Work Plan for Offshore Investigation of the Phase I Area of the Sparrows Point Site

Baltimore, Maryland

Prepared for

Sparrows Point Environmental Trust
Maul Foster & Alongi, Inc.
400 E. Mill Plain Blvd., Suite 400
Vancouver, Washington 98660

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031
(410) 584-7000

September 2014
Version: FINAL
EA Project No. 15131.01

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AVS	Acid volatile sulfide
BSC	Bethlehem Steel Corporation
BTAG	Biological Technical Assistance Group
CFR	Code of Federal Regulations
CMS	Corrective measures study
COC	Chain of custody
COPC	Contaminant of potential concern
CSM	Conceptual site model
DOC	Dissolved organic carbon
DOJ	Department of Justice
EA	EA Engineering, Science, and Technology Inc.
EcoSSL	Ecological Soil Screening Level
EDD	Electronic data deliverable
EEC	Environmental Engineering & Contracting, Inc.
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological risk assessment
ER-L	Effects Range–Low
ft	Foot (feet)
GPS	Global positioning system
HHRA	Human Health Risk Assessment
IRIS	Integrated Risk Information System
ISG	International Steel Group
KCI	KCI Technologies
LCS	Laboratory control sample
MDE	Maryland Department of the Environment
MDL	Method detection limit
Mittal	Netherlands Corporation Mittal Steel Company N.V.
MPA	Maryland Port Administration

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAD83	North American Datum of 1983
NPDES	National Pollutant Discharge Elimination System
NRWQCs	National Recommended Water Quality Criteria
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PID	Photoionization detector
PPL	Priority pollutant list
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RL	Reporting limit
SAV	Submerged aquatic vegetation
SEM	Simultaneously extracted metals
SLERA	Screening Level Ecological Risk Assessment
SOP	Standard Operating Procedure
SSA	Special Study Area
SVOC	Semivolatile organic compound
TOC	Total organic carbon
TRV	Toxicity reference value
UCLM	Upper Confidence Limit of the Mean
VOC	Volatile organic compound
VRS	Virtual Reference Station

1. INTRODUCTION

This work plan for the offshore investigations at the Sparrows Point Site (the Site) has been prepared by EA Engineering, Science, and Technology, Inc. (EA) on behalf of the Sparrows Point Environmental Trust (the Trust). This work plan addresses offshore investigations designed to provide information necessary to conduct a corrective measures study (CMS) for the Site. This investigation has been organized by the U.S. Environmental Protection Agency (EPA) and Maryland Department of the Environment (MDE) into two phases: Phase I, the northwest shoreline, and Phase II, the southeast shoreline (**Figure 1-1**). The Phase I offshore investigation is the focus of this work plan. Sampling of the Phase II area will be described in a work plan addendum, if determined to be necessary.

This work plan describes the field sampling and data-gathering methods that will be used to characterize the offshore sediment, stormwater, and sediment pore water in the Phase I area. The project includes field sampling; conducting analytical testing of sediment, stormwater, and pore water; evaluating test results; modeling the estimated surface water concentrations offshore; and conducting human health and ecological risk assessments.

1.1 SITE LOCATION, DESCRIPTION, AND HISTORY

The Sparrows Point Site is located on approximately 2,300 acres on the north side of the Patapsco River in Baltimore County, Maryland, approximately 6 miles southeast of downtown Baltimore. The Phase I area is located along the northwestern shoreline of the Site, along the Bear Creek shoreline (**Figure 1-1**).

Pennsylvania Steel built the first furnace at Sparrows Point in 1887. Bethlehem Steel Corporation (BSC) purchased the facility in 1916 and enlarged it by building mills to produce hot rolled sheet, cold rolled sheet, galvanized sheet tin mill products, and steel plate. During peak steel production in 1959, the facility operated 12 coke-oven batteries, 10 blast furnaces, and 4 open-hearth furnaces.

BSC declared bankruptcy in 2001. After the bankruptcy of BSC, the assets at Sparrows Point were acquired in May 2003 by International Steel Group Inc. (ISG). The Sparrows Point assets were held by ISG's subsidiary corporation ISG Sparrows Point LLC (ISG 2005). ISG was subsequently acquired in 2005 by Netherlands Corporation Mittal Steel Company N.V. When Mittal proposed to acquire the Luxemburg-based Arcelor SA, the U.S. Department of Justice (DOJ) raised anti-trust concerns regarding tin plate production. In February 2007, DOJ notified ArcelorMittal that it had to divest itself of the Sparrows Point steel mill under the Consent Decree filed by the DOJ in August 2006. In March 2008, the Russian firm OAO Severstal announced its purchase of the Sparrows Point plant from ArcelorMittal. An article in the *Baltimore Sun* indicated that Severstal completed the acquisition for $810 million in May 2008. In 2011, RG Steel, a subsidiary of Renco Group, Inc., purchased the Site from Severstal.

After RG Steel declared bankruptcy in 2012, the Site was bought by Environmental Liability Transfer, Inc., a liquidation firm specializing in redevelopment of commercial and industrial properties, and Hilco Sparrows Point LLC, which oversaw the auctioning of much of the remaining mill equipment in 2013. During this sale, funds were designated for investigation of impacts to the offshore area, as required under the Consent Decree. These funds are owned and managed by the Trust, and are being used to conduct the offshore investigation described in this document. As stated in the Trust Agreement, “the Sale Order for this property transfer provided that RG Steel deposit $500,000 of the purchase price into an escrow account to fund the costs for an offshore site-wide investigation and a corrective measures study.”

1.2 PREVIOUS INVESTIGATIONS

This section presents information gathered during the review of existing documents performed as a preliminary task in the Offshore Investigation. Information is presented for the Site as a whole, with a focus on information pertinent to the Phase I area.

Corrective Action activities under the Resource Conservation and Recovery Act (RCRA) have been conducted at the Site under a Consent Decree by EPA and MDE issued to BSC in 1997. Waste management at the Site includes air pollution controls throughout the manufacturing processes, two solid waste landfills, and waste treatment. The Consent Decree provided a synopsis of activities and conditions of concern at the Site, outlined corrective measures to be performed, and mandated a waste minimization plan. Corrective measures defined in the Consent Decree also included requirements for interim measures, a Site Wide Investigation, and a Corrective Measures Study. The Site Wide Investigation includes (1) characterization of the environmental setting, (2) source characterization, (3) contamination characterization, and 4) a risk assessment, including evaluation of the potential for current and future risk to human health and the environment from current and past releases of hazardous constituents at the Site.

Environmental investigations relating to the Phase I area are summarized in **Table 1-1**. In 1998, as part of the Site Wide Investigation, BSC submitted a *Description of Current Conditions* report (Rust 1998), which described the potential contaminant sources at the Site and proposed a detailed framework for future investigations. BSC then submitted a *Site Wide Investigation Groundwater Study Report* (CH2M Hill 2001), presenting characterization of the hydrogeology of the peninsula, followed by a *Site-Wide Investigation Release Site Characterization Study* (CH2M Hill 2002), which focused on contamination in the five Special Study Areas (SSAs), including Greys Landfill in the northern portion of the Phase I area and Humphrey Impoundment at the southern end. Additional groundwater sampling was begun in 2002 to further characterize the nature and extent of contamination in the five SSAs, but was delayed in 2003 due to ownership change of the facility during Summer 2003. The sampling required was completed in 2004 and the results were presented in the *Site Wide Investigation Report, Nature and Extent of Releases to Groundwater from the Special Study Areas* (URS 2005, 2006).

Among the interim measures described in the Consent Decree was continued operation of a groundwater pump and treat system to address metals contamination of groundwater at the Rod & Wire Mill Sludge Bin Remediation Area, which is located near the center of the Phase I area. This treatment system was reinstated in 2000, and semi-annual groundwater sampling and analysis is performed in this area under the work plan for re-establishment of the interim measures. The results of semiannual sampling from 2001 to 2013 consist of cadmium and zinc concentrations in groundwater, which are contained in recent annual reports for this interim measure (URS 2011 and 2012, Environmental Engineering & Contracting, Inc. [EEC] 2013, EnviroAnalytics Group 2014a).

The Consent Decree also required groundwater monitoring at Greys Landfill, which is located in the northern portion of the Phase I area. Recent sampling events include the following: two events in 2009, two events in 2010, one event in 2011, and two events in 2013. Groundwater samples collected were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals, and results were presented in groundwater monitoring reports (KCI Technologies [KCI] 2010 and 2011; EnviroAnalytics Group 2013 and 2014b).

Independent of the Consent Decree for Sparrows Point, a study of sedimentary contaminants in Baltimore Harbor, the Patapsco River, and Back River system was submitted to MDE in 1997 (Baker et al. 1997). This study included collection of surficial sediment samples from 80 locations in these water bodies in June 1996. These included a sample from Site 28, offshore of the Rod & Wire Mill in the Phase I area of Bear Creek. Most of the sediments collected were analyzed for polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and metals (including mercury); however, the sample from Site 28 contained “considerable oil and tar” that prevented accurate analysis of organics. Another study of contaminant trends in Baltimore Harbor was conducted in 2007 (Klosterhaus et al. 2007), and included collection of sediment, pore water, and a gravity core from a location in the Phase I area of Bear Creek. These samples were analyzed for PAHs, PCBs, brominated diphenyl ethers, and butyltins.

1.3 RISK ASSESSMENTS FOR SURROUNDING AREAS

Risk assessments for onshore and offshore areas surrounding the Phase I offshore area have been prepared by the Sparrows Point property owners, the Maryland Port Administration (MPA), and EPA Region III. Although these studies do not directly relate to the Phase I area, they were referenced in the preparation of this work plan.

ISG submitted a *Screening Level Ecological Risk Assessment for On-Site Areas* (URS 2009a), which was followed by a *Baseline Ecological Risk Assessment for On-Site Areas* submitted by Severstal (URS 2010). However, these assessments focused only on risks on the Peninsula, and deferred evaluation of offshore risks.

MPA prepared a *Risk Assessment of Offshore Areas Adjacent to the Proposed Coke Point Dredged Material Containment Facility at Sparrows Point* (EA 2011) for the offshore areas surrounding the Coke Point area of Sparrows Point, which is located approximately 1 mile south of the Phase I area. The bases of this risk assessment were data from studies conducted by MPA in support of its proposal to build a dredged material containment facility on Coke Point. The results of these studies, which included analysis of sediment and surface water samples for VOCs, PAHs, PCBs, dioxins and furans, metals, butyltins, and cyanide, were presented in the *Site Assessment for the Proposed Coke Point Dredged Material Containment Facility at Sparrows Point* (EA 2009) and the *Additional Offshore Delineation for the Proposed Coke Point Dredged Material Containment Facility* (EA 2010).

In 2011, EPA Region III issued a *Data Evaluation and Screening Level Human Health and Ecological Risk Assessment for Bear Creek Sediment* (Prince 2011). This study relied on existing sediment and tissue data from Bear Creek, including sediment data collected for the Chesapeake Bay Foundation in 2009, crab and fish tissue analyzed by MPA as part of the 2011 Risk Assessment, and sediment data for metals from one location in the Phase I area, from the *Spatial Mapping of Sedimentary Contaminants in the Baltimore Harbor/Patapsco River/Back River System* (Baker et al. 1997). The evaluation concluded that there is no expectation of unacceptable risk for any possible human health exposure from contact with sediment or consumption of crab or fish in Bear Creek, and that population-level adverse effects are not expected for wildlife.

1.4 PREVIOUS SCOPING DOCUMENTS FOR THE OFFSHORE INVESTIGATION

In 2009, Severstal submitted a *Work Plan, Sediment, Surface Water, and Groundwater Sampling Plan to Assess Current Groundwater Discharge Impacts to the Offshore Environment* (URS 2009b). However, EPA disapproved this document on the basis of deficiencies including the lack of specific plans for collecting surface water and sediment samples, and Severstal did not complete the proposed work. In 2012 RG Steel submitted a new plan, the *Offshore Ecological and Human Health Investigation Work Plan* (Integral Consulting, Inc. 2012). This work plan was approved by EPA in August 2012; however, RG Steel declared bankruptcy shortly thereafter, and the Trust was established to conduct the offshore investigation.

The Trust Agreement, which was signed in January 2014, stated that the purpose of the Environmental Trust includes “managing and/or funding implementation of activities in the offshore environment at the Site consistent with the Consent Decree and Sale Order.” (RG Steel and Silver 2014). Schedule 4 of the Agreement is a Scope of Work for Sparrows Point Offshore Investigation and Corrective Measures Study. This document is the basis for the scope of work presented in this Work Plan. Consistent with the Severstal and RG Steel work plans, this scope of work states that the offshore investigation does not need to address the area offshore of Coke Point, as the investigation conducted by MPA in support of the Coke Point offshore risk assessment (EA 2009, 2010) fulfilled the characterization requirements for this area. The Phase I area for offshore investigation as described in this scope also does not include the offshore area adjacent to the shipyard.

1.5 PROJECT OBJECTIVES AND TECHNICAL APPROACH

The overall objective of the activities presented in this Work Plan is to complete an offshore investigation of the Site, including a risk assessment. Specifically, the investigation will evaluate the quality of the sediment and pore water in the bioactive zone, as well as stormwater from nearby outfalls, to conduct an assessment of offshore risk for the Phase I area, and to support future development of an Offshore CMS for the Site.

Components of the Phase I offshore investigation include the following:

- Pore water sampling and analysis to characterize potential effects from discharge of groundwater from the Sparrows Point site into the Phase I area of Bear Creek;
- Stormwater sampling to assess the potential effects of stormwater outfalls on the Phase I area of Bear Creek;
- Surface sediment sampling and analysis; and
- Possible subsurface sediment sampling to 2 feet (ft) below the sediment/water interface to characterize sediment quality at depth.

1.6 DOCUMENT ORGANIZATION

Section 2 describes the project organization for the Sparrows Point offshore investigation. Section 3 summarizes preliminary data collection and screening performed in support of the offshore investigation. Section 4 describes the preliminary conceptual site model for the project area. Field activities and methodologies are described in Section 5. Section 6 outlines sample management protocols, and Section 7 describes components of the analytical testing program. Sections 8 and 9 describe data management and evaluation, and the use of the data in human health and ecological risk assessment.

2. PROJECT ORGANIZATION AND RESPONSIBILITIES

The EA 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 is provided as **Figure 2-1**.

Table 2-1 provides a list of key personnel, project roles, telephone numbers, cell phone numbers (if applicable), and email addresses. Additional personnel will/may assist with various tasks related to the project on an as needed basis.

2.1 PROJECT ORGANIZATION

Overall responsibility for ensuring that all technical and financial objectives of the proposed project are met will be assumed by the Project Manager, *Dr. Frank Barranco***.** Dr. Barranco will coordinate with Trust and EA personnel throughout all phases of the project, and will oversee subcontractors. Dr. Barranco is a Senior Hydrogeologist whose specific area of technical expertise relates to the occurrence, fate, persistence, and cleanup of hydrocarbons in hydrogeologic settings.

Dr. Barranco will coordinate activities related to all project components to ensure efficient project implementation, consistent field sampling methodologies, data assessment, and senior technical review of project deliverables.

The field team will consist of two EA personnel who will be responsible for surface sediment, stormwater, and pore water collection, and sample processing. EA personnel will also be responsible for coordination with the laboratory, mobilization/demobilization, and labeling and packing of samples.

2.2 EA PROJECT PERSONNEL

Each of the technical components of the project will be coordinated by professionals in the field.

Mr. John Morris will serve as the Field Lead, responsible for managing and leading the project sampling efforts under the direction of Dr. Barranco. He will lead the planning and coordination of field efforts, act as the liaison between the EA Project Manager and the field team, and provide daily field progress updates to Dr. Barranco.

Ms. Sanita Corum will serve as the Data Coordinator, under the direction of Dr. Barranco and *Dr. Dan Hinckley* (Project Chemist). Ms. Corum will coordinate with the laboratory personnel and data validator. Ms. Corum is responsible for managing the data analysis and ensuring that the validation of the analytical data is conducted and documented according to the requirements of this Work Plan.

Dr. Samantha Saalfield will serve as the Document Coordinator under the direction of Dr. Barranco and with the support of the other technical staff, and will also serve as the Project Geologist.

Mr. Michael Powell will perform statistical analysis of the data, as well as surface water modeling.

Ms. Cynthia Cheatwood and *Mr. Michael Ciarlo* will perform the human health and ecological risk assessments, respectively.

Ms. Peggy Derrick will serve as the Project Director and provide Senior Technical Review. She will review work plans and reports submitted to the Trust.

Mr. Peter Garger will serve as the project Health and Safety Manager. He is a Certified Industrial Hygienist with expertise in health and safety audits involving chemical, physical, and biological agents. He will be responsible for review of the Site Safety and Health Plan.

2.3 ADDITIONAL TEAM MEMBERS

TestAmerica Laboratories will provide EA with the analytical and physical chemistry support for the Sparrows Point project. TestAmerica is certified by all 50 states, including Maryland. The majority of testing will be conducted at TestAmerica's Pittsburgh facility, with support from TestAmerica's laboratory in Burlington, Vermont. *Ms. Carrie Gamber* will serve as the Analytical Laboratory Project Manager. She manages analytical laboratory projects for a variety of government, private sector, and utility clients. She is experienced with sample management, laboratory subcontracting activities, and EPA and RCRA specified guidance. She will be responsible for tracking the project samples through the analytical testing process, and she will provide progress reports on sample analyses to Ms. Corum.

3. PRELIMINARY DATA COLLECTION AND SCREENING

3.1 SUBAQUEOUS SURVEY

A subaqueous survey of the Phase I area was completed in May 2014, to characterize the offshore water depths and bottom structure, and inform the selection of sampling locations for the offshore investigation. The survey was comprised of two principal study elements: (1) a detailed subaqueous survey, including bathymetry and side scan sonar, and (2) a visual shoreline survey.

3.1.1 Bathymetry and Side Scan Sonar

The bathymetric and side scan sonar elements were performed in the shallow waters of Bear Creek over areas of riverbed that have the potential to be impacted by stormwater discharge and groundwater seepage. The subaqueous survey was designed to provide a base map of subaqueous topography and benthic habitat, as well as determine the presence and abundance of possible obstructions and submerged hazards. Visual observation of sediments was also conducted, to ground-truth the side scan sonar data. Results of these surveys are presented in **Appendix A**.

3.1.2 Visual Shoreline Survey

A visual shoreline survey was conducted on 12 May 2014 to characterize the general existing conditions of the shoreline, immediate upland area along the shoreline, and the intertidal zone. Results of the survey are presented in **Appendix B**.

3.2 GROUNDWATER SCREENING

Groundwater data from monitoring wells along the shoreline of the Phase I area were screened against risk-based surface water criteria, to identify contaminants of potential concern (COPCs) for sediment and pore water in the offshore. This screening was based on the assumption that contaminants in groundwater are also potential contaminants in offshore sediment and pore water, because groundwater is a primary mechanism of potential contaminant transport from the onshore to the offshore environment.

In the Phase I area, existing groundwater monitoring data associated with other sampling efforts are available from the vicinity of Greys Landfill, the Rod & Wire Mill, and Humphrey Impoundment. As described in Section 1.2, historical data were collected in 2002 and 2004, in association with the Nature and Extent Report (URS 2005, 2006). The data included in the Nature and Extent Report are the most recent groundwater data from the Humphrey Impoundment area. More recently, VOC, SVOC, and metals data have been collected as part of monitoring required at Greys Landfill (KCI 2010 and 2011; EnviroAnalytics Group 2013 and 2014b). Additionally, groundwater from the Rod & Wire Mill is regularly monitored for cadmium and zinc, in conjunction with a pump and treat system (URS 2011 and 2012, EEC 2013, EnviroAnalytics Group 2014a); however, no data for other potential COPCs are available for groundwater from this area.

Due to the lack of recent groundwater data from the Rod & Wire Mill and Humphrey Impoundment areas, additional groundwater data were collected in support of the Offshore Investigation, in June 2014, from 10 wells. The samples collected were analyzed for priority pollutant list (PPL) VOCs, SVOCs, and metals, and cyanide. Methods and results of groundwater sampling are presented in **Appendix C**.

3.2.1 Screening Criteria

Existing and new groundwater data were screened against the EPA National Recommended Water Quality Criteria (NRWQCs) (EPA 2009) for ecological risk (Saltwater Aquatic Life Continuous Criterion Concentration) and Human Health, Organism Only, where available. If NRWQCs for both ecological risk and human health risk were available for a given analyte, the lower of the two criteria was used for screening. For analytes with no NRWQCs, Biological Technical Assistance Group (BTAG) surface water benchmarks were used for screening. Marine benchmarks were used if available; if no marine benchmark was available for an organic analyte, the freshwater benchmark was used. Screening criteria are summarized in **Table 3-1**.

3.2.2 Screening of Existing Groundwater Data

Of the wells sampled in these historical reports, 12 well clusters and individual wells were identified within approximately 400 ft of the Phase I shoreline (6 near Greys Landfill, 5 near the Rod & Wire Mill, and 1 near Humphrey Impoundment). Data from these wells and well clusters from the historical documents were screened using the screening criteria presented in Section 3.2.1. The screening procedures for each data set are described below. Results of the screening are summarized on **Table 3-2**.

- <u>Nature & Extent Report</u> (URS 2005, 2006): Presents VOC, SVOC, metals, cyanide, and sulfide data collected from 2001 to 2004 at Greys Landfill and Humphrey Impoundment. Results for detected constituents from the hard-copy data tables were visually identified and compared to screening criteria.

- <u>Greys Landfill Groundwater Monitoring Reports</u> (KCI 2010, 2011; EnviroAnalytics Group 2013 and 2014b): Present VOC, SVOC, and metals data for groundwater collected from Greys Landfill between 2009 and 2013, as part of ongoing groundwater compliance monitoring for the landfill.

- <u>Interim Measures 2013 Annual Reports for the Former Sludge Bin Storage Area, Rod & Wire Mill Area</u> (URS 2011, 2012; EEC 2013; EnviroAnalytics Group 2014a): Present cadmium and zinc data from semiannual sampling between 2001 and 2013 of groundwater in the vicinity of the groundwater pump and treat interim measure at the former Rod & Wire Mill Sludge Bin Storage Area. Data were screened visually; the majority of cadmium and zinc data from this area exceed screening values.

3.2.3 Screening of New Groundwater Data

Screening results for data from the 10 wells sampled in June 2014 are presented in Tables 3 through 6 of **Appendix C**. Note that the analytical reports and validation reports for this groundwater sampling event have been provided under separate cover.

3.2.4 Groundwater Screening Results

Table 3-2 presents a summary of the constituents that have exceeded screening criteria in groundwater from monitoring wells adjacent to the Phase I area, from screening of both historical and 2014 datasets. The majority of these constituents (excepting the VOCs) have been reported at least once at a concentration of 10 or more times the screening criteria (shaded results in **Table 3-2**). The following constituents exceeded screening values in at least one well during at least one sampling event between 2001 and 2014:

VOCs
- 1,1-Dichloroethane
- Vinyl Chloride.

PAHs
- Benzo(a)anthracene
- Chrysene
- Naphthalene.

Other SVOCs
- Bis(2-Ethylhexyl) phthalate.

Inorganics
- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Silver
- Thallium
- Zinc
- Cyanide.

Based on the screening results, metals and cyanide are the primary COPCs for sediment and pore water in the Phase I Area, with multiple exceedances in both the historical and 2014 data. Multiple exceedances of the screening values for PAHs were reported in the 2014 data; relatively high detection limits during other investigations may have prevented previous detections of PAHs at concentrations exceeding the low-level screening values. Bis(2-ethylhexyl)phthalate was reported at concentrations exceeding the screening value in the majority of the wells. The only VOC concentrations exceeding screening values (for 1,1-dichloroethane and vinyl chloride) were in a sample collected in 2001, from one well near Greys Landfill.

4. PRELIMINARY CONCEPTUAL SITE MODEL

The preliminary Conceptual Site Model (CSM), developed based on current conditions, is presented in this section. The CSM will be revised based on information obtained as part of the Offshore Investigation.

4.1 CHEMICAL SOURCES

Potential sources of chemicals that have affected the Phase I area include the equipment, waste, and facilities associated with the steel making process, including Greys Landfill, the Rod & Wire Mill, and Humphrey Impoundment.

The following were among the waste types identified in the *Description of Current Conditions* (Rust 1998) as having been disposed in Greys Landfill: oily sludge, centrifuge cake from the wastewater treatment plant, blast furnace and sinter plant centrifuge cake, spill cleanup material, and dredged material from the Tin Mill Canal. Currently, industrial waste generated onsite during steel production is placed in Greys Landfill, along with debris from demolition and non-hazardous waste from the onsite wastewater treatment facility (EnviroAnalytics 2014b).

At the Rod Mill, from the 1940s to the 1980s, zinc ore was roasted with sulfuric acid, yielding high-purity zinc powder and a sludge rich in iron and cadmium. The Sludge Bin Storage Area was used for temporary storage of the dewatered sludge, until storage bins were installed in the early 1970s. Groundwater pump and treat began in this storage area in 1986, to address elevated concentrations of cadmium and zinc in the shallow and intermediate groundwater zones (Rust 1998).

Humphrey Impoundment was open water until 1970, and received wastewater from onsite industrial facilities. After this wastewater was diverted into the Tin Mill Canal, the impoundment was used as a dewatering area for various sludges and slurries generated onsite (Rust 1998). During visual observation of sediment conducted during the subaqueous survey (**Appendix A**), petroleum odor and sheen were observed in fine-grained sediments from the southern portion of the Phase I area, near Humphrey Impoundment and the outlet of the Tin Mill Canal.

4.2 CHEMICAL TRANSPORT

Fate and transport pathways govern the transfer of materials and chemicals between different environmental media, including from the onshore to the offshore environment.

The following transport mechanisms will be evaluated in this offshore investigation:

- <u>Groundwater transport</u> – As described in Section 3.2, contaminants are present in groundwater near the Phase I area. These contaminants have the potential to migrate into surface water via groundwater seepage into Bear Creek. It is expected that preferential pathways for groundwater flow may exist in areas where slag fill was placed historically, such as north of Greys Landfill and Humphrey Impoundment. The existing ground surface elevations and groundwater potentiometric surface maps suggest that potential groundwater seeps may intersect the surface water at the tide line. Chemicals transported via this pathway can either become bound in the sediments or remain dissolved and move from the pore water into the surface water. It is expected that concentrations in surface water contributed by seeps would be highest at ebb tide.

- Stormwater discharge – Active stormwater outfalls present in the Phase I area provide another potential release mechanism for transport of contaminants from the onshore to the offshore area. These contaminants may be present in soil onshore, and may erode, leach, or desorb into runoff and be transported to the offshore environment via stormwater. These chemicals may also become associated with sediments in Bear Creek or may remain in the surface water. The majority of stormwater in the vicinity of the Phase I area is directed to the Tin Mill Canal. Water in the canal is then pumped to the adjacent wastewater treatment plant, and treated water is discharged to Bear Creek through National Pollutant Discharge Elimination System (NPDES) permitted Outfall 014, which is monitored daily. However, water has been observed to flow from two outfalls (UNNAMED, between I-695 and Greys Landfill, and 018, in the southern portion of the Phase I area); the origin of the water flowing from these outfalls is unknown. An active stormwater outfall (071) accommodating overflow from the Greys Landfill stormwater pond has also been identified in the northern portion of the Phase I area. This pond collects stormwater from the landfill, and when cumulative precipitation increases the water level sufficiently, the pond overflows via Outfall 071. Additionally, Outfall 070 is an overflow channel that may flow during prolonged periods of heavy precipitation.

The partitioning of chemicals between sediments and surface water is determined by the properties of the chemical as well as the surrounding geochemistry. Chemicals such as VOCs and PAHs demonstrate variable dissolution. Metals vary in their solubility based on pH, concentration, and the presence of oxygen. Reducing conditions in brackish, permanently submerged sediments tend to produce forms of most cationic metals (e.g., copper, lead, nickel, zinc) that remain bound in sediment, but these same reducing conditions may favor solubilization of anionic metals (e.g., arsenic).

Bioaccumulation is also a relevant transport pathway. Plants and animals that come in contact with elevated concentrations of chemicals in sediment or water may uptake chemicals, and, depending on the chemical and the organism, these chemicals may accumulate in tissue. Several metals (i.e., arsenic and lead) and PCBs are known bioaccumulators. PAHs may bioaccumulate in crustaceans and other organisms.

4.3 POTENTIAL MEDIA OF CONCERN

Potential media of concern for risk evaluation include surface sediment, pore water, and surface water within Bear Creek and the Patapsco River. As discussed above, chemicals in groundwater may be transported to sediment and surface water at seeps. Chemicals in soil may become associated with sediment and surface water via stormwater discharge.

4.4 CONTAMINANTS OF POTENTIAL CONCERN

COPCs for the Phase I area, based on the potential onshore sources of contamination, include VOCs, SVOCs (including PAHs), PCBs, metals (including mercury), cyanide, and oil and grease. Of these, metals, cyanide, PAHs, and bis(2-ethylhexyl)phthalate (an SVOC) were identified as the primary COPCs for sediment and pore water, based on groundwater screening (see Section 3.2.4).

5. FIELD ACTIVITIES

The offshore investigation for the Phase I area will consist of collecting sediment, stormwater, and pore water samples to evaluate potential migration paths for contaminants to the offshore environment. Following sample collection and processing, samples will be submitted to TestAmerica–Pittsburgh for physical and chemical analyses.

Workdays will include approximately 12 hours of sampling each day. The sequence of sample collection 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 Lead.

5.1 FIELD SAMPLING OBJECTIVES

The objectives of the field sampling are summarized as follows:

- Provide quality sediment chemistry data to identify contamination related to inputs from the Sparrows Point shoreline, and

- Provide quality stormwater and pore water chemistry data to identify potential sources of contamination to the offshore areas.

5.2 PRECISION NAVIGATION AND HORIZONTAL CONTROL

Northing and easting coordinates (Maryland State Plane North American Datum of 1983 [NAD83], feet) for the sediment sampling to be performed under the first sampling event are provided in **Table 5-1**. The locations of pore water sampling, and additional surface and/or subsurface sediment sampling, will be determined based on the results obtained from the first sampling event.

Similar to the approach employed as part of the subaqueous survey effort (**Appendix A**), EA will utilize a roving Trimble SPS 461 global positioning system (GPS) receiver for precision positioning information during the sediment and pore water collection effort. Differential corrections for the satellite positioning data will be received real-time through a subscription to the KeyNetGPS Virtual Reference Station (VRS) Network (http://www.keynetgps.com). A broadband cellular modem aboard the vessel will allow the GPS receiver to interface directly with the VRS network and derive correctors to the satellite positioning information. Following the application of the VRS correctors, the positional information generated by the roving GPS unit will provide positioning information with a geodetic accuracy 10 centimeters in the horizontal plane at an update frequency of 2 hertz.

Prior to initiating sample collection, the National Geodetic Survey benchmark located in Cockeysville, Maryland (GENT - PID-JV5657) will be used as the cross-check mark to confirm geodetic accuracy for this field operation. In addition, daily performance and quality control (QC) checks of the positioning system will also be performed by verifying the GPS positioning information relative to the known position of Daymark No 5, a U.S. Coast Guard-maintained aid to navigation off of Long Point in Bear Creek.

The verified positioning information provided by the Trimble receiver will be ported directly to HYPACK navigation and data acquisition software running on a laptop computer via a serial connection. The HYPACK software will serve as the primary survey management system, logging time, position, and depth data, as well as providing a helmsman display that allows the vessel operator to maneuver the vessel to the appropriate sampling locations described above. Once in HYPACK, the geographic position data will be converted to Maryland State Plane coordinates (FIPS-1900) in the units of U.S. Survey Feet and the horizontal control of NAD83.

5.3 SEDIMENT SAMPLE COLLECTION AND ANALYSIS

Sediment samples will be collected and analyzed to provide data to be evaluated as part of the risk assessments (Section 9). The first round of sampling will include collection of surface sediments from 20 locations. Following receipt of the results from the first round, a conversation will be initiated with EPA and MDE to determine the necessity for additional surface sampling or for subsurface sampling.

5.3.1 Sediment Sampling Locations

Twenty locations for sampling of surface sediment during the first round of the offshore investigation (**Figure 5-1**, **Table 5-1**) were chosen to provide good spatial coverage of the Phase I area, and also to fulfill the following objectives:

- Assess potential transport of contaminants in groundwater to the offshore as follows:
    - Sample sediment adjacent to contaminated groundwater, and
    - Sample sediment in near-shore areas where groundwater seeps likely occur
- Assess potential transport of contaminants to the offshore environment via stormwater, by sampling sediment in proximity to one or more active stormwater outfalls
- Collect sediment from areas with a variety of sediment types and thus a variety of habitats
- Collect sediment from locations in the southern portion of the Phase I area where petroleum odor and sheen were observed during the subaqueous survey (**Appendix A**).

Based on these criteria, the 20 sampling locations were organized into eight transects (**Figure 5-1**), which were assigned the letters A through H from north to south. Each transects consists of two or three sampling locations.

Additional surface and/or subsurface sediment samples may be collected during the second round of field sampling, if necessary to provide further characterization of the nature and extent of contamination. Locations for this sampling, if performed, would be selected based on the results of the first round of sampling and analysis.

5.3.2 Collection of Surface Sediment Samples

Surface sediment samples will be collected to approximately 6 inches below the sediment surface using a Ponar grab sampler. Sampling operations will be conducted from an 18-ft Jon boat.

Sub-samples for VOC and acid volatile sulfide/simultaneously extracted metals (AVS/SEM) analysis (as applicable) will be collected from the Ponar sampler immediately after collection. These samples will be placed in 4-ounce bottles with no headspace. During this process, sediment samples will be screened using a photoionization detector (PID). The remainder of the sample will then be homogenized and sub-sampled into appropriate laboratory-cleaned containers using stainless steel sampling tools. Unused sediment will be returned to the sampling location.

Samples will be shipped via overnight delivery to TestAmerica–Pittsburgh on the day of collection. Sample processing equipment that comes into direct contact with the sediment (e.g., the Ponar sampler) will be decontaminated according to the protocols specified in Section 5.7 and in the SOP included in **Appendix D**.

5.3.3 Subsurface Sediment Samples

If determined by the project team to be necessary to support the project objectives, subsurface sediment cores will be collected via the Jon boat during the second round of field sampling, using a push core sampler with liner, to approximately 2 ft below the sediment surface. Multiple cores may be collected at each location, if necessary to provide the required volume of sediment.

Boring logs will be completed for each core, and the cores will be screened using a PID. If VOC and AVS/SEM analyses are to be performed, sub-samples for these analyses will be collected from the core as soon as possible after collection, prior to sample homogenization. The remainder of each core interval to be sampled will then be homogenized and placed into appropriate laboratory-cleaned containers using stainless steel spoons. Unused sediment will be returned to the vicinity of the sampling location.

Samples will be shipped via overnight delivery to TestAmerica–Pittsburgh on the day of collection. Sample processing equipment that comes into direct contact with the sediment (e.g., the AMS core sampler) will be decontaminated according to the protocols specified in Section 5.7.

5.3.4 Sediment Sample Analysis

Surface sediment grab samples collected during the first round of sampling will be analyzed as presented in **Table 5-2**. Samples from transects adjacent to active stormwater outfalls will be analyzed for all potential COPCs, as the contaminants present in stormwater are not well characterized. The potential COPCs for which these samples will be analyzed include VOCs, SVOCs (including PAHs), PCB Aroclors, PPL metals, mercury, cyanide, and oil and grease. Sediments from other areas will be analyzed for the COPCs for sediment and pore water (Section 4.1.4), as identified based on groundwater screening: PAHs, bis(2-ethylhexyl)phthalate (an SVOC), PPL metals, and cyanide. All samples will also be analyzed for AVS and SEM, to provide information regarding bioavailability of metals for the risk assessment, as well as total solids and total organic carbon (TOC). Additionally, sediment from two transects (B and E), where sediments of a variety of textures were observed during the subaqueous survey (**Appendix A**), will be analyzed for grain size and moisture content, to provide information regarding the hydraulic conductivity of the sediment. Note that the designation of stormwater-adjacent sediment sampling locations versus non-stormwater associated locations may change based on field observations regarding the activity of the stormwater outfalls present, and would result in a change to the analytical suite for the affected sediment samples. The sample containers, preservatives, and holding time requirements for sediment samples are provided in **Table 5-3**. The holding time will be initiated at sample collection.

5.4 STORMWATER SAMPLE COLLECTION AND ANALYSIS

Stormwater samples will be collected to assess potential inputs of contaminants to the offshore via stormwater outfalls, and results will be used in modeling concentrations of COPCs in surface water (see Section 8.4). Stormwater for analysis will be collected during up to two storm events, from any of the active, unmonitored stormwater outfalls in the Phase I area (018, 070, 071, and UNNAMED) that are observed to be flowing during those storm events (**Figure 5-1, Table 5-1**). One NPDES-permitted outfall (014) will also be sampled during a stormwater event. This outfall is monitored regularly for metals (chromium and lead), cyanide, and other anions under the NPDES permit.

Grab samples of stormwater will be collected from Outfalls 018 and UNNAMED during the first hour of the storm event, to capture the “first flush” of runoff. Outfalls 070 and 071 will also be sampled during the first hour if timing allows, although these outfalls likely do not experience a first flush, as they are fed by overflow from the stormwater pond. Outfall 014 will be sampled last, unless the logistics of site access prevent this order of sampling. It is anticipated that between three and five outfalls will be sampled during each sampling event. *In situ* water quality measurements (Section 5.5.1) will be taken at each outfall during sampling. Water for analytical testing will be stored in certified cleaned, laboratory-prepared containers with appropriate preservatives. Stormwater samples for analysis will be shipped via overnight delivery to TestAmerica–Pittsburgh on the day of collection.

Stormwater samples from the unmonitored outfalls (i.e., all except Outfall 014) will be analyzed for VOCs, SVOCs (including PAHs), PCB Aroclors, PPL metals, mercury, cyanide, and suspended solids. Samples from Outfall 014 will be analyzed for the same analytes with the exception of cyanide, which is included in the regular monitoring of this outfall. The sample containers, preservatives, and holding time requirements for stormwater are provided in **Table 5-3**. Holding times for the stormwater will begin when the samples are collected and placed into the appropriate sample containers.

5.5 PORE WATER SAMPLE COLLECTION AND ANALYSIS

Concentrations of COPCs in pore water will be evaluated directly as part of the risk assessments (Section 9), and will also be used in modeling steady-state concentrations of COPCs in surface water (Section 8.4). Pore water samples will be collected at times of low tide during the second round of field sampling. Following receipt of the results from the first-round sediment and stormwater sampling, a conversation will be initiated with EPA and MDE to determine the locations to be sampled for pore water. It is anticipated that the pore water sampling will be targeted primarily at locations where sediment impacts were observed during the first round.

A peristaltic pump will be used to draw pore water from a manually driven push-point sampler (see SOP in **Appendix D**). *In situ* water quality measurements (Section 5.5.1) will be used to monitor for potential incursion of surface water, which must be avoided during sampling.

It is expected that pore water samples will be analyzed for the COPCs identified for sediment and pore water (Section 4.1.4), based on groundwater screening: PAHs, metals (including mercury), cyanide, and bis(2-ethylhexyl)phthalate. Pore water samples will also be analyzed for dissolved organic carbon (DOC). Adjustments to the analytical suite for pore water samples may be made based on consultation with EPA and MDE, based on the results of the first round of sediment sampling and analysis. The sample containers, preservatives, and holding time requirements for pore water are provided in **Table 5-3**. Holding times for the pore water will begin when the samples are collected and placed into the appropriate sample containers.

5.5.1 *In Situ* Water Quality Measurements

Water quality measurements will be recorded *in situ* for pore water and surface water at each pore water sampling location, and also for stormwater, using a water quality meter, as described in the pore water sampling SOP in **Appendix D**. Measurements of surface water will be performed just above the sediment-water interface. The following parameters will be recorded on either field data sheets or in the field log book:

- Sampling location ID
- Sampling data and time
- Water depth
- Water temperature (degrees Celsius)

- Conductivity (microsiemens per liter)
- pH
- Dissolved oxygen (milligrams per liter) and/or oxidation-reduction potential (mV)
- Turbidity (nephelometric turbidity units).

EA will document calibration procedures and QC checks for the water quality meter.

5.6 QUALITY CONTROL SAMPLES

The overall analytical program for the first round of sampling, including QC samples, is summarized in **Table 5-4**.

5.6.1 Field Duplicates

Field duplicates are separate samples collected in the field at the same time and place as the parent sample. Duplicates are utilized to determine the accuracy and precision of field sampling and laboratory analytical activities. Field duplicates are also indicative of sample homogeneity. Duplicates of each matrix (sediment, stormwater, and pore water) will be collected at a frequency of at least 10 percent of the total number of discrete samples (see **Table 5-4** for sediment and stormwater duplicates to be collected during the first round of sampling). Duplicate samples will be collected, processed, and transported in the same manner as the parent samples.

5.6.2 Rinsate Blanks

Rinsate blanks are collected to determine the extent of contamination, if any, from the sampling equipment used as part of the project. Equipment blanks are collected by pouring deionized water, which will be provided by EA's Ecotoxicology Laboratory, over sampling equipment (e.g., ponar samplers or push-point samplers) that has been decontaminated using the procedure outlined in Section 5.7. Rinsate water is preserved and treated in the same manner as a field sample. The rinsate water is placed in laboratory-prepared containers, submitted to the analytical laboratory, and tested for the same chemical parameters as the sediments and site water. Rinsate blanks will be sent to the laboratory with the project samples.

5.6.3 Trip Blanks

A trip blank (also called a transport blank) is a sample of laboratory reagent water (preserved with hydrochloric acid) that is provided with the sample containers by the laboratory. It accompanies the sample containers into the field and back to the laboratory. The analysis of the trip blank identifies possible contamination associated with the residence of samples and containers during the collection, transport, and laboratory time. Trip blanks are analyzed for VOCs only. One trip blank will be included in each cooler containing sediment or water for VOC analysis.

5.7 EQUIPMENT DECONTAMINATION PROCEDURES

Equipment that will come into direct contact with sediment or water during sampling will be decontaminated prior to deployment in the field, and between sampling locations, to minimize cross-contamination. This includes ponar samplers, core samplers, core catchers, and stainless steel processing equipment (knives, bowls, scoops, 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 with site water
- Rinse with 10 percent nitric acid
- 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)
- Wrap equipment in aluminum foil, shiny side out.

Waste liquids will be contained during decontamination procedures and transferred to EA’s facility in Hunt Valley, Maryland, for disposal.

5.8 SAMPLING CONTINGENCIES

Although field investigation problems are not anticipated to occur, several such problems are possible. Sampling will be dependent upon daily weather conditions (including heavy rain, high winds, lightning, and/or fog) and vessel traffic. Severe weather forecasts may preclude sampling. The Field Lead will notify the Project Manager of weather-related delays.

EA is experienced with the logistics associated with sediment sampling via boat. The field staff is prepared to handle logistical challenges that may arise during the project. EA will report unanticipated logistical problems to the Trust, EPA, and MDE, and will provide feasible recommendations and/or modifications to the sampling program to achieve the project goals while adhering to the proposed schedule.

If core refusal or limited recovery is encountered during coring operations, if conducted, a limited number of additional attempts will be made to obtain sufficient sample volume. Three additional attempts will be conducted at a single location if refusal or limited recovery is encountered. After three attempts, the corer will be repositioned approximately 3-5 ft and penetration will be attempted again. If sufficient recovery cannot be attained after repositioning the corer three times, the Field Lead will contact the EA Project Manager. The EA Project Manager will contact EPA and MDE to discuss re-locating the station.

Unmonitored stormwater outfalls 070 and 071 drain overflow from the pond that collects stormwater from Greys Landfill. Efforts will be made to sample these outflows during storm events. However, if the water level in the pond is not sufficiently high to cause overflow during the sampling window for the project, then water may be sampled directly from the pond as a contingency, if EPA and MDE concur. The concentrations of COPCs from the pond would then be used in modeling both of these stormwater outfalls (see Section 8.4).

6. SAMPLE LABELING, CHAIN-OF-CUSTODY, AND DOCUMENTATION

6.1 FIELD LOGBOOK

Field notes for the field sampling will be recorded in permanently bound, dedicated field logbooks, in accordance with the SOP included in **Appendix D**. Information including the time and location of sampling, water depth, *in situ* water quality (for pore water samples), and core recoveries (if applicable) will be recorded in the log in indelible ink. A log documenting daily project activities will be completed throughout the duration of the onsite sample collection.

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, dated, and signed by the personnel entering information. Documentation will be initialed by the author and dated. Corrections to documentation will be made with a single line through the error with the author's initials and date.

Daily information recorded in the field logbook will include:

- Work performed
- Sampling performed (specifics as to location, type of samples, log number)
- Field analyses performed including instrument checks and calibration
- Problems encountered and corrective actions taken (specifics regarding sampling problems and alternate sampling methods utilized)
- QC activities including descriptions of problems and corrective actions taken.

Copies of the logbooks will be filed at EA's office in Hunt Valley, Maryland. Full copies of the project logbooks will be submitted as an appendix to the project report.

6.2 SAMPLE NUMBERING SYSTEM

Field samples collected during this investigation will be assigned a unique sample identifier. Sample designation will be an alpha-numeric code which will identify each sample by the matrix and location. The matrix will be identified by a two-letter code (SD = Sediment, ST = Stormwater, PW = Pore Water).

- Each sediment sampling transect has been assigned a letter, and samples are numbered consecutively moving away from the shoreline (**Figure 5-1**). "SS" will be used to designate surface sediment grab samples. For subsurface samples, if collected, the beginning depth from which the sample is collected will be added instead.

SD -	**A**	**01**	**SS**
Sample Matrix	Sediment Transect	Location on Transect	Depth

- Stormwater samples will be named with "ST" followed by the outfall number, and the date of sampling.

ST -	**070**	**101514**
Sample Matrix	Outfall Number	Date

- Pore water samples will be assigned letters consistent with the nearest sediment transect. If multiple pore water samples are collected on a transect, the samples will be numbered consecutively moving away from the shoreline.

PW -	**A**	**01**
Sample Matrix	Sediment Transect	Location on Transect

Field QC Samples

Duplicate samples, collected for quality assurance (QA)/QC purposes, will be designated by the by matrix and sequential duplicate number with a "DUP" prefix; for example, the first sediment duplicate will be labelled SD-DUP1. The identity of the duplicate will be recorded in field logbooks.

The sequential numbering convention will also be used for designation of rinsate blanks. The prefix for rinsate blanks will be "RB." For example, SD-RB1 would represent the first rinsate blank collected from sediment sampling equipment.

Note that matrix spikes / matrix spike duplicates (MS/MSDs) are not samples, but rather additional aliquots of normal samples. As such, the additional aliquots to support MS/MSDs will be labeled identically to the normal sample. However, a note will be made on the chain-of-custody (COC) alerting the lab that additional sample volume was collected to allow for the analysis of an MS/MSD.

6.3 SAMPLE LABELING

Sample containers will be affixed with a sample label that will be filled out at the time of collection. Information on the sample label will include, at a minimum, the following:

- Client
- EA project number
- Site location
- Sample location
- Date and time of collection
- Name of sampler
- Sample preservative(s).

Sample Label Example

Project Name:	Project Number:
Sample ID:	
Sample Date:	Sample Time:
Requested Analyses:	Preservatives:
	Initials:

6.4 CHAIN-OF-CUSTODY RECORDS

Samples collected in the field will be documented on a COC sheet that includes the date and time the sample was collected, the analyses requested, and the signatures of the personnel who collected and relinquished the samples, in accordance with the SOP in **Appendix D**. This COC will accompany all samples shipped for sample analyses.

6.5 SAMPLE PACKAGING AND SHIPPING

Samples and QC samples will be stored in an ice-filled cooler on the work platform until the end of each sampling day. Samples for laboratory analysis will be packaged in bubble wrap, placed in an ice-filled cooler (or cooler with blue ice), and shipped via overnight delivery to TestAmerica–Pittsburgh in Pittsburgh, Pennsylvania, in accordance with the SOP provided in **Appendix D**. Bubble wrap will be used to line the bottom and sides of the sample cooler and fill voids where needed to cushion the sample containers during transportation. Cooler(s) will be sealed with packing tape and custody seals, and a completed COC record representing the packaged samples will be taped to the inside of the cooler lid.

Samples will be sent directly to the following address:

TestAmerica–Pittsburgh
301 Alpha Dr.
RIDC Park
Pittsburgh, PA 15238
(412) 963-7058
Attn: Sample Receiving

7. ANALYTICAL TESTING

Analytical testing of sediment, pore water, and stormwater samples will be conducted by TestAmerica.

Sediment samples collected during the first round of offshore sampling will be analyzed for the target compounds and parameters indicated in **Table 5-2**. The overall analytical program for the first round of sampling (which includes sediment and stormwater sampling) is summarized in **Table 5-4**.

Stormwater samples will be analyzed for the following target compounds and parameters: VOCs, SVOCs (including PAHs), PCB Aroclors, PPL metals, mercury, cyanide, and suspended solids.

It is anticipated that pore water samples will be tested for the following target compounds and parameters: PAHs, metals, cyanide, bis(2-ethylhexyl)phthalate, and DOC. However, adjustments to the analytical suite for pore water samples may be made based on the results of the first round of sediment sampling and analysis.

The following sections outline key components of the testing program.

7.1 ANALYTICAL DETECTION AND REPORTING LIMITS

The detection limit is a statistical concept that corresponds to the minimum concentration of an analyte above which the net analyte signal can be distinguished with a specified probability from the signal because of the noise inherent in the analytical system. The method detection limit (MDL) was developed by EPA, and is defined as “the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero” (40 Code of Federal Regulations [CFR] 136, Appendix B). Reporting limits (RLs) are values set by the laboratory, above which analyte concentrations are not considered estimated. All analytical parameters will be quantified to the MDL. All detected values greater than or equal to the MDL, but less than the laboratory RL, will be qualified as estimated.

RLs and MDLs applicable to this project are listed in **Tables 7-1 and 7-2** for sediment and water, respectively. These tables also include NRWQCs for surface water and BTAG benchmarks for surface water and sediment. These commonly utilized criteria are presented to facilitate an initial assessment of the sensitivity of the analytical methods, as reflected in a comparison of the criteria to the RL and MDL. An initial assessment of sensitivity based on this comparison is presented for each analytical method in Section 7.2. Additional assessment of sensitivity using applicable risk screening criteria will be performed as part of the risk assessment.

For sediments with more than 50 percent moisture, sample weights will be adjusted by settling and decanting, when appropriate, prior to analysis to achieve the lowest possible reporting limits and improve accuracy.

7.2 ANALYTICAL METHODS

All inorganic and organic compounds for this project will be determined using the methods listed in **Tables 7-1 and 7-2**, as described in the laboratory's analytical SOPs. Laboratory SOPs can be provided upon request. To meet program-specific regulatory requirements for chemicals of concern, all methods/SOPs will be followed as stated, with some specific requirements noted below:

PPL VOCs

VOCs in sediment and water will be analyzed using SW846 Method 8260C. The laboratory RLs associated with this method for sediment analysis are lower than the BTAG benchmarks. The RLs for six VOCs in water are greater than the NRWQC and/or BTAG criteria. However, the MDLs for all but two of these are below the criteria, and the methods selected provide the lowest available detection limits.

PPL SVOCs including PAHs

To obtain RLs below the BTAG Screening Values (where possible), SVOCs in sediment and water will be analyzed using SW846 Method 8270D with low-level detection. The laboratory RLs associated with this method for sediment analysis are lower than the BTAG benchmarks for all PPL SVOCs. Even using the low-level method, the RLs for seven PAHs and seven other SVOCs in water are greater than the NRWQC and/or BTAG criteria. However, the MDLs are in many cases lower than the criteria, and the methods selected provide the lowest available detection limits.

PPL Metals

Because of potential matrix interferences, PPL metals in sediment and water will be analyzed using inductively coupled plasma/mass spectrometry according to the methodology specified (SW846 6020A), with the exception of mercury. Mercury will be analyzed by cold vapor atomic absorption methods (SW846 7470A for water and 7471A for sediment). The laboratory RLs for metals in sediment are below the BTAG screening values. For analysis of water, the RLs for cadmium, silver, and thallium are above the BTAG values. However, the MDLs are below the criteria, and the methods selected provide the lowest available detection limits.

PCB Aroclors

PCB Aroclors in sediment and water will be analyzed using SW846 Method 8082A. The laboratory RLs associated with this method for sediment analysis are lower than the BTAG value for total PCBs. The RLs and MDLs for analysis of PCBs in water are greater than the BTAG value and the human health NRWQC criterion for total PCBs. However, the methods selected provide the lowest available detection limits.

Cyanide

Total cyanide in both sediment and water will be analyzed using method SW846 9014. The laboratory RL using this method is higher than the BTAG and the NRWQC for saltwater aquatic life. However, this method represents the best commonly available technology for total cyanide determination and, therefore, the lowest feasible reporting limit.

Oil and Grease

Oil and grease in both sediment and water will be analyzed using EPA Method 1664B.

Total Organic Carbon

TOC in sediments will be determined using the 1988 EPA Region II combustion oxidation procedure (the Lloyd Kahn procedure).

Total Solids

Total solids in sediment samples will be determined using Standard Method 2540G.

Grain Size

Grain size distribution in sediment samples will be determined using ASTM Method D422.

Total Suspended Solids

TSS of water samples will be determined using Standard Method 2540D.

Dissolved Organic Carbon

DOC of water samples will be determined using Standard Method 5310C.

7.3 LABORATORY QUALITY CONTROL SAMPLES

QC samples will be analyzed at the frequency stated in the following table.

QC Sample	Frequency
Method Blanks	1 per analytical batch of 1-20 samples
Laboratory Control Sample	1 per analytical batch of 1-20 samples
Surrogates	Spiked into all field and QC samples (Organic Analyses)
Sample Duplicates	1 per analytical batch of 1-20 samples (Inorganic Analyses)
Matrix Spike/Matrix Spike Duplicate	1 per analytical batch of 1-20 samples

7.3.1 Method Blanks

The method (reagent) blank is used to monitor laboratory contamination. The method blank is usually a sample of laboratory reagent water processed through the same analytical procedure as the sample (i.e., digested, extracted, distilled). One method blank will be analyzed at a frequency of one per every analytical preparation batch of 20 or fewer samples.

7.3.2 Laboratory Control Samples

The laboratory control sample (LCS) is a fortified method blank consisting of reagent water or solid fortified with the analytes of interest for single-analyte methods and selected analytes for multi-analyte methods according to the appropriate analytical method. LCSs will be prepared and analyzed with each analytical batch, and analyte recoveries will be used to monitor analytical accuracy and precision.

7.3.3 Matrix Spike (MS) / Matrix Spike Duplicate (MSD)

A fortified sample (MS) is an aliquot of a field sample that is fortified with the analyte(s) of interest and analyzed to monitor matrix effects associated with a particular sample. Samples to be spiked will be chosen at random. The final spiked concentration of each analyte in the sample should be at least 10 times the calculated MDL. A duplicate-fortified sample (MSD) will be performed for every batch of 20 or fewer samples. MS/MSD analyses will be performed on sediment and water samples.

7.3.4 Sample Duplicates

A sample duplicate is a second aliquot of a field sample that is analyzed to monitor analytical precision associated with that particular sample. Sample duplicates will be performed on sediment, stormwater, and pore water samples for every batch of 20 samples, or for batches of fewer samples for those analytes that do not have MS/MSD analyses.

7.3.5 Surrogates

Surrogates are organic compounds that are similar to analytes of interest in chemical composition, extraction, and chromatography, but are not normally found in environmental samples. These compounds will be spiked into all blank, samples, and spiked samples prior to analysis for organic parameters. Generally, surrogates are not used for inorganic analyses. Percent recoveries will be calculated for each surrogate. Surrogates will be spiked into samples according to the requirements of the reference analytical method. Surrogate spike recoveries will be evaluated against the laboratory recovery limits and will be used to assess method performance and sample measurement bias. If sample dilution causes the surrogate concentration to fall below the quantitation limit, surrogate recoveries will not calculated.

8. DATA MANAGEMENT AND EVALUATION

8.1 DATA MANAGEMENT

Data management procedures are established to effectively process analytical and measurement data generated during the investigation such that the relevant data are readily accessible and accurately maintained. Data collected during the investigation, including field data and laboratory analytical data, will be stored in the project-specific database management system. Official and original field data documents (e.g., field sheets, hard copy maps, field log books, etc.) and electronic files (e.g., GPS files, photographs, etc.) related to this project will be stored and archived on a secure server in a project-specific network folder and/or in the paper project folders. For analytical data, TestAmerica, Inc. will prepare and submit electronically a Level IV analytical data package and electronic data deliverable (EDD). These data deliverables will also be stored in the project-specific network.

8.2 DATA VALIDATION

Data verification is the first step to the overall validation process. It ensures that field COCs, laboratory EDDs, and laboratory analytical data packages are reviewed for completeness and accuracy, as well as for conformance with the QAPP. Once analytical data have been received and a data assessment performed to verify their acceptability, data will be submitted to Environmental Data Services, Inc. for 80 percent Level III and 20 percent Level IV data validation using the most recent EPA National Functional Data Validation Guidelines. Data validation will include completeness and compliance checks, data assessment, and validation. While not all elements of the Tier I and Tier II validation process necessarily apply to these data, those that do will be reviewed and the data checked for completeness, accuracy, precision, and relevance. EA will evaluate the validated data collected to address the goals of this investigation.

8.3 STATISTICAL DERIVATION OF EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations (EPCs) will be developed to enable use of the chemical analytical data in the risk assessment. The EPC represents the average concentration contacted at an exposure point or points over an exposure period (EPA 1989). The EPC is estimated to provide a conservative estimate of the average concentration. Chemical analyses provide the chemical concentrations detected at each sample location. Some organisms, such as clams and worms, may be exposed to concentrations at a single location for most of their life span. However, most fish, crustaceans, wildlife, and humans may be exposed to sediment or surface water at many locations over time. Therefore, statistics will be used to calculate EPCs that represent overall exposures to sediment and water in the Phase I area of Bear Creek (EPA 1989, 1991, 1997a).

EPCs for sediment will be calculated directly from chemical analytical results of these media. EPCs for surface water will be calculated based on the results of the pore water sampling and surface water modeling (see Section 8.4). For ingestion of fish tissue and crabs, the EPC will be determined through the use of bio-uptake modeling.

EPCs for each COPC will be calculated the 95 percent upper confidence limit of the mean (UCLM) (EPA 1989). The EPC represents a reasonable estimate of the COPC concentration that is likely to be contacted by receptors over their expected exposure times. The 95 percent UCLM is used because in most situations, assuming long-term contact with the maximum concentration is not reasonable (EPA 1989). The 95 percent UCLM will be determined through the use of the EPA ProUCL program version 5.00.0 (EPA 2013). For the ecological risk assessment, two PAH EPCs will be calculated: one based on the sum of the low-molecular weight PAHs, and one based on the sum of the high-molecular weight PAHs. The individual PAHs within each group share similar modes of toxicity, and therefore it is appropriate to examine exposures to these compounds as a whole for some ecological receptors (EPA 2007). The bio-uptake modeling for fish tissue and crabs will take into account the 95 percent UCLM of surface water and sediment media for the determination of COPC concentrations.

8.4 SURFACE WATER MODELING

Modeling of stormwater and pore water results will be used to estimate EPCs for surface water. A tidally-dynamic model will be developed to examine the mixing of the constituent mass flux of groundwater and stormwater into Bear Creek. The U.S. Army Corps of Engineers models RMA2 (hydrodynamics) and RMA4 (water quality) will be used. Both are finite element numerical models. RMA2 calculates fluid flow velocities within a 2-dimensional grid system, and RMA4 uses the solutions to calculate movement of mass through the grid, based on advection and diffusion processes. These models will be executed within the framework provided by the Surface Water Modeling System software from Aquaveo.

Model inputs will include mass flux from sediment pore water and stormwater discharged from outfalls along the Bear Creek shoreline, as well as surface water contributions from Bear Creek and the Patapsco River. The mass flux of anthropogenic organic compounds and metals from groundwater to Bear Creek in the Phase I area will be estimated using pore water concentrations of constituents of interest, along with the approximate rate of flow of upland groundwater into surface water. Hydrographs of stormwater outfalls will be modeled using the EPA Storm Water Management Model, executed in a continuous mode using a long-term precipitation data set. Representative stormwater discharge concentrations obtained from analysis of stormwater samples will be applied to the modeled stormwater discharge to obtain stormwater mass flux. A zero background concentration will be used for all constituents, such that the model will only represent inputs of anthropogenic chemical mass from the calculated fluxes from Sparrows Point. COPCs will be modeled as conservative tracers in the surface water environment; thus no chemical reactions will be considered. Model results will be used to calculate an average surface weighed area concentration of each surface water COPC to be used as the EPC for surface water assessment in the human health and ecological risk assessments descried in Section 9 of this Work Plan.

9. RISK ASSESSMENT

Using the results of the Phase I offshore investigation, human health and ecological risk assessments will be completed to determine if there are potential concerns for ecological and human receptors. The following sections summarize the specific methodologies that will be used in the assessments.

9.1 REFINEMENT OF THE CONCEPTUAL SITE MODEL

The CSMs for ecological and human health risk, presented in the following sections, will be refined using the results of the offshore investigation. The CSMs identify exposure pathways that link receptors (e.g., wildlife and humans) to the elevated chemical concentrations observed in the offshore environment and that therefore require assessment.

The CSMs identify:

- the potential sources and release mechanisms for chemicals with elevated concentrations,
- the fate and transport of these chemicals,
- the media of concern at the site,
- potential pathways for ecological and human receptors, and
- potential wildlife receptors and human populations that could be exposed.

Exposure pathways that are complete and significant for the area will be included in the risk characterization. An exposure pathway describes the mechanism by which a potential receptor contacts chemicals present in the area. A complete exposure pathway requires the following four components:

- a source and mechanism of chemical release to the environment,
- an environmental transport medium for the released chemical,
- a point of potential contact with medium containing chemicals, and
- an exposure route (e.g., ingestion or dermal absorption) at the point of exposure.

All four components must exist for an exposure pathway to be complete and for exposure to occur. Incomplete exposure pathways do not result in actual exposure of receptors (wildlife or human) and will not be evaluated in the risk assessment.

9.2 ECOLOGICAL RISK ASSESSMENT METHODS

The ecological risk assessment (ERA) will be conducted in accordance with EPA guidance that is applicable to RCRA sites (EPA 1997a). An ERA is a study in which exposure and toxicity data are combined to develop an estimate of the potential for adverse impacts on ecological receptors from chemicals in the environment. Per EPA guidance, an ERA begins with an initial, precautionary evaluation of the potential for risks using chemical analytical data from environmental media at the site and literature-based information regarding toxicity and exposure (EPA 1997a). This is called a Screening Level ERA (SLERA), and typically consists of basic benchmark comparisons and precautionary exposure modeling. SLERAs often include additional refinement of initial comparisons using more realistic, less precautionary assumptions, site-specific qualitative information, and consideration of background concentrations. Where results of the SLERA are not conclusive, EPA guidance provides for further tiers of analyses that require specific collection of onsite ecological and toxicological data. This work plan sets forth the methods for the SLERA and refinement; the next step, baseline ecological risk assessment, may be performed following screening, if warranted, and would require additional approach development and planning based on the results of the SLERA.

9.2.1 Conceptual Site Model for Ecological Risk Assessment

The CSM presented in this section will be updated as necessary based on the information obtained during the Offshore Investigation, and will be used in refining the receptors, exposures, and endpoints for the ERA.

The Phase I area is located along the eastern side of Bear Creek, which flows into the Patapsco River. These water bodies are typically well mixed mesohaline aquatic environments in which chemical transport is affected by tidal flow and surface water input from storm events (EA 2009). As defined by the Subaqueous Survey (**Appendix A**), water depths in the Phase I area of Bear Creek vary from less than 1 ft along the shoreline to 13 ft near the centerline of Bear Creek, and the water is generally deeper in the northern portion of the area. Substrate is generally sandy near the shoreline, with silt and clay farther offshore and at the outflow of Humphrey Impoundment (**Appendix A**). Water quality in the Patapsco River is often poor because of eutrophication (EA 2003), a condition that is also expected to affect Bear Creek.

The Visual Shoreline Survey (**Appendix B**) included documentation of shoreline habitats. The survey found that the intertidal zone in the Phase I area was largely covered by slag and rock, with a very low diversity of plant species as well as wildlife. The second most abundant habitat type in the intertidal zone was sandy shoreline dominated by *Phragmites*, an invasive plant. These areas have low plant diversity but provide habitat for a variety of wildlife, including birds and frogs (**Appendix B**).

The offshore environment adjacent to the Sparrows Point Peninsula was characterized in a reconnaissance study through fisheries studies, benthic community surveys, and review of submerged aquatic vegetation (SAV) maps (EA 2003). White perch and Atlantic silversides dominated fish surveys, although other fish species and blue crabs were collected. The study also found that birds, including herons, cormorants, terns, gulls, and ospreys utilize offshore areas, including the shoreline and/or open water. Ospreys were observed to nest near deciduous cover along the shoreline of Coke Point, and may also nest along Bear Creek. Herons and cormorants were observed perching on a deteriorating wooden structure in the southern portion of the Phase I area during the Visual Shoreline Survey (**Appendix B**). No evidence of mammals or rare, threatened, or endangered species was observed during the reconnaissance study (EA 2003).

9.2.2 Selection of Representative Receptor Species

Ecological receptors potentially present at the offshore area include piscivorous wildlife (birds and mammals) and aquatic and benthic organisms (fish, crab, invertebrates, and plankton). Because the offshore area is not expected to support SAV or wetland plants other than *Phragmites*, herbivorous wildlife are not considered potential receptors. The SLERA cannot quantitatively evaluate all of the species/receptors potentially present at a site; therefore, representative receptor species are selected. These species act as surrogates for other species that have similar diets/feeding habitats.

Aquatic and Benthic Organisms

Toxicological benchmarks for the evaluation of risk to aquatic and benthic organisms are based on a wide variety of species and taxa, including crustaceans, fish, bivalves, worms, and algae. Therefore, the overall aquatic community or benthic community is identified as the representative receptor.

Piscivorous Wildlife

Two species were selected as representative receptors for piscivorous avian species. The great blue heron (*Ardea herodias*) is selected as an avian receptor species for evaluating potential adverse effects to birds from the ingestion of aquatic and benthic prey. Great blue heron are known to eat fish, invertebrates, and amphibians among other things. The osprey (*Pandion haliaetus*) is selected as an additional avian receptor species. Ospreys were observed at the offshore area. The osprey’s diet is comprised almost exclusively of fish, with some aquatic invertebrates such as crabs.

The raccoon (*Procyon lotor*) is selected as a mammalian receptor species for evaluating potential adverse effects to mammals from the ingestion of fish and aquatic invertebrates. The raccoon’s diet is very diverse but includes the consumption of fish and other aquatic animals. Although the raccoon is unlikely to feed in deeper water, they may feed in the shallows along the shore.

9.2.3 Exposure Pathway Analysis

The major routes of exposure for the identified receptor species are direct/dermal contact, ingestion, and inhalation.

Aquatic and benthic organisms may be exposed to chemicals in sediment, pore water, and surface water through direct contact and absorption through the skin and gills. Based on this information, direct exposure to sediment, pore water, and surface water is considered a complete and significant pathway for aquatic and benthic organisms.

The most significant exposure route for wildlife is ingestion of chemicals in impacted media (EPA 2003a). Wildlife may ingest chemicals in environmental media by incidentally drinking brackish surface water or by incidentally ingesting soil and sediment while grooming or foraging. Wildlife may also ingest chemicals accumulated in plants and animals that they consume as food. Ingestion of chemicals in sediment, pore water, surface water, and/or food is considered a complete and potentially significant exposure pathway for receptors. Dermal contact and inhalation are not expected to be significant exposure pathways for wildlife (EPA 2003a).

9.2.4 Assessment and Measurement Endpoints

Assessment endpoints are clear statements of an environmental value to be protected from impacts (EPA 1997a). The selection of assessment endpoints is based on the fundamental knowledge of site ecology, and incorporates consideration of the COPCs, exposure pathways, toxic mechanisms, and potentially important exposure groups. Per EPA guidance (EPA 1997a), the focus of the ecological risk assessment is to protect the ecological values at the site-wide population or community level except where threatened or endangered species are concerned.

The following preliminary assessment endpoints were defined to reflect the potential impacts of complete and significant exposure pathways:

- Viability of aquatic and benthic organism communities, and
- Viability of wildlife communities including piscivorous (fish-eating) birds and mammals.

The ERA will apply a weight of evidence approach in which multiple lines of evidence are evaluated, and their individual significance, or weight, is considered to derive a conclusion. In the case of ERA, each line of evidence is a measurement endpoint. Measurement endpoints are quantifiable ecological characteristics that are related to each assessment endpoint (EPA 1989). Because assessment endpoints are often defined in terms of ecological characteristics that are difficult to measure (e.g., the health of a population or community), measurement endpoints are selected to provide a quantifiable means of characterizing risks.

The measurement endpoints for this ERA were selected based on standard risk assessment methodology (EPA 1997a) with consideration of the available data. Quantitative and qualitative measurement endpoints are summarized in the sections below.

9.2.4.1 Aquatic and Benthic Organisms

Potential risks to aquatic and benthic organisms (plankton, invertebrates, fish) will be evaluated by comparing EPCs in surface sediment and pore water, and modeled concentrations in surface water, to commonly used sediment and surface water ecological screening benchmarks. Stormwater concentrations may be compared to acute surface water quality criteria to determine if there is an immediate risk for aquatic organisms. Benchmarks represent the threshold above which effects are expected and below which either no effect or a low effect is expected. Comparisons will initially be made using maximum exposure point concentrations as a precautionary initial screen. Comparisons will then be refined using mean and point-by-point concentrations as EPCs. Results from individual depth samples will be evaluated qualitatively with respect to each other to identify potential hot spots or anomalies.

Benthic organisms – The primary route of exposure for benthic organisms is through direct contact with and ingestion of sediment and pore water. Benchmarks for comparison against sediment concentrations will be derived from a number of sources, including BTAG Sediment Screening Benchmarks. For compounds without BTAG benchmarks, Effects Range–Low (ER-L) values reported in Long et al. (1995) and Long and Morgan (1990) will be employed as toxicity reference values (TRVs). Threshold effects levels for coastal sediments derived by MacDonald et al. (1996) will be used in the absence of ER-Ls. In the absence of these TRVs, the lowest value will be chosen from sediment quality benchmark values in Jones et al. (1997), ecotoxicological threshold values from EPA (1996), and Washington State sediment quality standards from Jones et al. (1997). Surface water ecological benchmarks will be used for comparison against pore water concentrations. These benchmarks used in screening will be chronic NRWQCs (EPA 2009) for the protection of aquatic life, which are developed to be protective of a broad range of taxa, feeding habits, and life stages of aquatic receptors. When a chronic NRWQC is not available for a particular chemical, the Tier II chronic value from Suter and Tsao (1996) will be used as the TRVs. These values are also highly conservative.

Aquatic organisms – The primary route of exposure for aquatic or free swimming organisms is through direct contact with, ingestion of, and respiration of surface water. To determine the potential for risks, modeled surface water concentrations will be compared to chronic NRWQCs (EPA 2009) and Tier II chronic values from Suter and Tsao (1996), as described for the screening of pore water for benthic organisms, above. As noted in the introduction to this section, stormwater concentrations may also be compared to acute NRWQCs.

The refined assessment for aquatic and benthic organisms will also include a comparison of offshore concentrations to background concentrations to determine the source-relatedness of risks. Other literature sources to be referenced during the refinement will include the consensus-based probable effects concentrations from MacDonald et al. 2000, EPA guidance for using equilibrium sediment benchmarks (EPA 2003b, 2005), and other sources as applicable. It will include a qualitative discussion of habitat quality and other factors such as bioavailability and physical factors that may influence results. Finally, the assessment will consider qualitative information available from past studies, including benthic community survey results, vegetation surveys, and fish surveys. These are potentially strong weights of evidence for or against potential risks.

9.2.4.2 Wildlife

For wildlife, measurement endpoints are based on the results of food web models that predict the dose of chemicals ingested by wildlife. These doses will be compared to TRVs for wildlife. The first measurement endpoint evaluated will be a comparison of doses based on maximum exposure point concentrations to no-effects TRVs. Refinement of the models will be conducted using mean exposure point concentrations. As part of refinement, doses will be compared to low-effects TRVs as well as modeled doses for background areas. Comparison to doses modeled using background concentrations aids in determining source-relatedness of risks. The refinement will include a qualitative discussion of habitat quality and other factors such as bioavailability and physical factors that may influence results. The results of food web modeling will be compared to actual fish and crab data from the Sparrows Point area (EA 2011). The refinement for wildlife will also include qualitative evaluation of information available from past studies regarding habitat quality.

The exposure assumptions used in wildlife exposure models are derived from data presented in Sample et al. (1996), EPA Ecological Soil Screening Levels (EcoSSLs), and EPA's Exposure Factors Handbook (1993). TRVs for wildlife are generally derived based upon measurements of survival, growth, or reproduction in the laboratory. Most of the toxicity data for these calculations were derived from Sample et al. (1996) and EPA EcoSSLs. Bioaccumulation factors relating surface water concentrations to fish tissue concentrations and relating sediment concentrations to benthic invertebrate tissue concentrations will be derived from EPA guidance (EPA 1999), EPA software and databases (EPA 2013, Computer Sciences Corporation 2008), consensus based studies (Bechtel 1998), and the scientific literature. While the EcoSSLs were developed for soil exposures, the models used to develop these benchmarks include ingestion rates, dose-based toxicity values, and other useful information for use in assessing aquatic exposures. When necessary, surrogate organic chemical TRVs can be used for the evaluation of potential adverse effects to wildlife. In cases where toxicological benchmarks or appropriate surrogates are not available for chemicals, the scientific literature will be reviewed for oral toxicity data.

9.2.5 Risk Characterization

The risk characterization will summarize the weight of evidence for each receptor and draw conclusions regarding the overall potential for ecological risks at the site. A qualitative discussion of habitat quality and other factors such as bioavailability and physical factors that may influence results will also be provided.

9.3 HUMAN HEALTH RISK ASSESSMENT (HHRA) METHODS

An HHRA will be completed to quantify potential current risks for human health. The HHRA will follow methods set forth in the following EPA guidance:

- Risk Assessment Guidance for Superfund (RAGS), *Volume 1: Human Health Evaluation Manual (Part A) (Interim Final)*, EPA/540/1-89/002, EPA 1989.

- Risk Assessment Guidance for Superfund (RAGS), *Volume 1: Human Health Evaluation Manual Supplemental Guidance – "Standard Default Exposure Factors" (Interim Final),* Publication 9285.7-01B, EPA 1991.

- *Guidelines for Data Usability in Risk Assessment (Part A)*. Office of Research and Development, EPA/540/R-92/003, EPA 1992.

- *Exposure Factors Handbook*, Volumes I, II, and III, EPA/600/P-95/002Fa, EPA 1997b.

- Risk Assessment Guidance for Superfund (RAGS), *Volume 1: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments)*. Office of Emergency and Remedial Response, Publication 9285.7-47, EPA 2002.

- *Human Health Toxicity Values in Superfund Risk Assessments*. Office of Solid Waste and Emergency Response, OSWER 9285.7-53, EPA 2003c.

- Risk Assessment Guidance for Superfund (RAGS), *Volume 1: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment)*, EPA/540/R/99/005, OSWER 9285.7-02EP, EPA 2004.

- *Exposure Factors Handbook: 2011 Edition*. EPA/600/R-090/052F, EPA 2011.

- *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*. Office of Solid Waste and Emergency Response, OSWER Directive 9200.1-120, EPA 2014a.

The HHRA will evaluate potential adverse health effects for potential current or future receptors that may result from exposure to chemicals from Site-related impacts in the offshore Phase I area, in the absence of any actions to control or mitigate the contamination (EPA 1989). The HHRA determines potential human exposures to site environmental media and toxicity data relevant to chemicals from the site to estimate potential health effects. The HHRA methodology follows a four-step process as set forth by EPA (1989): data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization.

9.3.1 Conceptual Site Model for Human Health Risk Assessment

The CSM presented in this section will be updated as necessary based on the information obtained during the Offshore Investigation, and will be used in refining the exposures and endpoints for the HHRA.

The CSM for the HHRA is based on a determination of expected activities within the offshore environment in the Phase I area. Based on the types of activities expected within the Phase I area, representative receptor populations and their activities are selected for evaluation in the risk assessment. The offshore environments are not controlled, and access to these areas is not limited. The land across Bear Creek from the Phase I area consists of residential properties, most with private boat piers. Therefore, people may use the area for boating, swimming, or fishing. Based on the documented and potential human uses at the site, two populations were identified as potential receptors: recreational users and commercial watermen.

Recreational Users – Recreational users can access the Phase I area by boat. Recreational users could use the surface water bodies adjacent to the Phase I area for swimming or fishing. This results in a complete contact point with chemicals modeled in surface water. Because of the brackish nature of the surface water, intentional ingestion is not expected to occur, and incidental ingestion while swimming would be minimal. Surface water dermal contact with the skin surface is the primary contact point. Surface water depths in the Phase I area range from 1 ft along the shoreline to 13 ft near the centerline of Bear Creek (**Appendix A**). Therefore, potential dermal contact with sediment is considered a complete exposure pathway for recreational users as a conservative measure. Recreational users are assumed to fish or crab in the area and consume their catch. Due to activities expected in the Phase I area, children younger than 6 years of age are not expected. Recreational users are assumed for two age ranges: an adolescent (age 7 to 16) and an adult (>16 years).

The following exposure routes are considered complete for recreational users:

- Dermal contact with surface water,
- Dermal contact with sediment, and
- Ingestion of fish or crabs.

Commercial Watermen – Commercial watermen may also use the area. Based upon fishing methods, it is assumed that the fishermen will come in contact with surface water and sediment during fishing activities. Therefore, surface water and sediment dermal contact with the skin is a complete exposure route. The dermal area exposed to surface water and sediment is the hands and forearms only. Incidental ingestion of surface water and sediment while fishing is likely to be non-existent to minimal and is not considered a complete exposure route. In addition, it is assumed that the watermen will ingest fish or crabs collected from the area. The commercial waterman is assumed to be an adult (>16 years).

The following exposure routes are considered complete for the commercial watermen:

- Dermal contact with surface water,
- Dermal contact with sediment, and
- Ingestion of fish or crabs.

9.3.2 Data Collection and Evaluation

The HHRA will evaluate results from surface sediment sampling, and modeled surface water and fish tissue/crab concentrations. Analytical results will undergo a data quality evaluation, and analytical qualifiers applied to these analytical results will be reviewed to determine if the results will be included or excluded from the HHRA. Following the assessment of data quality, sediment, surface water, and fish tissue/crabs will be compared to human health risk-based criteria. The risk-based criteria will take into account the complete exposure pathways identified in the CSM. State and Federal risk-based criteria are not available for most of the specific receptors and media of concern. For these receptors and media, site-specific risk-based criteria have been determined for the complete exposure pathways identified in the CSM. The site-specific risk-based criteria for COPCs expected to be risk drivers are presented in **Appendix E** and are based upon a carcinogenic risk level of 10^{-6} or non-carcinogenic hazard quotient of 0.1. Maximum detected concentrations in surface sediment, and maximum modeled surface water concentrations, will be compared to the risk-based criteria to determine COPCs for the risk assessment. For the ingestion of fish tissue/crabs, the modeled concentrations will be compared to the EPA Regional Screening Level for fish ingestion (EPA 2014b). Any chemical in which the maximum detected concentration exceeds the risk-based screening criteria will be considered a COPC for the HHRA. COPCs identified will be evaluated further to assess current offshore site risks.

9.3.3 Exposure Assessment

The exposure assessment estimates the magnitude of potential human contact to COPCs in sediment, surface water, and fish tissue/crabs. Each complete exposure pathway identified in the CSM will be evaluated in the exposure assessment. The identified COPCs will be converted into systemic doses, taking into account rates of contact (e.g., dermal exposure areas for swimmers, waders, and watermen) and absorption rates of different COPCs. The magnitude (i.e., COPC concentrations), frequency (i.e., number of days per year), and duration of these exposures are then combined to obtain estimates of daily intakes over a specified period of time (i.e., lifetime, activity-specific duration). In the exposure assessment, two different measures of intake are evaluated, depending on the nature of the effect being evaluated. When evaluating longer-term (i.e., chronic) exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (EPA 1989). This measure of intake is referred to as the average daily intake and is a less than lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily intake (EPA 1989).

To assess intake, expected rates of exposures and chemical concentrations (i.e., EPCs) are combined. Exposure parameters include rates of contact (e.g., ingestion rates, skin surface areas, etc.), exposure frequency and duration, body weight, and averaging time. The contact rate reflects the amount of contaminated media contacted per unit time or event. Exposure frequency and duration are used to estimate the total time of exposure to COPC in media of concern. Specific exposure parameters for surface water and sediment for each receptor have been chosen based on State and EPA guidance (EPA 1989, 1991, 1997b, 2004, 2011, 2014a, and 2014b) and other appropriate resources, and are presented in **Appendix E**. Ingestion rates for fish and crab will be calculated using the following assumptions: Weight of cooked fish/crab ingested by receptors per meal is assumed based upon the age range evaluated. For the adult receptors (recreational user and watermen), the assumption is 8 ounces (0.23 kg) of fish/crab per meal. For the adolescent and child recreational user, the assumption is 6 (0.17 kg) ounces and 3 ounces (0.085 kg) per meal, respectively. The EPCs for each COPC will be determined as described in Section 8.3.

9.3.4 Toxicity Assessment

The toxicity assessment considers the types of potential adverse health effects associated with exposure to COPCs; the relationship between magnitude of exposure and potential adverse effects; and related uncertainties, such as the weight of evidence of a particular COPC's carcinogenicity in humans. The HHRA will rely on existing toxicity information developed for specific chemicals. Since existing toxicity information will be used in the HHRA, these values are selected based upon EPA guidance (EPA 1989 and 2003c). Tier 1 values will be taken from the Integrated Risk Information System (IRIS) (EPA 2014c) for established, current values. When toxicity values are not available from IRIS, Tier 2 values will be examined. Tier 2 values are EPA's Provisional Peer Reviewed Toxicity Values, which are developed by the Office of Research and Development, the National Center for Environmental Assessment, and the Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by the Superfund program. Tier 3, other toxicity values, will be considered when Tier 1 or Tier 2 toxicity values are not available. These toxicity values will be taken from additional EPA and non-EPA sources and were chosen based on the most current and best peer-reviewed source available.

Toxicity values used for exposures that involve dermal contact with chemicals typically require adjustment of the oral toxicity values (oral reference doses or slope factors). This adjustment accounts for the difference between the daily intake dose through dermal contact as opposed to ingestion. Most toxicity values are based on the actual administered dose and must be corrected for the percent of chemical-specific absorption that occurs across the gastrointestinal tract prior to their use in dermal contact risk assessment (EPA 1989 and 2004). EPA recommends utilizing oral absorption efficiency factors in converting oral toxicity values to dermal toxicity values (EPA 2004). The chemical-specific parameters utilized in assessing dermal exposure, gastrointestinal dermal absorption factor, and the dermal absorption factor, are selected based on latest EPA dermal guidance (EPA 2004).

9.3.5 Risk Characterization

In the risk characterization, the toxicity values are compared with the calculated chemical intakes for the potential receptors to quantitatively estimate both carcinogenic and non-carcinogenic effects. The risk characterization will result in a numerical expression of risk for human contact with COPCs in surface water, sediment, and fish tissue/crabs. Non-carcinogenic and carcinogenic effects will be calculated for recreational users and commercial watermen. The risk characterization will be performed following EPA guidance (EPA 1989). The uncertainties associated with the risk assessment results will also be discussed.

10. REFERENCES

Baker, J., et al. 1997. Spatial Mapping of Sedimentary Contaminants in the Baltimore Harbor/Patapsco River/Back River System. Submitted to the Maryland Department of the Environment. 4 August.

Bechtel Jacobs Company LLC (Bechtel). 1998. *Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation*. Prepared for U.S. Department of Energy. August 1998.

CH2M Hill. 2001. Site Wide Investigation: Groundwater Study Report, Bethlehem Steel *Corporation, Sparrows Point Division*. Prepared by CH2M-Hill, Herndon Virginia for Bethlehem Steel Corporation, Sparrows Point Division, Maryland, December 2001.

———. 2002. Site-Wide Investigation Release Site Characterization Study. Prepared by CH2M-Hill, Herndon Virginia for Bethlehem Steel Corporation, Sparrows Point Division, Maryland, June 2002.

Computer Sciences Corporation. 2008. Biota-Sediment Accumulation Factor Data Set, Version 1.0. Prepared for U.S. Environmental Protection Agency.

EA Engineering, Science, and Technology, Inc. (EA). 2003. Reconnaissance Study of Sparrows Point as a Containment Site for Placement of Harbor Dredged Material: Environmental Conditions. Prepared for the Maryland Port Administration. December.

———. 2004. Feasibility Studies of Sparrows Point as a Containment Site for Placement of Harbor Dredged Material: Environmental Conditions.

———. 2009. Site Assessment for the Proposed Coke Point Dredged Material Containment Facility at Sparrows Point. Prepared for the Maryland Port Administration. November.

———. 2010. Additional Offshore Delineation for the Proposed Coke Point Dredged Material Containment Facility at Sparrows Point. Prepared for the Maryland Port Administration. August.

———. 2011. Risk Assessment of Offshore Areas Adjacent to the Proposed Coke Point Dredged Material Containment Facility at Sparrows Point. Prepared for the Maryland Port Administration. May.

Environmental Engineering & Contracting, Inc. (EEC). 2013. *Interim Measures 2012 Annual Report, Former Sludge Bin Storage Area, Rod & Wire Mill*. Prepared for Sparrows Point LLC. January.

EnviroAnalytics Group. 2013. Coke Point and Greys Landfills Semi-Annual Groundwater Monitoring Report, 1st Half 2013. Prepared for Sparrows Point LLC. June.

———. 2014a. Interim Measures 2013 Annual Report, Former Sludge Bin Storage Area, Rod and Wire Mill Area. Prepared for Sparrows Point LLC. January.

———. 2014b. Coke Point and Greys Landfills Semi-Annual Groundwater Monitoring Report, 2nd Half 2013. Prepared for Sparrows Point LLC. February.

Integral Consulting, Inc. 2012. *Offshore Ecological and Human Health Investigation Work Plan.* Prepared for RG Steel, LLC. May.

International Steel Group (ISG). 2005. Form 10-K, Annual Report for the Fiscal Year Ended December 31, 2004, filed by International Steel Group Inc. with the U.S. Securities and Exchange Commission, March 15, 2005, http://yahoo.brand.edgar-online.com/ EFX_dll/EDGARpro.dll?FetchFiling HTML1?SessionID=CTJrCmmKL9Ix6Pm&ID=3544712#L12721AE10VK_HTM_TOC PAGE

Jones, D.S., G.W. Suter II, and R.N. Hull. 1997. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision*. ES/ER/TM-95/R4. Prepared for U.S. Department of Energy, Office of Environmental Management. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

KCI Technologies (KCI). 2010. *Greys Landfill 2009 Groundwater Monitoring Report*. Prepared for Severstal Sparrows Point. January.

———. 2011. *Greys Landfill June 2011 Groundwater Monitoring Report*. Prepared for RG Steel Sparrows Point, LLC. June

Klosterhaus, S., et al. 2007. *Toxicity Identification and Evaluation and Long-Term Contaminant Trends in the Baltimore Harbor*. Submitted to the Maryland Department of the Environment. February.

Long, E.R. and L.G. Morgan. 1990. *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program*. National Oceanic and Atmospheric Administration, National Ocean Service, Seattle, Washington.

Long, E.R. D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management* 19(1):81-97.

MacDonald, D.D., R.S. Carr, F.D. Calder, E.R. Long, and C.G. Ingersoll. 1996. Development and evaluation of sediment quality guidelines for Florida coastal waters. *Ecotoxicology* 5:253-278.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Arch. Environ. Contam. Toxicol.* 39:20-31.

Prince, R. 2011. *Data Evaluation and Screening Level Human Health and Ecological Risk Assessment for Bear Creek Sediment.* Land and Chemicals Division, EPA Region III. October.

Rust. 1998. *Description of Current Conditions, Bethlehem Steel Corporation, Sparrows Point, Maryland*. Prepared by Rust Environment and Infrastructure, Harrisburg and Philadelphia Offices. January.

Sample, B.E., D.M. Opresko, and G.W. Suter. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*. ES/ER/TM-86/R3. Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Suter II, G.W., and C.L. Tsao. 1996. T*oxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision*. ES/ER/TM-96/R2. Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory.

U.S. Environmental Protection Agency (EPA). 1989. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A)*. Interim Final. EPA/540/1-89/002. Office of Emergency and Remedial Response.

———. 1991. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual – Supplemental Guidance-"Standard Default Exposure Factors" (Interim Final)*. Publication 9285.6-03.

———. 1992. *Guidelines for Data Usability in Risk Assessment (Part A)*. EPA/540/R-92/003. Office of Research and Development.

———. 1993. *Wildlife Exposure Factors Handbook*. 2 Vols. EPA/630/R-93/187a. Office of Research and Development.

———. 1996. Ecotox Thresholds. Eco Update, 3(2):1-12. EPA 540/F-95/038. U.S. Environmental Protection Agency (EPA), Office of Solid Waste and Emergency Response.

———. 1997a. Ecological Risk Assessment Guidance for Superfund. Process for Designing and Conducting Ecological Risk Assessments. Interim Final. U.S. EPA, Environmental Response Team Office of Emergency and Remedial Response. Edison, New Jersey.

———. 1997b. *Exposure Factors Handbook: Volumes I, II, and III.* EPA/600/P-95/002Fa.

———. 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Peer review draft. EPA Office of Solid Waste.

———. 2002. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part D: Standardized Planning, Reporting, and Review of Superfund Risk Assessments). Publication 9285.7-47. Office of Emergency and Remedial Response.

———. 2003a. *Guidance for Developing Ecological Soil Screening Levels.* OSWER Directive 9285.7-55. EPA Office of Solid Waste and Emergency Response.

U.S. Environmental Protection Agency (EPA). 2003b. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures*. EPA-600-R-02-013. Office of Research and Development. Washington, DC 20460.

———. 2003c. *Human Health Toxicity Values in Superfund Risk Assessments.* OSWER Directive 9285.7-53. Office of Solid Waste and Emergency Response.

———. 2004. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment).* EPA/540/R/99/005, OSWER Directive 9285.7-02EP. Office of Superfund Remediation and Technology Innovation.

———. 2005. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver, and Zinc).* EPA-600-R-02-011. Office of Research and Development. Washington, DC 20460. January.

———. 2007. *Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons*. OSWER Directive 9285.7-78. EPA Office of Solid Waste and Emergency Response.

———. 2009. *National Recommended Water Quality Criteria*. EPA Office of Science and Technology, Office of Water.

———. 2011. *Exposure Factors Handbook: 2011 Edition*. EPA/600/R-090/052F.

———. 2013. *ProUCL Version 5.0.00*. Software developed by EPA. Obtained on the Internet at http://www.epa.gov/ nerlesd1/tsc/software.htm. Las Vegas Technical Support Center for Monitoring and Site Characterization.

———. 2014a. *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*. OSWER Directive 9200.1-120. Office of Solid Waste and Emergency Response.

———. 2014b. Regional Screening Levels for Chemical Contaminants at Superfund Sites. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.

———. 2014c. Integrated Risk Information System database maintained on the Internet: http://www.epa.gov/iris. EPA Environmental Criteria and Assessment Office.

RG Steel and Silver, D.J. 2014. Environmental Trust Agreement by and between RG Steel Sparrows Point, LLC and Daniel J. Silver, trustee. January.

URS. 2005. *Site Wide Investigation, Report of Nature and Extent of Releases to Groundwater from the Special Study Areas, International Steel Group, ISG Sparrows Point, Inc. Facility, Sparrows Point, Maryland*. Prepared for ISG Sparrows Point, Inc. January.

———. 2006. Response to EPA Comments (4) and (5) dated December 15, 2005. Prepared by URS, under contract to ISG Sparrows Point LLC. Attachment to letter by Robert Abate, ISG Sparrows Point LLC to Andrew Fan, U.S. Environmental Protection Agency, Region III, and Richard Johnson, Maryland Department of Environment, December 6, 2006, 17 pp.

———. 2009a. *Screening Level Ecological Risk Assessment for On-Site Areas*. Prepared for Severstal Sparrows Point, LLC. April.

———. 2009b. *Work Plan, Sediment, Surface Water, and Groundwater Sampling Plan to Assess Current Groundwater Discharge Impacts to the Offshore Environment*. Prepared for Severstal-Sparrows Point, LLC. October.

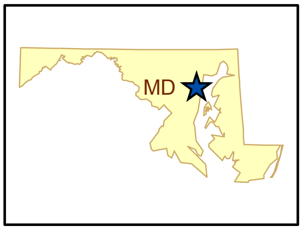
———. 2010. *Draft Baseline Ecological Risk Assessment for On-Site Areas*. Prepared for Severstal Sparrows Point, LLC. August.

———. 2011. *Interim Measures 2010 Annual Report, Former Sludge Bin Storage Area, Rod & Wire Mill*. Prepared for Severstal Sparrows Point, LLC. January.

———. 2012. *Interim Measures 2011 Annual Report, Former Sludge Bin Storage Area, Rod & Wire Mill*. Prepared for RG Steel Sparrows Point, LLC. January.

FIGURES

Document Path: \\lovetonfederal\agencies\GISData\Northeast\Maryland\SparrowsPoint\MXD\PhaseI and II Shorelines.mxd



Legend

■ ■ Phase I Northwest Shoreline

▬ Phase II Southeast Shoreline

Figure 1-1
Phase I and Phase II
Offshore Investigation Areas
Baltimore, Maryland

Map Date: August 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

N

1 inch = 2,123 feet

0 300 600 1,200
Feet

EA Engineering, Science, and Technology, Inc.

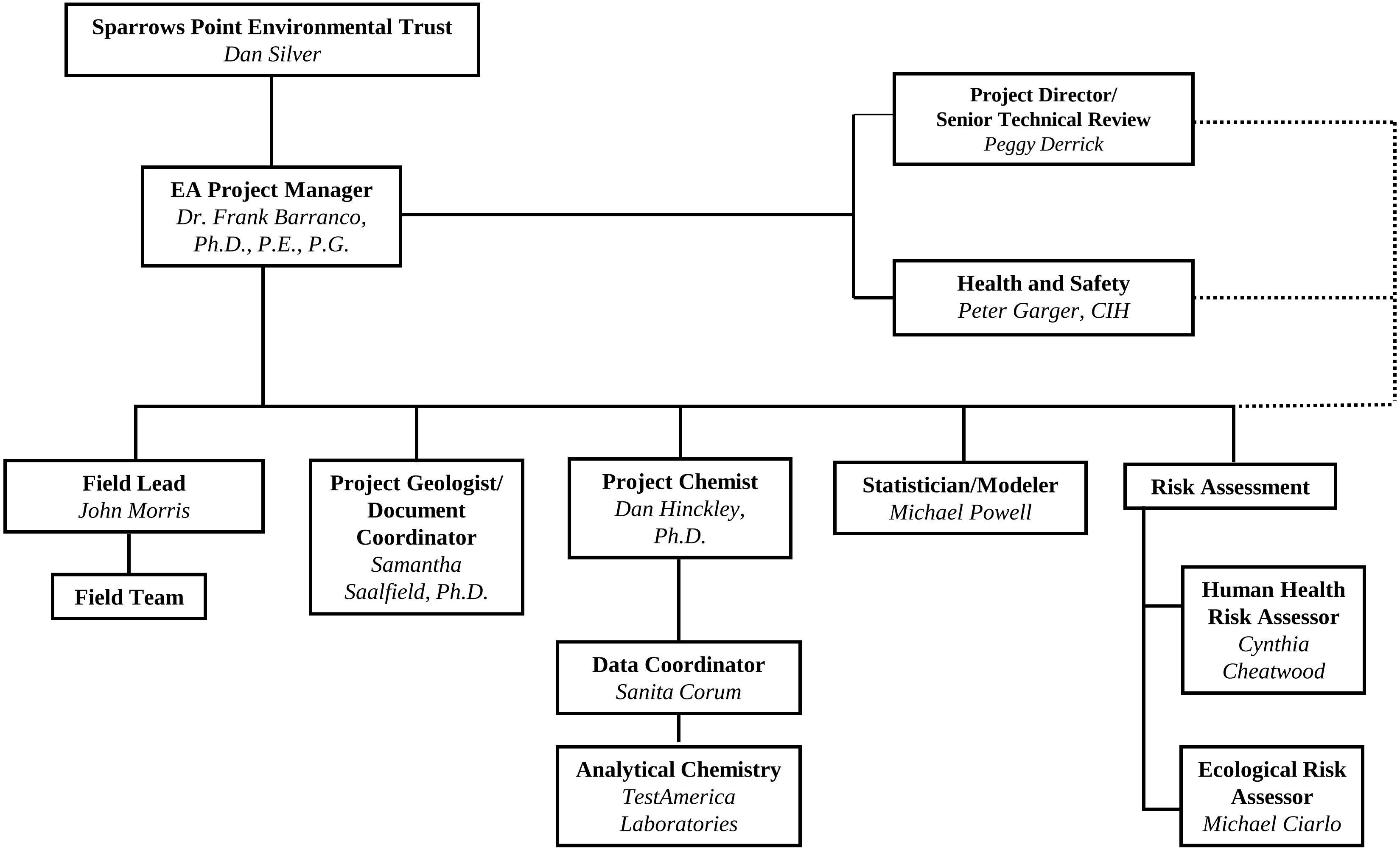
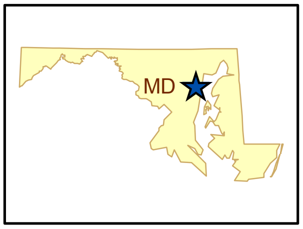


Figure 2-1. EA PROJECT TEAM ORGANIZATION
Sparrows Point Offshore Investigation



Legend

▬	Phase 1 Northwest Shoreline
〰	Perennial Creek/Stream
▬	Boundary between Sand and Fine Grainded Sediment
●	Proposed Sediment Sampling Location
■	Approximate Location of Active Stormwater Outfall
☒	Approximate Location of Inactive Stormwater Outfall
⊕	Greys Landfill Wells
⊕	Groundwater Well Sampled in June 2014

N

1 inch = 1,200 feet

0 300 600 1,200
Feet

Figure 5-1
Proposed Sampling Locations for the
First Round of the Offshore Investigation
Phase I Northwest Shoreline
Baltimore, Maryland

Map Date: August 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science, and Technology, Inc.

TABLES

Table 1-1. Chronological Summary of Previous Studies Relevant to the Phase I Investigation Area, Sparrows Point, Maryland

Reference	Summary
Baker et al. 1997. Spatial Mapping of Sedimentary Contaminants in the Baltimore Harbor/Patapsco River/Back River System.	Presented polycyclic aromatic hydrocarbon (PAH), polychlorinated biphenyl (PCB), pesticide, and metals (including mercury) concentrations for surficial sediment samples collected in June 1996 from 80 locations. Data were screened against the effects range-low (ER-L) and effects range-median (ER-M). A sample from Site 28, in the Phase I area of Bear Creek, contained "considerable oil and tar" that prevented accurate analysis of organics. All metals analyzed at Site 28 exceeded the ER-L, and chromium, nickel, lead, and mercury also exceeded the ER-M.
Rust Environment & Infrastructure. 1998. Description of Current Conditions, Bethlehem Steel Corporation, Sparrows Point, Maryland.	Described the potential contaminant sources and proposed a detailed framework for future investigations.
CH2M Hill. 2001. Site-Wide Investigation: Groundwater Study Report, Bethlehem Steel Corporation, Sparrows Point Division	Study (1) developed improved understanding of geologic material from surface to 120 feet deep, (2) investigated permeability and hydraulic head between layers, (3) characterized inputs and outputs of groundwater flow, (4) modeled site-wide groundwater flow, and (5) provided better data regarding on-site and off-site groundwater use.
CH2M Hill. 2002. Site-Wide Investigation Release Site Characterization Study	Study focused on five Special Study Areas (SSAs), including Greys Landfill and Humphrey Impoundment. Included measurement of water levels and collection of groundwater samples for analysis of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals. Defined the stratigraphy of 100-120 feet of subsurface materials.
URS 2005, 2006. Site Wide Investigation, Report of Nature and Extent of Releases to Groundwater from the Special Study Areas;	Evaluated the nature and extent of releases to groundwater from the SSAs. Included collection of groundwater samples from the vicinity of Greys Landfill and Humphrey Impoundment, which were analyzed for VOCs, SVOCs, and metals.
Klosterhaus et al. 2007. Toxicity Identification and Evaluation and Long-Term Contaminant Trends in the Baltimore Harbor.	Included collection of surficial sediment, pore water, and a gravity core at location BSM 28 in the Phase I area of Bear Creek. Sediments were analyzed for PCBs, PAHs, brominated diphenyl ethers, and butyltins.
KCI Technologies. 2010 and 2011. Greys Landfill Groundwater Monitoring Reports.	These reports include water level measurements and analytical results for groundwater samples collected from monitoring wells in the vicinity of Greys Landfill.
EnviroAnalytics. 2013 and 2014. Coke Point and Greys Landfills 1st Half and 2nd Half 2013 Groundwater Monitoring Reports.	These reports include water level measurements and analytical results for groundwater samples collected from monitoring wells in the vicinity of Greys Landfill (as well as Coke Point Landfill).
2011-2014. Interim Measures Annual Reports, Former Sludge Bin Storage Area, Rod and Wire Mill. Area	Include semi-annual measurement of water levels and sampling and analysis of groundwater collected from monitoring wells in the vicinity of the former Rod & Wire Mill, where a pump and treat interim measure is ongoing. Groundwater samples are analyzed for cadmium and zinc, the primary contaminants addressed by the interim measure.

Table 2-1. Project Personnel and Contact Information

Sparrows Point Offshore Investigation

Technical Expert	Project Role	Affiliation	Telephone Number	Cell Number	Fax Number	E-mail Address
Dan Silver	Trustee	Sparrows Point Environmental Trust	(360) 754-9343	-	-	danieljsilver@msn.com
Madi Novak	Contract Manager	Maul Foster	(503) 501-5212	-	-	mnovak@maulfoster.com
Luis Pizarro	Remedial Project Manager	EPA Region 3	(215) 814-3444	-	-	pizarro.luis@epa.gov
Andrew Fan	Remedial Project Manager	EPA Region 3	(215) 814-3426	-	-	fan.andrew@epamail.epa.gov
Ruth Prince, Ph.D.	Toxicologist	EPA Region 3	(215) 814-3118	-	-	prince.ruth@epa.gov
Barbara Brown	Land Restoration Program Coordinator	MDE	(410) 537-3212	-	-	barbara.brown1@maryland.gov
Frank Barranco, Ph.D., P.E., P.G.	EA Project Manager	EA	(410) 329-5137	(443) 286-8791	(410) 771-1625	fbarranco@eaest.com
Peggy Derrick	EA Program Manager	EA	(410) 329-5126	(717) 578-5323	(410) 771-1625	pderrick@eaest.com
Peter Garger, CIH	Corporate Health and Safety Officer	EA	410-527-2425	-	(410) 771-1625	pgarger@eaest.com
John Morris	Field Lead	EA	(410) 329-5164	401-439-1031	(410) 771-1625	johnmorris@eaest.com
Samantha Saalfield, Ph.D.	Document Coordinator and Project Geologist	EA	(410) 584-7000	-	(410) 771-1625	ssaalfield@eaest.com
Dan Hinckley, Ph.D.	Project Chemist	EA	(765) 465-4093	-	-	dhinckley@eaest.com
Michael Powell	Statistical Analysis/Modeling Task Manager	EA	(410) 584-7000	-	(410) 771-1625	mpowell@eaest.com
Cynthia Cheatwood	Human Health Risk Assessor	EA	(410) 329-5154	-	(410) 771-1625	ccheatwood@eaest.com
Michael Ciarlo	Ecological Risk Assessor	EA	(410) 584-7000	-	(410) 771-1625	mciarlo@eaest.com
Carrie Gamber	Analytical Laboratory - Project Manager	TestAmerica	(412) 963-2428	-	-	carrie.gamber@testamericainc.com

NOTES:
CIH = Certified Industrial Hygienist
EA = EA Engineering, Science, and Technology, Inc.
EPA = U.S. Environmental Protection Agency
MDE = Maryland Department of the Environment
P.G. = Professional Geologist
P.E. = Professional Engineer

Table 3-1. Groundwater Screening Criteria

Analyte	Units	NRWQC - Saltwater Aquatic Life CCC	NRWQC -Human Health (Organism Only)	BTAG Value (a)	Screening Value (b)
Volatile Organic Compounds					
1,1,1-Trichloroethane	µg/L	--	--	312	312
1,1,2,2-Tetrachloroethane	µg/L	--	4	90.2	4
1,1,2,2-Tetrachloroethylene	µg/L	--	3.3	45	3.3
1,1,2-Trichloroethane	µg/L	--	16	550	16
1,1,2-Trichloroethylene	µg/L	--	30	1,940	30
1,1-Dichloroethane	µg/L	--	--	47	47
1,1-Dichloroethylene	µg/L	--	7,100	2,240	7,100
1,2-Dichlorobenzene	µg/L	--	1,300	42	1,300
1,2-Dichloroethane	µg/L	--	37	1,130	37
1,2-Dichloropropane	µg/L	--	15	2,400	15
1,4-Dichlorobenzene	µg/L	--	190	19.9	190
Acetone	µg/L			564,000	564,000
Acrylonitrile	µg/L	--	0.25	581	0.25
Benzene	µg/L	--	51	110	51
Bromodichloromethane	µg/L	--	17	--	17
Bromoform	µg/L	--	140	640	140
Bromomethane	µg/L	--	--	120	120
Carbon disulfide	µg/L	--	--	0.92	0.92
Carbon Tetrachloride	µg/L	--	1.6	1,500	1.6
Chlorobenzene	µg/L	--	1,600	25	25
Chloroform	µg/L	--	470	815	470
Chloromethane	µg/L	--	--	2,700	2,700
cis-1,3-Dichloropropylene	µg/L	--	21	7.9	21
Dibromochloromethane	µg/L	--	13	--	13
Ethylbenzene	µg/L	--	2,100	25	2,100
Hexachlorobutadiene	µg/L	--	18	0.30	18
Methyl Butyl Ketone (2-Hexanone)	µg/L	--	--	99.00	99
Methyl Ethyl Ketone (2-Butanone)	µg/L	--	--	14,000	14,000
Methyl Isobutyl Ketone	µg/L	--	--	170	170
Methylene Chloride	µg/L	--	590	2,560	590
Methyl-tert-Butyl Ether	µg/L	--	--	11,070	11,070
Styrene	µg/L	--	--	910	910
Toluene	µg/L	--	15,000	215	15,000
Total Xylenes	µg/L	--	--	19	19
trans-1,2-Dichloroethylene	µg/L	--	10,000	970	10,000
trans-1,3-Dichloropropylene	µg/L	--	21	7.9	21
Vinyl acetate	µg/L	--	--	16	16
Vinyl chloride	µg/L	--	2.4	930	2.4

Table 3-1. Groundwater Screening Criteria

Analyte	Units	NRWQC - Saltwater Aquatic Life CCC	NRWQC -Human Health (Organism Only)	BTAG Value (a)	Screening Value (b)
Semivolatile Organic Compounds					
1,2,4-Trichlorobenzene	µg/L	--	70	5.4	70
1,2-Dichlorobenzene	µg/L	--	1,300	42	1,300
1,3-Dichlorobenzene	µg/L	--	960	28.5	960
1,4-Dichlorobenzene	µg/L	--	190	19.9	190
2,4,5-Trichlorophenol	µg/L	--	3,600	12	3,600
2,4,6-Trichlorophenol	µg/L	--	2.4	61	2.4
2,4-Dichlorophenol	µg/L	--	290	11	290
2,4-Dimethylphenol	µg/L	--	850	--	850
2,4-Dinitrophenol	µg/L	--	5,300	48.5	5,300
2,4-Dinitrotoluene	µg/L	--	3.4	44	3.4
2,6-Dinitrotoluene	µg/L	--	--	81	81
2-Chloronaphthalene	µg/L	--	1,600	--	1,600
2-Chlorophenol	µg/L	--	150	265	150
2-Methylnaphthalene	µg/L	--	--	4.2	4.2
2-Methylphenol	µg/L	--	--	1,020	1,020
2-Nitrophenol	µg/L	--	--	2,940	2,940
3,3´-Dichlorobenzidine	µg/L	--	0.028	73	0.028
4,6-Dinitro-2-methylphenol	µg/L	--	280	--	280
4-Bromophenyl-phenylether	µg/L	--	--	1.5	2
4-Methylphenol, 3-Methylphenol	µg/L	--	--	543	543
4-Nitrophenol	µg/L	--	--	71.7	71.7
Acenaphthene	µg/L	--	990	6.6	990
Aniline	µg/L	--	--	2.2	2
Anthracene	µg/L	--	40,000	0.18	40,000
Benz(a)anthracene	µg/L	--	0.0018	0.02	0.0018
Benzo[a]pyrene	µg/L	--	0.0018	0.02	0.0018
Bis(2-Chloroethyl)ether	µg/L	--	0.53	--	0.53
Bis(2-Ethylhexyl)phthalate	µg/L	--	2.2	16	2.2
Butylbenzylphthalate	µg/L	--	1,900	29.4	1,900
Dibenzofuran	µg/L	--	--	65	65
Diethylphthalate	µg/L	--	44,000	75.9	44,000
Dimethylphthalate	µg/L	--	1,100,000	580	1,100,000
Di-n-butylphthalate	µg/L	--	4,500	3.4	4,500
Di-n-octylphthalate	µg/L	--	--	22	22
Fluoranthene	µg/L	--	140	1.6	140
Fluorene	µg/L	--	5,300	2.5	5,300
Hexachlorobenzene	µg/L	--	0.00029	0.0003	0.00029
Hexachlorobutadiene	µg/L	--	18	0.30	18
Hexachlorocyclopentadiene	µg/L	--	1,100	0.07	1,100
Hexachloroethane	µg/L	--	3.3	9.4	3.3
Isophorone	µg/L	--	960	129	960
Naphthalene	µg/L	--	--	1.4	1.4

Table 3-1. Groundwater Screening Criteria

Analyte	Units	NRWQC - Saltwater Aquatic Life CCC	NRWQC -Human Health (Organism Only)	BTAG Value (a)	Screening Value (b)
Nitrobenzene	µg/L	--	690	66.8	690
N-Nitrosodimethylamine	µg/L	--	3	330,000	3
Pentachloroethane	µg/L	--	--	56.4	56.4
Pentachlorophenol	µg/L	7.9	3.0	7.9	3.0
Phenanthrene	µg/L	--	--	1.5	1.5
Pyrene	µg/L	--	4,000	0.24	4,000
Pyridine	µg/L	--	--	2,380	2,380
Metals and Cyanide					
Antimony	mg/L	--	0.64	0.5	0.64
Arsenic	mg/L	0.036	0.00014 (c)	0.0125	0.036
Cadmium	mg/L	0.0088	--	0.00012	0.0088
Chromium	mg/L	0.05	--	0.0575	0.05
Copper	mg/L	0.0031	--	0.0031	0.0031
Lead	mg/L	0.0081	--	0.0081	0.0081
Mercury	mg/L	0.00094	--	0.000016	0.00094
Nickel	mg/L	0.0082	4.6	0.0082	0.0082
Selenium	mg/L	0.071	4.2	0.071	0.071
Silver	mg/L	--	--	0.00023	0.00023
Thallium	mg/L	--	0.00047	0.0213	0.00047
Zinc	mg/L	0.081	26	0.081	0.081
Cyanide	mg/L	0.001	0.14	0.001	0.001

NOTES:

BTAG = EPA Region III Biological Technical Assistance Group

CCC = Criterion continuous (chronic) concentration

EPA = U.S. Environmental Protection Agency

mg/L = milligram(s) per liter

NRWQC = EPA National Recommended Water Quality Criteria

PPL = Priority Pollutant List

µg/L = microgram(s) per liter

(a) Surface water benchmarks from the EPA Region III BTAG. Marine benchmarks are presented unless not available, in which case the freshwater benchmark is presented (except for metals).

(b) Screening value is NRWQC where available (and the lower of Aquatic Life or Human Health criteria if both are available); if no NRWQC is available, then the screening value is the BTAG.

(c) EPA is currently reassessing the human health criteria for arsenic; therefore, the current value is not used for screening.

Table 3-2 Summary of Constituents Exceeding Screening Criteria in the Phase I Area, 2001-2014
ALL UNITS UG/L

Only concentrations exceeding screening values are shown. Concentrations more than 10 times the corresponding screening value are shaded.
-- = Concentration did not exceed the screening value; NA = Not Analyzed or Result Rejected

GREYS LANDFILL

	Screening Value	Dec-01	Jan-02	Jul-04	Jul-09	Oct-09	Mar-10	Jun-10	Apr-11	Mar-13
GL02-PZM006 / GL02(-5)										
TOTAL METALS										
Copper	3.1	--	NA	4.4	14	8.2	8.5	--	6.1	NA
Lead	8.1	--	NA	--	59	34	28	--	--	NA
Nickel	8.2	--	NA	30	25	27	22	20	31	NA
Silver	0.23	--	NA	--	--	--	0.7	--	--	NA
Thallium	0.47	--	NA	--	--	--	--	--	0.49	NA
Zinc	81	--	NA	87	630	400	250	--	120	NA
DISSOLVED METALS										
Copper	3.1	NA	NA	3.5	NA	NA	NA	NA	NA	NA
Nickel	8.2	NA	NA	30	NA	NA	NA	NA	NA	NA
MISC										
Cyanide, available	1	900	NA	NA	NA	NA	NA	NA	NA	NA
VOC										
1,1-Dichloroethane	47	69	NA	--	--	--	--	--	--	--
Vinyl Chloride	2.4	8.6	NA	--	--	--	2.5	--	--	--
SVOC										
Bis(2-Ethylhexyl)phthalate	2.2	--	NA	--	17	6.9	--	--	NA	NA
GL02-PZM028 / GL-02(-29)										
TOTAL METALS										
Arsenic	36	66	NA	90	--	--	--	--	--	--
Copper	3.1	--	NA	8.6	8.2	--	6.4	--	--	4.2
Nickel	8.2	--	NA	12	--	--	--	--	--	--
Silver	0.23	--	NA	--	--	--	0.63	--	--	--
Thallium	0.47	11.2	NA	--	--	--	--	--	--	--
Zinc	81	--	NA	--	81	--	--	--	--	--
DISSOLVED METALS										
Arsenic	36	NA	NA	91	NA	NA	NA	NA	NA	NA
Copper	3.1	NA	NA	8.2	NA	NA	NA	NA	NA	NA
Nickel	8.2	NA	NA	12	NA	NA	NA	NA	NA	NA
Thallium	0.47	NA	NA	--	NA	NA	NA	NA	NA	NA
SVOC										
Bis(2-Ethylhexyl)phthalate	2.2	--	NA	--	54	--	--	--	NA	NA
GL05(-7)										
TOTAL METALS										
Arsenic	36	NA	NA	NA	--	41	--	--	--	--
Chromium	50	NA	NA	NA	--	140	--	--	--	--
Copper	3.1	NA	NA	NA	5.1	85	12	--	--	4.2
Lead	8.1	NA	NA	NA	--	61	8.6	--	--	--
Nickel	8.2	NA	NA	NA	170	290	290	260	220	240
Silver	0.23	NA	NA	NA	--	--	2.2	--	--	--
Zinc	81	NA	NA	NA	160	620	240	210	150	210
SVOC										
Bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	50	28	--	--	NA	NA

Table 3-2 Summary of Constituents Exceeding Screening Criteria in the Phase I Area, 2001-2014

ALL UNITS UG/L

Only concentrations exceeding screening values are shown. Concentrations more than 10 times the corresponding screening value are shaded.

-- = Concentration did not exceed the screening value; NA = Not Analyzed or Result Rejected

	Screening Value	Dec-01	Jan-02	Jul-04	Jul-09	Oct-09	Mar-10	Jun-10	Apr-11	Mar-13
GL05(-25)										
Note: A well with designation GL05-PZM020 was sampled in December 2001; however, the Release Site Characterization Study indicates that this well was not in the same location as the current wells GL05.										
TOTAL METALS										
Copper	3.1	NA	NA	NA	4.9	--	--	--	--	--
Silver	0.23	NA	NA	NA	--	--	0.92	--	--	--
SVOC										
Bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	50	40	--	--	NA	NA
GL12(-3)										
TOTAL METALS										
Copper	3.1	NA	NA	NA	4.2	3.3	--	--	5.3	6.2
Mercury	0.94	NA	NA	NA	--	--	--	--	--	5.2
Nickel	8.2	NA	NA	NA	150	120	260	170	260	220
Silver	0.23	NA	NA	NA	--	--	1.8	--	--	--
Thallium	0.47	NA	NA	NA	2.3	--	--	--	--	--
Zinc	81	NA	NA	NA	300	340	270	310	340	323
SVOC										
Bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	63	110	--	--	NA	NA
GL12(-17)										
TOTAL METALS										
Nickel	8.2	NA	NA	NA	--	--	--	--	20	--
Silver	0.23	NA	NA	NA	--	--	0.81	--	--	--
SVOC										
Bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	--	7.9	--	--	NA	NA
GL15(-6)										
Note: A well with designation GL15-PZP003 was sampled in December 2001; however, the Release Site Characterization Study indicates that this well was not in the same location as the current wells GL15.										
TOTAL METALS										
Chromium	50	NA	NA	NA	--	--	310	150	--	--
Copper	3.1	NA	NA	NA	15	9.5	10	4.8	3.8	--
Lead	8.1	NA	NA	NA	--	--	22	--	--	--
Nickel	8.2	NA	NA	NA	11	160	--	--	17	--
Silver	0.23	NA	NA	NA	--	--	2.1	--	--	--
Thallium	0.47	NA	NA	NA	2.4	--	--	--	--	--
Zinc	81	NA	NA	NA	--	240	170	--	--	--
SVOC										
Bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	11	88	--	--	NA	NA
GL15(-36)										
Note: A well with designation GL15-PZM022 was sampled in December 2001; however, the Release Site Characterization Study indicates that this well was not in the same location as the current wells GL15.										
TOTAL METALS										
Chromium	50	NA	NA	NA	--	--	--	--	170	88
Copper	3.1	NA	NA	NA	5.2	--	6.8	3.3	8.1	8.3
Nickel	8.2	NA	NA	NA	--	--	19	18	17	--
Silver	0.23	NA	NA	NA	--	--	0.64	--	--	--
Thallium	0.47	NA	NA	NA	2.3	--	--	--	--	--
SVOC										
Bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	26	--	--	--	NA	NA

Table 3-2 Summary of Constituents Exceeding Screening Criteria in the Phase I Area, 2001-2014

ALL UNITS UG/L

Only concentrations exceeding screening values are shown. Concentrations more than 10 times the corresponding screening value are shaded.

-- = Concentration did not exceed the screening value; NA = Not Analyzed or Result Rejected

	Screening Value	Dec-01	Jan-02	Jul-04	Jul-09	Oct-09	Mar-10	Jun-10	Apr-11	Mar-13
GL-16(-6)										
Note: A well with designation GL16-PZP003 was sampled in December 2001; however, the Release Site Characterization Study indicates that this well was located on the north side of the landfill.										
TOTAL METALS										
Copper	3.1	NA	NA	NA	6.1	5.3	20	--	--	20
Nickel	8.2	NA	NA	NA	380	360	380	380	340	400
Silver	0.23	NA	NA	NA	--	--	0.57	--	--	--
Zinc	81	NA	NA	NA	700	750	760	640	620	750
SVOC										
bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	23	24	--	--	NA	NA
GL-16(-32)										
TOTAL METALS										
Copper	3.1	NA	NA	NA	20	18	11	6	--	--
Lead	8.1	NA	NA	NA	--		29	--	--	--
Nickel	8.2	NA	NA	NA	10	--	36	34	--	--
Silver	0.23	NA	NA	NA	--	--	0.55	--	--	--
SVOC										
bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	11	6.6	--	--	NA	NA
TS-01(-7)										
TOTAL METALS										
Copper	3.1	NA	NA	NA	19	3.3	11	9.3	5.2	--
Lead	8.1	NA	NA	NA	--	8.5	--	--	--	--
Nickel	8.2	NA	NA	NA	20	23	16	14	16	--
Silver	0.23	NA	NA	NA	--	--	0.64	--	--	--

HUMPHREY IMPOUNDMENT

	Screening Value	Jul-04	Jun-14
HI08-PZM003			
TOTAL METALS			
Chromium	50	--	52
Copper	3.1	6	35
Lead	8.1	--	92
Nickel	8.2	--	16
Zinc	81	--	210
DISSOLVED METALS			
Copper	3.1	4.8	NA
SVOC			
Benzo(a)anthracene	0.018	--	0.21
bis(2-Ethylhexyl)phthalate	2.2	28	11
Chrysene	0.018	--	0.22
MISC			
Cyanide, available	1	NA	21
HI08-PZM060			
TOTAL METALS			
Copper	3.1	3.7	--
DISSOLVED METALS			
Copper	3.1	3.3	NA
SVOC			
bis(2-Ethylhexyl)phthalate	2.2	--	14

Table 3-2 Summary of Constituents Exceeding Screening Criteria in the Phase I Area, 2001-2014

ALL UNITS UG/L

Only concentrations exceeding screening values are shown. Concentrations more than 10 times the corresponding screening value are shaded.

-- = Concentration did not exceed the screening value; NA = Not Analyzed or Result Rejected

ROD & WIRE MILL

Note: Cadmium and zinc data collected semiannually 2001-2013. If both results for a given year exceeded the screening value, the higher value is shown.

	Screening Value	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Jun-14
RW18-PZM047															
TOTAL METALS															
Cadmium	8.8	--	--	--	870	41	--	--	--	--	--	--	--	--	--
Copper	3.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	12
Nickel	8.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	26
Zinc	81	15,000	7,000	13,000	26,000	12,000	6,900	4,700	6,900	1,200	5,700	3,300	520	8,950	1,600
SVOC															
bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.2
Naphthalene	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.9
RW19-PZP000															
TOTAL METALS															
Zinc	81	88	--	140	--	--	--	--	--	--	--	--	150	--	--
MISC															
Cyanide, available	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,000
RW19-PZM020															
TOTAL METALS															
Arsenic	36	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	65
Cadmium	8.8	30	150	82	280	320	200	150	110	130	96	29	13	24	38
Copper	3.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.4
Nickel	8.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	13
Zinc	81	3,400	14,000	6,000	24,000	26,000	24,000	22,000	17,000	17,000	11,000	5,600	5,000	4,720	5,800
SVOC															
bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16
RW19-PZM050															
TOTAL METALS															
Cadmium	8.8	--	--	--	15	23	--	--	--	14	--	--	--	--	--
Nickel	8.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11
Zinc	81	530	430	230	240	92	220	86	330	540	190	160	76	129	170
SVOC															
bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.2
RW20-PZM020															
TOTAL METALS															
Cadmium	8.8	580	130	340	220	190	22	22	46	19	--	--	13	48	100
Nickel	8.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	18
Zinc	81	190,000	160,000	150,000	160,000	150,000	130,000	130,000	52,000	120,000	56,000	120,000	130,000	99,600	23,000

Table 3-2 Summary of Constituents Exceeding Screening Criteria in the Phase I Area, 2001-2014

ALL UNITS UG/L

Only concentrations exceeding screening values are shown. Concentrations more than 10 times the corresponding screening value are shaded.

-- = Concentration did not exceed the screening value; NA = Not Analyzed or Result Rejected

	Screening Value	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Jun-14
RW20-PZP000															
TOTAL METALS															
Arsenic	36	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	85
Cadmium	8.8	--	--	--	180	--	--	--	25	--	--	--	--	--	--
Copper	3.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.6
Nickel	8.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11
Zinc	81	--	--	81	130	--	--	--	100,000	--	--	--	--	--	--
SVOC															
Benzo(a)anthracene	0.018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.16
bis(2-Ethylhexyl)phthalate	2.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.5
Chrysene	0.018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.26
MISC															
Cyanide, available	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	160
TS04-PDM004															
TOTAL METALS															
Arsenic	36	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40
Cadmium	8.8	--	12	--	25	10	--	--	--	--	--	--	--	--	--
Copper	3.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15
Lead	8.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	25
Nickel	8.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	51
Zinc	81	5,500	15,000	8,200	14,000	15,000	310	240	150	--	120	--	410	227	2,400
TS04-PZM023															
TOTAL METALS															
Cadmium	8.8	11,000	4,300	3,200	1,200	1,100	800	380	190	280	390	250	--	--	--
Copper	3.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	25
Lead	8.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	160
Nickel	8.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21
Zinc	81	220,000	110,000	78,000	34,000	39,000	32,000	17,000	140,000	12,000	19,000	9,000	5,200	247	6,600

Table 5-1. Proposed Sampling Locations, First Round[1] of the Phase I Offshore Investigation

Transect	Location	Target Sampling Coordinates (Maryland State Plane North American Datum 1983, feet)	
		Northing	**Easting**
Sediment Samples			
A	SD-A01	574686.51735	1457224.17244
	SD-A02	574763.62692	1457109.33624
	SD-A-03	573952.20741	1456603.04220
B	SD-B01	574066.02727	1456481.36498
	SD-B02	573470.42054	1456431.48219
C	SD-C01	573555.92505	1456283.80751
	SD-C02	573679.90412	1455986.48764
	SD-C03	571876.32882	1455591.84008
D	SD-D01	571945.39584	1455695.44060
	SD-D02	570747.60005	1455843.18333
E	SD-E01	570708.06686	1455753.55702
	SD-E02	570391.38796	1455234.99382
	SD-E-03	569716.83796	1456197.81003
F	SD-F01	569775.66213	1456279.97361
	SD-F02	574855.71628	1456787.02349
G	SD-G01	569205.81960	1455856.00582
	SD-G02	569143.33743	1456418.34533
H	SD-H01	568930.89806	1456418.34533
	SD-H02	568893.40876	1456293.38100
	SD-H03	568755.94799	1455880.99869
Stormwater Samples			
Not Applicable	Outfall 014	568942.23881	1456677.07519
	Outfall 018	569724.16208	1456380.22584
	Outfall 070	573598.82646	1456593.15906
	Outfall 071	573951.007669	1456691.61772
	UNNAMED	573056.39820	1456650.55497

(1) The first round of field sampling includes surface sediment and stormwater sampling. Locations for pore water sampling and additional sediment sampling during the second round will be determined upon receipt of results from the first round.

Table 5-2 Proposed Analytical Program for the First Round Sediment Sampling by Transect

Sparrows Point Offshore Investigation

Transect	Category	VOCs	PAHs	SVOCs (w/PAHs)	DEHP only	PCBs	Metals	Mercury	Cyanide	Oil & Grease	SEM/AVS	Percent Solids	TOC	Grain Size	Moisture Content
A	non-SW	--	3	--	3	--	3	3	3	--	3	3	3	--	--
B	SW	2	--	2	--	2	2	2	2	2	2	2	2	2	2
C	SW	3	--	3	--	3	3	3	3	3	3	3	3	--	--
D	non-SW	--	2	--	2	--	2	--	2	--	2	2	2	--	--
E	non-SW	--	3	--	3	--	3	--	3	--	3	3	3	3	3
F	SW	2		2		2	2	2	2	2	2	2	2	--	--
G	SW	2	--	2	--	2	2	2	2	2	2	2	2	--	--
H	SW	3	--	3	--	3	3	3	3	3	3	3	3		
Total		12	8	12	8	12	20	15	20	12	20	20	20	5	5

Notes:

SW = sediment transect located adjacent to an active stormwater outfall

non-SW = sediment transect not located adjacent to an active stormwater outfall

AVS = Acid Volatile Sulfide

DEHP = bis(2-ethylhexyl)phthalate (an SVOC)

PAH = Polycyclic Aromatic Hydrocarbon

PCB = Polychlorinated Biphenyl

SEM = Simultaneously Extracted Metals

SVOC = Semivolatile Organic Compound

TOC = Total Organic Carbon

VOC = Volatile Organic Compound

Table 5-3. Sediment, Stormwater, and Pore water Sample Containers, Preservation Techniques, and Holding Times

Parameter	Analytical Method	Container	Preservation	Holding Time
SEDIMENT				
PPL VOCs	SW846 5035A/8260B	2 – 4 oz. bottles (no headspace)	4±2°C	14 days until analysis
SEM/AVS	SW846 6010B/9034	4 oz. glass jar (no headspace)	4±2°C	14 days
PPL Metals	SW846 6020A	8 oz. wide-mouth glass, Teflon-lined cap	4±2°C	6 months
Mercury	SW846 7471B	Same as 8 oz. jar for metals	4±2°C	28 days
Total Solids	SM 2540G	Same as 8 oz. jar for metals	4±2°C	NA
Total Organic Carbon	Lloyd Kahn	Same as 8 oz. jar for metals	4±2°C	14 days
PPL SVOCs/PAHs	SW846 8270C	Same as 8 oz. jar for metals	4±2°C	14 days (extraction) 40 days (analysis)
PCB Aroclors	SW846 8082A LL	Same as 8 oz. jar for metals	4±2°C	14 days (extraction) 40 days (analysis)
Cyanide	SW846 9014	Same as 8 oz. jar for metals	4±2°C	14 days
Oil and Grease	EPA Method 1644B	Same as 8 oz. jar for metals	4±2°C	28 days
Grain Size	ASTM D422	32 oz. Glass jar	4±2°C	6 months (grain size)
Moisture Content	D2216-90	Same as 32 oz. jar for grain size	4±2°C	6 months
STORMWATER				
PPL VOCs	SW846 8260B	3 – 40 mL glass VOA vials	4±2°C	7 days
PPL SVOCs/PAHs	SW846 8270C SIM	2 – 250 mL glass bottle, Teflon-lined cap	4±2°C	7 days (extraction) 40 days (analysis)
PPL Metals	SW846 6020A	250 mL plastic bottle	pH<2 with HNO_3, 4±2°C	6 months
Mercury	SW846 7470A	Same bottle as for metals	pH<2 with HNO_3, 4±2°C	28 days
PCB Aroclors	SW846 8082A LL	2 L glass bottle, Teflon-lined cap	4±2°C	7 days (extraction) 40 days (analysis)
Cyanide	SW846 9014	250 mL plastic bottle	pH >12 with NaOH, 4±2°C	14 days
Oil and Grease	EPA Method 1644B	2 L glass bottle, Teflon-lined cap	H_2SO_4 to pH <2; 4±2°C	28 days
Suspended Solids	SW846 2540D	250 mL plastic bottle	4±2°C	7 days

Table 5-3. Sediment, Stormwater, and Pore water Sample Containers, Preservation Techniques, and Holding Times

Parameter	Analytical Method	Container	Preservation	Holding Time
PORE WATER				
PPL SVOCs/PAHs	SW846 8270C	2 – 250 mL glass bottle, Teflon-lined cap (MIN: 1 – 250 mL bottle)	4±2°C	7 days (extraction) 40 days (analysis)
PPL Metals	SW846 6020A	250 mL plastic bottle (MIN: 100 mL bottle)	pH<2 with HNO_3, 4±2°C	6 months
Mercury	SW846 7470A	Same bottle as for metals	pH<2 with HNO_3, 4±2°C	28 days
Cyanide	SW846 9014	250 mL plastic bottle (MIN: 50 mL bottle)	pH >12 with NaOH, 4±2°C	14 days
Dissolved Organic Carbon	SW846 5310C	2 – 40 mL amber glass VOA vials (MIN: 1 – 40 mL vial)	H_2SO_4 to pH <2; 4±2°C	28 days

Notes:
AVS = Acid Volatile Sulfide
MIN = Minimum, indicates the minimum volume needed to perform one analysis, to be referenced if optimal volume cannot be obtained for porewater.
NA = Not Applicable
PAH = Polycyclic Aromatic Hydrocarbon
PCB = Polychlorinated Biphenyl
PPL = Priority Pollutant List
SEM = Simultaneously Extracted Metals
SVOC = Semivolatile Organic Compound
VOA = Volatile Organic Analysis

Table 5-4 Analytical Summary for the First Round[1] of Phase I Offshore Sampling

Sparrows Point Offshore Investigation

Parameter	Method	Surface Sediment Samples	Field Duplicates	Rinsate Blanks	Trip Blanks	Total Sediment	Stormwater	Field Duplicates	Trip Blanks	Total Stormwater
VOCs	SW846 8260C	12	1	1	2	**16**	8	1	2	**11**
PPL PAHs	SW846 8270D Low-Level	8	1	1	--	**10**	--	--	--	**--**
PPL SVOCs (including PAHs)	SW846 8270D Low-Level	12	1	1	--	**14**	8	1	--	**9**
SVOCs (bis(2-ethylhexyl)phthalate only)	SW846 8270D Low-Level	8	1	1	--	**10**	--	--	--	**--**
PCB Aroclors	SW846 8082A	12	1	1	--	**14**	8	1	--	**9**
PPL Metals	SW846 6020A	20	2	2	--	**24**	8	1	--	**9**
Mercury	SW846 7470A/7471B	15	2	2	--	**19**	8	1	--	**9**
Cyanide	EPA 9014	20	2	2	--	**24**	8	1	--	**9**
Oil and Grease	SW846 1664B/9071B	12	1	1	--	**14**	8	1	--	**9**
SEM/AVS	SW846 6010B/9034	20	2	2	--	**24**	--	--	--	**--**
Percent Solids	SW846 2540G	20	2	2	--	**24**	--	--	--	**--**
Total Organic Carbon	Lloyd Kahn	20	2	2	--	**24**	--	--	--	**--**
Grain Size	ASTM D422	5	--	--	--	**5**	--	--	--	**--**
Moisture Content	D2216-90	5	--	--	--	**5**	--	--	--	**--**
Suspended Solids	SW846 2540D	--	--	--	--	**--**	8	1	--	**9**

Notes:

AVS = Acid Volatile Sulfide

PAH = Polycyclic Aromatic Hydrocarbon

PCB = Polychlorinated Biphenyl

PPL = Priority Pollutant List

SEM = Simultaneously Extracted Metals

SVOC = Semivolatile Organic Compound

VOC = Volatile Organic Compound

(1) The first round of field sampling includes surface sediment and stormwater sampling. The analytical program for pore water sampling and additional sediment sampling during the second round will be determined upon receipt of results from the first round.

Table 7-1. Analytical Project Limits for Sediment Samples

Parameter	Units	Laboratory Reporting Limit	Laboratory Method Detection Limit (a)	BTAG Value (b)
PPL Volatile Organic Compounds - GC/MS (SW846 8260C)				
Acrolein	µg/kg	100	--	--
Acrylonitrile	µg/kg	100	--	--
Benzene	µg/kg	5.00	--	137
Bromodichloromethane	µg/kg	5.00	--	--
Bromoform	µg/kg	5.00	--	1,310
Bromomethane	µg/kg	5.00	--	--
Carbon tetrachloride	µg/kg	5.00	--	7,240
Chlorobenzene	µg/kg	5.00	--	162
Chloroethane	µg/kg	5.00	--	--
2-Chloroethyl vinyl ether	µg/kg	10.0	--	--
Chloroform	µg/kg	5.00	--	--
Chloromethane	µg/kg	5.00	--	--
Dibromochloromethane	µg/kg	5.00	--	--
1,2-Dichlorobenzene	µg/kg	5.00	--	989
1,3-Dichlorobenzene	µg/kg	5.00	--	842
1,4-Dichlorobenzene	µg/kg	5.00	--	460
trans-1,2-Dichloroethene	µg/kg	5.00	--	1,050
1,1-Dichloroethane	µg/kg	5.00	--	--
1,2-Dichloroethane	µg/kg	5.00	--	--
1,1-Dichloroethene	µg/kg	5.00	--	2,780
1,2-Dichloropropane	µg/kg	5.00	--	--
cis-1,3-Dichloropropene	µg/kg	5.00	--	7.31
trans-1,3-Dichloropropene	µg/kg	5.00	--	7.31
Ethylbenzene	µg/kg	5.00	--	305
Methylene chloride	µg/kg	5.00	--	--
1,1,2,2-Tetrachloroethane	µg/kg	5.00	--	200
Tetrachloroethene	µg/kg	5.00	--	190
Toluene	µg/kg	5.00	--	1,090
1,1,1-Trichloroethane	µg/kg	5.00	--	860
1,1,2-Trichloroethane	µg/kg	5.00	--	570
Trichloroethene	µg/kg	5.00	--	8,950
Vinyl chloride	µg/kg	5.00	--	--
PPL Polynuclear Aromatic Hydrocarbons – GC/MS (SW846 8270D Low Level)				
Acenaphthene	µg/kg	3.35	--	6.71
Acenaphthylene	µg/kg	3.35	--	5.87
Anthracene	µg/kg	3.35	--	46.9
Benzo[a]anthracene	µg/kg	3.35	--	74.8
Benzo[b]fluoranthene	µg/kg	3.35	--	27.2
Benzo[k]fluoranthene	µg/kg	3.35	--	240
Benzo[a]pyrene	µg/kg	3.35	--	88.8
Benzo[ghi]perylene	µg/kg	3.35	--	170
Chrysene	µg/kg	3.35	--	108
Dibenzo[a,h]anthracene	µg/kg	3.35	--	6.22
Fluoranthene	µg/kg	3.35	--	113
Fluorene	µg/kg	3.35	--	21.2
Indeno[1,2,3-cd]pyrene	µg/kg	3.35	--	17.0
1-Methylnaphthalene	µg/kg	3.35	--	--
2-Methylnaphthalene	µg/kg	3.35	--	20.2
Naphthalene	µg/kg	3.35	--	34.6
Phenanthrene	µg/kg	3.35	--	86.7
Pyrene	µg/kg	3.35	--	153

Table 7-1. Analytical Project Limits for Sediment Samples

Parameter	Units	Laboratory Reporting Limit	Laboratory Method Detection Limit (a)	BTAG Value (b)
Other PPL Semivolatile Organic Compounds – GC/MS (SW846 8270D Low Level)				
Benzidine	µg/kg	335.00	--	--
Bis(2-chloroethyl)ether	µg/kg	3.35	--	--
Bis(2-chloroethoxy)methane	µg/kg	3.35	--	--
2,2'-oxybis[1-chloropropane]	µg/kg	3.35	--	--
Bis(2-ethylhexyl) phthalate	µg/kg	33.4	--	182
4-Bromophenyl phenyl ether	µg/kg	16.5	--	1,230
Butyl benzyl phthalate	µg/kg	16.5	--	16.8
4-Chloro-3-methylphenol	µg/kg	16.5	--	--
2-Chloronaphthalene	µg/kg	3.35	--	--
2-Chlorophenol	µg/kg	16.5	--	340
4-Chlorophenyl phenyl ether	µg/kg	16.5	--	--
Di-n-butyl phthalate	µg/kg	16.5	--	1,160
3,3'-Dichlorobenzidine	µg/kg	16.5	--	2,060
2,4-Dichlorophenol	µg/kg	3.35	--	117
Diethyl phthalate	µg/kg	16.5	--	218
Dimethyl phthalate	µg/kg	16.5	--	--
2,4-Dimethylphenol	µg/kg	16.5	--	29
2,4-Dinitrophenol	µg/kg	85	--	--
4,6-Dinitro-2-methylphenol	µg/kg	85	--	--
2,4-Dinitrotoluene	µg/kg	16.5	--	42
2,6-Dinitrotoluene	µg/kg	16.5	--	--
Di-n-octyl phthalate	µg/kg	16.5	--	--
1,2-Diphenylhydrazine	µg/kg	16.5	--	--
Hexachlorobenzene	µg/kg	3.35	--	20
Hexachlorobutadiene	µg/kg	3.35	--	--
Hexachlorocyclopentadiene	µg/kg	16.5	--	139
Hexachloroethane	µg/kg	16.5	--	804
Isophorone	µg/kg	16.5	--	--
Nitrobenzene	µg/kg	33.4	--	--
N-Nitrosodimethylamine	µg/kg	16.5	--	--
N-Nitrosodi-n-propylamine	µg/kg	3.35	--	--
N-Nitrosodiphenylamine	µg/kg	16.5	--	422,000
2-Nitrophenol	µg/kg	16.5	--	--
4-Nitrophenol	µg/kg	85	--	--
Pentachlorophenol	µg/kg	16.5	--	7,970
Phenol	µg/kg	3.35	--	420
1,2,4-Trichlorobenzene	µg/kg	16.5	--	473
2,4,6-Trichlorophenol	µg/kg	16.5	--	2,650
PCB Aroclors – GC (SW846 8082A)				
PCB-1016	µg/kg	0.417	--	--
PCB-1221	µg/kg	0.417	--	--
PCB-1232	µg/kg	0.417	--	--
PCB-1242	µg/kg	0.417	--	--
PCB-1248	µg/kg	0.417	--	--
PCB-1254	µg/kg	0.417	--	--
PCB-1260	µg/kg	0.417	--	--
Total PCBs	µg/kg	--	--	40

Table 7-1. Analytical Project Limits for Sediment Samples

Parameter	Units	Laboratory Reporting Limit	Laboratory Method Detection Limit (a)	BTAG Value (b)
PPL Metals – ICP/MS (SW846 6020A)				
Antimony	mg/kg	0.1	--	--
Arsenic	mg/kg	0.05	--	7.24
Beryllium	mg/kg	0.05	--	--
Cadmium	mg/kg	0.05	--	0.68
Chromium	mg/kg	0.1	--	52.3
Copper	mg/kg	0.1	--	18.7
Lead	mg/kg	0.05	--	30.2
Nickel	mg/kg	0.05	--	15.9
Selenium	mg/kg	0.25	--	2.00
Silver	mg/kg	0.05	--	0.73
Thallium	mg/kg	0.05	--	--
Zinc	mg/kg	0.25	--	124
Metals - Cold Vapor (SW846 7471B)				
Mercury	mg/kg	0.0165	--	0.13
Total Cyanide (SW846 9014)				
Cyanide	mg/kg	0.25	0.0734	0.10
Oil and Grease (EPA Method 1664B)				
Oil and Grease	mg/kg	167	--	--
Wet Chemistry Parameters				
Total Organic Carbon (Lloyd Kahn)	mg/kg	1000	--	--
Percent Moisture	%	0.1	--	--

NOTES:

BTAG = EPA Region III Biological Technical Assistance Group
EPA = U.S. Environmental Protection Agency
GC = Gas chromatography
ICP = Inductively coupled plasma
MS = Mass spectrometry
PCB = Polychlorinated biphenyl
PPL = Priority Pollutant List

(a) Method detection limits are shown only if the reporting limit is greater than the BTAG value, and are required to be updated periodically and therefore subject to change.

(b) Surface water benchmarks from the EPA Region III BTAG. Marine benchmarks are presented unless not available, in which case the freshwater benchmark is presented (except for metals).

Blue shading indicates a BTAG value lower than the laboratory reporting limit.

Table 7-2. Analytical Project Limits for Stormwater and Pore Water Samples

		Laboratory Limits		EPA Ecological Criteria			EPA Human Health Criteria
Parameter	Units	Laboratory Reporting Limit	Laboratory Method Detection Limit (a)	NRWQC - Saltwater Aquatic Life CCC	BTAG Value (b)	Ecological Criteria (c)	NRWQC -Human Health (Organism Only)
PPL Volatile Organic Compounds - GC/MS (SW846 8260C)							
Acrolein	µg/L	100	5.73	3	0.55	3	9
Acrylonitrile	µg/L	50.0	6.82	--	581	581	0.25
Benzene	µg/L	5.00	--	--	110	110	51
Bromodichloromethane	µg/L	5.00	--	--	--	--	17
Bromoform	µg/L	5.00	--	--	640	640	140
Bromomethane	µg/L	5.00	--	--	120	120	--
Carbon tetrachloride	µg/L	5.00	1.08	--	1,500	1500	1.6
Chlorobenzene	µg/L	5.00	--	--	25	25	1600
Chloroethane	µg/L	5.00	--	--	--	--	--
2-Chloroethyl vinyl ether	µg/L	10.0	--	--	--	--	--
Chloroform	µg/L	5.00	--	--	815	815	470
Chloromethane	µg/L	5.00	--	--	2,700	2700	--
Dibromochloromethane	µg/L	5.00	--	--	--	--	13
1,2-Dichlorobenzene	µg/L	5.00	--	--	42	42	1,300
1,3-Dichlorobenzene	µg/L	5.00	--	--	28.5	28.5	960
1,4-Dichlorobenzene	µg/L	5.00	--	--	19.9	19.9	190
trans-1,2-Dichloroethene	µg/L	5.00	--	--	970	970	10,000
1,1-Dichloroethane	µg/L	5.00	--	--	47	47	--
1,2-Dichloroethane	µg/L	5.00	--	--	1,130	1130	37
1,1-Dichloroethene	µg/L	5.00	--	--	2,240	2240	7,100
1,2-Dichloropropane	µg/L	5.00	--	--	2,400	2400	15
cis-1,3-Dichloropropene	µg/L	5.00	--	--	7.9	7.9	21
trans-1,3-Dichloropropene	µg/L	5.00	--	--	7.9	7.9	21
Ethylbenzene	µg/L	5.00	--	--	25	25	2,100
Methylene chloride	µg/L	5.00	--	--	2,560	2560	590
1,1,2,2-Tetrachloroethane	µg/L	5.00	0.932	--	90.2	90.2	4
Tetrachloroethene	µg/L	5.00	0.825	--	45	45	3.3
Toluene	µg/L	5.00	--	--	215	215	15,000
1,1,1-Trichloroethane	µg/L	5.00	--	--	312	312	--
1,1,2-Trichloroethane	µg/L	5.00	--	--	550	550	16
Trichloroethene	µg/L	5.00	--	--	1,940	1940	30
Vinyl chloride	µg/L	5.00	1.29	--	930	930	2.4
PPL Polynuclear Aromatic Hydrocarbons (PAHs) – GC/MS (SW846 8270D Low Level)							
Acenaphthene	µg/L	0.200	--	--	6.6	6.6	990
Acenaphthylene	µg/L	0.200	--	--	--	--	--
Anthracene	µg/L	0.200	0.0189	--	0.18	0.18	40,000
Benzo[a]anthracene	µg/L	0.200	0.0366	--	0.02	0.02	0.018
Benzo[b]fluoranthene	µg/L	0.200	0.0487	--	--	--	0.018
Benzo[k]fluoranthene	µg/L	0.200	0.0301	--	--	--	0.018
Benzo[a]pyrene	µg/L	0.200	0.0282	--	0.02	0.02	0.018
Benzo[ghi]perylene	µg/L	0.200	--	--	--	--	--
Chrysene	µg/L	0.200	0.0309	--	--	0.018	0.018
Dibenzo[a,h]anthracene	µg/L	0.200	0.0268	--	--	0.018	0.018
Fluoranthene	µg/L	0.200	--	--	1.6	1.6	140
Fluorene	µg/L	0.200	--	--	2.5	2.5	5,300
Indeno[1,2,3-cd]pyrene	µg/L	0.200	--	--	--	--	--
Naphthalene	µg/L	0.200	--	--	1.4	1.4	--
Phenanthrene	µg/L	0.200	--	--	1.5	1.5	--
Pyrene	µg/L	0.200	--	--	0.24	0.24	4,000

Table 7-2. Analytical Project Limits for Stormwater and Pore Water Samples

		Laboratory Limits		EPA Ecological Criteria			EPA Human Health Criteria
Parameter	Units	Laboratory Reporting Limit	Laboratory Method Detection Limit (a)	NRWQC - Saltwater Aquatic Life CCC	BTAG Value (b)	Ecological Criteria (c)	NRWQC -Human Health (Organism Only)
Other PPL Semivolatile Organic Compounds – GC/MS (SW846 8270D Low Level)							
Benzidine	µg/L	20	4.74	--	3.9	3.9	0.00002
Bis(2-chloroethyl)ether	µg/L	1	0.0317	--	--	--	0.53
Bis(2-chloroethoxy)methane	µg/L	1	--	--	--	--	--
2,2'-oxybis[1-chloropropane]	µg/L	1	--	--	--	--	--
Bis(2-ethylhexyl) phthalate	µg/L	2	--	--	16	16	2.2
4-Bromophenyl phenyl ether	µg/L	1	--	--	1.5	1.5	--
Butyl benzyl phthalate	µg/L	1	--	--	29.4	29.4	1,900
4-Chloro-3-methylphenol	µg/L	1	--	--	--	--	--
2-Chloronaphthalene	µg/L	0.2	--	--	--	--	1,600
2-Chlorophenol	µg/L	1	--	--	265	265	150
4-Chlorophenyl phenyl ether	µg/L	1	--	--	--	--	--
Di-n-butyl phthalate	µg/L	1	--	--	3.4	3.4	4,500
3,3'-Dichlorobenzidine	µg/L	1	0.147	--	73	73	0.028
2,4-Dichlorophenol	µg/L	1	--	--	11	11	290
Diethyl phthalate	µg/L	1	--	--	75.9	75.9	44,000
Dimethyl phthalate	µg/L	1	--	--	580	580	1,100,000
2,4-Dimethylphenol	µg/L	1	--	--	--	--	850
2,4-Dinitrophenol	µg/L	5	--	--	48.5	48.5	5,300
4,6-Dinitro-2-methylphenol	µg/L	5	--	--	--	--	280
2,4-Dinitrotoluene	µg/L	1	--	--	44	44	3.4
2,6-Dinitrotoluene	µg/L	1	--	--	81	81	--
Di-n-octyl phthalate	µg/L	1	--	--	22	22	--
1,2-Diphenylhydrazine	µg/L	1	--	--	--	--	--
Hexachlorobenzene	µg/L	1	0.061	--	0.0003	0.0003	0.00029
Hexachlorobutadiene	µg/L	1	0.0937	--	0.3	0.3	18
Hexachlorocyclopentadiene	µg/L	1	0.136	--	0.07	0.07	1,100
Hexachloroethane	µg/L	1	--	--	9.4	9.4	3.3
Isophorone	µg/L	1	--	--	129	129	960
Nitrobenzene	µg/L	2	--	--	66.8	66.8	690
N-Nitrosodimethylamine	µg/L	1	--	--	330,000	330000	3
N-Nitrosodi-n-propylamine	µg/L	1	0.0501	--	--	--	0.51
N-Nitrosodiphenylamine	µg/L	1	--	--	120	120	6
2-Nitrophenol	µg/L	1	--	--	2,940	2940	--
4-Nitrophenol	µg/L	5	--	--	71.7	71.7	--
Pentachlorophenol	µg/L	1	--	7.9	7.9	7.9	3
Phenol	µg/L	1	--	--	58	58	860,000
1,2,4-Trichlorobenzene	µg/L	1	--	--	5.4	5.4	70
2,4,6-Trichlorophenol	µg/L	1	--	--	61	61	2.4
PCB Aroclors – GC (SW846 8082A)							
PCB-1016	µg/L	0.010	0.00252	--	--	--	--
PCB-1221	µg/L	0.010	0.00249	--	--	--	--
PCB-1232	µg/L	0.010	0.00293	--	--	--	--
PCB-1242	µg/L	0.010	0.00186	--	--	--	--
PCB-1248	µg/L	0.010	0.00227	--	--	--	--
PCB-1254	µg/L	0.010	0.00229	--	--	--	--
PCB-1260	µg/L	0.010	0.00136	--	--	--	--
Total PCBs	µg/L	--	--	0.03	0.000074	0.03	0.000064

Table 7-2. Analytical Project Limits for Stormwater and Pore Water Samples

		Laboratory Limits		EPA Ecological Criteria			EPA Human Health Criteria
Parameter	Units	Laboratory Reporting Limit	Laboratory Method Detection Limit (a)	NRWQC - Saltwater Aquatic Life CCC	BTAG Value (b)	Ecological Criteria (c)	NRWQC -Human Health (Organism Only)
PPL Metals – ICP/MS (SW846 6020A)							
Antimony	µg/L	2.00	--	--	500	500	640
Arsenic	µg/L	1.00	--	36	12.5	36	0.14 (d)
Beryllium	µg/L	1.00	--	--	--	--	--
Cadmium	µg/L	1.00	0.114	8.8	0.12	8.8	--
Chromium	µg/L	2.00	--	50	57.5	50	--
Copper	µg/L	2.00	--	3.1	3.1	3.1	--
Lead	µg/L	1.00	--	8.1	8.1	8.1	--
Nickel	µg/L	1.00	--	8.2	8.2	8.2	4,600
Selenium	µg/L	5.00	--	71	71	71	4,200
Silver	µg/L	1.00	0.0362	--	0.23	0.23	--
Thallium	µg/L	1.00	0.0152	--	21.3	21.3	0.47
Zinc	µg/L	5.00	--	81	81	81	26,000
Mercury ‑ Cold Vapor (SW846 7470A)							
Mercury	µg/L	0.200	0.0384	0.94	0.016	0.94	--
Total Cyanide (SW846 9014)							
Cyanide	µg/L	10.0	3.2	1	1	1	140
Oil and Grease (EPA Method 1664B)							
Oil and Grease	mg/L	5.0	--	--	--	--	--
Wet Chemistry Parameters							
Total Suspended Solids (SM 2540D)	mg/L	2.00	--	--	--	--	--
Dissolved Organic Carbon (SM 5310C)	mg/L	1.00	--	--	--	--	--

NOTES:

Assistance Group

CCC = criterion continuous (chronic) concentration

EPA = U.S. Environmental Protection Agency

GC = Gas chromatography

ICP = Inductively coupled plasma

MS = Mass spectrometry

NRWQC = EPA National Recommended Water Quality Criteria

PCB = Polychlorinated biphenyl

PPL = Priority Pollutant List

(a) Method detection limits are shown only if the reporting limit is greater than the ecological and/or human health criterion, and are required to be updated periodically and therefore subject to change.

(b) Surface water benchmarks from the EPA Region III BTAG. Marine benchmarks are presented unless not available, in which case the freshwater benchmark is presented (except for metals).

(c) Ecological criteria is NRWQC-CCC where available; otherwise, BTAG.

(d) EPA is currently reassessing the human health criteria for arsenic; therefore, this value was not used in assessing sensitivity.

Blue shading indicates that the criterion is lower than the laboratory reporting limit.

APPENDIX A

SUBAQUEOUS SURVEY RESULTS TECHNICAL MEMORANDUM

EA Engineering, Science, and Technology, Inc.

225 Schilling Circle
Hunt Valley, MD 21031
Telephone: 410-584-7000
FAX: 410-771-1625
www.eaest.com

14 August 2014

TECHNICAL MEMORANDUM

TO: Andrew Fan (EPA)
Barbara Brown (MDE)
Madi Novak (Maul Foster & Alongi, Inc.)
Dan Silver (Sparrows Point Environmental Trust)

FROM: John Morris, Subaqueous Survey Task Lead and Field Lead
Frank Barranco, Project Manager

SUBJECT: **Subaqueous Survey Results – Bathymetry and Side Scan Sonar**

The Sparrows Point Environmental Trust (the Trust) contracted EA Engineering, Science, and Technology, Inc. (EA) to plan and implement the subaqueous survey of the Northwest Shoreline study area (the Phase I area) adjacent to the Sparrows Point Facility. The following Technical Memorandum describes the field methods and results of the bathymetry and side scan sonar portions of the subaqueous survey, conducted as part of Task 2 of the Sparrows Point Environmental Investigation.

Background and Objectives:

The subaqueous survey of the Phase I area was comprised of two principal study elements: 1) a detailed subaqueous survey including bathymetry and side scan sonar, and 2) a visual shoreline survey. The technical approach and results of the detailed subaqueous survey are described in this memorandum, while methods and results of the shoreline survey were provided as a separate, stand-alone document. The bathymetric and side scan sonar survey elements were performed in the shallow waters of Bear Creek over areas of riverbed that have the potential to be impacted by stormwater discharge and groundwater seepage. The subaqueous survey was designed to provide a base map of subaqueous topography and benthic habitat, as well as to determine the presence and abundance of possible obstructions and submerged hazards. The information from the subaqueous survey will be used in the development of the work plan for the Sparrows Point Offshore Investigation to identify sediment and pore water sampling locations that are representative of all types of benthic habitat present in the offshore area.

For the purposes of conducting the survey and presenting the results, the Phase I survey area was sub-divided into Upper and Lower regions that were separated by the Interstate 695 (I-695) bridge spanning Bear Creek. The Upper region of the survey area extended from the I-695 Bridge approximately 4,500 feet (ft) to the north-northeast, terminating at the railroad bridge. The Lower region of the Phase I survey area extended approximately 3,700 ft south of the I-695 Bridge to the mouth of Humphrey Creek.

Subaqueous Survey Methodology:

The field effort for the subaqueous survey was conducted over several days in May 2014 that offered suitable conditions for data acquisition. Bathymetric survey operations were performed on 6 and 8 May, while side scan sonar operations were performed on 13 May and visual observations of sediment were performed on 25 May. A shallow draft, 17-ft Jon boat powered by an outboard motor served as the primary survey platform for the hydrographic survey elements. A 23-ft Monark survey vessel powered by twin outboard motors was the platform employed to support the sediment sampling operations. The survey activity was staged from the boat ramp facility at Turner Station Park in Peach Orchard Creek.

Bathymetric data were collected over a series of 162 main-scheme bathymetric survey lines that were established within the Phase I study area (73 in the Lower region and 89 in the Upper region). The bathymetric survey lines were oriented perpendicular to shore and the existing bottom contours (shore-normal), spaced at 50-ft intervals, and extended a minimum of 200 ft into Bear Creek (Figure 1). For the side scan sonar survey element, a total of 27 survey lines, oriented parallel to shore and spaced at 80 ft intervals, were occupied (15 in the Lower region and 12 in the Upper region). Bathymetric and sonar data were collected from the deeper water at the main stem of Bear Creek into the shallows up to the navigable limits at the eastern margin of the water body or to the limitation of the acoustic sensors.

Following the bathymetric and side scan sonar survey efforts, a series of 40 surface sediment samples were visually inspected within the Phase I survey area to aid groundtruthing the side scan sonar data such that a map of habitat could be developed (Figure 2; Table 1). Sampling was performed in late May, with locations selected based on the intensity of the acoustic return and presence/absence of sediment texture (boundary roughness, bedforms, etc.) in the sonar records.

Precision Navigation and Horizontal Control

Positioning information for the subaqueous survey was provided by a roving Trimble SPS 461 global positioning system (GPS) receiver. Differential corrections for the satellite positioning data were received real-time through a subscription to the KeyNetGPS Virtual Reference Station (VRS) Network (http://www.keynetgps.com). A broadband cellular modem aboard the vessel allowed the GPS receiver to interface directly with the VRS network and derive correctors to the satellite positioning information. Following the application of the VRS correctors, the positional information generated by the roving GPS unit provides positioning information with a geodetic accuracy of approximately 10 centimeters (cm) in the horizontal plane at an update frequency of 2 Hertz (Hz).

The National Geodetic Survey (NGS) benchmark located at the entrance to Dundalk Marine Terminal (6984/PID-AI8114) was identified as the preferred cross-check mark for geodetic accuracy for this field operation. However, access to the facility was not granted by Maryland Port Administration on 6 May, citing security concerns/lack of escort capability and preventing validation of VRS corrections in proximity to the survey area. As a result, the initial verification of GPS system accuracy was performed at an alternate benchmark offering first order horizontal control.

On 7 May, the field crew established the navigation system over the GENT benchmark (PID-JV5657) in Cockeysville, Maryland. Position comparisons between the published coordinates and observed coordinates of the benchmark were made using both standard US Coast Guard (USCG) differential corrections broadcast via the Annapolis, Maryland beacon, as well as the KeyNetGPS VRS corrections to GPS satellite data. The USCG beacon corrections resulted in a geodetic accuracy of approximately 1 ft (29.6 cm), while the use of KeyNetGPS VRS corrections via subscription improved geodetic accuracy of the system to 0.4 ft (13 cm). In addition to the benchmark verification of system performance, daily quality control (QC) checks of the positioning system were also performed by checking the GPS positioning information relative to the known position of Daymark No. 5 off of Long Point in Bear Creek. This process indicated the data provided by the Trimble SPS 461 receiver in combination with the KeyNetGPS VRS data were of sufficient accuracy and repeatability over the course of the survey.

The positioning information provided by the Trimble receiver was ported directly to HYPACK navigation and data acquisition software running on a laptop computer via a serial connection. The HYPACK software served as the primary survey management system, logging time, position, and depth data, as well as providing a helmsman display that allowed the vessel operator to maneuver the vessel and associated sensors along the predetermined survey lines described above. Once in HYPACK, the geographic position data were converted to Maryland State Plane coordinates (FIPS-1900) in the units of US Survey Feet and the horizontal control of North American Datum of 1983 (NAD 83).

Bathymetric Data Acquisition

An ODOM Hydrotrac single-beam survey fathometer interfaced with a narrow-beam, 200 kilohertz (kHz) transducer was used to measure individual water depths to a resolution of 0.1 ft. Approximately 10 measured depth values were collected, adjusted for transducer depth, and transmitted to the data acquisition and survey system within a one-second interval. The transducer was set to a fixed depth below the waterline (1.5-ft draft) and a correction applied to the soundings by the fathometer to reflect the actual depth between the water surface and bottom of Bear Creek. The functionality and performance of the fathometer was verified several times each survey day via a series of lead line measurements.

During the survey, raw depth soundings obtained by the fathometer were ported directly to HYPACK where they were time-tagged and merged with positioning information, creating continuous depth records along the actual survey track. These data were then stored for post-processing and analysis at the conclusion of the survey. In addition, the raw depth soundings were plotted over the pre-determined survey lines to re-create the vessel track and verify data quality and coverage.

In order to adjust the raw soundings for variation of sound velocity through the water column, a Seabird Instruments, Inc., SEACAT SBE 19 Conductivity, Temperature, and Depth (CTD) probe was used to obtain sound velocity profiles multiple times during each survey day. The data collected by the CTD probe was then bin-averaged to 1.5-ft depth intervals to account for any pycnoclines (rapid changes in density that create distinct layers within the water column). Sound velocity correction factors were then calculated using the bin-averaged values. A mean sound velocity profile was calculated from the multiple individual profiles acquired each survey day. This mean velocity profile was used to develop a depth correction factor, based on the ratio of actual sound velocity within the water column to the assumed sound velocity set within the fathometer. This correction factor was then applied during the post-processing of the bathymetric data.

Since the survey area resides within a tidal system that is subject to two flood and two ebb tides per tide day (24 hours 50 minutes), a correction of the raw bathymetric soundings required normalization to a common vertical datum to account for changes in water level. Normalization of water depths/river bottom topography within the survey area was supported through the use of water level observations recorded at the nearby National Oceanographic and Atmospheric Administration (NOAA) Center for Operational Oceanographic Products and Services (CO-OPS) monitoring station #8574680 at Ft. McHenry. Offsets to the Ft. McHenry observations based on Hawkins Point (+6 minute time offset; 0.99 height corrector) were applied to represent the time and height of the tide over the Phase I survey area.

In addition, two Onset Hobo U20 water level sensors were deployed within the survey area, obtaining water temperature and pressure readings at three minute intervals, offering a pressure measurement accuracy of +/- 0.02 ft for the development of site specific water level records. Each logger was placed in the shallow subtidal (-10 ft) area of the Upper and Lower regions of the Phase I survey area using bottom-mounted moorings on 6 May 2014 and left undisturbed until the conclusion of side scan sonar operations on 13 May 2014 (Figure 2; Table 2). Upon recovery, the time-series data were downloaded, corrected for atmospheric pressure, and converted to water level. These data were then compared to the NOAA water level records to evaluate the appropriateness of the Patapsco River information for the development of correctors for Bear Creek.

Bathymetric Data Processing

Upon completion, all the raw depth soundings obtained along the main scheme and tie lines were reviewed, corrected for water column sound velocity, and then normalized to a vertical datum of Mean Lower Low Water (MLLW) using the corrected NOAA water level information in HYPACK's single beam editor module. Erroneous data points associated with cavitation in the water column or suspect data points were flagged and removed from further processing and eventual output.

As a quality control measure, the main scheme and tie line soundings were overlaid in HYPACK and values compared to verify all correctors were properly applied and strong agreement between overlapping soundings. Cross-check comparisons of over 1200 points within the survey grid indicated that data showed consistent agreement within the areas of overlap. The observed arithmetic mean difference between the main scheme and tie line data sets was low (-0.13 ft or 1.6 inches), with a small absolute mean difference (0.235 ft or 2.8 inches) and standard deviation (0.275 ft or 3.3 inches). The differences that were observed were attributable to small-scale inconsistencies in Bear Creek and Patapsco River water levels over the survey period, as well as changes in vessel configuration (minor changes in draft) during side scan sonar operations during which the tie line data were collected. At the proposed level of resolution, these data were deemed suitable for characterization of the bottom topography within the survey area and first-order planning of a future Corrective Measures Study.

At the conclusion of the post-processing effort, the bathymetric survey data set was compiled into a comprehensive *.XYZ text file consisting of X and Y position coordinates and positive depths referenced to MLLW represented as Z. The initial XYZ file was then exported to a geodatabase for use in gridding routines and development of digital elevation model (DEM) of water depth referenced to the MLLW vertical plane. The DEM was used to generate contour maps and facilitate description of water depth and bottom topography within the Phase I survey area.

Although a published vertical conversion factor between MLLW and North American Vertical Datum of 1988 NAVD 88 was not readily available for Hawkins Point via NOAA or the

National Geodetic Survey (NGS), this value was estimated via interpolation from other published datum information for both Hawkins Point (Station 8574821) and Ft. McHenry (Station 8574680). As a final step in the post-processing effort a 0.8-ft conversion factor was applied to the MLLW-normalized data to permit presentation of bottom topography referenced to the approximate NAVD 88 vertical plane. These data were used to generate a supplemental DEM that will allow the bottom topography information to be readily combined with any terrestrial elevation information and generate a seamless DEM of the Phase I area, if necessary for future activities.

Side Scan Sonar Data Acquisition

Side scan sonar was collected along 27 survey lines, oriented parallel to shore and spaced at 80-ft (24 m) intervals within the study area. The sonar range settings were held at 82-ft (25 m) per channel (port and starboard), resulting in approximately 200 percent coverage of the bottom. The swath data were collected in all accessible areas to the depth limitation of the sonar system sensor and vessel. The timing of side scan sonar survey operations was controlled such that the survey lines in close proximity to the shoreline were occupied at the time of high tide.

An EdgeTech 4200, dual frequency (300/600 kHz) side scan sonar system was employed to obtain the acoustic imagery of the river bottom within the Phase I survey area. The side scan tow body was flown above the bottom via a bow-mount arrangement at an altitude that created the best possible sonar grazing angle and image of the substrate, as well as any hard targets (e.g., debris items) residing on the sediment-water interface. Given the bow mount configuration for the towfish, actual altitudes above the river bed ranged from 3 ft to 10 ft (1 to 3 m) depending upon the water depth along the survey line being occupied.

The sonar data acquisition and logging was performed through an interface with a topside control system running EdgeTech Discover software and logged in the EdgeTech proprietary *.JSF format. Prior to post processing, the side scan data were reviewed in Discover and exported in the form of generic eXtended Triton Format *.XTF files, then imported into Chesapeake Technology’s SonarWiz (version 5) software.

Side Scan Sonar Data Processing

Once in SonarWiz, the side scan sonar data were subjected to slant range correction, removing the water column artifact present in the raw data. In addition, small-scale adjustments to the towfish positioning were performed based on offsets from the GPS antenna, as well as signal gains to optimize contrast in the acoustic imagery. Following the position corrections, the lower frequency 300 kHz imagery was used to support sediment classification and development of a habitat map. The higher frequency 600 kHz data were converted to a bronze color palette that enhanced the appearance of objects on the river bottom and then subjected to comprehensive target detection and identification. A database of targets was compiled within SonarWiz and exported as a comprehensive list of acoustic targets for use in a GIS framework to support future phases of the study. Given the 200 percent coverage of the survey area, the majority of the targets were imaged and detected in adjacent lanes and therefore represented twice in the database.

The final element of side scan sonar data processing within SonarWiz included the output of acoustic imagery as geo-referenced *.TIF files for incorporation into a geodatabase and use in a

GIS framework. The individual side-scan-sonar lanes were assembled to create a digital, geo-referenced sonar mosaic of the study area with a resolution of 0.1 ft per pixel. The mosaic was then combined with ground-truth information regarding sediment composition in order to derive maps of benthic habitat type within the GIS. The sonar data were also used to examine bottom texture, examine changes in sedimentation patterns, as well as evaluate trends in debris type, distribution, and concentration.

Sediment Grab Sampling

To groundtruth the side scan sonar data, a series of 40 surficial sediment samples were visually inspected within the Phase I survey area (Figure 2; Table 1). At each location, a stainless steel Petite Ponar grab sampler with a surface area of 0.25 ft^2 was lowered to the river bottom via soft line to recover and inspect sediment from the river bottom. Locations were selected following the review of side scan sonar data so individual locations strategically targeted areas of sediment transition (fine-grained to sandy substrate) and other areas that required additional information to support the development of a benthic habitat map.

During the field operations, the actual position of each visual inspection location was logged at the time of collection, and the contents of the sampler described (color and texture) and digitally photographed in the field. The sediment from each location was immediately discarded in the area from which it was collected. Upon completion, the sediment survey data were compiled within a spreadsheet, then ported into a geodatabase for display within a GIS framework. The photographs and descriptions of the surficial sediments were also included in a geodatabase to permit their combined use with the side scan sonar records as a means of determining benthic habitat type based on both sediment texture and intensity of the acoustic backscatter.

Subaqueous Survey Results

Water Level

Water level readings from the water level sensors described above were used to document the tidal and meteorological influences, as well as the impact of local freshwater discharge into the basin on water level over the survey area. Since the elevations of the pressure sensors were not measured relative to a fixed vertical datum upon deployment, the data usage was limited to evaluating the phase and height of the tides over the Phase I survey area and the appropriateness of water level observations made by the NOAA gauge at the entrance to Baltimore Harbor, corrected to nearby Hawkins Point.

Gauge 222 was deployed in the Upper region of the survey grid with approximately 8.7 ft of overlying water at low tide (MLLW; Figure 3). Gauge 223 was deployed in the Lower region of the survey grid with approximately 7.2 ft of overlying water at low tide (MLLW; Figure 3). Both instruments collected complete records and provided good insight into both high and low frequency fluctuations of water level within the Phase I survey area. When compared to the NOAA water level observations in the Patapsco River at the entrance to Baltimore Harbor (Station 8574680), the data records appear to roughly align in terms of phase and height. In general, it appeared that water levels in the region remained were relatively high throughout much of the observation period. Water levels remained approximately 1 ft above the MLLW mark at low tide and only approached the MLLW mark during the low tide event early on 12 May.

Normalizing the Gauge 222 and 223 data to the approximate MLLW vertical plane based on the NOAA observations and comparing the phase and height offsets indicated that strong agreement in the records did occur during the latter portion of the survey period (13 May 2014; Figure 4). However, the same normalized records also indicated that differences in water level between the Patapsco River and Bear Creek on the order of 0.1 to 0.2 feet (1.2 to 2.4 inches) were observed during the 6 and 8 May survey efforts. Although minor, this asymmetry in the water level records appeared to be the root cause of arithmetic mean and absolute mean differences in depth values documented in cross-check comparisons between the main scheme (6 and 8 May) and tie line (13 May) bathymetric datasets. Based on the low magnitude of these differences in water level, they are likely attributable to short-lived meteorological events within the watershed that resulted in increased freshwater runoff/discharge and retention within the basin.

Bathymetry and Bottom Topography

The bathymetric survey covered the area from the Phase I Northwest shoreline out to the main stem of Bear Creek (Figure 5). When normalized to MLLW, water depths within the overall survey area ranged from less than 1 ft along the shoreline in the Lower region of the survey area to a maximum of 13 ft near the centerline of Bear Creek in the Upper region. Distinct differences were observed in the water depth and bottom topography (i.e., slope, shelf width) noted between the Upper and Lower survey areas, indicative of dissimilar hydrodynamic and depositional processes.

The Lower region of the survey area was found to be a primarily shallow water environment and displayed generally shallow water depths ranging from 1 ft along the armored shoreline to a maximum of 10 ft just south of the I-695 Bridge spanning Bear Creek (Figure 6). The bottom topography of the Lower region was dominated by a relatively broad shelf feature that extended over 400 ft west from shoreline at multiple locations. Water depths over this feature generally ranged from 2 ft to 4 ft, but bottom slope tended to increase beyond the 5 ft depth contour. A subtle basin feature was apparent at the southern margins of the survey area, approximately 600 ft west of the entrance to Humphrey Creek (Figure 6). The position and shape of this basin suggests it is depositional in nature and likely received a substantial amount of sediment from the discharge of Humphrey Creek.

In contrast, the Upper region of the Phase I survey area displayed greater complexity in the bottom topography with generally deeper water depths (Figure 7). When normalized to MLLW, water depths in this region ranged from approximately 1 ft along the shoreline to 13 ft at the western margin of the grid located at the main stem of Bear Creek. Two broader shelf features were detected in the Upper region of the Phase I survey area, both associated with the Sparrows Point shoreline. The first feature was approximately 300 ft wide and extended west from the armored shoreline of Greys Landfill into Bear Creek, while the second feature was 400 ft wide and located just south of the Peninsula Expressway (MD Route 157) bridge. In both cases, water depths at the edge of the features increased sharply from 6 ft to 9 ft (4 percent grade or 2.5 degree slope) before the bottom slope decreased (1 percent grade or 0.6 degree slope) and water depths gradually increased to 13 ft at the eastern margin of the survey area.

In addition to the shallow shelf features described above, a distinct basin feature was also detected in the bathymetric survey data collected in the Upper region of the Phase I survey area. Water depths at the center of the basin were approximately 10 ft, with the eastern margin of the feature less than 100 ft from the armored shoreline. The edges of the basin displayed strong relief in proximity to shore as water depths rapidly increased from 2 ft to 9 ft over the 100 ft linear distance (7 percent grade or 4 degree slope). In the center of the basin, the topographic relief was considerably less (approximately 1 percent grade or 0.6 degree slope), indicative of a quiescent, depositional environment.

As final step in the bathymetric data processing, the water depth information referenced to MLLW were converted to elevation referenced to the approximate NAVD 88 vertical plane by applying a 0.8-ft conversion factor derived via interpolation. The resulting elevation information is presented in Figures 8 through 10, to facilitate comparison of riverbed elevation to maps and/or measurements made in support of terrestrial operations (i.e., topographic mapping, well drilling, etc.).

Side Scan Sonar and Riverbed Composition

High frequency (600 kHz) and low frequency (300 kHz) side scan sonar data were collected simultaneously in the Phase I survey area in mid-May. These two data sets each produced a complete acoustic image of the riverbed from the Phase I Northwest shoreline out to the main stem of Bear Creek. However, the high and low frequency sonar data were processed separately and used for different purposes. The increased intensity of the acoustic energy produced by the low frequency side scan was primarily used to evaluate and map surface sediment composition based on the intensity of the backscatter. High frequency sonar, which emits lower energy, yields higher resolution acoustic imagery. As a result the 600 kHz data set was best suited for detecting and discriminating hard targets on the riverbed, producing fairly detailed images of the detected objects.

As part of the benthic habitat mapping element, the 300 kHz side scan sonar data were compiled into a single mosaic and combined with sediment visual inspection data (Figure 11). Areas of riverbed exhibiting sand or other coarse-grained material (shell, gravel, etc.) as the principal component of the surface sediments tended to yield higher acoustic backscatter making it appear darker in the imagery. In contrast, areas exhibiting a lighter, homogenous appearance in the acoustic imagery were commonly dominated by finer-grained sediments (silts and clays; Table 3). In some areas the transition between substrate types was abrupt (as was noted between sediment visual inspection samples 11 and 12, as well as 33 and 34), while in others it appeared to be more gradational.

As would be expected, areas dominated by sand existed in the shallower waters of the surveyed area, as well as those expected to be higher energy environments that displayed increased sediment texture (ripples, bedforms, etc.). Although the boundary between sandy and fine-grained sediments appeared to reflect the bottom topography within the Phase I survey area, there was no direct correlation to a specific depth contour (Figure 12). This finding suggests that more than one mechanism affects sedimentary environment and the resulting benthic habitat type within the site (e.g., hydrodynamics, surface waves, runoff sources, exposure).

The information from visual inspection of sediment and 300 kHz side scan sonar obtained in the Lower region of the survey area indicate the southern and western margins of this region were principally comprised of silty clay (Figure 13). The mouth of Humphrey Creek, located behind the wooden breakwater structure in the southeast corner of the survey, was also dominated by the same silty clay material. The color, composition, and other characteristics documented during the sampling event (Table 3) suggested much of this material was deposited from the outflow of Humphrey Creek. Fine sand with varying amounts of silt dominated the riverbed within the remainder of the Lower survey area (Figure 13). This fine sand (with varying silt fractions) comprised much of the wide shelf feature that was detected in the bathymetric survey. Estimates of areal coverage on opposing sides of the sand/fine-grained sediment boundary in the Lower region of the survey indicate that approximately 37 acres or 60 percent of the surface area mapped by side scan sonar exhibited a sandy substrate, while the surface sediments in the remaining 25 acres or 40 percent were fine-grained in nature.

The side scan sonar and information from visual inspection of sediment in the Upper region of the survey area consistently demonstrated strong contrasts between areas dominated by fine and coarser-grained sediments. Similar to the Lower region, sandy or coarser grained sediments appeared as darker sonar returns (Figure 14) and were concentrated in the shallow waters near the shoreline and over the shelf features detected during the bathymetric survey. The shelf along the eastern margin of the survey displayed a sand base with a wide range of silt fractions. The shelf just south of the Peninsula Expressway bridge was heterogeneous in composition with a variety of coarser grained material recovered, including medium to coarse sand and gravel (30 percent) at the shallowest locations (Table 3). Based on estimates of areal side scan sonar coverage, fine sand and other coarser-grained sediments dominate the surface sediments within approximately 32 acres or 36 percent of the Upper region. Homogenous, fine-grained sediments described as brown to black silty clay with varying amounts of shell fragments dominated the deeper waters including the main stem of Bear Creek, as well as the basin feature in the northeastern quadrant of the Phase I survey area. Estimates of fine-grained sediment coverage in the Upper region of the survey indicate that approximately 38 acres or 64 percent of the surface area was dominated by silt and silty clay.

Fine-grained material was generally detected at water depths exceeding 8 ft, but no specific depth contour aligned with the transition between fine-grained and sandy substrate. The presence of sand and coarse-grained material over the shelf features is indicative of higher energy regimes that prevent the settlement and deposition of fine-grained sediments, or periodic high energy events actively winnowing and transporting fines from the riverbed at this locations. Given the small tidal range and limited size of the Bear Creek basin, tidal currents alone would be insufficient to resuspend fine-grained sediments on a regular basis. However, periodic wind events may generate surface waves and orbital currents in the bottom waters capable of delivering sufficient energy to resuspend bedded fine-grained material and transport it to nearby depositional areas (deeper waters, basin feature, etc.).

Examining the overall morphology of Bear Creek, it appears each shelf feature along the Phase I shoreline roughly aligns with one of the tributaries along the western side of the water body (Peach Orchard Cove, Clement Cove, and Bull Neck Creek). The orientation of these adjacent tributaries and surrounding topography may serve to focus the energy of westerly and northwesterly winds onto these shelf features, resulting in surface waves capable of impacting specific areas along the Phase I Northwest shoreline. In addition, these tributaries provide increased fetch [>0.6 nautical miles (nmi)], allowing these waves generated by elevated westerly winds to reach larger heights and deliver higher levels of energy to these shelf features. As a result, periodic west wind events could have a measurable impact on the riverbed residing in shallow waters along the eastern margin of Bear Creek, serving as a the primary mechanism to remobilize and sort bottom sediments via orbital motion.

Submerged Debris and Sediment Texture

The secondary purpose of the side scan sonar survey was to detect and map debris items that have accumulated on the riverbed within the survey area. A thorough review of high frequency (600 kHz) sonar records detected over 770 sonar contacts and areas of interest at the sediment-water interface. Given the 200 percent coverage of the side scan sonar, many of these items were imaged multiple times during the survey, providing at least two perspectives and supplemental information for use in target discrimination. As a result, it is estimated that 300 to 400 targets and target clusters were detected and mapped in the side scan survey area. The majority of the objects that were identified and measured appeared to be anthropogenic in origin, varied in shape and ranged in length from 2 ft to 70 ft. The majority of the items that were imaged are common in industrial waterways (tires, metallic debris, etc.), especially those adjacent to known landfill areas. In terms of natural riverbed features, the 600 kHz side scan also detected areas of riverbed displaying increased texture or bedforms, submerged limbs, logs, etc. These areas were recorded in a comprehensive target database.

Figure 15 provides some example images of items detected in the Lower region of the Phase I survey area. The hard targets and debris items that were mapped along the western margin of the survey area tended to be distributed broadly and were smaller in size (2 to 5 ft in length; Figure 15A) suggesting they drifted into the area prior to settling to the bottom (e.g., tires) or were discharged from passing recreational and commercial vessels transiting through the area (e.g., scrap metal, anchors). Larger debris items, with greater vertical profile, were observed in the shallower waters nearer to the eastern shoreline. Along the shoreline, the sonar imagery displayed the coarse texture of the shoreline in this region, which is comprised of deposited stone and rip rap rock for increased stability and erosion resistance.

Sediment texture was readily apparent in the 600 kHz sonar collected in much of the Lower region (see example in Figure 15B). The presence of sediment texture and bedforms are indicative of areas subject to increased energy at the sediment-water interface via either near-bottom currents or orbital motion related to the passage of surface waves. Generally, a considerable sand component or increased cohesiveness (homogenous clay) is required in the sediment matrix to allow textural elements to form and persist over time. In this instance, the high frequency sonar provided exceptional images of sediment texture and aided in identifying areas of transition from homogenous silts and clays to those of increasing sand content.

In the southwest corner of the survey area, what appeared to be a section of large-diameter flexible conduit or fluid transfer line (e.g., for water or fuel) was exposed above the water line during the May 2014 survey. Although the exposed conduit was present 25 to 50 ft outside the western margin of the survey area, the side scan sonar apparently imaged a large sediment furrow from which the item emanated upon becoming buoyant (Figure 15C). Based on the imagery, this object was buried 1-2 ft below the sediment-water interface at one time, but became sufficiently buoyant to breach the riverbed and float to the surface. The lack of any drag marks or anchor scars discounts the possibility of the conduit being physically disturbed prior to emerging from the river bottom.

In the Upper region, many of the same types of targets were detected as those imaged in the Lower region (i.e., tires and other small-scale debris items). However, the distribution of submerged debris items tended to be shifted toward the eastern and northern margins of the survey area. These areas correspond to the shelf features identified in the bathymetric survey data. Many of these debris items were linear and displayed lengths exceeding 50 ft (Figure 16A). These larger items are present in relatively shallow water (2 to 5 ft) and do represent hazards to personnel, vessels, and equipment involved in future survey. These hazards should be considered and mitigated in the technical approach. In addition to the larger-scale debris, numerous clusters of smaller-scale debris with lengths ranging from 2 to 10 ft were detected over the shelf feature south of the Peninsula Highway Bridge, as well as those adjacent to the landfill (Figure 16B).

Given their location relative to the known fill areas to the east, it is quite likely that these shelf features are actually comprised of fill material that had been placed there as part of historic land creation/reclamation or shoreline protection efforts. The majority of these debris items were probably remnant solid waste that was incorporated in the fill material versus items that were deposited at these locations over time. With bottom conditions regularly exhibiting erosional characteristics over these shelf features, these items (e.g., waste steel material, discarded appliances, etc.) are likely sufficiently dense to resist remobilization and movement and now reside at the sediment-water interface due to the displacement of any sediment overburden. In terms of representing potential sources of contamination, additional investigation would be required to fully characterize these items and determine if they currently contain or did contain hazardous materials.

Figure 1. Aerial photograph displaying the placement of single beam bathymetry (blue) and side scan sonar (red) survey lanes relative to the Phase I Northwest Shoreline in Bear Creek.

Figure 2. Aerial photo displaying the location of the two water level gauge locations (green) and 40 locations where visual inspection of surface sediment was performed within the Phase I survey area (gray).

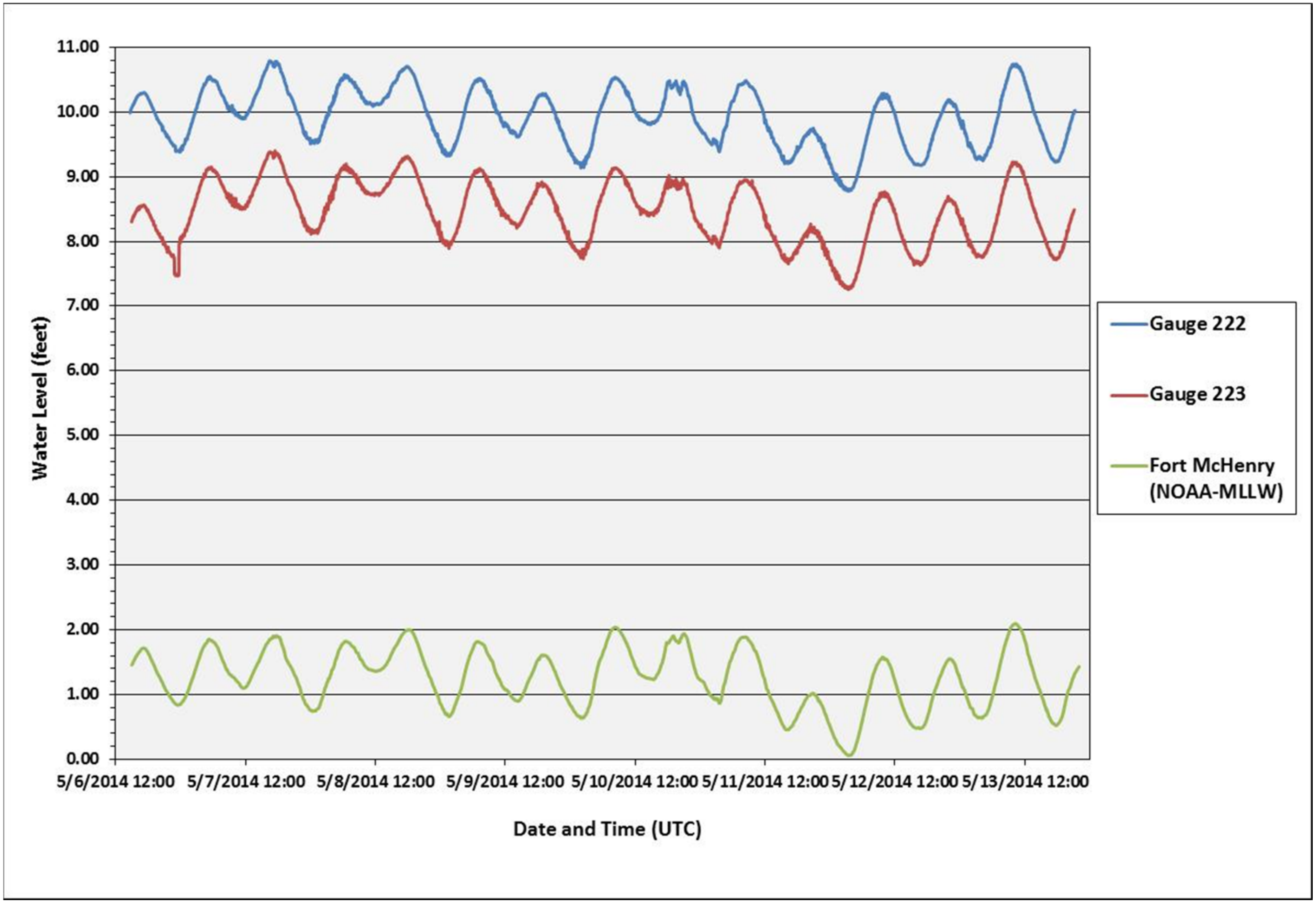


Figure 3. Chart displaying water level measurements collected by Gauges 222 (Upper; blue) and 223 (Lower; red) in Bear Creek in comparison to water level observations relative to MLLW collected by the NOAA Station 8574680 at the entrance to Baltimore Harbor (green).

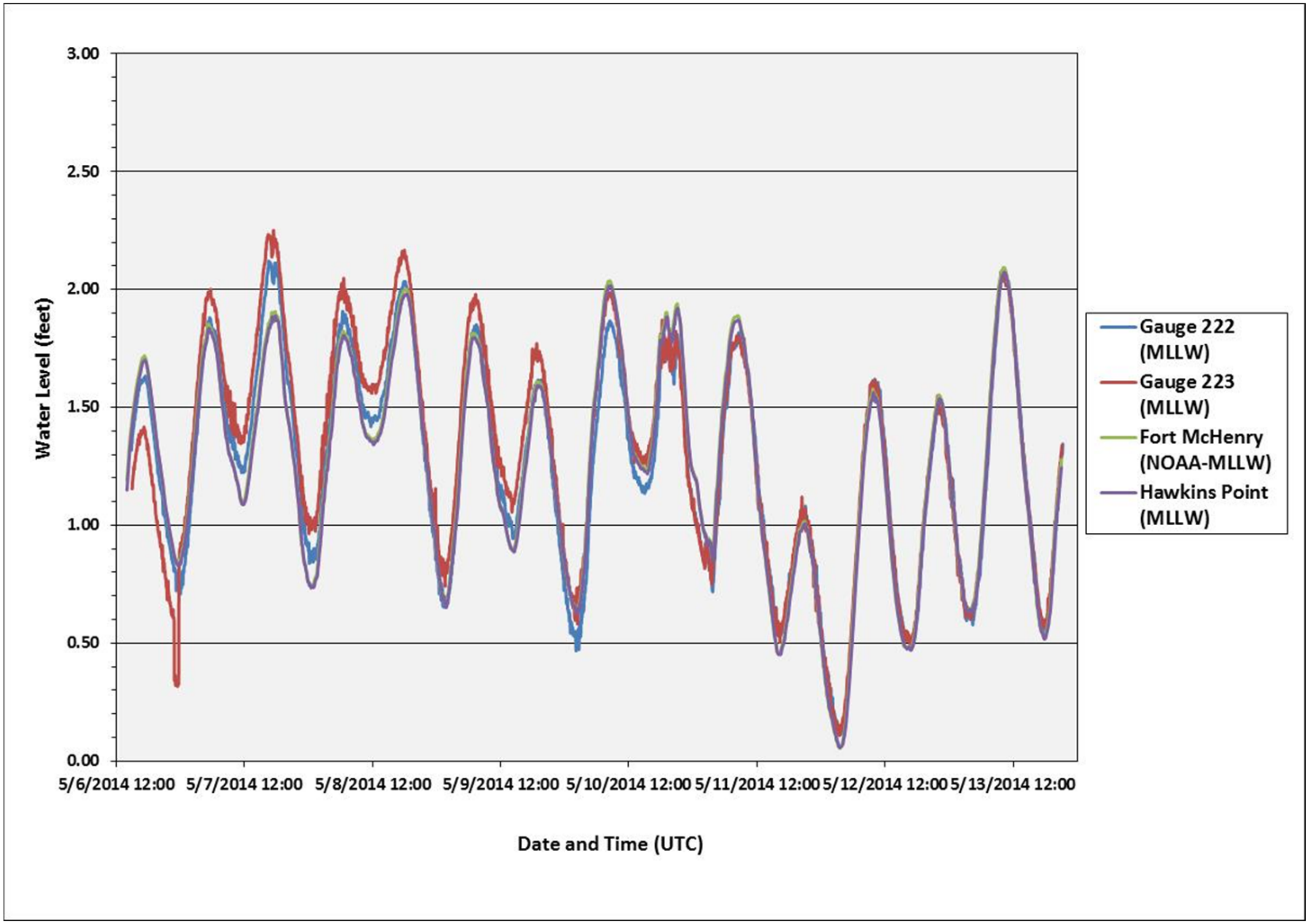


Figure 4. Chart displaying water level measurements collected by Gauges 222 (Upper; blue) and 223 (Lower; red) in Bear Creek approximated to the MLLW vertical plane in comparison to water level observations relative to MLLW collected by the NOAA Station 8574680 both uncorrected (green) and corrected to Hawkins Point (violet).

Figure 5. Bathymetric chart for the entire Phase I survey area presented as water depths relative to MLLW and associated bottom topography.

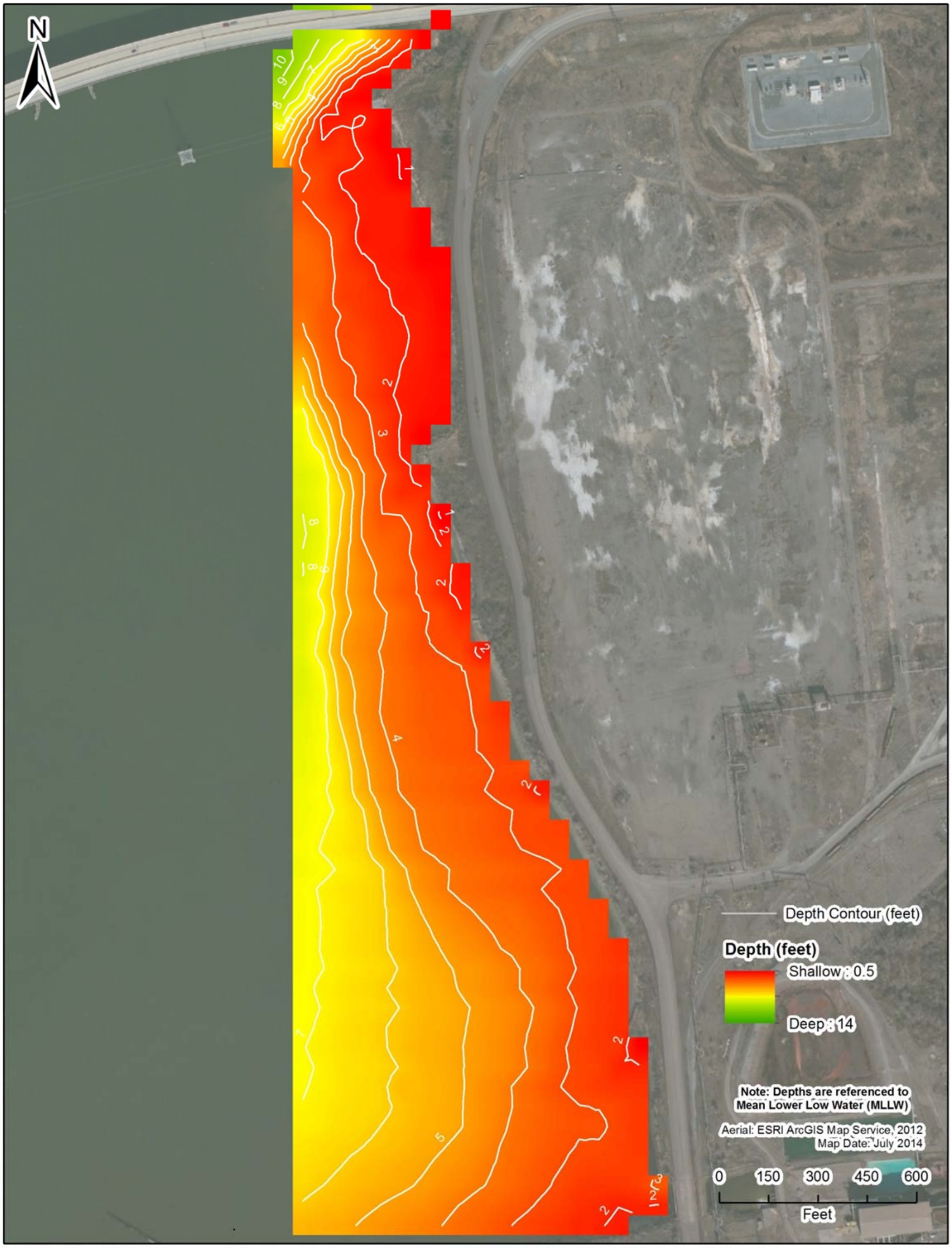
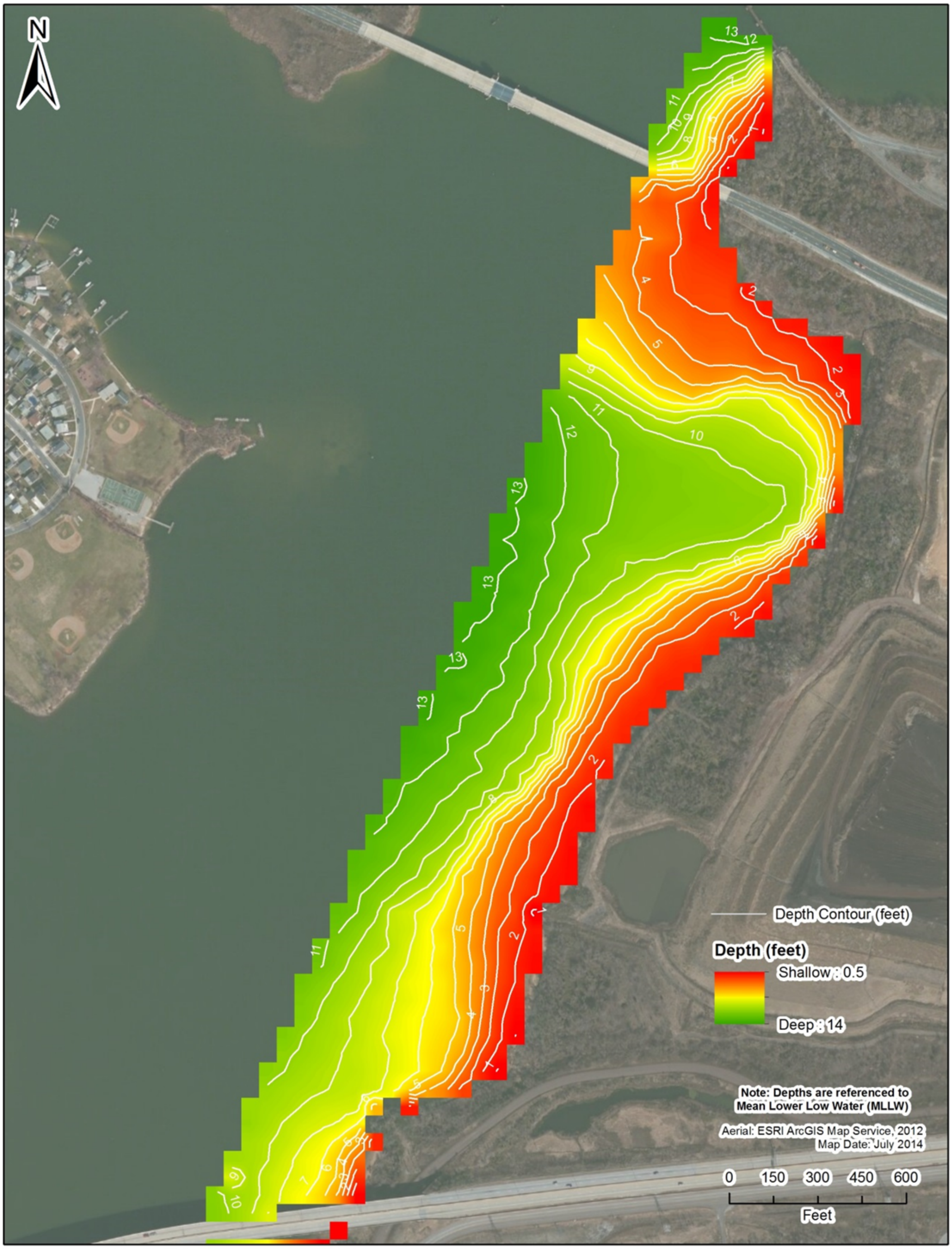


Figure 6. Bathymetric chart for the Lower region of the Phase I survey area displaying water depths relative to MLLW.



Note: Depths are referenced to Mean Lower Low Water (MLLW)

Aerial: ESRI ArcGIS Map Service, 2012
Map Date: July 2014

Figure 7. Bathymetric chart for the Upper region of the Phase I survey area displaying water depths relative to MLLW.

Figure 8. Chart of topographic relief for the entire Phase I survey area based on elevation measurements referenced to the vertical datum of NAVD 88 (approximated).

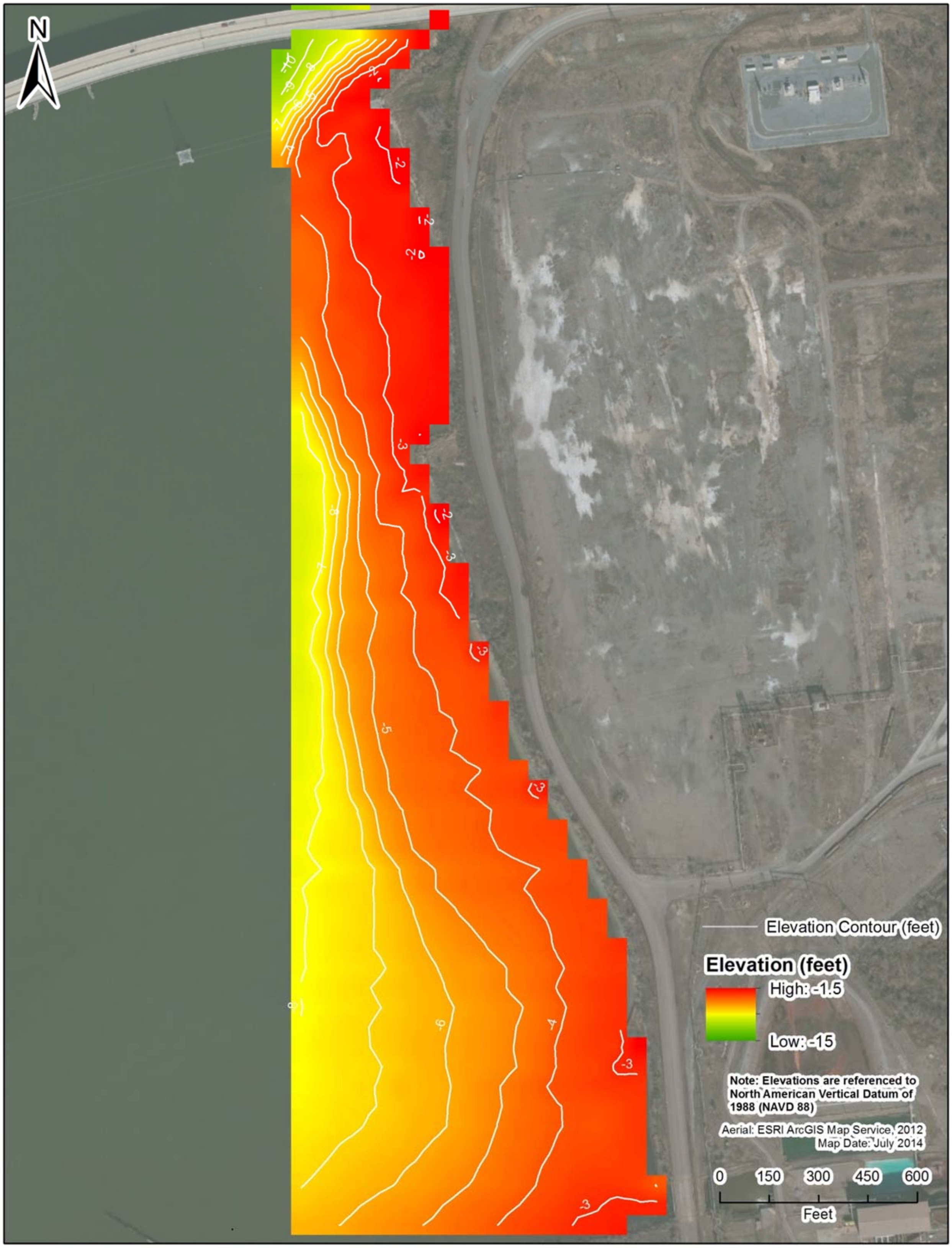


Figure 9. Chart of topographic relief for the Lower region of the Phase I survey area based on elevation measurements referenced to the vertical datum of NAVD 88 (approximated).

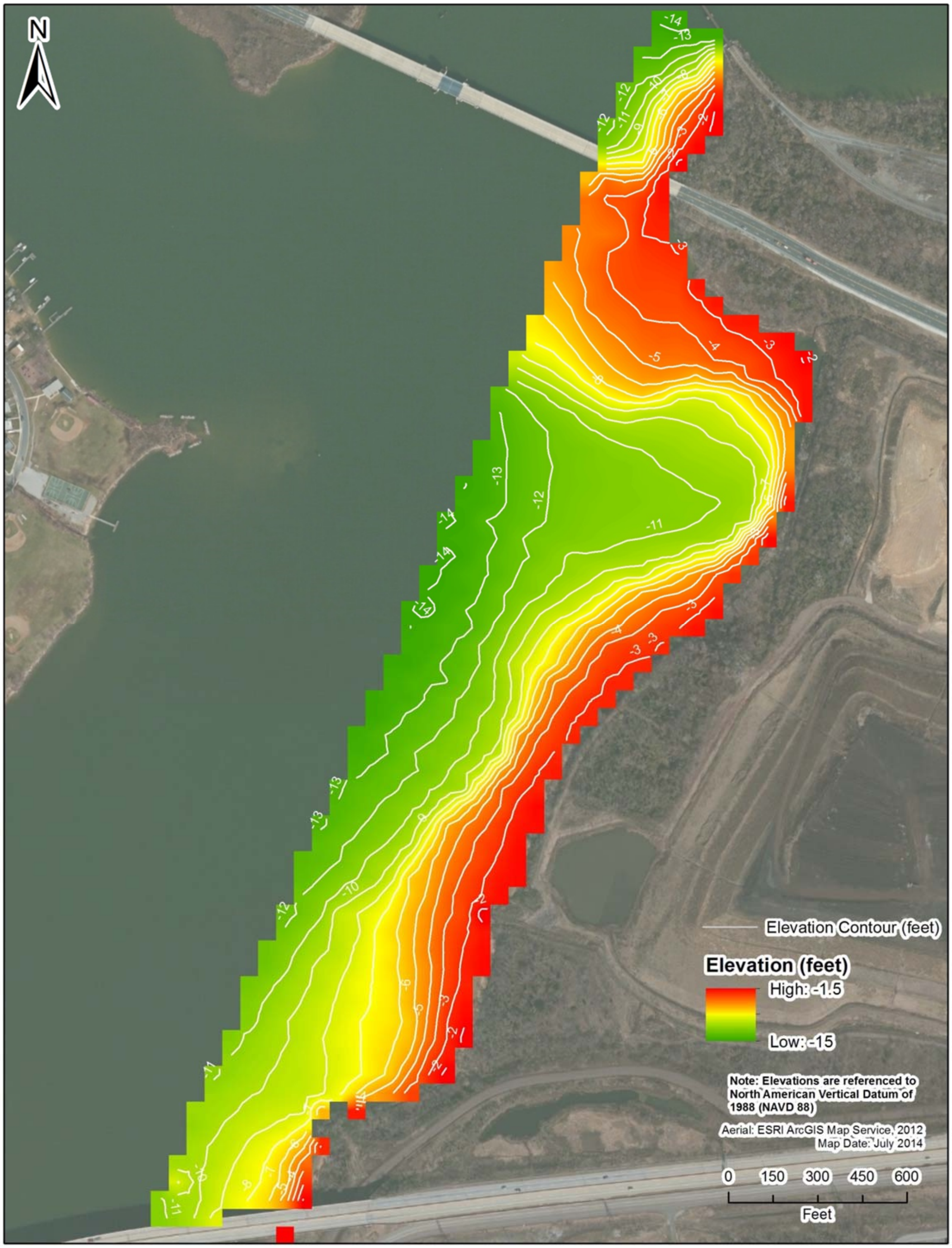


Figure 10. Chart of topographic relief for the Upper region of the Phase I survey area based on elevation measurements referenced to the vertical datum of NAVD 88 (approximated).

Figure 11. Mosaic of the low frequency (300 kHz) side scan sonar overlaid by the locations of sediment visual inspections (color coded by sediment type). By combining these data types a boundary between fine-grained and sandy substrates (yellow) could be rendered and areal coverage estimated

Figure 12. Mosaic of the low frequency (300 kHz) side scan sonar overlaid by the locations of sediment visual inspections (color coded by sediment type) and depth contours (MLLW). By combining these data types a correlation between shallower water depths and coarser grained material can be identified.

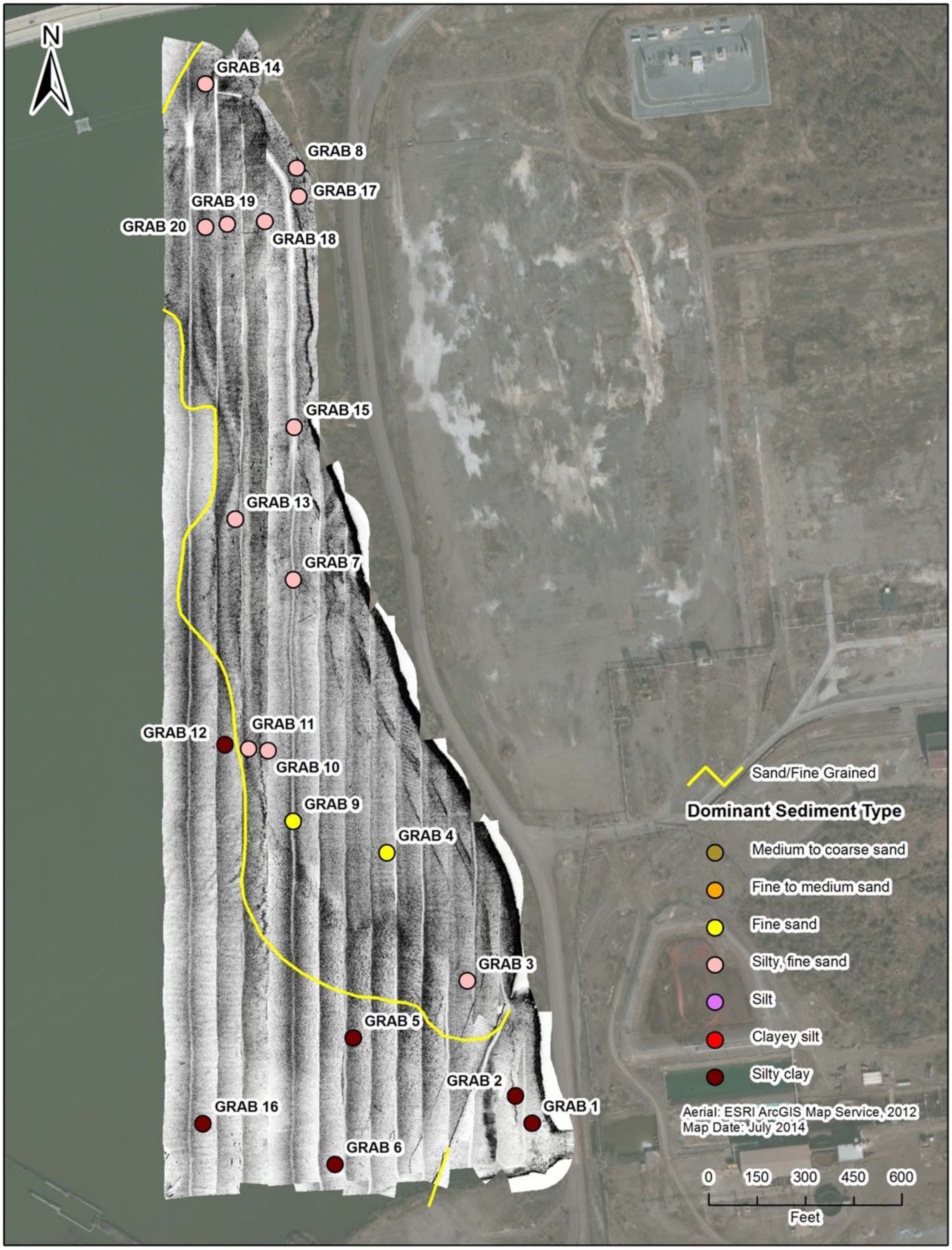


Figure 13. Mosaic of the low frequency (300 kHz) side scan sonar overlaid by the locations of sediment visual inspections (color coded by sediment type) collected in the Lower region of the Phase I survey area. The single contour line (yellow) indicates the approximate boundary between fine-grained and sandy substrates.

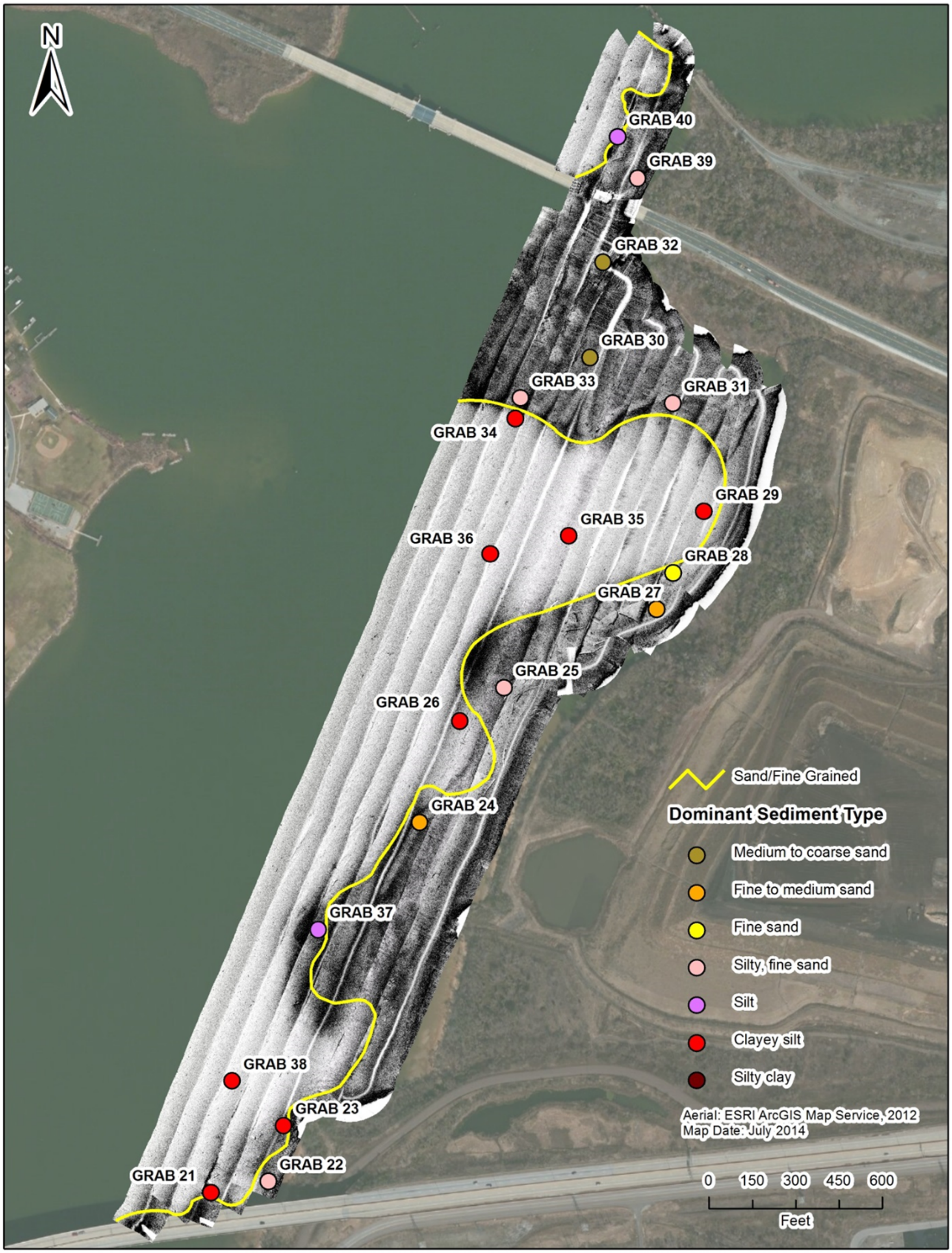


Figure 14. Mosaic of the low frequency (300 kHz) side scan sonar overlaid by the locations of sediment visual inspections (color coded by sediment type) collected in the Upper region of the Phase I survey area. The single contour line (yellow) indicates the approximate boundary between fine-grained and sandy substrates.

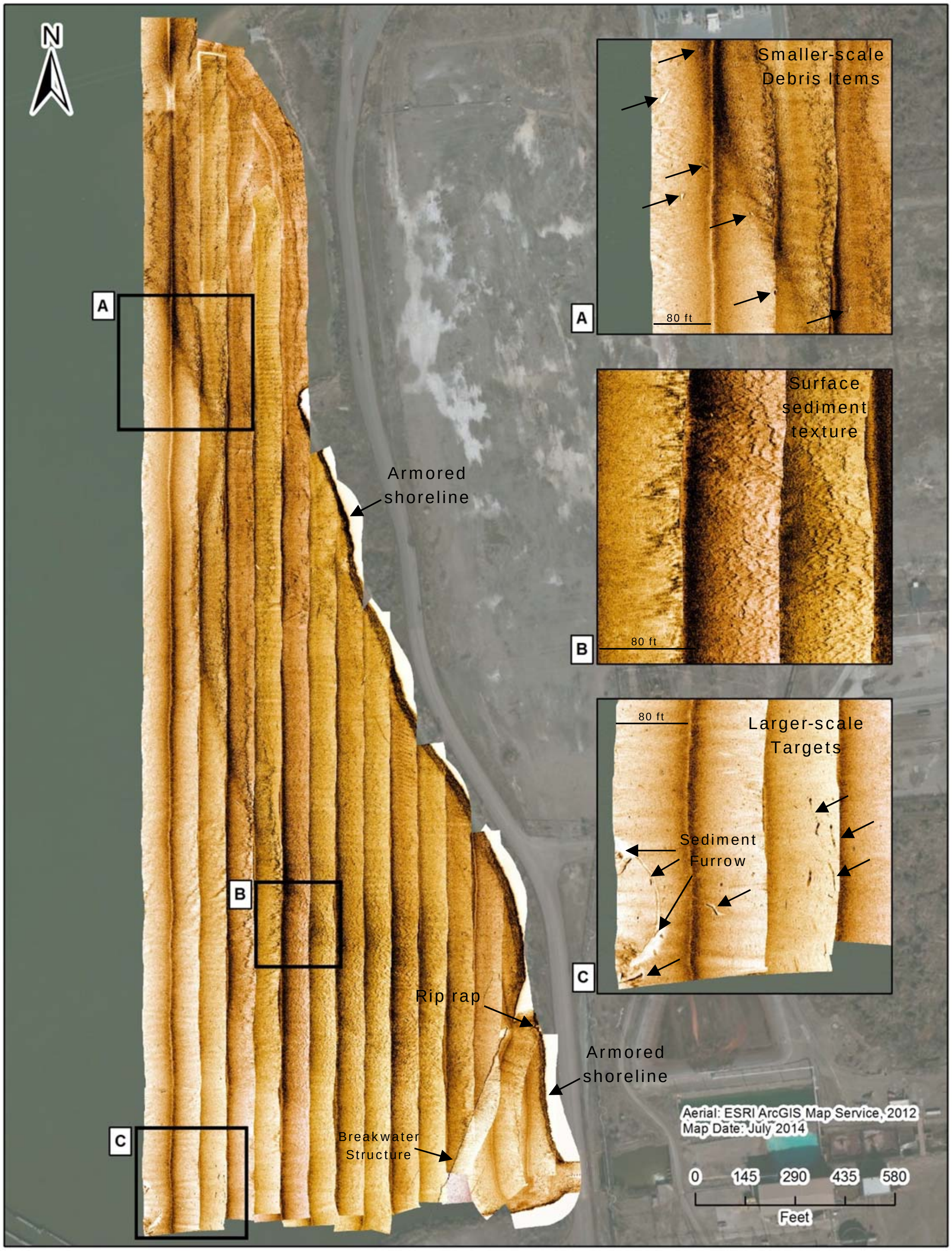


Figure 15. Mosaic of the high frequency (600 kHz) side scan sonar data collected in the Lower region of the Phase I survey area with zoom-in areas displaying examples of relatively small-scale debris items (A), sediment texture changes (B) and larger-scale targets (objects, sediment furrow, etc.).

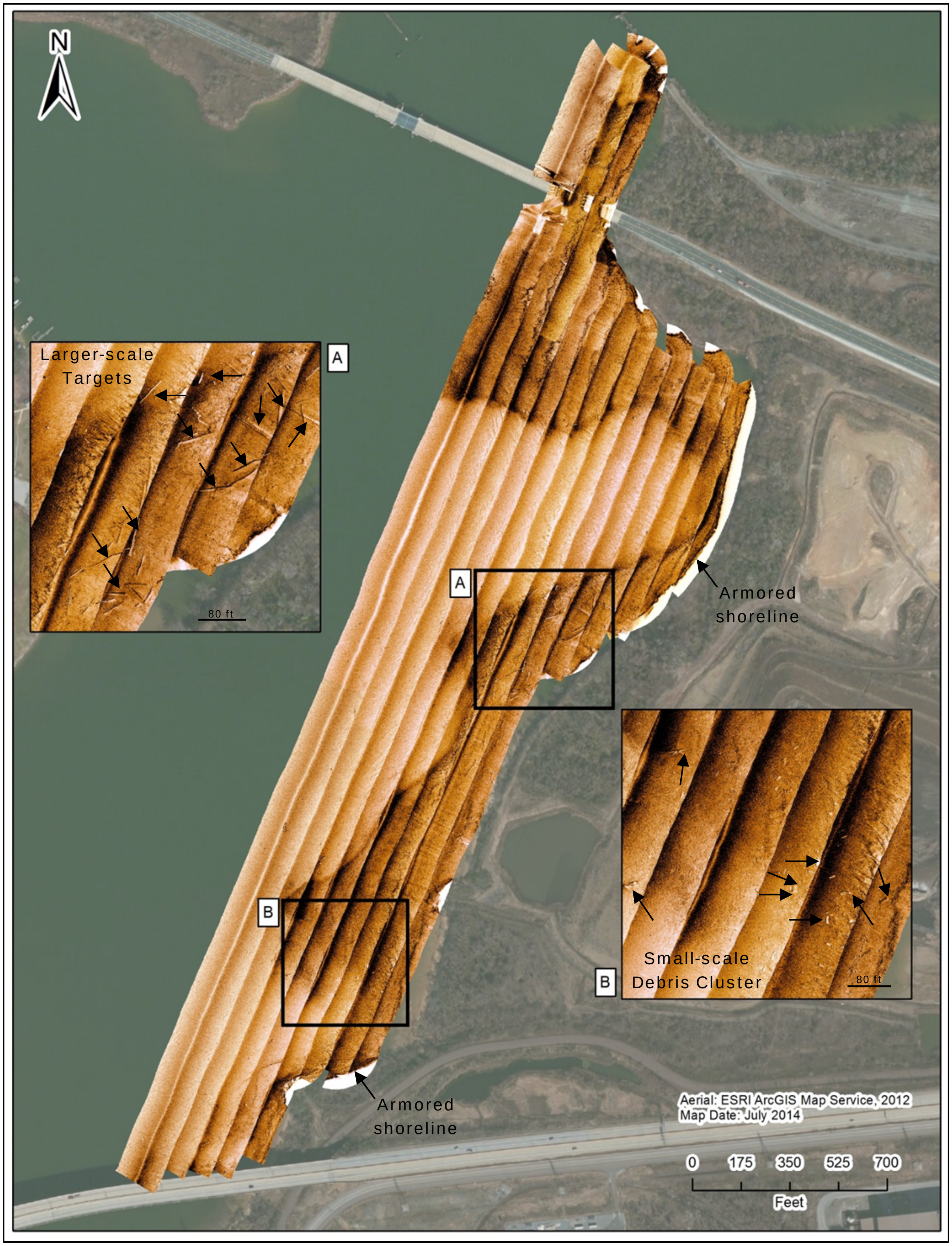


Figure 16. Mosaic of the high frequency (600 kHz) side scan sonar data collected in the Upper region of the Phase I survey area with zoom-in areas displaying examples of larger scale, linear targets (solid waste, steel rods, poles, etc.; A) and a cluster of small-scale debris residing at the sediment-water interface (B).

Table 1. Sediment Grab Sample Locations Occupied in the Lower and Upper Regions of the Phase I Survey Area

Region	Sample	Position (NAD 83)			
		Maryland State Plane (feet)		Geographic Coordinates	
		Easting	Northing	Latitude	Longitude
Lower Bear Creek	GRAB 1	1456466.24	568955.24	39° 13.6683´ N	76° 29.4723´ W
	GRAB 2	1456415.20	569040.25	39° 13.6823´ N	76° 29.4830´ W
	GRAB 3	1456264.86	569398.24	39° 13.7414´ N	76° 29.5144´ W
	GRAB 4	1456014.44	569796.89	39° 13.8073´ N	76° 29.5670´ W
	GRAB 5	1455909.75	569220.58	39° 13.7125´ N	76° 29.5899´ W
	GRAB 6	1455853.91	568826.66	39° 13.6476´ N	76° 29.6021´ W
	GRAB 7	1455723.70	570647.89	39° 13.9478´ N	76° 29.6276´ W
	GRAB 8	1455733.45	571928.16	39° 14.1587´ N	76° 29.6240´ W
	GRAB 9	1455723.34	569894.90	39° 13.8237´ N	76° 29.6285´ W
	GRAB 10	1455644.46	570115.37	39° 13.8601´ N	76° 29.6450´ W
	GRAB 11	1455584.19	570119.34	39° 13.8608´ N	76° 29.6578´ W
	GRAB 12	1455511.45	570133.08	39° 13.8632´ N	76° 29.6731´ W
	GRAB 13	1455542.69	570835.68	39° 13.9789´ N	76° 29.6657´ W
	GRAB 14	1455449.94	572188.96	39° 14.2019´ N	76° 29.6838´ W
	GRAB 15	1455727.06	571122.50	39° 14.0259´ N	76° 29.6263´ W
	GRAB 16	1455443.43	568954.17	39° 13.6690´ N	76° 29.6889´ W
	GRAB 17	1455740.13	571839.99	39° 14.1441´ N	76° 29.6227´ W
	GRAB 18	1455634.29	571761.76	39° 14.1313´ N	76° 29.6452´ W
	GRAB 19	1455519.06	571752.93	39° 14.1300´ N	76° 29.6696´ W
	GRAB 20	1455449.75	571744.83	39° 14.1287´ N	76° 29.6843´ W
Upper Bear Creek	GRAB 21	1455660.07	572604.92	39° 14.2702´ N	76° 29.6388´ W
	GRAB 22	1455859.17	572643.96	39° 14.2765´ N	76° 29.5965´ W
	GRAB 23	1455913.14	572837.07	39° 14.3082´ N	76° 29.5849´ W
	GRAB 24	1456384.19	573885.16	39° 14.4804´ N	76° 29.4839´ W
	GRAB 25	1456674.32	574350.50	39° 14.5568´ N	76° 29.4218´ W
	GRAB 26	1456522.90	574236.38	39° 14.5382´ N	76° 29.4541´ W
	GRAB 27	1457202.91	574621.84	39° 14.6010´ N	76° 29.3095´ W
	GRAB 28	1457260.78	574747.70	39° 14.6217´ N	76° 29.2971´ W
	GRAB 29	1457366.70	574959.61	39° 14.6565´ N	76° 29.2744´ W
	GRAB 30	1456972.68	575492.77	39° 14.7447´ N	76° 29.3573´ W
	GRAB 31	1457258.53	575333.86	39° 14.7183´ N	76° 29.2969´ W
	GRAB 32	1457018.28	575821.44	39° 14.7988´ N	76° 29.3472´ W
	GRAB 33	1456731.55	575351.55	39° 14.7217´ N	76° 29.4085´ W
	GRAB 34	1456713.91	575281.71	39° 14.7102´ N	76° 29.4124´ W
	GRAB 35	1456899.71	574875.23	39° 14.6431´ N	76° 29.3735´ W
	GRAB 36	1456626.98	574813.00	39° 14.6331´ N	76° 29.4313´ W
	GRAB 37	1456032.16	573513.99	39° 14.4196´ N	76° 29.5589´ W
	GRAB 38	1455733.79	572991.05	39° 14.3337´ N	76° 29.6227´ W
	GRAB 39	1457138.25	576111.92	39° 14.8466´ N	76° 29.3215´ W
	GRAB 40	1457068.16	576254.25	39° 14.8701´ N	76° 29.3362´ W

Table 2. Water Level Gauge Deployment Locations in the Lower and Upper Regions of the Phase I Survey Area

Region	Gauge	Position (NAD 83)			
		Maryland State Plane (feet)		Geographic Coordinates	
		Easting	Northing	Latitude	Longitude
Lower Bear Creek	**222**	1457370.07	574846.29	39° 14.6379´ N	76° 29.2739´ W
Upper Bear Creek	**223**	1455473.15	571022.14	39° 14.0097´ N	76° 29.6802´ W

Table 3. Sediment Grab Sampling Results in the Lower and Upper Regions of the Phase I Survey Area

Region	Sample	Dominant Sediment Type	Description
Lower Bear Creek	GRAB 1	Silty clay	Black, silty clay or clayey silt with minor sand fraction. Petroleum odor, sheen on discharge (live worms)
	GRAB 2	Silty clay	Black, silty clay or clayey silt with minor sand fraction. Petroleum odor, organic debris, sheen on discharge (live worms)
	GRAB 3	Silty sand	Tan to gray, silty, fine sand. 10% shell fragments
	GRAB 4	Sand	Tan to gray, sand with minor silt fraction. Whole clam shell
	GRAB 5	Silty clay	Black, silty clay or clayey silt with minor sand fraction. Petroleum odor, sheen on discharge (live worms)
	GRAB 6	Silty clay	Black, silty clay or clayey silt with minor sand fraction. Petroleum odor, sheen on discharge
	GRAB 7	Silty sand	Tan, silty sand with whole clam shells
	GRAB 8	Silty sand	Brown, silty sand with trace amounts of shell fragments
	GRAB 9	Sand	Tan sand with minor silt fraction
	GRAB 10	Silty sand	Tan, silty sand with shell fragments (<5%)
	GRAB 11	Silty sand	Tan, silty sand with shell fragments (<5%)
	GRAB 12	Silty clay	Black, silty clay or clayey silt with minor sand fraction. Petroleum odor and whole shells (5%)
	GRAB 13	Silty sand	Tan to dark gray silty sand. <1% shell fragments
	GRAB 14	Silty, fine sand	Brown, silty sand with shell fragments (5%)
	GRAB 15	Silty sand	Tan to dark gray silty sand. 5% shell fragments
	GRAB 16	Silty clay	Black, silty clay or clayey silt with minor sand fraction. Petroleum odor, sheen on discharge (live worms). Limited shell fragments
	GRAB 17	Clay mixed with sand	Yellow clay mixed with sand, some shell (5%)
	GRAB 18	Silty sand	Brown, silty sand with whole shell and shell fragments
	GRAB 19	Silty sand	Brown, silty sand with whole shell and shell fragments
	GRAB 20	Silty sand	Brown silty sand with shell fragments (10-15%)
Upper Bear Creek	GRAB 21	Clayey silt	Black, clayey silt with wood
	GRAB 22	Silty sand	Brown to gray, shelly, silty, sand with shell and organic debris (25%)
	GRAB 23	Clayey silt	Dark brown to gray, shelly, clayey, silt with wood fragments (10% wood/35% shell). 3 cm shell maximum
	GRAB 24	Fine to medium sand	Tan, fine to medium sand with a small silt fraction and shell fragments
	GRAB 25	Silty, fine sand	Tan to gray, silty, fine sand with some shell and limited gravel
	GRAB 26	Clayey silt	Black, clayey silt with live clams. Shell 3 to 4 cm maximum
	GRAB 27	Fine to medium sand	Tan, fine to medium sand with small silt fraction
	GRAB 28	Fine sand	Brown, silty, fine sand
	GRAB 29	Clayey silt	Black, clayey silt with modest amounts of shell (1%)
	GRAB 30	Medium to coarse sand	Brown, medium to coarse sand with 25% shell fragments
	GRAB 31	Silty sand	Tan to black silty sand with tube worms and shell fragments (10%). Shell (<1 cm)
	GRAB 32	Medium to coarse sand	Brown, medium to coarse sand. 30% gravel, 15% shell fragments (2 cm)
	GRAB 33	Silty sand	Brown to black silty sand with shell fragments and whole shell (2 cm)
	GRAB 34	Clayey silt	Black, clayey silt with whole shells (10%; <1 cm)
	GRAB 35	Clayey silt	Black, clayey silt with whole shells (10%; <1 cm)
	GRAB 36	Clayey silt	Black, clayey silt with whole shells (10%; <1 cm)
	GRAB 37	Silt	Black silt with oyster shell (70%; 4 cm)
	GRAB 38	Clayey silt	Black, clayey silt with whole shells (5%; <1 cm)
	GRAB 39	Silty sand	Tan to brown, silty sand with reeds and tube worms
	GRAB 40	Silt	Black silt with small fine sand fraction and shell frags (5%; 2 cm)

APPENDIX B

VISUAL SHORELINE SURVEY TECHNICAL MEMORANDUM

EA Engineering, Science, and Technology, Inc.

225 Schilling Circle
Hunt Valley, MD 21031
Telephone: 410-584-7000
FAX: 410-771-1625
www.eaest.com

14 August 2014

TECHNICAL MEMORANDUM

TO: Andrew Fan (EPA)
Barbara Brown (MDE)
Madi Novak (Maul Foster & Alongi, Inc.)
Dan Silver (Sparrows Point Environmental Trust)

FROM: Thomas King, Visual Shoreline Survey Field Lead
Frank Barranco, Project Manager

SUBJECT: **Visual Shoreline Survey – Sparrows Point Phase 1 Area**

Background

The Sparrows Point Environmental Trust (the Trust) has contracted EA Engineering, Science, and Technology, Inc. (EA) to plan and implement the subaqueous survey of the Northwest Shoreline study area adjacent to the Sparrows Point Facility. As part of the subaqueous survey, EA also conducted a visual shoreline investigation of the area of review in order to identify, map, describe, and photograph noteworthy natural and anthropogenic or natural features along the Bear Creek shoreline, which may have some bearing on the overall site Phase 1 characterization and/or eventual corrective measures.

The project site is located approximately 6 miles southeast of Baltimore, Maryland, in the vicinity of I-695 and Bear Creek (Appendix A: Figure 1). More specifically the visual shoreline investigation focused on an area of review which consisted of the shoreline along the east side of Bear Creek, from the railroad crossing north of Route 157, south to the confluence of Humphrey's Creek (Appendix A: Figure 2). The area of review is bisected by I-695 which separates the area of review into a northern and southern portion.

Methods

The visual shoreline survey was conducted on May 12, 2014 by two of EA's environmental scientists in order to characterize the general existing conditions of the shoreline, immediate upland area along the shoreline, and the intertidal zone. The survey was conducted during the low tide in order to properly observe the intertidal zone and effectively walk the area of review. Transportation to and from the area of review was facilitated using a 17-foot (ft) shallow-draft, open cockpit boat. Although the majority of the visual inspection was conducted from the boat, EA's environmental scientists routinely walked along the shoreline to further investigate the area of review where needed.

During the shoreline survey EA documented the various shoreline habitats including the dominant vegetative cover, presence of invasive species, general substrates, existing infrastructure (outfalls, roads, etc.), common debris, and wildlife observations. The field team surveyed the exposed shoreline and located noteworthy anthropogenic or natural features using a Trimble GeoXT handheld Global Positioning System (GPS) and also by taking on-site photographs of the area of review. In addition to the immediate shoreline, EA also identified the general characteristics of the area between the shoreline and the developed land associated with the Sparrows Point facilities. The GPS data were then utilized to create shoreline condition maps (Appendix A: Figures 3 and 4) to identify and map the existing conditions within the area of review. The on-site photographs are included in Appendix Band the locations are depicted on Figures 5 and 6 (Appendix A).

Results

During the visual shoreline survey EA assessed both the immediate shoreline identified as the intertidal zone and the shoreline just above the intertidal zone identified as the upper shoreline. The Intertidal zone was identified as a narrow area that varied from approximately 2 feet to 10 feet in width and is inundated during high tides. The upper shoreline was identified as the area from the mean high water line to the nearest developed area, which typically consisted of a roadway or site infrastructure.

During the field assessment EA identified four common shoreline types along the immediate shoreline and four habitat types for the upper shoreline. These areas are depicted on the shoreline condition maps in Appendix A and described in greater detail below.

Immediate Shoreline

The majority of the immediate shoreline substrate consists of slag and rock that appears to be from the historic fill areas of slag from the development onshore. The slag and rock were typically observed in long stretches of the shoreline and were overgrown by herbaceous vines such as Virginia creeper (*Parthenocissus quinquefolia*), poison ivy (*Toxicodendron radicans*), and Japanese honeysuckle (*Lonicera japonica*). The areas of slag and rock were typically found along steeper slopes of the shoreline and provide some shoreline protection from erosion. A very low diversity of plant species as well as wildlife were observed in these areas as little habitat is available along the rocky shoreline (Figures 3 and 4).

The second most abundant area of shoreline consists of sandy shoreline dominated by common reed (*Phragmites australis*), which is an invasive plant species. With a few exceptions, the phragmites areas typically extended beyond the immediate shoreline and extended into the upper shoreline. Although plant diversity is low in these areas due to the phragmites ability to outcompete most species, these areas typically provided habitat for bird species including, red winged black birds (*Agelaius phoeniceus*), sand piper species (Family: *Scolopacidae*), and killdeer (*Charadrius vociferus*). Green frogs (*Rana clamitans*) and bullfrogs (*Lithobates catesbeiana*) were also observed in the dense areas of phragmites, as well as mammal tracks. The areas of phragmites also contained a high amount of debris and trash since it is the only habitat along the shoreline capable of receiving and holding debris.

Along the northern most portion of the area of review, EA observed rip-rap and concrete armoring in the vicinity of the bridge abutments for Route 157 and the railroad crossing. These areas are in good condition structurally and provided protection from erosion, but provide little to no habitat value.

The final shoreline type consists of small pockets throughout the area of review where there is no shoreline protection (rock, slag, armoring) and the slopes are not conducive for the phragmites. These areas were identified as eroded stream banks along the shoreline with little vegetation and protection with the exception of some deciduous woody vines. The eroded shoreline typically consisted of silt loam of fine sandy loam with sparse vegetation dominated by staghorn sumac (*Rhus typhina*), sweetgum (*Liquidambar styraciflua*), black locust (*Robinia pseudoacacia*), Virginia creeper, and Japanese honeysuckle.

Upper Shoreline

The upper shoreline consists mostly of either developed areas or deciduous uplands. The developed areas include roadways, parking lots, stormwater infrastructure and bridge abutments. These areas were not assessed in detail. The deciduous forest on the upper shoreline provides the most diverse habitat and is dominated by sweetgum, red maple (*Acer rubrum*), red oak (*Quercus rubra*), staghorn sumac, Japanese honeysuckle, Virginia creeper, poison ivy, and box elder (*Acer negundo*).

As discussed for the above, the areas of phragmites identified along the immediate shoreline commonly extend into the upper shoreline. Although the phragmites along the immediate shoreline is associated with sandy substrate, the phragmites on the upper shoreline was observed within substrate with silt loam characteristics (Phragmites/Wetland). These areas of phragmites above the intertidal zone are considered nontidal emergent wetlands.

In addition to the emergent wetlands, EA identified four areas of nontidal forested wetlands within the upper shoreline. These four wetland areas were all located north of I-695. The forested wetlands were dominated by box elder and red maple overstory with jewelweed (*Impatiense capensis*) and sensitive fern (*Onoclea sensibilis*).

Significant Observations

In addition to characterizing the typical habitats within the shoreline, EA also documented significant observations throughout the area of review. During the site visit on May 12, 2014 EA did not observe any abnormal odors, soil staining, or water sheens within the area of review. However, during the site visit EA personnel identified 3 plastic drums within the phragmites wetland on the northern portion of the area of review.

EA personnel also identified four outfalls along the shoreline as described in Table 1 below. In general these outfalls appeared to be in good condition with little deterioration.

Table 1. Outfall Observation Within the Study Area

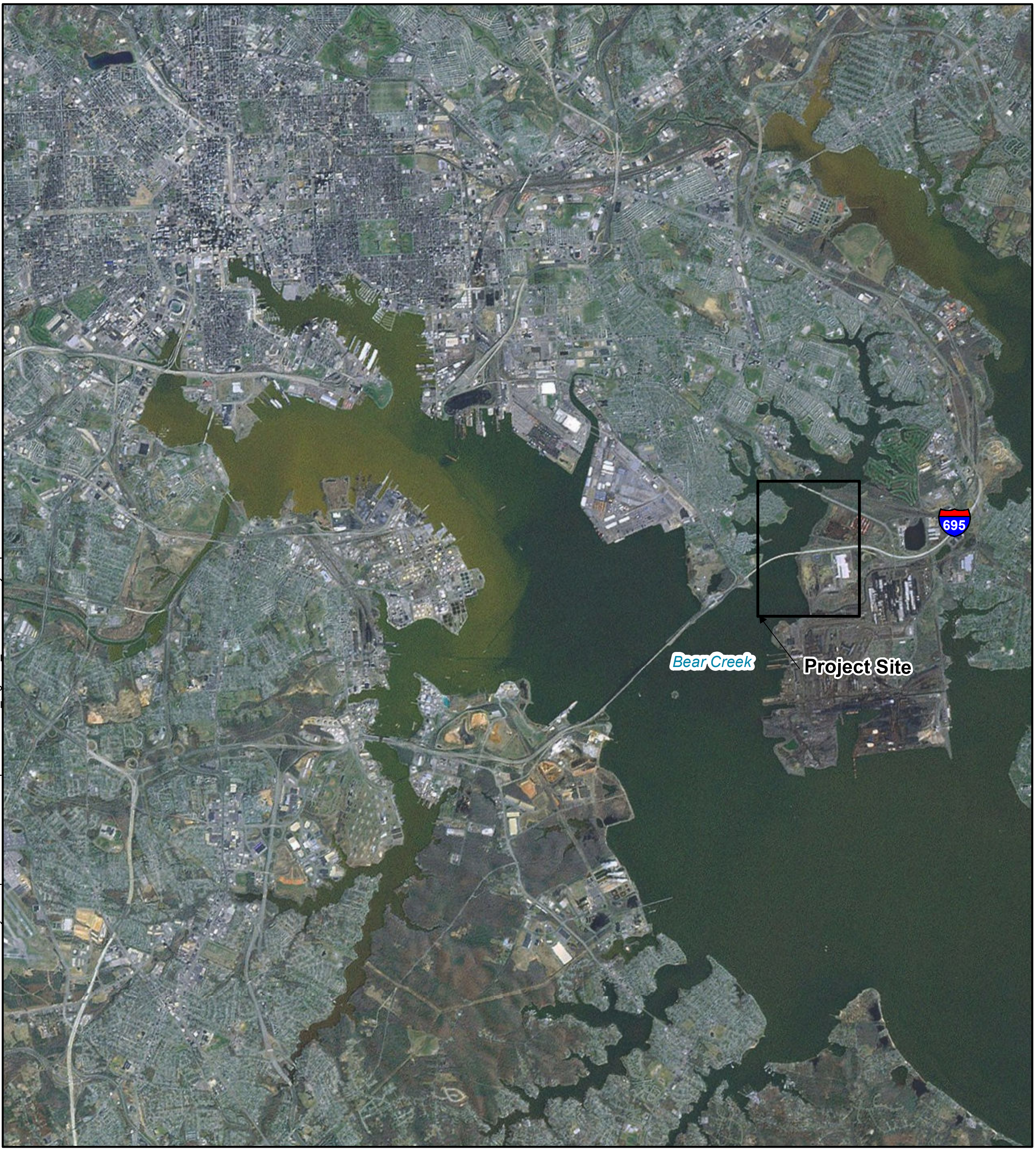
Outfall	Size	Material	Location
#1	36 inches	Corrugated metal	39°14’29” N / 76°29’24” W
#2	70 inches	Concrete	39°13’56” N / 76°29’34” W
#3	48 inches	Concrete	39°13’47” N / 76°29’29” W
#4	36 inches	Corrugated metal	39°14’20” N / 76°29’26” W

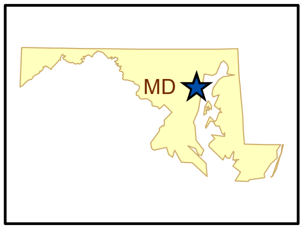
As previously discussed the abutments and shoreline protection associated with the bridges and road crossings appeared to be in good condition with no deterioration.

One wooden structure was identified on the southernmost portion of the area of review. This structure appears to have been an old bulkhead or sea-wall near the confluence of Humphrey’s Creek. This wooden structure, although deteriorated and missing portions does provide a perch area for shorebirds such as great blue heron (*Ardea herodias*), and double-crested cormorants (*Phalacrocorax auritus*).

APPENDIX A
FIGURES

Document Path: L:\GISData\Northeast\Maryland\SparrowsPoint\MXD\SparrowsPoint_Figure1_GeneralVicinityMap.mxd





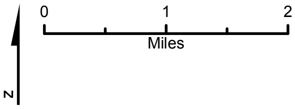
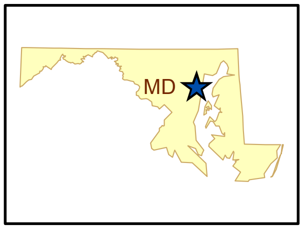


Figure 1
General Vicinity Map
Sparrows Point Environmental Trust
Baltimore, Maryland

Map Date: June 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science,
and Technology, Inc.

Document Path: L:\GISData\Northeast\Maryland\SparrowsPoint\MXD\SparrowsPoint_Figure2_AreaofReviewMap.mxd



Legend

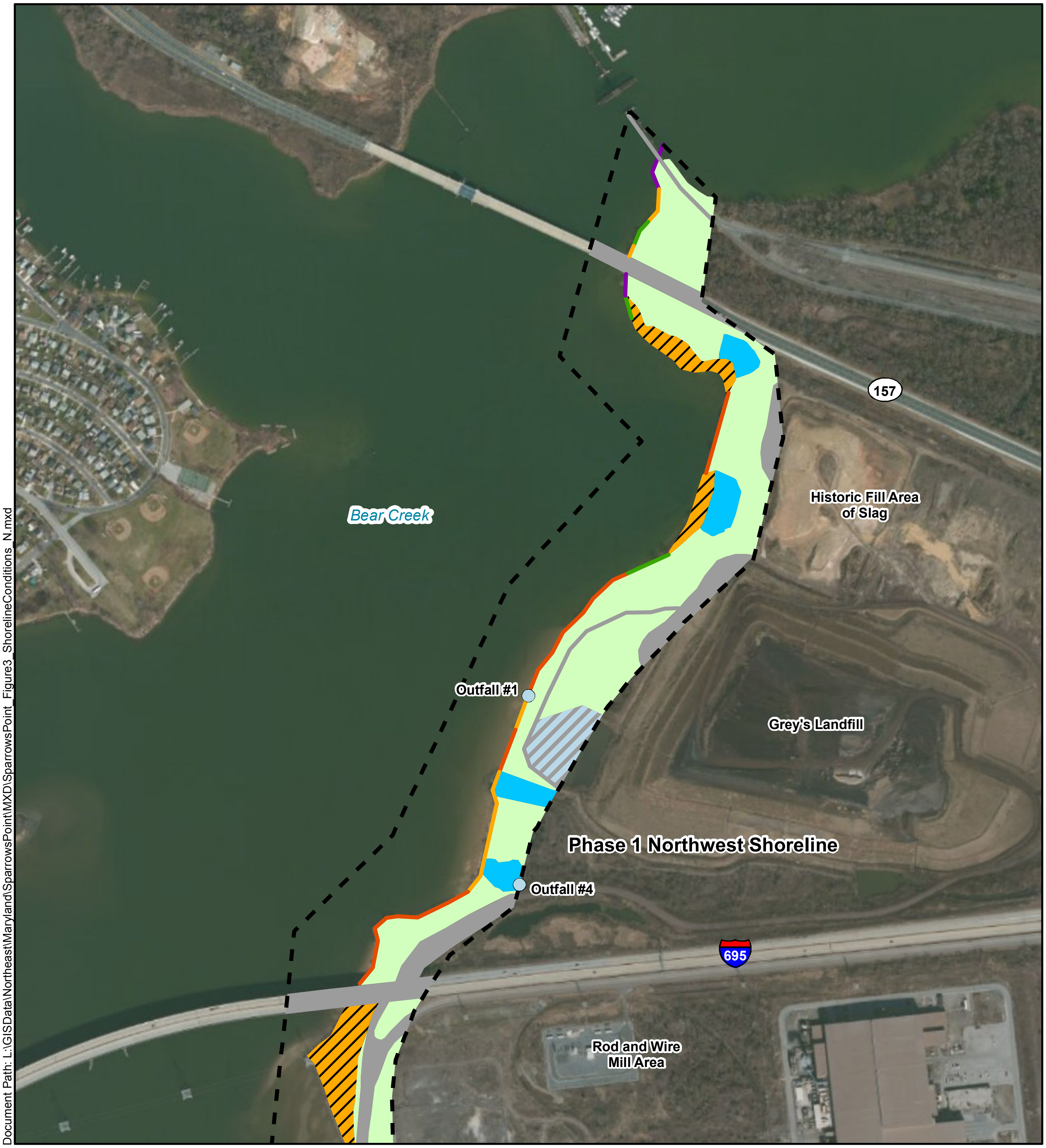
⌐¬ Area of Review

〰 Perennial Creek/Stream

Figure 2
Area of Review Map
Sparrows Point Environmental Trust
Baltimore, Maryland

Map Date: June 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science, and Technology, Inc.



Document Path: L:\GISData\Northeast\Maryland\SparrowsPoint\MXD\SparrowsPoint_Figure3_ShorelineConditions_N.mxd

Figure 3
Shoreline Conditions - North Area of Review
Sparrows Point Environmental Trust
Baltimore, Maryland

Map Date: June 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science, and Technology, Inc.

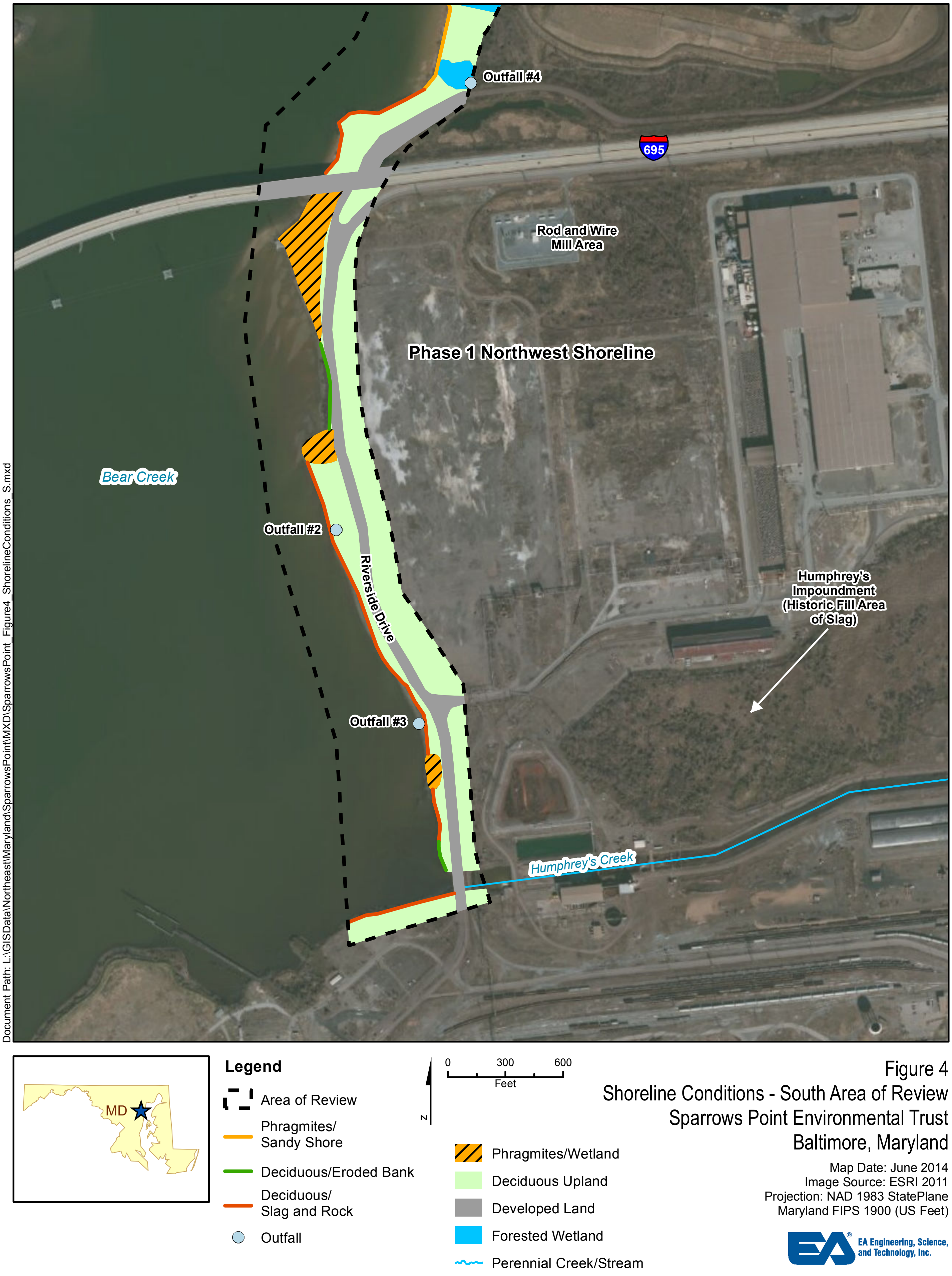


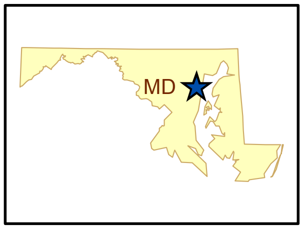
Figure 4
Shoreline Conditions - South Area of Review
Sparrows Point Environmental Trust
Baltimore, Maryland

Map Date: June 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science, and Technology, Inc.

Document Path: L:\GISData\Northeast\Maryland\SparrowsPoint\MXD\SparrowsPoint_Figure4_ShorelineConditions_S.mxd

Document Path: L:\GISData\Northeast\Maryland\SparrowsPoint\MXD\SparrowsPoint_Figure5_PhotographLocs_N.mxd



Legend

▚ Area of Review

○ Photograph Location

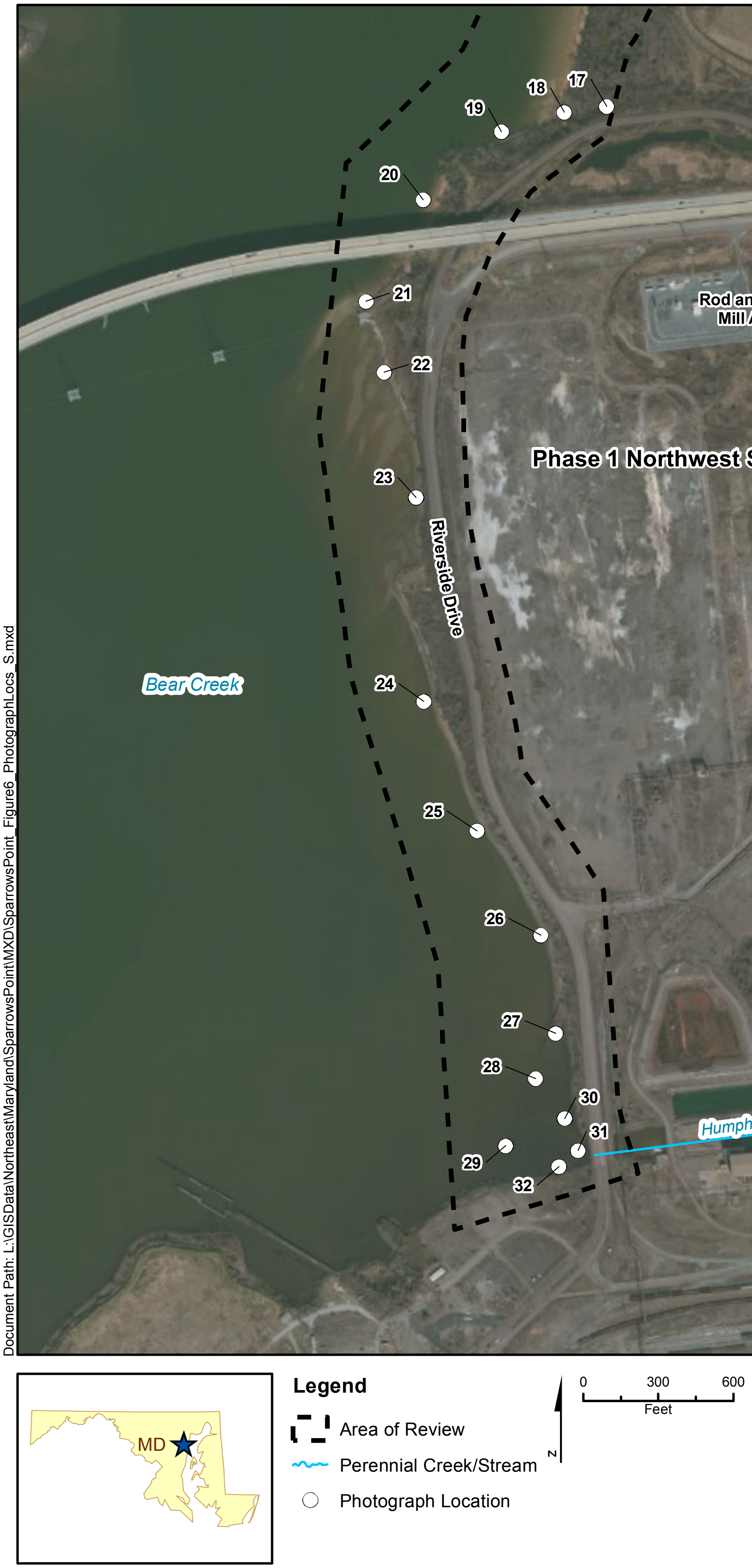
N

0 300 600
Feet

Figure 5
Photograph Locations - North Area of Review
Sparrows Point Environmental Trust
Baltimore, Maryland

Map Date: June 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science, and Technology, Inc.



Document Path: L:\GISData\Northeast\Maryland\SparrowsPoint\MXD\SparrowsPoint_Figure6_PhotographLocs_S.mxd

Figure 6
Photograph Locations - South Area of Review
Sparrows Point Environmental Trust
Baltimore, Maryland

Map Date: June 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science, and Technology, Inc.

APPENDIX B
SITE PHOTOGRAPHS

Site Photographs
Visual Shoreline Survey – Sparrows Point Phase 1 Area
Photos Taken May 12, 2014

Photograph 1: Rip-rap protection at the northern end of the area of review.

Photograph 2: Sparse phragmites stand along the sandy shoreline on the northern end of the area of review.

Photograph 3: Vegetated buffer along the shoreline between the railroad tracks and Route 157.

Photograph 4: Shoreline beneath Route 157.

Photograph 5: Erosion along the shoreline directly south of Route 157.

Photograph 6: Dense phragmites stand directly south of Route 157.

Photograph 7: Trash and debris commonly found along the shoreline throughout the area of review.

Photograph 8: Slag and concrete identified along the shoreline near the historic fill area of slag, south of Route 157.

Photograph 9: Plastic drums found within the phragmites wetland area on the northern portion of the area of review.

Photograph 10: Slag and concrete identified along the shoreline near the historic fill area of slag, south of Route 157.

Photograph 11: Phragmites stand along the shoreline.

Photograph 12: Rock and slag located along the shoreline of Grey’s Landfill.

Photograph 13: Outfall #1

Photograph 14: Sandy shoreline identified near Outfall #1.

Photograph 15: Stormwater management pond located at Gray's Landfill.

Photograph 16: eroded shoreline located along the northern portion of the area of review.

Photograph 17: Outfall #4

Photograph 18: Forested wetland located at Outfall #4, just north of I-695.

Photograph 19: Slag shoreline located directly north of I-695.

Photograph 20: Sandy shoreline with light phragmites located along the shoreline beneath I-695.

Photograph 21: Dense phragmites, intertidal marsh located directly south of I-695.

Photograph 22: Dense phragmites, intertidal marsh located directly south of I-695

Photograph 23: Eroded shoreline along Riverside Drive, just south of I-695.

Photograph 24: Outfall #2.

Photograph 25: Rock and slag shoreline located along Riverside Drive.

Photograph 26: Outfall #3.

Photograph 27: Small phragmites pocket located along Riverside Drive at the start of the old wooden structure.

Photograph 28: Old wooden structure located along the southern end of the area of review.

Site Photographs
Visual Shoreline Survey – Sparrows Point Phase 1 Area
Photos Taken May 12, 2014

Photograph 29: shorebirds identified on the old wooden structure on the southern portion of the area of review.

Photograph 30: Eroded bank along the shoreline, just north of Humphrey's Creek.

Photograph 31: Confluence of Humphrey's Creek with Bear Creek.

Photograph 32: Rocky shoreline located along the southernmost portion of the area of review.

APPENDIX C

GROUNDWATER SAMPLING RESULTS TECHNICAL MEMORANDUM

EA Engineering, Science, and Technology, Inc.

225 Schilling Circle
Hunt Valley, MD 21031
Telephone: 410-584-7000
FAX: 410-771-1625
www.eaest.com

8 September 2014

TECHNICAL MEMORANDUM

TO: Andrew Fan (EPA)
Barbara Brown (MDE)
Madi Novak (Maul Foster & Alongi, Inc.)
Dan Silver (Sparrows Point Environmental Trust)

FROM: Michael Phillips, Groundwater Investigation Field Lead
Samantha Saalfield, Project Geologist
Frank Barranco, Project Manager

SUBJECT: **Groundwater Investigation – Sparrows Point Phase 1 Area**

Background

The Sparrows Point Environmental Trust (the Trust) has contracted EA Engineering, Science, and Technology, Inc. (EA) to plan and implement the Offshore Investigation of the Phase 1, Northwest Shoreline study area, adjacent to the Sparrows Point Facility. As part of the Offshore Investigation, EA also conducted a groundwater sampling event to identify constituents of potential concern (COPCs) that may be transported to offshore surface water or sediments via groundwater flow. Groundwater investigation field activities were conducted between 18 and 27 June 2014. This event included a monitoring well integrity evaluation and well redevelopment, conducted prior to the sampling to verify well integrity and ensure representativeness of samples collected. All work was conducted in accordance with the *Proposed Approach and Methods for Groundwater Sampling* memorandum dated 16 June 2014.

The Phase I area is located approximately 6 miles southeast of Baltimore, Maryland, in the vicinity of I-695 and Bear Creek. More specifically, the groundwater investigation focused on existing monitoring wells along the shoreline in the vicinity of Rod & Wire Mill and Humphrey Impoundment in the Phase I area.

Monitoring Locations

Ten existing wells were selected for sampling to provide data from the shallow, intermediate, and deep groundwater zones along the Phase I shoreline (**Table 1**). Well locations are illustrated on **Figure 1**.

Monitoring Well Survey

The monitoring well survey was conducted on 18 June 2014 by one of EA's environmental scientists in order to assess the integrity of the wells selected for sampling. The protective casing and riser were inspected for damage at each well. The cap on each well was removed and a water level indicator was used to measure the depth of the well and assess whether silt had accumulated at the bottom. The latitude and longitude of each well was measured using World Geodetic System (WGS) 1984 datum with a hand-held global positioning system unit. A photo of each well, including visual indication of the well number, was taken to document its physical condition. All information collected during the monitoring well survey was recorded on well integrity field forms (**Attachment A**).

Although deficiencies in well condition were observed for most of the wells (**Table 2**), none of these deficiencies were found to affect well usability. Due to a bent casing and riser, well HI08-PZM060 could not be sampled with a standard 2-inch submersible pump. Based on the well survey, the ten wells proposed for sampling were found to be in acceptable condition.

Monitoring Well Development

The wells selected for sampling were successfully redeveloped prior to sampling, in accordance with the Standard Operating Procedure (SOP) for Redevelopment of Existing Monitoring Wells included in the *Proposed Approach and Methods for Groundwater Sampling* memorandum dated 16 June 2014. Redevelopment was performed to maximize the representativeness of the samples collected. Two well development techniques, over-pumping and surging, were employed in tandem. Over-pumping was performed using a stainless steel submersible pump to remove water from the well at a rate higher than recharge. Surging was accomplished using a tight-fitting surge block, gently surged throughout the screened interval for periods of 5-10 minutes. During development, a multiparameter water quality meter equipped with a flow-through cell was utilized to record water quality readings (pH, temperature, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) after purging of each well redevelopment volume. Redevelopment volumes and water quality data were recorded on well development field forms (**Attachment B**). A minimum of three well volumes were purged from each well. Alternating surging and pumping continued until water quality parameters had stabilized over three consecutive readings. A total of approximately 214 gallons of groundwater was generated during development activities. Development water was drummed and transported to a secure offsite staging area pending disposal.

Groundwater Sampling Methodology

Groundwater samples were collected using low-flow methods, consistent with the SOP for Low-Flow Groundwater Sampling included in the *Proposed Approach and Methods for Groundwater Sampling* memorandum dated 16 June 2014. Each well was purged at 0.2-0.5 L/min and water quality indicator parameters (turbidity, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and pH) were recorded every 5 minutes and recorded on the purge form (**Attachment C**). Purging continued until three consecutive measurements indicated turbidity less than 10 NTUs and less than approximately 10 percent variability in the other parameters. The depth to water in each well was measured prior to purging, during purging, and after sampling using an electronic water level indicator. Purge water was collected in 55-gallon drums for appropriate disposal. Disposable LDPE tubing was used for purging and sampling of each well, and non-dedicated equipment (submersible pump and water level indicator) in contact with groundwater was decontaminated between wells in accordance with the SOP.

Samples were collected in clean containers provided by the laboratory, and immediately placed in a cooler with ice to maintain a temperature of <4 ^{0} C. One duplicate sample (062514-DP at location RW20-PZM020) was collected, and a trip blank was included in each cooler containing bottles for analysis of volatile organic compounds (VOCs).

Samples and QC samples were stored in an ice-filled cooler until the end of each sampling day. Samples were packaged in bubble wrap, placed in an ice-filled cooler and shipped via overnight delivery to TestAmerica–Pittsburgh in Pittsburgh, Pennsylvania. Cooler(s) were sealed with packing tape and custody seals, and a completed chain-of-custody record representing the packaged samples was taped to the inside of the cooler lid.

TestAmerica analyzed the groundwater samples for the following:

- Priority pollutant list (PPL) VOCs by EPA Method 8260C
- Low-level PPL semivolatile organic compounds (SVOCs) (including polycyclic aromatic hydrocarbons [PAHs]) by EPA Method 8270D
- Total PPL metals by EPA Method 6020A
- Mercury by EPA Method 7470A
- Cyanide by EPA Method 9014.

The primary IDW from the groundwater sampling consisted of development water, purge water, and decontamination fluids. This IDW was drummed and transported to a secure offsite staging area. The results of the groundwater sampling will be used to characterize the water for disposal. Solid IDW (personal protective equipment, sample tubing, etc.) was bagged and disposed of as municipal solid waste.

Results

Tables 3 through 6 present the concentrations of VOCs, PAHs, other SVOCs, and metals and cyanide, respectively, reported in groundwater. Analytical and validation reports have been provided under separate cover and will be retained by EA.

Comparison of results for the field duplicate and its parent sample generally indicated good agreement. However, the reported concentration of bis(2-chloroethyl)ether in the duplicate was substantially higher than the concentration in the parent sample. Based on this high relative percent difference, the results for this analyte were J-qualified by the data validator, to indicate that they are estimated. Additionally, five PAHs were detected at low concentrations in the duplicate but were not detected in the parent sample.

Seven of the cyanide results were also qualified during data validation, based on low recoveries in the matrix spike and matrix spike duplicate, and a detection of cyanide in one of the method blanks. These qualifications included the rejection of three non-detect cyanide results; the data are not of sufficient quality to indicate that cyanide is not present at detectable levels in the wells corresponding to these results (RW19-PZM020, RW19-PZM050, and HI08-PZM060).

The analytical results were screened using the project screening values (**Table 7**). Where available, National Recommended Water Quality Criteria (NRWQCs) were used as screening values. For constituents for which NRWQCs are available for both aquatic life and human health, the lower of the Saltwater Aquatic Life Criterion Continuous Concentration or the Human Health (Organism Only) Criterion was used. For constituents for which no NRWQCs are available, EPA Region III Biological Technical Assistance Group marine surface water benchmarks were used as screening criteria. If no marine benchmark was available, the freshwater benchmark was used, except in the cases of metals.

Constituents exceeding the screening criteria, by analytical group, are summarized below and presented in **Figure 2**.

VOCs – No VOCs were detected in any of the samples collected.

PAHs – Benzo[a]anthracene and chrysene were reported at concentrations exceeding the screening criterion of 0.0018 µg/L in samples from two wells (HI08-PZM003 and RW20-PZP000). The naphthalene concentration reported in the sample from RW18-PZM047 also exceeded the screening criterion of 1.4 µg/L.

SVOCs – The only SVOC reported at a concentration exceeding a screening criterion was bis(2-ethylhexyl)phthalate, in samples from six wells (HI08-PZM003, HI08-PZM060, RW18-PZM047, RW19-PZM020, RW19-PZM050 and RW20-PZP000).

Metals – Concentrations of the following metals exceeded screening criteria in one or more samples: arsenic, cadmium, chromium, copper, lead, nickel, and zinc. The metals reported at concentrations exceeding screening criterion in the most wells were nickel (eight wells), zinc (seven wells), and copper (six wells). The wells with the most metals at concentrations exceeding criteria were HI08-PZM003, RW19-PZM020, and TS04-PDM004 (five metals each).

Cyanide – Cyanide concentrations exceeded the screening criterion (1 µg/L) in samples from three wells (HI08-PZM003, RW19-PZP000, and RW20-PZP000).

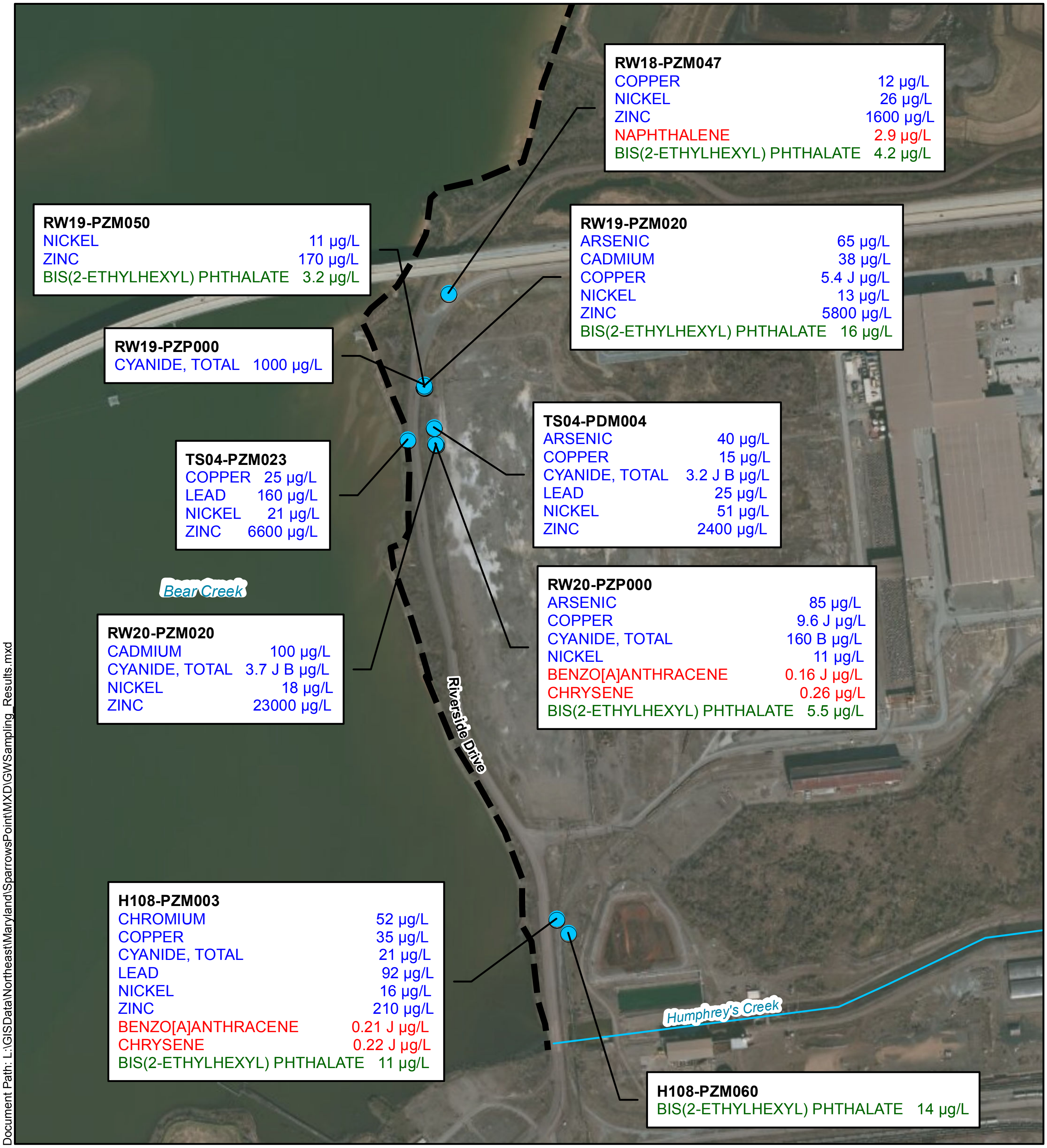
As stated above, these exceedances were used, along with exceedances in historical data available from other sampling events, to identify COPCs for sediment and pore water in the Phase I area. A discussion of the COPCs is included in the *Work Plan for Offshore Investigation of the Phase I Area of the Sparrows Point Site* (EA 2014).

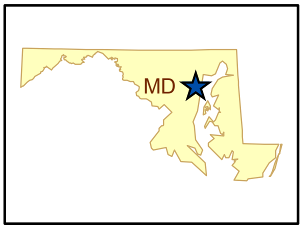
Document Path: \\lovetonfederal\GISData\Northeast\Maryland\SparrowsPoint\MXD\SparrowsPoint_Figure1_ProposedGWSamplingLocs_rev2.mxd

Figure 1
Groundwater Sampling Locations
Sparrows Point Environmental Trust
Baltimore, Maryland

Map Date: August 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science, and Technology, Inc.





Legend

- ▬ ▬ Phase 1 Northwest Shoreline
- 〰 Perennial Creek/Stream
- ● Groundwater Well Sampled June 2014

Notes:
J = compound detected but below reporting limt
B = compound detected in the method bank
µg/L = micrograms per liter
Blue = Inorganic result
Red = Polycyclic Aromatic Hydrocarbon (PAH) result
Green = Semi-Volatile Organic Compound (SVOC) result

Figure 2
Groundwater Sampling Results that Exceed Screening Criteria
Sparrows Point Environmental Trust
Baltimore, Maryland

Map Date: August 2014
Image Source: ESRI 2011
Projection: NAD 1983 StatePlane
Maryland FIPS 1900 (US Feet)

EA Engineering, Science, and Technology, Inc.

Document Path: L:\GISData\Northeast\Maryland\SparrowsPoint\MXD\GWSampling_Results.mxd

Table 1
Groundwater Monitoring Wells

Well	Area	Groundwater Zone
HI08-PZM003	Humphrey Impoundment	Shallow
HI08-PZM060	Humphrey Impoundment	Deep
RW18-PZM047	Rod & Wire Mill	Deep
RW19-PZP000	Rod & Wire Mill	Shallow
RW19-PZM020	Rod & Wire Mill	Intermediate
RW19-PZM050	Rod & Wire Mill	Deep
RW20-PZP000	Rod & Wire Mill	Shallow
RW20-PZM020	Rod & Wire Mill	Intermediate
TS04-PDM004	Rod & Wire Mill	Shallow
TS04-PZM023	Rod & Wire Mill	Intermediate

Table 2
Monitoring Well Integrity Evaluation

Well	Location (WGS 1984)	Comments
HI08-PZM003	39º 13’45.051 N/76º 29’26.750 W	Casing heaved; integrity of riser not affected
HI08-PZM060	39º 13’44.403 N/76º 29’25.053 W	Casing and riser bent slightly at ground surface
RW18-PZM047	39º 14’14.370 N/76º 29’33.018 W	No casing lid, no well plug
RW19-PZP000	39º 14’10.073 N/76º 29’34.524 W	No well plug
RW19-PZM020	39º 14’10.001 N/76º 29’34.569 W	No well plug
RW19-PZM050	39º 14’09.981 N/76º 29’34.496 W	No well plug
RW20-PZP000	39º 14’07.330 N/76º 29’33.860 W	No well plug
RW20-PZM020	39º 14’07.303 N/76º 29’33.795 W	No well plug
TS04-PDM004	39º 14’08.076 N/76º 29’33.947 W	No well plug
TS04-PZM023	39º 14’07.523 N/76º 29’35.538 W	Flush-mount

Table 3
Concentrations of Volatile Organic Compounds in Groundwater

ANALYTE	UNITS	AVG RL	Sparrows Point Screening Criteria	062614-TB	062714-TB	H108-PZM003	H108-PZM060	RW18-PZM047	RW19-PZM020	RW19-PZM050	RW19-PZP000	RW20-PZM020	RW20-PZP000	TS04-PDM004	TS04-PZM023
1,1,1-TRICHLOROETHANE	UG/L	5	312	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2,2-TETRACHLOROETHANE	UG/L	5	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2-TRICHLOROETHANE	UG/L	5	16	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,1-DICHLOROETHANE	UG/L	5	47	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,1-DICHLOROETHENE	UG/L	5	7100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-DICHLOROBENZENE	UG/L	5	1300	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-DICHLOROETHANE	UG/L	5	37	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-DICHLOROPROPANE	UG/L	5	15	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,3-DICHLOROBENZENE	UG/L	5	960	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,4-DICHLOROBENZENE	UG/L	5	190	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-CHLOROETHYL VINYL ETHER	UG/L	10	---	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
ACROLEIN	UG/L	100	3	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
ACRYLONITRILE	UG/L	50	0.25	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
BENZENE	UG/L	5	51	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
BROMOFORM	UG/L	5	140	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
BROMOMETHANE	UG/L	5	120	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
CARBON TETRACHLORIDE	UG/L	5	1.6	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
CHLOROBENZENE	UG/L	5	1600	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
CHLORODIBROMOMETHANE	UG/L	5	17	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
CHLOROETHANE	UG/L	5	---	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U	7 U	5 U
CHLOROFORM	UG/L	5	470	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
CHLOROMETHANE	UG/L	5	2700	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
CIS-1,3-DICHLOROPROPENE	UG/L	5	21	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
DICHLOROBROMOMETHANE	UG/L	5	13	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
ETHYLBENZENE	UG/L	5	2100	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
METHYLENE CHLORIDE	UG/L	5	590	5 U *	5 U *	5 U	5 U	5 U *	5 U	5 U	5 U	5 U	5 U	5 U	5 U *
TETRACHLOROETHENE	UG/L	5	3.3	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
TOLUENE	UG/L	5	15000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
TRANS-1,2-DICHLOROETHENE	UG/L	5	10000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
TRANS-1,3-DICHLOROPROPENE	UG/L	5	21	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
TRICHLOROETHENE	UG/L	5	30	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
VINYL CHLORIDE	UG/L	5	2.4	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

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

Shaded values exceed Sparrows Point Screening Criteria

U = compound was analyzed, but not detected

RL = reporting limit

Table 4
Concentrations of Polycyclic Aromatic Hydrocarbons in Groundwater

ANALYTE	UNITS	AVG RL	Sparrows Point Screening Criteria	H108-PZM003	H108-PZM060	RW18-PZM047	RW19-PZM020	RW19-PZM050	RW19-PZP000	RW20-PZM020	RW20-PZP000	TS04-PDM004	TS04-PZM023
ACENAPHTHENE	UG/L	0.202	990	0.23 U	0.2 U	**0.43**	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	0.21 U
ACENAPHTHYLENE	UG/L	0.202	---	**0.21 J**	0.2 U	**0.61**	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	0.21 U
ANTHRACENE	UG/L	0.202	40000	**0.15 J**	0.2 U	**0.39**	0.19 U	0.2 U	**0.093 J**	0.2 U	**0.064 J**	0.19 U	**0.038 J**
BENZO[A]ANTHRACENE	UG/L	0.202	0.018	**0.21 J**	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.2 U	**0.16 J**	0.19 U	0.21 U
BENZO[A]PYRENE	UG/L	0.202	0.018	0.23 U	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	0.21 U
BENZO[B]FLUORANTHENE	UG/L	0.202	0.018	0.23 U	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	0.21 U
BENZO[G,H,I]PERYLENE	UG/L	0.202	---	0.23 U	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	0.21 U
BENZO[K]FLUORANTHENE	UG/L	0.202	0.018	0.23 U	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	0.21 U
CHRYSENE	UG/L	0.202	0.018	**0.22 J**	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.2 U	**0.26**	0.19 U	0.21 U
DIBENZ(A,H)ANTHRACENE	UG/L	0.202	0.018	0.23 U	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	0.21 U
FLUORANTHENE	UG/L	0.202	140	**0.32**	0.2 U	**0.42**	0.19 U	0.2 U	0.19 U	0.2 U	**0.11 J**	0.19 U	**0.12 J**
FLUORENE	UG/L	0.202	5300	0.23 U	0.2 U	**1.2**	0.19 U	0.2 U	0.19 U	0.2 U	**0.084 J**	0.19 U	**0.056 J**
INDENO[1,2,3-CD]PYRENE	UG/L	0.202	---	0.23 U	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	0.21 U
NAPHTHALENE	UG/L	0.202	1.40	0.23 U	0.2 U	**2.9**	0.19 U	0.2 U	0.19 U	0.2 U	0.2 U	0.19 U	**0.097 J**
PHENANTHRENE	UG/L	0.202	1.5	**0.2 J**	0.2 U	**0.68**	0.19 U	0.2 U	**0.15 J**	0.2 U	**0.39**	0.19 U	**0.19 J**
PYRENE	UG/L	0.202	4000	**0.25**	0.2 U	**0.26**	0.19 U	0.2 U	0.19 U	0.2 U	**0.063 J**	0.19 U	**0.091 J**

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

Shaded values exceed Sparrows Point Screening Criteria

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

U = compound was analyzed, but not detected

RL = reporting limit

Table 5
Concentrations of Other Semivolatile Organic Compounds in Groundwater

ANALYTE	UNITS	AVG RL	Sparrows Point Screening Criteria	H108-PZM003	H108-PZM060	RW18-PZM047	RW19-PZM020	RW19-PZM050	RW19-PZP000	RW20-PZM020	RW20-PZP000	TS04-PDM004	TS04-PZM023
1,2,4-TRICHLOROBENZENE	UG/L	0.998	---	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
1,2-DIPHENYLHYDRAZINE(AS AZOBENZENE)	UG/L	0.998	---	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
2,2'-OXYBIS[1-CHLOROPROPANE]	UG/L	0.998	---	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
2,4,6-TRICHLOROPHENOL	UG/L	0.998	2.4	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
2,4-DICHLOROPHENOL	UG/L	0.998	290	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
2,4-DIMETHYLPHENOL	UG/L	0.998	850	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
2,4-DINITROPHENOL	UG/L	5.05	5300	5.7 U	5 U	5.2 U	4.8 U	5 U	4.8 U	1 U	5 U	4.8 U	5.2 U
2,4-DINITROTOLUENE	UG/L	0.998	3.4	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
2,6-DINITROTOLUENE	UG/L	0.998	81	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
2-CHLORONAPHTHALENE	UG/L	0.202	1600	0.23 U	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	1 U	0.2 U	0.19 U	0.21 U
2-CHLOROPHENOL	UG/L	0.998	150	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
2-NITROPHENOL	UG/L	0.998	2940	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
3,3'-DICHLOROBENZIDINE	UG/L	0.998	0.028	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
4,6-DINITRO-2-METHYLPHENOL	UG/L	5.05	280	5.7 U	5 U	5.2 U	4.8 U	5 U	4.8 U	1 U	1 U	4.8 U	5.2 U
4-BROMOPHENYL PHENYL ETHER	UG/L	0.998	1.5	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
4-CHLORO-3-METHYLPHENOL	UG/L	0.998	---	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
4-CHLOROPHENYL PHENYL ETHER	UG/L	0.998	---	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
4-NITROPHENOL	UG/L	5.05	71.7	5.7 U	5 U	5.2 U	4.8 U	5 U	4.8 U	1 U	1 U	4.8 U	5.2 U
BENZIDINE	UG/L	20.2	---	23 U	20 U	21 U	19 U	20 U	19 U	1 U	1 U	19 U	21 U
BENZOIC ACID	UG/L	5.05	---	5.7 U	5 U	5.2 U	4.8 U	5 U	4.8 U	1 U	1 U	4.8 U	4.8 U
BIS(2-CHLOROETHOXY)METHANE	UG/L	0.998	---	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
BIS(2-CHLOROETHYL)ETHER	UG/L	0.998	0.53	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
BIS(2-ETHYLHEXYL) PHTHALATE	UG/L	2.02	2.2	**11**	**14**	**4.2**	**16**	**3.2**	**2.2**	**1.3 J**	**5.5**	**1.6 J**	**1.1 J**
BUTYL BENZYL PHTHALATE	UG/L	0.998	1900	**0.39 J**	**0.32 J**	**0.28 J**	**2.4**	**2.5**	**0.37 J**	**0.28 J**	**0.71 J**	**0.24 J**	**2.3**
DIETHYL PHTHALATE	UG/L	0.998	44000	1.1 U	1 U	**0.39 J**	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
DIMETHYL PHTHALATE	UG/L	0.998	1100000	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
DI-N-BUTYL PHTHALATE	UG/L	0.998	4500	1.1 U	1 U	1 U	**0.25 J**	**1.4**	**0.3 J**	1 U	1 U	0.96 U	**0.28 J**
DI-N-OCTYL PHTHALATE	UG/L	0.998	22	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
HEXACHLOROBENZENE	UG/L	0.998	0.00029	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
HEXACHLOROBUTADIENE	UG/L	0.998	18	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
HEXACHLOROCYCLOPENTADIENE	UG/L	0.998	1100	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
HEXACHLOROETHANE	UG/L	0.998	3.3	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
ISOPHORONE	UG/L	0.998	960	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
NITROBENZENE	UG/L	2.02	690	2.3 U	2 U	2.1 U	1.9 U	2 U	1.9 U	2 U	2 U	1.9 U	2.1 U
N-NITROSODIMETHYLAMINE	UG/L	0.998	---	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
N-NITROSODI-N-PROPYLAMINE	UG/L	0.998	0.51	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
N-NITROSODIPHENYLAMINE	UG/L	0.998	6	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
PENTACHLOROPHENOL	UG/L	0.998	3	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U
PHENOL	UG/L	0.998	860000	1.1 U	1 U	1 U	0.96 U	1 U	0.96 U	1 U	1 U	0.96 U	1 U

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

Shaded values exceed Sparrows Point Screening Criteria

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

U = compound was analyzed, but not detected

RL = reporting limit

Table 6
Concentrations of Inorganic Constituents in Groundwater

ANALYTE	UNITS	AVG RL	Sparrows Point Screening Criteria	H108-PZM003	H108-PZM060	RW18-PZM047	RW19-PZM020	RW19-PZM050	RW19-PZP000	RW20-PZM020	RW20-PZP000	TS04-PDM004	TS04-PZM023
ANTIMONY	UG/L	10	640	10 U	10 U	10 U	10 U	10 U	10 U	**0.13 J**	**5.3 J**	**1.5 J**	10 U
ARSENIC	UG/L	5	36	**14**	**26**	**1.5 J**	**65**	5 U	**18**	**25**	**85**	**40**	**14**
BERYLLIUM	UG/L	5	---	**2.2 J**	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
CADMIUM	UG/L	5	8.8	**0.86 J**	5 U	**1.3 J**	**38**	**0.87 J**	5 U	**100**	5 U	**3.1 J**	**5.5**
CHROMIUM	UG/L	10	50	**52**	10 U	**28**	**3.6 J**	**19**	**35**	**5 J**	**9.2 J**	**32**	**47**
COPPER	UG/L	10	3.1	**35**	10 U	**12**	**5.4 J**	**2.6 J**	**2.4 J**	**2.1 J**	**9.6 J**	**15**	**25**
LEAD	UG/L	5	8.1	**92**	**0.14 J**	**6**	**0.5 J**	**1.5 J**	**2.2 J**	**0.97 J**	**7.1**	**25**	**160**
MERCURY	UG/L	0.2	0.9	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.05 U	0.2 U	0.2 U	0.2 U	0.2 U
NICKEL	UG/L	5	8.2	**16**	5 U	**26**	**13**	**11**	**1.6 J**	**18**	**11**	**51**	**21**
SELENIUM	UG/L	25	71	25 U	25 U	25 U	**3.5 J**	25 U	25 U	**6.4 J**	25 U	25 U	**3.8 J**
SILVER	UG/L	5	0.23	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
THALLIUM	UG/L	5	0.47	**0.32 J**	5 U	5 U	5 U	5 U	**0.11 J**	5 U	5 U	5 U	**0.22 J**
ZINC	UG/L	25	81	**210**	25 U	**1600**	**5800**	**170**	**11 J**	**23000**	**37**	**2400**	**6600**

CYANIDE, TOTAL	UG/L	19	1	**21 J**	R	10 U	R	R	**1000 J**	10 U	**160**	10 U	10 U

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

Shaded values exceed Sparrows Point Screening Criteria

B = compound was detected in the method blank

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

P = the percent difference between the original and confirmation analysis is greater than 25%

R = the sample results are unusable because certain data quality criteria were not met; the analyte may or may not be present in the sample

U = compound was analyzed, but not detected

RL = reporting limit

Table 7. Analytical Project Limits and Screening Values for Groundwater Samples

Parameter	Units	NRWQC Saltwater Aquatic Life CCC	NRWQC Human Health (Organism Only)	BTAG Value (a)	Screening Value (b)
PPL Volatile Organic Compounds					
Acrolein	µg/L	3	9	0.55	3
Acrylonitrile	µg/L	--	0.25	581	0.25
Benzene	µg/L	--	51	110	51
Bromodichloromethane	µg/L	--	17	--	17
Bromoform	µg/L	--	140	640	140
Bromomethane	µg/L	--	--	120	120
Carbon tetrachloride	µg/L	--	1.6	1,500	1.6
Chlorobenzene	µg/L	--	1600	25	1600
Chloroethane	µg/L	--	--	--	--
2-Chloroethyl vinyl ether	µg/L	--	--	--	--
Chloroform	µg/L	--	470	815	470
Chloromethane	µg/L	--	--	2,700	2,700
Dibromochloromethane	µg/L	--	13	--	13
1,2-Dichlorobenzene	µg/L	--	1,300	42	1,300
1,3-Dichlorobenzene	µg/L	--	960	28.5	960
1,4-Dichlorobenzene	µg/L	--	190	19.9	190
trans-1,2-Dichloroethene	µg/L	--	10,000	970	10,000
1,1-Dichloroethane	µg/L	--	--	47	47
1,2-Dichloroethane	µg/L	--	37	1,130	37
1,1-Dichloroethene	µg/L	--	7,100	2,240	7,100
1,2-Dichloropropane	µg/L	--	15	2,400	15
cis-1,3-Dichloropropene	µg/L	--	21	7.9	21
trans-1,3-Dichloropropene	µg/L	--	21	7.9	21
Ethylbenzene	µg/L	--	2,100	25	2,100
Methylene chloride	µg/L	--	590	2,560	590
1,1,2,2-Tetrachloroethane	µg/L	--	4	90.2	4
Tetrachloroethene	µg/L	--	3.3	45	3.3
Toluene	µg/L	--	15,000	215	15,000
1,1,1-Trichloroethane	µg/L	--	--	312	312
1,1,2-Trichloroethane	µg/L	--	16	550	16
Trichloroethene	µg/L	--	30	1,940	30
Vinyl chloride	µg/L	--	2.4	930	2.4
PPL Polynuclear Aromatic Hydrocarbons					
Acenaphthene	µg/L	--	990	6.6	990
Acenaphthylene	µg/L	--	--	-	--
Anthracene	µg/L	--	40,000	0.18	40,000
Benzo[a]anthracene	µg/L	--	0.018	0.02	0.018
Benzo[b]fluoranthene	µg/L	--	0.018	-	0.018
Benzo[k]fluoranthene	µg/L	--	0.018	-	0.018
Benzo[a]pyrene	µg/L	--	0.018	0.02	0.018
Benzo[ghi]perylene	µg/L	--	--	-	--
Chrysene	µg/L	--	0.018	-	0.018
Dibenzo[a,h]anthracene	µg/L	--	0.018	-	0.018
Fluoranthene	µg/L	--	140	1.6	140
Fluorene	µg/L	--	5,300	2.5	5,300
Indeno[1,2,3-cd]pyrene	µg/L	--	--	-	--
Naphthalene	µg/L	--	--	1.4	1.4
Phenanthrene	µg/L	--	--	1.5	1.5
Pyrene	µg/L	--	4,000	0.24	4,000
Other PPL Semivolatile Organic Compounds					
Benzidine	µg/L	--	0.00002	3.9	0.00002
Bis(2-chloroethyl)ether	µg/L	--	0.53	--	0.53

Table 7. Analytical Project Limits and Screening Values for Groundwater Samples

Parameter	Units	NRWQC Saltwater Aquatic Life CCC	NRWQC Human Health (Organism Only)	BTAG Value (a)	Screening Value (b)
Bis(2-chloroethoxy)methane	µg/L	--	--	--	--
2,2'-oxybis[1-chloropropane]	µg/L	--	--	--	--
Bis(2-ethylhexyl) phthalate	µg/L	--	2.2	16	2.2
4-Bromophenyl phenyl ether	µg/L	--	--	1.5	2
Butyl benzyl phthalate	µg/L	--	1,900	29.4	1,900
4-Chloro-3-methylphenol	µg/L	--	--	--	--
2-Chloronaphthalene	µg/L	--	1,600	--	1,600
2-Chlorophenol	µg/L	--	150	265	150
4-Chlorophenyl phenyl ether	µg/L	--	--	--	--
Di-n-butyl phthalate	µg/L	--	4,500	3.4	4,500
3,3'-Dichlorobenzidine	µg/L	--	0.028	73	0.028
2,4-Dichlorophenol	µg/L	--	290	11	290
Diethyl phthalate	µg/L	--	44,000	75.9	44,000
Dimethyl phthalate	µg/L	--	1,100,000	580	1,100,000
2,4-Dimethylphenol	µg/L	--	850	--	850
2,4-Dinitrophenol	µg/L	--	5,300	48.5	5,300
4,6-Dinitro-2-methylphenol	µg/L	--	280	--	280
2,4-Dinitrotoluene	µg/L	--	3.4	44	3.4
2,6-Dinitrotoluene	µg/L	--	--	81	81
Di-n-octyl phthalate	µg/L	--	--	22	22
1,2-Diphenylhydrazine	µg/L	--	--	--	--
Hexachlorobenzene	µg/L	--	0.00029	0.0003	0.00029
Hexachlorobutadiene	µg/L	--	18	0.30	18
Hexachlorocyclopentadiene	µg/L	--	1,100	0.07	1,100
Hexachloroethane	µg/L	--	3.3	9.4	3.3
Isophorone	µg/L	--	960	129	960
Nitrobenzene	µg/L	--	690	66.8	690
N-Nitrosodimethylamine	µg/L	--	3	330,000	3
N-Nitrosodi-n-propylamine	µg/L	--	0.51	--	0.51
N-Nitrosodiphenylamine	µg/L	--	6.0	120	6.0
2-Nitrophenol	µg/L	--	--	2,940	2,940
4-Nitrophenol	µg/L	--	--	71.7	71.7
Pentachlorophenol	µg/L	7.9	3.0	7.9	3.0
Phenol	µg/L	--	860,000	58	860,000
1,2,4-Trichlorobenzene	µg/L	--	70	5.4	70
2,4,6-Trichlorophenol	µg/L	--	2.4	61	2.4

Table 7. Analytical Project Limits and Screening Values for Groundwater Samples

Parameter	Units	NRWQC Saltwater Aquatic Life CCC	NRWQC Human Health (Organism Only)	BTAG Value (a)	Screening Value (b)
PPL Metals + Mercury					
Antimony	μg/L	--	640	500	640
Arsenic	μg/L	36	0.14 (c)	12.5	36
Beryllium	μg/L	--	--	--	--
Cadmium	μg/L	8.8	--	0.12	8.8
Chromium	μg/L	50	--	57.5	50
Copper	μg/L	3.1	--	3.1	3.1
Lead	μg/L	8.1	--	8.1	8.1
Nickel	μg/L	8.2	4,600	8.2	8.2
Selenium	μg/L	71	4,200	71	71
Silver	μg/L	--	--	0.23	0.23
Thallium	μg/L	--	0.47	21.3	0.47
Zinc	μg/L	81	26,000	81	81
Mercury	μg/L	0.94	--	0.016	0.94
Total Cyanide					
Cyanide	μg/L	1	140	1	1

NOTES:
BTAG = EPA Region III Biological Technical Assistance Group
CCC = Criterion continuous (chronic) concentration
EPA = U.S. Environmental Protection Agency
NRWQC = EPA National Recommended Water Quality Criteria
PPL = Priority Pollutant List
(a) Surface water benchmarks from the EPA Region III BTAG. Marine benchmarks are presented unless not available, in which case the freshwater benchmark is presented (except for metals).
(b) Screening value is NRWQC where available (and the lower of Aquatic Life or Human Health criteria if both are available); otherwise, BTAG.
(c) EPA is currently reassessing the human health criteria for arsenic; therefore, the current value is not used for screening.

ATTACHMENT A
WELL INTEGRITY EVALUATION FIELD LOGS

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: TS04-PZM023 Date: 6/18/14 Time: 1600

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	Yes	[✓ No]
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	Yes	[✓ No]
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	[✓ Yes]	No

Photo

Well Depth: 26.01' TOC

Latitude (WGS1984): 39°14'07.523

Longitude (WGS1984): 76°29'35.538

Comments:

flush-mount well

Was photo taken? Y Photo taken facing: W

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: N

If so, summarize recommendations to re-establish well integrity:

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: RW18-PZM047 Date: 6/18/14 Time: 1540

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	[✓ Yes]	No
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	[✓ Yes]	No

Well Depth: ~~39°14'14.370~~ 62.33' TOC

Latitude (WGS1984): 39°14'14.370

Longitude (WGS1984): 76°29'33.018

Photo

Comments:

no casing lid, no well cap

Was photo taken? Y Photo taken facing: W

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: N

If so, summarize recommendations to re-establish well integrity:

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: RW19-PZP000 Date: 6/18/14 Time: 1525

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	[✓ Yes]	No
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	[✓ Yes]	No

Photo

Well Depth: 11.93' TOC

Latitude (WGS1984): 39°14'10.073

Longitude (WGS1984): 76°29'34.524

Comments:

no well cap

Was photo taken? Y Photo taken facing: S

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: N

If so, summarize recommendations to re-establish well integrity:

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: RW19-PZM050 Date: 6/16/14 Time: 1510

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	[✓ Yes]	No
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	[✓ Yes]	No

Photo

Well Depth: 61.34' TOC

Latitude (WGS1984): 39°14'09.981

Longitude (WGS1984): 76°29'34.496

Comments:

no well cap

Was photo taken? Y Photo taken facing: S

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: N

If so, summarize recommendations to re-establish well integrity:

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: RW19-PZM020 Date: 6/18/14 Time: 1500

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	[✓ Yes]	No
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	[✓ Yes]	No

Photo

Well Depth: 31.71' TOC

Latitude (WGS1984): 39°14'10.001

Longitude (WGS1984): 76°29'34.569

Comments:

no well cap

Was photo taken? Y Photo taken facing: S

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: N

If so, summarize recommendations to re-establish well integrity:

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: H108-PZM003 Date: 6/18/14 Time: 1445

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	Yes	[✓ No]
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	[✓ Yes]	No
Is a lock present and functioning	[✓ Yes]	No
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	[✓ Yes]	No

Photo

Well Depth: 17.08' TOC

Latitude (WGS1984): 39°13'45.051

Longitude (WGS1984): 76°29'26.750

Comments:

protective casing heaved; can be sampled (integrity of PVC not affected)

Was photo taken? Y Photo taken facing: S

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: Y

If so, summarize recommendations to re-establish well integrity: protective casing needs to be re-set

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: H108-PZM060 Date: 6/18/14 Time: 1420

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	Yes	[✓ No]
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	Yes	[✓ No]
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	Yes	[✓ No]

Photo

Well Depth: ~~39°13'44.403~~ 72.92 TOC

Latitude (WGS1984): 39°13'44.403

Longitude (WGS1984): 76°29'25.053

Comments:

casing/PVC bent; can sample via peristaltic

Was photo taken? Y Photo taken facing: N

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: Y

If so, summarize recommendations to re-establish well integrity: protective casing + PVC need replaced above ground surface

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: TS04-PDM004 Date: 6/18/14 Time: 1335

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	Yes	[✓ No]
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	[✓ Yes]	No

Photo

Well Depth: 18.19' TOC

Latitude (WGS1984): 39°14'08.076

Longitude (WGS1984): 76°29'33.947

Comments:

no well cap

Was photo taken? Y Photo taken facing: W

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: N

If so, summarize recommendations to re-establish well integrity:

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: RW20-PZP000 Date: 6/18/14 Time: 1315

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	[✓ Yes]	No
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	[✓ Yes]	No

Photo

Well Depth: 11.60' TOC

Latitude (WGS1984): 39°14'07.330

Longitude (WGS1984): 76°29'33.460

Comments:

~~DTW~~ no well cap

Was photo taken? Y Photo taken facing: N

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: N

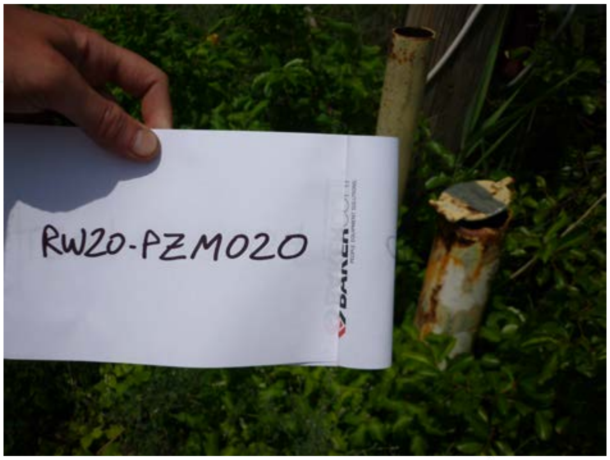
If so, summarize recommendations to re-establish well integrity:

WELL INTEGRITY EVALUATION FIELD LOG

Well Designation: RW20-PZM020 Date: 6/18/14 Time: 1300

Well Location: Sparrows Pt Technician: MP

Is a protective casing present	[✓ Yes]	No
Are bollards present	[✓ Yes]	No
Is there evidence of frost heave (leaning protective casing, broken concrete around base)?	Yes	[✓ No]
Is a lock present and functioning	Yes	[✓ No]
Is there a well identification tag or sign?	[✓ Yes]	No
Upon opening the well, is the PVC riser centered in the well?	[✓ Yes]	No
Is there an elevation measurement reference mark on the PVC riser?	Yes	[✓ No]
Is the well straight?	Yes	[✓ No]



Photo

Well Depth: 35.61' TOC

Latitude (WGS1984): 39°14'07.303

Longitude (WGS1984): 76°29'33.795

Comments:

DTW 4.14' TOC ; no well cap

Was photo taken? Y Photo taken facing: N

HAS THE INTEGRITY OF THE WELL AFFECTED USABILITY: N

If so, summarize recommendations to re-establish well integrity:

ATTACHMENT B
FIELD RECORD OF WELL DEVELOPMENT

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Point	Project No: 1513101	Date: 6/23/11
EA Personnel: MP	Development Method: surge/overpump	
Weather/Temperature/Barometric Pressure: 60 sun		Time: 1215

Well No.: TS04-PDM004	Well Condition: good
Well Diameter: 2"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 9.94	D. Well Volume/ft: 0.16
B. Total Well Depth (ft): 18.19	E. Total Well Volume (gal)[C*D]: 1.32
C. Water Column Height (ft): 8.25	F. Five Well Volumes (gal): 6.60

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	~~1.3~~ 15	30	40	55	65
Depth to Water (ft)	9.94	10.48	10.22	10.78	10.45	10.92
Purge Rate (gpm)	1.0	1.0	1.0	1.0	1.0	1.0
Volume Purged (gal)	0	1.3	2.6	3.9	5.2	6.6
pH	6.79	6.70	6.69	6.69	6.69	6.68
Temperature (°F)	17.12	16.94	17.01	16.64	16.91	16.87
Conductivity (~~µmhos~~ µS/cm)	393	367	362	360	361	360
Dissolved Oxygen	1.68	2.49	1.90	2.84	2.61	2.70
Turbidity (NTU)	>1000	>1000	294	134	129	136
ORP (mV)	22.5	28.8	29.0	29.0	29.1	29.1

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS:

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Pt.	Project No: 1513101	Date: 6/23/14
EA Personnel: T. McJilton	Development Method: Surge/~~B~~ Pump	
Weather/Temperature/Barometric Pressure: Sunny 80 °F 1020.3 mb		Time: 1305

Well No.: RW20-PZM020	Well Condition: Ok. unlocked/open
Well Diameter: 4"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 14.50	D. Well Volume/ft: 0.653
B. Total Well Depth (ft): ~~17.80~~' 35.61	E. Total Well Volume (gal)[C*D]: 13.78
C. Water Column Height (ft): 21.11	F. Five Well Volumes (gal): 68.92

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	20	25	20	20	
Depth to Water (ft)	21.95	22.16	20.42	20.46	20.50	
Purge Rate (gpm)	3.0	3.0	3.0	3.0	3.0	
Volume Purged (gal)	2	15	30	45	60	
pH	2.85	5.36	6.30	6.19	6.16	
Temperature (°F)	18.77	18.03	18.17	18.46	19.21	
Conductivity (µmhos/cm)	4186	8926	1164	1176	1188	
Dissolved Oxygen	2.22	1.41	2.16	2.18	2.26	
Turbidity (NTU)	30.0	36.5	30.7	30.2	29.6	
ORP (mV)	334.7	-27.9	-77.2	76.1	72.6	

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS:

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Pt	Project No: 1513101	Date: 6/23/14
EA Personnel: MP	Development Method: surge/overpump	
Weather/Temperature/Barometric Pressure: 60 sun		Time: 1400

Well No.: H104-PZM003	Well Condition: good
Well Diameter: 2"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 15.77	D. Well Volume/ft: 0.16
B. Total Well Depth (ft): 17.06	E. Total Well Volume (gal)[C*D]: 0.21
C. Water Column Height (ft): 1.31	F. Five Well Volumes (gal): 1.05

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	6/24 0830	20	20	15	20
Depth to Water (ft)	15.77	15.11	15.15	15.15	15.15	15.15
Purge Rate ~~(gpm)~~ mL/min	300	300	300	300	300	300
Volume Purged (gal)	0.21	0.5	0.7	0.9	1.1	1.3
pH	7.23	7.18	7.28	7.42	7.42	7.76
Temperature (°F)	16.68	15.92	16.07	16.16	16.24	17.21
Conductivity ~~(µmhos~~ µS/cm)	1083	1142	1149	1086	1084	1124
Dissolved Oxygen	4.47	6.49	5.69	4.78	4.62	4.46
Turbidity (NTU)	233	162	276	207	199	196
ORP (mV)	-66.8	-51.2	-8.1	46.8	47.2	43.5
Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS: Initial purge 6/23, allow to recharge overnight

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Point	Project No: 151301	Date: 6/24/14
EA Personnel:	Development Method: Surge / Pump	
Weather/Temperature/Barometric Pressure: Sunny 83°F 1021.1 mb		Time: 1100

Well No.: T904-PZM023	Well Condition: OK. J-Plug present.
Well Diameter: 2"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 6.50	D. Well Volume/ft: 0.163
B. Total Well Depth (ft): 26.01	E. Total Well Volume (gal)[C*D]: 3.18
C. Water Column Height (ft): 19.51	F. Five Well Volumes (gal): 15.90

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	1430	6/25 1000	30	30	
Depth to Water (ft)	7.5	13.7	10.55	17.56	17.50	
Purge Rate (gpm)	3.0	3.0	3.0	3.0	3.0	
Volume Purged (gal)	3.0	5.0	7.5	9.0	10.5	
pH	6.68	7.07	6.65	6.92	6.93	
Temperature (°F)	18.08	19.22	18.37	18.97	19.76	
Conductivity (µmhos/cm)	176	1117	1165	1209	1256	
Dissolved Oxygen	1.92	2.49	2.53	2.46	2.64	
Turbidity (NTU)	61.2	65.6	95.6	92.4	91.7	
ORP (mV)	-157.2	-120.9	-116.4	-110.3	107.8	
Parameter	**6 Volumes**	**7 Volumes**	**8 Volumes**	**9 Volumes**	**10 Volumes**	**End**
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS: Well dry after initial pump. Will let recharge. Check @ 1430. Will pump well. Well dry after second pump. Will let recharge over night.

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Point	Project No: 1513101	Date: 6/23 & 6/24
EA Personnel: T. McJilton	Development Method: Surge / Pump	
Weather/Temperature/Barometric Pressure: Sunny 82° 1020.3 mb		Time:

Well No.: RW20-PZP000	Well Condition: open / unlocked
Well Diameter: 2"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 4.85	D. Well Volume/ft: 0.163
B. Total Well Depth (ft): 11.80	E. Total Well Volume (gal)[C*D]: 1.13
C. Water Column Height (ft): 6.95	F. Five Well Volumes (gal): ~~5.56~~ 5.65

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	15	20	6/24 0830 20	15	20
Depth to Water (ft)	6.21	8.76	9.15	4.25	7.30	8.95
Purge Rate (gpm)	3.0	3.0	3.0	3.0	3.0	3.0
Volume Purged (gal)	0.2	1.2	2.3	3.4	4.5	5.6
pH	9.35	8.86	9.84	9.59	9.54	8.91
Temperature (°F)	21.02	20.63	20.77	19.68	19.14	18.87
Conductivity (µmhos/cm)	363	248	260	310	290	285
Dissolved Oxygen	2.37	7.36	7.01	7.10	7.20	6.86
Turbidity (NTU)	1135	1104	1127	272	263	252
ORP (mV)	-97.5	50.1	1.0	80.0	78.6	75.6

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS: After two volumes well recharged too slowly to pump. Came back on 6/24 to complete development. Black plastic flakes (electrical tape or pvc) observed when well pumped dry. Well pumped dry at 5 volumes (3rd reading on 6/24). Readings stable.

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Pt	Project No: 1513101	Date: 6/24/14
EA Personnel: MP	Development Method:	
Weather/Temperature/Barometric Pressure: 60 sun		Time: 1300

Well No.: H104-PZM060	Well Condition: casing bent
Well Diameter: 2"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 12.34	D. Well Volume/ft: 0.16
B. Total Well Depth (ft): 72.92	E. Total Well Volume (gal)[C*D]: 9.69
C. Water Column Height (ft): 60.58	F. Five Well Volumes (gal): 48.46

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	20	45	65	75	90
Depth to Water (ft)	12.34	12.55	12.53	12.60	12.88	12.80
Purge Rate (gpm)	1.0	1.0	1.0	1.0	1.0	1.0
Volume Purged (gal)	0	10	20	30	40	50
pH	6.53	6.54	6.48	6.51	6.48	6.47
Temperature (°F)	21.26	18.50	17.84	16.59	15.94	15.60
Conductivity (~~µmhos~~ uS/cm)	3694	4063	4141	3914	3955	3962
Dissolved Oxygen	4.23	1.67	1.23	0.63	1.05	1.10
Turbidity (NTU)	64.7	>1000	38.9	24.0	20.7	18.9
ORP (mV)	-59.1	-99.3	-96.9	-104.0	-102.6	-101.1
Parameter	**6 Volumes**	**7 Volumes**	**8 Volumes**	**9 Volumes**	**10 Volumes**	**End**
Time (min)	100					
Depth to Water (ft)	12.45					
Purge Rate (gpm)	1.0					
Volume Purged (gal)	60					
pH	6.47					
Temperature (°F)	16.03					
Conductivity (µmhos/cm)	3964					
Dissolved Oxygen	1.08					
Turbidity (NTU)	19.2					
ORP (mV)	-101.6					

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS:

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Pt	Project No: 1513101	Date: 6/23/14
EA Personnel: MP	Development Method: surge/overpump	
Weather/Temperature/Barometric Pressure: 60 sun		Time: 1430

Well No.: RW19-PZP000	Well Condition: good
Well Diameter: 2"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 9.01	D. Well Volume/ft: 0.16
B. Total Well Depth (ft): 11.93	E. Total Well Volume (gal)[C*D]: 0.47
C. Water Column Height (ft): 2.92	F. Five Well Volumes (gal): 2.34

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	0900 6/24	1040	1130	1150	1215
Depth to Water (ft)	9.01	8.99	8.99	9.01	9.00	9.04
Purge Rate (gpm)	1.5	1.5	1.5	1.5	1.5	1.5
Volume Purged (gal)	0	0.5	1.0	1.5	2.0	2.5
pH	7.68	9.07	9.22	9.70	9.81	9.80
Temperature (°F)	16.29	17.80	16.81	17.54	17.99	17.01
Conductivity (~~µmhos~~ µS/cm)	575	661	672	616	497	364
Dissolved Oxygen	2.14	6.10	4.38	7.47	6.12	6.29
Turbidity (NTU)	460	>1000	119	138	75.0	60.7
ORP (mV)	-178.8	46.4	29.0	1.4	-12.3	-37.1

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)	1230	1245				
Depth to Water (ft)	9.05	9.02				
Purge Rate (gpm)	1.5	1.5				
Volume Purged (gal)	3.0	3.5				
pH	9.75	9.73				
Temperature (°F)	17.33	17.12				
Conductivity (µmhos/cm)	372	360				
Dissolved Oxygen	6.38	6.25				
Turbidity (NTU)	56.2	57.8				
ORP (mV)	-37.8	-38.6				

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS: initial purge 6/23, allow to recharge overnight

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Pt	Project No: 1513101	Date: 6/24/14
EA Personnel: MP	Development Method: surge/overpump	
Weather/Temperature/Barometric Pressure: 75 sun		Time: 0930

Well No.: RW19-PZM050	Well Condition: good
Well Diameter: 2"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 10.49	D. Well Volume/ft: 0.16
B. Total Well Depth (ft): 61.34	E. Total Well Volume (gal)[C*D]: 8.14
C. Water Column Height (ft): 50.45	F. Five Well Volumes (gal): 40.68

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	1025	1140	1230	1315	1405
Depth to Water (ft)	10.49	24.53	31.06	31.80	32.49	33.06
Purge Rate (gpm)	1.5	1.5	1.5	1.5	1.5	1.5
Volume Purged (gal)	0	8	16	25	33	41
pH	6.58	6.60	6.58	6.55	6.55	6.54
Temperature (°F)	17.20	17.69	16.38	16.79	16.84	16.66
Conductivity (~~µmhos~~ uS/cm)	347	354	360	367	369	369
Dissolved Oxygen	3.03	3.90	3.12	2.88	2.97	2.88
Turbidity (NTU)	117	38.2	21.5	16.9	16.4	16.6
ORP (mV)	-118.4	-100.7	-69.1	-57.3	-54.6	-54.0
Parameter	**6 Volumes**	**7 Volumes**	**8 Volumes**	**9 Volumes**	**10 Volumes**	**End**
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS:

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Pt.	Project No: 151301	Date: 6/24/25
EA Personnel: TM	Development Method:	
Weather/Temperature/Barometric Pressure: Sunny 75 - 90°		Time: 0945

Well No.: RW18-PZM047	Well Condition: Fair. open /No lid or Plug.
Well Diameter: 2"	Measurement Reference: TOC
Well Volume Calculations	
A. Depth To Water (ft): 15.60	D. Well Volume/ft: 0.163
B. Total Well Depth (ft): 62.33	E. Total Well Volume (gal)[C*D]: 7.61
C. Water Column Height (ft): 46.73	F. Five Well Volumes (gal): 38.08

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	20	6/25 0845	1140	1400	
Depth to Water (ft)	17.1	25.2	49.1	56.21	56.15	
Purge Rate (gpm)	3.0	3.0	3.0	3.0	3.0	
Volume Purged (gal)	0.2	7.6	9.8	10.5	11.5	
pH	7.25	6.91	6.06	6.17	6.23	
Temperature (°F)	18.20	20.4	21.21	20.76	20.43	
Conductivity (µmhos/cm)	1066	889	592	621	634	
Dissolved Oxygen	3.61	1.10	1.98	2.06	2.09	
Turbidity (NTU)	105.5	657	127	120	118	
ORP (mV)	-55.1	-150.8	-20.4	-21.6	-21.9	

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS: Well dry after first volume collected. will let recharge. check WL at 1410 on 6/24. WL at 56.4 ft. extremely slow recharge. Try to pump but pump wont push water. will let sit overnight.

EA Engineering, P.C.
EA Science and Technology

FIELD RECORD OF WELL DEVELOPMENT

Project Name: Sparrows Pt
Project No: 1513101
Date: 6/24/14
EA Personnel: MP
Development Method: surge/overpump
Weather/Temperature/Barometric Pressure: 75 sun
Time: 0950

Well No.: RW19-PZM020
Well Condition: good
Well Diameter: 2"
Measurement Reference: TOC

Well Volume Calculations

A. Depth To Water (ft): 14.33
D. Well Volume/ft: 0.16
B. Total Well Depth (ft): 31.71
E. Total Well Volume (gal)[C*D]: 2.78
C. Water Column Height (ft): 17.38
F. Five Well Volumes (gal): 13.9

Parameter	Beginning	1 Volume	2 Volumes	3 Volumes	4 Volumes	5 Volumes
Time (min)	0	20	35	50	70	80
Depth to Water (ft)	14.33	14.81	14.61	14.79	14.63	14.66
Purge Rate (gpm)	1.5	1.5	1.5	1.5	1.5	1.5
Volume Purged (gal)	0	3	6	8	11	14
pH	6.17	5.76	5.75	5.70	5.68	5.68
Temperature (°F)	15.99	18.60	16.83	17.85	16.62	17.17
Conductivity (~~µmhos~~ uS/cm)	8957	12880	13101	13280	13312	13329
Dissolved Oxygen	0.89	2.40	1.48	1.65	1.64	1.61
Turbidity (NTU)	72.2	180	41.4	18.6	12.1	4.5
ORP (mV)	41.9	46.3	49.9	53.4	53.8	53.9

Parameter	6 Volumes	7 Volumes	8 Volumes	9 Volumes	10 Volumes	End
Time (min)						
Depth to Water (ft)						
Purge Rate (gpm)						
Volume Purged (gal)						
pH						
Temperature (°F)						
Conductivity (µmhos/cm)						
Dissolved Oxygen						
Turbidity (NTU)						
ORP (mV)						

NOTE: NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.

COMMENTS AND OBSERVATIONS:

ATTACHMENT C
FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Page 1 of 1

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name:	Sparrows Pt	Project Number:	151,3101
Well ID:	RW20-PZP000	Well Lock Status:	N/A
Well Condition:	good	Weather:	90 sun

Gauge Date:	6/25/14	Gauge Time:	1200
Sounding Method:	WL	Measurement Ref:	TOC
Stick Up/Down (ft):	~3	Well Diameter (in.):	2

Purge Date:	6/25/14	Purge Time:	1215
Purge Method:	Submersible	Field Personnel:	MP
Ambient Air VOCs (ppm):	0	Well Mouth VOCs (ppm):	0

WELL VOLUME

A. Well Depth (ft):	11.80	D. Well Volume/ft (L):	
B. Depth to Water (ft):	4.26	E. Well Volume (L) (C*D):	
C. Liquid Depth (ft) (A-B)	7.54	F. Three Well Volumes (L) (E*3):	

G. Measurable LNAPL? Yes ________ /ft [✓ No] ________

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	4.26	4.51	4.54	4.55	4.54	4.54
Purge Rate (L/min)	0.2	→	→	→	→	→
Volume Purged (L)	1	2	3	4	5	6
pH	7.24	8.01	8.23	8.29	8.34	8.35
Temperature (°C)	23.70	25.67	25.32	25.66	25.81	25.75
Conductivity (~~µmhos~~/cm) µS	604	405	389	379	376	374
Dissolved Oxygen (mg/L)	4.52	3.66	3.90	3.94	3.92	3.91
Turbidity (NTU)	202	116	59.0	18.8	10.9	8.5
eH (mV)	-118.8	-121.6	-124.1	-134.0	-136.9	-139.7

Total Quantity of Water Removed (L):	6.0		
Samplers:	MP	Sampling Time (Start/End):	1250
Sampling Date:	6/25/14	Decontamination Fluids Used:	Liquinox/DI
Sample Type:	grab	Sample Preservatives:	HCL/HNO$_3$/NaOH/4oC
Sample Bottle IDs:	RW20-PZP000		
Sample Parameters:	VOC, SVOC, metals, cyanide		

1250 collect RW20-PZP000

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Sparrows Pt
Well ID: RW20-PZM020
Well Condition: good
Project Number: 1513101
Well Lock Status: N/A
Weather: 80 s.m

Gauge Date: 6/25/14
Sounding Method: WL1
Stick Up/Down (ft): ~3
Gauge Time: 0900
Measurement Ref: TOC
Well Diameter (in.): 4

Purge Date: 6/25/14
Purge Method: submersible
Ambient Air VOCs (ppm): 0
Purge Time: 0930
Field Personnel: MP
Well Mouth VOCs (ppm): 0

WELL VOLUME

A. Well Depth (ft): 35.61
B. Depth to Water (ft): 14.15
C. Liquid Depth (ft) (A-B) 21.46
D. Well Volume/ft (L):
E. Well Volume (L) (C*D):
F. Three Well Volumes (L) (E*3):
G. Measurable LNAPL? Yes ________ /ft [✓ No]

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	14.15	14.22	14.24	14.23	14.24	14.25
Purge Rate (L/min)	0.2	"	"	"	"	"
Volume Purged (L)	1	2	3	4	5	6
pH	6.71	6.67	6.60	6.83	6.80	6.78
Temperature (°C)	18.70	19.52	20.77	22.70	23.14	23.24
Conductivity (~~umhos~~ µS/cm)	12363	12539	12939	13543	13664	13704
Dissolved Oxygen (mg/L)	2.19	2.04	1.71	1.04	1.01	0.99
Turbidity (NTU)	111	143	47.9	20.2	20.9	11.3
eH (mV)	-121.7	-106.8	-109.9	-109.1	-110.6	-111.3

Total Quantity of Water Removed (L): 7.0
Samplers: MP
Sampling Date: 6/25/14
Sample Type: grab
Sample Bottle IDs: RW20-PZM020/062514-DP
Sample Parameters: VOC, SVOC, metals, cyanide
Sampling Time (Start/End): 1005
Decontamination Fluids Used: Liquinox + DI
Sample Preservatives: HCL/HNO3/NaOH/4°C

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Sparrows Pt Project Number: 1513101 Date: 6/25/14

Well ID: RW20-PZM020 Field Personnel: MP

Parameter	6	7	8	9	10	11
Time (min.)	30					
Depth to Water (ft)	14.25					
Purge Rate (L/min)	.2					
Volume Purged (L)	7					
pH	6.75					
Temperature (°C)	23.18					
Conductivity (μmhos/cm)	13727					
Dissolved Oxygen (mg/L)	0.98					
Turbidity (NTU)	6.4					
eH (mV)	-111.2					

Parameter	12	13	14	15	16	17
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (μmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Comments and Observations:

1005 collect sample RW20-PZM020 and duplicate 062514-DP

Figure 1.

Page 1 of 2

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name:	Sparrows Pt.	Project Number:	1513101
Well ID:	TS04- PDM004	Well Lock Status:	None
Well Condition:	ok - open / unlocked	Weather:	Sunny 90° F

Gauge Date:	6/25/14	Gauge Time:	1215
Sounding Method:	WL Meter	Measurement Ref:	TOC
Stick Up/Down (ft):	~ 3	Well Diameter (in.):	2"

Purge Date:	6/25/14	Purge Time:	1220
Purge Method:	Low Flow	Field Personnel:	TM
Ambient Air VOCs (ppm):	—	Well Mouth VOCs (ppm):	—

WELL VOLUME

A. Well Depth (ft):	18.19	D. Well Volume/ft (L):	0.16
B. Depth to Water (ft):	10.10	E. Well Volume (L) (C*D):	1.29
C. Liquid Depth (ft) (A-B)	8.09	F. Three Well Volumes (L) (E*3):	3.88

G. Measurable LNAPL? Yes ________ /ft No ✓

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	10.18	10.22	10.37	10.46	10.49	10.50
Purge Rate (L/min)	0.2	0.2	0.2	0.2	0.2	0.2
Volume Purged (L)	0.2	1.2	2.2	3.2	4.2	5.2
pH	7.16	6.67	6.93	6.95	6.90	6.85
Temperature (°C)	21.55	23.31	23.66	22.67	22.19	22.71
Conductivity (µmhos/cm)	519	507	517	528	546	550
Dissolved Oxygen (mg/L)	5.83	5.28	4.89	4.94	4.71	4.26
Turbidity (NTU)	126	131	197	176	151	146
eH (mV)	39.9	40.2	22.0	17.3	26.1	31.7

Total Quantity of Water Removed (L):	~15 L.		
Samplers:	TM	Sampling Time (Start/End):	1340/1350
Sampling Date:	6/25/14	Decontamination Fluids Used:	Liquinox / DI
Sample Type:	GW Grab	Sample Preservatives:	HCL, NaOH, HNO_3
Sample Bottle IDs:	TS04- PDM004		
Sample Parameters:	VOC, SVOC, Metals, Hg, Cn		

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Sparrows Pt Project Number: 1513101 Date: 6/25/14

Well ID: TS04- PDM004 Field Personnel: TM.

Parameter	6	7	8	9	10	11
Time (min.)	30	35	40	45	50	55
Depth to Water (ft)	10.51	10.53	10.53	10.54	10.55	10.56
Purge Rate (L/min)	0.2	0.2	0.2	0.2	0.2	0.2
Volume Purged (L)	6.2	7.2	8.2	9.2	10.2	11.2
pH	6.57	6.43	6.60	6.52	6.67	6.68
Temperature (°C)	22.74	22.76	21.65	21.70	21.71	21.79
Conductivity (µmhos/cm)	542	537	531	529	532	554
Dissolved Oxygen (mg/L)	4.29	3.48	4.19	4.05	4.12	4.10
Turbidity (NTU)	90	74	56	64	39	18
eH (mV)	38.9	48.2	43.5	48.7	45.2	44.7

Parameter	12	13	14	15	16	17
Time (min.)	60	65	70			
Depth to Water (ft)	10.56	10.56	10.56			
Purge Rate (L/min)	0.2	0.2	0.2			
Volume Purged (L)	12.2	13.2	14.2			
pH	6.68	6.67	6.68			
Temperature (°C)	22.74	22.17	21.86			
Conductivity (µmhos/cm)	562	559	571			
Dissolved Oxygen (mg/L)	4.07	4.09	4.11			
Turbidity (NTU)	9.8	9.8	9.6			
eH (mV)	39.1	38.6	37.2			

Comments and Observations: Sample Collected 1340 - TS04 - PDM004

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Sparrows Pt
Project Number: 1513101
Well ID: H108-PZM003
Well Lock Status: locked
Well Condition: protective casing heaved; PVC intact
Weather: 60 sun

Gauge Date: 6/26/14
Gauge Time: 0900
Sounding Method: WLI
Measurement Ref: TOC
Stick Up/Down (ft): ~4
Well Diameter (in.): 2

Purge Date: 6/26/14
Purge Time: 0925
Purge Method: peristaltic
Field Personnel: MP
Ambient Air VOCs (ppm): 0
Well Mouth VOCs (ppm): 0

WELL VOLUME

A. Well Depth (ft): 17.08
B. Depth to Water (ft): 15.34
C. Liquid Depth (ft) (A-B) 1.74
D. Well Volume/ft (L):
E. Well Volume (L) (C*D):
F. Three Well Volumes (L) (E*3):
G. Measurable LNAPL? Yes ________ /ft No ________

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	15.34	15.58	15.57	15.58	15.59	15.61
Purge Rate (L/min)	0.1	→				
Volume Purged (L)	0	0.5	1.0	1.5	2.0	2.5
pH	6.14	5.55	6.02	4.93	4.90	4.89
Temperature (°C)	22.11	21.47	21.88	21.14	21.41	21.30
Conductivity (~~umhos~~ µS/cm)	1332	1301	1267	1217	1210	1205
Dissolved Oxygen (mg/L)	4.76	6.08	5.11	4.96	4.93	4.91
Turbidity (NTU)	310	99.2	50.4	37.7	12.9	8.8
eH (mV)	504.4	460.6	438.6	430.7	429.5	429.0

Total Quantity of Water Removed (L): 2.5
Samplers: MP
Sampling Time (Start/End): [illegible] 0955
Sampling Date: 6/26/14
Decontamination Fluids Used: liquinox / DI
Sample Type: grab
Sample Preservatives: HCL / HNO_3 / NaOH / 4°C
Sample Bottle IDs: H108-PZM003
Sample Parameters: VOC, SVOC, metals, cyanide

0955 collect sample H108-PZM003

Figure 1.

Page 1 of 2

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Sparrows Pt
Well ID: H108-PZM060
Well Condition: casing/PVC bent @ GS
Project Number: 1513101
Well Lock Status: NA
Weather: 85 sun

Gauge Date: 6/26/14
Sounding Method: WLI
Stick Up/Down (ft): ~3
Gauge Time: 1030
Measurement Ref: TOC
Well Diameter (in.): 2

Purge Date: 6/26/14
Purge Method: peristaltic
Ambient Air VOCs (ppm): 0
Purge Time: 1050
Field Personnel: MP
Well Mouth VOCs (ppm): 0

WELL VOLUME

A. Well Depth (ft): 72.92
B. Depth to Water (ft): 12.31
C. Liquid Depth (ft) (A-B) 60.61
D. Well Volume/ft (L):
E. Well Volume (L) (C*D):
F. Three Well Volumes (L) (E*3):
G. Measurable LNAPL? Yes ______ /ft No ______

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	12.31	12.34	12.35	12.35	12.36	12.36
Purge Rate (L/min)	0.2	→				
Volume Purged (L)	1	2	3	4	5	6
pH	7.16	7.67	7.93	7.63	7.57	7.50
Temperature (°C)	23.23	17.98	17.97	17.81	17.63	17.90
Conductivity (~~µmhos~~/cm) µS	3180	3672	3668	3672	3671	3673
Dissolved Oxygen (mg/L)	6.66	3.20	2.58	2.18	2.10	2.06
Turbidity (NTU)	24.5	30.6	17.1	20.6	14.0	9.8
eH (mV)	13.4	-64.2	-114.2	-103.0	-102.7	-101.9

Total Quantity of Water Removed (L): 6.0
Samplers: MP
Sampling Date: 6/26/14
Sample Type: grab
Sample Bottle IDs: H108-PZM060
Sample Parameters: VOC, SVOC, metals, cyanide
Sampling Time (Start/End): 1130
Decontamination Fluids Used: Liquinox/DI
Sample Preservatives: HCL/HNO3/NaOH/4°C

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name:	Sparrows Point	Project Number:	1513101
Well ID:	RW19-PZM20	Well Lock Status:	None
Well Condition:	Fair	Weather:	Sunny 83°F

Gauge Date:	6/26/14	Gauge Time:	1120
Sounding Method:	WL Tape	Measurement Ref:	TOC
Stick Up/Down (ft):	~3	Well Diameter (in.):	2"

Purge Date:	6/26/14	Purge Time:	1125
Purge Method:	Low Flow	Field Personnel:	TM
Ambient Air VOCs (ppm):	—	Well Mouth VOCs (ppm):	—

WELL VOLUME

A. Well Depth (ft):	31.71	D. Well Volume/ft (L):	0.163
B. Depth to Water (ft):	14.70	E. Well Volume (L) (C*D):	2.77
C. Liquid Depth (ft) (A-B)	17.01	F. Three Well Volumes (L) (E*3):	8.31

G. Measurable LNAPL? Yes ________ /ft No ✓

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	14.75	14.80	14.80	14.81	14.81	14.80
Purge Rate (L/min)	0.2	0.2	0.2	0.2	0.2	0.2
Volume Purged (L)	0.2	1.2	2.2	3.2	4.2	5.2
pH	6.04	5.84	5.79	5.73	5.73	5.71
Temperature (°C)	17.85	17.36	17.10	17.05	17.03	17.09
Conductivity (μmhos/cm)	1024	1126	1187	1256	1286	1289
Dissolved Oxygen (mg/L)	6.57	2.86	1.47	1.17	1.14	1.10
Turbidity (NTU)	127	27.1	13.7	6.95	6.91	6.56
eH (mV)	51.5	55.7	56.5	56.2	59.2	57.7

Total Quantity of Water Removed (L): ~6 L

Samplers:	TM	Sampling Time (Start/End):	1155 - 1200
Sampling Date:	6/26/14	Decontamination Fluids Used:	Liquinox / DI
Sample Type:	Grab	Sample Preservatives:	HCL, NaOH, HNO3

Sample Bottle IDs: RW19-PZM020

Sample Parameters: VOC, SVOC, Metals, Hg, Cn

Sample RW-19-PZM020 collected @ 1155

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name:	Sparrows Pt.	Project Number:	1513101
Well ID:	RW19-PZM050	Well Lock Status:	None
Well Condition:	Fair	Weather:	Sunny 80°F

Gauge Date:	6/26/14	Gauge Time:	1020
Sounding Method:	WL Tape	Measurement Ref:	TOC
Stick Up/Down (ft):	~3	Well Diameter (in.):	2"

Purge Date:	6/26/14	Purge Time:	1030
Purge Method:	Low Flow	Field Personnel:	TM
Ambient Air VOCs (ppm):	—	Well Mouth VOCs (ppm):	—

WELL VOLUME

A. Well Depth (ft):	61.34	D. Well Volume/ft (L):	0.163
B. Depth to Water (ft):	21.55	E. Well Volume (L) (C*D):	6.48
C. Liquid Depth (ft) (A-B)	39.79	F. Three Well Volumes (L) (E*3):	19.45

G. Measurable LNAPL? Yes ________ /ft No —

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	~~20~~ 15	20 ~~25~~	25
Depth to Water (ft)	21.57	21.68	21.74	21.78	21.78	21.78
Purge Rate (L/min)	0.2	0.2	0.2	0.2	0.2	0.2
Volume Purged (L)	0.2	1.2	2.2	3.2	4.2	5.2
pH	7.91	6.97	6.39	6.35	6.29	6.24
Temperature (°C)	20.37	20.17	19.99	19.86	19.34	19.22
Conductivity (µmhos/cm)	355	348	345	344	342	339
Dissolved Oxygen (mg/L)	5.42	3.26	2.17	0.67	0.61	0.61
Turbidity (NTU)	136	27	8.2	7.6	7.4	7.3
eH (mV)	-128.6	-76.2	-68.1	-58.6	-60.2	-60.9

Total Quantity of Water Removed (L): ~6 L

Samplers:	TM	Sampling Time (Start/End):	1100 - 1110
Sampling Date:	6/26/14	Decontamination Fluids Used:	Liquinox / DI
Sample Type:	Grab	Sample Preservatives:	HCL, HNO3, NaOH

Sample Bottle IDs: RW19-PZM050

Sample Parameters: VOC, SVOC, Metals, Hg, Cr

Sample RW19-PZM050 collected @ 1105

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Sparrows Pt.
Project Number: 1513101
Well ID: RW19-PZM000
Well Lock Status: None
Well Condition: Fair
Weather: Sunny 77°F

Gauge Date: 6/26/14
Gauge Time: 0910
Sounding Method: WL Tape
Measurement Ref: TOC
Stick Up/Down (ft):
Well Diameter (in.): 2"

Purge Date: 6/26/14
Purge Time: 0930
Purge Method: Low Flow.
Field Personnel: TM
Ambient Air VOCs (ppm): –
Well Mouth VOCs (ppm): –

WELL VOLUME

A. Well Depth (ft): 11.93
D. Well Volume/ft (L): 0.163
B. Depth to Water (ft): 9.40
E. Well Volume (L) (C*D): 0.41
C. Liquid Depth (ft) (A-B): 2.53
F. Three Well Volumes (L) (E*3): 1.23
G. Measurable LNAPL? Yes ______ /ft No —

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	9.45	9.51	9.55	9.58	9.60	9.60
Purge Rate (L/min)	0.2	0.2	0.2	0.2	0.2	0.2
Volume Purged (L)	0.2	1.2	2.2	3.2	4.2	5.2
pH	5.49	5.34	9.40	9.94	10.01	9.76
Temperature (°C)	21.79	21.79	21.54	21.63	20.78	20.68
Conductivity (µmhos/cm)	730	633	480	496	552	586
Dissolved Oxygen (mg/L)	4.50	5.54	6.89	7.32	7.48	7.37
Turbidity (NTU)	130	26.1	17.5	8.6	8.4	7.2
eH (mV)	23.6	47.0	49.7	56.5	58.1	61.5

Total Quantity of Water Removed (L): ~~[illegible]~~ ~8.5L
Samplers: TM
Sampling Time (Start/End): 1010 – 1015
Sampling Date: 6/26/14
Decontamination Fluids Used: Liquinox / DI
Sample Type: Grab
Sample Preservatives: HCL, HNO3, NAOH
Sample Bottle IDs: RW19-PZM000
Sample Parameters: VOC, SVOC, Metals, Hg, CN

Sample RW19-PZM000 collected @ 1010

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Sparrows Pt Project Number: 1513101 Date: 6/26/14

Well ID: RW19-PZM000 Field Personnel: TM

Parameter	6	7	8	9	10	11
Time (min.)	30	35				
Depth to Water (ft)	9.61	9.62				
Purge Rate (L/min)	0.2	0.2				
Volume Purged (L)	6.2	7.2				
pH	9.57	9.61				
Temperature (°C)	20.62	20.67				
Conductivity (µmhos/cm)	595	599				
Dissolved Oxygen (mg/L)	7.46	7.52				
Turbidity (NTU)	7.3	7.6				
eH (mV)	59.4	58.3				

Parameter	12	13	14	15	16	17
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Comments and Observations: — Sample collected @ 1010

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name:	Sparrows Pt.	Project Number:	1513101
Well ID:	RW18-PZM047	Well Lock Status:	None
Well Condition:	Poor. No J plug or lid on casing	Weather:	Sunny 73°

Gauge Date:	6/27/14	Gauge Time:	0835
Sounding Method:	WL Tape	Measurement Ref:	TOC
Stick Up/Down (ft):	2	Well Diameter (in.):	2

Purge Date:	6/27/14	Purge Time:	0900
Purge Method:	Low Flow	Field Personnel:	TM
Ambient Air VOCs (ppm):	—	Well Mouth VOCs (ppm):	—

WELL VOLUME

A. Well Depth (ft):	62.60	D. Well Volume/ft (L):	0.163
B. Depth to Water (ft):	44.40	E. Well Volume (L) (C*D):	2.96
C. Liquid Depth (ft) (A-B)	18.20	F. Three Well Volumes (L) (E*3):	8.89

G. Measurable LNAPL? Yes ________ /ft No ________

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	4440	44.82	44.82	44.82	44.83	44.84
Purge Rate (L/min)	0.2	0.2	0.2	0.2	0.2	0.2
Volume Purged (L)	0.2	1.2	2.2	3.2	4.2	5.2
pH	9.61	7.26	6.19	5.91	5.66	5.64
Temperature (°C)	19.26	18.91	20.26	18.70	18.89	19.01
Conductivity (µmhos/cm)	219	336	439	444	451	455
Dissolved Oxygen (mg/L)	9.36	3.17	2.09	1.00	1.02	1.07
Turbidity (NTU)	976	840	310	180	78.7	29.1
eH (mV)	127	116	14	-26.7	-55.5	-56.4

Total Quantity of Water Removed (L): ~ ~~6~~ 7

Samplers:	TM	Sampling Time (Start/End):	0935 - 0940
Sampling Date:	6/27/14	Decontamination Fluids Used:	Liquinox / DI
Sample Type:	Grab	Sample Preservatives:	HCL, HNO_3, NaOH, 4°C

Sample Bottle IDs: RW18-PZM047

Sample Parameters: VOC, SVOC, Metals, Hg, Cn

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name: Sparrows Pt. Project Number: 1513101 Date: 6/27/14

Well ID: RW18-PZM047 Field Personnel: TM

Parameter	6	7	8	9	10	11
Time (min.)	30					
Depth to Water (ft)	44.84					
Purge Rate (L/min)	0.2					
Volume Purged (L)	6.2					
pH	5.64					
Temperature (°C)	18.95					
Conductivity (µmhos/cm)	468					
Dissolved Oxygen (mg/L)	1.09					
Turbidity (NTU)	9.6					
eH (mV)	-55.7					

Parameter	12	13	14	15	16	17
Time (min.)						
Depth to Water (ft)						
Purge Rate (L/min)						
Volume Purged (L)						
pH						
Temperature (°C)						
Conductivity (µmhos/cm)						
Dissolved Oxygen (mg/L)						
Turbidity (NTU)						
eH (mV)						

Comments and Observations: Well in poor condition- casing had no lid and J-plug missing! Open to elements. Sample collected at 0935

Figure 1.

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Site Name:	Sparrows PT	Project Number:	1513101
Well ID:	TS04- PZM023	Well Lock Status:	None
Well Condition:	Fair	Weather:	Sunny 83°F

Gauge Date:	6/27/14	Gauge Time:	1000
Sounding Method:	WL Tape	Measurement Ref:	TOC
Stick Up/Down (ft):	Flush	Well Diameter (in.):	2

Purge Date:	6/27/14	Purge Time:	1020
Purge Method:	Low Flow	Field Personnel:	TM
Ambient Air VOCs (ppm):	—	Well Mouth VOCs (ppm):	—

WELL VOLUME

A. Well Depth (ft):	25.61	D. Well Volume/ft (L):	0.163
B. Depth to Water (ft):	11.00	E. Well Volume (L) (C*D):	2.38
C. Liquid Depth (ft) (A-B)	14.61	F. Three Well Volumes (L) (E*3):	7.14

G. Measurable LNAPL? Yes ________ /ft No ✓

Parameter	Beginning	1	2	3	4	5
Time (min.)	0	5	10	15	20	25
Depth to Water (ft)	11.00	11.27	11.32	11.35	11.35	11.37
Purge Rate (L/min)	0.2	0.2	0.2	0.2	0.2	0.2
Volume Purged (L)	0.2	1.2	2.2	3.2	4.2	5.2
pH	7.21	6.64	7.63	6.83	6.83	6.85
Temperature (°C)	17.24	18.89	19.25	19.16	19.64	18.99
Conductivity (µmhos/cm)	1263	1337	1294	1246	1207	1189
Dissolved Oxygen (mg/L)	1.13	1.62	2.10	2.73	2.91	2.97
Turbidity (NTU)	927	762	417	116	26.2	9.4
eH (mV)	-136.7	-116.5	-110.9	-104.2	-103.7	-101.9

Total Quantity of Water Removed (L): ~ 6

Samplers:	TM	Sampling Time (Start/End):	1050 - 1100
Sampling Date:	6/27/14	Decontamination Fluids Used:	Liquinox / DI
Sample Type:	Grab	Sample Preservatives:	HCL, NaOH, HNO_3, 4°C

Sample Bottle IDs: TS04-PZM023

Sample Parameters: VOC, SVOC, Metals, Hg, CN

Sample TS04-PZM023 collected at 1050. surface casing lid not secure.

Figure 1.

APPENDIX D

STANDARD OPERATING PROCEDURES

Standard Operating Procedure No. 002
for
Chain-of-Custody Form

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 0
August 2007

CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for use of the chain-of-custody form. An example is provided as Figure SOP002-1. Other formats with similar levels of detail are acceptable.

2. MATERIALS

The following materials may be required: chain-of-custody form and indelible ink pen.

3. PROCEDURE

- Give the site name and project name/number.
- Enter the sample identification code.
- Indicate the sampling dates for all samples.
- List the sampling times (military format) for all samples.
- Indicate “grab” or “composite” sample with an “X.”
- Specify the sample location.
- Enter the total number of containers per cooler.
- List the analyses/container volume.
- Obtain the signature of sample team leader.
- State the carrier service and airbill number, analytical laboratory, and custody seal numbers.
- Sign, date, and time the “relinquished by” section.
- Upon completion of the form, retain the shipper copy, and affix the other copies to the inside of the sample cooler, in a zip-seal bag to protect from moisture, to be sent to the designated laboratory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency (U.S. EPA). 1980. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80.

———. 1990. Sampler's Guide to the Contract Laboratory Program. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C. December.

———. 1991. User's Guide to the Contract Laboratory Program. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response. January.

Company Name:

Project Manager or Contact:

Phone:

Project No.

Dept.: Task:

Project Name:

Sample Storage Location:

ATO Number:

Page of

Report #:

Parameters/Method Numbers for Analysis

Chain-of-Custody Record

EA Laboratories
231 Schilling Circle
Hunt Valley, MD 21031
Telephone: (410) 584-7000

Report Deliverables:
1 2 3 4 D E

EDD: Yes/No

DUE TO CLIENT: _________

Date	Time	Water	Soil	Sample Identification 19 Characters	**No. of Containers**														**EA Labs Accession Number**	Remarks
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																**LPM**:
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																

				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																
				ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ ξ																

Samples by: (Signature)	Date/Time |	Relinquished by: (Signature)	Date/Time |	Received by: (Signature)	Date/Time |
Relinquished by: (Signature)	Date/Time |	Received by Laboratory: (Signature)	Date/Time |	Airbill Number:	Sample Shipped by: (Circle) Fed Ex. Puro. UPS Hand Carried Other:

Cooler Temp. _______C pH: ___ Yes ___ No Comments: Custody Seals Intact ___ Yes ___ No

NOTE: Please indicate method number for analyses requested. This will help clarify any questions with laboratory techniques.

Standard Operating Procedure No. 004
for
Sample Packing and Shipping

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 0
August 2007

CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

2. MATERIALS

The following materials may be required:

Clear tape	Plastic garbage bags
Custody seals	Sample documentation
Ice	Waterproof coolers (hard plastic or metal)
Metal cans with friction-seal lids (e.g., paint cans)	Zip-seal plastic bags
Packing material[1]	

3. PROCEDURE

Check cap tightness and verify that clear tape covers label and encircles container. Wrap sample container in bubble wrap or closed cell foam sheets. Enclose each sample in a clear zip-seal plastic bag.

Place several layers of bubble wrap, or at least 1 in. of vermiculite on the bottom of the cooler. Line cooler with open garbage bag, place all the samples upright inside a garbage bag, and tie the bag.

Double bag and seal loose ice to prevent melting ice from soaking the packing material. Place the ice outside the garbage bags containing the samples.

Pack shipping containers with packing material (closed-cell foam, vermiculite, or bubble wrap). Place this packing material around the sample bottles or metal cans to avoid breakage during shipment.

Enclose all sample documentation (i.e., Field Parameter Forms, chain-of-custodies) in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation.

Seal the coolers with signed and dated custody seals so that if the cooler were opened, the custody seal would be broken. Place clear tape over the custody seal to prevent damage to the seal.

---

1. Permissible packing materials are: (a) (non-absorbent) bubble wrap or closed cell foam packing sheets, or (b) (absorbent) vermiculite. Organic materials such as paper, wood shavings (excelsior), and cornstarch packing “peanuts” will not be used.

Refer to SOP Nos. 001, 002, 016, and 039.

Tape the cooler shut with packing tape over the hinges and place tape over the cooler drain. Ship all samples via overnight delivery on the same day they are collected if possible.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Any samples suspected to be of medium/high contaminant concentration or containing dioxin must be enclosed in a metal can with a clipped or sealable lid (e.g., similar to a paint can). Label the outer metal container with the sample number of the sample inside.

6. REFERENCES

U.S. Environmental Protection Agency (U.S. EPA). 1980. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80.

———. 1990. Sampler's Guide to the Contract Laboratory Program. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C. December.

———. 1991. User's Guide to the Contract Laboratory Program. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response. January.

Standard Operating Procedure No. 005
for
Field Decontamination

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 0
August 2007

CONTENTS

Page

1. SCOPE AND APPLICATION

All personnel or equipment involved in intrusive sampling, or which enter a hazardous waste site during intrusive sampling, must be thoroughly decontaminated prior to leaving the site to minimize the spread of contamination and prevent adverse health effects. This Standard Operating Procedure describes the normal decontamination of sampling equipment and site personnel.

2. MATERIALS

The following materials may be required:

0.01N HCl	Non-phosphate laboratory detergent (liquinox)
0.10N nitric acid	Plastic garbage bags
Aluminum foil or clean plastic sheeting	Plastic sheeting, buckets, etc. to collect wash water and rinsates
Approved water	Pressure sprayer, rinse bottles, brushes
High performance liquid chromatography (HPLC)-grade water[1]	Reagent grade alcohol[2]

3. PROCEDURE

3.1 SAMPLE BOTTLES

At the completion of each sampling activity, the exterior surfaces of the sample bottles must be decontaminated as follows:

- Ensure the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

3.2 PERSONNEL DECONTAMINATION

Review the project Health and Safety Plan for the appropriate decontamination procedures.

---

1. For the purposes of this Standard Operating Procedure, HPLC-grade water is considered equivalent to “deionized ultra filtered water,” “reagent-grade distilled water,” and “deionized organic-free water.” The end product being water which is pure with no spurious ions or organics to contaminate the sample. The method of generation is left to the individual contractor.
2. For the purposes of this Standard Operating Procedure, the term “reagent grade alcohol” refers to either pesticide grade isopropanol or reagent grade methanol.

3.3 EQUIPMENT DECONTAMINATION

3.3.1 Water Samplers

3.3.1.1 Bailers

After each use, polytetrafluoroethelyne (PTFE) double check valve bailers used for groundwater sampling will be decontaminated as follows:

- Discard all ropes used in sampling in properly marked sealable container, or as directed by the Health and Safety Plan. NOTE: No tubing is to be used in conjunction with a bailer in collecting samples.
- Scrub the bailer to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate detergent.
- Rinse off detergent three times with approved water.
- Rinse bailer with reagent grade alcohol.
- Rinse bailer three times with HPLC-grade water.
- Rinse bailer with 0.10N nitric acid solution.
- Rinse bailer three times with HPLC-grade water.
- Allow bailer to air dry.[3]
- Wrap bailer in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.
- Dispose of used decontamination solutions with drummed purge water.
- Rinse bailer with HPLC-grade water immediately prior to re-use.

3.3.1.2 Pumps

Submersible pumps will be decontaminated as follows:

---

[3] If the bailer has just been used for purging and is being decontaminated prior to sampling, do not air dry. Double rinse with HPLC-grade water and proceed to collect samples.

- Scrub the exterior of the pump to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate detergent. (Steam cleaning may be substituted for detergent scrub.)

- Calculate the volume of pump plus any tubing which is not disposable and not dedicated to a single well. Pump three volumes of non-phosphate laboratory detergent solution to purge and clean the interior of the pump.

- Rinse by pumping no less than nine volumes of approved water to rinse.

- Rinse pump exterior with reagent grade alcohol.

- Rinse pump exterior with HPLC-grade water.

- Allow pump to air dry.

- Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.

- Prior to reusing pump rinse exterior again with HPLC-grade water. (Double rinse in Bullet 5 above may be substituted for this step).

3.3.1.3 Dip Samplers

All dip samplers, whether bucket, long-handled, or short-handled, will be decontaminated in the same manner as provided in Section 3.3.1.1.

3.3.1.4 Labware

Labware, such as beakers, which are used to hold samples for field measurements, water chemistry, etc. will be decontaminated according to the procedures in Section 3.3.1.1.

3.3.1.5 Water Level Indicators

Electric water level indicators, weighted measuring tapes, or piezometers used in the determination of water levels, well depths, and/or non-aqueous phase liquid levels will be decontaminated in accordance with Section 3.3.1.1. Clean laboratory wipes may be substituted for brushes. Tapes, probes, and piezometers should be wiped dry with clean laboratory wipes, and coiled on spools or clean plastic sheeting rather than allowed to air dry.

3.3.2 Solid Materials Samplers

Solid materials samplers include soil sampling probes, augers, trowels, shovels, sludge samplers, and sediment samplers, which will be decontaminated as follows:

- Scrub the sampler to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate laboratory detergent.

- Rinse off detergent with approved water.

- Rinse sampler with reagent grade alcohol.

- Rinse sampler with HPLC-grade water.

- For non-metallic samplers only, rinse sampler with 0.10N nitric acid solution.

- For non-metallic samplers only, rinse sampler with HPLC-grade water.

- Allow sampler to air dry.

- Wrap sampler in aluminum foil clean plastic sheeting, or store in a new zipseal bag (size permitting) or clean, dedicated polyvinyl chloride or PTFE storage container.

- Dispose used decontamination solutions properly according to the site-specific Health and Safety Plan.

- Rinse sampler with HPLC-grade water immediately prior to re-use.

3.3.3 Other Sampling and Measurement Probes

Soil gas sampling probes will be decontaminated as solids sampling devices.

Temperature, pH, conductivity, redox, and dissolved oxygen probes will be decontaminated according to manufacturer’s specifications. If no such specifications exist, remove gross contaminant and triple rinse probe with HPLC-grade water. A summary of the decontamination procedures to be used must be included in the instrument-specific standard operating procedure.

Measuring tapes that become contaminated through contact with soil during field use will be decontaminated as follows:

- Wipe tape with a clean cloth or laboratory wipe that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination. Rinse cloth in the solution and continue wiping until tape is clean.

- Wipe tape with a second clean, wet cloth (or laboratory wipe) to remove soap residues.

- Dry tape with a third cloth (or laboratory wipe) and rewind into case, or re-coil tape.

3.3.4 Drilling Rigs and Other Heavy Equipment

All drilling rigs and associated equipment such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out) will be decontaminated prior to site entry after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed prior to site entry when there is a likelihood that contamination has accumulated on tires and as spatter or dust enroute from one site to the next.

- Place contaminated equipment in an enclosure designed to contain all decontamination residues (water, sludge, etc.).
- Steam clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) have been removed.
- Water used will be taken from an approved source.
- Containerize in 55-gal drums; sample; characterize; and, based on sample results, dispose of all decontamination residues properly.

Other heavy equipment includes use of backhoes, excavators, skid steers, etc. If heavy equipment is utilized during field activities, i.e., a backhoe for test pitting, the bucket should not come in contact with soil to be sampled. If the bucket contacts the soil to be sampled, then it should be decontaminated between sample locations, following the same procedures as listed above for a drill rig.

3.3.5 High Performance Liquid Chromatography-Grade Water Storage

Dedicated glass storage containers will be used solely for dispensing HPLC-grade water. New HPLC-grade water containers will be decontaminated as follows:

- Clean with tap water from approved source and non-phosphate laboratory detergent while scrubbing the exterior and interior of the container with a stiff-bristled brush.
- Rinse thoroughly with approved water.
- Rinse with 0.01N nitric acid.
- Rinse with approved water.
- Rinse thoroughly with HPLC-grade water.
- Fill clean container with HPLC-grade water. Cap with one layer of PTFE-lined paper and one layer of aluminum foil. Secure cap with rubber band and date the container.

Used HPLC-grade water containers will be decontaminated as follows:

- Clean the exterior with tap water from an approved source, non-phosphate laboratory detergent, and a stiff-bristled brush.
- Rinse the exterior thoroughly with HPLC-grade water.
- Rinse the interior twice with pesticide-grade isopropanol.
- Rinse interior thoroughly with HPLC-grade water.
- Fill clean container with HPLC-grade water. Cap with one layer of PTFE-lined paper and one layer of aluminum foil. Secure cap with rubber band and date the container.

3.3.6 Ice Chests and Reusable Shipping Containers

- Scrub exterior/interior with approved brush and liquinox detergent.
- Rinse off detergent three times with approved water.
- Let air dry and properly store until re-use.

NOTE: If container/ice chest is severely contaminated, clean as thoroughly as possible, render unusable, and properly dispose.

4. MAINTENANCE

HPLC-grade water will be stored only in decontaminated glass containers with aluminum foil lids as stipulated above. The water may not be stored for more than nor used more than 3 days after manufacture.

HPLC-grade water will be manufactured onsite. An approved tap water source will be used as the influent to the system. Procedures for system setup, operation, and maintenance will conform to manufacturer's specifications.

5. PRECAUTIONS

Dispose of all wash water, rinse water, rinsates, and other sampling wastes (tubing, plastic sheeting, etc.) in properly marked, sealable containers, or as directed by the Health and Safety Plan.

Once a piece of equipment has been decontaminated, be careful to keep it in such condition until needed.

Do not eat, smoke, or drink onsite.

6. REFERENCES

Site-specific Health and Safety Plan.

Standard Operating Procedure No. 016
for
Surface Water, Groundwater, and Soil/Sediment Field Logbooks

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 0
August 2007

CONTENTS

Page

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for recording surface water, groundwater, soil/sediment sampling information, instrument calibration data, and data from hydrologic testing in the field logbooks. Acceptable field logbooks are: bound, unprinted books such as a surveyor's field book, or a federal supply service No. 7530-00-222-3525 record book (or equivalent); or they may be company-proprietary, pre-printed forms bound into a field logbook. Example forms are provided herein. Alternate, equivalent forms are acceptable.

2. MATERIALS

The following material may be required: applicable field logbook and indelible ink pen.

3. PROCEDURE

Information pertinent to soil/sediment, groundwater, or surface water sampling will be recorded in the appropriate logbook. Each page/form of the logbook will be consecutively numbered. Entries will be made in indelible ink. Corrections will consist of line-out deletions that are initialed and dated. If using carbon paper or self-duplicating forms, before entering data in logbook, insert a sheet protector between form sets to isolate first blank form from remaining forms.

3.1 SOIL/SEDIMENT LOGBOOK (Requires Figures SOP016-1 and SOP016-3)

3.1.1 Field Parameter Form (Items on Figures SOP016-1 and SOP016-2)

1. HIGH CONCENTRATION EXPECTED?: Answer "Yes" or "No."

2. HIGH HAZARD?: Answer "Yes" or "No."

3. SITE: Record the complete name of the site.

4. AREA: Record the area designation of the sample site.

5. INST CODE: Record the 2-letter installation code appropriate for the installation or site. Correct abbreviations can be found on Pages 3-6 of the IRDMS User's Guide for chemical data entry.

6. FILE NAME: Record "CSO" for a soil sample or "CSE" for a sediment sample.

7. SITE TYPE: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User's Guide for chemical data entry. This entry must match the Site Type on the map file form.

8. SITE ID: Record a code up to 10 characters or numbers which is unique to the site.

9. FIELD SAMPLE NUMBER: Record a code specific for the sample.

10. DATE: Enter the date the sample was taken.

11. TIME: Enter the time (12-hour or 24-hour clock acceptable as long as internally consistent) the sample was taken.

12. AM PM: Circle "AM" or "PM" to designate morning or afternoon (12-hour clock).

13. SAMPLE PROG: Record "GQA" (Groundwater Quality Assessment) or other appropriate sample program.

14. DEPTH (TOP): Record the total depth sampled.

15. DEPTH INTERVAL: Record the intervals at which the plug will be sampled.

16. UNITS: Record the units of depth (feet, meters)

17. SAMPLE MEASUREMENTS: Check the appropriate sampling method.

18. CHK: Check off each container released to a laboratory.

19. ANALYSIS: Record the type of analysis to be performed on each sample container.

20. SAMPLE CONTAINER: Record the sample container type and size.

21. NO.: Record the number of containers.

22. REMARKS: Record any remarks about the sample

23. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: Record the total number of containers.

24. SITE DESCRIPTION: Describe the location where the sample was collected.

25. SAMPLE FORM: Record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System.

26. COLOR: Record the color of the sample as determined from standard Munsell Color Charts.

27. ODOR: Record the odor of the sample or "none." See SOP No. 001 Section 5.

28. PID (HNu): Record the measured PID (HNu) values.

29. UNUSUAL FEATURES: Record anything unusual about the site or sample.

30. WEATHER/TEMPERATURE: Record the weather and temperature.

31. SAMPLER: Record your name.

3.1.2 Map File Form (Figure SOP016-3)

1. The map file logbook form will be located on the reverse of the field parameter logbook form, or on an adjoining page of the field logbook (if level book is used).

2. SITE ID: Record the Site ID from the field parameter form.

3. POINTER: Record the field sample number for the sample being pointed to.

4. DESCRIPTION/MEASUREMENTS: Describe the location where the sample was taken, along with distances to landmarks.

5. SKETCH/DIMENSIONS: Diagram the surroundings and record the distances to landmarks.

6. MAP REFERENCE: Record which U.S. Geological Survey Quad Map references the site.

7. COORDINATE DEFINITION: Write the compass directions the X- and Y-Coordinates of the map run.

8. COORDINATE SYSTEM: Write “UTM” (Universal Transverse Mercator).

9. SOURCE: Record the 1-digit code representing the Map Reference.

10. ACCURACY: Give units (e.g., write “1-M” for 1 meter).

11. X-COORDINATE: Record the X-Coordinate of the sample site location.

12. Y-COORDINATE: Record the Y-Coordinate of the sample site location.

13. UNITS: Record the units map sections are measured in.

14. ELEVATION REFERENCE: Record whether topography was determined from a map or a topographical survey.

15. ELEVATION SOURCE: Record the 1-digit code representing the elevation reference.

16. ACCURACY: Record the accuracy of the map or survey providing the topographical information.

17. ELEVATION: Record the elevation of the sampling site.

18. UNITS: Write the units in which the elevation is recorded.

19. SAMPLER: Write your name.

3.2 SURFACE WATER LOGBOOK (Requires Figures SOP016-2 and SOP016-3)

3.2.1 Field Parameter Form (Items Unique to Figure SOP016-3)

1. CAL REF: Record the calibration reference for the pH meter.

2. pH: Record the pH of the sample.

3. TEMP: Record the temperature of the sample in degrees Celsius.

4. COND: Record the conductivity of the water.

5. For all other sections, see Section 3.2.1.

3.3 GROUNDWATER SAMPLING LOGBOOK (Requires Figures SOP016-2, SOP016-3, and SOP016-4)

3.3.1 Field Parameter Form (Items on Figure SOP016-4)

1. WELL NO. OR ID: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User’s Guide for chemical data entry.

2. SAMPLE NO.: Record the reference number of the sample.

3. WELL/SITE DESCRIPTION: Describe the location where the sample was taken, along with distances to landmarks.

4. X-COORD and Y-COORD: Record the survey coordinates for the sampling site.

5. ELEV: Record the elevation where the sample was taken.

6. UNITS: Record the units the elevation was recorded in.

7. DATE: Record the date in the form MM/DD/YY.

8. TIME: Record the time, including a designation of AM or PM.

9. AIR TEMP.: Record the air temperature, including a designation of C or F (Celsius or Fahrenheit).

10. WELL DEPTH: Record the depth of the well in feet and inches.

11. CASING HT.: Record the height of the casing in feet and inches.

12. WATER DEPTH: Record the depth (underground) of the water in feet and inches.

13. WELL DIAMETER: Record the diameter of the well in inches.

14. WATER COLUMN HEIGHT: Record the height of the water column in feet and inches.

15. SANDPACK DIAM.: Record the diameter of the sandpack. Generally, this will be the same as the bore diameter.

16. EQUIVALENT VOLUME OF STANDING WATER: Use one of the following equations, to determine one equivalent volume (EV):

1 EV = Volume in casing + volume in saturated sand pack. Or to restate:

$$1\ \mathrm{EV} = (BR_w^2h_w + 0.30B(R_s^2 - R_w^2)h_s) * (0.0043)$$

where

R_s = Radius of sandpack in inches
R_w = Radius of well casing in inches
h_s = Height of sandpack in inches
h_w = Water depth in inches

0.0043 = gal/in.^{3}
and filter pack porosity is assumed as 30 percent

— OR —

Volume in casing = (0.0043 gal/in.^{3})(B)(12 in./ft)(R_c^2)(W_h)

where

R_c = Radius of casing in inches
W_h = Water column height in feet

Vol. in sandpack = (0.0043 gal/in.^{3})(B)(12 in./ft)($R_b^2 - R_c^2$)(W_h)(0.30)

(if W_h is less than the length of the sandpack),

— PLUS —

Vol. in sandpack = $(0.0043 \text{ gal/in.}^3)(B)(12 \text{ in./ft})(R_b^2 - R_c^2)(S_h)(0.30)$

(if W_h is greater than the length of the sandpack).

where
R_b = Radius of the borehole
S_h = Length of the sandpack.

Show this calculation in the comments section.

17. VOLUME OF BAILER OR PUMP RATE: Record bailer volume or pump rate.

18. TOTAL NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers required to remove 3 equivalent volumes (EV) of water from the well or the total purge time and volume as applicable.

19. WELL WENT DRY? Write “YES” OR “NO.”

20. NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers or pump time which made the well go dry.

21. VOLUME REMOVED: Record the volume of water (gal) removed before the well went dry.

22. RECOVERY TIME: Record the time required for the well to refill.

23. PURGE AGAIN?: Answer “YES” or “NO.”

24. TOTAL VOL. REMOVED: Record the total volume of water (in gal) removed from the well.

25. CAL REF.: Record the calibration reference for the pH meter.

26. TIME: Record time started (INITIAL T[0]), 2 times DURING the sampling and the time sampling ended (FINAL).

27. pH: Record the pH at start of sampling (INITIAL), twice DURING the sampling and at the end of sampling (FINAL).

28. TEMP: Record the water temperature (Celsius) at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

29. COND: Record the conductivity of the water at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

30. D.O.: Record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

31. TURBIDITY: Record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

32. ORD: Record the oxidation/reduction (RedOx) potential of the water sample at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

33. HEAD SPACE: Record any positive readings from organic vapor meter reading taken in well headspace prior to sampling.

34. NAPL: Record the presence and thickness of any non-aqueous phase liquids (light or dense)

35. COMMENTS: Record any pertinent information not already covered in the form.

36. SIGNATURE: Sign the form.

3.4 FIELD CALIBRATION FORMS (Maintained as a separate logbook, or incorporated into sampling logbooks)

3.4.1 Items on Figure SOP016-5

1. Record time and date of calibration. Note whether 12- or 24-hour clock was used.

2. Record calibration standard reference number.

3. Record meter I.D. number

4. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line.

5. Record value of reference standard (as required).

6. COMMENTS: Record any pertinent information not already covered on form.

7. SIGNATURE: Sign form.

3.5 GROUNDWATER HYDROLOGY TESTS LOGBOOK (Must include Figures SOP016-6 and SOP016-7 and/or SOP016-8, OR SOP016-9 or SOP016-10)

3.5.1 Field Permeability Test Data Sheet (Items on Figures SOP016-6)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

4. PROJECT NO.: Record the contractor assigned project number or the contract number.

5. LOCATION: Specific location

6. CLIENT: Agency or company with the contract under which the work is being performed.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

9. TEST TYPE: Short description of the type of test to be performed.

10. RISING/FALLING HEAD WITH SLUG: Check if the test involved the insertion/removal of and inert object.

11. RISING/FALLING HEAD WITHOUT SLUG: Check if the test involved the addition/removal of a quantity of water.

12. START DATE: Date on which the test was begun.

13. CLOCK TIME: Time each datum (depth to groundwater level) is collected. Note whether 12- or 24-hour clock was used.

14. ELAPSED TIME: Time since the last datum was collected.

15. DEPTH TO GWL (ft): Depth to the top of the groundwater table (Groundwater Level) as measured by manual methods.

16. REC. (ft): Water level as reported by transducer/datalogger (this is the depth of water above the transducer.

17. TIME: Time the discharge rate check was begun (addition or removal of water method). Note whether 12- or 24-hour clock was used.

18. FLOW METER (Addition or removal of water method): The amount of water added or removed as registered by the flowmeter, in gal of liters.

19. DISCHARGE RATE: Flowmeter reading divided by time interval (gal/min or liters/min).

20. SIGNATURE: The person completing this form must sign the form at the end of the test.

21. DATE: Date the form was signed.

3.5.2 Groundwater Levels – Single Well (Items on Figure SOP016-7)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: Remedial investigation wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATE: Date of each water level reading
16. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.
17. ELAPSED TIME: Time since test was begun.
18. DEPTH TO WATER: Measured depth to the groundwater table.
19. WATER ELEVATION: Elevation of the top of the groundwater table (use datum listed above).
20. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).
21. TAPE NO.: The unique identification number of the traceable standard tape used to calibrate the measuring device.
22. WELL STATUS: Condition of the well at the time of measuring (see abbreviation key at the bottom of the data sheet).
23. REMARKS: Any additional pertinent comments not specifically required above.
24. INITIALS: Initials of person completing this data entry.
25. ABBREVIATION KEYS: Self explanatory.
26. SIGNATURE: The person completing this form must sign the form at the end of the test.
27. DATE: Date the form was signed.

3.5.3 Groundwater Levels – Single Well (Items on Figure SOP016-8)

1. CONTRACTOR: Organization performing the test.
2. SEQ. #: Enter page number of this set of forms (page # of #).
3. PROJECT NO.: Record the contractor assigned project number or the contract number.
4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.
5. PROJECT NAME: Record the name assigned by the contractor’s organization to the project.
6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

WELL DATA

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATALOGGER: This section is record of pertinent datalogger information.

16. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

17. MODEL: Enter the model number of the datalogger.

18. S/N: Enter the serial number of this datalogger.

19. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

20. TRANSDUCER: This section is a listing of pertinent information about the transducer used.

21. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

22. MODEL: Enter the model number of the transducer.

23. S/N: Enter the serial number of this transducer.

24. INPUT/UNITS: What are the units this transducer uses?

25. RANGE: Record the pressure or depth range over which this transducer is certified.

CALIBRATION

26. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer. (Usually in psi, or kpa).

27. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

28. VOLUME WATER ADDED/REMOVED: (Applicable if inert object insertion/removal method was not employed.) Record the volume of water added to or removed from the well.

29. DISCHARGE RATE: If z (above) is filled, enter the rate at which this water was added or removed.

30. INITIAL WATER LEVEL (ft): Enter the water level in the well at the beginning of the test.

31. PRESSURE TRANSDUCER SUBMERGENCE: Record the depth to which the transducer is submerged at the beginning of the test and the depth to the transducer at the end if the test. All depths will be recorded to the nearest 0.01 ft.

32. TIME: Record the time the test is begun and ended. Note whether 12- or 24-hour clock was used.

33. OBSERVED CHANGES IN ADJACENT WELLS: Note any changes in water levels in nearby wells.

34. RESULTS RECORDED ON DISKETTE #: Tracking number of the diskette on which these data are archived.

35. DISKETTE FILE NAME: Name of the file(s).

36. SIGNATURE: The person completing this form must sign the form at the end of the test

37. DATE: Date the form was signed.

3.6 GROUNDWATER LEVELS – MULTIPLE WELLS (Items on Figure SOP016-9)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

5. LOCATION: Specific location.

6. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

7. CLIENT: Agency with the contract under which the work is being performed.

8. REMARKS: Any pertinent observations not specifically required above.

9. WELL: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

10. DATE: Date this measurement was made.

11. TIME: Time this measurement was made. Note whether 12- or 24-hour clock was used.

12. DEPTH TO WATER: Depth from MP to top of groundwater table.

13. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

14. MP ELEV.: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

15. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).

16. REMARKS/MP: Describe the location and nature of the measuring point.

17. INITIALS: Initials of the person completing this form.

18. ABBREVIATION KEYS: Self explanatory.

19. SIGNATURE: The person completing this form must sign the form at the end of the test.

20. DATE: Date the form was signed.

3.7 GROUNDWATER LEVELS – DATALOGGERS (Items on Figure SOP016-10)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

WELL DATA

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019, Section 3.4).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

DATALOGGER (This section is a record of pertinent datalogger information)

15. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

16. MODEL: Enter the model number of the datalogger.

17. S/N: Enter the serial number of this datalogger.

18. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

TRANSDUCER (This section is a listing of pertinent information about the transducer used)

19. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

20. MODEL: Enter the model number of the transducer.

21. S/N: Enter the serial number of this transducer.

22. INPUT/UNITS: What are the units this transducer uses?

23. RANGE: Record the pressure or depth range over which this transducer is certified.

CALIBRATION

24. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer (usually in psi, or kpa).

25. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

26. DATE: Date of each water level reading

27. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.

28. LOGGING TIME INTERVAL: Time since test was begun.

29. WL FEET BELOW MP: Measured depth to the groundwater table from measuring point.

30. SUBMERGENCE: Depth of water above the transducer.

31. MEAS.METHOD: What device/method was used to measure the water level.

32. TAPE NO.: Record the tape identification number.

33. TRANSDUCER MOVED?: Was the transducer moved since the last water level reading?

34. REMARKS: Any pertinent remarks not otherwise specified.

35. INITIALS:

DATA TRANSFER TO DISKETTE:

36. DATE: Date data were archived onto diskette.

37. TIME: Time stamp the computer assigns the data file.

38. FILE NAME: Name assigned the data file.

39. SOFTWARE USED FOR TRANSFER: Any special software, or computer operating system used to write the files to diskette. NOTE: If a "shareware" archiver which compresses files was used, and the archived file is not self-extracting, a copy of the unarchive program should be copied onto the diskette also.

40. OUTPUT FORMAT: What is the format of the output file? (DOS, UNIX, Binary, Compressed?)

41. INITIALS: Initials of the person who copied the data to diskette.

42. ABBREVIATION KEY: Self-explanatory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency. 1984. User's Guide to the Contract Laboratory Program. July.

FIGURE SOP016-1
FIELD PARAMETER LOGBOOK
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

INSTALLATION/SITE ________________________________ AREA ___________________

INST CODE FILE NAME ____

SITE TYPE SITE ID
FIELD SAMPLE NUMBER

DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.

DEPTH (TOP) DEPTH INTERVAL UNIT _____________

SAMPLING METHOD:

SPLIT SPOON AUGER SHELBY TUBE SCOOP OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS
SITE DESCRIPTION:____
SAMPLE FORM ______________________ COLOR _____________ ODOR _____________
PID (HNu) _______________________ UNUSUAL FEATURES _______________________
____
WEATHER/TEMPERATURE
SAMPLER

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

FIGURE SOP016-2
FIELD PARAMETER LOGBOOK
GROUNDWATER AND SURFACE WATER SAMPLES

INSTALLATION/SITE AREA
INST CODE FILE NAME SITE TYPE
SITE ID FIELD SAMPLE NUMBER
DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.
DEPTH (TOP) DEPTH INTERVAL UNITS

SAMPLING MEASUREMENTS

CAL REF.	pH	TEMPERATURE C	CONDUCTIVITY	OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION
SAMPLING METHOD
SAMPLE FORM COLOR ODOR
PID (HNu)
UNUSUAL FEATURES
WEATHER/TEMPERATURE _________________________ SAMPLER _________________

FIGURE SOP016-3
MAP FILE LOGBOOK

SITE ID POINTER ____________________
DESCRIPTION/MEASUREMENTS
SKETCH/DIMENSIONS:

MAP REFERENCE
COORDINATE DEFINITION (X is Y is)
COORDINATE SYSTEM SOURCE ACCURACY
X-COORDINATE Y-COORDINATE UNITS
ELEVATION REFERENCE
ELEVATION SOURCE ACCURACY ELEVATION
UNITS

SAMPLER

FIGURE SOP016-4
MAP FILE AND PURGING LOGBOOK
GROUNDWATER SAMPLES

WELL COORD. OR ID SAMPLE NO.______________
WELL/SITE
DESCRIPTION____
____
X-COORD. Y-COORD. _______________ ELEV. UNITS
DATE ____/____/____ TIME AIR TEMP.

WELL DEPTH _________ ft _________ in. CASING HT. __________ ft _______ in.
WATER DEPTH __________ ft _________ in. WELL DIAMETER __________ in.
WATER COLUMN HEIGHT _________ ft _________ in. SANDPACK DIAM. ________ in.
EQUIVALENT VOLUME OF STANDING WATER ____________ (gal) (L)
VOLUME OF BAILER ___________ (gal) (L) or PUMP RATE ___________ (gpm) (lpm)
TOTAL NO. OF BAILERS (5 EV)___________ or PUMP TIME ___________ MIN.
WELL WENT DRY? [Yes] [No] NUM. OF BAILERS ________ or PUMP TIME______MIN
VOL. REMOVED __________ (gal) (L) RECOVERY TIME __________ MIN
PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED __________ (gal) (L)

Date and Time	Quantity Removed	Time Required	pH	Cond	Temp	ORD	Turb	DO	Character of water (color/ clarity/odor/partic.)
(before)									
(during)									
(during)									
(during									
(after)									

COMMENTS:____
____
____
____

SIGNATURE

FIGURE SOP016-5
FIELD CALIBRATION: pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, OXIDATION-REDUCTION POTENTIAL, AND DISSOLVED OXYGEN METERS

INITIAL CALIBRATION	FINAL CALIBRATION
DATE:	DATE:
TIME:	TIME:

pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ______________________________

pH STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
7.0			
10.0			
4.0			

CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID _________________

COND. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

TEMPERATURE METER CALIBRATION

METER ID ________________

TEMP. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
ICE WATER			
BOILING WATER			
OTHER			

FIGURE SOP016-5 *(continued)*

TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ____________________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

COMMENTS:____

____

____

____

____

SIGNATURE

FIGURE SOP016-6
FIELD PERMEABILITY TEST DATA SHEET

Contractor: **Seq. #** /

Project Name:	Project #:
Location:	Client:
Party Chief:	Contractor:
Observation Well:	
Test Type: Rising/Falling Head w/Slug	Rising/Falling Head w/out Slug

Start Date:								Discharge Rate		
Clock Time	Elapsed Time (min)	Depth to GWL (ft)	Rec (ft)	Clock Time	Elapsed Time	Depth to GWL (ft)	Rec (ft)	Time	Flow Meter	Discharge Rate

Signature: ______________________________________ **Date:** _____________________

FIGURE SOP016-7
GROUNDWATER LEVELS – SINGLE WELL

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:
Well No.: Site: Area:
Site: Area:
Area:

up (+)/down (-) from: Datum = MSL or:
Datum = MSL or:

Measuring Point Description:

Datalogger:
Manufacturer: Model: S/N:
Tag No. Programmed in Logger:

Transducer: Manufacturer: Model: S/N:
Input/Units: Range:

Calibration:
Pressure Rating:
0 ft submergence = (v) / (mv) ft submergence = (v) / (mv)

Volume Water Added/Removed:
Discharge Rate:
Initial Water Level (ft):

Pressure Transducer Submergence
Initial (ft): Final(ft): Time:Start: End:
Observed Changes in Adjacent Wells:

Results Recorded on Diskette #:
Diskette File Name:

Signature: ____ **Date:** ______________________

FIGURE SOP016-8
GROUNDWATER LEVELS – MULTIPLE WELLS

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:

Measuring Point Description:
Remarks:
Well No.:
Site: Area: up (+)/down (-) from:
up (+)/down (-) from:
up (+)/down (-) from:
Datum = MSL or:

Date	Time	Elapsed Time	Depth to Water	Water Elevation	Meas. Meth.	Tape No.	Well Status	Remarks	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

Signature: ______________________________ **Date:** ____________________

FIGURE SOP016-8 *(continued)*

Contractor: **Seq. #** /

Project No.:
Project Name: Location:
Field Party Chief: Client:

Well	Date	Time	Depth to Water	Stickup	MP Elev.	Meas. Meth.	Tape No.	Remarks/MP	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

FIGURE SOP016-9
GROUNDWATER LEVELS DATALOGGERS

Contractor

Project No.: **Well No.:**

Project Name: **Site:**

Field Party Chief: **Area:**

WELL DATA: Stickup: **(ft)** **up (+)/down (-) from:**

MP Elevation: **Datum = MSL or:**

Measuring Point Description:

Remarks:

Datalogger:

Manufacturer: Model: S/N:

Tag No. Programmed in Logger:

Transducer: Manufacturer: Model: S/N:

Input/Units: Range:

Calibration: Pressure Rating:

0 ft submergence = (v) / (mv) ft submergence = (v)

Logging	Date	Time	Logging Time Interval	WL, ft Below MP	Submergence (logger reading)	Meas. Method	Tape No.	Well Status	Transducer Moved	Remarks	Initials
Start											
Stop											
Start											
Stop											

Data Transfer to Disk

Date	Time	File Name	Software Used for Transfer	Output Format	Initials

Measurement Method:

A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:

D = Dry
F = Flowing
P = Pumping
RP = Recently
NP = Nearby well pumping
NRP = Nearby well recently pumped
X = Obstructed

Signature **Date**

Standard Operating Procedure No. 021
for
Sediment Sampling

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 1
August 2010

CONTENTS

Page

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) delineates protocols for sampling sediments from streams, rivers, ditches, lakes, ponds, lagoons, and marine and estuarine systems.

EA recognizes that other protocols have been developed that meet the criteria of quality and reproducibility. Clients may have their own sediment sampling protocols which may contain methodologies and procedures that address unique or unusual site-specific conditions or may be in response to local regulatory agency requirements. In such cases, EA will compare its and the client's protocols. The goal is to provide the client with the most quality; therefore, if the client's protocols provide as much or more quality assurance than EA's protocols for the particular site or project, EA will adopt those particular protocols and this SOP will be superseded in those respects. If EA is required to implement the client's protocols in lieu of EA's protocols, EA will make the client formally aware of any concerns regarding differences in protocols that might affect data quality and will document such concerns in the project file.

2. PROCEDURES

The water content of sediment varies. Sediments range from soft to dense and fine to rocky. A variety of equipment may be necessary to obtain representative samples, even at a single site. Factors to consider in selecting the appropriate sampling equipment include sample location (edge or middle of the waterbody), depth of water and sediment, grain size, water velocity, and analytes of interest.

3. GENERAL PROCEDURES

1. Surface water and sediment samples are to be collected at the same location (if both are required in the project-specific Sampling and Analysis Plan).

2. Collect the surface water sample first. Sediment sampling usually results in disturbance of the sediments, which may influence the analytical results of the surface water samples.

3. Wear gloves when collecting samples. Comply with the Health and Safety Plan specifications for proper personal protective equipment.

4. If sampling from a boat or near waterbodies with depths of 4 ft or more, the sampling team will wear life jackets.

5. Wading into a waterbody disturbs the sediment. Move slowly and cautiously, approach the sample location from downstream. If flow is not strong enough to move entrained particles away from the sample location, wait for the sediment to resettle before sampling.

6. Collect samples first from areas suspected of being the least contaminated, thus minimizing the risk of cross-contamination.

7. Collecting samples directly into sample containers is not recommended. Sediment samples should be placed in Teflon®, stainless steel, or glass trays, pans, or bowls for sample preparation.

8. Use the proper equipment and material construction for the analytes of interest. For example, for volatile organic compound analysis, the sampling material in direct contact with the sediment or surface water must consist of Teflon, polyethylene, or stainless steel.

9. Refer to EA SOP No. 005 (Field Decontamination) for proper decontamination methods before and after sampling and between samples.

10. Collect samples for volatile organic compound analysis first. Do not mix such samples before placing them in the sample containers. For composite volatile organic compound samples, place equal aliquots of each subsample in the sample container.

11. Sediment that will be analyzed for other than volatile organic compounds should be prepared as follows:

    - Place the sediment in a mixing container.
    - Divide the sediment into quarters.
    - Mix each quarter separately and thoroughly.
    - Combine the quarters and mix thoroughly.
    - For composite samples, mix each subsample as described above. Place equal aliquots of each subsample in a mixing container and follow the procedure described above.

12. Mark the sampling location on a site map. Record sampling location coordinates with a Global Positioning System unit, photograph (optional, recommended) and describe each location, and place a numbered stake above the visible high water mark on the bank closest to the sampling location. The photographs and description must be adequate to allow the sampling station to be relocated at a future date.

13. Dispose of investigation-derived wastes according to applicable rules and regulations.

4. CORERS

A corer provides a vertical profile of the sediment, which may be useful in tracing historical contaminant trends. Because displacement is minimal, a corer is particularly useful when sampling for trace metals and organics. Corers can be constructed out of a variety of materials.

For example, a 2-in. diameter polyvinyl chloride pipe with a Teflon or polyethylene liner can be lowered into the sediment; a 2-in. diameter well cap can be used to form an airtight seal and negative pressure as the pipe is withdrawn.

- Ensure that the corer and (optional) liner are properly cleaned.

- Stand downstream of the sample location.

- Force the corer into the sediment with a smooth continuous motion. Rotate (not rock) the corer if necessary to penetrate the sediment.

- Twist the corer to detach the sample; then withdraw the corer in a single smooth motion. If the corer does not have a nosepiece, place a cap on the bottom to keep the sediment in place.

- Remove the top of the corer and decant the water (into appropriate sample containers for surface water analysis, if required).

- Remove the nosepiece or cap and deposit the sample into a stainless steel, Teflon, or glass tray.

- Transfer the sample into sample containers using a stainless steel spoon (or equivalent device).

5. SCOOPS AND SPOONS

When sampling at the margins of a waterbody or in shallow water, scoops and spoons may be the most appropriate sampling equipment. For collecting samples several feet from shore or in deeper water, the scoop or spoon may be attached to a pole or conduit.

- Stand downstream of the sample location.

- Collect the sample slowly and gradually to minimize disturbing the fine particles.

- Decant the water slowly to minimize loss of fine particles.

- Transfer the sediment to sample containers or mixing trays, as appropriate.

6. DREDGES

Three types of dredges are most frequently used: Peterson, Ponar, and Eckman. Many other dredge types are available; their applicability will depend upon site-specific factors.

6.1 PETERSON AND PONAR DREDGES

These dredges are suitable for hard, rocky substrates, deep waterbodies, and streams with fast currents. Ponars have top screens and side plates to prevent sample loss during retrieval.

- Open the jaws and place the cross bar into the proper notch.
- Lower the dredge to the bottom, making sure it settles flat.
- When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.
- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval.
- Open the jaws and transfer the sediment to sample containers or to a mixing tray.

6.2 ECKMAN DREDGE

The Eckman dredge works best in soft substrates in waterbodies with slow or no flow.

- Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.
- Lower the dredge to the bottom, making sure it settles flat.
- Holding the line taut, send down the message to close the jaws.
- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval.
- Open the jaws and transfer the sediment to sample containers or a mixing tray.

7. REFERENCES

None.

Standard Operating Procedure No. 035
for
Small Boat Operations

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 1
August 2010

CONTENTS

1. BACKGROUND

The threat from working on or near surface water bodies comes from both chemical hazards and physical hazards such as drowning. When there is a need for sampling to be conducted using small boats, EA will provide necessary safety gear, i.e., life vests, nets, and other floating devices and appropriate training.

1.1 PURPOSE

This Standard Operating Procedure (SOP) establishes the operating requirements for small boats conducting inland and coastal marine work.

1.2 SCOPE

This SOP applies to the operation of small boats, including launches, motorboats, working platforms, and skiffs, for inland (rivers, lakes, and bays) and coastal marine work. This SOP applies to EA personnel operating a small boat or working on a subcontractor-operated small boat. This SOP covers small boat requirements, work over or near bodies of water, personal floatation devices (PFDs), lifesaving and safety skiffs, severe weather precautions, and cold water and drowning hazards. This SOP is mandatory for EA personnel. Subcontractors are responsible for analyzing the hazards of activities they control and for preparing job hazard analysis and maintaining equivalent safety requirements.

1.3 DEFINITIONS

Small Boat—Includes dinghies, 1- or 2-man rowboats, up to and including larger vessels typically up to 50 ft in length, and work barges.

Float Plan—A written summary of the details of the trip, including route, type of vessel, persons aboard, and other salient information which may be useful in the event of an emergency.

Job Hazard Analysis—A concise analysis of the specific task considering the body of water, vessel, unique job requirements, training and experience of crew, and other circumstances as may be appropriate.

1.4 REFERENCES

EA Corporate Vessel Operations Manual. December 2004.

Federal Requirements and Safety Tips for Recreational Boats. 1994. Boating Education Branch. April.

U.S. Army Corps of Engineers. 2003. Safety and Health Requirements Manual. Volume EM 385-1-1. September.

U.S. Coast Guard. 1994. Federal Requirements and Safety Tips for Recreational Boats.

1.5 RESPONSIBILITIES

The Project Health and Safety Officer is responsible for review and approval of small boat operations as described in the Health and Safety Plan. The Project Health and Safety Officer provides any necessary safety requirements to the project team. The Project Health and Safety Officer shall review the job hazard analysis prepared by project personnel.

Onsite Health and Safety Officer**—**The Health and Safety Officer is responsible for ensuring proper use of small boats at field locations. The Health and Safety Officer ensures that only trained personnel operate small boats, subcontractors implement safety programs, and that all equipment is properly maintained. The Onsite Safety Officer is responsible for filing or maintaining a float plan.

Small Boat Operators**—**EA personnel working on small boats will follow this procedure and any applicable health and safety procedures identified in the Health and Safety Plan and the vessel rules. Small boat operators will identify any conflicts in procedures or any problems or equipment failures to the Health and Safety Officer. Small boat operators shall demonstrate training, experience, and compliance with state requirements for operator education and licensing prior to operating any vessel. For larger bodies of water, or rapidly moving water, knowledge of local conditions shall be obtained prior to embarkation.

2. SMALL BOAT REQUREMENTS

All small boats used by EA personnel must meet the minimum requirements in the U.S. Army Corps of Engineers Safety and Health Requirements Manual EM 385-1-1 and the applicable Occupational Safety and Health Administration or state plan requirements, as well as meeting applicable U.S. Coast Guard Regulations. These requirements include the following:

- Small boats will meet the minimum floatation requirements of the U.S. Coast Guard, and must have a certification tag affixed to the hull.
- The maximum number of passengers and weight that may be safely transported must be posted on all small boats.
- The number of personnel on the small boat cannot exceed the number of Type I PFDs onboard.
- Each small boat will have sufficient room freeboard, and stability to safely carry the allowable number of personnel and cargo.

- Each motored boat measuring less than 26 ft in length will carry one 1A-10 BC fire extinguisher; motored boats measuring greater than 26 ft will carry two 1A-10 BC fire extinguishers.

Operators and occupants of small craft shall review Federal Requirements and Safety Tips for Recreational Boats (U.S. Coast Guard 1994) before engaging in work from rafts, dinghies, canoes, rowboats, or Jon boats.

2.1 WORK OVER OR NEAR WATER

Work over or near water, where the potential exists for personnel to fall in and possibly drown, will be conducted in accordance with the requirements of applicable Occupational Safety and Health Administration standards and the U.S. Army Corps of Engineers EM 385-1-1 standards. This includes work from shore, bridges, work platforms, and vessels. Work within 15 ft of unobstructed access to water is within the requirements of this section. Personnel will follow the guidelines listed below except where personnel are protected by continuous guardrails, safety belts, or nets, or are conducting work along beaches or similar shorelines:

- Personnel will use the buddy system at all times.

- Swimming is prohibited, with the following exceptions: (1) certified divers performing their duties, and (2) personnel entering water to prevent injury or loss of life.

- All personnel will wear a U.S. Coast Guard-approved PFD of the type able to support an unconscious person (Type 1 with 32-lb floatation).

- At least one Type IV throwable device (ring buoy, horseshoe buoy) will be available on the small boat. Throwable devices should be U.S. Coast Guard-approved and equipped with 150 ft of 600-lb capacity rope.

- If specified in the Health and Safety Plan, at least one person will provide a dedicated safety watch/look-out.

2.2 PERSONAL FLOATATION DEVICES

All EA personnel will wear a U.S. Coast Guard-approved, Type 1 PFD when working over or near bodies of water. PFDs should meet the following requirements:

- Before and after each use, the PFD will be inspected for defects that would alter its strength or buoyancy.

- All PFDs will be equipped with retro reflective tape.

PFDs need not be donned when working on larger craft (>26 ft) except when working over water or outside railing. PFDs should be worn at all times when working on smaller craft.

2.3 SAFETY EMERGENCY DRILL

The vessel operator shall provide a list of crew duties for normal operations and emergencies. Emergencies which shall be covered include man-overboard, vessel fire, and vessel emergency.

The vessel operator shall provide an orientation and emergency drill. An emergency drill shall be conducted at the start of each task, and monthly thereafter, or as provided for in U.S. Coast Guard regulations.

2.4 FLOAT PLAN

A float plan provides essential information to enable the U.S. Coast Guard or other emergency search and rescue teams to initiate a search in the event of personnel not reporting in on schedule. The vessel operator will file a daily float plan with the site representative and with the project health and safety representative listed in the Health and Safety Plan. Upon daily completion of on-water work, the vessel operator will check in with the designated on shore individual. The float plan is provided in Appendix A.

2.5 EMERGENCY PLAN

The emergency plan should list a main dock and an alternate dock, and provide emergency medical support contact for each location.

2.6 COMMUNICATIONS

A marine VHF radio shall be maintained onboard and in operable condition. At least one of the boat personnel shall have a mobile telephone onboard during operations.

2.7 OCEAN REQUIREMENTS

Contact the Corporate Health and Safety Officer and Project Health and Safety Officer prior to planning any work which requires work in open ocean.

2.8 SEVERE WEATHER PRECAUTIONS

During field operations involving small boats, EA personnel will make provisions for severe weather. Severe weather includes sudden and locally severe storms, high winds, hurricanes, and floods. Before beginning work over water, the Health and Safety Officer will evaluate weather reports and conditions to ascertain local weather and prevent personnel exposure to severe weather. In the event that severe weather is encountered, personnel will cease field operations and immediately return to shore.

2.9 COLD WATER AND DROWNING HAZARDS

EA personnel conducting field operations with a small boat may be exposed to cold water and drowning hazards. When water temperature is below 45°F, hypothermia is a serious hazard. A person can lose feeling in extremities within 5 minutes. Under no circumstances will EA personnel enter the water from a small boat unless conducting diving operations or performing a rescue.

Symptoms of hypothermia are discussed during standard first aid training and in the EA Health and Safety Program Plan. If a person who has fallen into the water displays symptoms of hypothermia, he or she should be treated immediately and the field operations canceled. Under no circumstances should the victim be given hot liquids, since they can accelerate shock. Drinks no warmer than body temperature are acceptable. If symptoms are severe and rapid evacuation is not possible, remove the victim’s wet clothing and cover the victim with a blanket. Continue to treat the victim for shock.

When a high risk of cold water and drowning hazards exists, all field staff members should be familiar with cold water survival techniques. If a team member falls into the water, he or she should not remove any clothing in the water because all clothing will provide insulation. Although clothing creates added drag while swimming, the added insulation of the clothing outweighs the disadvantage of the additional drag.

If a team member falls into the water, another team member should try to reach the person in the water with an oar, paddle, pole, or similar object. The victim should try to grab the extended item. If the victim is unconscious, the rescuer should try to hook the victim’s PFD, clothing, or hair and pull him or her toward the boat. Once the victim is retrieved, the other team members should begin any necessary emergency medical procedures. If no emergency medical procedures are necessary, the victim should change into dry clothing.

2.10 JOB HAZARD ANALYSIS

The requirements for preparing a job hazard analysis apply specifically to all on-water operations. Appendix B provides a sample job hazard analysis; however, an actual job hazard analysis shall consider the specific task including the body of water, vessel type, unique job requirements, training and experience of crew, and other circumstances such as tides, weather, water temperature, access of rescue craft, and other factors as may be appropriate. Job hazard analysis must be prepared specifically for each task and crew in accordance with the U.S. Army Corps of Engineers Safety and Health Requirements Manual EM 385-1-1.

Appendix A

Float Plan

APPENDIX A

FLOAT PLAN

1 Name and phone number of person filing plan.

2 Description of boat (type, color, trim, registration number, length, name, make, other).

3 Engine type (horsepower, fuel capacity, number of engines, and fuel [diesel or gasoline]).

4. Survival—Equipment onboard (check):

- Anchor
- Flares
- Flashlight
- Food
- Life ring with 150 ft of line.
- Paddles
- PFDs
- Smoke signals
- Water.

5. Marine Radio onboard (type, frequencies):

6. Automobile (tag number, type, color, make, trailer tag number, where parked)

7. Persons aboard (name, affiliation, and telephone number)

8. Do any of the persons aboard have a medical problem (identify type)

9. Trip plan (depart from @ time, arrive to @ time; via waypoints; expect to return no later than time)

10. Operational area (attach map)

11. If not returned by (a.m./p.m. time), call the U.S. Coast Guard or onshore contact.

12. Onshore contact:

Alternate Other Numbers

Contact	Number

Appendix B

Job Hazard Analysis Form

APPENDIX B

JOB HAZARD ANALYSIS FORM

Activity Hazard Analysis		
Task	**Potential Hazards**	**Hazard Control Measures**
MOBILIZATION/ DEMOBILIZATION	Physical Hazards (slips, trips, falls, cuts, etc.)	• Clear walkways/work areas of equipment, tools, and debris. • Watch for accumulation of water work surfaces. • Mark, identify, or barricade obstructions. • Wear cut-resistant work gloves when the possibility of lacerations or other injury caused by sharp or protruding objects occurs.
	Physical Hazards (material handling moving, lifting)	• Observe proper lifting techniques. • Obey sensible lifting limits (60-lb maximum per person manual lifting). • Use mechanical lifting equipment (hand carts, trucks, etc.) to move large awkward loads. • Use two or more persons for heaving bulk lifting.
	Physical Hazards (vehicle and pedestrian traffic)	• Use orange traffic cones where necessary. • Use reflective warning vests if exposed to vehicular traffic. • Locate staging areas in locations with minimal traffic.
	Physical Hazards (cold/heat stress)	• Monitor cold/heat stress as recommended in Section 6 of the Generic Health and Safety Plan.
	Munitions and Explosives of Concern (MEC) Hazard	• Practice site reconnaissance with a trained, experienced MEC specialist capable of recognizing MEC hazards. • If MEC is discovered, use existing access roads to retract from the MEC.
	Biological Hazards (insects, poisonous plants, ticks)	• Wear protective outer clothing and insect repellant to avoid insect bites and ticks. • Wear long sleeve shirts when working in areas with poison ivy or oak. • Workers with allergies should carry antidote kits, if necessary.
SAMPLING ACTIVITIES	Physical Hazards (slips, trips, falls, cuts, etc.)	• Clear walkways/work areas of equipment, tools, and debris. • Watch for accumulation of water work surfaces. • Mark, identify, or barricade obstructions. • Wear cut-resistant work gloves when the possibility of lacerations or other injury caused by sharp or protruding objects occurs.
	Physical Hazards (electrical)	• Identify electrical utility hazards prior to sampling. • Inspect work areas for spark sources, maintain safe distances, properly illuminate work areas, and provide barriers to prevent inadvertent contact. • Maintain minimum clearance distances for overhead energized electrical lines as specified in the Generic Health and Safety Plan.
	Physical Hazards (weather)	• Monitor radio for up-to-date severe weather forecasts. • Discontinue work during thunderstorms and severe weather events.
	Physical Hazards (vehicle and pedestrian traffic)	• Establish an exclusion zone around the drilling location. • Use orange traffic cones (if necessary). • Use reflective warning vests if exposed to vehicular traffic. • Locate staging areas in locations with minimal traffic.

Activity Hazard Analysis		
Task	**Potential Hazards**	**Hazard Control Measures**
SAMPLING ACTIVITIES (continued)	Physical Hazards (cold/heat stress)	• Monitor cold/heat stress as recommended in Section 6 of the Generic Health and Safety Plan.
	MEC Hazards	• Follow established MEC avoidance protocols when performing intrusive sampling activities. • If MEC is discovered or suspected, use existing access roads to retract from the MEC.
	Chemical Hazards (including MEC)	• Perform environmental monitoring as required in the Site-Specific Health and Safety Plan. • Where appropriate, personal protective equipment as indicated in the Site-Specific Health and Safety Plan.
	Biological Hazards (bloodborne pathogens)	• Wear proper personal protective equipment, including nitrile gloves and a face shield or goggles when sampling sludge. • Wash with soap and water as soon as personal protective equipment is removed or when contact or exposure has occurred.
	Biological Hazards (insects, poisonous plants, and ticks)	• Wear protective outer clothing and insect repellant to avoid insect bites and ticks. • Wear long sleeve shirts when working in areas with poison ivy or oak. • Worker with allergies should carry antidote kits, if necessary.
BOATING ACTIVITIES	Physical Hazards (weather)	• Monitor radio for up-to-date severe weather forecasts. • Boat operators will be trained by the site supervisor and/or the senior boat operator. • Discontinue work during thunderstorms and severe weather events.
	Physical Hazard (slips, trips, and falls, including falls overboard)	• Boat operator will inspect the boat prior to operation. The operator will ensure the number of personal floatation devices is equal to or greater than the number of passengers onboard. • No personnel will embark or disembark the vessel without the direction of the vessel operator. Vessel operator will ensure passengers are wearing personal floatation devices while on deck. At the request of the operator, personnel will be seated. • Passengers will stay seated until boat is docked. Ensure three-point contact whenever possible or practical. • A Type IV throwable device will be readily available onboard.

Standard Operating Procedure No. 043 for Multi-Probe Water Quality Monitoring Instruments

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
April 2011

CONTENTS

1. PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure is to delineate protocols for field operation of multi-probe water quality instruments. The instrument can monitor a variety of basic parameters including dissolved oxygen, percent saturation, temperature, pH, specific conductance, resistivity, salinity, total dissolved solids, oxidation reduction potential (ORP), level, and depth.

Use of brand names in this Standard Operating Procedure is not intended as endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc. are acceptable. If alternate equipment is to be used, the contractor will provide applicable and comparable standard operating procedures for the maintenance and calibration of same.

2. MATERIALS

The following materials may be required:

- Multi-probe instrument
- Probe/sonde with appropriate cables
- Appropriate standards
- Accessories (batteries, charger, case, etc.)
- Instrument logbook
- Manufacturer’s Operations Manual.

3. CALIBRATION PROCEDURE

Calibration must be performed daily at a minimum before using the instrument. Calibration may be performed in the laboratory or in the field. Detailed step-by-step calibration procedures for the equipment described below are provided in the most recent version of the manufacturer’s Operations Manual. Documentation includes at a minimum: time, date, analyst, standard, primary standard lot number, secondary standard lot number, and expiration dates of standards.

Fill the calibration cup with the appropriate standard as follows:

• Temperature:	None required
• Specific Conductance:	Conductivity standards
• pH:	pH 7 buffer plus pH 4 and/or pH 10 buffer
• Dissolved Oxygen:	Saturated air or saturated water
• ORP:	Quinhydrone (Zobell’s Solution)
• Turbidity:	Nephelometric turbidity unit (NTU) standards
• Salinity:	Calibration for specific conductance
• Depth/Level:	Set zero in air.

3.1 CONDUCTIVITY CALIBRATION

Conductivity meters are calibrated at least once per day to at least one standard. The standard should be selected in accordance with the range expected to be measured (e.g., 1.0 µS/cm standard should not be used to calibrate meters being used in saltwater). See manufacturer's recommendations in the Operations Manual for additional information on calibration standard selection. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.2 pH CALIBRATION

The pH meters are calibrated at least once per day to a minimum of two standard buffers (pH 4 and 7, or pH 7 and 10) in accordance with the range expected to be measured. The calibration is verified using a fresh solution of pH 7 buffer post-calibration. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.3 DISSOLVED OXYGEN CALIBRATION

Dissolved oxygen meters are air calibrated at least once per day. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.4 OXIDATION REDUCTION POTENTIAL CALIBRATION

ORP meters are calibrated at least once per day to at least one standard. It is recommended that Zobell's Solution is used; however, another solution can be used as long as it meets the manufacturer's specifications for calibration. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.5 TURBIDITY CALIBRATION

The turbidity meters are calibrated at least once per day to a minimum of two standards (0 NTU and 100 or 126 NTUs recommended) in accordance with the range expected to be measured. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.6 DEPTH/LEVEL CALIBRATION

The depth and level calibration is performed with the depth sensor module in the air and not immersed in any solution. The appropriate correction for height above the water surface is inputted into the meter. Calibration information is recorded in conjunction with the data collected for that sampling event.

3.7 ADDITIONAL CALIBRATIONS

Additional measurements may be taken with the multi-probe water quality instruments. For any of these measurements, the calibration procedures will be conducted in accordance with the manufacturer’s specifications. Calibration information is recorded in conjunction with the data collected for that sampling event.

4. FIELD OPERATION

4.1 SETUP OF MULTI-PROBE WATER QUALITY INSTRUMENT

Post-calibration and prior to sampling, the multi-probe water quality instrument will be set up for data collection. If the cables have been unattached, they will be reconnected to the transmitter (if applicable) and the display. Once all cables are attached, the meter will be turned on and allowed to warm up for a few seconds in order to allow the display screen to load.

4.2 SURFACE WATER

Prior to sampling, check the condition of the probes before each deployment. When sampling in surface water, the sensor must be in an amount of water sufficient for all probes to be submerged. Data values displayed on the display screen are recorded in the field logbook and accepted into the instrument’s data logger. Post-data collection, the sensor will be retrieved and rinsed for use at the next sample location. If travel time between sample locations is great, the display is to be turned off. When all sampling is completed, disconnect all equipment and return it to its proper storage location.

4.3 GROUNDWATER

Prior to sampling, check the condition of the probes before each deployment. When sampling groundwater, mount sampler on a flow-through sampler cup. Start sampler pump and allow pump/hose system to be purged of air bubbles. Sampling rate should be set to record all parameters each time 1-3 liters (unless otherwise specified in the sampling plan) have been removed from the well. Record all the monitored values in the appropriate field logbook to ensure against inadvertent data loss.

5. MAINTENANCE

All maintenance should be performed in accordance with the manufacturer’s Operations Manual.

6. PRECAUTIONS

Check the condition of the probes frequently between sampling. Do not force pins into connections, note keying sequence. If field readings are outside the expected range, check for bubbles on, or damage to, the probes. If there are no bubbles or damage, recalibrate the sensor.

7. REFERENCES

Manufacturer's Operations Manual.

Standard Operating Procedure for Push-point Porewater Sampling

Prepared by

EA Engineering, Science, and Technology, Inc.
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 0
August 2014

CONTENTS

Page

1. OBJECTIVE

The objective of this Standard Operating Procedure is to ensure proper use of a temporary pushpoint sampler (PPS). The PPS is used to collect porewater samples for analysis. The results from PPS data can help to delineate the area(s) of contaminant discharge.

2. MATERIALS

The following materials will be necessary to sample porewater with PPS:

- PPS – approximately 6 millimeter diameter stainless steel tube with machined point and 4-centimeter long slotted screen zone tip (Figure 1)
- Sampling Platform – 8-inch diameter, steel or polycarbonate
- Guard rod – used internally this rod is used to place PPS at desired depth
- Filter socks – to cover the openings on the tip of the PPS, and minimize the amount of particulates in the sample.
- Peristaltic pump to draw water samples through PPS
- Flexible tubing – to use with peristaltic pump (for example Tygon® or Teflon®). Sufficient length of tubing is required to reach from the sampling location boat to shore where sampler will be stationed.
- Myron Ultrameter or other water quality meter with capacity to measure water quality for small volumes
- Sample containers appropriate for the required analyses

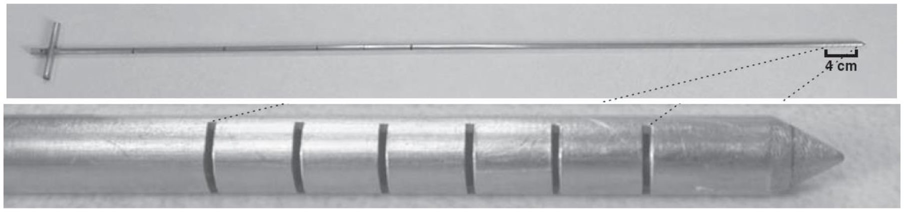


Figure 1. Example of PPS (Figure from Zimmerman et al. 2005)

3. PROCEDURE

- Don personal protective equipment.

- Analyze and record water quality parameters (temperature, pH, conductivity, and oxidation-reduction potential [ORP]) of surface water from the sampling location.

- Working above the water surface, insert the PPS into the sampling platform (Figure 2) and lock it so that the PPS will be advanced to the desired sampling depth when the platform is placed on the sediment surface. Then insert the guard rod into the PPS, and place a filter sock over the tip of the PPS.

- Place the platform flat on the sediment surface, so that the PPS with guard rod is inserted into the sediment to the desired depth, perpendicular to the surface.

- Remove the guard rod, and DO NOT reinsert until the sampler has been cleaned (see Section 5, Precautions). Attach sample tubing to the PPS and the other end of tubing to the peristaltic pump.

- After the tubing has been connected to the peristaltic tubing, pump water until flow is steady (flow may be very slow, e.g., only a drop at a time), to purge the PPS and the tubing. Once flow is steady, begin taking and recording water quality measurements and compare to the surface water quality.

- When the water quality stabilizes with values distinct from the surface water (including negative ORP), place tubing from the pump in the sampling container and begin to collect sample.

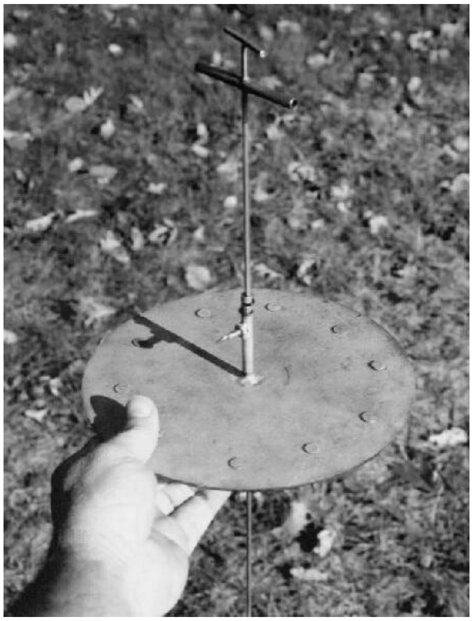


Figure 2. PushPoint sampler with sampling platform and guard rod. Photograph from M.H.E. products (http://www.mheproducts.com)

- Re-check and record water quality parameters periodically during the sample collection process, to make sure they remain stable. If surface water begins to infiltrate the porewater samples, the specific conductance will change to be more similar to the surface water. If surface water infiltrates the porewater sample prior to the recovery of an adequate volume, the water cannot be used for analysis, and a new sample at the location must be collected, using a decreased flow rate from the peristaltic pump.

4. MAINTENANCE

Between samples and after completion of analysis, decontamination procedures should be performed on the PPS and tubing should be replaced to avoid cross-contamination of the samples.

5. PRECAUTIONS

Note: refer also to the Health and Safety Plan.

After guard rod has been removed, DO NOT reinsert guard rod into the sampler for any reason until the sampler has been cleaned. Any sediment particles which have rolled between the two metal surfaces will cause the parts to lock together and this can permanently damage the sampler.

When conducting sampling, take caution to not disturb the sampling area. If wading, sampler should lean out to insert the PPS as far away as possible to reduce effects of sampler on the sample.

Porewater samples must not include surface water. If the conductivity of the sample begins to mimic the conductivity of the surface water, indicating surface water infiltration, then the sample must not be used and a new sample must be collected.

6. REFERENCES

Henry, M.A. and Veenstra, J.A. 2006. *Geophysical and Porewater Sampling Methods for Source Area and Groundwater Discharge Investigations.* Proceedings from the Fourth Annual International Conference on Remediation of Contaminated Sediments.

U.S. Environmental Protection Agency. 2013. Pore Water Sampling. Region 4, Science and Ecosystem Support Division.

Zimmerman, M.J., Massey, A.J., and Campo, K.W. 2005. *Pushpoint Sampling for Defining Spatial and Temporal Variations in Contaminant Concentrations in Sediment Pore Water near the Ground-Water/Surface-Water Interface*. U.S. Geological Survey Scientific Investigations Report 2005-5036.

APPENDIX E

HUMAN HEALTH SCREENING LEVELS AND EXPOSURE PARAMETERS

TABLE E-1
CALCULATED SITE-SPECIFIC HHRA SCREENING LEVELS FOR SEDIMENT
PHASE I AREA, SPARROWS POINT OFFSHORE INVESTIGATION

Constituent(1)	CAS No.	Adult Calculated Concentration		Adolescent Calculated Concentration		Watermen Calculated Concentration		Selected Screening Level(1)
		Cancer (mg/kg)	Non-Cancer (mg/kg)	Cancer (mg/kg)	Non-Cancer (mg/kg)	Cancer (mg/kg)	Non-Cancer (mg/kg)	(mg/kg)
Metals								
ANTIMONY	7440-36-0	NA	1.91E+03	NA	4.10E+02	NA	8.88E+02	4.10E+02
ARSENIC	7440-38-2	2.48E+02	3.19E+03	1.06E+02	6.83E+02	9.21E+01	1.48E+03	9.21E+01
BERYLLIUM	7440-41-7	NA	4.46E+02	NA	9.56E+01	NA	2.07E+02	9.56E+01
CADMIUM	7440-43-9	NA	7.97E+03	NA	1.71E+03	NA	3.70E+03	1.71E+03
CHROMIUM	7440-47-3	NA	6.22E+05	NA	1.33E+05	NA	2.89E+05	1.33E+05
COPPER	7440-50-8	NA	1.27E+06	NA	2.73E+05	NA	5.92E+05	2.73E+05
CYANIDE	57-12-5	NA	1.91E+04	NA	4.10E+03	NA	8.88E+03	4.10E+03
LEAD	7439-92-1	NA	NA	NA	NA	NA	NA	0.00E+00
MERCURY	7439-97-6	NA	2.23E+02	NA	4.78E+01	NA	1.04E+02	4.78E+01
NICKEL	7440-02-0	NA	6.37E+05	NA	1.37E+05	NA	2.96E+05	1.37E+05
SELENIUM	7782-49-2	NA	1.59E+05	NA	3.41E+04	NA	7.40E+04	3.41E+04
SILVER	7440-22-4	NA	6.37E+03	NA	1.37E+03	NA	2.96E+03	1.37E+03
THALLIUM	7440-28-0	NA	3.19E+02	NA	6.83E+01	NA	1.48E+02	6.83E+01
ZINC	7440-66-6	NA	9.56E+06	NA	2.05E+06	NA	4.44E+06	NA
Polycyclic Aromatic Hydrocarbons (PAHs)								
2-METHYLNAPHTHALENE	91-57-6	NA	9.81E+03	NA	2.10E+03	NA	4.55E+03	2.10E+03
ACENAPHTHENE	83-32-9	NA	1.47E+05	NA	3.15E+04	NA	6.83E+04	3.15E+04
ACENAPHTHYLENE	208-96-8	NA	1.47E+05	NA	3.15E+04	NA	6.83E+04	3.15E+04
ANTHRACENE	120-12-7	NA	7.36E+05	NA	1.58E+05	NA	3.41E+05	1.58E+05
BENZO(A)ANTHRACENE	56-55-3	1.18E+02	NA	1.68E+01	NA	4.37E+01	NA	1.68E+01
BENZO(A)PYRENE	50-32-8	1.18E+01	NA	1.68E+00	NA	4.37E+00	NA	1.68E+00
BENZO(B)FLUORANTHENE	205-99-2	1.18E+02	NA	1.68E+01	NA	4.37E+01	NA	1.68E+01
BENZO(K)FLUORANTHENE	207-08-9	1.18E+03	NA	1.68E+02	NA	4.37E+02	NA	1.68E+02
CHRYSENE	218-01-9	1.18E+04	NA	1.68E+03	NA	4.37E+03	NA	1.68E+03
DIBENZO(A,H)ANTHRACENE	53-70-3	1.18E+01	NA	1.68E+00	NA	4.37E+00	NA	1.68E+00
FLUORANTHENE	206-44-0	NA	9.81E+04	NA	2.10E+04	NA	4.55E+04	2.10E+04
FLUORENE	86-73-7	NA	9.81E+04	NA	2.10E+04	NA	4.55E+04	2.10E+04
INDENO(1,2,3-CD)PYRENE	193-39-5	1.18E+02	NA	1.68E+01	NA	4.37E+01	NA	1.68E+01
NAPHTHALENE	91-20-3	NA	4.90E+04	NA	1.05E+04	NA	2.28E+04	1.05E+04
PHENANTHRENE	85-01-8	NA	7.36E+04	NA	1.58E+04	NA	3.41E+04	1.58E+04
PYRENE	129-00-0	NA	7.36E+04	NA	1.58E+04	NA	3.41E+04	1.58E+04
PCBs								
Aroclor 1016	12674-11-2	1.14E+03	1.59E+02	4.88E+02	3.41E+01	4.23E+02	7.40E+01	3.41E+01
Aroclor 1221	11104-28-2	3.98E+01	NA	1.71E+01	NA	1.48E+01	NA	1.48E+01
Aroclor 1232	11141-16-5	3.98E+01	NA	1.71E+01	NA	1.48E+01	NA	1.48E+01
Aroclor 1248	12672-29-6	3.98E+01	NA	1.71E+01	NA	1.48E+01	NA	1.48E+01
Aroclor 1254	11097-69-1	3.98E+01	4.55E+01	1.71E+01	9.75E+00	1.48E+01	2.11E+01	9.75E+00
Aroclor 1260	11096-82-5	3.98E+01	NA	1.71E+01	NA	1.48E+01	NA	1.48E+01

Notes:

(1) Selected Screening Level for inorganics is "NA" due to calculated values are greater than equilibrium (i.e. 1E+06 mg/kg).

TABLE E-2
CALCULATED SITE-SPECIFIC HHRA SCREENING LEVELS FOR SURFACE WATER
PHASE I AREA, SPARROWS POINT OFFSHORE INVESTIGATION

Constituent	CAS No.	Adult Calculated Concentration		Adolescent Calculated Concentration		Watermen Calculated Concentration		Selected Screening Level
		Cancer (ug/L)	Non-Cancer (ug/L)	Cancer (ug/L)	Non-Cancer (ug/L)	Cancer (ug/L)	Non-Cancer (ug/L)	(ug/L)
Metals								
ANTIMONY	7440-36-0	NA	1.31E+02	NA	1.15E+02	NA	2.22E+02	1.15E+02
ARSENIC	7440-38-2	5.09E+01	6.55E+02	8.97E+01	5.77E+02	6.91E+01	1.11E+03	5.09E+01
BERYLLIUM	7440-41-7	NA	3.06E+01	NA	2.69E+01	NA	5.18E+01	2.69E+01
CADMIUM	7440-43-9	NA	5.46E+01	NA	4.81E+01	NA	9.25E+01	4.81E+01
CHROMIUM	7440-47-3	NA	2.13E+04	NA	1.87E+04	NA	3.61E+04	1.87E+04
COPPER	7440-50-8	NA	8.73E+04	NA	7.69E+04	NA	1.48E+05	7.69E+04
CYANIDE	57-12-5	NA	1.31E+03	NA	1.15E+03	NA	2.22E+03	1.15E+03
LEAD	7439-92-1	NA	NA	NA	NA	NA	NA	15[a]
MERCURY	7439-97-6	NA	2.18E+02	NA	1.92E+02	NA	3.70E+02	1.92E+02
NICKEL	7440-02-0	NA	8.73E+03	NA	7.69E+03	NA	1.48E+04	7.69E+03
SELENIUM	7782-49-2	NA	1.09E+04	NA	9.61E+03	NA	1.85E+04	9.61E+03
SILVER	7440-22-4	NA	7.28E+02	NA	6.41E+02	NA	1.23E+03	6.41E+02
THALLIUM	7440-28-0	NA	2.18E+01	NA	1.92E+01	NA	3.70E+01	NA
ZINC	7440-66-6	NA	1.09E+06	NA	9.61E+05	NA	1.85E+06	9.61E+05

Notes:

a) The selected screening level for lead in surface water is equal to the Maximum Contaminant Level (MCL).

TABLE E-3
EXPOSURE PARAMETERS USED IN SITE-SPECIFIC SCREENING LEVEL CALCULATIONS
PHASE I AREA, SPARROWS POINT OFFSHORE INVESTIGATION

Exposure Parameters	Units	Adult	Youth (6-16)	Watermen	**References**
Dermal - Sediment					
SA (Skin Surface Area)[1]	*cm*^{2}	4,090	3,760	2,530	USEPA 2011, 2014
EF (Exposure Frequency)[2]	*d/year*	32	32	39	BPJ (1)
ED (Exposure Duration)	*years*	20	10	25	USEPA 2011, 2014
CF (Conversion Factor)	*kg/mg*	0.000001	0.000001	0.000001	USEPA 1989
AF (Adherence Factor)	*mg/cm*^{2}*-event*	0.07	0.2	0.2	USEPA 2004
ABS (Absorption Fraction)	*unitless*	*chemical specific*	*chemical specific*	*chemical specific*	USEPA 2004
BW (Body Weight)	*kg*	80	45	80	USEPA 2011, 2014
ATc (Averaging Time-Cancer)	*d/yr*	25,550	25,550	25,550	USEPA 1989
ATnc (Averaging Time-NonCancer)	*d/yr*	7,300	3,650	9,125	USEPA 1989
Dermal - Surface Water					
SA (Skin Surface Area)[3]	*cm*^{2}	20,900	13,350	2,530	USEPA 2011, 2014
ET (Exposure Time)	*hours/day*	2	2	8	BPJ (2)
EF (Exposure Frequency)[2]	*d/year*	32	32	39	BPJ (2)
ED (Exposure Duration)	*years*	20	10	25	USEPA 2011, 2014
CF (Conversion Factor)	*L/cm*^{3}	0.001	0.001	0.001	USEPA 1989
PC (Permeability Constant)	*cm/hr*	*chemical specific*	*chemical specific*	*chemical specific*	
ATc (Averaging Time-Cancer)	*d/yr*	25,550	25,550	25,550	USEPA 1989
ATnc (Averaging Time-NonCancer)	*d/yr*	7,300	3,650	9,125	USEPA 1989
BW (Body Weight)	*kg*	80	45	80	USEPA 2011, 2014

Notes:

(1) Skin surface area for the recreational user exposure to sediment assumes contact with lower legs and feet only. For the watermen, contact is with the hands and forearms only. The skin surface areas are the mean values. Individual body part surface areas are taken from Tables 7-2 and 7-12 of USEPA, 2011. For the adult recreational user, the surface area is taken from Table 7-12 for males where lower legs = 0.271 m^2 and feet = 0.138m^2 for a total skin surface area of 0.409m^2 (4,090 cm^2). For the adolescent recreational user, the surface area for the feet = 0.105m^2 were taken from Table 7-2 for a 11 to 16 year old. Skin surface area for the lower legs is not available for the adolescent, so the surface area lower legs for the adult were used (0.271m^2) for a total skin surface area of 0.376 m^2 (3,760cm^2). For the watermen, the surface area for the forearms (0.146 m^2) and hands (0.107 m^2) were taken from Talbe 7-12 for males for a total skin surface area of 0.253 m2 (2,530 cm^2)

(2) Exposure frequencies are determined based upon professional judgement. For the recreational user, it is assumed swimming or surface water contact will occur 2 days per week during warmer months, June to September (32 Days) . For the watermen, fishing is expected to occur March through November, for a total of 9 months or 39 weeks. It is expected that a watermen would not fish exclusively near the Sparrows Point offshore environment. The watermen fishes near Sparrows Point 1 day/week for a total of 39 days/year.

(3) Skin surface area for recreational user exposure to surface water assumes full body exposure. For the watermen, contact is with the hands and forearms only. Individual body part surface areas are taken from Tables 7-1 and 7-10 of USEPA, 2011. The skin surface areas are the mean values. For the adult recreational user, full body surface area is the weighted average of mean values from Table 7-10 for adults, male and female 21+. For the adolescent recreational user, the whole body surface areas from Table 7-1 were averaged for the 6 to 11 age group (1.08 m^2) and 11 to 16 age group (1.59 m^2) for an average of 1.335 m^2 (13,350 cm^2). For the watermen, the skin surface areas are the same as the sediment exposure pathway.

References:

USEPA, 1989. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* . Office of Emergency and Remedial Response, EPA/540/1-89/002. December.

USEPA, 2004. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment). Final* . Office of Superfund Remediation and Technology Innovation, EPA/540/R-99/005. July.

USEPA, 2011. *Exposure Factors Handbook: 2011 Edition* . Office of Research and Development, EPA/600/R-090/052F. September.

USEPA, 2014. *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors* . Office of Solid Waste and Emergency Response, OSWER Directive 9200.1-120. February 6.

TABLE E-4
CALCULATIONS FOR SITE-SPECIFIC SEDIMENT HHRA SCREENING LEVELS
PHASE I AREA, SPARROWS POINT OFFSHORE INVESTIGATION

Receptor	CANCER			NON-CANCER		
	Ingestion intake variable	Dermal intake variable	Inhalation intake variable	Ingestion intake variable	Dermal intake variable	Inhalation intake variable
Adult	NA	8.96E-08	NA	NA	3.14E-07	NA
Adolescent	NA	2.09E-07	NA	NA	1.47E-06	NA
Watermen	NA	2.41E-07	NA	NA	6.76E-07	NA

Acceptable risk = 1.00E-06
Acceptable HI = 0.1

For Non-Cancer

$$\text{Screening Level (mg/kg)} = \frac{[\text{Target HI x AT}_{nc}\text{ x BW}]}{[\text{EF x ED x (1/RfD}_o\text{ x GIABS) x SA x AF x ABS x CF}]}$$

For Cancer

$$\text{Screening Level (mg/kg)} = \frac{[\text{Target Risk x AT}_{c}\text{ x BW}]}{[\text{EF x ED x (CSF}_o\text{/GIABS) x SA x AF x ABS x CF}]}$$

Constituent	CAS No.	Oral		GI ABS(1)	Dermal		ABS(1)	Mutagen	Cancer			Non-Cancer		
									Dermal			Dermal		
		CSF_o $(mg/kg\text{-}day)^{-1}$	RfD_o (mg/kg-day)		CSF_d $(mg/kg\text{-}day)^{-1}$	RfD_d (mg/kg-day)			Adult (mg/kg)	Adolescent (mg/kg)	Watermen (mg/kg)	Adult (mg/kg)	Adolescent (mg/kg)	Watermen (mg/kg)
Metals														
ANTIMONY	7440-36-0	NA	4.00E-04	0.15	NA	6.00E-05	0.01		NA	NA	NA	1.91E+03	4.10E+02	8.88E+02
ARSENIC	7440-38-2	1.50E+00	3.00E-04	1	1.50E+00	3.00E-04	0.03		2.48E+02	1.06E+02	9.21E+01	3.19E+03	6.83E+02	1.48E+03
BERYLLIUM	7440-41-7	NA	2.00E-03	0.007	NA	1.40E-05	0.01		NA	NA	NA	4.46E+02	9.56E+01	2.07E+02
CADMIUM	7440-43-9	NA	1.00E-03	0.025	NA	2.50E-05	0.001		NA	NA	NA	7.97E+03	1.71E+03	3.70E+03
CHROMIUM	7440-47-3	NA	1.50E+00	0.013	NA	1.95E-02	0.01		NA	NA	NA	6.22E+05	1.33E+05	2.89E+05
COPPER	7440-50-8	NA	4.00E-02	1	NA	4.00E-02	0.01		NA	NA	NA	1.27E+06	2.73E+05	5.92E+05
CYANIDE	57-12-5	NA	6.00E-04	1	NA	6.00E-04	0.01		NA	NA	NA	1.91E+04	4.10E+03	8.88E+03
LEAD	7439-92-1	NA	NA	1	NA	NA	0.01		NA	NA	NA	NA	NA	NA
MERCURY	7439-97-6	NA	1.00E-04	0.07	NA	7.00E-06	0.01		NA	NA	NA	2.23E+02	4.78E+01	1.04E+02
NICKEL	7440-02-0	NA	2.00E-02	1	NA	2.00E-02	0.01		NA	NA	NA	6.37E+05	1.37E+05	2.96E+05
SELENIUM	7782-49-2	NA	5.00E-03	1	NA	5.00E-03	0.01		NA	NA	NA	1.59E+05	3.41E+04	7.40E+04
SILVER	7440-22-4	NA	5.00E-03	0.04	NA	2.00E-04	0.01		NA	NA	NA	6.37E+03	1.37E+03	2.96E+03
THALLIUM	7440-28-0	NA	1.00E-05	1	NA	1.00E-05	0.01		NA	NA	NA	3.19E+02	6.83E+01	1.48E+02
ZINC	7440-66-6	NA	3.00E-01	1	NA	3.00E-01	0.01		NA	NA	NA	9.56E+06	2.05E+06	4.44E+06
Polycyclic Aromatic Hydrocarbons (PAHs)														
2-METHYLNAPHTHALENE	91-57-6	NA	4.00E-03	1	NA	4.00E-03	0.13		NA	NA	NA	9.81E+03	2.10E+03	4.55E+03
ACENAPHTHENE	83-32-9	NA	6.00E-02	1	NA	6.00E-02	0.13		NA	NA	NA	1.47E+05	3.15E+04	6.83E+04
ACENAPHTHYLENE	208-96-8	NA	6.00E-02	1	NA	6.00E-02	0.13		NA	NA	NA	1.47E+05	3.15E+04	6.83E+04
ANTHRACENE	120-12-7	NA	3.00E-01	1	NA	3.00E-01	0.13		NA	NA	NA	7.36E+05	1.58E+05	3.41E+05
BENZO(A)ANTHRACENE	56-55-3	7.30E-01	NA	1	7.30E-01	NA	0.13	M	1.18E+02	1.68E+01	4.37E+01	NA	NA	NA
BENZO(A)PYRENE	50-32-8	7.30E+00	NA	1	7.30E+00	NA	0.13	M	1.18E+01	1.68E+00	4.37E+00	NA	NA	NA
BENZO(B)FLUORANTHENE	205-99-2	7.30E-01	NA	1	7.30E-01	NA	0.13	M	1.18E+02	1.68E+01	4.37E+01	NA	NA	NA
BENZO(K)FLUORANTHENE	207-08-9	7.30E-02	NA	1	7.30E-02	NA	0.13	M	1.18E+03	1.68E+02	4.37E+02	NA	NA	NA
CHRYSENE	218-01-9	7.30E-03	NA	1	7.30E-03	NA	0.13	M	1.18E+04	1.68E+03	4.37E+03	NA	NA	NA
DIBENZO(A,H)ANTHRACENE	53-70-3	7.30E+00	NA	1	7.30E+00	NA	0.13	M	1.18E+01	1.68E+00	4.37E+00	NA	NA	NA
FLUORANTHENE	206-44-0	NA	4.00E-02	1	NA	4.00E-02	0.13		NA	NA	NA	9.81E+04	2.10E+04	4.55E+04
FLUORENE	86-73-7	NA	4.00E-02	1	NA	4.00E-02	0.13		NA	NA	NA	9.81E+04	2.10E+04	4.55E+04
INDENO(1,2,3-CD)PYRENE	193-39-5	7.30E-01	NA	1	7.30E-01	NA	0.13	M	1.18E+02	1.68E+01	4.37E+01	NA	NA	NA
NAPHTHALENE	91-20-3	NA	2.00E-02	1	NA	2.00E-02	0.13		NA	NA	NA	4.90E+04	1.05E+04	2.28E+04
PHENANTHRENE	85-01-8	NA	3.00E-02	1	NA	3.00E-02	0.13		NA	NA	NA	7.36E+04	1.58E+04	3.41E+04
PYRENE	129-00-0	NA	3.00E-02	1	NA	3.00E-02	0.13		NA	NA	NA	7.36E+04	1.58E+04	3.41E+04
PCBs														
Aroclor 1016	12674-11-2	7.00E-02	7.00E-05	1	7.00E-02	7.00E-05	0.14		1.14E+03	4.88E+02	4.23E+02	1.59E+02	3.41E+01	7.40E+01
Aroclor 1221	11104-28-2	2.00E+00	NA	1	2.00E+00	NA	0.14		3.98E+01	1.71E+01	1.48E+01	NA	NA	NA
Aroclor 1232	11141-16-5	2.00E+00	NA	1	2.00E+00	NA	0.14		3.98E+01	1.71E+01	1.48E+01	NA	NA	NA
Aroclor 1248	12672-29-6	2.00E+00	NA	1	2.00E+00	NA	0.14		3.98E+01	1.71E+01	1.48E+01	NA	NA	NA
Aroclor 1254	11097-69-1	2.00E+00	2.00E-05	1	2.00E+00	2.00E-05	0.14		3.98E+01	1.71E+01	1.48E+01	4.55E+01	9.75E+00	2.11E+01
Aroclor 1260	11096-82-5	2.00E+00	NA	1	2.00E+00	NA	0.14		3.98E+01	1.71E+01	1.48E+01	NA	NA	NA

(1) Taken from U.S. EPA 2004, *Risk Assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* , Final. OSWER 9285.7-02EP and U.S. EPA 2003, Region 3, *Updated Dermal Exposure Assessment*

TABLE E-5
CALCULATIONS FOR SITE-SPECIFIC SURFACE WATER SCREENING LEVELS
PHASE I AREA, SPARROWS POINT OFFSHORE INVESTIGATION

Receptor	CANCER			NON-CANCER		
	Ingestion intake variable	Dermal intake variable	Inhalation intake variable	Ingestion intake variable	Dermal intake variable	Inhalation intake variable
Adult	NA	7.64E+04	NA	NA	2.18E+04	NA
Adolescent	NA	1.35E+05	NA	NA	1.92E+04	NA
Watermen	NA	1.04E+05	NA	NA	3.70E+04	NA

Acceptable risk = 1.00E-06
Acceptable HI = 0.1

For Non-Cancer

$$\text{Screening Level (mg/kg)} = \frac{[\text{Target HI} \times AT_{nc} \times BW]}{[EF \times ED \times (1/RfD_o \times GIABS) \times SA \times PC \times ET \times CF]}$$

For Cancer

$$\text{Screening Level (mg/kg)} = \frac{[\text{Target Risk} \times AT_c \times BW]}{[EF \times ED \times (CSF_o/GIABS) \times SA \times PC \times ET \times CF]}$$

Constituent	CAS No.	Oral		GI ABS(1)	Dermal		PC(1)	Mutagen	Cancer			Non-Cancer		
									Dermal			Dermal		
		Slope Factor (mg/kg-day)$^{-1}$	RfD (mg/kg-day)		Slope Factor (mg/kg-day)$^{-1}$	RfD (mg/kg-day)	(cm/hr)		Adult (ug/L)	Adolescent (ug/L)	Watermen (ug/L)	Adult (ug/L)	Adolescent (ug/L)	Watermen (ug/L)
Metals														
ANTIMONY	7440-36-0	NA	4.00E-04	0.15	NA	6.00E-05	1.00E-03		NA	NA	NA	1.31E+02	1.15E+02	2.22E+02
ARSENIC	7440-38-2	1.50E+00	3.00E-04	1	1.50E+00	3.00E-04	1.00E-03		5.09E+01	8.97E+01	6.91E+01	6.55E+02	5.77E+02	1.11E+03
BERYLLIUM	7440-41-7	NA	2.00E-03	0.007	NA	1.40E-05	1.00E-03		NA	NA	NA	3.06E+01	2.69E+01	5.18E+01
CADMIUM	7440-43-9	NA	1.00E-03	0.025	NA	2.50E-05	1.00E-03		NA	NA	NA	5.46E+01	4.81E+01	9.25E+01
CHROMIUM	7440-47-3	NA	1.50E+00	0.013	NA	1.95E-02	2.00E-03		NA	NA	NA	2.13E+04	1.87E+04	3.61E+04
COPPER	7440-50-8	NA	4.00E-02	1	NA	4.00E-02	1.00E-03		NA	NA	NA	8.73E+04	7.69E+04	1.48E+05
CYANIDE	57-12-5	NA	6.00E-04	1	NA	6.00E-04	1.00E-03		NA	NA	NA	1.31E+03	1.15E+03	2.22E+03
LEAD	7439-92-1	NA	NA	1	NA	NA	1.00E-03		NA	NA	NA	NA	NA	NA
MERCURY	7439-97-6	NA	1.00E-04	1	NA	1.00E-04	1.00E-03		NA	NA	NA	2.18E+02	1.92E+02	3.70E+02
NICKEL	7440-02-0	NA	2.00E-02	0.04	NA	8.00E-04	2.00E-04		NA	NA	NA	8.73E+03	7.69E+03	1.48E+04
SELENIUM	7782-49-2	NA	5.00E-03	1	NA	5.00E-03	1.00E-03		NA	NA	NA	1.09E+04	9.61E+03	1.85E+04
SILVER	7440-22-4	NA	5.00E-03	0.04	NA	2.00E-04	6.00E-04		NA	NA	NA	7.28E+02	6.41E+02	1.23E+03
THALLIUM	7440-28-0	NA	1.00E-05	1	NA	1.00E-05	1.00E-03		NA	NA	NA	2.18E+01	1.92E+01	3.70E+01
ZINC	7440-66-6	NA	3.00E-01	1	NA	3.00E-01	6.00E-04		NA	NA	NA	1.09E+06	9.61E+05	1.85E+06

(1) Taken from U.S. EPA 2004, *Risk Assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* , Final. OSWER 9285.7-02EP.