged 7.90 mg/L at Mill Hill stations. Salinity averaged 7.90 ppm, pH averaged 8.43, and temperature averaged 21.98°C (Table 6-3).

Severn River

Water samples were collected on October 2011. DO averaged 7.74 mg/L at Severn River stations. Salinity averaged 4.78 ppm and temperature averaged 18.07°C. The pH meter was malfunctioning and measurements are not available for the Severn River sites (Table 6-4).

6.2.2 Oyster Characteristics

Mill Hill

At least 200 grams of wet tissue were collected at all Mill Hill sites. Table 6-5 summarizes the oyster characteristics for tissue collection at each site on Mill Hill. Appendix E contains individual measurements of oysters from all Mill Hill sites. In MH-Reference individual oyster length ranged from 70.82 mm to 121.75 mm, and average oyster length was 98.32 mm. The oyster box to live ratio over the entire MH-Reference reef was 1 box:5 live oysters.

In the Mill Hill study sites individual oyster length ranged from 53.49 mm (MH-2) to 137 mm (MH-7) across all Mill Hill sites. Average length of oysters collected ranged from 73.43 mm (MH-2) to 96.44 mm (MH-1). The oyster box to live ratio ranged from 2 boxes:1 live oyster (MH-6) to 1 box:5 live oysters (MH-3).

Severn River

Weight of wet tissue collected at all Severn River sites was as close to 200 grams as possible. Table 6-6 summarizes the oyster characteristics for tissue collection at each Severn River site. All oysters collected at Severn River were clumped and smaller than 3 inches, individual measurements were not feasible. In WCU, 265 grams of wet tissue was collected from 200 oysters.

In the Severn River study sites total weight collected in each station ranged from 187 grams (Wade 2-4) to 246 grams (Wade 2-2). The number of oysters collected at each site ranged from 167 (Wade 2-4) to 200 (Wade 2-2). Oyster box to live oyster ratio measurements were not feasible at any of these sites.

6.2.3 TAL Analysis

6.2.3.1 Water

Mill Hill

Of the 24 tested metals 16 were detected in site water from the MH Reference site (Table 6-7). Arsenic, Barium, Beryllium, Cadmium, Cobalt, Mercury, Silver, Vanadium, and total Cyanide were not detected in the MH-Reference site.

In the Mill Hill study sites, of the 24 tested metals 19 were detected in site water from all the sites (Table 6-7). Beryllium, Cadmium, Mercury, Silver, and total Cyanide were not detected in any of the Mill Hill study sites. Antimony was detected in all study sites except MH-4 and MH-5. For metals with established Water Quality Criteria (WQC), detected concentrations in the site water were all below EPA saltwater acute and/or chronic WQC.

Severn River

Of the 24 tested metals 16 were detected in site water from the WCU station (reference) (Table 6-8). Antimony, Beryllium, Cadmium, Mercury, Silver, Thallium, Vanadium, and total Cyanide were not detected in the WCU site.

In the remaining Severn River study sites, of the 24 tested metals 17 were detected in site water from all sites (Table 6-8). Antimony, Beryllium, Cadmium, Mercury, Silver, Thallium, and total Cyanide were not detected in any of the Severn River study sites. Arsenic was detected in all sites except for WU. Vanadium was detected in all sites except for Wade 2-3 and WU. For metals with established WQC, detected concentrations of Copper were 3.2 µg/L at the Wade 2-5 (stone) site, above both the EPA saltwater acute and chronic WQC. No other detected concentrations of metals exceeded EPA saltwater acute and chronic WQC.

6.2.3.2 Sediments

Mill Hill

Of the 24 tested metals 22 were detected in sediments from the MH Reference site (Table 6-9). Mercury and total Cyanide were not detected in the MH Reference site.

In the Mill Hill study sites, of the 24 tested metals 21were detected in sediments in all of the study sites (Table 6-9). Mercury was not detected in any of the study sites. Selenium was detected in all sites except MH-4 and MH-6. Total Cyanide was only detected in MH-6.

Severn River

Of the 24 tested metals 24 were detected in sediments from the WCU site (reference) (Table 6-10). Arsenic, Chromium, Copper, Lead, Nickel, and Zinc concentrations exceeded TEL concentrations. Arsenic and Nickel concentrations exceeded ERL concentrations.

In the remaining Severn River study sites, of the 24 tested metals 22 were detected in sediments from all the study sites (Table 6-10). Selenium was detected in all sites except for Wade 2-3. Total Cyanide was detected in all sites except for WU. Arsenic concentrations at Wade 2-2 and WU exceed TEL and ERL concentrations. Copper concentrations at Wade 2-2 exceeded TEL concentrations. Nickel concentrations at Wade 2-2 and WU exceeded TEL concentrations.

6.2.3.3 Oyster Tissue

Mill Hill

Of the 24 tested metals 22 were detected in oyster tissues from the MH-Reference Site (Table 6-11). Beryllium and total Cyanide were not detected in the MH-Reference Site.

In all of the remaining Mill Hill study sites, of the 24 tested metals 21 were detected in oyster tissues from all the study sites (Tables 6-12 – 6-18). Beryllium was not detected in any of the Mill Hill sites. Antimony was detected in all sites except MH-2 and MH-7. Thallium was detected in all sites except MH-2, MH-4, and MH-6.

Severn River

Of the 24 tested metals 21 were detected in oyster tissues from the WCU site (reference) (Table 6-19). Beryllium, Mercury, and Thallium were not detected in the WCU station.

In all of the remaining Severn River study sites, of the 24 tested metals 23 were detected in oyster tissues from all sites (Tables 6-20 – 6-24). Mercury was not present in any of the oyster tissues from all the Severn River study sites. Beryllium was only detected in Wade 2-3. Thallium was detected in all sites except Wade 2-5.

6.3 QUALITATIVE REEF ANALYSIS

6.3.1 Mill Hill

Detailed divers' observations from each Mill Hill site are contained in Table 6-25. Pictures from Mill Hill stations MH-2 and MH-6 collected during the December 2010 dive can be found in Appendix F-1. The station MH-Reference had blue crabs and jellies present, most oysters were clumped, and there were very few mussels and barnacles covering the site. The main part of the reef was covered in shell, but the edges were sandy. No fish were present in MH-Reference. In the other Mill Hill sites, blue crabs, mud crabs, anemones, and jellies were present. Fish, mainly gobies, were present in MH-4 (shell with concrete rubble base), MH-5 (recycled concrete) and MH-7 (stone). MH-1 (oyster shell) and MH-2 (shell with slag base) were covered in broken shells or oysters. MH-3 (shell with stone base), MH-4, MH-5, MH-6 (slag), and MH-7 were covered in mostly barnacles and mussels. Additional divers' observations indicate there was extensive mussel covering most of the substrate at MH-6 (Appendix B). Oysters in MH-3and MH-4 were found mostly in clumps, while oysters in MH-1were found mostly as single oysters.

6.3.2 Severn River

Detailed divers' observations from each Severn River site are contained in Table 6-26. Pictures from substrate collected at the Wade 2-3 station during the March 2011 dive can be found in Appendix F-2. WCU (reference) was muddy and shells were present in the sediments. In sites Wade 2-2 (mixed substrate) and Wade 2-3 (slag) there were blue crabs present. Wade 2-3 was shallower than the other study sites. Wade 2-4 (concrete) and Wade 2-5 (stone) had low visibility. In Wade 2-3, Wade 2-5, and WU oysters were concentrated in troughs of substrates. Additional divers' observations indicate there was spat present on shell discovered at Wade 2-3 (Appendix B).

6.3.3 Severn River Tray Analysis

Water quality data from each site was collected at the time of planting and can be found in Table 6-27. Pictures of the trays prior to deployment and after collection can be found in Appendix F-3 and F-4 respectively. Tables 6-28– 6-31 summarize the species collected from each tray at the Severn River. Divers were unable to locate one of the trays from site WU, which detached from the substrate. The planting at Wade 2-4 had the highest number of benthic organisms among all the sites. Among all plantings, the most abundant benthic species collected were ribbed mussels (*Geukensiademissa*) and mud crabs (*Rhithropanopeusharrisii*).

Oysters were the most abundant in Wade 2-4, and the least abundant on Wade 2-3, only one oyster was recovered from Wade 2-3. Lengths of the oysters collected from the trays are in Table 6-32 – 6-35.

Gobies (*Gobiosomabosci*) were the most abundant fish collected in all plantings. Wade 2-4 had the highest number of fish present. Additionally, barnacles (*Balanus improvises*), bryozoans, and hydrozoans were found covering the planting substrates in most sites.

TABLE 6-1. CHEMICAL CONCENTRATIONS (WT. %) IN SLAG

INITIAL SCREENING OF OYSTER REEFS (MARCH 2011)

ANALYTE	UNITS	MH-2	MH-6	Wade 2-3	Slag from Grubb et al. 2010	Slag from Phoenix (BOF)*
Al_2O_3	Wt.%	0.13	9.06	5.13	4.09	1.22
Alkalies as NA_2O	Wt.%	0.27	0.05	<0.01	--	--
BaO	Wt.%	<0.01	<0.01	<0.01	--	--
CaO	Wt.%	54.26	39.37	37.51	37.21	41.14
Cr_2O_3	Wt.%	<0.01	0.62	0.23	--	--
Fe_2O_3	Wt.%	0.12	20.1	28.07	26.84	--
K_2O	Wt.%	0.05	0.02	<0.01	0.02	--
L.O.I. (950°C)	Wt.%	43.75	2.79	-1.38	--	--
MgO	Wt.%	0.33	10.62	11.15	10.31	9.21
Mn_2O_3	Wt.%	0.08	4.79	4.3	3.97	--
Na_2O	Wt.%	0.24	0.04	<0.01	0.03	--
P_2O_5	Wt.%	0.07	0.72	0.62	0.78	0.63
SiO_2	Wt.%	0.72	10.2	13.31	10.65	14.34
SO_3	Wt.%	0.24	0.41	0.13	0.16	--
SrO	Wt.%	0.13	0.03	0.03	--	--
TiO_2	Wt.%	0.01	0.41	0.36	0.46	0.41
ZnO	Wt.%	<0.01	<0.01	<0.01	--	--
Exposure Time		9 years	9 years	11 months	--	--

*production driven monitoring of Severstal BOF slag from Jan 1, 2010 to Sep 1, 2010 by Phoenix Services

MH-2 = 3" shell with 6" slag base (Sample ID MH-1-Slag)

MH-6 = 6" slag (Sample ID MH-2-Slag)

Wade 2-3 = slag (Sample ID W-1-Slag)

TABLE 6-2. METAL CONCENTRATIONS (UG/L) IN WATER
INITIAL SCREENING OF OYSTER REEFS

ANALYTE	UNITS	RL	MH-2[(a)]	MH-6[(a)]	Wade 2-3[(b)]
ALUMINUM	UG/L	150	**130 J**	**372**	**96.4 B**
ANTIMONY	UG/L	10	**0.24 J**	**0.62 J**	**2.1 B**
ARSENIC	UG/L	5	**5.5**	**4.9 J**	**4.2 B**
BARIUM	UG/L	50	**33.8 J**	**35.2 J**	**27 B**
BERYLLIUM	UG/L	5	5 U	5 U	5 U
CADMIUM	UG/L	5	5 U	5 U	5 U
CALCIUM	UG/L	500	**152,000 B**	**159,000 B**	**62,900**
CHROMIUM, TOTAL	UG/L	10	**5.8 J**	**6.7 J**	10 U
COBALT	UG/L	2.5	**0.68 J**	**0.68 J**	**0.34 B**
COPPER	UG/L	10	**3.1 J**	**1.9 J**	**2.1 B**
IRON	UG/L	250	**463 B**	**476 B**	**381**
LEAD	UG/L	5	**1.2 J**	**3.7 J**	**0.26 B**
MAGNESIUM	UG/L	500	**419,000 B**	**439,000 B**	**173,000**
MANGANESE	UG/L	2.5	**27.7 B E**	**40.6 B**	**61.4**
NICKEL	UG/L	5	**2.2 J**	**2.2 J**	**2.9 B**
POTASSIUM	UG/L	500	**129,000**	**134,000**	**54,800**
SELENIUM	UG/L	25	**17 J**	**15.8 J**	**13.8 B**
SILVER	UG/L	5	5 U	5 U	5 U
SODIUM	UG/L	500	**3,260,000**	**3,470,000**	**1,440,000 J**
THALLIUM	UG/L	5	5 U	**0.58 J**	5 U
VANADIUM	UG/L	5	**1.6 B J**	**0.54 B J**	5 U
ZINC	UG/L	25	**14.5 B J**	**13 B J**	**10.6 B**
MERCURY	UG/L	0.2	0.2 U	**0.059 J**	0.2 U
TOTAL CYANIDE	UG/L	10	10 U	10 U	**3.1 B J**

NOTES: Bold values represent detected concentrations.
RL is reported for non-detected constituents.

(a) = collected on 12/10/2010 at Mill Hills

(b) = collected on 3/22/2011 in Severn River

MH-2 = 3" shell with 6" slag base (Sample ID MH-1-Slag)

MH-6 = 6" slag (Sample ID MH-2-Slag)

Wade 2-3 = slag (Sample ID W-1-Slag)

RL = average reporting limit

J = compound was detected, but below the reporting limit (value is estimated)

B = detected in the laboratory method blank

E = concentration detected is over the method calibration limit

U = compound was analyzed but not detectedout or above the RL

TABLE 6-3. MILL HILL WATER QUALITY
September 2011

Station	Temperature (°C)	Salinity (ppm)	pH	Dissolved Oxygen (mg/L)
MH-Reference	22.33	7.91	8.62	8.91
MH-1	21.72	7.89	8.39	7.4
MH-2	21.88	7.9	8.29	7.24
MH-3	21.94	7.87	8.44	7.83
MH-4	22.15	7.89	8.58	8.42
MH-5	22.05	7.9	8.48	7.87
MH-6	21.78	7.91	8.22	7.04
MH-7	21.97	7.89	8.44	7.52
Average	**21.98**	**7.90**	**8.43**	**7.78**

TABLE 6-4. SEVERN RIVER WATER QUALITY

October 2011

Station	Temperature (°C)	Salinity (ppm)	pH	Dissolved Oxygen (mg/L)
WCU	17.92	4.79	NA	7.81
Wade 2-2	18.05	4.78	NA	6.69
Wade 2-3	18.1	4.76	NA	7.91
Wade 2-4	18.1	4.75	NA	7.61
Wade 2-5	18.23	4.74	NA	8.67
WU	17.99	4.84	NA	7.75
Average	**18.07**	**4.78**	**NA**	**7.74**

TABLE 6-5. MILL HILL COLLECTED OYSTERS CHARACTERISTICS

September 2011

Station	Substrate Type	Number of Oysters	Length Range (mm)	Average Length (mm)	Average Width (mm)	Total Weight (grams)	Oyster Box to Live Ratio
Reference (MH-8)	Restored Oyster Shell Reef	44	70.82-121.75	98.32	26.35	392	1 box : 5 live
MH-1	6" oyster shell (3" fines, 3" shell)	28	57.96-120.76	96.44	39.08	267	1 box : 3 live
MH-2	3" shell with 6" slag base	38	53.49-115.48	73.43	25.19	233	1 box : 3 live
MH-3	3" shell with 6" stone base	60	67.60-109.49	84.26	22.50	432	1 box : 5 live
MH-4	3" shell with 6" concrete rubble base	47	59.84-133.73	86.03	25.37	327	1 box : 3 live
MH-5	6" recycled concrete	23	55.15-132.17	81.55	24.54	209	1 box : 1 live
MH-6	6" slag	39	65.23-125.56	88.85	29.34	339	2 box : 1 live
MH-7	6" stone	33	57.53-137.00	93.93	32.07	363	1 box : 1 live

TABLE 6-6. SEVERN RIVER COLLECTED OYSTERS CHARACTERISTICS

October 2011

Location	Substrate	Weight (grams)	Number of Oysters
WCU	Recovered Oyster Shell	265	100+
Wade 2-2	Concrete, stone, and slag	246	200
Wade 2-3	Slag	225	170
Wade 2-4	Concrete	187	167
Wade 2-5	Stone	211	150+
WU	Stone with Oyster Shell Veneer	231	100+

TABLE 6-7. METAL CONCETRATIONS IN SITE WATER FOR MILL HILL

September 2011

ANALYTE	UNITS	EPA ACUTE CRITERIA	EPA CHRONIC CRITERIA	RL	MH-REF	MH-1	MH-2	MH-3	MH-4	MH-5	MH-6	MH-7	Field Blank
ALUMINUM	UG/L	--	--	30	**9.6 J B**	**110 B**	**270 B**	**90 B**	**98 B**	**150 B**	**420 B**	**96 B**	**14 J B**
ANTIMONY	UG/L	--	--	1.34	**0.091 J**	**0.11 J**	**0.076 J**	**0.072 J**	0.019 U	0.019 U	**0.021 J**	**0.94 J**	0.019 U
ARSENIC	UG/L	69	36	0.84	0.29 U	**4.1**	**4.1**	**4.5**	**4.8**	**4.4**	**4.9**	**3.9**	0.29 U
BARIUM	UG/L	--	--	7.8	0.098 U	**34 B**	**33 B**	**33 B**	**34 B**	**35 B**	**33 B**	**34 B**	0.098 U
BERYLLIUM	UG/L	--	--	0.037	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U	0.037 U
CADMIUM	UG/L	40	8.8	0.11	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
CALCIUM	UG/L	--	--	100	**37 J B**	**120000 B**	**120000 B**	**120000 B**	**120000 B**	**130000 B**	**120000 B**	**120000 B**	**52 J B**
CHROMIUM	UG/L	1100	50	2	**3.5**	**4.1**	**4.6**	**4.8**	**4.8**	**5.3**	**5.8**	**4.5**	**3.2**
COBALT	UG/L	--	--	0.395	0.026 U	**0.53**	**0.58**	**0.55**	**0.56**	**0.63**	**0.72**	**0.5**	0.026 U
COPPER	UG/L	4.8	3.1	2	**0.41 J**	**2.1**	**2**	**1.8 J**	**2.2**	**1.8 J**	**2.1**	**2**	**0.43 J**
IRON	UG/L	--	--	50	**11 J B**	**190 B**	**300 B**	**150 B**	**160 B**	**220 B**	**520 B**	**150 B**	**11 J B**
LEAD	UG/L	210	8.1	1	**0.036 J B**	**0.88 J B**	**0.95 J B**	**0.73 J B**	**0.48 J B**	**0.72 J B**	**1.3 B**	**2.1 B**	**0.13 J B**
MAGNESIUM	UG/L	--	--	100	**53 J B**	**360000 B**	**340000 B**	**360000 B**	**360000 B**	**360000 B**	**340000 B**	**360000 B**	**32 J B**
MANGANESE	UG/L	--	--	5	**0.16 J B**	**48 B**	**66 B**	**46 B**	**47 B**	**58 B**	**94 B**	**49 B**	**0.21 J B**
MERCURY	UG/L	1.8	0.94	0.038	0.038 U	0.038 U	0.038 U	0.038 U	0.038 U	0.038 U	0.038 U	0.038 U	0.038 U
NICKEL	UG/L	74	8.2	0.908	**0.21 J**	**2**	**1.8**	**1.6**	**1.6**	**1.9**	**2**	**1.5**	0.17 U
POTASSIUM	UG/L	--	--	100	**36 J**	**110000**	**100000**	**110000**	**110000**	**110000**	**100000**	**110000**	**25 J**
SELENIUM	UG/L	290	71	5	**1.3 J**	**12**	**12**	**15**	**15**	**16**	**15**	**13**	**0.65 J**
SILVER	UG/L	1.9	--	0.036	0.036 U	0.036 U	0.036 U	0.036 U	0.036 U	0.036 U	0.036 U	0.036 U	0.036 U
SODIUM	UG/L	--	--	3911	**450 B**	**3000000 B**	**3000000 B**	**3100000 B**	**3100000 B**	**3200000 B**	**2700000 B**	**2900000 B**	**300 B**
THALLIUM	UG/L	--	--	0.89	**0.017 J B**	**0.054 J B**	**0.045 J B**	**0.038 J B**	**0.035 J B**	**0.035 J B**	**0.022 J B**	**0.018 J B**	0.015 U
VANADIUM	UG/L	--	--	0.694	0.082 U	**0.6 J B**	**1.3 B**	**0.76 J B**	**0.82 J B**	**0.92 J B**	**1.4 B**	0.082 U	0.082 U
ZINC	UG/L	90	81	5	**1.4 J**	**7.9**	**7.7**	**5.9**	**6.6**	**4.2 J**	**9.6**	**5.1**	**2.7 J**
CYANIDE, TOTAL	UG/L	1	1	1.5	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U

*Sources: USEPA 2011. National Recommended Water Quality Criteria

RL = average reporting limit

B = compound was detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

a= Exceeds acute criterion

b= Exceeds chronic criterion

TABLE 6-8. METAL CONCENTRATIONS IN SITE WATER FOR SEVERN RIVER

October 2011

ANALYTE	UNITS	EPA ACUTE CRITERIA	EPA CHRONIC CRITERIA	RL	WCU	W2-2	W2-3	W2-4	W2-5	WU	Field Blank
ALUMINUM	UG/L	--	--	150	**150**	**320**	**340**	**250**	**390**	**230**	**5.5 J**
ANTIMONY	UG/L	--	--	0.094	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	2 U
ARSENIC	UG/L	69	36	4.41	**1.5 J**	**3.1 J**	**3.1 J**	**3 J**	**2 J**	1.5 U	1 U
BARIUM	UG/L	--	--	50	**29 J**	**28 J**	**30 J**	**29 J**	**29 J**	**29 J**	10 U
BERYLLIUM	UG/L	--	--	0.18	0.18 U	0.18 U	0.18 U	0.18 U	0.18 U	0.18 U	1 U
CADMIUM	UG/L	40	8.8	0.57	0.57 U	0.57 U	0.57 U	0.57 U	0.57 U	0.57 U	1 U
CALCIUM	UG/L	--	--	500	**60000 B**	**59000 B**	**61000 B**	**62000 B**	**60000 B**	**61000 B**	**7 J B**
CHROMIUM	UG/L	1100	50	10	**4.7 J**	**4.2 J**	**4.9 J**	**4.8 J**	**6.1 J**	**4.7 J**	**0.66 J**
COBALT	UG/L	--	--	2.5	**0.27 J**	**0.42 J**	**0.41 J**	**0.29 J**	**0.42 J**	**0.34 J**	0.5 U
COPPER	UG/L	4.8	3.1	10	**2.7 J**	**2.6 J**	**2.9 J**	**2.6 J**	**3.2 J b**	**2.5 J**	2 U
IRON	UG/L	--	--	250	**390**	**790**	**830**	**590**	**930**	**540**	50 U
LEAD	UG/L	210	8.1	5	**1.4 J B**	**1.4 J B**	**2.6 J B**	**0.98 J B**	**2.5 J B**	**1.1 J B**	**0.069 J B**
MAGNESIUM	UG/L	--	--	500	**160000**	**160000**	**170000**	**170000**	**160000**	**170000**	**2.1 J**
MANGANESE	UG/L	--	--	25	**39**	**56**	**56**	**46**	**61**	**44**	5 U
MERCURY	UG/L	1.8	0.94	0.038	0.038 U	0.038 U	0.038 U	0.038 U	0.038 U	0.038 U	0.2 U
NICKEL	UG/L	74	8.2	5	**1.7 J**	**2.2 J**	**2.2 J**	**1.7 J**	**2 J**	**1.6 J**	1 U
POTASSIUM	UG/L	--	--	500	**47000**	**47000**	**49000**	**49000**	**47000**	**48000**	100 U
SELENIUM	UG/L	290	71	25	**6.3 J**	**4.7 J**	**8.2 J**	**6.7 J**	**6 J**	**5.1 J**	5 U
SILVER	UG/L	1.9	--	0.18	0.18 U	0.18 U	0.18 U	0.18 U	0.18 U	0.18 U	1 U
SODIUM	UG/L	--	--	500	**1200000 B**	**1200000 B**	**1300000 B**	**1300000 B**	**1300000 B**	**1300000 B**	**38 J B**
THALLIUM	UG/L	--	--	0.897	0.076 U	0.076 U	0.076 U	0.076 U	**0.16 J**	0.076 U	1 U
VANADIUM	UG/L	--	--	2.71	0.41 U	**1.4 J**	0.41 U	**1.1 J**	**1.4 J**	0.41 U	1 U
ZINC	UG/L	90	81	25	**6.1 J**	**7.3 J**	**6.9 J**	**6.1 J**	**8.7 J**	**6.4 J**	5 U
CYANIDE, TOTAL	UG/L	1	1	1.5	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	10 U

*Sources: USEPA 2011. National Recommended Water Quality Criteria

RL = average reporting limit

B = compound was detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

a= Exceeds acute criterion

b= Exceeds chronic criterion

TABLE 6-9. METAL CONCENTRATIONS (MG/KG) IN SEDIMENT FROM MILL HILL

September 2011

ANALYTE	UNITS	RL	TEL*	PEL*	ERL**	ERM**	MH-Reference	MH-1	MH-2	MH-3	MH-4	MH-5	MH-6	MH-7
ALUMINUM	MG/KG	2.000	--	--	--	--	**640.00**	**740**	**800**	**820**	**770**	**700**	**1200**	**870**
ANTIMONY	MG/KG	0.130	--	--	--	--	**0.097 J**	**0.097 J**	**0.028 J**	**0.022 J**	**0.041 J**	**0.047 J**	**0.035 J**	**0.019 J**
ARSENIC	MG/KG	0.066	7.24	41.6	8.2	70	**0.68**	**0.85**	**0.91**	**0.6**	**0.72**	**0.46**	**1.2**	**0.9**
BARIUM	MG/KG	0.661	--	--	--	--	**4.1 B**	**4.1 B**	**3.1 B**	**3.9 B**	**4.2 B**	**2.6 B**	**5.9 B**	**3.6 B**
BERYLLIUM	MG/KG	0.066	--	--	--	--	**0.062 J**	**0.053 J**	**0.061 J**	**0.047 J**	**0.053 J**	**0.047 J**	**0.077**	**0.055 J**
CADMIUM	MG/KG	0.066	0.676	4.21	1.2	9.6	**0.025 J**	**0.034 J**	**0.033 J**	**0.04 J**	**0.038 J**	**0.034 J**	**0.047 J**	**0.032 J**
CALCIUM	MG/KG	6.613	--	--	--	--	**4100 B**	**24000 B**	**4900 B**	**31000 B**	**10000 B**	**2800 B**	**11000 B**	**6800 B**
CHROMIUM	MG/KG	0.130	52.3	160.4	81	370	**1.9 B**	**2.1 B**	**2.8 B**	**2.4 B**	**2.3 B**	**2.2 B**	**26 B**	**3 B**
COBALT	MG/KG	0.033	--	--	--	--	**1.10**	**1.2**	**1.5**	**1.3**	**1.4**	**0.96**	**1.7**	**1.1**
COPPER	MG/KG	0.130	18.7	108.2	34	270	**2.20**	**1.4**	**1.5**	**1.9**	**12**	**6.7**	**2**	**1.4**
IRON	MG/KG	3.325	--	--	--	--	**1300.0**	**1500**	**1700**	**1600**	**1700**	**1400**	**4900**	**1800**
LEAD	MG/KG	0.066	30.24	112.18	46.7	218	**2.0**	**1.6**	**1.9**	**1.7**	**2**	**1.8**	**2.3**	**1.7**
MAGNESIUM	MG/KG	6.613	--	--	--	--	**320 B**	**450 B**	**380 B**	**600 B**	**930 B**	**910 B**	**2200 B**	**420 B**
MANGANESE	MG/KG	0.333	--	--	--	--	**65 B**	**120 B**	**72 B**	**150 B**	**150 B**	**57 B**	**500 B**	**110 B**
MERCURY	MG/KG	0.007	0.13	0.696	0.15	0.71	0.0071 U	0.0071 U	0.007 U	0.0074 U	0.0072 U	0.0073 U	0.0077 U	0.0074 U
NICKEL	MG/KG	0.066	15.9	42.8	20.9	51.6	**1.60**	**1.5**	**1.7**	**1.5**	**1.7**	**1.4**	**2.3**	**1.6**
POTASSIUM	MG/KG	6.613	--	--	--	--	**140.00**	**160**	**160**	**170**	**160**	**150**	**170**	**170**
SELENIUM	MG/KG	0.257	--	--	--	--	**0.059 J**	**0.048 J**	**0.067 J**	**0.062 J**	0.033 U	**0.059 J**	0.034 U	**0.075 J**
SILVER	MG/KG	0.066	0.73	1.77	1	3.7	**0.011 J**	**0.012 J**	**0.018 J**	**0.01 J**	**0.012 J**	**0.011 J**	**0.015 J**	**0.012 J**
SODIUM	MG/KG	6.613	--	--	--	--	**930.00**	**1100**	**930**	**1300**	**1200**	**1200**	**1300**	**930**
THALLIUM	MG/KG	0.066	--	--	--	--	**0.038 J**	**0.046 J**	**0.053 J**	**0.045 J**	**0.044 J**	**0.029 J**	**0.048 J**	**0.028 J**
VANADIUM	MG/KG	0.066	--	--	--	--	**1.9 B**	**2 B**	**2.5 B**	**2.4 B**	**2.7 B**	**2.5 B**	**13 B**	**2.6 B**
ZINC	MG/KG	0.333	124	271	150	410	**7.4000**	**6.8**	**8.1**	**8.3**	**8.4**	**8**	**12**	**8.5**
CYANIDE, TOTAL	MG/KG	0.101	--	--	--	--	0.066 U	0.064 U	0.064 U	0.067 U	0.065 U	0.065 U	**0.14 J**	0.066 U

***Source:** MacDonald et al. 1996. Ecotoxicology 5: 253-278.

****Source:** Long et al. 1995. Environmental Management 19 (1).

NOTE: Bold and shaded concentrations exceed sediment quality guidelines.

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

RL = average reporting limit

TEL = threshold effects value

PEL = probable effects level

ERL = effects range low

ERM = effects range median

a= exceeds TEL

b= exceeds PEL

c= exceeds ERL

d=exceeds ERM

TABLE 6-10 . METAL CONCENTRATIONS (MG/KG) IN SEDIMENT FROM SEVERN RIVER

October 2011

ANALYTE	UNITS	RL	TEL*	PEL*	ERL**	ERM**	WCU	W2-2	W2-3	W2-4	W2-5	WU
ALUMINUM	MG/KG	2.483	--	--	--	--	**11000**	**8900**	**1100**	**6900**	**1100**	**8000**
ANTIMONY	MG/KG	0.163	--	--	--	--	**0.49 B**	**0.35 B**	**0.046 J B**	**0.28 B**	**0.35 B**	**0.29 B**
ARSENIC	MG/KG	0.083	7.24	41.6	8.2	70	**13 ac**	**8.9 ac**	**1.1**	**7**	**1**	**11 ac**
BARIUM	MG/KG	0.827	--	--	--	--	**23 B**	**22 B**	**5.4 B**	**20 B**	**13 B**	**17 B**
BERYLLIUM	MG/KG	0.083	--	--	--	--	**1.3**	**1.1**	**0.12**	**0.79**	**0.12**	**0.9**
CADMIUM	MG/KG	0.083	0.676	4.21	1.2	9.6	**0.28**	**0.3**	**0.033 J**	**0.27**	**0.06 J**	**0.24**
CALCIUM	MG/KG	59	--	--	--	--	**990 B**	**23000 B**	**28000 B**	**55000 B**	**370000 B**	**4100 B**
CHROMIUM	MG/KG	0.163	52.3	160.4	81	370	**58 B a**	**51 B**	**6.4 B**	**42 B**	**43 B**	**44 B**
COBALT	MG/KG	0.042	--	--	--	--	**14**	**12**	**2**	**9.8**	**1.6**	**11**
COPPER	MG/KG	0.163	18.7	108.2	34	270	**24 a**	**23 a**	**2.7**	**17**	**3.3**	**17**
IRON	MG/KG	4.167	--	--	--	--	**40000 B**	**33000 B**	**3500 B**	**25000 B**	**10000 B**	**30000 B**
LEAD	MG/KG	0.083	30.24	112.18	46.7	218	**33 B a**	**27 B**	**3.4 B**	**27 B**	**17 B**	**24 B**
MAGNESIUM	MG/KG	8.267	--	--	--	--	**3700 B**	**4000 B**	**910 B**	**3300 B**	**4000 B**	**3000 B**
MANGANESE	MG/KG	2.865	--	--	--	--	**770 B**	**1200 B**	**320 B**	**1500 B**	**2400 B**	**720 B**
MERCURY	MG/KG	0.028	0.13	0.696	0.15	0.71	**0.12**	**0.11**	**0.0098 J**	**0.087**	**0.045**	**0.11**
NICKEL	MG/KG	0.083	15.9	42.8	20.9	51.6	**21 ac**	**19 a**	**2.2**	**15**	**0.13**	**17 a**
POTASSIUM	MG/KG	8.267	--	--	--	--	**4000**	**3200**	**370**	**2500**	**350**	**2900**
SELENIUM	MG/KG	0.366	--	--	--	--	**0.93**	**0.75**	0.034 U	**0.61**	**0.12 J**	**0.75**
SILVER	MG/KG	0.083	0.73	1.77	1	3.7	**0.22**	**0.16**	**0.016 J**	**0.13**	**0.023 J**	**0.16**
SODIUM	MG/KG	8.267	--	--	--	--	**2100 B**	**2000 B**	**770 B**	**1600 B**	**2300 B**	**2100 B**
THALLIUM	MG/KG	0.083	--	--	--	--	**0.089 J**	**0.086 J**	**0.035 J**	**0.082**	**0.017 J**	**0.072 J**
VANADIUM	MG/KG	0.083	--	--	--	--	**56**	**48**	**5.5**	**38**	**23**	**42**
ZINC	MG/KG	0.417	124	271	150	410	**140 a**	**120**	**19**	**110**	**15**	**110**
CYANIDE, TOTAL	MG/KG	0.367	--	--	--	--	**0.18 J B**	**0.19 J B**	**0.27 J B**	**0.11 J B**	**0.41 B**	0.089 U

***Source:** MacDonald et al. 1996. Ecotoxicology 5: 253-278.

****Source:** Long et al. 1995. Environmental Management 19 (1).

NOTE: Bold and shaded concentrations exceed sediment quality guidelines.

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

RL = average reporting limit

TEL = threshold effects value

PEL = probable effects level

ERL = effects range low

ERM = effects range median

a= exceeds TEL

b= exceeds PEL

c= exceeds ERL

d=exceeds ERM

TABLE 6-11. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR MILL HILL STATION MH-REFERENCE

September 2011

			Mill Hill Station MH-Reference				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.750	**15**	**23**	**11**	**36**	**31**
ANTIMONY	MG/KG	0.183	0.19 U	**0.12 J**	**0.013 J**	**0.0065 J**	0.16 U
ARSENIC	MG/KG	0.092	**0.54**	**1.1**	**0.7**	**1**	**1**
BARIUM	MG/KG	0.916	**0.17 J**	**0.22 J**	**0.11 J**	**0.31 J**	**0.33 J**
BERYLLIUM	MG/KG	0.092	0.095 U	0.092 U	0.096 U	0.091 U	0.081 U
CADMIUM	MG/KG	0.092	**0.11**	**0.22**	**0.13**	**0.24**	**0.2**
CALCIUM	MG/KG	9.155	**600 B**	**780 B**	**400 B**	**1200 B**	**1500 B**
CHROMIUM	MG/KG	0.183	**0.068 J**	**0.056 J**	**0.055 J**	**0.078 J**	**0.075 J**
COBALT	MG/KG	0.046	**0.057**	**0.079**	**0.057**	**0.1**	**0.092**
COPPER	MG/KG	0.183	**6.3**	**10**	**5.8**	**8.4**	**7.3**
IRON	MG/KG	4.583	**35**	**58**	**31**	**80**	**75**
LEAD	MG/KG	0.092	**0.053 J B**	**0.074 J B**	**0.041 J B**	**0.099 B**	**0.084 B**
MAGNESIUM	MG/KG	9.155	**290 B**	**270 B**	**280 B**	**280 B**	**270 B**
MANGANESE	MG/KG	0.458	**7 B**	**8.8 B**	**7.7 B**	**14 B**	**13 B**
MERCURY	MG/KG	0.032	0.033 U	**0.014 J**	**0.014 J**	**0.015 J**	**0.015 J**
NICKEL	MG/KG	0.092	**0.54**	**0.53**	**0.53**	**0.54**	**0.51**
POTASSIUM	MG/KG	9.155	**960**	**1400**	**1300**	**1500**	**1500**
SELENIUM	MG/KG	0.458	**0.3 J**	**0.63**	**0.44 J**	**0.62**	**0.62**
SILVER	MG/KG	0.092	**0.064 J**	**0.12**	**0.075 J**	**0.1**	**0.098**
SODIUM	MG/KG	9.155	**1800**	**1300**	**1600**	**1300**	**1200**
THALLIUM	MG/KG	0.092	0.095 U	0.092 U	**0.0086 J**	**0.0045 J**	**0.002 J**
VANADIUM	MG/KG	0.092	**0.078 J**	**0.1**	**0.053 J**	**0.12**	**0.12**
ZINC	MG/KG	0.458	**180 B**	**260 B**	**150 B**	**260 B**	**230 B**
CYANIDE, TOTAL	MG/KG	0.495	0.49 U	0.5 U	0.49 U	0.5 U	0.5 U

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-12. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR MILL HILL STATION MH-1

September 2011

			Mill Hill Station MH-1				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.750	**10**	**8.6**	**11**	**9.3**	**8.4**
ANTIMONY	MG/KG	0.183	**0.007 J**	**0.11 J**	**0.03 J**	**0.012 J**	**0.0049 J**
ARSENIC	MG/KG	0.092	**0.98**	**0.91**	**1**	**1**	**0.87**
BARIUM	MG/KG	0.916	**0.18 J**	**0.18 J**	**0.39 J**	**0.18 J**	**0.16 J**
BERYLLIUM	MG/KG	0.092	0.095 U	0.091 U	0.091 U	0.089 U	0.081 U
CADMIUM	MG/KG	0.092	**0.33**	**0.32**	**0.41**	**0.26**	**0.22**
CALCIUM	MG/KG	9.155	**1200 B**	**720 B**	**1300 B**	**1400 B**	**720 B**
CHROMIUM	MG/KG	0.183	**0.11 J B**	**0.12 J B**	**0.14 J B**	**0.064 J B**	**0.058 J B**
COBALT	MG/KG	0.046	**0.089**	**0.092**	**0.11**	**0.11**	**0.092**
COPPER	MG/KG	0.183	**11**	**8.9**	**11**	**12**	**9.6**
IRON	MG/KG	4.583	**43**	**35**	**42**	**41**	**35**
LEAD	MG/KG	0.092	**0.044 J B**	**0.045 J B**	**0.053 J B**	**0.049 J B**	**0.041 J B**
MAGNESIUM	MG/KG	9.155	**280 B**	**280 B**	**300 B**	**270 B**	**280 B**
MANGANESE	MG/KG	0.458	**5.5 B**	**5.1 B**	**10 B**	**5.6 B**	**5.4 B**
MERCURY	MG/KG	0.032	**0.013 J**	**0.012 J**	**0.017 J**	**0.014 J**	**0.014 J**
NICKEL	MG/KG	0.092	**0.49**	**0.52**	**0.49**	**0.53**	**0.51**
POTASSIUM	MG/KG	9.155	**1400**	**1300**	**1400**	**1500**	**1400**
SELENIUM	MG/KG	0.458	**0.5**	**0.51**	**0.63**	**0.57**	**0.51**
SILVER	MG/KG	0.092	**0.12**	**0.099**	**0.12**	**0.13**	**0.12**
SODIUM	MG/KG	9.155	**1400**	**1500**	**1500**	**1300**	**1400**
THALLIUM	MG/KG	0.092	**0.0062 J**	0.091 U	0.091 U	0.089 U	0.081 U
VANADIUM	MG/KG	0.092	**0.07 J B**	**0.081 J B**	**0.074 J B**	**0.058 J B**	**0.061 J B**
ZINC	MG/KG	0.458	**380**	**330**	**380**	**420**	**340**
CYANIDE, TOTAL	MG/KG	0.495	**0.45 J**	0.49 U	**0.11 J**	**0.31 J**	**0.32 J**

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-13. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR MILL HILL STATION MH-2

September 2011

			Mill Hill Station MH-2				
					Sample C		
ANALYTE	**UNITS**	**RL**	**Sample A**	**Sample B**	**C**	**Duplicate**	**Triplicate**
ALUMINUM	MG/KG	2.750	**9.6**	**19**	**18**	**17**	**18**
ANTIMONY	MG/KG	0.183	0.19 U	0.17 U	0.19 U	0.19 U	0.19 U
ARSENIC	MG/KG	0.092	**1**	**1.2**	**1**	**1.1**	**0.75**
BARIUM	MG/KG	0.916	**0.2 J**	**0.23 J**	**0.2 J**	**0.17 J**	**0.19 J**
BERYLLIUM	MG/KG	0.092	0.097 U	0.083 U	0.095 U	0.094 U	0.093 U
CADMIUM	MG/KG	0.092	**0.34**	**0.2**	**0.2**	**0.23**	**0.16**
CALCIUM	MG/KG	9.155	**840 B**	**1100 B**	**680 B**	**770 B**	**650 B**
CHROMIUM	MG/KG	0.183	**0.1 J B**	**0.11 J B**	**0.14 J B**	**0.12 J B**	**0.18 J B**
COBALT	MG/KG	0.046	**0.075**	**0.073**	**0.068**	**0.063**	**0.065**
COPPER	MG/KG	0.183	**19**	**15**	**11**	**13**	**8.1**
IRON	MG/KG	4.583	**44**	**60**	**50**	**50**	**45**
LEAD	MG/KG	0.092	**0.049 J B**	**0.075 J B**	**0.066 J B**	**0.063 J B**	**0.056 J B**
MAGNESIUM	MG/KG	9.155	**290 B**	**280 B**	**270 B**	**270 B**	**260 B**
MANGANESE	MG/KG	0.458	**6 B**	**9.3 B**	**8.9 B**	**8.9 B**	**7.9 B**
MERCURY	MG/KG	0.032	**0.013 J**	**0.014 J**	**0.014 J**	**0.016 J**	**0.012 J**
NICKEL	MG/KG	0.092	**0.47**	**0.5**	**0.54**	**0.54**	**0.51**
POTASSIUM	MG/KG	9.155	**1400**	**1500**	**1300**	**1400**	**1200**
SELENIUM	MG/KG	0.458	**0.58**	**0.68**	**0.55**	**0.54**	**0.46**
SILVER	MG/KG	0.092	**0.16**	**0.16**	**0.11**	**0.13**	**0.1**
SODIUM	MG/KG	9.155	**1500**	**1300**	**1400**	**1300**	**1400**
THALLIUM	MG/KG	0.092	0.097 U	0.083 U	0.095 U	0.094 U	0.093 U
VANADIUM	MG/KG	0.092	**0.12 B**	**0.11 B**	**0.099 B**	**0.065 J B**	**0.084 J B**
ZINC	MG/KG	0.458	**500**	**280**	**200**	**240**	**250**
CYANIDE, TOTAL	MG/KG	0.495	**0.36 J**	0.5 U	**0.11 J**	**0.13 J**	0.48 U

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-14. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR MILL HILL STATION MH-3

September 2011

			Mill Hill Station MH-3				
					Sample C		
ANALYTE	**UNITS**	**RL**	**Sample A**	**Sample B**	**C**	**Duplicate**	**Triplicate**
ALUMINUM	MG/KG	2.750	**64**	**41**	**31**	**54**	**46**
ANTIMONY	MG/KG	0.183	0.18 U	**0.11 J**	**0.015 J**	**0.0062 J**	0.19 U
ARSENIC	MG/KG	0.092	**1**	**0.88**	**0.9**	**1.3**	**0.78**
BARIUM	MG/KG	0.916	**0.53 J**	**0.33 J**	**0.23 J**	**0.6 J**	**0.28 J**
BERYLLIUM	MG/KG	0.092	0.088 U	0.083 U	0.088 U	0.092 U	0.093 U
CADMIUM	MG/KG	0.092	**0.22**	**0.19**	**0.2**	**0.23**	**0.15**
CALCIUM	MG/KG	9.155	**3700 B**	**2100 B**	**1400 B**	**3800 B**	**990 B**
CHROMIUM	MG/KG	0.183	**0.29 B**	**0.19 B**	**0.15 J B**	**0.27 B**	**0.2 B**
COBALT	MG/KG	0.046	**0.094**	**0.083**	**0.079**	**0.1**	**0.076**
COPPER	MG/KG	0.183	**8.3**	**8**	**7.4**	**10**	**5.9**
IRON	MG/KG	4.583	**110**	**80**	**65**	**110**	**83**
LEAD	MG/KG	0.092	**0.14 B**	**0.1 B**	**0.084 J B**	**0.14 B**	**0.11 B**
MAGNESIUM	MG/KG	9.155	**320 B**	**300 B**	**290 B**	**360 B**	**300 B**
MANGANESE	MG/KG	0.458	**20 B**	**14 B**	**13 B**	**24 B**	**15 B**
MERCURY	MG/KG	0.032	0.032 U	**0.013 J**	**0.012 J**	**0.014 J**	**0.013 J**
NICKEL	MG/KG	0.092	**0.58**	**0.51**	**0.53**	**0.58**	**0.58**
POTASSIUM	MG/KG	9.155	**1400**	**1400**	**1400**	**1500**	**1200**
SELENIUM	MG/KG	0.458	**0.56**	**0.52**	**0.5**	**0.68**	**0.44 J**
SILVER	MG/KG	0.092	**0.1**	**0.1**	**0.092**	**0.13**	**0.073 J**
SODIUM	MG/KG	9.155	**1400**	**1400**	**1400**	**1400**	**1600**
THALLIUM	MG/KG	0.092	0.088 U	0.083 U	**0.0072 J**	**0.0055 J**	**0.0024 J**
VANADIUM	MG/KG	0.092	**0.18 B**	**0.099 B**	**0.14 B**	**0.17 B**	**0.18 B**
ZINC	MG/KG	0.458	**170**	**170**	**200**	**210**	**120**
CYANIDE, TOTAL	MG/KG	0.495	**0.12 J**	**0.15 J**	**0.28 J**	**0.22 J**	0.5 U

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-15. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR MILL HILL STATION MH-4

September 2011

			Mill Hill Station MH-4				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.750	**12**	**26**	**13**	**20**	**20**
ANTIMONY	MG/KG	0.183	0.19 U	0.19 U	0.18 U	**0.13 J**	**0.025 J**
ARSENIC	MG/KG	0.092	**0.94**	**1**	**0.91**	**0.97**	**1.1**
BARIUM	MG/KG	0.916	**0.15 J**	**0.27 J**	**0.13 J**	**0.24 J**	**0.22 J**
BERYLLIUM	MG/KG	0.092	0.095 U	0.097 U	0.091 U	0.096 U	0.086 U
CADMIUM	MG/KG	0.092	**0.24**	**0.24**	**0.19**	**0.21**	**0.24**
CALCIUM	MG/KG	9.155	**1100 B**	**1600 B**	**620 B**	**1500 B**	**730 B**
CHROMIUM	MG/KG	0.183	**0.11 J B**	**0.23 B**	**0.12 J B**	**0.14 J B**	**0.11 J B**
COBALT	MG/KG	0.046	**0.07**	**0.074**	**0.053**	**0.057**	**0.076**
COPPER	MG/KG	0.183	**8.5**	**8.6**	**8.3**	**7.7**	**7.9**
IRON	MG/KG	4.583	**36**	**57**	**37**	**48**	**51**
LEAD	MG/KG	0.092	**0.054 J B**	**0.084 J B**	**0.056 J B**	**0.075 J B**	**0.069 J B**
MAGNESIUM	MG/KG	9.155	**280 B**	**280 B**	**260 B**	**280 B**	**290 B**
MANGANESE	MG/KG	0.458	**6.5 B**	**11 B**	**7.3 B**	**8.2 B**	**8.5 B**
MERCURY	MG/KG	0.032	**0.012 J**	**0.012 J**	**0.013 J**	**0.012 J**	**0.014 J**
NICKEL	MG/KG	0.092	**0.48**	**0.52**	**0.46**	**0.48**	**0.53**
POTASSIUM	MG/KG	9.155	**1400**	**1400**	**1300**	**1300**	**1500**
SELENIUM	MG/KG	0.458	**0.52**	**0.55**	**0.49**	**0.51**	**0.58**
SILVER	MG/KG	0.092	**0.1**	**0.097**	**0.083 J**	**0.088 J**	**0.089**
SODIUM	MG/KG	9.155	**1400**	**1300**	**1300**	**1400**	**1300**
THALLIUM	MG/KG	0.092	0.095 U	0.097 U	0.091 U	0.096 U	0.086 U
VANADIUM	MG/KG	0.092	**0.06 J B**	**0.12 B**	**0.072 J B**	**0.1 B**	**0.12 B**
ZINC	MG/KG	0.458	**250**	**210**	**190**	**180**	**240**
CYANIDE, TOTAL	MG/KG	0.495	**0.11 J**	**0.13 J**	0.51 U	**0.15 J**	0.49 U

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-16. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR MILL HILL STATION MH-5

September 2011

			Mill Hill Station MH-5				
					Sample C		
ANALYTE	**UNITS**	**RL**	**Sample A**	**Sample B**	**C**	**Duplicate**	**Triplicate**
ALUMINUM	MG/KG	2.750	**13**	**15**	**50**	**8**	**12**
ANTIMONY	MG/KG	0.183	**0.015 J**	**0.0049 J**	**0.004 J**	0.18 U	0.2 U
ARSENIC	MG/KG	0.092	**0.97**	**0.9**	**0.82**	**0.81**	**0.92**
BARIUM	MG/KG	0.916	**0.2 J**	**0.2 J**	**0.21 J**	**0.15 J**	**0.16 J**
BERYLLIUM	MG/KG	0.092	0.093 U	0.089 U	0.1 U	0.092 U	0.098 U
CADMIUM	MG/KG	0.092	**0.21**	**0.18**	**0.14**	**0.22**	**0.16**
CALCIUM	MG/KG	9.155	**410 B**	**1200 B**	**390 B**	**580 B**	**680 B**
CHROMIUM	MG/KG	0.183	**0.073 J**	**0.12 J**	**0.13 J**	**0.078 J**	**0.063 J**
COBALT	MG/KG	0.046	**0.1**	**0.098**	**0.67**	**0.069**	**0.067**
COPPER	MG/KG	0.183	**13**	**14**	**7.6**	**7.9**	**4.4**
IRON	MG/KG	4.583	**49**	**49**	**150**	**37**	**41**
LEAD	MG/KG	0.092	**0.056 J B**	**0.058 J B**	**0.083 J B**	**0.042 J B**	**0.056 J B**
MAGNESIUM	MG/KG	9.155	**300 B**	**290 B**	**400 B**	**270 B**	**290 B**
MANGANESE	MG/KG	0.458	**7.7 B**	**9.4 B**	**10 B**	**4.2 B**	**6.3 B**
MERCURY	MG/KG	0.032	**0.014 J**	**0.014 J**	**0.013 J**	**0.015 J**	**0.011 J**
NICKEL	MG/KG	0.092	**0.53**	**0.55**	**0.61**	**0.48**	**0.52**
POTASSIUM	MG/KG	9.155	**1300**	**1300**	**1100**	**1100**	**1400**
SELENIUM	MG/KG	0.458	**0.58**	**0.47**	**0.41 J**	**0.43 J**	**0.6**
SILVER	MG/KG	0.092	**0.16**	**0.14**	**0.086 J**	**0.086 J**	**0.098**
SODIUM	MG/KG	9.155	**1500**	**1500**	**1500**	**1400**	**1500**
THALLIUM	MG/KG	0.092	**0.0053 J**	**0.0021 J**	0.1 U	0.092 U	0.098 U
VANADIUM	MG/KG	0.092	**0.045 J**	**0.072 J**	**0.15**	**0.031 J**	**0.059 J**
ZINC	MG/KG	0.458	**430 B**	**400 B**	**170 B**	**260 B**	**210 B**
CYANIDE, TOTAL	MG/KG	0.495	0.51 U	0.48 U	0.48 U	**0.42 J**	0.48 U

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-17. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR MILL HILL STATION MH-6

September 2011

			Mill Hill Station MH-6				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.750	**20**	**17**	**11**	**13**	**19**
ANTIMONY	MG/KG	0.183	0.19 U	**0.12 J**	**0.028 J**	**0.013 J**	**0.008 J**
ARSENIC	MG/KG	0.092	**1**	**0.95**	**1**	**1.1**	**0.97**
BARIUM	MG/KG	0.916	**0.28 J**	**0.25 J**	**0.17 J**	**0.22 J**	**0.23 J**
BERYLLIUM	MG/KG	0.092	0.097 U	0.095 U	0.087 U	0.092 U	0.098 U
CADMIUM	MG/KG	0.092	**0.29**	**0.21**	**0.23**	**0.32**	**0.26**
CALCIUM	MG/KG	9.155	**2400 B**	**1700 B**	**580 B**	**1400 B**	**740 B**
CHROMIUM	MG/KG	0.183	**0.1 J**	**0.12 J**	**0.051 J**	**0.077 J**	**0.054 J**
COBALT	MG/KG	0.046	**0.099**	**0.074**	**0.072**	**0.1**	**0.094**
COPPER	MG/KG	0.183	**7.9**	**7.6**	**11**	**9.6**	**7**
IRON	MG/KG	4.583	**69**	**74**	**46**	**62**	**57**
LEAD	MG/KG	0.092	**0.066 J B**	**0.062 J B**	**0.053 J B**	**0.059 J B**	**0.069 J B**
MAGNESIUM	MG/KG	9.155	**300 B**	**290 B**	**270 B**	**300 B**	**290 B**
MANGANESE	MG/KG	0.458	**9.4 B**	**10 B**	**6.5 B**	**7.2 B**	**8.2 B**
MERCURY	MG/KG	0.032	0.032 U	**0.013 J**	**0.01 J**	**0.016 J**	**0.014 J**
NICKEL	MG/KG	0.092	**0.48**	**0.52**	**0.47**	**0.49**	**0.53**
POTASSIUM	MG/KG	9.155	**1400**	**1300**	**1300**	**1400**	**1400**
SELENIUM	MG/KG	0.458	**0.64**	**0.52**	**0.55**	**0.64**	**0.65**
SILVER	MG/KG	0.092	**0.12**	**0.1**	**0.11**	**0.11**	**0.098**
SODIUM	MG/KG	9.155	**1400**	**1400**	**1300**	**1400**	**1400**
THALLIUM	MG/KG	0.092	0.097 U	0.095 U	0.087 U	0.092 U	0.098 U
VANADIUM	MG/KG	0.092	**0.14**	**0.082 J**	**0.083 J**	**0.093**	**0.095 J**
ZINC	MG/KG	0.458	**370 B**	**230 B**	**330 B**	**410 B**	**290 B**
CYANIDE, TOTAL	MG/KG	0.495	0.49 U	0.5 U	0.48 U	0.5 U	0.52 U

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-18. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR MILL HILL STATION MH-7

September 2011

			Mill Hill Station MH-7				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.750	**14**	**12**	**14**	**23**	**19**
ANTIMONY	MG/KG	0.183	0.2 U	0.18 U	0.17 U	0.18 U	0.18 U
ARSENIC	MG/KG	0.092	**0.76**	**0.81**	**1**	**0.93**	**0.96**
BARIUM	MG/KG	0.916	**0.15 J**	**0.16 J**	**0.17 J**	**0.32 J**	**0.48 J**
BERYLLIUM	MG/KG	0.092	0.098 U	0.088 U	0.083 U	0.091 U	0.088 U
CADMIUM	MG/KG	0.092	**0.16**	**0.19**	**0.26**	**0.24**	**0.3**
CALCIUM	MG/KG	9.155	**610 B**	**800 B**	**680 B**	**3400 B**	**1900 B**
CHROMIUM	MG/KG	0.183	**0.059 J**	**0.032 J**	**0.0067 J**	**0.079 J**	**0.07 J**
COBALT	MG/KG	0.046	**0.094**	**0.095**	**0.097**	**0.092**	**0.1**
COPPER	MG/KG	0.183	**5.2**	**5.5**	**6.5**	**10**	**8.7**
IRON	MG/KG	4.583	**40**	**40**	**47**	**62**	**53**
LEAD	MG/KG	0.092	**0.055 J B**	**0.05 J B**	**0.057 J B**	**0.078 J B**	**0.067 J B**
MAGNESIUM	MG/KG	9.155	**280 B**	**290 B**	**270 B**	**300 B**	**300 B**
MANGANESE	MG/KG	0.458	**6 B**	**5.8 B**	**6.2 B**	**11 B**	**15 B**
MERCURY	MG/KG	0.032	**0.014 J**	**0.011 J**	**0.014 J**	**0.015 J**	**0.014 J**
NICKEL	MG/KG	0.092	**0.53**	**0.54**	**0.46**	**0.48**	**0.51**
POTASSIUM	MG/KG	9.155	**1300**	**1400**	**1400**	**1400**	**1400**
SELENIUM	MG/KG	0.458	**0.58**	**0.45**	**0.47**	**0.54**	**0.58**
SILVER	MG/KG	0.092	**0.11**	**0.09**	**0.078 J**	**0.095**	**0.097**
SODIUM	MG/KG	9.155	**1500**	**1500**	**1300**	**1400**	**1400**
THALLIUM	MG/KG	0.092	0.098 U	0.088 U	0.083 U	0.091 U	0.088 U
VANADIUM	MG/KG	0.092	**0.073 J**	**0.055 J**	**0.052 J**	**0.089 J**	**0.068 J**
ZINC	MG/KG	0.458	**330 B**	**230 B**	**270 B**	**290 B**	**400 B**
CYANIDE, TOTAL	MG/KG	0.495	0.49 U	0.51 U	**0.16 J**	**0.13 J**	0.51 U

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-19. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR SEVERN RIVER STATION WEEMS CREEK UPPER

October 2011

			Severn River Station Weems Creek Upper				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.757	**19**	**8.6**	**16**	**16**	**12**
ANTIMONY	MG/KG	0.183	**0.0065 J**	0.18 U	0.19 U	0.2 U	0.19 U
ARSENIC	MG/KG	0.092	**0.87**	**0.66**	**0.74**	**0.7**	**0.77**
BARIUM	MG/KG	0.916	**0.17 J**	**0.092 J**	**0.19 J**	**0.18 J**	**0.12 J**
BERYLLIUM	MG/KG	0.092	0.092 U	0.09 U	0.093 U	0.099 U	0.094 U
CADMIUM	MG/KG	0.092	**0.53**	**0.4**	**0.5**	**0.44**	**0.47**
CALCIUM	MG/KG	9.157	**830**	**340**	**1000**	**1200**	**770**
CHROMIUM	MG/KG	0.183	**0.2 B**	**0.14 J B**	**0.17 J B**	**0.23 B**	**0.13 J B**
COBALT	MG/KG	0.046	**0.052**	**0.039 J**	**0.045 J**	**0.052**	**0.045 J**
COPPER	MG/KG	0.183	**47**	**26**	**51**	**38**	**47**
IRON	MG/KG	4.587	**70**	**38**	**60**	**57**	**45**
LEAD	MG/KG	0.092	**0.097**	**0.056 J**	**0.082 J**	**0.079 J**	**0.069 J**
MAGNESIUM	MG/KG	9.157	**200 B**	**190 B**	**200 B**	**210 B**	**200 B**
MANGANESE	MG/KG	0.459	**6.4**	**3.9**	**7.3**	**7**	**4.7**
MERCURY	MG/KG	0.033	0.032 U	0.031 U	0.033 U	0.03 U	0.031 U
NICKEL	MG/KG	0.092	**0.43**	**0.48**	**0.51**	**0.47**	**0.44**
POTASSIUM	MG/KG	9.157	**890**	**850**	**810**	**880**	**910**
SELENIUM	MG/KG	0.459	**0.46**	**0.36 J**	**0.4 J**	**0.41 J**	**0.4 J**
SILVER	MG/KG	0.092	**0.29**	**0.25**	**0.29**	**0.28**	**0.28**
SODIUM	MG/KG	9.157	**650**	**700**	**700**	**730**	**700**
THALLIUM	MG/KG	0.092	0.092 U	0.09 U	0.093 U	0.099 U	0.094 U
VANADIUM	MG/KG	0.092	**0.049 J**	**0.02 J**	**0.032 J**	0.099 U	0.094 U
ZINC	MG/KG	0.459	**430 B**	**380 B**	**400 B**	**450 B**	**440 B**
CYANIDE, TOTAL	MG/KG	0.492	**0.16 J**	**0.21 J**	0.49 U	0.48 U	**0.83**

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-20. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR SEVERN RIVER STATION WADE 2-2

October 2011

			Severn River Station WADE 2-2				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.757	**30**	**17**	**17**	**20**	**20**
ANTIMONY	MG/KG	0.183	**0.025 J B**	**0.013 J B**	**0.0048 J B**	**0.0056 J B**	**0.005 J B**
ARSENIC	MG/KG	0.092	**0.88**	**0.82**	**0.7**	**0.87**	**0.74**
BARIUM	MG/KG	0.916	**0.59 J**	**0.22 J**	**0.2 J**	**0.21 J**	**0.2 J**
BERYLLIUM	MG/KG	0.092	0.094 U	0.093 U	0.095 U	0.087 U	0.099 U
CADMIUM	MG/KG	0.092	**0.54**	**0.43**	**0.43**	**0.51**	**0.35**
CALCIUM	MG/KG	9.157	**6600**	**1900**	**1600**	**1100**	**1100**
CHROMIUM	MG/KG	0.183	**0.3 B**	**0.17 J B**	**0.42 B**	**0.18 B**	**0.18 J B**
COBALT	MG/KG	0.046	**0.074**	**0.055**	**0.056**	**0.059**	**0.056**
COPPER	MG/KG	0.183	**34**	**29**	**26**	**32**	**24**
IRON	MG/KG	4.587	**120**	**78**	**110**	**95**	**92**
LEAD	MG/KG	0.092	**0.14 B**	**0.1 B**	**0.092 J B**	**0.12 B**	**0.11 B**
MAGNESIUM	MG/KG	9.157	**280 B**	**230 B**	**250 B**	**220 B**	**230 B**
MANGANESE	MG/KG	0.459	**16**	**7.5**	**13**	**7.9**	**7.6**
MERCURY	MG/KG	0.033	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U
NICKEL	MG/KG	0.092	**0.53**	**0.58**	**0.55**	**0.53**	**0.59**
POTASSIUM	MG/KG	9.157	**880**	**840**	**840**	**940**	**810**
SELENIUM	MG/KG	0.459	**0.45 J**	**0.39 J**	**0.37 J**	**0.44**	**0.38 J**
SILVER	MG/KG	0.092	**0.21**	**0.2**	**0.18**	**0.19**	**0.17**
SODIUM	MG/KG	9.157	**710**	**710**	**720**	**670**	**750**
THALLIUM	MG/KG	0.092	**0.0067 J**	**0.0036 J**	**0.002 J**	**0.0019 J**	0.099 U
VANADIUM	MG/KG	0.092	**0.087 J**	**0.093**	**0.24**	0.087 U	0.099 U
ZINC	MG/KG	0.459	**350**	**300**	**310**	**320**	**270**
CYANIDE, TOTAL	MG/KG	0.492	**0.42 J**	**0.19 J**	0.51 U	**0.35 J**	**0.64**

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-21. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR SEVERN RIVER STATION WADE 2-3

October 2011

			Severn River Station Wade 2-3				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.757	**28**	**43**	**31**	**35**	**60**
ANTIMONY	MG/KG	0.183	**0.0047 J B**	**0.0046 J B**	0.19 U	**0.12 J B**	**0.019 J B**
ARSENIC	MG/KG	0.092	**0.83**	**1.2**	**0.61**	**0.75**	**0.87**
BARIUM	MG/KG	0.916	**0.2 J**	**0.22 J**	**0.19 J**	**0.18 J**	**0.29 J**
BERYLLIUM	MG/KG	0.092	0.086 U	0.084 U	0.097 U	0.09 U	**0.0075 J**
CADMIUM	MG/KG	0.092	**0.57**	**0.63**	**0.53**	**0.57**	**0.53**
CALCIUM	MG/KG	9.157	**1300**	**410**	**320**	**310**	**510**
CHROMIUM	MG/KG	0.183	**0.21 B**	**0.28 B**	**0.32 B**	**0.25 B**	**0.4 B**
COBALT	MG/KG	0.046	**0.11**	**0.14**	**0.1**	**0.12**	**0.14**
COPPER	MG/KG	0.183	**66**	**71**	**51**	**39**	**68**
IRON	MG/KG	4.587	**120**	**180**	**140**	**160**	**230**
LEAD	MG/KG	0.092	**0.15 B**	**0.2 B**	**0.15 B**	**0.17 B**	**0.23 B**
MAGNESIUM	MG/KG	9.157	**210 B**	**220 B**	**200 B**	**200 B**	**200 B**
MANGANESE	MG/KG	0.459	**6.7**	**9.7**	**7**	**8.3**	**10**
MERCURY	MG/KG	0.033	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U
NICKEL	MG/KG	0.092	**0.52**	**0.53**	**0.56**	**0.51**	**0.56**
POTASSIUM	MG/KG	9.157	**920**	**870**	**710**	**810**	**820**
SELENIUM	MG/KG	0.459	**0.43**	**0.48**	**0.34 J**	**0.42 J**	**0.45**
SILVER	MG/KG	0.092	**0.42**	**0.38**	**0.36**	**0.39**	**0.37**
SODIUM	MG/KG	9.157	**690**	**670**	**730**	**670**	**640**
THALLIUM	MG/KG	0.092	0.086 U	0.084 U	0.097 U	0.09 U	**0.0081 J**
VANADIUM	MG/KG	0.092	**0.12**	**0.14**	**0.13**	**0.13**	**0.21**
ZINC	MG/KG	0.459	**630**	**630**	**570**	**660**	**560**
CYANIDE, TOTAL	MG/KG	0.492	**0.73**	0.5 U	**0.36 J**	**0.43 J**	**1.4**

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-22. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR SEVERN RIVER STATION WADE 2-4

October 2011

			Severn River Station Wade 2-4				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.757	**26**	**25**	**29**	**23**	**11**
ANTIMONY	MG/KG	0.183	**0.0072 J B**	**0.0037 J B**	**0.0032 J B**	0.19 U	0.18 U
ARSENIC	MG/KG	0.092	**0.75**	**0.82**	**0.86**	**0.83**	**0.5**
BARIUM	MG/KG	0.916	**0.3 J**	**0.66 J**	**0.36 J**	**0.25 J**	**0.12 J**
BERYLLIUM	MG/KG	0.092	0.099 U	0.092 U	0.089 U	0.096 U	0.088 U
CADMIUM	MG/KG	0.092	**0.49**	**0.63**	**0.6**	**0.52**	**0.3**
CALCIUM	MG/KG	9.157	**1400**	**11000**	**3600**	**1600**	**390**
CHROMIUM	MG/KG	0.183	**0.36 B**	**0.23 B**	**0.28 B**	**0.24 B**	**0.17 J B**
COBALT	MG/KG	0.046	**0.061**	**0.067**	**0.068**	**0.058**	**0.036 J**
COPPER	MG/KG	0.183	**33**	**35**	**31**	**32**	**19**
IRON	MG/KG	4.587	**97**	**99**	**110**	**93**	**43**
LEAD	MG/KG	0.092	**0.12 B**	**0.14 B**	**0.14 B**	**0.12 B**	**0.072 J B**
MAGNESIUM	MG/KG	9.157	**220 B**	**300 B**	**240 B**	**210 B**	**200 B**
MANGANESE	MG/KG	0.459	**12**	**12**	**11**	**9.5**	**6.9**
MERCURY	MG/KG	0.033	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U
NICKEL	MG/KG	0.092	**0.63**	**0.47**	**0.52**	**0.52**	**0.63**
POTASSIUM	MG/KG	9.157	**820**	**860**	**920**	**940**	**630**
SELENIUM	MG/KG	0.459	**0.43 J**	**0.46**	**0.42 J**	**0.48**	**0.29 J**
SILVER	MG/KG	0.092	**0.18**	**0.2**	**0.19**	**0.19**	**0.099**
SODIUM	MG/KG	9.157	**730**	**690**	**660**	**630**	**850**
THALLIUM	MG/KG	0.092	**0.005 J**	**0.0024 J**	**0.002 J**	0.096 U	0.088 U
VANADIUM	MG/KG	0.092	**0.044 J**	**0.13**	**0.057 J**	**0.057 J**	**0.043 J**
ZINC	MG/KG	0.459	**290**	**330**	**310**	**320**	**190**
CYANIDE, TOTAL	MG/KG	0.492	**0.2 J**	**0.23 J**	**0.41 J**	**0.52**	**0.1 J**

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-23. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR SEVERN RIVER STATION WADE 2-5

October 2011

			Severn River Station Wade 2-5				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.757	**23**	**22**	**11**	**22**	**12**
ANTIMONY	MG/KG	0.183	**0.12 J B**	**0.027 J B**	**0.01 J B**	**0.0057 J B**	0.17 U
ARSENIC	MG/KG	0.092	**0.87**	**0.82**	**0.51**	**0.86**	**0.75**
BARIUM	MG/KG	0.916	**0.22 J**	**0.24 J**	**0.13 J**	**0.27 J**	**0.15 J**
BERYLLIUM	MG/KG	0.092	0.085 U	0.091 U	0.085 U	0.088 U	0.087 U
CADMIUM	MG/KG	0.092	**0.45**	**0.5**	**0.33**	**0.53**	**0.37**
CALCIUM	MG/KG	9.157	**980**	**1300**	**430**	**1300**	**450**
CHROMIUM	MG/KG	0.183	**0.2 B**	**0.23 B**	**0.21 B**	**0.37 B**	**0.25 B**
COBALT	MG/KG	0.046	**0.059**	**0.061**	**0.038 J**	**0.063**	**0.045**
COPPER	MG/KG	0.183	**25**	**36**	**21**	**27**	**24**
IRON	MG/KG	4.587	**91**	**97**	**48**	**93**	**57**
LEAD	MG/KG	0.092	**0.12 B**	**0.16 B**	**0.068 J B**	**0.12 B**	**0.082 J B**
MAGNESIUM	MG/KG	9.157	**200 B**	**200 B**	**200 B**	**220 B**	**200 B**
MANGANESE	MG/KG	0.459	**11**	**11**	**6.9**	**13**	**8.7**
MERCURY	MG/KG	0.033	0.033 U	0.033 U	0.033 U	0.033 U	0.033 U
NICKEL	MG/KG	0.092	**0.52**	**0.53**	**0.66**	**0.56**	**0.56**
POTASSIUM	MG/KG	9.157	**860**	**900**	**620**	**830**	**780**
SELENIUM	MG/KG	0.459	**0.44**	**0.43 J**	**0.34 J**	**0.42 J**	**0.37 J**
SILVER	MG/KG	0.092	**0.18**	**0.23**	**0.12**	**0.22**	**0.16**
SODIUM	MG/KG	9.157	**650**	**650**	**850**	**700**	**740**
THALLIUM	MG/KG	0.092	0.085 U	0.091 U	0.085 U	0.088 U	0.087 U
VANADIUM	MG/KG	0.092	**0.052 J**	**0.078 J**	0.085 U	**0.068 J**	0.087 U
ZINC	MG/KG	0.459	**300**	**320**	**190**	**330**	**260**
CYANIDE, TOTAL	MG/KG	0.492	**0.38 J**	**0.9**	**0.28 J**	**0.17 J**	**0.27 J**

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-24. *Crassostrea virginica* : REPLICATE TISSUE CONCENTRATIONS FOR SEVERN RIVER STATION WEEMS UPPER

October 2011

			Severn River Station Weems Upper				
					Sample C		
ANALYTE	UNITS	RL	Sample A	Sample B	C	Duplicate	Triplicate
ALUMINUM	MG/KG	2.757	**13**	**17**	**19**	**14**	**17**
ANTIMONY	MG/KG	0.183	**0.0098 J**	**0.03 J**	**0.015 J**	**0.01 J**	**0.0041 J**
ARSENIC	MG/KG	0.092	**0.72**	**0.91**	**0.77**	**0.63**	**0.7**
BARIUM	MG/KG	0.916	**0.12 J**	**0.42 J**	**0.2 J**	**0.13 J**	**0.14 J**
BERYLLIUM	MG/KG	0.092	0.095 U	0.093 U	0.097 U	0.094 U	0.09 U
CADMIUM	MG/KG	0.092	**0.4**	**0.56**	**0.43**	**0.32**	**0.42**
CALCIUM	MG/KG	9.157	**540**	**8900**	**1400**	**600**	**500**
CHROMIUM	MG/KG	0.183	**0.15 J B**	**0.17 J B**	**0.25 B**	**0.18 J B**	**0.16 J B**
COBALT	MG/KG	0.046	**0.041 J**	**0.051**	**0.048 J**	**0.039 J**	**0.044 J**
COPPER	MG/KG	0.183	**26**	**46**	**21**	**18**	**17**
IRON	MG/KG	4.587	**53**	**66**	**67**	**51**	**60**
LEAD	MG/KG	0.092	**0.074 J**	**0.093**	**0.089 J**	**0.068 J**	**0.077 J**
MAGNESIUM	MG/KG	9.157	**190 B**	**230 B**	**210 B**	**200 B**	**200 B**
MANGANESE	MG/KG	0.459	**5.6**	**8.2**	**7.7**	**6.1**	**5.8**
MERCURY	MG/KG	0.033	0.032 U	0.033 U	0.033 U	0.033 U	0.031 U
NICKEL	MG/KG	0.092	**0.52**	**0.49**	**0.5**	**0.55**	**0.49**
POTASSIUM	MG/KG	9.157	**800**	**870**	**900**	**790**	**870**
SELENIUM	MG/KG	0.459	**0.37 J**	**0.48**	**0.47 J**	**0.32 J**	**0.38 J**
SILVER	MG/KG	0.092	**0.17**	**0.21**	**0.2**	**0.14**	**0.15**
SODIUM	MG/KG	9.157	**730**	**720**	**680**	**770**	**710**
THALLIUM	MG/KG	0.092	**0.0071 J**	**0.0078 J**	**0.0034 J**	**0.002 J**	0.09 U
VANADIUM	MG/KG	0.092	**0.012 J**	0.093 U	**0.027 J**	**0.036 J**	0.09 U
ZINC	MG/KG	0.459	**270 B**	**320 B**	**290 B**	**230 B**	**260 B**
CYANIDE, TOTAL	MG/KG	0.492	**0.36 J**	**0.51**	**0.31 J**	**0.14 J**	**0.11 J**

NOTES: Bold values represent detected concentrations.

RL is reported for non-detected constituents.

Tissue concentrations are reported as wet weight

RL = average reporting detection limit

B = detected in the laboratory method blank

J = compound was detected, but below the reporting limit (value is estimated)

U = compound was analyzed, but not detected

TABLE 6-25. DIVER'S OBSERVATIONS OF MILL HILL REEFS
September 2011

Stations							
MH Reference	MH-1	MH-2	MH-3	MH-4	MH-5	MH-6	MH-7
Restored Oyster Shell Reef	6" oyster shell (3" fines, 3" shell)	3" shell with 6" slag base	3" shell with 6" stone base	3" shell with 6" concrete rubble base	6" recycled concrete	6" slag	6" stone
Very similar to other shell sites Very few single oysters Blue crabs and jellies present Not many mussels and barnacles present No fish present Sandy around edge of reef; main area covered in shell	Blue crabs, anemones, and jellies present Similar to reef MH-2 but more oysters present Single oysters as opposed to clumps No mussels present	Reef covered in broken shell Blue crabs and anemones present Most oysters present recovered	Some areas of reef completely covered by shell; edges of reef—no shell bare stone Blue crabs, mud crabas, mussels, and barnacles present Fewer oysters than MH-1 Oysters found in clumps not singles Very few large oysters	Alternate substrate covered in barnacles and mussels Few fish and blue crabs present Few single oysters – majority in clumps – high density	Some fish present (gobies) Lots of jellies present Alternates substrate encrusted with mussels, barnacles, and anemones Thin layer of sediment on substrate	Lots of mussels present Blue crabs and anemones present Alternate substrate covered in barnacles Many gobies and blennies present	Lots of small fish (gobies) present Lots of mud crabs present Substrate covered in mussels and barnacles Anemones and jellies present Lots of relief on site - not flat

TABLE 6-26. DIVER'S OBSERVATIONS OF SEVERN RIVER REEFS
October 2011

Stations					
WCU	Wade 2-2	Wade 2-3	Wade 2-4	Wade 2-5	WU
Recovered Oyster Shell	Concrete, Stone, and Slag	Slag	Concrete	Stone	Stone with Oyster Shell Venner
Muddy – deep sediment with shell	Blue crabs present Southwest corner of the reef (outside of the study area) a reef of large oysters is present	Reef 2-5 ft shallower than others More relief present – not flat Blue crabs present Oysters concentrated in troughs of substrate	< 1 ft of visibility Sedimentation present	Small barnacles present on alternate substrate Some algae present Low visibility < 1 ft Oysters wedged between alternate substrate	Lots of shell – area covered Filamentous algae present Oysters concentrated in troughs

TABLE 6-27. IN SITU WATER QUALITY FOR TRAY PLACEMENT AT THE WADE PLOT IN THE SEVERN RIVER

May 2011

Plot Name	Substrate Type	Location ID	Date	Time	Location		Water Depth (ft)	Sample Depth (ft)	Temperature (C^o)	Salinity (ppt)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)
					Latitude (N^o)	Longitude (W^o)							
Weems	Stone with oyster shell veneer	Weems Upper	5/10/2011	0922	38° 59’ 56”	076° 29’ 48”	10	Surface	18.33	1.87	11.46	9.13	7.6
								Bottom	18.3	2.41	8.8	8.73	28.2
Wade	Slag	Wade 2-3	5/10/2011	1128	39° 00’ 09”	076° 00’ 04”	17	Surface	18.61	1.73	11.86	9.07	7.8
								Bottom	18.31	2.32	9.57	8.84	21.1
Wade	Concrete	Wade 2-4	5/10/2011	1031	39° 00’ 08”	076° 30’ 01”	10	Surface	18.42	1.76	11.79	9.14	7
								Bottom	18.26	2.42	8.79	8.74	8.4
Wade	Stone	Wade 2-5	5/10/2011	1108	39° 00’ 09”	076° 30’ 03”	17	Surface	18.57	1.72	12.03	9.2	7.1
								Bottom	18.22	2.42	8.51	8.72	11.4

TABLE 6-28. SPECIES COUNT AND PERCENT COVER FROM TRAYS AT WADE 2-3

September 2011

Species		Tray 1		Tray 2		Tray 3		Tray 4		Totals
BENTHOS		Count	Percent Cover	Count	Percent Cover	Count	Percent Cover	Count	Percent Cover	
Scientific Name	**Common Name**									
Rhithropanopeus harrisii	Mud crab	150		122		133		112		*517*
Eurypanopeus depressus	Mud crab	2		0		1		0		*3*
Polychaeta	Marine worm	4		1		1		2		*8*
Amphipoda	Scuds	1		0		2		1		*4*
Palaemonetes sp.	Grass shrimp	4		43		15		2		*64*
Geukensia demissa	Ribbed mussel	59		86		51		84		*280*
Mytilopsis leucophaeta	False dark mussel	10		0		10		12		*32*
Crassostrea virginica	Oyster	0		1		0		0		*1*
Balanus improvisus	Barnacle		10		30		20		15	
Bryozoa	Ectoproct Bryozoans (encrusting type)		10		20		10		5	
Hydrozoa	Hydroids		0		0		0		0	
FISH										
Gobiosoma bosci	Gobies	24		14		14		9		*61*
Lepomis sp.	Sunfish	0		0		0		0		*0*

TABLE 6-29. SPECIES COUNT AND PERCENT COVER FROM TRAYS AT WADE 2-4

September 2011

Species		Tray 1		Tray 2		Tray 3		Tray 4		Totals
BENTHOS		Count	Percent Cover	Count	Percent Cover	Count	Percent Cover	Count	Percent Cover	
Scientific Name	**Common Name**									
Rhithropanopeus harrisii	Mud crab	168		171		138		126		*603*
Eurypanopeus depressus	Mud crab	4		0		0		0		*4*
Polychaeta	Marine worm	27		15		13		0		*55*
Amphipoda	Scuds	0		0		1		0		*1*
Palaemonetes sp.	Grass shrimp	0		0		0		0		*0*
Geukensia demissa	Ribbed mussel	83		55		27		111		*276*
Mytilopsis leucophaeta	False dark mussel	15		15		5		47		*82*
Crassostrea virginica	Oyster	43		3		0		0		*46*
Balanus improvisus	Barnacle		50		30		40		20	
Bryozoa	Ectoproct Bryozoans (encrusting type)		10		10		10		10	
Hydrozoa	Hydroids		5		10		30		10	
FISH										
Gobiosoma bosci	Gobies	48		24		45		20		*137*
Lepomis sp.	Sunfish	0		0		0		0		*0*

TABLE 6-30. SPECIES COUNT AND PERCENT COVER FROM TRAYS AT WADE 2-5

September 2011

Species		Tray 1		Tray 2		Tray 3		Tray 4		Totals
BENTHOS		Count	Percent Cover	Count	Percent Cover	Count	Percent Cover	Count	Percent Cover	
Scientific Name	**Common Name**									
Rhithropanopeus harrisii	Mud crab	148		119		152		124		*543*
Eurypanopeus depressus	Mud crab	2		2		6		0		*10*
Polychaeta	Marine worm	2		1		9		3		*15*
Amphipoda	Scuds	0		0		0		0		*0*
Palaemonetes sp.	Grass shrimp	19		1		5		16		*41*
Geukensia demissa	Ribbed mussel	53		91		119		73		*336*
Mytilopsis leucophaeta	False dark mussel	15		14		28		7		*64*
Crassostrea virginica	Oyster	1		1		9		8		*19*
Balanus improvisus	Barnacle		30		20		20		30	
Bryozoa	Ectoproct Bryozoans (encrusting type)		10		20		40		30	
Hydrozoa	Hydroids		0		1		5		0	
FISH										
Gobiosoma bosci	Gobies	29		9		21		18		*77*
Lepomis sp.	Sunfish	0		0		1		0		*1*

TABLE 6-31. SPECIES COUNT AND PERCENT COVER FROM TRAYS AT WEEMS UPPER

September 2011

Species		Tray 1		Tray 2		Tray 3		Tray 4		Totals
BENTHOS		Count	Percent Cover	Count	Percent Cover	Count	Percent Cover	Count	Percent Cover	
Scientific Name	**Common Name**			***Missing Tray****						
Rhithropanopeus harrisii	Mud crab	133				60		174		*367*
Eurypanopeus depressus	Mud crab	0				0		2		*2*
Polychaeta	Marine worm	20				3		7		*30*
Amphipoda	Scuds	11				0		26		*37*
Palaemonetes sp.	Grass shrimp	0				2		2		*4*
Geukensia demissa	Ribbed mussel	66				151		173		*390*
Mytilopsis leucophaeta	False dark mussel	11				8		47		*66*
Crassostrea virginica	Oyster	2				0		1		*3*
Balanus improvisus	Barnacle		5				20		30	
Bryozoa	Ectoproct Bryozoans (encrusting type)		20				10		20	
Hydrozoa	Hydroids		0				0		0	
FISH										
Gobiosoma bosci	Gobies	7				6		16		*29*
Lepomis sp.	Sunfish	0				0		0		*0*

*Divers were unable to locate the tray. Line holding the tray broke and the tray became dislodged.

TABLE 6-32. LENGHTS OF OYSTER RECOVERED FROM TRAYS AT WADE 2-3 (Slag)

September 2011

	Tray 1	Notes	Tray 2	Notes	Tray 3	Notes	Tray 4	Notes
Number of Oysters	0		1		0		0	
Length (mm)			48					

TABLE 6-33. LENGHTS OF OYSTER RECOVERED FROM TRAYS AT WADE 2-4 (Concrete)

September 2011

	Tray 1	Notes	Tray 2	Notes	Tray 3	Notes	Tray 4	Notes
Number of Oysters	43	Most oysters	3	On oyster	0		0	
Length (mm)	41	attached to oyster	13	shell				
	32	shells. Three	12					
	33	attachment marks	41					
	35	were on the						
	35	substrate which						
	42	probably held some						
	45	of the shell clumps						
	38							
	46							
	36							
	33							
	30							
	38							
	40							
	26							
	35							
	31							
	33							
	35							
	34							
	36							
	32							
	46							
	41							
	36							
	37							
	25							
	36							
	35							
	26							
	28							
	31							
	40							
	35							
	28							
	24							
	34							
	32							
	24							
	41							
	51							
	42							
	51							

TABLE 6-34. LENGHTS OF OYSTER RECOVERED FROM TRAYS AT WADE 2-5 (Stone)

September 2011

	Tray 1	Notes	Tray 2	Notes	Tray 3	Notes	Tray 4	Notes
Number of Oysters	1	On	1	On	9	7 attached to	8	Attached
Length (mm)	48	Substrate	71	Substrate	48	oyster shell.	41	to oyster
					50	Last 2	38	shell
					61	attached to	32	
					42	substrate	40	
					48		48	
					42		46	
					45		52	
					70		45	
					51			

TABLE 6-35. LENGHTS OF OYSTER RECOVERED FROM TRAYS AT WEEMS UPPER (Stone with oyster shell veneer)

September 2011

	Tray 1	Notes	Tray 2	Notes	Tray 3	Notes	Tray 4	Notes
Number of Oysters	2	Attached to		***Missing***	0		0	
Length (mm)	16	oyster shell		***Tray****				
	38							

*Divers were unable to locate the tray. Line holding the tray broke and the tray became dislodged.

7.0 REFERENCES

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Appendix A
Field Sampling Plan

FIELD SAMPLING PLAN

USACE CHESAPEAKE BAY OYSTER RECOVERY PROJECT, INITIAL SCREENING OF OYSTER REEFS

Prepared for

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March 2011

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^{o}C	degrees Celsius
CBF	Chesapeake Bay Foundation
COC	Chain of Custody
DGPS	Differential Global Positioning System
EA	EA Engineering, Science, and Technology
EPA	United States Environmental Protection Agency
^{0}F	degrees Fahrenheit
FSP	Field Sampling Plan
HNO_3	Nitric Acid
in.	inch
m^2	square meters
mm	millimeter
MDE	Maryland Department of the Environment
MDL	Method Detection Limit
MDNR	Maryland Department of Natural Resources
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ORP	Oyster Recovery Partnership
PVC	Polyvinyl chloride
QC	Quality Control
TAL	Target analyte list
TAT	Turn-around-time
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
YSI	Yellow Springs Instruments

1. PROJECT OVERVIEW

The United States Army Corps of Engineers – Baltimore District (USACE-Baltimore) is permitted to construct oyster reef habitat using alternate substrates. Reefs have been constructed in two tributaries in the Maryland section of the Chesapeake Bay using alternative substrates, multiple reefs at Mill Hill in Eastern Bay (Figure 1-1) in 2002 and the Severn River in 2009 (Figure 1-2).

The composition of the weathered slag in the Severn River and Mill Hill plantings will be evaluated to determine if exposure to the estuarine environment has an effect on the metals content of the planted slag. X-ray fluorescence will be used to determine the bulk composition of the slag. XRF will be performed in the laboratory on a composite sample that will be collected, pulverized, and homogenized from a five-point sample within each of the reefs restored using slag.

The steel slag placed in the Severn River was produced at the Severstal Steel Mill at Sparrows Point in Baltimore, MD. It is also believed that the material placed at Mill Hill in 2002 would have been from Sparrows Point as this is the regional source of steel slag. According to communications with Phoenix Services, it is reasonable to assume that the composition of the steel slag produced at the facility has not changed since the Mill Hill planting in 2002. Therefore, the bulk composition published by Grubb et al. (2010) represents the original composition of the slag prior to placement and will be used to compare the composition of the weathered slag. Analyses shall be performed so that results can be compared with those presented in Grubb et al. (2010).

In 2002, Maryland Department of Natural Resources (MDNR) constructed seven substrate plantings at the Mill Hill sanctuary using the combinations of substrate shown below:

- 6 in. (thickness of planting or depth) shell (3 in. fines and 3 in. shell)
- 3in. shell on a 6 in. slag base
- 3 in. shell on a 6 in. stone base
- 3 in. shell on a 6 in. concrete rubble base
- 6 in. recycled concrete
- 6 in. slag
- 6 in. stone

Figure 1-1 provides a map of the Mill Hill Sanctuary and various oyster plantings that have been completed since 2000. This site was monitored in 2003 by MDNR for growth, density, oyster mortality, spat-set, and disease. Concrete (32 oysters/m^2) and slag (44 oysters/m^2) attracted more larvae, or at least resulted in more spat surviving on it, than stone, shell, concrete with shell, reef balls, slag with shell, or stone with shell (<1 to 15 oysters/m^2). MDNR Fall Survey data shows continued presence of oysters on the Mill Hill Sanctuary (adjacent areas to the alternate substrate plantings, but within the Mill Hill Sanctuary).

In 2009, USACE constructed 13.4 acres of oyster reef habitat in the Severn River between the U.S. 50 and Route 450 bridges using oyster shell, stone, concrete, and steel slag on four reefs: Wade, Weems Upper, Traces Hollow, and Peach Orchard (Figure 1-2). Four separate plantings at Wade, the planting at Weems Upper, and a Chesapeake Bay Foundation (CBF) planting will be investigated by this project.

EA Engineering, Science, and Technology, Inc. (EA) has been contracted by the USACE-Baltimore District to perform metals analysis and an initial screening of oysters growing on various alternate substrates and reef habitats.

1.1 SCOPE OF THE FIELD SAMPLING PLAN

This field sampling plan (FSP) describes the field sampling and data-gathering methods for the project. The scope of this FSP follows guidance provided by the United States Environmental Protection Agency (USEPA) *National Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (2000).

1.2 PROJECT PURPOSE AND OBJECTIVES

The purpose of this project is to conduct initial screening of oyster reefs restored using alternate substrates. The initial contaminant screening will focus on further characterizing the steel slag used to construct oyster reefs and characterizing the oysters growing on the reefs.

Specific objectives of the initial screening study are to:

- Perform an initial screening of oyster reefs constructed of alternate substrates to include a description of their present state and obtain a sample of the substrate;
- Characterize the composition of steel slag exposed to the estuarine environment;
- Perform a qualitative survey of the habitat and ecological community that has developed at the restored sites at Mill Hill and a semi-quantitative screening at the Severn River sites;
- Collect specific data at each site including oyster size, oyster and spat density, oyster mortality, water quality, water depth of each reef, and videography and photography of each reef, and
- Quantify concentrations of metals in oyster tissue.

1.3 PROJECT LOCATION

Distinct plantings have been constructed in two tributaries of the Chesapeake Bay; seven distinct plantings were constructed at Mill Hill in Eastern Bay near Kent Island, Maryland (Figure 1-1), and eleven distinct plantings were constructed in the Severn River near Annapolis, Maryland,

between the Route 50 and Route 450 bridges (Figure 1-2). For the initial screening, seven locations plus an oyster shell reef (a total of eight locations) will be sampled at Mill Hill and five of the plantings plus an oyster shell reef (a total of six locations) will be sampled in the Severn River. Table 1-1 lists the sample location coordinates and substrate types for the Mill Hill site and Table 1-2 lists the sample location coordinates and substrate types for the Severn River site.

1.4 ANALYTICAL TESTING

Target analytes, target detection limits, and methodologies will be in accordance with USEPA guidance (2000) and Maryland Department of the Environment (MDE) standard operating procedures (2009). Analytical testing will be conducted by TestAmerica Pittsburgh and testing of steel slag samples will be conducted by CTLGroup Laboratories. The list of target analytes, target detection limits, methodologies, and sample holding times are derived from the following guidance documents:

- Maryland Department of the Environment (MDE). 2009. *Standard Operating Procedures for Fish and Shellfish Collection and Analysis.* Draft.

- U.S. Environmental Protection Agency (USEPA). 2000. *National Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis.* Third Edition. Office of Water. EPA 823-B-00-007.

The Target Analyte List (TAL) analysis for oyster tissue will include the following analytes: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, and cyanide.

Steel slag samples will be analyzed using X-ray fluorescence to determine bulk composition of the slag.

1.5 SITE-SPECIFIC SAMPLING AND ANALYSIS PROBLEMS

Sampling problems could include weather and vessel traffic. Potential site-specific problems include the following:

- Vessel traffic (ships, tugs/barges, pleasure craft);
- Weather (cold, high winds, lightning, fog) related delays;
- Insufficient oyster recovery.

The field operations crew is experienced with the logistics associated with sampling activities in busy ports and harbors. The field operations staff is prepared to handle logistical challenges that may arise during the project. The Field Operations Manager will report unanticipated logistical problems to the EA Project Manager and the USACE- Baltimore District Technical Lead and will provide recommendations and/or modifications to the sampling program to achieve the project goals while adhering to the proposed schedule.

Potential chemical analysis problems associated with the project may include:

- Matrix interferences

TestAmerica-Pittsburgh is experienced with conducting analytical testing of tissues. Matrix spike (MS) and matrix spike duplicate (MSD) samples will be run with each batch of samples to measure potential matrix interferences. In addition, TestAmerica-Pittsburgh is prepared and committed to achieving the project-required expedited turn-around-time (TAT) for the sample results. The laboratory is prepared to "trouble-shoot" and report any problems during the testing process to the EA Project Manager and the USACE – Baltimore District Technical Lead.

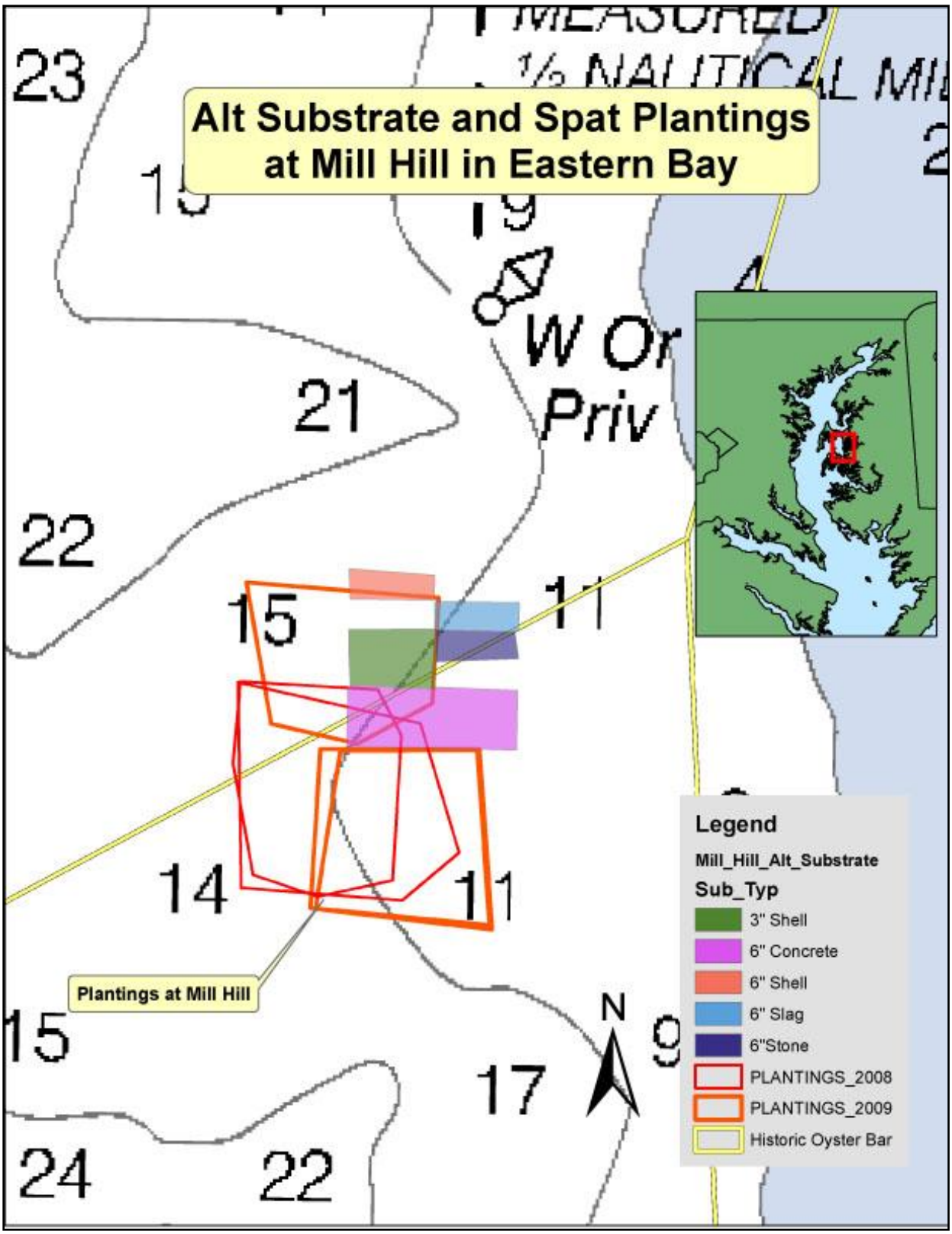


Figure 1-1. Oyster Reefs Located at Mill Hill, Eastern Bay, Maryland

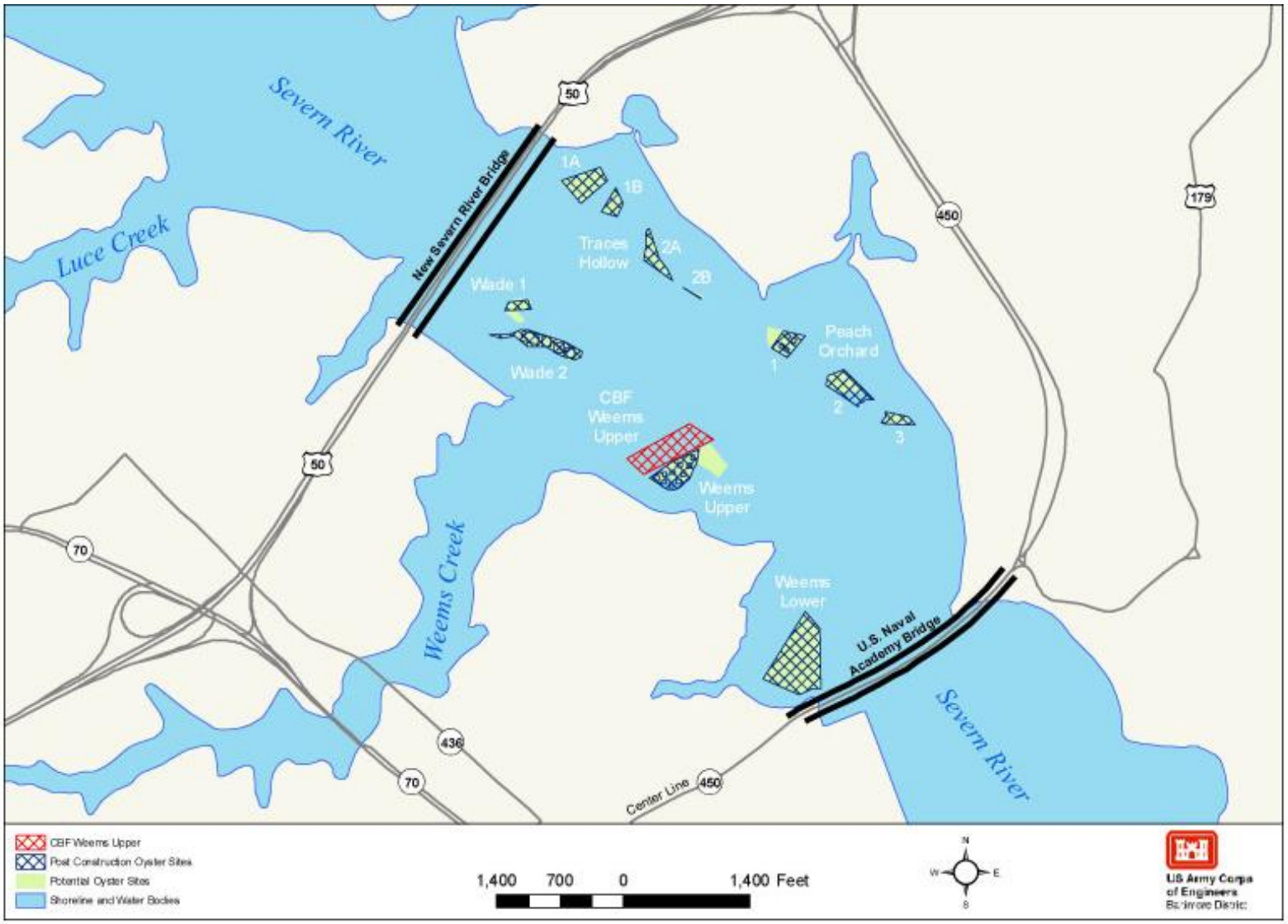


Figure 1-2. Oyster Reefs Located in Severn River, Maryland

TABLE 1-1. SAMPLE LOCATIONS AT MILL HILL

Location ID	Substrate	Size (acres)	Planting Number	Latitude	Longitude
MH-1	6" oyster shell (3"fines, 3"shell)	1	1	38^{0}54.520’	76^{0}13.000’
			2	38^{0} 54.518’	76^{0}12.924’
			3	38^{0}54.499’	76^{0}13.001’
			4	38^{0}54.499’	76^{0}12.925’
MH-2	3"shell with 6” slag base	1	1	38^{0}54.499’	76^{0}13.001’
			2	38^{0}54.499’	76^{0}12.925’
			3	38^{0}54.478’	76^{0}13.001’
			4	38^{0}54.479’	76^{0}12.923’
MH-3	3"shell with 6” stone base	1	1	38^{0}54.478’	76^{0}13.001’
			2	38^{0}54.479’	76^{0}12.923’
			3	38^{0}54.458’	76^{0}13.001’
			4	38^{0}54.458’	76^{0}12.923’
MH-4	3"shell with 6” concrete rubble base	1	1	38^{0}54.458’	76^{0}13.001’
			2	38^{0}54.458’	76^{0}12.923’
			3	38^{0}54.439’	76^{0}12.999’
			4	38^{0}54.438’	76^{0}12.924’
MH-5	6"recycled concrete	4.5	1	38^{0}54.438’	76^{0}13.001’
			2	38^{0}54.438’	76^{0}12.924’
			3	38^{0}54.438’	76^{0}12.849’
			4	38^{0}54.395’	76^{0}13.002’
			5	38^{0}54.395’	76^{0}12.924’
			6	38^{0}54.394’	76^{0}12.848’
MH-6	6" slag	1	1	38^{0}54.498’	76^{0}12.924’
			2	38^{0}54.498’	76^{0}12.847’
			3	38^{0}54.479’	76^{0}12.924’
			4	38^{0}54.479’	76^{0}12.848’
MH-7	6" stone	1	1	38^{0}54.479’	76^{0}12.929’
			2	38^{0}54.479’	76^{0}12.851’
			3	38^{0}54.457’	76^{0}12.923’
			4	38^{0}54.459’	76^{0}12.846’

TABLE 1-2. SAMPLE LOCATIONS IN SEVERN RIVER

Location ID	Reef Name	Substrate	Size (acres)	Planting Number	Latitude	Longitude
W2-2	Wade 2-2	concrete, stone, and slag	0.5	1	39^{0}0.162181’	76^{0}30.092999’
				2	39^{0}0.179640’	76^{0}30.087240’
				3	39^{0}0.187680’	76^{0}30.127439’
				4	39^{0}0.157680’	76^{0}30.083399’
				5	39^{0}0.157919’	76^{0}30.061859’
W2-3	Wade 2-3	concrete	0.25	1	39^{0}0.175980’	76^{0}30.062221’
				2	39^{0}0.176644’	76^{0}30.083836’
				3	39^{0}0.165361’	76^{0}30.054899’
				4	39^{0}0.147300’	76^{0}30.054540’
				5	39^{0}0.147600’	76^{0}30.033000’
W2-4	Wade 2-4	stone	0.25	1	39^{0}0.165660’	76^{0}30.033420’
				2	39^{0}0.136920’	76^{0}30.028020’
				3	39^{0}0.154981’	76^{0}30.028379’
				4	39^{0}0.155281’	76^{0}30.006839’
				5	39^{0}0.137220’	76^{0}30.006480’
W2-5	Wade 2-5	slag	0.25	1	39^{0}0.136920’	76^{0}30.028020’
				2	39^{0}0.163800’	76^{0}29.556481’
				3	39^{0}0.191280’	76^{0}29.557320’
				4	39^{0}0.174540’	76^{0}29.470140’
				5	39^{0}0.135121’	76^{0}29.512319’
				6	39^{0}0.163800’	76^{0}29.556481’
WU	Weems Upper	stone with oyster shell veneer	2.7	1	38^{0}59.916766’	76^{0}29.835171’
				2	38^{0}59.945521’	76^{0}29.782680’
				3	38^{0}59.968857’	76^{0}29.718556’
				4	38^{0}59.943487’	76^{0}29.724225’
				5	38^{0}59.936220’	76^{0}29.730780’
				6	38^{0}59.915940’	76^{0}29.741220’
				7	38^{0}59.911440’	76^{0}29.749319’
				8	38^{0}59.902602’	76^{0}29.760893’
				9	38^{0}59.897442’	76^{0}29.769779’
				10	38^{0}59.894440’	76^{0}29.779831’
				11	38^{0}59.895269’	76^{0}29.790290’
				12	38^{0}59.899084’	76^{0}29.800857’
				13	38^{0}59.916766’	76^{0}29.835171’
WCU	Weem's Creek Upper	recovered oyster shell	5	1	39^{0}0.016000’	76^{0}29.740000’
				2	38^{0}59.986000’	76^{0}29.685000’
				3	38^{0}59.923000’	76^{0}29.847000’
				4	38^{0}59.951000’	76^{0}29.888000’

2. PROJECT ORGANIZATION AND PERSONNEL

The project team is organized to provide professional expertise in each of the major components necessary for the completion of the project. A project team organization chart and the project team contact information are provided in Figure 2-1 and Table 2-1.

The Field Team will consist of personnel from University of Maryland and a representative of EA Engineering, Science, and Technology, Inc. The University of Maryland will be responsible for vessel operations and sample collection. EA personnel will be responsible for equipment decontamination, site water collection, homogenization and compositing of samples, labeling and packing of samples, transport of samples to appropriate testing laboratories, and direct coordination with analytical laboratories.

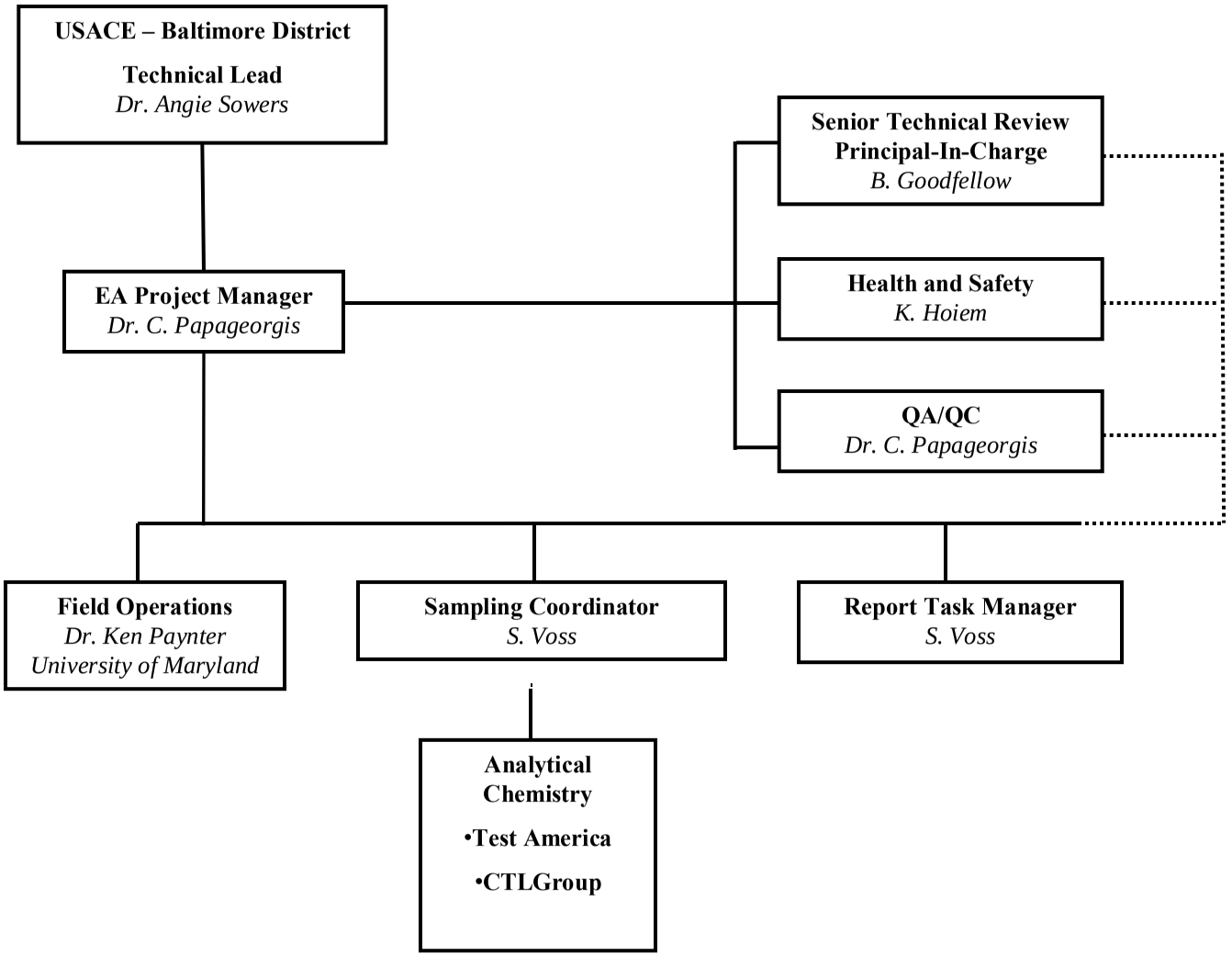


FIGURE 2-1. PROJECT TEAM ORGANIZATION
USACE Chesapeake Bay Oyster Recovery Project – Initial Screening of Oyster Reefs

TABLE 2-1. PROJECT TEAM CONTACTS

Technical Expert	Project Role	Affiliation	Telephone Number	Mobile Number	Fax Number	E-mail Address
Carrie Gamber	Analytical Laboratory - Project Manager	TestAmerica Laboratories	(412) 963-2428	--	(412) 963-2468	carrie.gamber@testamericainc.com
Bill Goodfellow	Senior Technical Review, Principal-In-Charge	EA	(410) 329-5121	(717) 891-9907	(410) 771-4204	bgoodfellow@eaest.com
Kris Hoiem	Health and Safety Officer	EA	(410) 329-5149	(443) 463-5334	(410) 771-4204	khoiem@eaest.com
Scott Nettles	Slag Analysis	CTLGroup	(847) 965-7500	--	--	snettles@ctlgroup.com
Christine Papageorgis	Project Manager/Senior Technical Review	EA	(410) 329-5130	(410) 215-3240	(410) 771-4204	cpapageorgis@eaest.com
Dr. Ken Paynter	Field Manager	University of Maryland	(301) 405-6893	(301) 520-1562	--	paynter@umd.edu
Angie Sowers	USACE, Project Manager	USACE-Baltimore District	(410) 962-7440	(443) 676-4679	--	Angela.Sowers@usace.army.mil
Sam Voss	Sampling Coordinator	EA	(410) 771-4950	(410) 218-5888	(410) 771-4204	svoss@eaest.com

3. FIELD ACTIVITIES

The field investigation will consist of an initial screening of oyster reefs, characterization of the composition of steel slag exposed to the estuarine environment, and a qualitative survey of the habitat and ecological community that has developed at the restored sites.

Workdays will be up to 10 hours in duration (dock to dock), with approximately 8 hours of sampling each day. The sequence of sample collection in any given area will be dependent upon local site and weather conditions. The day-to-day sequence of sampling will be determined at the discretion of the Field Operations Manager. Upon completion of field activities, samples will be submitted to TestAmerica-Pittsburgh for oyster tissue analysis and CTLGroup Laboratories for steel slag analysis.

3.1 SAMPLING OBJECTIVES

The general objectives of the field sampling and sample processing include:

- Evaluation of steel slag composition from 2 locations (plantings) at Mill Hill and 1 location in the Severn River (Wade 2-5).
- Screening of seven substrate locations and a reference site at Mill Hill.
- Screening of six substrate locations in the Severn River.
- *In situ* water quality measurements at each sampling location.
- Submittal of steel slag samples to CTLGroup Laboratories for composition analysis.
- Submittal of oyster tissue samples to TestAmerica for Target Analyte List (TAL) analysis.
- Submittal of water samples for each location for TAL analysis.
- Submittal of sediment sample from 8 locations at Mill Hill and 6 locations in the Severn River for TAL analysis.
- Videography and photography at each location.

Table 3-1 presents a summary of the data to be collected in each task and an inventory of the samples that will be analyzed by Test America and CTLGroup. Table 3-2 lists the method detection limits for sediment, water, and tissue analyses by Test America.

3.2 SAMPLING LOCATION DETERMINATION

Sample locations were provided by USACE-Baltimore. Coordinates (latitude and longitudes) are provided in Table 1-1 (Mill Hill) and Table 1-2 (Severn River). Sampling locations will be located in the field using a Differential Global Positioning System (DGPS).

3.3 SAMPLE VOLUME REQUIREMENTS

A minimum mass of 200 grams of wet tissue is required per sample for oyster tissue TAL analysis. Steel slag sample analysis will require 1 pound of slag per sample.

3.4 *IN SITU* WATER QUALITY MEASUREMENTS

Water quality measurements will be recorded *in situ* at each sampling location using an YSI water quality probe. Water temperature, salinity, dissolved oxygen, and pH will be recorded at the bottom of the water column at each sampling location 6 inches to 12 inches above the reef. EA will document calibration procedures and QC checks for the YSI water quality probe. The following parameters will be recorded in the field log book:

- Location number
- Sampling data and time
- Water depth
- Water temperature [degrees Celsius (ºC)]
- Salinity (parts per thousand)
- Dissolved oxygen (milligrams per liter)
- pH

3.5 SAMPLE COLLECTION, STORAGE, AND TRANSPORT

3.5.1 Slag Composition

Steel slag will be sampled from five points within each of the slag plantings at Mill Hill (2 plantings) and at Wade 2-5 in the Severn. The five points shall be randomly distributed across the planting, bur representative of the planting. The contractor shall use professional judgment to determine that the five points are the most-representative of the planting. For each planting, the five samples will be pulverized and homogenized into one composite sample for X-ray fluorescence (XRF) in order to determine the bulk composition of the slag. Approximately 1 pound of slag will be collected and submitted to CTL Group Laboratory for analysis.

3.5.2 Mill Hill Oyster Reef Screening

Sampling shall be performed at each of the seven substrate plantings as well as an adjacent site (reference site) that has been restored using oyster shell by Oyster Recovery Partnership (ORP) (Figure 1-1). Table 1-1 provides the coordinates of the seven Mill Hill plantings to be sampled. Videography and a still picture shall be collected at each reef type to characterize the reef environment prior to other sampling activities.

At each planting, three randomly located samples will be collected by divers. On reefs constructed with alternate substrate, traditional harvesting gear cannot be used due to potential damage to the gear. Sampling shall be undertaken while water temperatures remain above 50° F (10° C). Divers shall place a quadrat (square made from PVC piping) on the surface of the reef

to demark the sampling area. Quadrat size will be specified by the contractor but must be within the range of 0.5 to 1.0 m^2. A uniform quadrat size will be used for all sampling. All materials within the quadrat boundaries (including but not limited to substrate, living and dead oysters, shell, debris, and all benthic fauna) will be placed in a fine mesh bag and provided to the onboard crew for size measurement of oysters and counting of spat, living, and box oysters. The length of all oysters will be measured according to standard practices, and living and dead oysters enumerated. All oysters not being retained for TAL analyses shall be returned to the reef.

A total of 25 market-sized oysters (3 in. length or greater) will be collected at each of three sampling points. For TAL analysis, the full soft tissue body of collected oysters will be homogenized into one composite sample for each sampling point. The oysters will be prepared for analysis and preserved according to the requirements of the analyzing laboratory and in compliance with EPA guidance (EPA 2000) and Maryland Department of the Environment standard operating procedures (MDE 2009). The collected mass will provide sufficient sample to run triplicates at one of the three sampling points on each reef.

In the event that 25 market-sized oysters are not present within a quadrat, the quadrat shall be laid down adjacent to the first location and oysters collected until 25 specimens are collected. If it is not possible to collect 25 market-sized oysters, the minimum mass required by the sampling laboratory will be collected (200 grams of wet tissue). If oysters are small, the contractor will collect additional specimens to ensure the targeted sample size is achieved. Because oyster size and age affects the potential metals bioaccumulation, every attempt should be made to collect oysters of similar size across all sampling points. In accordance with EPA guidance (EPA 2000), the total length (or size) of the smallest individual in any composite sample should be no less than 75 percent of the total length (or size) of the largest individual in the composite sample (EPA 2000). For example, if the largest specimen is 200 mm, then the smallest individual included in the composite sample should be at least 150 mm (EPA 2000). For all samples, the number of oysters collected for a sample and the weight and length of each oyster will be recorded and provided to USACE. If sufficient oyster mass is not present at this planting or portions of this planting, the contractor shall consult with USACE and use professional judgment to collect a sample and not waste the sampling opportunity. The contractor and USACE shall then jointly decide how to proceed with this task.

Substrate type will be recorded at each location and a representative sample retained to confirm bottom type. Sample size should be that which would occupy a double-bagged quart-size plastic zip top bag, with as much air removed as possible. For plantings restored using slag, the bottom sample will be collected in addition to the slag sample collected for Task 3.5.1 analyses.

All samples shall be preserved according to Table 6-8 in the EPA National Guidance (EPA 2000). Sample handling, processing, and chain of custody shall be conducted according to Section 7 in the EPA National Guidance (EPA 2000).

3.5.3 Severn River Oyster Reef Screening

Figure 1-2 shows the locations of the Severn River plantings and coordinates are provided in Table 1-2. Sampling shall be performed in the fall (October-November) at Wade#2 and Weems

Upper, as well as a neighboring sanctuary reef that has been restored without the use of alternate substrate (CBF and ORP planting restored at Weems Upper). At the Wade #2 planting, each of the following plantings will be sampled: slag (#2-5), concrete ((#2-3), stone (#2-4), and mixed substrates (#2-2). The Weems Upper planting to be sampled is comprised of stone with a shell veneer.

At each planting, three randomly located samples will be collected by divers (traditional harvesting gear may be damaged on reefs constructed with alternate substrates). Sampling shall be undertaken while water temperatures remain above 50° F (10° C). Divers shall place a quadrat (square made from PVC piping) on the surface of the reef to demark the sampling area. Quadrat size will be specified by the contractor but must be within the range of 0.5 to 1.0 m^2. All materials within the quadrat boundaries (including but not limited to substrate, living and dead oysters, shell, debris, and all benthic fauna) will be placed in a fine mesh bag and provided to the onboard crew for size measurement of oysters and counting of spat, living, and box oysters. The length of all oysters will be measured according to standard practices, and living and dead oysters enumerated. All oysters not being retained for TAL analyses shall be returned to the reef.

A total of 25 market-sized oysters (3 in. length or greater) will be collected at each of three sampling points. In the field, the contractor shall indentify and sample three representative locations. For TAL analysis, the full soft tissue body of collected oysters will be homogenized into one composite sample for each sampling point. The oysters will be prepared for analysis and preserved according to the requirements of the analyzing laboratory and in compliance with EPA guidance (EPA 2000) and Maryland Department of the Environment standard operating procedures (MDE 2009). The collected mass will provide sufficient sample to run triplicates at one of the three sampling points on each reef.

In the event that 25 market-sized oysters are not present within a quadrat, the quadrat shall be laid down adjacent to the first location and oysters collected until 25 specimens are collected. If it is not possible to collect 25 market-sized oysters, the minimum mass required by the sampling laboratory will be collected (200 grams of wet tissue). If oysters are small, the contractor will collect additional specimens to ensure the targeted sample size is achieved. Because oyster size and age affects the potential metals bioaccumulation, every attempt should be made to collect oysters of similar size across all sampling points. In accordance with EPA guidance (EPA 2000), the total length (or size) of the smallest individual in any composite sample should be no less than 75 percent of the total length (or size) of the largest individual in the composite sample (EPA 2000). For example, if the largest specimen is 200 mm, then the smallest individual included in the composite sample should be at least 150 mm (EPA 2000). For all samples, the number of oysters collected for a sample and the weight and length of each oyster will be recorded and provided to USACE. If sufficient oyster mass is not present at this planting or portions of this planting, the contractor shall consult with USACE and use professional judgment to collect a sample and not waste the sampling opportunity. The contractor and USACE shall then jointly decide how to proceed with this task.

Substrate type will be recorded and a representative sample retained to confirm bottom type. Sample size should be that which would occupy a double-bagged quart-size plastic zip top bag,

with as much air removed as possible. For plantings restored using slag, the bottom sample will be collected in addition to the sample collected for Task 3.5.1 analyses.

All samples shall be preserved according to Table 6-8 in the EPA National Guidance (EPA 2000). Sample handling, processing, and chain of custody shall be conducted according to Section 7 in the EPA National Guidance (EPA 2000).

3.5.4 Field Blanks

Field blank samples are used to determine if analytical data has been compromised as a result of sampling procedures or field conditions. Field blanks may be used to establish background levels of contamination, and may reveal the possibility of cross-contamination or procedural errors in the collection, packaging, and shipping of samples. To prepare the field blank, a minimum of 200 grams of oyster tissue obtained from a commercial source will be prepared as a sample for laboratory analysis. The field blank sample should be prepared before going into the field, and should accompany other samples through the chain of custody (for example, it should be placed in the sample cooler taken to the field and should be managed the same way other samples are managed and analyzed).

3.5.5 Site Water

Site water will be collected at the center of each planting for TAL analysis at the bottom of the water column approximately 6 to 12 in above the reef. Seven site water samples will be collected at the Mill Hill plantings and 6 site water samples will be collected at the Severn River plantings. Site water samples will be kept at 4^0C and will be shipped to Test America laboratory for analysis.

3.5.6 Sediment Samples (TAL Analysis)

A five-point composite sediment sample will be collected for TAL analysis at each of the eight Mill Hill plantings and six Severn River plantings. For the slag plantings, the five sampling points for sediment collection will be co-located with sites where slag was collected per Section 3.5.1. Composites will be produced by homogenizing the five separate grab samples in a stainless-steel bowl and placing the sediment in a pre-cleaned, laboratory container. The five-points of sediment collection will be co-located with sites where slag was collected per Section 3.5.1. Composite sediment samples will be kept at 4^0C and will be shipped to Test America laboratory for analysis.

3.5.7 Qualitative Description of Reef Community

Further analyses shall be performed on the quadrat samples described in Sections 3.5.2 and 3.5.3 in order to characterize the reef community at each bar.

3.5.7.1 Mill Hill Plantings

At the Mill Hill sites, the analyses will be qualitative with coverage estimates and diver descriptions of the existing reefs and quadrat samples. A record will be made of organisms that are present in quadrat samples and on reefs for one sample on each of the 8 substrate plantings. If fouling organisms such as barnacles are dense, they will be described as a percent cover of the shell or substrate rather than enumerated. A general description of the reef site shall be recorded, including a description of the degree of coverage of fouling organisms, estimated water visibility, the depth of sedimentation (description of quality of substrate), and any nekton species that were seen using the reef.

3.5.7.2 Severn River Plantings

Sampling trays will be used to investigate the Severn River oyster reef communities. A tray will be placed within the reef structure of each substrate type at the following plantings: Wade 2-3 (concrete), Wade 2-4 (granite), Wade 2-5 (slag), and Weems Creek Upper (CBF site- shell). Sampling trays will be deployed for one growing season; upon collection of trays organisms shall be identified and counted from each sample tray. If fouling organisms such as barnacles are dense, they can be described as a percent cover of the shell or substrate rather than enumerated. A general description of the reef site shall be recorded, including a description of the degree of coverage of fouling organisms, estimated water visibility, the depth of sedimentation (description of quality of substrate), and any nekton species that were visibly seen using the reef.

3.6 EQUIPMENT DECONTAMINATION PROCEDURES

Equipment that will come into direct contact with sediment during sampling will be decontaminated prior to deployment in the field and between each sampling location to minimize cross-contamination. This includes the Ponar grab sampler and stainless steel processing equipment (spoons, knives, bowls, etc.). While performing the decontamination procedure, phthalate-free nitrile gloves will be used to prevent phthalate contamination of the sampling equipment or the samples.

The decontamination procedure is described below:

- Rinse equipment using site water
- Rinse with 10 percent nitric acid (HNO_3)
- Rinse with distilled or de-ionized water
- Rinse with methanol followed by hexane
- Rinse with distilled or de-ionized water
- Air dry (in area not adjacent to the decontamination area)

Waste liquids will be contained during decontamination procedures and transferred to EA's facility in Sparks, Maryland, for disposal (see Section 6).

3.7 SAMPLING CONTINGENCIES

Sampling will be dependent upon daily weather conditions (including heavy rain, high winds, lightning and/or fog), and severe weather forecasts may preclude sampling. The USACE–Baltimore District Technical Lead will be notified of weather-related delays by the Field Operations Manager.

If limited recovery is encountered during sampling operations, the Field Operations Manager and USACE-Baltimore Technical Lead will determine the appropriate corrective actions (e.g., re-location of a station).

TABLE 3-1. SUMMARY OF TASKS AND ANALYTICAL SAMPLE INVENTORY

Task/ Media Samples for Analytical Laboratory	Slag	Tissue	Water	Substrate
Task 1 Slag Composition				
2 sites Mill Hill ; 5 sampling points each to make composites; choose 3 for Task 2	2			
1 site Severn Wade2-5; five sampling points to make composite ; choose 5 random locations for Task 3	1			
Compare weathered slag with Grubb et al (2010)				
Total samples for XRF Analysis	**3**			
Task 2 Screening of Mill Hill				
Seven sites plus reference site				
3 samples per site; size, #spat, living and box oysters, substrate type; length; tissue		24		
Tissue replicates (1 sample per site in triplicate)		16		
Water			8	
Sediment/substrate representative sample retained to confirm bottom type				
Five point composite sediment sample				8
Field Data-Dissolved oxygen, temperature, pH, salinity at 6-12"above reef, depth to reef				
Videography; still photos				
Field Blank		1	1	
Total Samples for TAL analysis Task 2		**41**	**9**	**8**
Task 3 Screening of Severn River Reefs 2011				
Wade #2-2, 2-3, 2-4, 2-5; Weems Upper (5 sites)				
Reference CBF/ORP Site At Weems Upper				
3 samples per site; size, #spat, living and box oysters, substrate type; length; tissue		18		
Tissue replicates (1 sample per site in triplicate)		12		
Sediment/substrate representative sample retained to confirm bottom type				
Water			6	
Sediment				6
Field Data-Dissolved oxygen, temperature, pH, salinity at 6-12"above reef, depth to reef				
Videography; still photos				
Field Blank		1	1	
Total Samples for TAL analysisTask 2		**31**	**7**	**6**
Task 4A Qualitative Description of Mill Hill 2010				
Qualitative estimates of coverage of quadrat samples by diver				
Record of organisms present for 1 sample on each of 8 plantings				
General description (coverage by fouling organisms, visibility, sedimentation, nekton species)				
Task 4B Qualitative Description of Severn Sites 2011				
Total of Four (4) sampling trays placed on Wade 2-3, 2-4, 2-5, and CBF Reference site at Weems Upper; organisms from trays to be identified and counted				
General description (coverage by fouling organisms, visibility, sedimentation, nekton species)				

TABLE 3-2. METHOD DETECTION LIMITS (MDL) FOR SEDIMENT, WATER, AND TISSUE ANALYSES

Sediment

TAL Metals (Method 6020)

Compound	RL	Units	MDL	Units
Aluminum	3	mg/kg	0.2849	mg/kg
Antimony	0.2	mg/kg	0.0026	mg/kg
Arsenic	0.1	mg/kg	0.0181	mg/kg
Barium	1	mg/kg	0.0107	mg/kg
Beryllium	0.1	mg/kg	0.0075	mg/kg
Cadmium	0.1	mg/kg	0.007	mg/kg
Calcium	10	mg/kg	1.326	mg/kg
Chromium	0.2	mg/kg	0.0061	mg/kg
Cobalt	0.05	mg/kg	0.0015	mg/kg
Copper	0.2	mg/kg	0.033	mg/kg
Iron	5	mg/kg	0.3539	mg/kg
Lead	0.1	mg/kg	0.0038	mg/kg
Magnesium	10	mg/kg	0.187	mg/kg
Manganese	0.05	mg/kg	0.0103	mg/kg
Nickel	0.1	mg/kg	0.0113	mg/kg
Potassium	10	mg/kg	1.3583	mg/kg
Selenium	0.5	mg/kg	0.0502	mg/kg
Silver	0.1	mg/kg	0.0039	mg/kg
Sodium	10	mg/kg	1.369	mg/kg
Thallium	0.1	mg/kg	0.002	mg/kg
Vanadium	0.1	mg/kg	0.0079	mg/kg
Zinc	0.5	mg/kg	0.0648	mg/kg

Mercury 7471A

Compound	RL	Units	MDL	Units
Mercury	0.033	mg/kg	0.0109	mg/kg

Total Cyanide 9012A

Compound	RL	Units	MDL	Units
Total Cyanide	0.5	mg/kg	0.0968	mg/kg

Water

TAL Metals (Method 6020)

Compound	RL	Units	MDL	Units
Aluminum	30	ug/L	2.5662	ug/L
Antimony	2	ug/L	0.0187	ug/L
Arsenic	1	ug/L	0.2908	ug/L
Barium	10	ug/L	0.098	ug/L
Beryllium	1	ug/L	0.0367	ug/L
Cadmium	1	ug/L	0.1144	ug/L
Calcium	100	ug/L	2.8374	ug/L
Chromium	2	ug/L	0.5433	ug/L
Cobalt	0.5	ug/L	0.0263	ug/L
Copper	2	ug/L	0.2443	ug/L
Iron	50	ug/L	6.0901	ug/L
Lead	1	ug/L	0.0192	ug/L
Magnesium	100	ug/L	1.1665	ug/L
Manganese	0.5	ug/L	0.0389	ug/L
Nickel	1	ug/L	0.1749	ug/L
Potassium	100	ug/L	5.823	ug/L
Selenium	5	ug/L	0.4216	ug/L
Silver	1	ug/L	0.0362	ug/L
Sodium	100	ug/L	3.8135	ug/L
Thallium	1	ug/L	0.0152	ug/L
Vanadium	1	ug/L	0.0824	ug/L
Zinc	5	ug/L	0.9609	ug/L

Mercury 7470A

Compound	RL	Units	MDL	Units
Mercury	0.2	ug/L	0.0384	ug/L

Total Solids 2540G

Compound	RL	Units	MDL	Units
Total Solids	10	mg/L	10	mg/L

Total Cyanide 9012A

Compound	RL	Units	MDL	Units
Total Cyanide	10	ug/L	1.5	ug/L

Tissues

TAL Metals (Method 6020)

Compound	RL	Units	MDL	Units
Aluminum	3	mg/kg	0.236	mg/kg
Antimony	0.2	mg/kg	0.0033	mg/kg
Arsenic	0.1	mg/kg	0.0165	mg/kg
Barium	1	mg/kg	0.0077	mg/kg
Beryllium	0.1	mg/kg	0.0037	mg/kg
Cadmium	0.1	mg/kg	0.0091	mg/kg
Calcium	10	mg/kg	1.7787	mg/kg
Chromium	0.2	mg/kg	0.008	mg/kg
Cobalt	0.05	mg/kg	0.0025	mg/kg
Copper	0.2	mg/kg	0.0085	mg/kg
Iron	5	mg/kg	0.2887	mg/kg
Lead	0.1	mg/kg	0.0034	mg/kg
Magnesium	10	mg/kg	0.3794	mg/kg
Manganese	0.05	mg/kg	0.0145	mg/kg
Nickel	0.1	mg/kg	0.0068	mg/kg
Potassium	10	mg/kg	0.9931	mg/kg
Selenium	0.5	mg/kg	0.0406	mg/kg
Silver	0.1	mg/kg	0.0024	mg/kg
Sodium	10	mg/kg	0.7241	mg/kg
Thallium	0.1	mg/kg	0.002	mg/kg
Vanadium	0.1	mg/kg	0.0058	mg/kg
Zinc	0.5	mg/kg	0.0117	mg/kg

Mercury 7471A

Compound	RL	Units	MDL	Units
Mercury	0.033	mg/kg	0.0109	mg/kg

4. SAMPLE CHAIN-OF-CUSTODY AND DOCUMENTATION

Field notes will be recorded in a permanently bound, dedicated field logbook. A log of sampling activities, location coordinates, and water depths will be recorded in the log in indelible ink. In addition, *in situ* water quality measurements will be recorded at each sampling location using an electronic water quality monitoring instrument.

Personnel names, local weather conditions, and other information that may impact the field sampling program will also be recorded. Similar appropriate information will be recorded in this logbook as samples are processed and submitted to the laboratories for analyses. Each page of the logbook will be numbered and dated by the personnel entering information. Corrections to documentation will be made with a single line through the error with the author's initials and date. Copies of the logbooks will be filed at EA's office in Sparks, Maryland. Full copies of the project logbooks will be submitted as an appendix to the project report.

4.1 NUMBERING SYSTEM

The sample numbering system will be used to communicate sample location and sample type between the field crew and the laboratory. Location IDs are listed in Table 1-1 (Mill Hill sampling locations) and Table 1-2 (Severn River sampling locations).

An example of the sample IDs is as follows:

MH-1-SLAG

where the set of letters denotes the site designation (MH denotes Mill Hill locations and W denotes locations in Severn River). The next digit is the station number and the next set of letters is the type of sample collected. Three different types of samples will be collected:

- SLAG – slag sample to be submitted for chemical analyses
- OYSTER – oyster tissue sample to be submitted for chemical analyses
- WAT – site water sample to be submitted for chemical analyses
- SEDIMENT – substrate (sediment) sample to be submitted for chemical analyses

4.2 SAMPLE DOCUMENTATION

4.2.1 Sample Labels

Sample labels for slag, site water, and sediment will contain at a minimum the location ID, sample date, and sample time. Sample containers for the oyster tissue samples will be labeled with the following information:

- Project: USACE Oyster Reef Monitoring
- Site Name: Specify Mill Hill or Severn
- Oyster Reef/Planting Name

- Site Description including substrate
- Sample Station ID
- Date Sampled (m/d/yr)
- Time Sampled (24 hr)
- Sample Type
- Sample Depth
- Latitude/Longitude (GPS coordinate)
- Name of persons doing collecting
- Collection method

4.2.2 Chain-of-Custody Records

Samples collected in the field will be documented on a chain-of-custody (COC). Separate COCs will accompany the samples to TestAmerica and CTL Group for sample analysis.

5. SAMPLE PACKING AND SHIPPING

Slag, site water, oyster tissue, and field blank samples will be stored in ice-filled coolers on the work platform until the end of each sampling day. Samples for analytical testing will be packaged in bubble wrap, secured individually in ziplock bags, placed in an ice-filled cooler, and shipped via overnight express to TestAmerica and CTL Group laboratories.

Site water, oyster tissue, sediment samples, and field blank samples for chemical analysis will be sent directly to the following address:

TestAmerica–Pittsburgh
301 Alpha Drive
Pittsburgh, PA. 15238
(412) 963-7058
Attn: Sample Management

Slag samples submitted for chemical analyses will be shipped directly to the following address:

CTL Group
5400 Old Orchard Road
Skokie, IL 60077-1030
(847) 965-7500
Attn: Scott Nettles

Coolers will have a copy of the COC form taped to the inside of the top lid.

6. INVESTIGATION-DERIVED WASTES

Waste liquids produced during decontamination procedures will be contained at the areas of decontamination and collected in 5-gallon buckets with lids and transferred to a 55-gallon secure drum at the end of the project. Decontamination waste liquid generated will be contained directly in a secure drum located at EA's warehouse facilities in Sparks, Maryland. The liquid contained in the drums will be tested, characterized, and disposed of by a subcontractor.

7. CORRECTIVE ACTIONS

Corrective actions or deviations from the work plan that are deemed necessary during field operations will be verbally approved by the Field Operations Manager, EA's Project Manager, and/or the USACE–Baltimore District Technical Lead, or their designated representatives. Any corrective actions taken during field activities will be documented in the field logbook and filed at EA's office in Sparks, Maryland. Corrective actions will be discussed in the project report.

8. REFERENCES

Grubb, D.G., M. Wazne, and N.E. Malasavage. 2010. *Characterization of Slag Fines for Use as a Dredged Material Amendment.* GeoFlorida 2010: Advances in Analysis, Modeling, and Design, Geotechnical Special Publication No. 199, D. Fratta, A.J. Puppala, and B. Muhunthan (eds.). ASCE, pp. 10.

Maryland Department of the Environment (MDE). 2009. *Standard Operating Procedures for Fish and Shellfish Collection and Analysis.* Draft.

U.S. Environmental Protection Agency (USEPA). 2000. *National Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis.* Third Edition. Office of Water. EPA 823-B-00-007.

Appendix B
Field Logbook and Dive Trip Reports

9/19/11

0745 - meet Univ. of MD boat @ dock
0815 - depart dock for Mill Hill locations
0900 - arrive on site @ Mill Hill

MH-6

0910 - divers in water at MH-6
water depth 12 ft

0915 - MH-6 site water collected

0920 - MH-6 sediment collected

0930 - 25+ oysters collected

Water Quality - MH-6

Temp.	21.78
Sal.	7.91
pH	8.22
DO	7.04

MH-6 - reef description by divers:
- lots of mussels present
- blue crabs and anemones present
- alternate substrate covered in barnacles and many gobies and blennies present

MH-6 description cont'd:
- oyster box to live ratio:
2 boxes for every 1 live oyster

0945 - on site at MH-2

MH-2

0955 - MH-2 site water collected
0959 - MH-2 sediment collected

1000 - 25+ oysters recovered

1005 - Water Quality @ MH-2

Temp.	21.88
Sal.	7.90
pH	8.29
DO	7.24

MH-2 - reef description by divers:
- reef covered in broken shell
- blue crabs + anemones present
- most oysters present recovered
- oyster box to live ratio:
1 box for every 3 live oysters

1015 - on site @ MH-1

MH-1

1025 - 25+ oysters recovered
1027 - MH-1 site water collected
1030 - MH-1 sediment collected

1035 - Water Quality @ MH-1

Temp	21.72
Sal.	7.89
pH	8.39
DO	7.4

MH-1 - reef description by divers:
- blue crabs, anemones + jellies present
- similar to reef MH-2 but more oysters present
- single oysters as opposed to clumps
- no mussels present
- oyster box to live ratio:
1 box for every 3 live oysters

1040 - on site @ MH-3

MH-3

1051 - MH-3 site water collected
1056 - MH-3 sediment collected

1052 - 25+ oysters collected

1058 - Water Quality for MH-3
Temp. 21.94
Sal. 7.87
pH 8.44
DO 7.83

MH-3 reef description by divers:
- some areas of reef completely covered by shell; edges of reef - no shell bare stone
- blue crabs, mud crabs, mussels, and barnacles present
- fewer oysters than at MH-1
- oysters found in clump not singles
- very few large oysters
- oyster box to live ratio:
  1 box for every 5 live oysters

1105 - on-site @ MH-7

MH-7

1115 - MH-7 site water collected
1118 - MH-7 sediment collected

1117 - 25+ oysters collected

1121 - Water Quality @ MH-7
Temp. 21.97
Sal 7.89
pH 8.44
DO 7.52

MH-7 reef description by divers:
- lots of small fish (gobies) present
- lots of mud crabs present
- substrate covered in mussels + barnacles
- anemones + jellies present
- lots of relief onsite - not flat
- oyster box to live ratio:
  1 box for 1 live oyster

1128 - onsite @ MH-5

MH-5

1135 - MH5 sediment collected
1137 - MH-5 site water collected
1139 - 25+ oysters collected

1142 - water quality @ MH-5
Temp 22.05
Sal. 7.90
pH 8.48
DO 7.87

MH-5 reef description by divers:
- some fish present (gobies)
- lots of jellies present
- alternates substrate encrusted with mussels, barnacles, and anemones
- thin layer of sediment on substrate
oyster bar to live ratio:
1 bar for every 1 live oyster

- less oysters present than at MH-7

1150 - onsite @ MH-4

MH-4

1159 - 25+ oysters collected
1204 - MH-4 site water collected
1207 - MH-4 sediment collected

1154 water quality @ MH-4
Temp 22.15
Sal 7.89
pH 8.58
DO 8.42

MH-4 reef description by divers:
- alternate substrate covered in barnacles + mussels
- few fish + blue crabs present
- few single oysters - majority in clumps - high density
oyster bar to live ratio:
1 bar for every 3 live oysters

1212 on site @ MH-REF

MH-REF

1222 - MH-Ref site water collected
1227 - MH-Ref sediment collected
1231 - 25+ oyster recovered

1215 Water Quality @ MH-Ref

Temp	22.33
Sal.	7.91
pH	8.62
DO	8.91

MH-Ref reef description by divers:
- very similar to other shell sites
- very few single oysters
- blue crabs + jellies present
- not many mussels + barnacles present
- no fish present
- Sandy around edge of reef; main area covered in shell

oyster box to live ration
1 box for every 5 live oysters

10/6/11

0930 - meet Univ. of MD boat at dock
1000 - leave dock for Severn River

1050 - onsite @ Wade 2-5

1100 - W2-5 sediment collected
1105 - W2-5 site water collected
1120 - 150+ oysters collected - very small

1058 Water Quality @ W2-5

Temp	18.23
Sal	4.74
pH	- not working
DO	8.67

Wade 2-5 reef description by divers:
- small barnacles present of alternate substrate
- some algae present
- low visibility - < 1 ft
- oysters wedged between alternate

1122 - on site @ Wade 2-4

1130 W2-4 sediment collected
1135 W2-4 site water collected
1140 - approximately 167 oysters collected

1142 - Water Quality @ W2-4
Temp 18.10
Sal 4.75
pH not working
DO 7.61

Wade 2-4 description by divers:
- < 1 ft of visibility
- Sedimentation present

1145 onsite @ Wade 2-3

1150 - W2-3 sediment collected
1155 W2-3 site water collected
1200 approx. 170 oysters collected

1142 Water Quality @ W2-3
Temp 18.1
Sal 4.76
pH not working
DO 7.91

Wade 2-3 reef description by divers:
- reef 2-3 ft shallower than others
- more relief present - not flat
- blue crabs present
- oysters concentrated in troughs of substrate

1210 - on site @ Weems Creek Upper

1220 WCU sediment collected
1224 WCU site water collected
1228 - 100+ oysters collected

1230 water Quality at WCU
Temp 17.92
Sal 4.79
pH not working
DO 7.61

Weems Creek Upper reef description:
- muddy - deep sediment w/ shell

1240 - onsite at Weems Upper
1245 - WCU sediment collected
1250 WCU site water collected
1258 100+ oysters collected

1300 water Quality at WCU
Temp 17.99
Sal 4.84
pH not working
DO 7.75

Weems Upper reef description
- lots of shell - area covered
- filamentous algae present
- oysters concentrated in troughs

1310 - on site at Wade 2-2

1320 W2-2 sediment collected
1325 W2-2 site water collected
1330 - approximately 200 oysters recovered

1335 water Quality at W2-2
Temp 18.05
Sal 4.78
pH not working
DO 6.69

Wade 2-2 reef description:
- blue crabs present
- southwest corner of the reef - (off of the study area) a reef of large oysters is present

9/22/11

0730 - meet boat @ dock
plan to sample @ Seven Ru sites

0830 - depart dock - Angie USACE
Hillary Lane UofM
Adrian
Ken Paynter
Sam Voss EA

0915 - on site to pull trays

- Wade 2-5

0945 - tray 1 of 4 recovered
- total of 10 pieces of substrate removed
- 2 photos on deck

0957 - tray 2 of 4 recovered
- total of 14 pieces of substrate remov
- 3 photos on deck

1002 - tray 3 of 4 recovered
- total of 7 pieces of substrate rem
- no photos

1015 - tray 4 of 4 recovered
total of 8 pieces of substrate removed
- 2 photos
* pieces of substrate that were removed were similar in size to piece still in tray (@ 6-10 inches)

1026 - on site @ Wade 2- ~~4~~ 3 to pull trays
- Wade 2- ~~4~~ 3

1100 - tray 1 of 4 recovered
- 6 pieces of substrate removed
- 1 photo

1105 - tray 2 of 4 recovered
- 0 pieces of substrate removed
- 2 photos

1110 - tray 3 of 4 removed
- 6 pieces of substrate removed
- 1 photo

1115 - tray 4 of 4 removed
- 6 pieces of substrate
1 photo

1125 - onsite at WADE 2-34

Wade 2-34

1138 - tray 1 of 4 recovered
- 0 pieces of substrate removed
- 1 photos

1144 - tray 2 of 4 recovered
- 4 pieces of substrate removed
- 1 photos

1147 - tray 3 of 4 recovered
- 6 pieces of substrate removed
- 0 photos

* only 3 of the 4 trays were recovered

1205 - on site @ Weems ~~Creek~~ Upper (~~Lower~~)

~~Weems~~ WC4
- tray 1 of 4 recovered
- 0 pieces of substrate removed
- 2 photos

WC4

1220 - tray 2 of 4 recovered
- 0 pieces of substrate removed
- 1 photos

1224 - tray 3 of 4 recovered
- 0 pieces of substrate removed
- 1 photos

1237 - tray 4 of 4 recovered
- 0 pieces of substrate removed
- 1 photos

☆ location was actually Weems Upper - change labels on tray bags ☆ ✓ done STV 4/22

University of Maryland-Paynter Labs/USACE Alternate Substrate Monitoring Trip Report

Trip Details:
Date: December 10th, 2010
Departure Time: 11:00am
Departure Location: Oak Grove Marina, South River, Maryland
Arrival Time: 3:00pm
Location of Work: Eastern Bay, Mill Hill Alternate Substrate Plantings

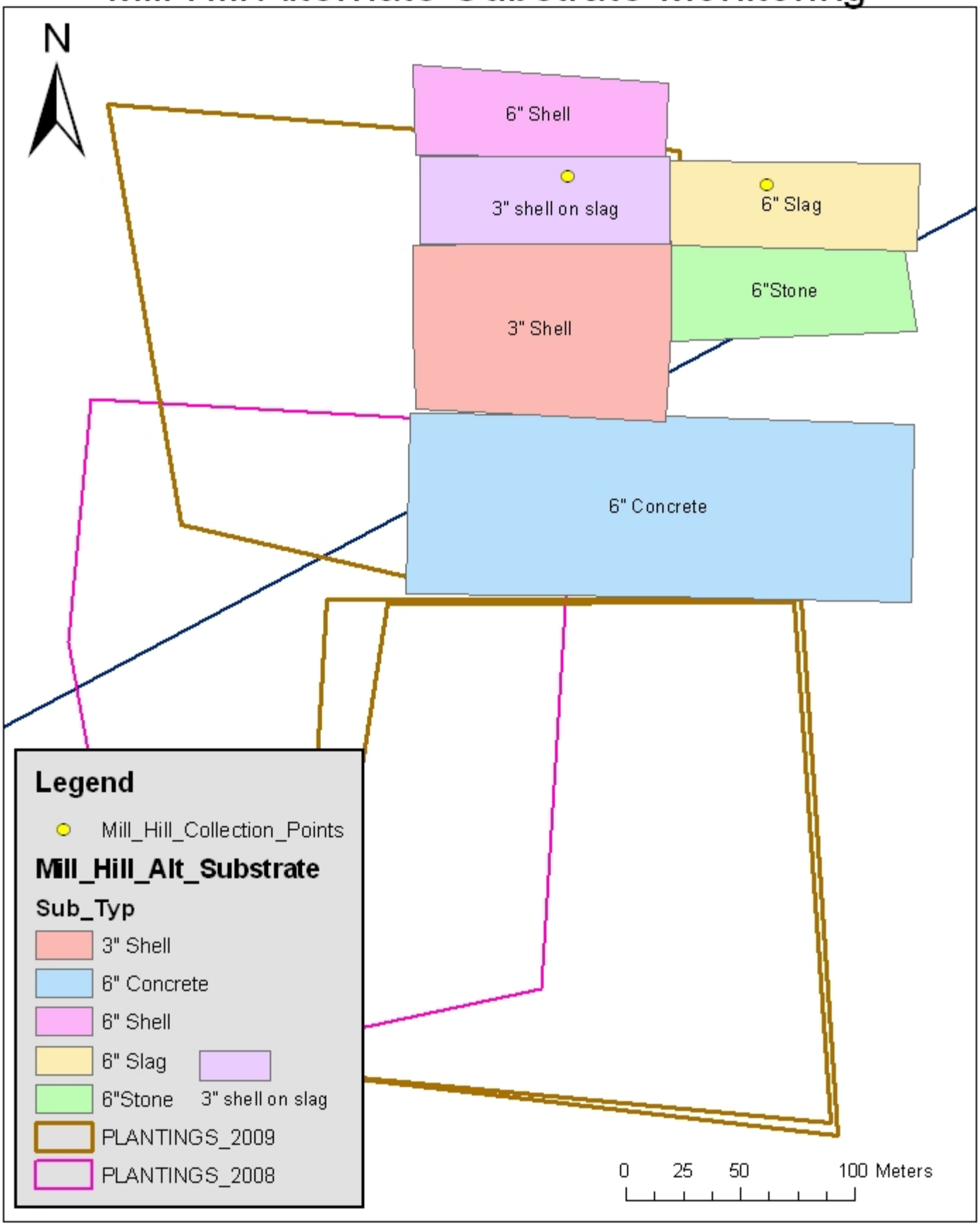
Weather Conditions:
Air Temperature: 0.4°C
Water Temperature: 4.0°C
Winds: 7.7m/s
Visibility: unlimited

Personnel:
Ken Paynter: Captain
Hillary Lane: Lead Diver
Adriane Michaelis: Diver
Jan Vicente: Diver
Rebecca Kulp: Deckhand
John Houvener: USACE Dive Safety Officer

Description of Work:
One 20-minute dive was conducted at each of the slag plantings (6" slag and 3" shell on slag) at Mill Hill on December 10th, 2010. Figure 1 shows the location of each dive at Mill Hill. Divers dropped at the center of each plot and surveyed the area for the presence of oysters. Alternate substrate and water samples were collected at each site and delivered to EA Engineering on December 13th, 2010. Two oysters were found at the 6" slag planting attached to the substrate and were also delivered to EA Engineering. Extensive mussel coverage was observed at the slag site. Mussels were found completely covering much of the substrate and were mistaken by the divers in the low-visibility waters as being oyster coverage. This mis-observation was corrected once the samples were brought on the boat, when it became obvious that the species present was, in fact, mussels and not oyster. Water and air temperatures were very low, making long surveys of the plots for more oysters impractical. Since oysters were not found in high densities at the slag plantings and cold air and water temperatures created dangerous conditions for the divers, no other substrates were investigated for the presence of oysters.

Attachments:
Figure 1: Map of Mill Hill Alternate Substrate survey
Pictures: 5 underwater pictures of alternate substrate
December 2010 GIS Data: Point shapefile of survey locations

Paynter Lab/USACE
Mill Hill Alternate Substrate Monitoring



University of Maryland-Paynter Labs/USACE Alternate Substrate Monitoring Trip Report

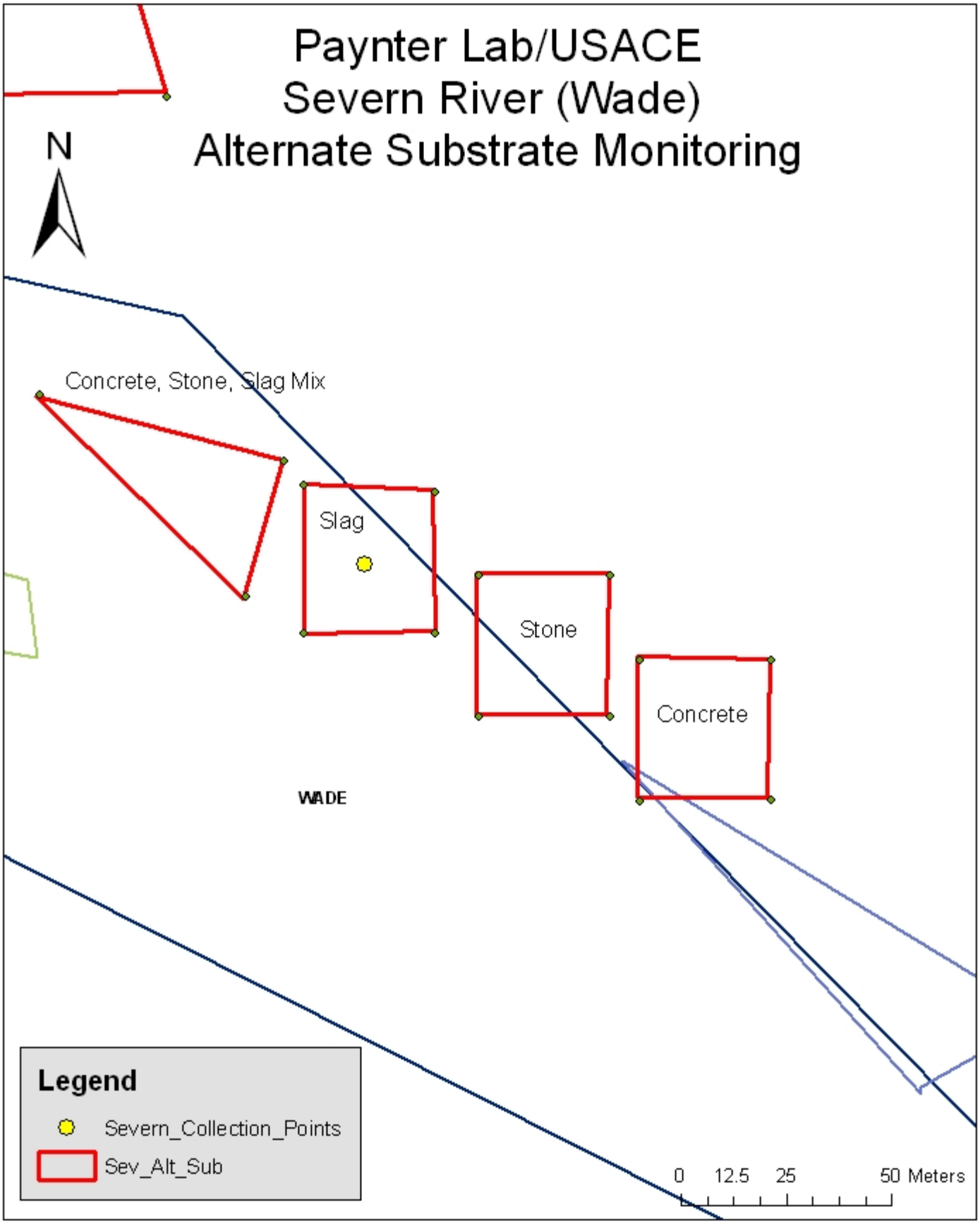
Trip Details:
Date: March 22nd, 2011
Departure Time: 11:00am
Departure Location: Oak Grove Marina, South River, Maryland
Arrival Time: 3:00pm
Location of Work: Severn River, Wade Alternate Substrate Plantings

Weather Conditions:
Air Temperature: 9.4°C
Water Temperature: 7.8°C
Winds: 4.6m/s
Visibility: unlimited

Personnel:
Ken Paynter: Captain
Hillary Lane: Lead Diver
Adriane Michaelis: Diver
Jan Vicente: Diver
Drew Needham: Deckhand

Description of Work:
One 20-minute dive was conducted at the slag planting at Wade oyster bar in the Severn River on March 22nd, 2011. Figure 1 shows the location of the dive at Wade. A survey of the plantings at Wade in the fall of 2010 determined the substrate type at each of the four alternate material plantings at Wade, allowing for divers to only survey one of the plantings. Divers dropped at the center of the slag plot and surveyed the area for the presence of oysters. Alternate substrate and water samples were collected and picked up by EA Engineering on March 22nd, 2011. Oyster spat on shell was discovered at the slag planting and were photographed, but were returned to the substrate. Slag recovered at the site as well as any spat on shell that were found were photographed (see Pictures).

Attachments:
Figure 1: Map of the Wade Alternate Substrate survey
Pictures: Photos of slag material and spat on shell collected at Wade
March 2011 GIS Data: Point shapefile of survey location at Wade


Paynter Lab/USACE
Severn River (Wade)
Alternate Substrate Monitoring
N
Concrete, Stone, Slag Mix
Slag
Stone
Concrete
WADE
Legend
Severn_Collection_Points
Sev_Alt_Sub
0 12.5 25 50 Meters

University of Maryland-Paynter Labs/USACE Alternate Substrate Monitoring Trip Report

Trip Details:

Date: May 10, 2011
Departure Time: 8:00am
Departure Location: Oak Grove Marina, South River, Maryland
Arrival Time: 3:00pm
Location of Work: Severn River, Wade and Weems Alternate Substrate Plantings

Weather Conditions:

Air Temperature: 14.9 C
Water Temperature: 16.7 C
Winds: 5.7 m/s

Personnel:

Ken Paynter: Captain
Hillary Lane: Lead Diver
Steve Allen: Diver
Adriane Michaelis: Back-up Diver/Deckhand
Adam Kumm: EA Engineering/Deckhand

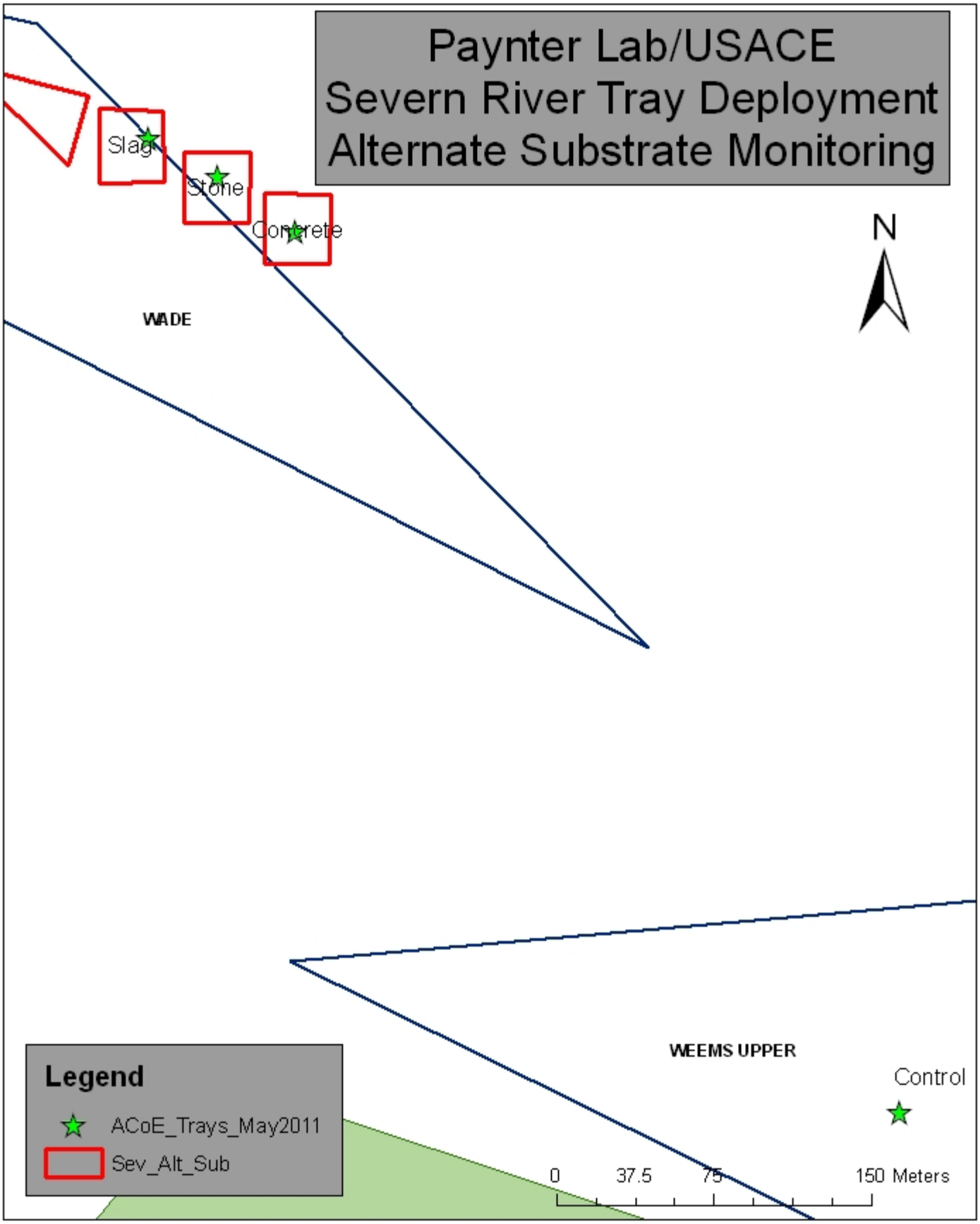
Description of Work:

Benthic sampling trays were placed by divers at Wade and Weems Upper alternate substrate planting sites in the Severn River on May 10, 2011. Divers dropped in the center of each alternate substrate type, first to place a screw anchor near the buoyed marker anchor, and then again with each set of trays. Each dive lasted approximately 10-15 minutes. Visibility below water was approximately 1m. Figure 1 shows the location of each dive.

Four (56 cm^2) trays were placed approximately 3m apart from one another on each type of alternate substrate at Wade: concrete, slag, and stone. Additionally, four trays were placed on the Weems Upper alternate substrate site (composed of granite with shell veneer). At each substrate type, the four trays were connected via line to a central screw anchor, and trays were also anchored using rebar. When placing trays, alternate substrate was collected from the area that the tray was to occupy and loaded on to the tray. The tray was then moved into the area in which the substrate originated, to make the tray as much a part of the natural reef as possible. A staff member from EA engineering was on board to collect water quality data. No photographs were taken. Trays are to remain in the water for one year, at which point they will be removed by divers and benthic life will be evaluated by EA Engineering.

Attachments:

Figure 1: Map of Severn River alternate substrate benthic sample tray locations.
ACoE Trays May2011: GIS point shapefile of Severn River benthic sample tray locations.


Paynter Lab/USACE
Severn River Tray Deployment
Alternate Substrate Monitoring
Slag
Stone
Concrete
N
WADE
WEEMS UPPER
Control
Legend
ACoE_Trays_May2011
Sev_Alt_Sub
0
37.5
75
150 Meters

Appendix C
University of Maryland Dive Plans

UM Dive Plan

You successfully submitted the information below.

The dive safety officer will notify you if your dive plan is approved.

Remember to submit your Dive Log after each diving expedition or monthly, at the latest.

Logout

Date Submitted: Tuesday, 11/23/2010
Submitted by:Lane, Hillary Anne
Department: BiologyCollege of Chemical & Life Sciences
Phone: 3014059701
Email: hillaryannelane@gmail.com
Address: Biology-Psychology Building - Room: 1210

Dive Monitor: Karen Kesler
Dive Monitor's Phone Number: (443) 928-3155
Dates of Research Dives: 12/9/10
Location of Dives: Severn, Magothy, Choptank, Chester, Patuxent River

1. Participating Scientific Divers and Emergency Information

#	Diver's Name	Depth Certification	Certifying Agency	Emergency Phone	Emergency Contact	Relationship
1	Hillary Lane	30'	PADI	(202) 487-0312	Dan Rosenthal	Cousin
2	Steve Allen	30'	PADI	(843) 324-4909	Sara Kingston	Wife
3	Adriane Michaelis	30'	NAUI	(734) 775-5175	Betty Michaelis	Mom
4	Jan Vicente Raczkowski	30'	NAUI	(336) 669-3581	Charlie Raczkowski	Uncle

2. Emergency plan (Oxygen unit and first aid kit must be on site)
   Nearest Hyberbaric Chamber location: Baltimore
   Method of transport/contact: Fastest Available
   UM Emergency Phone: (301) 405-0330
   DAN: (919) 684-9111
   DNR Phone: (410) 267-8108

US Coast Guard Phone: (410) 260-8888

3. Approximate number of proposed dives: 12
4. Estimated depths and bottom times anticipated: 20' for 20 minutes
5. Estimated completion time and time out of water: 5:00pm
6. Decompression status and repetitive dive plans if required: No decompression dives planned.
7. Nonemergency deviations from this dive plan and/or UM Dive manual must be authorized.
8. Proposed work, equipment and boats to be employed: Transect sampling, quadrat sampling, underwater video, Boat: Callinectes

UNIVERSITY OF MARYLAND ENVIRONMENTAL S@FETY Division of Administrative Affairs

UM Dive Plan

You successfully submitted the information below.

The dive safety officer will notify you if your dive plan is approved.

Remember to submit your Dive Log after each diving expedition or monthly, at the latest.

Logout

Date Submitted: Monday, 03/14/2011
Submitted by:Lane, Hillary Anne
Department: BiologyCollege of Chemical & Life Sciences
Phone: 3014059701
Email: hillaryannelane@gmail.com
Address: Biology-Psychology Building - Room: 1210

Dive Monitor: Karen Kesler
Dive Monitor's Phone Number: (443) 928-3155
Dates of Research Dives: 3/22/11
Location of Dives: Severn, Magothy, Choptank, Chester, Patuxent River

1. Participating Scientific Divers and Emergency Information

#	Diver's Name	Depth Certification	Certifying Agency	Emergency Phone	Emergency Contact	Relationship
1	Hillary Lane	30'	PADI	(202) 487-0312	Dan Rosenthal	Cousin
2	Steve Allen	30'	PADI	(843) 324-4909	Sara Kingston	Wife
3	Adriane Michaelis	30'	NAUI	(734) 775-5175	Betty Michaelis	Mother
4	Jan Vicente Raczkowksi	30'	NAUI	(336) 669-3581	Charlie Raczkowksi	Uncle

2. Emergency plan (Oxygen unit and first aid kit must be on site)
   Nearest Hyberbaric Chamber location: Baltimore
   Method of transport/contact: Fastest available
   UM Emergency Phone: (301) 405-0330
   DAN: (919) 684-9111
   DNR Phone: (410) 267-8108
   US Coast Guard Phone: (410) 260-8888

3. Approximate number of proposed dives: 12
4. Estimated depths and bottom times anticipated: 20' for 20 minutes
5. Estimated completion time and time out of water: 5:00 pm
6. Decompression status and repetitive dive plans if required: No decompression dives planned.
7. Nonemergency deviations from this dive plan and/or UM Dive manual must be authorized.
8. Proposed work, equipment and boats to be employed: Transect sampling, quadrat sampling, underwater video. Boat: Callinectes.

UNIVERSITY OF MARYLAND ENVIRONMENTAL S@FETY Division of Administrative Affairs

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UM Dive Plan

You successfully submitted the information below.

The dive safety officer will notify you if your dive plan is approved.

Remember to submit your Dive Log after each diving expedition or monthly, at the latest.

Logout

Date Submitted: Thursday, 05/05/2011
Submitted by:Lane, Hillary Anne
Department: BiologyCollege of Chemical & Life Sciences
Phone: 3014059701
Email: hillaryannelane@gmail.com
Address: Biology-Psychology Building - Room: 1210

Dive Monitor: Karen Kesler
Dive Monitor's Phone Number: (443) 928-3155
Dates of Research Dives: 5/10/11
Location of Dives: Severn, Magothy, Choptank, Chester, Patuxent River

1. Participating Scientific Divers and Emergency Information

#	Diver's Name	Depth Certification	Certifying Agency	Emergency Phone	Emergency Contact	Relationship
1	Hillary Lane	30'	PADI	(202) 487-0312	Dan Rosenthal	Cousin
2	Adriane Michaelis	30'	NAUI	(734) 775-5175	Betty Michaelis	Mother
3	Jan Vicente Raczkowski	30'	NAUI	(336) 669-3581	Charlie Raczkowski	Uncle
4	Steve Allen	30'	PADI	(843) 324-4909	Sarah Kingston	Wife

2. Emergency plan (Oxygen unit and first aid kit must be on site)
   Nearest Hyberbaric Chamber location: Baltimore
   Method of transport/contact: Fastest available
   UM Emergency Phone: (301) 405-0330
   DAN: (919) 684-9111
   DNR Phone: (410) 267-8108
   US Coast Guard Phone: (410) 267-8108

3. Approximate number of proposed dives: 12
4. Estimated depths and bottom times anticipated: 20' for 20 minutes
5. Estimated completion time and time out of water: 5:00 pm
6. Decompression status and repetitive dive plans if required: No decompression dives planned.
7. Nonemergency deviations from this dive plan and/or UM Dive manual must be authorized.
8. Proposed work, equipment and boats to be employed: Transect sampling, quadrat sampling, underwater video. Boat: Callinectes

Appendix D
Chain of Custody Forms

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratory location: _____
Regulatory program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other _____

TestAmerica Laboratories, Inc.

Client Contact				
Company Name: EA Engineering	Client Project Manager: Christine Papageorgis	Site Contact:	Lab Contact:	COC No: 009102
Address: 15 Loveton Circle	Telephone: 410 771 4950 ext. 5130	Telephone:	Telephone:	____ of ____ COCs
City/State/Zip: Sparks, MD 21152	Email: cpapageorgis@eaest.com	Analysis Turnaround Time (in BUS days)	Analyses	For lab use only
Phone: (410) 771-4950		TAT if different from below ____		Walk-in client ☐
Project Name: USACE Oyster Reef Monitoring	Method of Shipment/Carrier: UPS	☐ 3 weeks		Lab pickup ☐
Project Number: 6213266	Shipping/Tracking No: 12 2E5 781 01 9772 2344	☐ 2 weeks		Lab sampling ☐
PO #		☐ 1 week		Job/SDG No:
		☐ 2 days		
		☐ 1 day		

Sample Identification	Sample Date	Sample Time	Matrix: Air	Aqueous	Sediment	Solid	Other:	Containers & Preservatives: H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH	Unpres	Other:	Filtered Sample (Y/N)	Composite=C / Grab=G	TAL metals	Mercury	Cyanide	Sample Specific Notes / Special Instructions:
MH-WA-01	12/10/10	1230		X					X							G	X	X		
MH-WA-02		1230		X						X						G			X	
MH-WA-03		1340		X					X							G	X	X		
MH-WA-04		1340		X						X						G			X	

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return to Client ☐ Disposal By Lab ☐ Archive For _____ Months

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company: EA	Date/Time: 11/3/11 1200	Received by:	Company: TA	Date/Time: 11/4/11 0900
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Client:	Project Manager:	Parameters/Method Numbers for Analysis	Chain of Custody Record
EA Engineering Science, and Technology, Inc. 15 Loveton Circle Sparks, MD 21152	Christine Papageorgis Phone: 410-329-5130 Field Contact: Todd Ward Phone: 410-746-1250		Laboratory: TestAmerica - Pittsburgh 301 Alpha Drive Pittsburgh, PA 15238 phone: 412.963.2428 fax: 412.963.2468 ATTN: Carrie Gamber
Project Name: USACE Oyster Reef Monitoring Project#: 62132.66	TestAmerica Quote #: 18006079-0		
Page 1 of 1			

Date	Time	Water	Sediment	Sample Identification	No. of Containers	TAL Metals (6020)	Mercury (7470A)	Total Cyanide (9012A)	Remarks
3/22/11	1500	X		W-1-WAT	2	X	X	X	SEE PROJECT SPECIFIC ANALYTE LIST

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	SITE WATER - USACE OYSTER REEF MONITORING PROJECT
Todd Ward	3/22/11 1500			
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time	

SAMPLE SUBMISSION FORM

CTLGROUP
Building Knowledge. Delivering Results. www.CTLGroup.com

An AASHTO Accredited Laboratory – Aggregates, Cement & Concrete

SHIPPING:

Attention: SCOTT NETTLES Date Submitted: 3/24/11

Shipped: ☒FedEx ☐UPS ☐USPS ☐Walk-In ☐Other:

Delivery Date: 3/25/11 Tracking No.: 8750 3618 9800 No. Pkgs: 1

CTLGROUP USE:

Date Received:

CTLGroup WR:

Proj. Manager:

CONTACT INFO:

Submitter's Name: TODD WARD
Company: EA ENGINEERING
Mailing Address: 15 LOVETON CIRCLE
City, State, Zip: SPARKS MD 21152
Country: USA
Phone: 410-746-1250
Fax: 410-771-4204
Email: tward@eaest.com

Send Results To: CHRISTINE PAPAGEORGIS
Company: EA ENGINEERING
Mailing Address: 15 LOVETON CIRCLE
City, State, Zip: SPARKS MD 21152
Country: USA
Phone: 410-329-5130
Fax: 410-771-4204
Email: cpapageorgis@eaest.com

Send Final Report by:

☒Regular Mail ☐Express Mail* ☒Email

* Express mail service will be billed at cost plus 10%.

PAYMENT OPTIONS:

1) PURCHASE ORDER / INVOICE:

P.O. Number: 8766
Send Invoice To:
Company:
Mailing Address:
City, State, Zip:
Country:
Email:

New Clients: Please enclose payment with your first order or complete the attached Credit Check Application

2) ADVANCE PAYMENT:

Check No.: _____ Check Amount: $

3) CREDIT CARD:

Credit Card Type: ☐VISA ☐MasterCard ☐AmEx

Cardholder's Name (print):

Credit Card Number:

Exp. Date: _____ (mm/yyyy) V-Code No.: _____

CC Billing Address:

City, State Zip:

Credit Card Payments: All CC information (above) & Authorized Signature (below) are required for CC payment.

SAMPLE HANDLING:

Number of Samples Submitted: 3

List all samples on second page. Attach additional pages as needed.

Are any samples Hazardous Materials? ☐YES ☒NO

Hazardous materials must be clearly marked on packaging and MSDS are required. After testing, hazardous materials will be returned or disposed of at submitter's expense.

Special Sample Storage?: No.

After testing, are samples to be: ☐Returned?** Or ☒Disposed of?

** Return shipping will be billed at cost plus 10%.

PROJECT BACKGROUND:

Reasons for testing or problem observed, if any:

XRF analysis on slag from 2 estuarine environments

Project Name: USACE-OYSTER REEF MONITORING
Location: CHESAPEAKE BAY, MD
Type of Structure: ARTIFICIAL REEFS
Size & Age: —

Is this a Litigation Case? ☐YES ☒NO

AUTHORIZATION: See attached Lab. Service Order. EA's PROCUREMENT OFFICE IS PROCESSING 2nd Service Order for additional sample.

I've read and agree with CTLGroup's **Standard Terms and Conditions** (attached)? ☒YES

Amount Authorized: $ _____ (U.S. funds) Authorized Signature: Todd Ward

Party responsible for payment must authorize work.

This signed Submission Form MUST accompany samples. Testing will not be started until written authorization is received.

Please attach relevant documents (if applicable, specifications/mix design, photographs, test results ...).

SAMPLES SUBMITTED - Mark each sample with Sample ID *(Hazardous materials must be clearly marked on packaging)*

Sample ID *10 characters or less*	Type of Material	Analysis / Test(s) Requested
MH-1-SLAG	slag	XRF (ASTM C1271)
MH-2-SLAG	"	"
W-1-SLAG	"	"

Please attach relevant documents (if applicable, specifications/mix design, photographs, test results).

Client:	Project Manager:
EA Engineering Science, and Technology, Inc.	**Karin Olsen**
	Phone: **410-329-5112**
15 Loveton Circle	Field Contact:
Sparks, MD 21152	**Sam Voss**
	Phone: **410-218-5888**

Project Name: Oyster Reefs

Project#: 62533.01

Page 1 of 1

Sediment Samples

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7470A)	Cyanide (9012A)										Remarks
9/19/2011	1027	X		MH-1-WAT	2	X	X	X										SEE PROJECT SPECIFIC ANALYTE LIST
9/19/2011	0955	X		MH-2-WAT	2	X	X	X										
9/19/2011	1051	X		MH-3-WAT	2	X	X	X										
9/19/2011	1204	X		MH-4-WAT	2	X	X	X										
9/19/2011	1137	X		MH-5-WAT	2	X	X	X										
9/19/2011	0915	X		MH-6-WAT	2	X	X	X										
9/19/2011	1115	X		MH-7-WAT	2	X	X	X										
9/19/2011	1222	X		MH-REF-WAT	2	X	X	X										
9/19/2011	1234	X		MH-FB	2	X	X	X										

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
TestAmerica - Pittsburgh
301 Alpha Drive
Pittsburgh, PA 15238

phone: 412.963.2428
fax: 412.963.2468

ATTN: Carrie Gamber

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time
Relinquished by: (Signature) Karin A. Olsen	Date/Time 9/20/11 1600	Received by Laboratory: (Signature)	Date/Time

Water Samples

Client:	Project Manager:
EA Engineering Science, and Technology, Inc.	**Karin Olsen**
	Phone: **410-329-5112**
15 Loveton Circle	Field Contact:
Sparks, MD 21152	**Sam Voss**
	Phone: **410-218-5888**

Project Name: Oyster Reefs

Project#: 62132.66

Page 1 of 1

Sediment Samples

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7471A)	Cyanide (9012A)	Total Solids SM 2540G									
9/19/2011	1030		X	MH-1-SED	1	X	X	X	X									
9/19/2011	0959		X	MH-2-SED	1	X	X	X	X									
9/19/2011	1056		X	MH-3-SED	1	X	X	X	X									
9/19/2011	1207		X	MH-4-SED	1	X	X	X	X									
9/19/2011	1135		X	MH-5-SED	1	X	X	X	X									
9/19/2011	0920		X	MH-6-SED	1	X	X	X	X									
9/19/2011	1118		X	MH-7-SED	1	X	X	X	X									
9/19/2011	1227		X	MH-REF-SED	1	X	X	X	X									

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
TestAmerica - Pittsburgh
301 Alpha Drive
Pittsburgh, PA 15238

phone: 412.963.2428
fax: 412.963.2468

ATTN: Carrie Gamber

Remarks

SEE PROJECT SPECIFIC ANALYTE LIST

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	**Sediment Samples**
Relinquished by: (Signature) Karin A. Olsen	Date/Time 9/20/11 1600	Received by Laboratory: (Signature)	Date/Time	

Client:	Project Manager:	Parameters/Method Numbers for Analysis	Chain of Custody Record
EA Engineering Science, and Technology, Inc. **15 Loveton Circle** **Sparks, MD 21152**	**Karin Olsen** Phone: **410-329-5112** Field Contact: **Sam Voss** Phone: **410-218-5888**		Laboratory: **TestAmerica - Pittsburgh** **301 Alpha Drive** **Pittsburgh, PA 15238** **phone: 412.963.2428** **fax: 412.963.2468** **ATTN: Carrie Gamber**
Project Name: Oyster Reefs Project#: 62533.01			
Page 1 of 3	**Sediment Samples**		

Date	Time	Tissue	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7471A)	Cyanide (9012A)	Homogenization									Remarks
9/19/2011	1025	X		MH-1-Oyster-A	1	X	X	X	X									
9/19/2011	1025	X		MH-1-Oyster-B	1	X	X	X	X									
9/19/2011	1025	X		MH-1-Oyster-C	1	X	X	X	X									
9/19/2011	1025	X		MH-1-Oyster-CD	1	X	X	X	X									
9/19/2011	1025	X		MH-1-Oyster-CT	1	X	X	X	X									
9/19/2011	1000	X		MH-2-Oyster-A	1	X	X	X	X									
9/19/2011	1000	X		MH-2-Oyster-B	1	X	X	X	X									
9/19/2011	1000	X		MH-2-Oyster-C	1	X	X	X	X									
9/19/2011	1000	X		MH-2-Oyster-CD	1	X	X	X	X									
9/19/2011	1000	X		MH-2-Oyster-CT	1	X	X	X	X									
9/19/2011	1052	X		MH-3-Oyster-A	1	X	X	X	X									
9/19/2011	1052	X		MH-3-Oyster-B	1	X	X	X	X									
9/19/2011	1052	X		MH-3-Oyster-C	1	X	X	X	X									
9/19/2011	1052	X		MH-3-Oyster-CD	1	X	X	X	X									
9/19/2011	1052	X		MH-3-Oyster-CT	1	X	X	X	X									

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	**Tissue Samples**
Relinquished by: (Signature)	Date/Time 10/5/11 8:15:45	Received by Laboratory: (Signature)	Date/Time	

Client:	Project Manager:	Parameters/Method Numbers for Analysis	Chain of Custody Record
EA Engineering Science, and Technology, Inc.	**Karin Olsen**		Laboratory:
	Phone: **410-329-5112**		**TestAmerica - Pittsburgh**
15 Loveton Circle	Field Contact:		**301 Alpha Drive**
Sparks, MD 21152	**Sam Voss**		**Pittsburgh, PA 15238**
	Phone: **410-218-5888**		**phone: 412.963.2428**
Project Name: Oyster Reefs			**fax: 412.963.2468**
Project#: 62533.01			**ATTN: Carrie Gamber**
Page 2 of 3	**Sediment Samples**		

Date	Time	Tissue	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7471A)	Cyanide (9012A)	Homogenization									Remarks
9/19/2011	1159	X		MH-4-Oyster-A	1	X	X	X	X									
9/19/2011	1159	X		MH-4-Oyster-B	1	X	X	X	X									
9/19/2011	1159	X		MH-4-Oyster-C	1	X	X	X	X									
9/19/2011	1159	X		MH-4-Oyster-CD	1	X	X	X	X									
9/19/2011	1159	X		MH-4-Oyster-CT	1	X	X	X	X									
9/19/2011	1139	X		MH-5-Oyster-A	1	X	X	X	X									
9/19/2011	1139	X		MH-5-Oyster-B	1	X	X	X	X									
9/19/2011	1139	X		MH-5-Oyster-C	1	X	X	X	X									
9/19/2011	1139	X		MH-5-Oyster-CD	1	X	X	X	X									
9/19/2011	1139	X		MH-5-Oyster-CT	1	X	X	X	X									
9/19/2011	930	X		MH-6-Oyster-A	1	X	X	X	X									
9/19/2011	930	X		MH-6-Oyster-B	1	X	X	X	X									
9/19/2011	930	X		MH-6-Oyster-C	1	X	X	X	X									
9/19/2011	930	X		MH-6-Oyster-CD	1	X	X	X	X									
9/19/2011	930	X		MH-6-Oyster-CT	1	X	X	X	X									

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	**Tissue Samples**
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time	
[signature]	10/5/11 1545			

Client:	Project Manager:	Parameters/Method Numbers for Analysis	Chain of Custody Record
EA Engineering Science, and Technology, Inc. **15 Loveton Circle** **Sparks, MD 21152**	**Karin Olsen** Phone: **410-329-5112** Field Contact: **Sam Voss** Phone: **410-218-5888**		Laboratory: **TestAmerica - Pittsburgh** **301 Alpha Drive** **Pittsburgh, PA 15238** **phone: 412.963.2428** **fax: 412.963.2468** **ATTN: Carrie Gamber**
Project Name: Oyster Reefs Project#: 62533.01			
Page 3 of 3	**Sediment Samples**		

Date	Time	Tissue	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7471A)	Cyanide (9012A)	Homogenization									Remarks
9/19/2011	1117	X		MH-7-Oyster-A	1	X	X	X	X									
9/19/2011	1117	X		MH-7-Oyster-B	1	X	X	X	X									
9/19/2011	1117	X		MH-7-Oyster-C	1	X	X	X	X									
9/19/2011	1117	X		MH-7-Oyster-CD	1	X	X	X	X									
9/19/2011	1117	X		MH-7-Oyster-CT	1	X	X	X	X									
9/19/2011	1235	X		MH-REF-Oyster-A	1	X	X	X	X									
9/19/2011	1235	X		MH-REF-Oyster-B	1	X	X	X	X									
9/19/2011	1235	X		MH-REF-Oyster-C	1	X	X	X	X									
9/19/2011	1235	X		MH-REF-Oyster-CD	1	X	X	X	X									
9/19/2011	1235	X		MH-REF-Oyster-CT	1	X	X	X	X									

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	**Tissue Samples**
Relinquished by: (Signature) Sam Voss	Date/Time 10/5/11 1545	Received by Laboratory: (Signature)	Date/Time	

Client:	Project Manager:	Parameters/Method Numbers for Analysis	Chain of Custody Record
EA Engineering Science, and Technology, Inc.	**Karin Olsen**		Laboratory:
	Phone: **410-329-5112**		**TestAmerica - Pittsburgh**
15 Loveton Circle	Field Contact:		**301 Alpha Drive**
Sparks, MD 21152	**Sam Voss**		**Pittsburgh, PA 15238**
	Phone: **410-218-5888**		**phone: 412.963.2428**
Project Name: Oyster Reefs			**fax: 412.963.2468**
Project#: 62132.66			**ATTN: Carrie Gamber**
Page 1 of 1	**Water Samples**		

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7470A)	Cyanide (9012A)										Remarks
10/6/2011	1325	X		W2-2-WAT	2	X	X	X										**SEE PROJECT SPECIFIC ANALYTE LIST**
10/6/2011	1155	X		W2-3-WAT	2	X	X	X										
10/6/2011	1135	X		W2-4-WAT	2	X	X	X										
10/6/2011	1105	X		W2-5-WAT	2	X	X	X										
10/6/2011	1253	X		WU-WAT	2	X	X	X										
10/6/2011	1229	X		WCU-WAT	2	X	X	X										
10/6/2011	1338	X		SEVERN - FB	2	X	X	X										

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	**Sediment Samples**
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time	
	10/7/11 1500			

Client:	Project Manager:	Parameters/Method Numbers for Analysis	Chain of Custody Record
EA Engineering Science, and Technology, Inc.	**Karin Olsen**		Laboratory:
	Phone: **410-329-5112**		**TestAmerica - Pittsburgh**
15 Loveton Circle	Field Contact:		**301 Alpha Drive**
Sparks, MD 21152	**Sam Voss**		**Pittsburgh, PA 15238**
	Phone: **410-218-5888**		**phone: 412.963.2428**
Project Name: Oyster Reefs			**fax: 412.963.2468**
Project#: 62132.66			**ATTN: Carrie Gamber**
Page 1 of 1	**Sediment Samples**		

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7471A)	Cyanide (9012A)	Total Solids SM 2540G	Remarks
10/6/2011	1320		X	W2-2-SED	1	X	X	X	X	**SEE PROJECT SPECIFIC ANALYTE LIST**
10/6/2011	1150		X	W2-3-SED	1	X	X	X	X	
10/6/2011	1130		X	W2-4-SED	1	X	X	X	X	
10/6/2011	1100		X	W2-5-SED	1	X	X	X	X	
10/6/2011	1245		X	WU-SED	1	X	X	X	X	
10/6/11	1220		X	WCU - SED	1	X	X	X	X	

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	**Sediment Samples**
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time	
[signature]	10/7/11 1500			

Client:	Project Manager:
EA Engineering Science, and Technology, Inc.	**Karin Olsen**
	Phone: **410-329-5112**
15 Loveton Circle	Field Contact:
Sparks, MD 21152	**Sam Voss**
	Phone: **410-218-5888**

Project Name: Oyster Reefs

Project#: 62533.01

Page 1 of 2

Sediment Samples

Date	Time	Tissue	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7471A)	Cyanide (9012A)	Homogenization									Remarks
10/7/2011	1100	X		W2-2-Oyster-A	1	X	X	X	X									
10/7/2011	1100	X		W2-2-Oyster-B	1	X	X	X	X									
10/7/2011	1100	X		W2-2-Oyster-C	1	X	X	X	X									
10/7/2011	1100	X		W2-2-Oyster-CD	1	X	X	X	X									
10/7/2011	1100	X		W2-2-Oyster-CT	1	X	X	X	X									
10/7/2011	1215	X		W2-3-Oyster-A	1	X	X	X	X									
10/7/2011	1215	X		W2-3-Oyster-B	1	X	X	X	X									
10/7/2011	1215	X		W2-3-Oyster-C	1	X	X	X	X									
10/7/2011	1215	X		W2-3-Oyster-CD	1	X	X	X	X									
10/7/2011	1215	X		W2-3-Oyster-CT	1	X	X	X	X									
10/7/2011	1250	X		W2-4-Oyster-A	1	X	X	X	X									
10/7/2011	1250	X		W2-4-Oyster-B	1	X	X	X	X									
10/7/2011	1250	X		W2-4-Oyster-C	1	X	X	X	X									
10/7/2011	1250	X		W2-4-Oyster-CD	1	X	X	X	X									
10/7/2011	1250	X		W2-4-Oyster-CT	1	X	X	X	X									

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
TestAmerica - Pittsburgh
301 Alpha Drive
Pittsburgh, PA 15238

phone: 412.963.2428
fax: 412.963.2468

ATTN: Carrie Gamber

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	**Tissue Samples**
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time	

Client:	Project Manager:
EA Engineering Science, and Technology, Inc.	**Karin Olsen**
	Phone: **410-329-5112**
15 Loveton Circle	Field Contact:
Sparks, MD 21152	**Sam Voss**
	Phone: **410-218-5888**

Project Name: Oyster Reefs

Project#: 62533.01

Page 2 of 2

Sediment Samples

Date	Time	Tissue	Sediment	Sample Identification	No. of Containers	Metals (TAL List) 6020	Mercury (7471A)	Cyanide (9012A)	Homogenization									Remarks
10/7/2011	1320	X		W2-5-Oyster-A	1	X	X	X	X									
10/7/2011	1320	X		W2-5-Oyster-B	1	X	X	X	X									
10/7/2011	1320	X		W2-5-Oyster-C	1	X	X	X	X									
10/7/2011	1320	X		W2-5-Oyster-CD	1	X	X	X	X									
10/7/2011	1320	X		W2-5-Oyster-CT	1	X	X	X	X									
10/7/2011	1200	X		WU-Oyster-A	1	X	X	X	X									
10/7/2011	1200	X		WU-Oyster-B	1	X	X	X	X									
10/7/2011	1200	X		WU-Oyster-C	1	X	X	X	X									
10/7/2011	1200	X		WU-Oyster-CD	1	X	X	X	X									
10/7/2011	1200	X		WU-Oyster-CT	1	X	X	X	X									
10/7/2011	1130	X		WCU-Oyster-A	1	X	X	X	X									
10/7/2011	1130	X		WCU-Oyster-B	1	X	X	X	X									
10/7/2011	1130	X		WCU-Oyster-C	1	X	X	X	X									
10/7/2011	1130	X		WCU-Oyster-CD	1	X	X	X	X									
10/7/2011	1130	X		WCU-Oyster-CT	1	X	X	X	X									

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
TestAmerica - Pittsburgh
301 Alpha Drive
Pittsburgh, PA 15238

phone: 412.963.2428
fax: 412.963.2468

ATTN: Carrie Gamber

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	**Tissue Samples**
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time	

Appendix E
Oyster Data from Mill Hill Sites

Mill Hill - Reference

Oyster	Length (mm)	Width (mm)
1	88.6	24.45
2	98.91	27.27
3	105.17	22.21
4	95.73	25.08
5	114.67	27.19
6	121.23	30.51
7	112.4	28.71
8	108.01	26.61
9	116.49	30.41
10	99.37	26.03
11	121.75	27.84
12	106.17	26.65
13	98.36	15.98
14	112.67	27.05
15	98.32	16.69
16	95.85	31.31
17	85.5	36.22
18	87.15	27.19
19	74.11	26
20	100.94	23.43
21	97.77	26.51
22	123.73	28.9
23	102.61	28.67
24	100.32	24.2
25	83.12	27.39
26	83.11	24
27	92.1	21.01
28	109.62	36.81
29	120.38	22.4
30	110.56	18.71
31	86.22	23.92
32	90.17	26.32
33	89.25	24.3
34	85.67	31.72
35	80.51	28.8
36	87.29	22.94
37	104.67	27.86
38	112.22	24.8
39	99.37	24.6
40	90	29.33
41	70.82	26.15
42	108.11	28.45
43	83.67	29.08
44	73.6	25.88

Total Wet Weight of Tissue = 392 grams

Mill Hill - 1

Oyster	Length (mm)	Width (mm)
1	107.74	48.91
2	96.24	47.12
3	103.51	48.63
4	105.18	43.88
5	103.39	43.39
6	120.76	43.36
7	108.04	40.68
8	98.15	34.48
9	90.57	31.62
10	106.5	43.02
11	97.48	45.51
12	90.18	45.03
13	90.67	45.68
14	120.72	46.01
15	110.94	47.69
16	105.25	44.04
17	86.43	32.7
18	74.66	22.17
19	104.66	41.35
20	112.19	36.01
21	93.07	37.74
22	92.68	35.11
23	97.27	40.14
24	98.17	41.6
25	93.64	39.83
26	61	21.05
27	57.96	20.9
28	73.3	26.69

Total Wet Weight of Tissue = 267 grams

Mill Hill - 2

Oyster	Length (mm)	Width (mm)
1	80.73	17.18
2	77.05	30.19
3	66.31	21.08
4	80.79	31.29
5	115.48	41.69
6	53.49	21.72
7	74.19	24.88
8	81.18	28.92
9	100.79	34.8
10	73.62	22.65
11	69.8	14.36
12	73.24	21.95
13	68.46	27.11
14	76.45	28.23

15	72.9	28.94
16	82.01	36.4
17	68.25	26.26
18	59.81	12.44
19	62.81	20.99
20	61.12	24.92
21	67.67	21.33
22	75.5	22.42
23	66.59	20.33
24	53.53	24.47
25	84.3	21.14
26	70.24	19.11
27	61.01	22.59
28	74.67	22.31
29	67.01	29.45
30	74.19	25.64
31	73.3	27.7
32	68.34	29.83
33	71.1	24.19
34	85.57	34.76
35	59.54	19.09
36	106.78	33.87
37	58.27	18.74
38	74.29	24.27

Total Wet Weight of Tissue = 233 grams

Mill Hill - 3

Oyster	Length (mm)	Width (mm)
1	90.37	12.47
2	102.71	24.33
3	80.71	21.25
4	88.53	20.36
5	75.99	25.7
6	73.12	15.08
7	86.74	25.82
8	86.9	24.4
9	102.77	42.62
10	83.99	21.96
11	75.91	21.14
12	98.68	19.9
13	109.49	16.15
14	92.77	23.63
15	71.35	20.64
16	103.43	22.27
17	70.29	26.38
18	92.9	21.98
19	77.18	23.02
20	67.6	22.28
21	86.08	23.21
22	75.55	18.14
23	102.53	22.53
24	104.23	22.3
25	95.5	20.51
26	107.05	23.27
27	76.33	19.72
28	73.45	22.9
29	100.83	23.91
30	86.66	26.89
31	79.7	27.53
32	83.86	29.78
33	77.25	31.02
34	83.38	24.97
35	90.91	16.02
36	96.12	17.92
37	77.85	25.86
38	81.24	27.45
39	98.74	36.22
40	84.57	20.02
41	103.35	18.14
42	76.62	19.55
43	68.6	21.92
44	80.08	18.75
45	74.38	22.03
46	75.19	24.17
47	72.15	21.04
48	72.62	24.19
49	86.09	24.15
50	83.86	14.8
51	76.06	15.36
52	67.7	23.55
53	102.75	17.88
54	81.55	21.56
55	72.69	22.54
56	76.59	20.09
57	75.72	20.5
58	71.29	24.24
59	71.09	23.78
60	73.99	20.11

Total Wet Weight of Tissue = 432 grams

Mill Hill - 4

Oyster	Length (mm)	Width (mm)
1	76.27	24.09
2	73.62	28.89
3	101.12	34.94
4	94.76	29.87

5	81.99	25.11
6	67.11	19.25
7	76.2	18.97
8	93.84	25.09
9	88.19	26.22
10	89.01	28.28
11	83.79	22.88
12	77.27	19.72
13	77.68	25.03
14	75.34	21.57
15	89.62	25.51
16	75.19	24.25
17	98.65	24.79
18	76.89	25.34
19	73.46	21.49
20	83.14	23.17
21	80.16	17.78
22	85.39	33.76
23	93.94	24.16
24	85.41	24.88
25	69.4	21.22
26	79.82	17.27
27	87	20.25
28	73.32	24
29	78.85	22.23
30	116.68	23.76
31	78.57	25.04
32	87.38	28.65
33	125.1	38.83
34	93.43	30.12
35	68.71	21.12
36	104.89	24.33
37	133.73	33.71
38	98.1	26.85
39	104.88	31.02
40	93.34	26.43
41	63.51	23.03
42	83.14	24.71
43	59.84	25.21
44	77.83	25.75
45	74.59	28.66
46	93.89	26.88
47	99.51	28.29

Total Wet Weight of Tissue = 327 grams

Mill Hill - 5

Oyster	Length (mm)	Width (mm)
1	105.7	26.02
2	111.44	30.15
3	120.49	32.19
4	67.34	22.64
5	64.55	18.08
6	113	32.88
7	70.32	20.39
8	62.19	23.69
9	80.78	16.61
10	67.55	22.65
11	64.8	25.3
12	112.6	36.08
13	85.55	20.42
14	70.74	29.57
15	80.91	19.74
16	60.17	19.37
17	57.59	20.62
18	61.21	23.87
19	74.03	23.27
20	88.69	22.44
21	68.65	18.8
22	55.15	19.07
23	132.17	40.49

Total Wet Weight of Tissue =209 grams

Mill Hill - 6

Oyster	Length (mm)	Width (mm)
1	107.97	47.29
2	109.03	36.53
3	82.5	33.53
4	83.71	23.87
5	97.21	29.99
6	125.56	35.02
7	80.41	29.79
8	107.33	29.6
9	123.62	32.73
10	116.9	41.52
11	95.42	25.37
12	120.81	40.9
13	102.22	50.12
14	99.69	47.86
15	84.89	21.66
16	90.06	20.7
17	115.98	37.49
18	99.74	38.67
19	108.14	22.74
20	65.91	27.18
21	90.52	34.43
22	72.23	29.68

23	95.42	35.81
24	82.49	24.47
25	67.6	21.74
26	96.02	33.48
27	94.91	29.52
28	73.62	17.59
29	64.82	22.68
30	85.47	25.9
31	74.45	20.56
32	76.9	19.61
33	61.97	28.09
34	68.06	24.29
35	65.23	18.76
36	71.52	23.77
37	69.09	22.4
38	71.72	21.24
39	65.91	17.55

Total Wet Weight of Tissue = 399 grams

Mill Hill - 7

Oyster	Length (mm)	Width (mm)
1	137	33.4
2	112.94	33.25
3	76.15	23.83
4	70.15	25.45
5	59.52	22.54
6	112.22	39.5
7	100.02	33.74
8	100.12	30.76
9	78.51	26.11
10	106.66	42.98
11	107.8	25.4
12	79.41	24.96
13	57.53	23.88
14	78.1	25.23
15	74.74	22.34
16	77.43	36.2
17	103.32	43.96
18	83.9	27.56
19	102.4	25.67
20	109.66	34.68
21	84.61	36.34
22	67.09	31.2
23	136.04	38.63
24	113.82	41.39
25	81.83	21.39
26	71.3	25.76
27	94.01	38.84
28	126.23	47.43
29	110.4	37.39
30	110.73	42.21
31	81.49	39.51
32	99.32	33.52
33	95.09	23.24

Total Wet Weight of Tissue = 363 grams

Appendix F-1
Mill Hill Reefs Pictures

Photo 1. Underwater photographs of Mill Hill alternate substrate

Photo 2. Underwater photograph of Mill Hill alternate substrate

Photo 3. Underwater photograph of Mill Hill alternate substrate

Photo 4. Underwater photograph of Mill Hill alternate substrate

Appendix F -2
Severn River Reefs Pictures

Photo 1. Photograph of slag material from Wade 2-3

Photo 2. Photograph of slag material and spat from Wade 2-3

Photo 3. Photograph of slag material from Wade 2-3

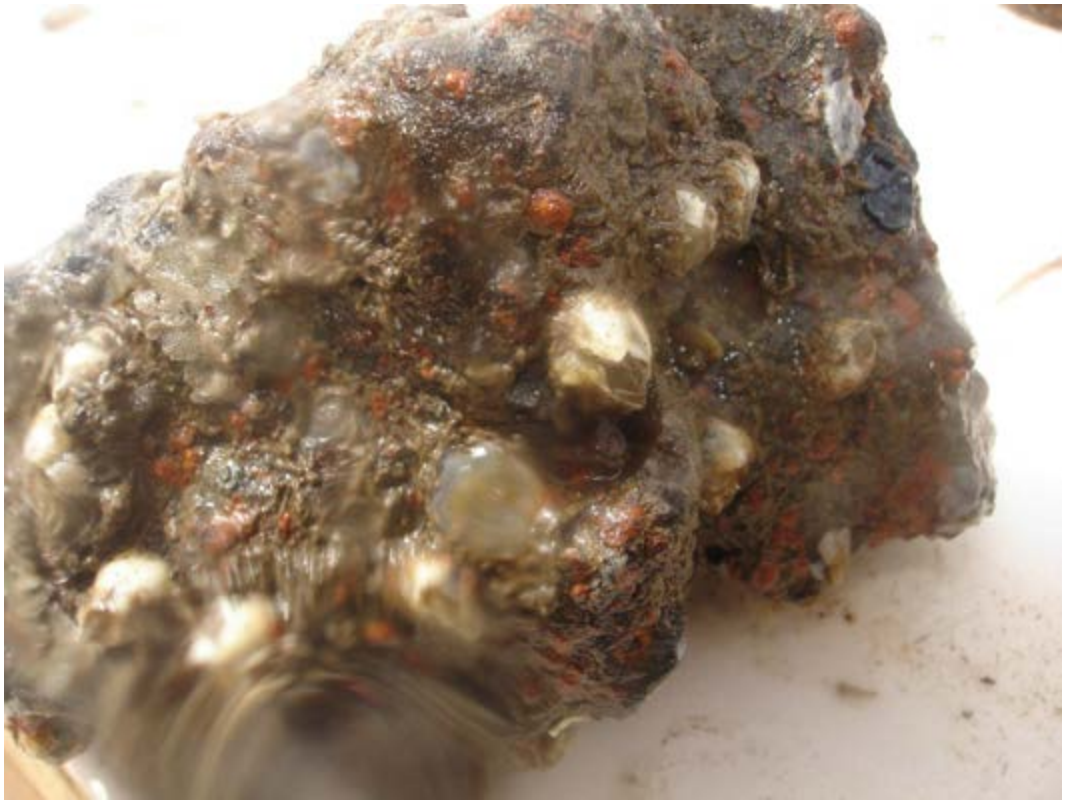

Photo 4. Photograph of slag material from Wade 2-3

Appendix F-3
Severn River Trays Deployment Pictures

Photo 1. Oyster Trays to be Deployed in Severn River Sites

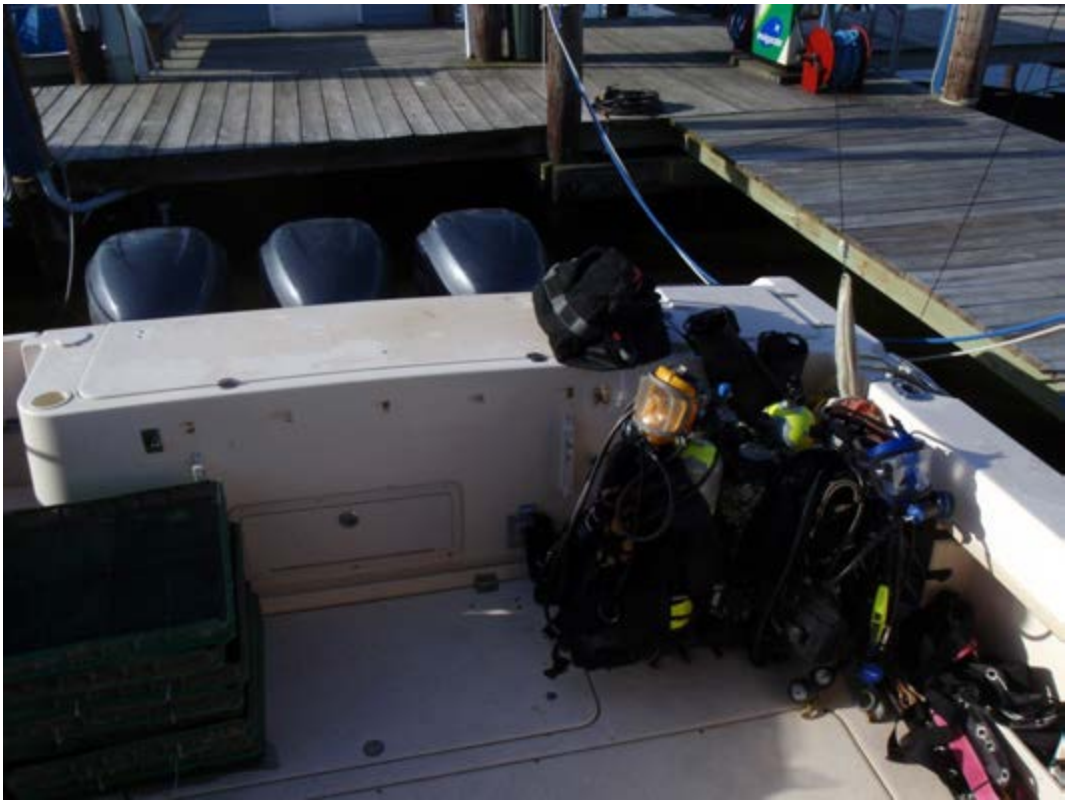

Photo 2. Dive Gear to be Used for Severn River Tray Deployment

Photo 3. Divers Preparing to Deploy Trays at Weems Upper Site

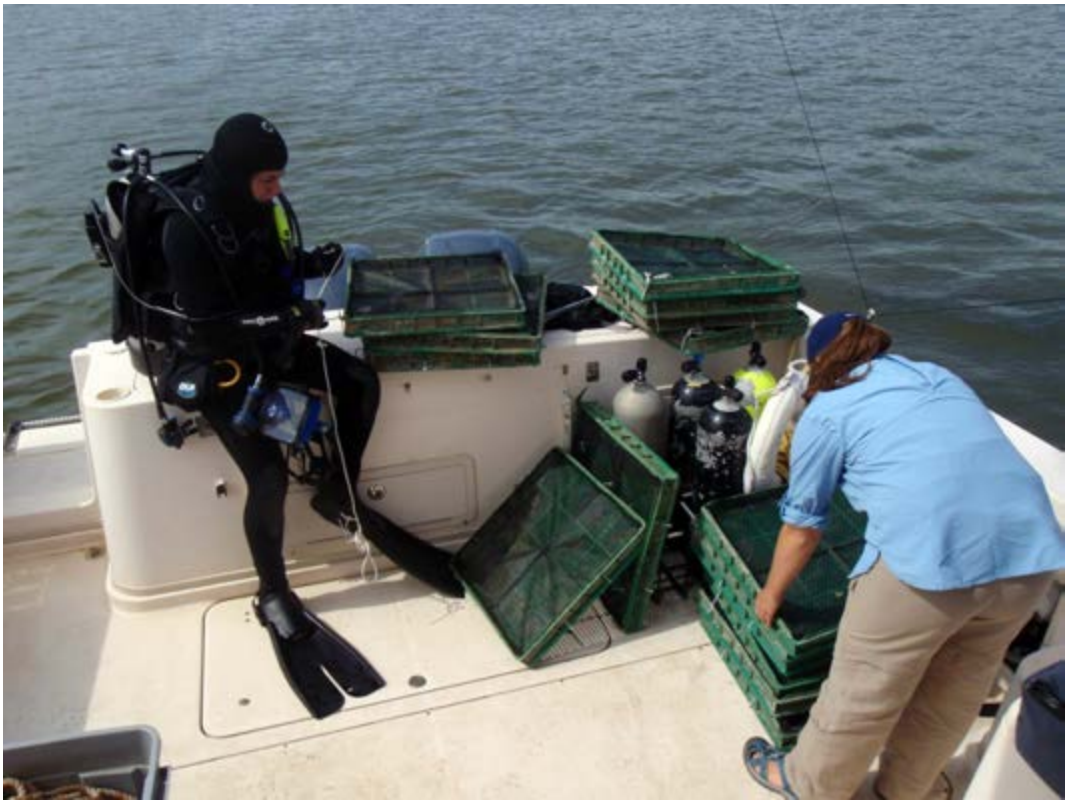

Photo 4. Divers Preparing to Deploy Trays at Weems Upper Site

Photo 5. Diver Preparing to Enter Water with Tray at Weems Upper Site. Dive Marker Buoy in the Background

Appendix F-4
Severn River Trays Collection Pictures

Photo 1. Tray Recovered from Wade 2-2

Photo 2. Tray Recovered from Wade 2-2

Photo 3. Tray Recovered from Wade 2-2

Photo 4. Tray Recovered from Wade 2-2

Photo 5. Tray Recovered from Wade 2-2

Photo 6. Tray Recovered from Wade 2-3

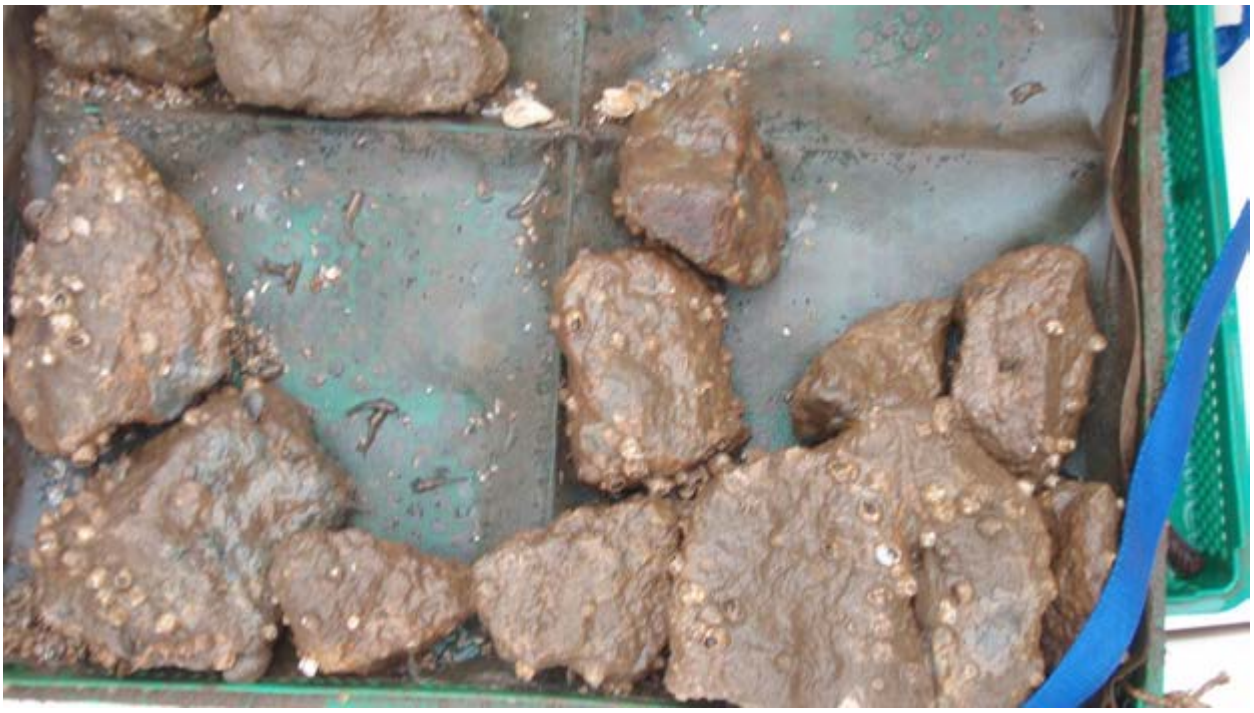

Photo 7. Tray Recovered from Wade 2-4

Photo 8. Tray Recovered from Wade 2-4

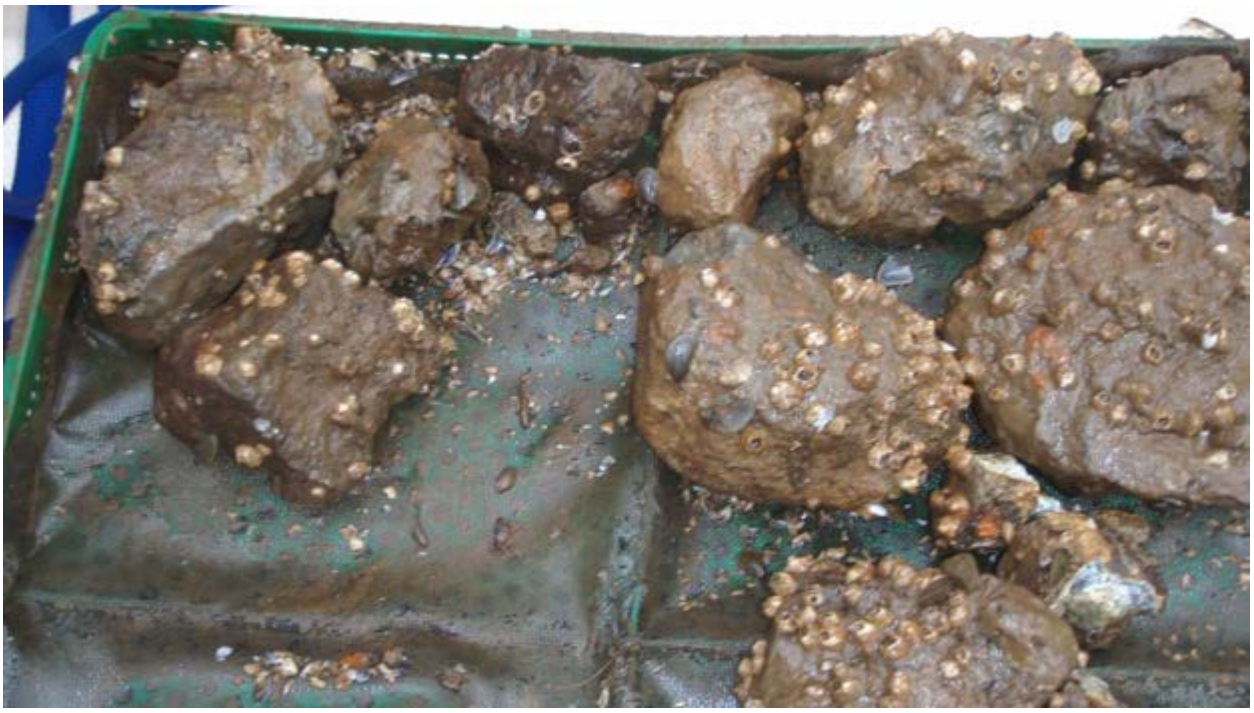

Photo 9. Tray Recovered from Wade 2-4

Photo 10. Tray Recovered from Wade 2-4

Photo 11. Tray Recovered from Wade 2-5

Photo 12. Tray Recovered from Wade 2-5

Photo 13. Tray Recovered from Wade 2-5

Photo 14. Tray Recovered from Weems Upper

Photo 15. Tray Recovered from Weems Upper

Photo 16. Tray Recovered from Weems Upper

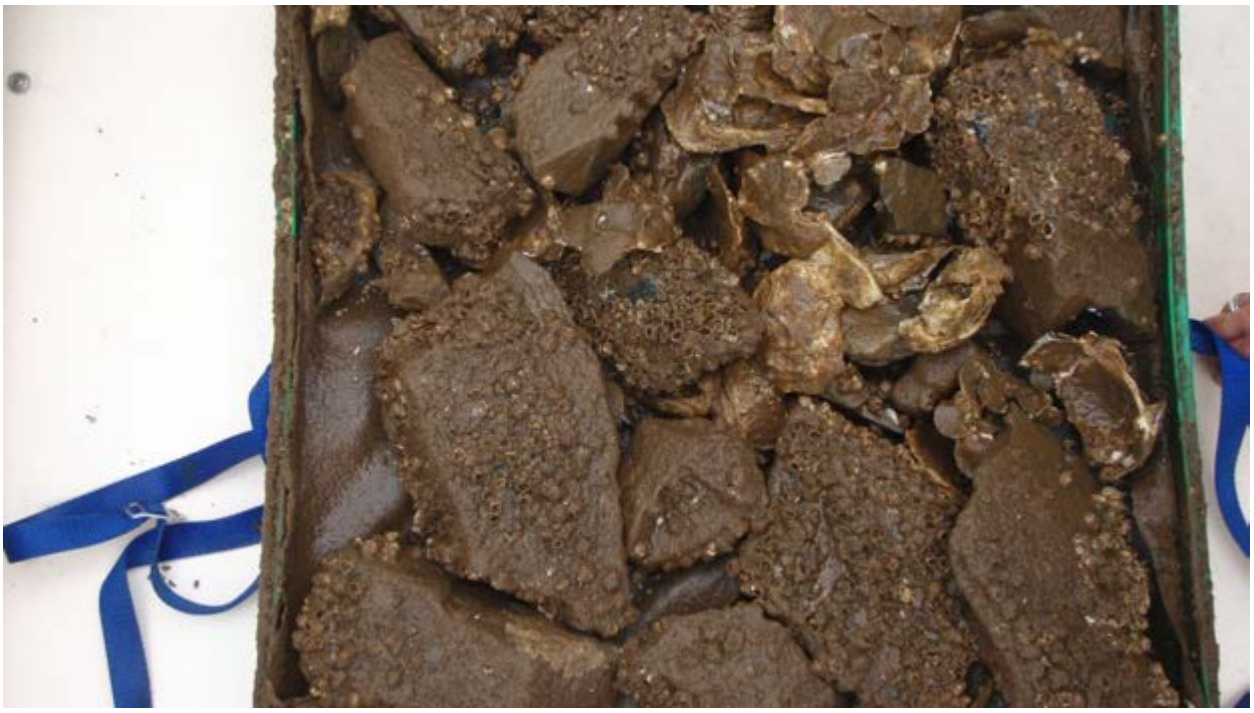

Photo 17. Tray Recovered from Weems Upper

Photo 18. Stone with Attached Fauna from Wade 2-5 Recovered Tray

Photo 19. Slag Pieces (Top) and Concrete Pieces (Bottom) from Recovered Trays (Wade 2-3 and Wade 2-4 Respectively)

Photo 20. Typical Fauna Associated with Recovered Trays from Severn River Sites