WORK PLAN
SEDIMENT, SURFACE WATER, AND GROUNDWATER SAMPLING PLAN TO ASSESS CURRENT GROUNDWATER DISCHARGE IMPACTS TO THE OFFSHORE ENVIRONMENT

Prepared for

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Tables

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SECTION ONE: INTRODUCTION

This work plan responds to the Maryland Department of the Environment (MDE) letter dated August 13, 2009 to Severstal-Sparrows Point (Severstal) requiring submission of a work plan to conduct an offsite Sediment Sampling Plan. Severstal acknowledges MDE's concern that offsite discharge of impacted groundwater may be impacting offsite sediment. The work plan focuses on the Coke Oven and Coke Point (CO/CP) Area where high concentrations of benzene are confirmed in shallow groundwater and data indicate shallow groundwater discharge is impacting surrounding surface water.

1.1 SHALLOW GROUNDWATER FLOW

Groundwater in the CO/CP Area of the Sparrows Point facility is impacted by facility-related chemicals (primarily benzene and naphthalene, but also other Chemicals of Potential Interest (COPIs)). Generally, shallow groundwater flows radially from the north-central region of the CO/CP Area into surrounding surface water bodies--the Patapsco River (located west and south of the CO/CP Area) and the Turning Basin (located east of the CO/CP Area), as conceptually illustrated in Figure 1. The implication is that offshore surface water and sediments could be impacted by discharge of impacted shallow groundwater. Where offshore sediments represent viable habitat (e.g., sediment areas beyond the submerged slag areas that armor the perimeter of the CO/CP Area) aquatic ecologic risks that would require future assessment could be posed by the current discharge of impacted groundwater.

1.2 SURFACE WATER BENZENE ASSESSMENT

In March of 2005, the initial phase of the offshore investigation focused on analyzing surface water for benzene to assess potential surface water impacts from discharge of benzene-impacted groundwater. Eighteen surface water samples were collected from the Patapsco River offshore of the northwestern portion of the CO/CP Area (Figure 2) and were analyzed for various volatile organic compounds (VOCs), including benzene. The surface water benzene concentrations were orders of magnitude higher than any other VOC concentration, ranging up to 330 ug/l, with an average concentration of 87 ug/l (Table 1 and Figure 2). The benzene concentrations and their distribution within the Patapsco River indicate that surface water is impacted by discharge of benzene-contaminated shallow groundwater from the northwestern portion of the CO/CP Area.

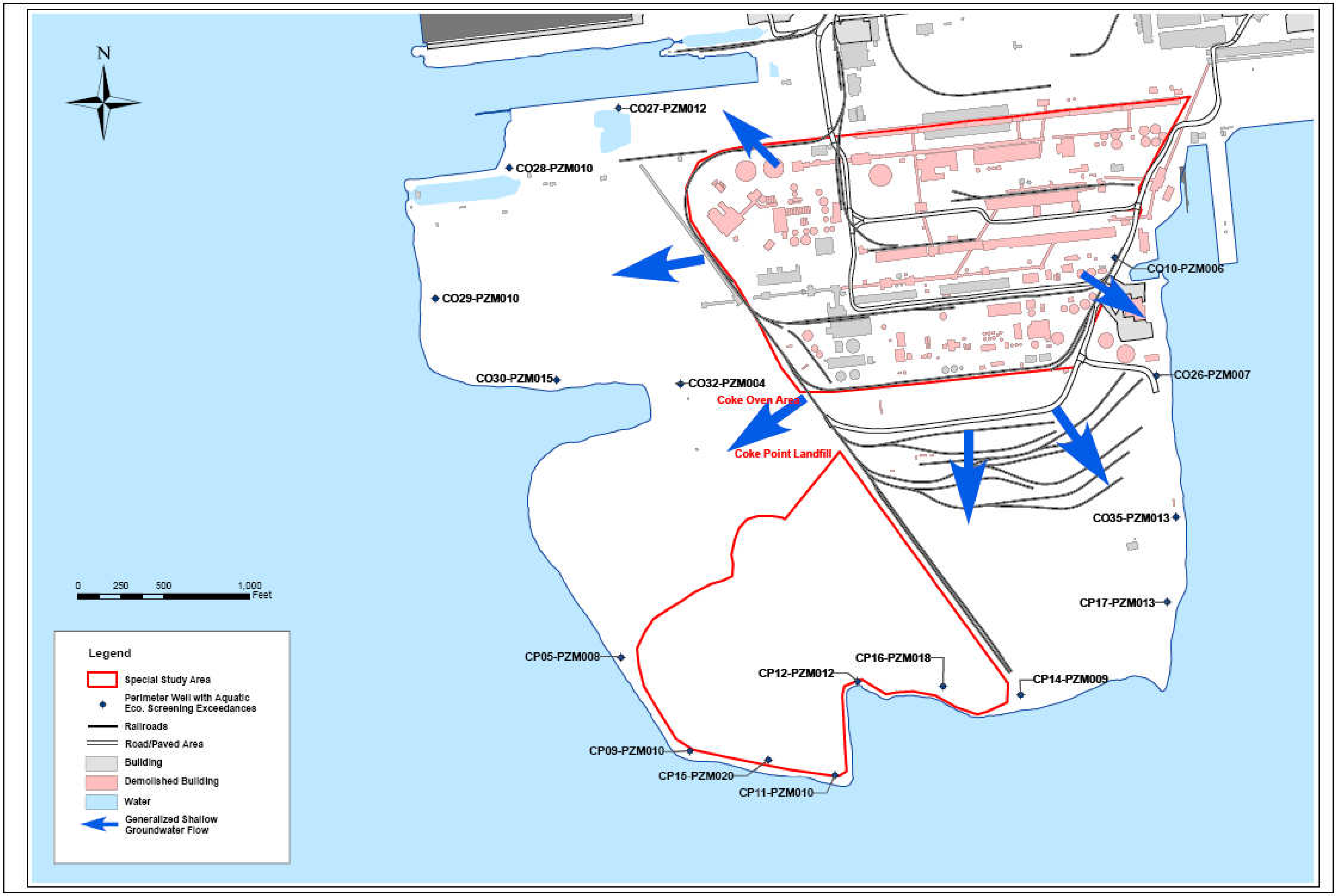

Figure 1: Generalized Shallow Groundwater Flow Directions at the CO/CP Area

Table 1: Surface Water Benzene Concentrations (ug/l)

	West--**Northern Transect**--East		
	SW-3	**SW-2**	**SW-1**
Distance from shoreline (ft)	250	100	10
Shallow	6.8	330	260
Mid	1.4	1.9	210
Deep	0	8.9	110

	West--**Southern Transect**--East		
	SW-6	**SW-5**	**SW-4**
Distance from shoreline (ft)	250	100	10
Shallow	38	140	32
Mid	2.9	52	140
Deep	4.9	8.3	220

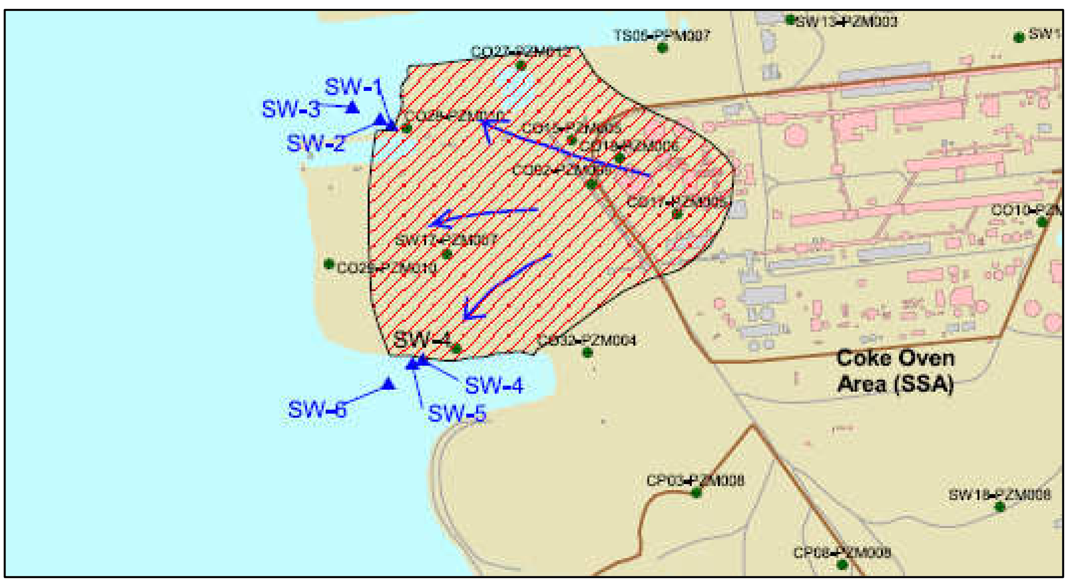

Figure 2: March 2005 Surface Water Benzene Sample Locations

1.3 CONCEPTUAL SITE MODEL

A conceptual site model is presented which identifies possible groundwater migration pathways into surface water (Figure 3). This figure presents a conceptual groundwater-to-surface water flow model for the CO/CP Area that illustrates the following two conceptual shallow groundwater flow paths: 1) lateral groundwater seepage/discharge from slag directly into surface water, and 2) groundwater seepage/discharge from slag into underlying sediments and then seepage from the sediments into the Patapsco River.

Other Figure 3 representations include:

- The made land (predominantly slag) comprising the CO/CP Area is relatively permeable compared to the pre-existing natural sediments/deposits upon which the slag was placed.
- Accordingly, shallow groundwater predominantly seeps laterally through the slag toward the surrounding surface water bodies under a relatively flat gradient that reflects the permeable nature of the slag.
- Some vertical groundwater seepage occurs across the quasi-horizontal boundary between the bottom of the slag and the underlying river sediments, but this seepage is small compared to the horizontal seepage from the slag directly into surface water.
- Tidal fluctuations induce seepage direction reversals, particularly near the existing river embankment consisting of the face of the placed slag.
- Potential seepage of groundwater through sediments may cause sediment pore water to be impacted by groundwater constituents.

This conceptual groundwater-to-surface water flow model is considered applicable to the entire shore line of the CO/CP Area, considering the similar genesis of the entire CO/CP Area and shoreline.

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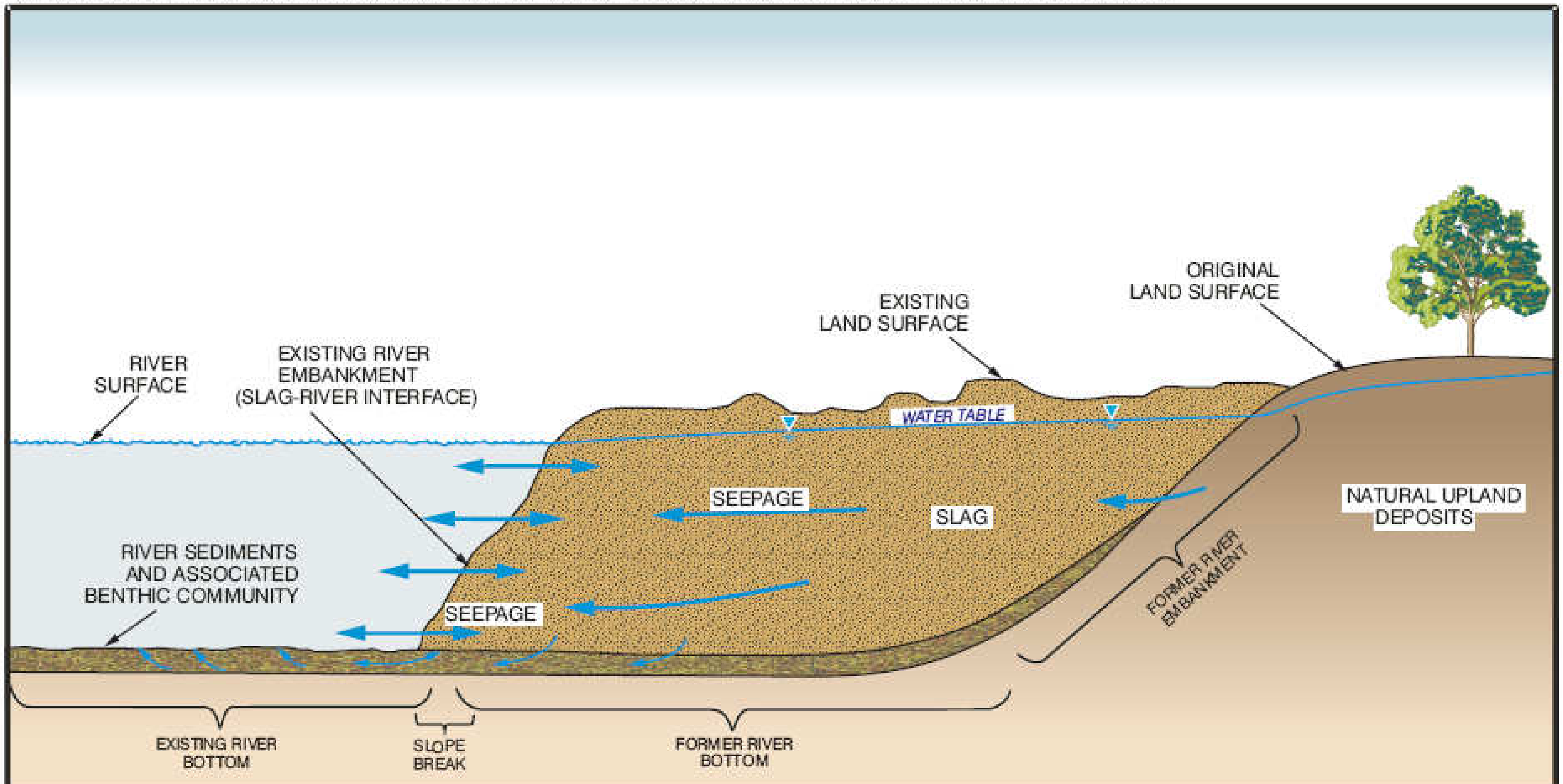

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Figure 3: Conceptual Groundwater-to-Surface Water Flow Model

1.4 PERIMETER WELL SCREENING

Figure 1 illustrates the locations of shallow groundwater monitoring wells (total of 16) near the shore line around the entire CO/CP Area. The groundwater chemistry results for these wells were compared to EPA Region 3 Biological Technical Assistance Group (BTAG) marine surface water benchmarks. If EPA Region 3 BTAG screening values were not available for a constituent, alternate chronic estuarine or marine values were selected from various published sources or derived by methods such as the Target Lipid Model, which was developed to predict the toxicity of chemicals that act via narcosis to aquatic organisms.

All of the Figure 1 perimeter wells exhibited exceedances of one or more screening values, implying the potential for groundwater impacts to surface water at locations other than the primary benzene discharge area illustrated in Figure 2.

1.5 SAMPLING PLAN OBJECTIVES

There are two primary sampling plan objectives, which include offsite sediment analysis required by MDE. Objectives are identified below and then discussed in more detail in Section 2.0:

- **Objective 1—**Assess Potential Groundwater Impacts to Surface Water Surrounding the Entire CO/CP Area Peninsula
- **Objective 2—**Assess Groundwater to Surface Water Migration Pathways and Evaluate Offshore Sediments

SECTION TWO: SAMPLING PLAN

2.1 OBJECTIVE 1—DETERMINE THE CONCENTRATION OF CO/CP AREA GROUNDWATER CHEMICALS IN SURFACE WATER SURROUNDING THE ENTIRE CO/CP AREA PENINSULA

Figure 4 illustrates 16 planned offshore surface water transects, each 500 feet long, along which surface water samples will be collected from various depths. Generally, the transects terminate adjacent to the perimeter wells where benchmark exceedances have occurred. Exceptions (transects 5, 11, and 13) result from a desire to have the transects roughly evenly spaced along the shoreline.

The samples will be analyzed for the chemicals detected in groundwater above the aquatic benchmark screening values (primarily COPI VOCs, SVOCs, and metals). Along each of the 16 transects the following five sampling stations are planned, which match the stations used in the March 2005 surface water benzene study:

- Station 1 is at the shoreline
- Station 2 is at the mid-point of the Slag-River Interface
- Station 3 is at the Slag Toe
- Station 4 is 250 feet from the shoreline
- Station 5 is 500 feet from the shoreline

A shallow water sample will be collected from shoreline Station 1 (16 samples). Shallow, middle, and deep surface water samples will be collected from Stations 2 through 5 (192 samples). Sampling along transect 16 will be adjusted as dictated by shoreline configuration constraints.

The Slag Toe at Station 3 will be identified by conducting a bathymetric survey of the entire CO/CP Area peninsula prior to any surface water sampling. This survey is described in Attachment A, and the planned survey area is illustrated in Figure 4.

Three surface water background stations are planned as identified during the March 2005 surface water sampling program, one of each at the following locations: Baltimore Inner Harbor, Curtis Creek, and Bear Creek head waters. At each background station a shallow, middle, and deep surface water sample will be collected (9 samples).

During the bathymetric survey, physical characterization of the CO/CP Area shoreline is planned to assess the:

- Water Depth surrounding the CO/CP Area.
- Offshore Slag Toe location (via physical sounding).
- Slag-River Interface topography (via physical sounding).
- Presence and thickness of a possible sediment veneer overlying the slag.

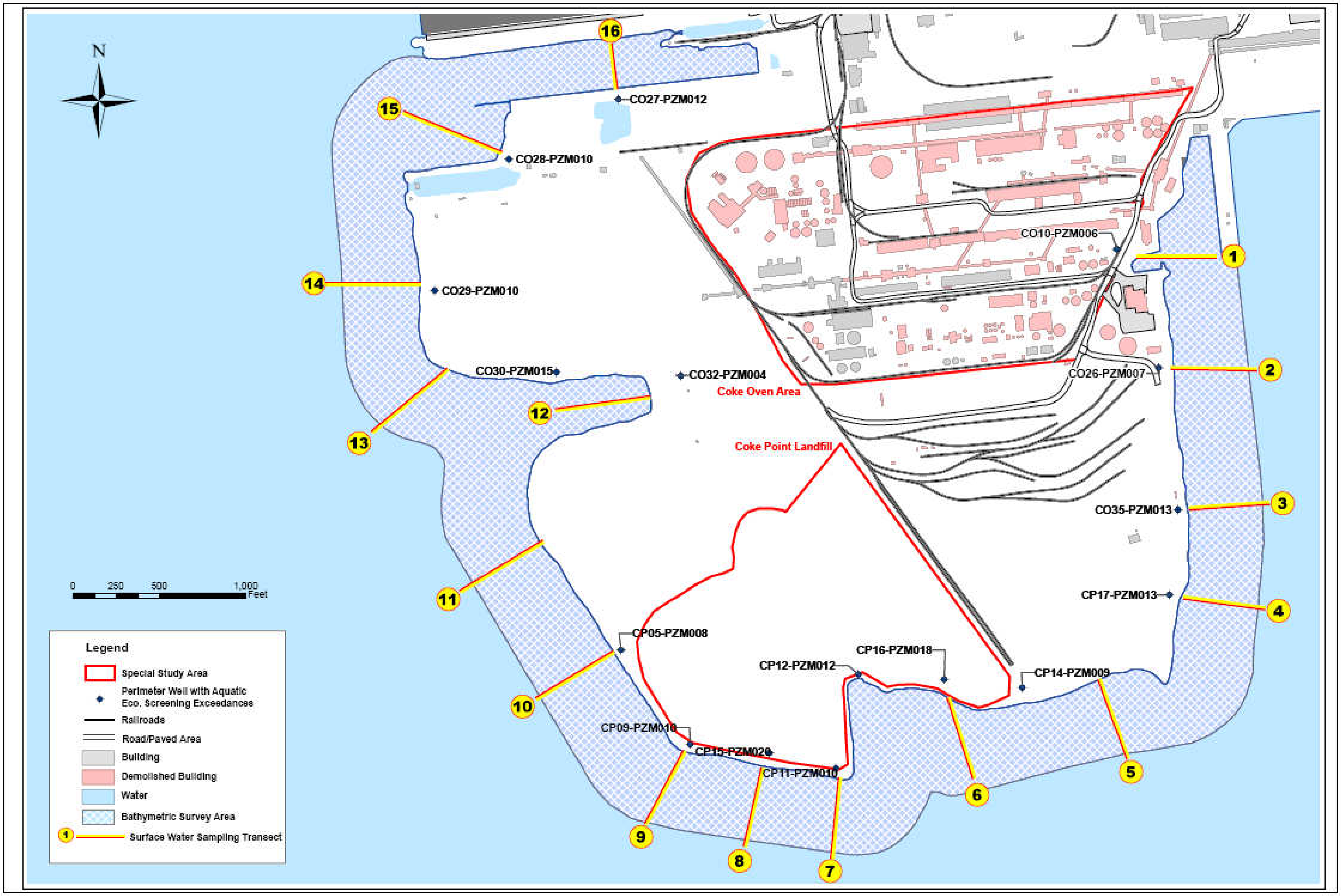


Figure 4: Surface Water Sample Transects and Bathymetric Survey Area

The following additional assessments supplement the transect sampling, bathymetric survey, and physical characterization:

- Another round of CO/CP Area water level measurements using all available existing monitoring wells. Specific conductivity will also be measured to estimate water density variations and adjust water levels accordingly. A water table contour map will be prepared, corresponding to the time-frame when the surface water transect samples are collected.
- Another round of shallow perimeter well groundwater samples and analysis of the samples for COPI parameters, also corresponding to the time-frame when the transect surface water samples are collected.

During shallow groundwater elevation monitoring, tidal influences will be minimized by: 1) attempting to monitor the wells during a time period not exceeding 3 hours, and 2) using data recorders to continuously monitor surface water and groundwater elevations at selected locations. Planned additional activities during measurement of water levels are summarized below and described in greater detail in Attachment B:

- Site Walk and Well Survey
- Well Repairs
- Pressure Transducer Installation
- Water Level and Specific Conductivity Measurement

2.2 OBJECTIVE 2—ASSESS GROUNDWATER TO SURFACE WATER MIGRATION PATHWAYS AND EVALUATE OFFSHORE SEDIMENTS

The conceptual site model (Figure 3) for groundwater impacts to surface water identifies two primary potential chemical migration pathways from groundwater into surface water: 1) lateral impacted groundwater discharge through slag, and 2) lateral/vertical groundwater seepage through offshore sediments (represented by small blue flow arrows in Figure 3). If impacted groundwater is migrating through sediments, sediment pore water chemistry will be impacted and aquatic benthic organisms may be at risk.

The offshore sediment assessment will consist of tasks to further refine the potential chemical migration pathways of the conceptual site model. These tasks will include analyzing sediment pore water surrounding the northwestern portion of the CO/CP Area for benzene. The presence of benzene in sediment pore water would indicate that active groundwater discharge impacts sediments.

The consistent presence of benzene in groundwater at the northwestern portion of the CO/CP Area make it a good tracer to track groundwater seepage into surrounding surface water and potentially into/through sediments. Positive tracer attributes are: 1) it is present in very high concentrations in site groundwater, and 2) its potential presence in sediments is most likely a consequence of active groundwater seepage through the sediments due to benzene’s relative low environmental persistence.

The sediment pore water assessment will be conducted along the three transects (Transects A, B, C) illustrated in Figure 5 because this is the area where groundwater benzene concentrations are highest. Transects A, B, and C match the surface water assessment transects 15, 14, and 13 respectively, illustrated in Figure 4. The surface water chemistry data derived from surface water sampling along transects 13, 14, and 15 will be supplemented with sediment pore water data to be collected as described here. Potential absence of benzene from sediment pore water indicates that the migration pathway for groundwater constituents into surface water is via direct groundwater discharge into surface water rather than by groundwater seepage through sediments. As indicated in Section 1.3 above, this groundwater-to-surface water flow regime is considered applicable to the entire shore line of the CO/CP Area, considering the similar genesis of the entire CO/CP Area and shoreline.

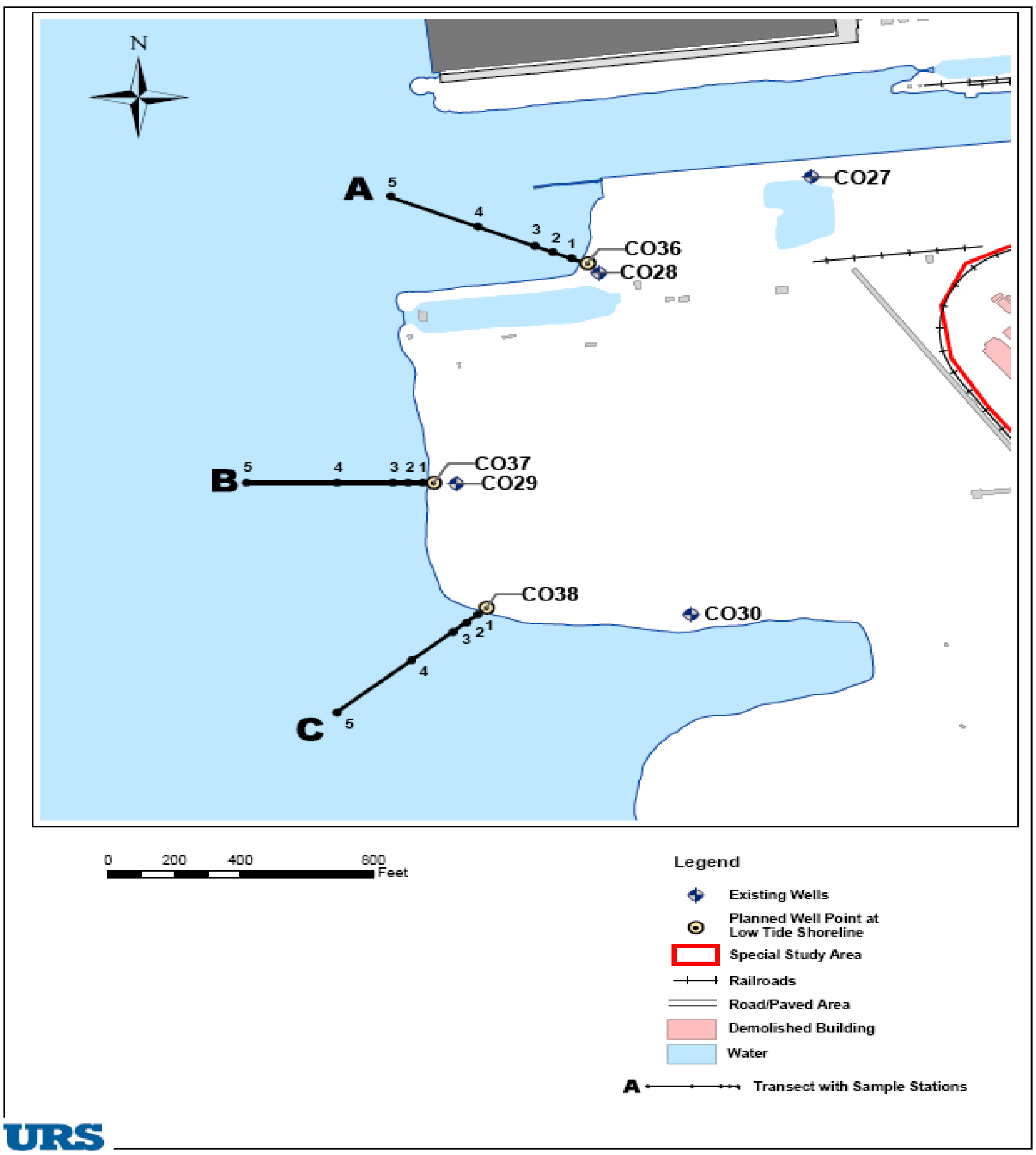


Figure 5: Planned Benzene Tracing Transect Locations—Northwestern CO Area

Benzene in Shoreline Groundwater: one sample will be collected from each of the three planned new well points (CO36, CO37, and CO38) to be hand-installed at the low tide shoreline, as illustrated in Figure 5.

Benzene in Sediment Pore Water from along Transects A, B, and C:

- One sediment pore water sample (6 to 12 inches) from the slag Sediment Veneer (if present)
- Two sediment pore water samples from the Slag Toe (6 to 12 inches and 12 to 24 inches)
- Two sediment pore water samples from each of the Stations 3 through 5 (6 to 12 inches and 12 to 24 inches)

Two sediment pore water depth intervals are planned for some locations to address the possibility that benzene could enter sediment porewater from the over-lying surface water column which is known to contain benzene. If the shallow sediment pore water contains benzene but the deeper sediment pore water does not, the implication is that benzene entered the shallow sediment pore water from the over-lying water column rather than by groundwater seepage.

Best Sediment pore water sampling technique. Broad categories for sampling sediment pore water include in-situ methods that use samplers that are inserted directly into the sediment, and ex situ methods that remove the sediment and isolate the pore water elsewhere. For the area offshore of the CO/CP Area, viable approaches are:

- Deployment of modified Hesslein in-situ pre-water samplers (peepers) that can be inserted directly into soft sediments and are retrieved following a pre-set equilibration period (usually 2 to 3 weeks); and
- Bulk sediment collection and ex-situ pore water recovery by centrifugation in an environment and via protocols that would minimize VOC volatilization to the atmosphere.

Given the high-energy offshore environment near the CO/CP Area and the unsafe conditions there (e.g., strong currents, waves, underwater obstructions, poor visibility water), manual insertion of passive diffusion bags or other in-situ sampling device (via SCUBA) is not feasible.

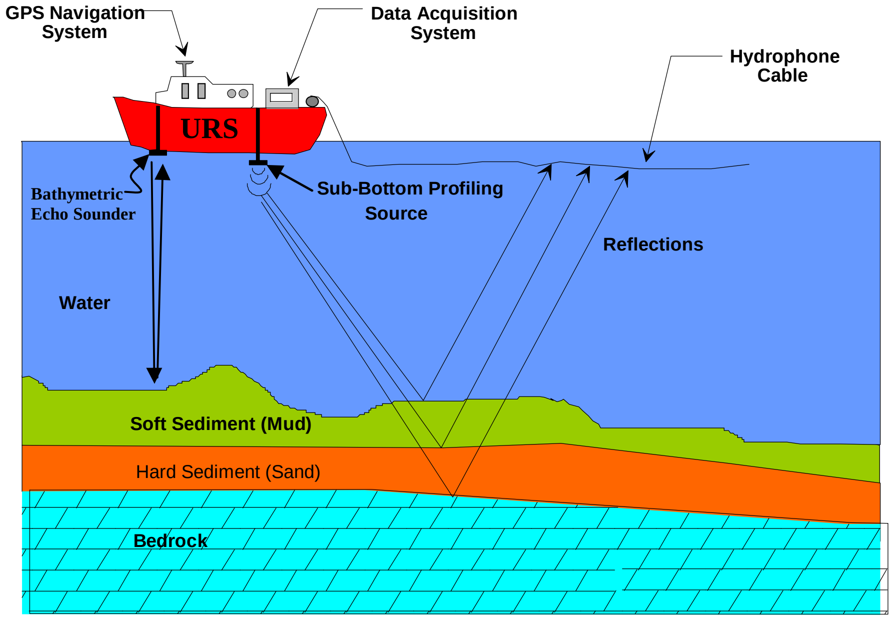
Results from the prior described bathymetric survey will help with the assessment of the best sediment pore water sampling technique.

Sediment pore water benzene data will be reviewed to determine if the groundwater-to-sediment pore water pathway is complete. If benzene is present in the sediment pore water, the implication is that the pathway may be complete (i.e., benzene-impacted groundwater is seeping into Patapsco River sediments). Additionally, such results would indicate that expanded sediment analysis should be considered for other chemicals and locations, and possibly including bulk sediment analysis. If benzene is not present in the sediment pore water, this will indicate that groundwater seepage from the CO/CP Area is not transporting groundwater chemicals into sediment pore water (i.e., the groundwater-to-sediment pore water pathway is incomplete and benthic organisms are not at risk from impacted groundwater). If benzene is detected in pore water, but at a concentration below eco-screening benchmarks, then the indication would be that the pathway may be complete but does not pose a risk to aquatic benthic organisms.

ATTACHMENT A

BATHYMETRIC AND SUB-BOTTOM SURVEY

The geophysical investigation will consist of a combination of bathymetric surveying and sub-bottom profiling. The bathymetric survey system consists of an echo sounder. The sub-bottom profiling survey utilizes a data collection system consisting of a survey boat, an acoustic energy source (transducer), an array of hydrophones (seismic streamer) and an acquisition and recording system as shown below.



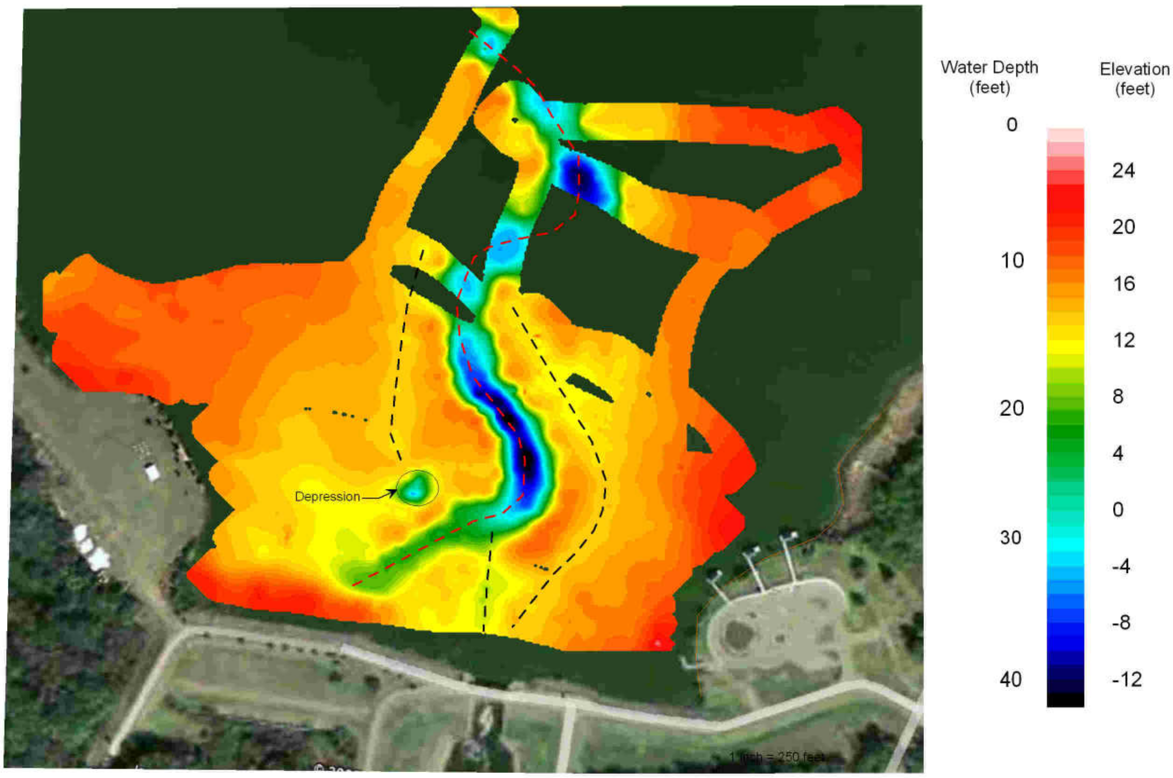
Bathymetric and Sub-bottom Profiling Methods

The acoustic source from the sub-bottom profiler emits seismic pulses into the water at a defined interval (typically in the range of 1 pulse per second). These pulses travel downward through the water column. At the seafloor some of the seismic energy is reflected upward toward the surface. The remaining energy penetrates the seafloor and is subsequently reflected off the relatively complex series of subsurface layers below the seafloor. The reflected pulses are detected by sensors in a seismic streamer cable towed along the water surface. The detected signals are then processed and recorded on a graphic or digital recorder.

The amplitudes of the reflected signals depend upon the impedance contrast between the various layers. The depths to the seismic interfaces can be computed from the travel times for the reflected waves by correlating the results with existing geologic data such as boring logs or through estimating the seismic velocities of the water and sub-bottom layers.

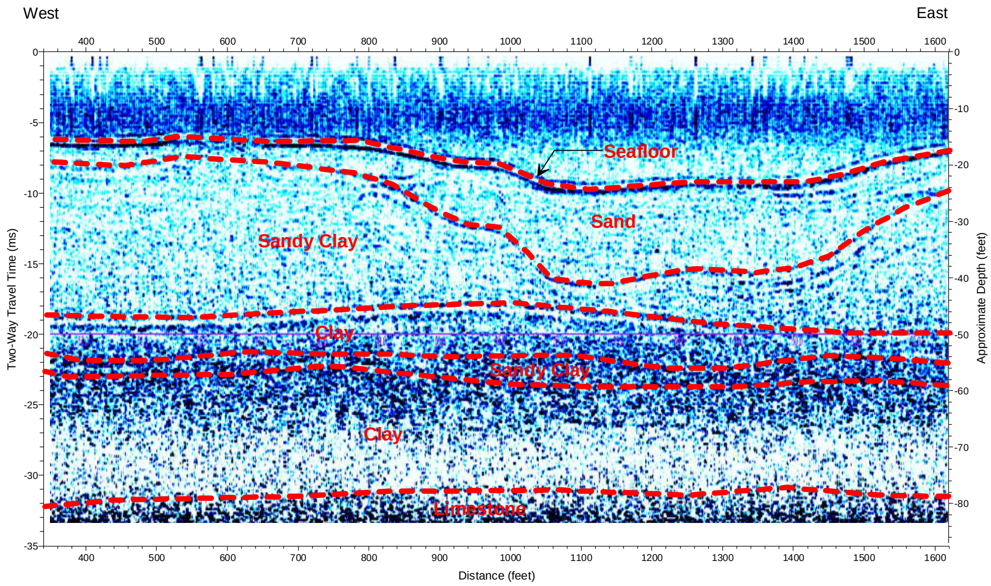
The geophysical investigation will consist of both bathymetric and sub-bottom profiling surveys. The bathymetry survey will be designed to provide high resolution mapping of the topography of the harbor bottom. Bathymetric data will be collected using a MIDAS Surveyor hydrographic survey system. The system includes a dual frequency echo sounder transducer consisting of a 210 kilohertz (kHz) high frequency sensor and a 33 kHz low frequency sensor. The high frequency sensor is optimized for high resolution mapping of the bottom in shallow water. The low frequency sensor is generally optimized for surveying in deeper water and the signal typically penetrates softer upper sediments. The combination of the two sensors can thus provide information on the thickness of soft sediments overlying a hard bottom, if present.

An example of a bathymetric survey URS recently completed marina area in Florida is provided below.



Example Bathymetric Survey Results

The sub-bottom data will be recorded using a single-channel seismic streamer towed at or near the sea surface behind the survey boat. The hydrophone streamer is comprised of multiple element amplifiers at regularly spaced intervals that act as a single receiving system. The acquisition parameters are determined by the user in the topside digital acquisition system, where the raw data is recorded for preliminary processing and interpretation. An example of processed results from a sub-bottom profiling survey URS recently completed for design of a tunnel along the Gulf Coast of Florida is provided below.



Example Sub-Bottom Profiling Results

Survey Design

The geophysical surveys will be completed using a small motorized survey vessel. Geophysical data will be collected along a series of profile lines along the accessible extent of the area of interest. The locations of the profile lines will be optimized during surveying based on observed variations in subsurface conditions as indicated by preliminary processing of the initial profiles.

The sub-bottom profiling data will be collected using an Applied Acoustics Engineering Geopulse System seismic energy source (800 Hz to 2 KHz), a GeoAcoustic amplifier and filter, and a marine hydrophone streamer. Positional data acquisition and navigation will be conducted using a Trimble ProXRS differential global positioning system (DGPS). Positioning and geophysical data will be recorded digitally using a Chesapeake Technology, Inc. Digital Acquisition System.

Recommended Side Scan Sonar Survey

URS recommends that side scan sonar surveying also be used to further characterize the area of interest. The side scan sonar survey will provide detailed information relative to bottom conditions including the relative consistency of the bottom sediments and will aid in delineating potential man-made obstructions (submerged foundations, sunken vessels) and/or hard bottom features. The side scan sonar survey will also provide useful information for identifying other potential hazards including disturbed sediments, erosion channels, and slides.

ATTACHMENT B

Scope of Work

Water Level and Specific Conductivity Measurements

Scope of Work

Water Level and Specific Conductivity Measurements
Coke Oven and Coke Point Areas
Severstal-Sparrows Point, LLC Facility, MD

The following Scope of Work pertains to tasks associated with the collection of water level and specific conductivity measurements at the Sparrows Point Coke Oven and Coke Point Areas. The data will address groundwater flow and density data gaps identified during the preparation of the Nature and Extent Report (January 2005).

Groundwater at the site is influenced by tidal conditions. Accurate analysis of groundwater flow dynamics requires that data are collected during the same period of a lunar cycle (low tide, for example). Previous data were collected over longer periods of time. In addition, specific conductivity measurements will be collected at the same time as the water levels to assess how groundwater flow at the site is influenced by varying densities.

Proposed activities have been divided into 4 tasks that are described further below:

1. Site Walk and Well Survey
2. Well Repairs
3. Pressure Transducer Installation
4. Water Level and Specific Conductivity Measurement

The data collected during the activities discussed in this SOW will be presented in a letter report upon completion of the final task. The letter report will include figures and tables illustrating the data with URS interpretation and recommendations.

A daily site safety briefing will be conducted on site prior to all field activities.

Task 1: Site Walk and Well Survey

URS, with support from Severstal-Sparrows Point, LLC, will conduct a well survey for each well and surface water gauge location to be identified for water level and specific conductivity measurements. The well survey will confirm that the wells can be located, accessed, are clearly and accurately labeled, and are in suitable condition prior to URS collecting water level and specific conductivity measurements (Task 3). URS will permanently label each well with an aluminum tag embossed with the well name during the well survey.

Task 2: Well Repairs

Repairs may be completed for wells that have been damaged and that Severstal-Sparrows Point, LLC and URS identify as critical for water level measurements. The repairs will be completed prior to collecting water level measurements and may include reinstalling wells that have been severely damaged. Wells requiring repairs will include those identified during the proposed well survey (Task 1). URS will prepare a technical memorandum recommending wells to repaired, with estimated costs to complete, prior to water level measurements.

Task 3: Pressure Transducer Installation

URS will install pressure transducers with data loggers in 10 monitoring wells and 3 surface water gauge (SWG) locations in the Coke Oven and Coke Point Areas. The pressure transducers will record head pressures over a 7 day period to assess tidal effects on groundwater flow. The 13 locations were previously used for pressure transducer readings in December 2003.

Task 4: Water Level and Specific Conductivity Measurements

Water level measurements will be collected during a 3-hour period, starting 1.5 hours before low tide.

Water levels will be collected by four (4) URS field technicians working separately. The following will be recorded for each well:

- Photoionization reading of the well head space
- Depth to water
- Time the measurement was made (to the nearest minute)
- Total well depth
- Presence of any non-aqueous phase liquid
- Any odor observed
- General condition of the well

Specific conductivity readings will be collected using a down-well, in-situ conductivity probe that will be lowered down to the groundwater.

The following methodology will be used for small inner diameter wells that will not accommodate the probe:

1. Prior to the water level collection event, to minimize set up time at each well, install disposable tubing in the wells. Install the tubing at the midpoint of the well screen.
2. After the water level measurement is made, attach the disposable tubing to a peristaltic pump.
3. Purge approximately 1 gallon of water from 2-inch inner-diameter wells (a) to ensure that the sample is representative of groundwater in the formation. Adjust the purge rate to limit drawdown in the well to less than 1 foot.
4. After purging, collect a sample in a clean jar or beaker. Measure the specific conductivity of the sample with the specific conductivity probe/meter.
5. Record the specific conductivity measurement, collect the total depth measurement and secure the well before proceeding to the next.

The collection of water levels and specific conductivity measurements will be scheduled to coincide with the pressure transducer data collection period.

Notes:

[a] Purge volumes: 1-inch ID well = 0.25 gallons
4-inch ID well = 3 gallons