SECTION 4

Field and Laboratory Methods and Results

Seven field investigations were performed at DMT to support the sediment and surface water study: a hydrographic and geophysical survey, two groundwater upwelling surveys, and four quarterly sampling events. The field investigation activities and dates are summarized in Table 4-1. Field and laboratory methods and results are described below.

4.1 Field Methods and Results

Sample collection activities during the four quarterly sampling events were performed in accordance with the methods described in the Work Plan. Meteorological conditions during each of the quarterly sampling events are summarized in Table 4-2. Sampling activities were generally performed in the following order: collection of water column data, collection of surface water samples, and collection of surficial sediment; first for pore water extraction and then for surficial sediment chemistry. Vibracores were collected in a separate visit to each sampling location prior to collection of the pore water and surface water samples because different sampling equipment was used. Methods and results for each aspect of the field investigation are presented below.

4.1.1 Surface Water

Water Column Data

At each location, vertical water quality profiles were established prior to the collection of surface water and sediment samples. Water column profiles were collected using a Seabird SBE-19® conductivity/temperature/depth (CTD) profiler equipped with sensors for measuring temperature, conductivity, pH, dissolved oxygen (DO), and turbidity (salinity is derived from conductivity measurements). After the sensors were allowed to equilibrate at each location, the instrument was slowly lowered through the water column at a rate of less than 1 foot/second until it contacted the sediment surface. Data from the sensors were recorded at a frequency of two measurements per second. After recovery of the CTD, data were uploaded to a computer and processed into 1-foot average values.

Water column profiles from the four surveys are included in the field reports provided in Appendix C. Water quality data are summarized in Table 4-3. Water temperatures at DMT ranged from 2.5 °C to 28.4 °C (mean = 15.4 °C), which closely resemble temperatures at the reference locations (2.8 °C to 27.4 °C; mean = 14.2 °C). While temperatures did not seem to vary much as a function of sampling location, there were significant variations in temperature as a function of season. Increases in surface water temperature correspond to increases in microbial activity, which results in the consumption of oxygen and formation of the key reductants sulfide and Fe(II) as discussed in Section 2.2.1.

Salinities at DMT during all four sampling events ranged from 3.1 to 16.3 parts per thousand (ppt) (mean = 10.7 ppt), which are consistent with those at the reference location (5.2 to 16 ppt; mean = 11 ppt). Salinities appear to be slightly lower in the shallow water transects (Transects A, B, C and J; mean = 8.9 ppt) than in the deeper water transects (D-H;

mean = 11 ppt). Salinity profiles show a trend of increasing salinity with depth. The lower salinity measures in the upper portion of the water column are characteristic of freshwater input (e.g. rainfall and storm drains) and the higher density associated with more saline waters. Most notably, the average salinity at DMT in May 2007 was approximately 8.1 ppt but nearly 13 ppt in August 2007.

DO concentrations were substantially higher in the colder months of December and February (mean = 10.5 mg/L) than in the other sampling events, and was lowest in August (mean = 3.75 mg/L). DO did not vary much by depth in the shallower transects (Transects A, B, C and J) and were indicative of aerobic conditions throughout the water column except in August (Table 4-3). At the deeper sampling locations, DO concentrations declined dramatically with depth. In fact, at sampling locations with water depths of greater than 25 feet, the environment at the sediment-water interface was highly reducing with DO concentrations averaging less than 2.5 mg/L.

The pH values seen in the water throughout the water column ranged from 6.9 to 9.1, showing pH levels that are generally not conducive to Cr(III) solubility. Overall, pH did not vary significantly either by transect location or depth in the water column.

Surface Water Sample Collection

Water quality profiles were reviewed in the field to determine if the water column was stratified and select an appropriate sampling depth for the mid-depth surface water sample. Once the sample depths were established, surface water samples were collected by lowering tubing attached to a weighted measuring line to the deepest target depth and using a peristaltic pump to retrieve the water. Samples were collected directly into bottles provided by the laboratory. Headspace was minimized in all water samples, particularly those for analysis of parameters sensitive to changes in redox potential (Fe[II] and Mn[II]). Samples for the analysis of dissolved phase parameters were field-filtered using a 0.45-micron filter attached to the sample tubing. Upon completion of the water collection from the deep interval, the tubing was raised to the next target sample depth and purged prior to sample collection. Dedicated tubing was utilized at each sampling location.

Table 4-4 lists the analytical parameters and associated laboratory methods for surface water and other media. A summary of the surface water samples collected in the four quarterly sampling events is provided in Table 4-5a. At some locations, the number of samples collected varied from one event to the next because the depth of the water column varied due to tides.

4.1.2 Pore Water and Surficial Sediment

In situ Sediment Quality Parameters

Upon completion of the surface water sampling, surficial sediment (0-6 inches) was collected using a Van Veen sediment sampler. Prior to removing sediment samples from the sampler, geochemical parameters were measured using Oakton Acorn® pH/millivolt (mV)/ORP meters, one with a double-juncture pH probe and the other with an ORP platinum band electrode. Measurements were performed by placing the probes within the surface sediment in the Van Veen sediment sampler. The measurements were recorded prior to collecting sediment samples for pore water extraction in the laboratory. Results are provided in Table 4-6. The geochemical parameters measured with the pH/mV/ORP meter are representative of both sediments and pore water, which are assumed to be in equilibrium. ORP measurements (relative to a silver/silver chloride reference voltage) were converted to Eh (relative to a standard hydrogen reference) by adding 205 mV to the field measurements. Pore water samples were also analyzed for pH and ORP in the laboratory.

Overall, Eh measurements indicate that reducing to moderately oxidizing conditions occur in surficial sediments at the site and reference stations in all seasons. The extent of reducing conditions was greatest in August 2007, and least in February 2008. Positive Eh measurements were primarily associated with the shallow area in the southeastern part of the site (transects A-C). Geochemical conditions are discussed further in Section 5.2.

Pore Water and Surficial Sediment Sample Collection

Sediment samples for pore water extraction were collected first using pre-cut sections of Lexan® tubing. The tubes measured 4.5 inches tall and 3 inches wide. Each Lexan® tube was pushed into the sediment within the Van Veen sampler without touching the sides or bottom of the device. The tube was then immediately removed and Teflon® liners were placed on the sediment on both ends of the tube prior to capping the container. The Teflon® reduced contact of oxygen with sediment on either end of the tube. The Lexan® tubes were immediately sealed with pipe tape to minimize leakage or exposure to the atmosphere. Careful attention was given to minimize potential oxidation of the pore water parameters.

In the May 2007 and August 2007 sampling events, collection of sufficient pore water volume from some of the A transect locations using the Lexan® tubes was difficult or impossible due to the sandy composition of the sediment. Therefore, additional sediment for pore water extraction was collected from these locations in the December 2007 and February 2008 events using 1-L, pre-cleaned, wide-mouth glass jars. After the Lexan® tubes were filled, 8 to 12 glass jars were filled by inserting each jar into the sediment at an oblique angle down to 0.5 feet; then a pre-cleaned, dedicated high density polyethylene (HDPE) scoop or gloved hand was used to push additional sediment into the jar to minimize head space and prevent the sediment from falling out of the jar as it was removed from the grab. As soon as the jar was removed from the grab, the threads were wiped off and the lid secured. Care was taken to handle the sediment as little as possible when filling the glass jars. Gloves were changed between stations.

Once pore water samples were collected, the remaining sediment in the Van Veen was used to fill sample jars for bulk sediment chemical and geochemical analyses using a plastic spoon. Several of the geochemical parameters can become unstable in the presence of oxygen; therefore, surficial sediment samples for analysis of Fe(II), Mn(II), and AVS/simultaneously extracted metals (SEM) were collected in Lexan® tubes using the same procedure described for the pore water sample collection.

Anaerobic handling of pore water samples for geochemical analysis occurred in the laboratory. Surficial sediment samples collected in the field within Lexan® tubes for pore water extraction were transported to Lancaster Laboratories Inc. (LLI), where the sediment was then transferred to centrifuge tubes within a nitrogen-purged glove box. The samples were then centrifuged at 2800*g* for 40 minutes. Pore water was extracted from the centrifuge tubes for chemical and geochemical analysis within the glove box, thereby minimizing exposure to oxygen.

Tables 4-5b and 4-5c provide summaries of the pore water and sediment samples collected in the four quarterly sampling events and associated analytical parameters. As shown in Table 4-5c, geochemical parameters were analyzed in each of the surficial sediment samples because they represent the biologically active zone.

4.1.3 Sediment Cores

Sediment cores were collected during the August 2007 and February 2008 (locations B-5 and J1 through J4 only) field surveys from the same locations as surficial sediment and pore water samples using a vibracoring device. Cores were collected from a sufficient depth to recover a minimum of 3 feet of sediment. A minimum of two cores were collected from each location. To the degree possible, zero headspace and an anaerobic environment were maintained within the cores. Upon removing the core barrel from the vibracoring device, excess water was drained off. The excess core tube was sliced off before capping the tube. Cores were stored vertically in an onboard refrigerator.

The cores were kept in a vertical position except when the core tubes were removed from the vibracoring device. The cores were briefly in a horizontal position when they were removed from the coring device on the deck of the boat and again when the cores were processed. When the cores are in a horizontal position, mixing may have occurred at the top of the core (generally the top 1–2 inches) where the sediment is loose and unconsolidated. However, the surficial sediment samples (0- to 6-inch composites) were taken from a grab sampler and not from the core. The representativeness of the mid-depth and deep core samples is not affected by any mixing of the surficial sediment in the core. In addition, the subsurface sediment samples were taken from the center of the core, and material in contact with the core liner was not included in the sample to prevent potential cross-contamination by surficial sediment.

At each sampling location, one core was split open lengthwise using an electric swivel head shear cutter. This first core was used for photographic documentation, identification and characterization of the soil/sediment characteristics, and selection of stratigraphic intervals for sampling. Cores were described according to American Society for Testing and Materials (ASTM) Method D2488-93 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure; modified slightly to apply to sediments). Two subsurface sediment samples were collected from each location based upon the observed stratigraphy. Each sample was composed of a single sediment type. Sample jars were filled with a composite sample of sediment from the targeted interval from one or two cores, depending upon the volume of sample required for analysis. Sediment was composited by mixing in dedicated plastic bags. The sample containers were filled using dedicated plastic spoons.

Sediment aliquots from the core samples that were analyzed for redox sensitive parameters (e.g. Fe(II), Mn(II), and AVS/SEM) were submitted to the laboratory by segmenting an intact core at the appropriate intervals based on the stratigraphy observed in the opened core. Teflon® liners were placed on each of the core segment, the interval was capped, and the core segments were wrapped with pipe tape in the same manner as the Lexan® tubes utilized to collect the pore water samples.

Table 4-5c provides a summary of the surficial and subsurface sediment samples collected, and the associated analytical parameters. Geochemical parameters were analyzed in a subset of subsurface sediment samples to provide information about potential biogeochemical transformations of chromium at depth in the sediment column. Specifically, subsurface sediment samples from the first location at each transect were analyzed for geochemical parameters (e.g., A1, B1, etc.).

4.1.4 Hydrographic and Geophysical Survey

Methods

An integrated hydrographic and geophysical survey was conducted at DMT in December 2006 to document existing bathymetric and sub-bottom conditions adjacent to the terminal. The survey methods are briefly described below; additional detail regarding the methodology, equipment, and the survey results is provided in Appendix A.

Hydrographic and sub-bottom profile data were obtained along a series of tracks oriented parallel to the DMT terminal faces, spaced 50-feet apart to a distance of approximately 2000 feet offshore of DMT. Data were also acquired along nine transects oriented perpendicular to the DMT terminal faces and the other tracks. In total, approximately 80 nautical miles (nm) of track lines were investigated. Hydrographic and sub-bottom data were collected simultaneously along all track lines where safe and practical.

Two electronic water level recorders (a primary and secondary recorder for backup and quality control) were installed on-site to continuously document tidal variation during the investigation. The water level recorders were referenced to North American Vertical Datum (NAVD 1988) and provided a means to adjust water depth data to the datum.

Specific equipment installed on the survey vessel and used to complete the investigation includes a differential global positioning system (DGPS), precision survey-grade depth sounder, and a sub-bottom profiling system that relied on acoustic reflections from the river bed to infer the composition of bottom sediments. A complete discussion of this equipment, along with the operational procedures for data collection, can be found in Appendix A.

Bathymetry

A bathymetric map of the Patapsco River and Colgate Creek adjacent to DMT based on the data acquired in the survey is provided in Figure 4-1. The map clearly shows a network of steep-sided navigation channels traversing the project area that allow shipping access to the DMT and Seagirt Marine Terminal from the Fort McHenry navigation channel. The channels encompass nearly half of the area surveyed and are a minimum of 39 feet deep, although some areas are as deep as 48 feet. The channel bottom is variable, a likely artifact of past dredging operations. Water depths measured outside the channels were generally less than 20 feet. The bottom topography in these shallow areas appears less variable than the channel topography. The only major bottom feature detected outside the navigation channels was an approximate 1,500-foot elongate depression (1-3 feet deep) detected in the southeastern sector of the survey area approximately 1,500 feet south of the DMT’s southeastern pier face. Location B-4 was located within this elongate depression (see Figure 3-1), which may represent a relict dredged channel.

Sediment Characteristics

The physical characteristics of the Patapsco River sediments near DMT were determined through the sub-bottom profiling survey, visual descriptions of surficial sediment samples and sediment cores, and sediment grain size analyses. These data indicate that a variety of sediment types is present in the study area.

The sub-bottom profiler utilizes an acoustic signal that penetrates the river bottom and reflects off of surfaces corresponding to different layers of sediment. The survey identified five different bottom types within the study area based on acoustic characteristics, as shown in Figure 4-2. Types 1 and 2 correspond to the dredged channels, where sub-bottom penetration was limited or absent. Signal penetration can be impeded by several factors, including the presence of gaseous sediments and irregular morphology of the sediment bed. Gas in sediments is generated by the decomposition of naturally occurring organic material, and is common in fine-grained sediments in rivers and estuaries. Irregular surfaces that result from dredging operations can disperse acoustic energy and prevent it from penetrating the river bed. Type 3 sediments had a continuous sub-bottom reflector several feet below the river bed, and the characteristics of the overlying surficial sediments were indicative of high water content. Type 3 sediments were found in the shallow areas between the dredged channels in the west and north parts of the study area. Type 4 sediments had shallow sub-bottom penetration, and were found in the shallow areas in the southern part of the study area. Deep sub-bottom penetration (up to 50 feet) was achieved in Type 5 sediments, in shallow water at the southeastern end of the study area. Numerous push probes in this area encountered hard (impenetrable) materials; in most cases, a layer of softer material less than 3 feet thick was encountered above the hard bottom. Type 5 sediments correspond with the locations of Transects A, B, C, and J.

Surficial sediments collected in the four quarterly sampling events were composed of loosely consolidated sand, silt, and clay mixtures at locations corresponding to Type 1-4 bottoms. Sand was found at many of the locations with a Type 5 bottom (transects A-C and J). In some locations, well-consolidated sand or clay was encountered at depths ranging from 0.4 to 2.5 feet below the surface, predominately in areas with Type 4 or 5 bottoms. Grain size distribution and sediment types are provided in Table 4-7.

4.1.5 Groundwater Upwelling Surveys

Groundwater upwelling surveys were performed in the Patapsco River adjacent to DMT in December 2006 and October-November 2007. The surveys collected *in situ* measurements of temperature and conductivity in subsurface sediment and in overlying surface water using a Trident probe equipped with direct push temperature and conductivity sensors. Spatial patterns of surface and subsurface temperature and conductivity are used to identify areas where groundwater may be discharging to a surface water body (Chadwick et al., 2003). Detailed survey methodology and results are presented in Appendix B.

The sampling grid for each survey consisted of the 19 primary transects of 3 stations each, and 17 supplementary stations to further delineate potential groundwater upwelling zones around the periphery of DMT. Testing occurred at 100-foot intervals out from the periphery at each of those locations, beginning immediately adjacent to the terminal (i.e. at 0 feet, 100 feet, and 200 feet). Exact locations were adjusted depending on site conditions. At locations where potential groundwater upwelling was identified, additional samples were taken along and adjacent to the transect, to better delineate the upwelling area. Ancillary measurements of relative groundwater and surface water levels were collected in two monitoring wells and in the harbor adjacent to DMT every ten minutes using water level loggers.

The Trident probe survey at each location was performed from a small boat by inserting the probe into the seabed to a depth of approximately 2 feet below the sediment-water interface. Once on station with the probe inserted, data was collected from the probe (subsurface) and reference (surface water at 1 foot above the interface) conductivity and temperature sensors and the pole-mounted GPS attached to the unit. The real-time data was then reviewed in numeric format, and displayed spatially using graphical information system software. The real-time spatial display allowed rapid identification of the most likely areas of groundwater discharge. The resulting survey data were used to develop spatial maps indicating potential areas of groundwater discharge.

Statistical summaries of the survey results are provided in Table 4-8, and the potential groundwater upwelling areas identified in each survey are shown on Figure 4-3. The results of both surveys indicated that the strongest evidence of groundwater discharge was in the southeastern part of the study area near Area 1501/1602 (in the vicinity of transects A and B). This area of upwelling was identified primarily on the basis of lower subsurface conductivity conditions relative to the overlying surface water. Subsurface conductivity measurements were similar in both surveys, whereas subsurface temperatures were 4-5°C warmer and less variable in November 2007 compared to December 2006.

4.1.6 Waterfront Perimeter Groundwater Monitoring

A network of seven shallow monitoring wells is present along the waterfront perimeter of Area 1501/1602, including five shallow wells and two temporary piezometers that were installed in an isolated, thin sand layer below the shallow water table unit. Cr(VI) was only detected in two groundwater samples from these wells, at concentrations of 39 µg/L and 45 µg /L.[1] Both detections were below the saltwater acute and chronic NRWQC for Cr (VI) (1,100 µg /L and 50 µg /L, respectively) and the MDE Groundwater Standard (100 µg /L). Phase 3 groundwater sampling results will be provided in the Phase 3 Investigation Data Summary Report and all groundwater results will be summarized in the Chromium Transport Study Report.

4.2 Laboratory Methods and Analyses

Samples collected for analysis of chemical and geochemical parameters were processed by LLI. The majority of the analyses were performed by LLI, although the analysis of some parameters (e.g., grain size) was subcontracted to different laboratories. Analysis of Mn(II) was subcontracted to Microseeps and Metrohm. Laboratories used in this investigation are certified under the National Environmental Laboratory Accreditation Program (NELAP), and have state certification for the specific analyses, as applicable. Laboratory analyses were conducted according to USEPA and State of Maryland guidance for sample collection and testing methods.

Laboratory handling protocols were specifically developed to ensure that samples were handled in an anaerobic environment due to the instability of the following geochemical

[1] Cr(VI) has also been detected in samples from an older well installed within the COPR fill material; however, Cr(VI) has not been detected in samples from two adjacent wells installed outside of the COPR cell.

parameters in aerobic conditions: Mn(II), Fe(II), AVS/SEM, and sulfide. Exposure to aerobic conditions during sampling and analysis can result in the oxidation of these parameters and thus result in false negative results. Thus, pore water was extracted in the laboratory within a nitrogen-purged anaerobic glove box to minimize oxidation and preserve the original condition of the samples. A discussion of the analytical results for all media is presented in Section 5.

4.3 Data Management and Validation

After laboratory analyses were completed, the sample results were loaded into the project database and verified, and the hard copy data packages were subjected to an independent, third party data validation process to assess the usability of the data. Validata LLC, an independent validation firm, applied the review criteria detailed in the DMT Quality Assurance Project Plan (CH2M HILL, 2006b), USEPA data validation guidance (USEPA, 1993; 1995; and 2004b), and New Jersey Department of Environmental Protection guidelines for Cr(VI) analysis (NJDEP, 2005). Areas of the review included holding time compliance, calibration verification, blank results, matrix spike precision and accuracy, method accuracy as demonstrated by laboratory control samples (LCS), field duplicate results, surrogate recoveries, internal standard performance, and interference checks (as applicable to the method). Additionally, the reviewers re-calculated the final laboratory quantitations to verify proper reporting of analyte concentrations, spike recoveries, and calibrations. Any non-conformances were documented and data not within acceptance limits were appended with a qualifying flag, which consists of a single or double-letter abbreviation indicating the nature of the identified non-conformance. Data validation summaries for the four quarterly sampling events are provided in Appendix D.

4.4 Work Plan Modifications

The objectives of the sediment and surface water study were achieved with some modifications to the approach presented in Work Plan. These modifications were as follows:

- Adjustments of selected sample locations during the first quarterly sampling event in May 2007 based on field conditions encountered
- Collection of fewer surface water samples than proposed due to the shallow water depth at some locations
- Slight modifications to the pore water collection and extraction procedures at locations with sandy sediments
- Moving the collection of subsurface sediment samples forward on the project schedule
- Reduction in the number of sampling locations and analytical parameters in the third and fourth quarterly sampling events based on the findings of the first and second quarterly sampling events
- Addition of five sampling locations in the fourth quarterly sampling event to address potential data gaps identified after the first three events.

Each of these modifications is discussed further below. Proposed changes in the sampling program (i.e., elimination and addition of sampling locations and changes in analytical parameters) were communicated to MDE in writing prior to implementation.

4.4.1 Sample Location Adjustments

Sample locations presented in the Work Plan were established to characterize conditions associated with potential chromium transport pathways such as outfalls and areas of groundwater upwelling. Target coordinates were established for these locations and provided to the sampling vessel subcontractor. In most cases, samples were collected within a few feet of the target coordinates. However, during the first quarterly sampling event (May 2007), it was determined that the target location for location F-4 was on a slope adjacent to the dredged channel. The slope of the shelf prevented the Van Veen grab sampler from obtaining a sample. Thus, the location was moved out beyond the sloped area to the nearest point up slope on the shoal where a sample could be collected. Additionally, all the planned Transect C locations were adjusted in the May 2007 event. These locations were selected to represent conditions adjacent to the 14th Street outfall. When the target locations were reached in the field, Transect C was found to be approximately 50-100 feet south of the outfall. Thus, the transect was shifted as close to the outfall as was feasible. The locations sampled in the May 2007 field event were revisited during subsequent sampling events with no further adjustments.

4.4.2 Surface Water Sample Numbers

The number of surface water samples collected and analyzed was reduced from the number described in the Work Plan. The reduction in sample number was due to the fact that the depth of overlying surface water in Transects A, B, C, and I was generally 10 feet or less, and the water quality profiles indicated that no significant stratification was present. Therefore, at locations of depths less than 10 feet, only surface and bottom samples were collected. For stations where the depth was 5 feet or less, only one mid-depth sample was collected.

4.4.3 Pore Water Collection and Extraction

In the May 2007 and August 2007 sampling events, collection of sufficient pore water volume from some of the A transect locations using Lexan® tubes was difficult or impossible due to the sandy nature of the sediment. Insufficient pore water volume was generated and not all of the specified analyses could be performed. Therefore, additional sediment for pore water extraction was collected from these locations using 1-L, pre-cleaned, wide-mouth glass jars during the December 2007 and February 2008 sampling events, as described in Section 4.1.2.

While not specifically addressed within the Work Plan, an important modification to the planned laboratory protocol for pore water extraction was made. The original plan for extracting pore water samples was to collect the samples within Lexan® tubes that were specifically cut to a size that would fit the centrifuge at the laboratory. Pre-investigation trials were conducted to assess the integrity of the Lexan® within the centrifuge, and the ability of the caps and pipe tape to prevent leakage. Clean sediments were placed within the Lexan® tubes during test runs, and the results suggested that this process could effectively be used for this investigation. However, after the first day of sample collection, the Lexan® tubes placed in the centrifuge did not behave the same as those from the trial runs.

Therefore, the procedure was modified so that sediment was removed from the Lexan® tubes within a nitrogen-purged anaerobic glove box and placed within centrifuge tubes. The samples were then centrifuged to separate pore water and sediment, and extract the pore water for chemical and geochemical analysis. The integrity of each pore water sample was ensured through decontamination of Lexan® tubes and collection of equipment blanks identified in the Work Plan for other sampling equipment. Centrifugation vials and associated equipment were maintained with under laboratory seal until used, or decontaminated if used more than once.

4.4.4 Subsurface Sediment Collection

Subsurface sediment sampling was performed as part of the second quarterly sampling event (August 2007) rather than the third as specified in the Work Plan to more rapidly provide information on subsurface conditions. Additionally, the Work Plan specified the collection of subsurface samples from the intervals of 0.5–1.5 feet and 1.5–3.0 feet from every station. Instead, subsurface sediment samples were collected from two 6-inch subsurface intervals. This approach was adopted because several different sediment types were observed in many of the cores. Different sediment types may represent different times of deposition, and/or different depositional environments. In addition, the grain size distribution and total organic carbon (TOC) content influence the concentration of metals in sediment. Therefore, the sampling approach was modified to ensure that each subsurface sediment sample represented a single lithologic unit and uniform sediment type to facilitate data interpretation.

4.4.5 Addition and Deletion of Sampling Locations and Analytes

Locations E3, F1, F3, G1, G3, H2, and H3 were not sampled in December 2007 and February 2008 because the May 2007 and August 2007 field investigations indicated that they are farther from stormwater outfalls, show no evidence of potential groundwater upwelling, and have relatively low concentrations of total chromium in sediment. Additionally, the analysis of selected geochemical parameters (ammonia, sulfides, and Mn(II)) was omitted from the last two sampling events because other geochemical parameters (Fe(II), ORP, TOC, dissolved organic carbon (DOC), and pH) provided more consistent and useful information regarding geochemical conditions.

During the February 2008 sampling event, four additional sampling locations (Transect J) were added along the periphery of Area 1501/1602 (southeast of DMT) to support the Chromium Transport Study. In addition, one sampling location was added along Transect B. Surficial sediment, subsurface sediment, surface water, and pore water samples were collected from the new locations, and samples were analyzed for the same parameters as the rest of the fourth quarterly samples, including additional COPR-related constituents (aluminum, calcium, iron, magnesium, manganese, and vanadium).

TABLE 4-1

Summary of Field Investigation Dates and Activities Performed

Dundalk Marine Terminal, Baltimore, Maryland

Survey	Dates	Groundwater Upwelling Survey	Hydrographic/ Geophysical Survey	Pore Water Sampling	Surface Water Sampling	Surficial Sediment Sampling	Subsurface Sediment Sampling
December 2006	12/08/06 - 12/11/06	X					
December 2006	12/13/06 - 12/20/06		X				
May 2007	05/08/07 - 05/18/07			X	X	X	
August 2007	08/07/07 - 08/22/07			X	X	X	X
October-November 2007	10/29/07 - 11/02/07	X					
December 2007	12/05/07 - 12/12/07			X [1]	X [1]		
February 2008	02/19/08 - 02/29/08			X [1]	X [1]	X [2]	X [2]

[1] Subset of locations sampled

[2] New sampling locations only

TABLE 4-2

Climatological Data

Dundalk Marine Terminal, Baltimore, Maryland

DATE	MEAN TEMP (°F)	HIGH TEMP (°F)	TIME	LOW TEMP (°F)	TIME	HEAT DEG DAYS	COOL DEG DAYS	TOTAL RAIN (inches)	AVG WIND SPEED (mph)	HIGH SPEED (mph)	TIME	DOM DIR
May 2007												
5/7/2007	55.8	65.9	6:00 PM	45.2	6:00 AM	9.2	0.0	0.00	6.8	21.0	12:00 PM	ENE
5/8/2007	59.5	70.9	8:00 PM	46.5	7:00 AM	6.7	1.2	0.00	5.0	14.0	3:00 PM	SE
5/9/2007	66.3	75.8	7:00 PM	59.8	6:00 AM	1.4	2.7	0.00	5.5	19.0	8:00 PM	SSE
5/10/2007	69.8	75.1	5:00 PM	66.6	2:00 AM	0.0	4.8	0.00	9.6	25.0	3:00 PM	SE
5/11/2007	72.9	84.1	6:00 PM	66.0	8:00 AM	0.0	7.9	0.00	6.0	18.0	5:00 PM	S
5/12/2007	70.6	77.9	2:00 PM	60.1	11:00 PM	0.6	6.1	0.72	6.0	29.0	9:00 PM	E
5/13/2007	63.4	71.3	7:00 PM	54.7	8:00 AM	3.0	1.4	0.03	9.6	26.0	8:00 AM	NNW
5/14/2007	61.5	67.4	7:00 PM	51.8	7:00 AM	4.2	0.7	0.00	8.0	21.0	10:00 PM	SE
5/15/2007	71.2	80.5	6:00 PM	61.7	6:00 AM	0.7	6.9	0.00	13.5	28.0	7:00 PM	SSW
5/16/2007	72.2	79.8	5:00 PM	64.8	12:00 M[a]	0.0	7.2	0.61	13.6	31.0	3:00 PM	SW
5/17/2007	64.3	69.7	2:00 PM	59.2	12:00 M[a]	1.6	0.9	0.00	6.2	19.0	11:00 AM	NW
5/18/2007	58.4	63.4	7:00 PM	55.4	9:00 AM	6.6	0.0	0.00	6.6	21.0	8:00 AM	NNE
August 2007												
8/6/2007	80.8	87.9	5:00 PM	73.8	3:00 AM	0.0	15.8	0.15	5.6	20.0	2:00 AM	SE
8/7/2007	85.6	90.4	1:00 PM	79.7	6:00 AM	0.0	20.6	0.00	5.2	18.0	3:00 PM	SE
8/8/2007	90.6	99.8	5:00 PM	82.5	5:00 AM	0.0	25.6	0.00	10.0	26.0	3:00 PM	W
8/9/2007	82.6	88.8	12:00 PM	75.6	2:00 PM	0.0	17.6	0.24	5.2	33.0	1:00 PM	ENE
8/10/2007	81.4	91.0	4:00 PM	68.8	12:00 M[a]	0.0	16.4	0.00	6.8	26.0	8:00 PM	W
8/11/2007	73.0	81.8	6:00 PM	62.3	6:00 AM	0.3	8.3	0.00	5.5	18.0	4:00 PM	N
8/12/2007	80.1	85.7	5:00 PM	71.9	7:00 AM	0.0	15.1	0.00	6.7	21.0	4:00 PM	SSE
8/13/2007	83.1	91.5	5:00 PM	75.9	4:00 AM	0.0	18.1	0.00	7.0	26.0	2:00 PM	NW
8/14/2007	78.9	86.4	4:00 PM	70.2	7:00 AM	0.0	13.9	0.00	4.7	24.0	3:00 PM	NNW
8/15/2007	80.4	88.3	2:00 PM	70.9	5:00 AM	0.0	15.4	0.00	6.3	18.0	6:00 AM	SW
8/16/2007	81.1	87.8	5:00 PM	73.9	11:00 AM	0.0	16.1	0.15	5.3	31.0	10:00 AM	SW
8/17/2007	84.4	93.3	5:00 PM	76.4	7:00 AM	0.0	19.4	0.00	8.5	27.0	10:00 PM	SW
8/18/2007	75.1	81.4	1:00 AM	70.0	9:00 AM	0.0	10.1	0.00	6.0	24.0	1:00 AM	W
8/19/2007	70.8	74.2	3:00 AM	65.6	12:00 M[a]	0.0	5.8	0.12	5.4	16.0	3:00 AM	NNE
8/20/2007	66.1	70.5	4:00 PM	62.4	3:00 AM	0.7	1.8	0.81	4.7	19.0	7:00 PM	NNE
8/21/2007	65.3	67.8	5:00 AM	63.2	1:00 PM	0.3	0.7	0.38	6.3	18.0	1:00 PM	NNE
8/22/2007	65.8	69.9	4:00 PM	61.3	7:00 AM	1.1	1.9	0.03	4.3	14.0	8:00 AM	NNE
December 2007												
12/4/2007	34.9	38.1	2:00 PM	31.0	12:00 M[a]	30.1	0.0	0.0	15.0	40.0	11:00 AM	W
12/5/2007	29.8	31.7	8:00 AM	27.4	12:00 M[a]	35.2	0.0	0.00	4.3	20.0	2:00 AM	W
12/6/2007	28.1	33.7	4:00 PM	22.3	8:00 AM	36.9	0.0	0.12	3.8	17.0	6:00 AM	NW
12/7/2007	32.9	36.1	12:00 PM[*]	23.5	5:00 AM	32.1	0.0	0.07	4.5	15.0	1:00 PM	SSW
12/8/2007	39.4	46.2	2:00 PM	35.8	5:00 AM	25.6	0.0	0.20	1.3	10.0	4:00 PM	S
12/9/2007	38.5	40.6	3:00 AM	36.6	2:00 PM	26.5	0.0	0.12	2.7	19.0	11:00 PM	NE
12/10/2007	43.5	47.1	4:00 PM	39.6	1:00 AM	21.5	0.0	0.08	1.5	11.0	2:00 PM	NNW
12/11/2007	44.2	49.2	12:00 PM[a]	42.4	8:00 AM	20.8	0.0	0.00	3.5	13.0	3:00 PM	NNE
12/12/2007	50.6	57.5	1:00 PM	42.5	12:00 M[a]	14.4	0.0	0.00	5.1	22.0	10:00 AM	NNW
February 2008												
2/18/2008	30.4	65.6	1:00 PM	-90.0[b]	12:00 PM	34.6	0.0	0.20	1.0	25.0	8:00 PM	SSE
2/19/2008	39.1	45.0	4:00 PM	30.3	12:00 M[a]	25.9	0.0	0.00	9.8	33.0	6:00 PM	WSW
2/20/2008	28.6	31.9	1:00 PM	26.3	12:00 M[a]	36.4	0.0	0.01	4.4	19.0	9:00 PM	NNW
2/21/2008	26.3	31.3	12:00 M*	19.4	8:00 AM	38.8	0.0	0.00	6.7	23.0	12:00 M*	NW
2/22/2008	31.4	34.9	11:00 PM	27.6	6:00 AM	33.6	0.0	0.08	3.9	23.0	1:00 AM	SE
2/23/2008	34.5	36.1	4:00 PM	32.9	11:00 PM	30.5	0.0	0.05	3.0	14.0	5:00 PM	N
2/24/2008	35.0	41.5	3:00 PM	28.5	7:00 AM	30.0	0.0	0.00	4.1	18.0	2:00 AM	NW
2/25/2008	41.0	48.8	5:00 PM	36.3	6:00 AM	24.0	0.0	0.00	3.0	13.0	11:00 AM	W
2/26/2008	43.9	48.2	5:00 PM	38.8	1:00 AM	21.1	0.0	0.14	5.1	31.0	2:00 PM	W
2/27/2008	36.5	45.6	1:00 AM	26.7	12:00 M[a]	28.5	0.0	0.00	13.1	31.0	1:00 AM	W
2/28/2008	26.8	33.0	5:00 PM	20.9	7:00 AM	38.2	0.0	0.00	10.0	29.0	1:00 AM	W
2/29/2008	33.0	41.5	9:00 PM	23.5	5:00 AM	32.0	0.0	0.00	8.8	28.0	4:00 PM	SSE

NAME: MES Station CITY: Baltimore STATE: Maryland

ELEV: 25 ft LAT: 39° 14' 32" N LONG: 76° 31' 20" W

[a] Not clear from original records whether the data were recorded at pm or am.

[b] This is the low temperature reported by MES; however, it is not correct.

mph miles per hour

DOM DIR Dominant wind direction.

TABLE 4-3

Water Quality Characteristics

Dundalk Marine Terminal, Baltimore, Maryland

May 2007 - February 2008										
		Temperature	Turbidity	pH	Oxygen	Saturation	Depth	(density)	Salinity	Conductance
		°C	NTU	SU	mg/L	%	ft	kg/m^3	PSU	uS/cm
A Transect	Average	15.9	10.6	8.11	7.83	76	3	1,005.11	8.6	14,859
	Min	2.5	5.8	7.23	1.44	18	1	1,002.07	4.8	8,577
	Max	24.2	25.9	8.93	15.62	131	5	1,010.14	12.9	22,266
B Transect	Average	13.4	12.2	8.08	8.94	84	5	1,006.09	9.4	16,272
	Min	3.4	2.4	7.19	2.31	30	1	1,001.87	4.2	7,933
	Max	26.3	39.1	8.61	13.06	109	10	1,010.73	13.6	23,439
C Transect	Average	15.5	11.8	8.25	8.90	86	5	1,005.10	8.5	14,807
	Min	3.8	7.6	7.27	1.99	26	1	1,001.79	4.1	7,701
	Max	25.7	26.5	8.93	13.82	128	10	1,010.67	13.7	23,358
D Transect	Average	14.0	8.8	7.89	7.56	74	20	1,007.43	11.2	19,160
	Min	3.4	4.3	6.86	0.08	1	1	1,000.53	3.6	6,655
	Max	28.0	21.2	8.96	14.23	145	42	1,012.17	16.3	26,590
E Transect	Average	15.2	9.5	7.93	7.09	71	20	1,007.03	10.9	18,656
	Min	3.1	3.9	6.92	0.09	1	1	1,000.19	3.1	5,654
	Max	28.1	27.5	9.01	14.06	145	45	1,012.34	16.3	26,828
F Transect	Average	16.1	9.2	7.94	6.92	72	19	1,007.12	11.2	19,125
	Min	3.0	4.9	6.89	0.61	6	1	1,001.70	4.6	8,294
	Max	28.4	19.2	9.07	14.77	176	44	1,012.49	16.2	27,103
G Transect	Average	16.1	8.3	7.92	7.40	77	20	1,006.69	10.6	18,190
	Min	3.4	4.0	6.94	0.11	1	1	1,000.40	3.1	5,705
	Max	28.2	23.5	9.02	14.27	156	43	1,012.19	16.0	26,530
H Transect	Average	16.1	8.2	7.87	6.25	63	19	1,006.97	11.0	18,777
	Min	3.2	4.2	6.95	0.08	1	1	1,001.37	3.8	6,960
	Max	28.1	20.4	8.81	12.54	132	41	1,011.62	15.6	25,557
I Transect	Average	17.3	8.7	8.25	8.79	90	5	1,004.99	8.7	15,123
	Min	4.5	4.3	7.38	2.35	32	0	1,001.20	3.9	7,071
	Max	27.2	35.8	8.98	13.38	151	11	1,010.90	14.1	23,907
J Transect	Average	4.9	8.7	7.48	10.50	87	2	1,007.16	9.1	16,155
	Min	4.0	3.5	7.29	7.61	66	1	1,006.36	8.2	14,547
	Max	7.1	10.3	8.18	11.36	100	5	1,007.31	9.3	16,437
37 Reference	Average	14.1	7.9	7.93	7.75	75	19	1,007.20	10.9	18,755
	Min	3.6	4.7	6.96	0.09	1	1	1,002.30	5.2	9,366
	Max	27.3	13.6	8.82	14.98	125	38	1,011.48	16.0	26,196
37a Reference	Average	14.3	8.6	7.96	8.28	83	18	1,007.17	10.9	18,766
	Min	3.1	4.9	6.95	1.85	19	1	1,002.18	5.2	9,306
	Max	27.3	14.3	8.93	14.26	123	37	1,011.35	15.0	24,784
37b Reference	Average	14.0	8.6	7.95	8.18	81	19	1,007.38	11.1	19,140
	Min	2.8	5.2	6.93	0.13	2	1	1,002.30	5.3	9,460
	Max	27.4	14.9	8.76	14.07	119	37	1,011.45	16.0	26,235
DMT Overall	Average	15.4	9.1	7.95	7.33	73	17	1,006.81	10.7	18,262
	Min	2.5	2.4	6.86	0.08	1	0	1,000.19	3.1	5,654
	Max	28.4	39.1	9.07	15.62	176	45	1,012.49	16.3	27,103
Reference Overall	Average	14.2	8.4	7.95	8.07	80	19	1,007.25	11.0	18,886
	Min	2.8	4.7	6.93	0.09	1	1	1,002.18	5.2	9,306
	Max	27.4	14.9	8.93	14.98	125	38	1,011.48	16.0	26,235

TABLE 4-3

Water Quality Characteristics

Dundalk Marine Terminal, Baltimore, Maryland

Quarter 1 (May 2007)										
		Temperature °C	Turbidity NTU	pH SU	Oxygen mg/L	Saturation %	Depth ft	(density) kg/m³	Salinity PSU	Conductance uS/cm
A Transect	Average	19.5	14.8	8.54	8.68	97	3	1,002.23	5.2	9,226
	Min	18.6	8.9	8.37	7.59	86	1	1,002.07	4.8	8,577
	Max	20.6	25.9	8.71	10.02	111	5	1,003.33	6.9	12,118
B Transect	Average	19.2	17.6	8.38	8.82	99	5	1,002.47	5.4	9,590
	Min	18.3	9.3	8.21	7.56	84	1	1,001.87	4.7	8,387
	Max	20.4	39.1	8.61	9.52	109	9	1,003.10	6.1	10,752
C Transect	Average	19.8	8.8	8.90	10.69	121	5	1,001.85	4.7	8,513
	Min	19.4	7.9	8.87	8.51	95	1	1,001.79	4.7	8,486
	Max	20.1	11.2	8.93	11.33	128	10	1,001.95	4.7	8,543
D Transect	Average	16.3	9.0	7.79	6.25	69	20	1,005.36	8.4	14,565
	Min	11.3	5.6	6.86	0.63	6	1	1,000.53	3.6	6,655
	Max	22.0	14.4	8.96	12.46	145	42	1,010.70	14.3	23,960
E Transect	Average	16.6	8.7	7.99	6.75	75	20	1,005.06	8.1	14,070
	Min	10.9	3.9	6.92	0.32	3	1	1,000.19	3.1	5,654
	Max	21.6	17.1	9.01	12.65	145	45	1,011.28	14.9	25,014
F Transect	Average	16.0	8.3	7.79	5.81	64	19	1,005.63	8.7	15,024
	Min	11.5	4.9	6.89	0.61	6	1	1,001.70	4.6	8,294
	Max	20.0	14.8	8.94	12.11	137	44	1,010.52	14.1	23,626
G Transect	Average	15.9	7.6	7.89	7.15	78	21	1,005.05	7.9	13,755
	Min	11.1	4.0	6.94	0.98	10	1	1,000.40	3.1	5,705
	Max	21.7	11.0	9.02	13.08	152	43	1,011.09	14.7	24,693
H Transect	Average	14.7	7.3	7.90	6.66	71	19	1,005.41	8.1	14,094
	Min	10.9	4.6	6.95	1.20	12	1	1,001.37	3.8	6,960
	Max	18.8	9.9	8.81	12.07	132	41	1,011.16	14.8	24,783
I Transect	Average	27.0	5.9	8.23	3.23	43	5	1,005.18	11.6	19,505
	Min	26.8	4.3	8.20	2.35	32	1	1,004.97	11.4	19,152
	Max	27.2	10.8	8.31	4.68	63	11	1,005.30	11.7	19,711
J Transect	Average	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Min	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Max	NA	NA	NA	NA	NA	NA	NA	NA	NA
37 Reference	Average	27.0	6.6	8.19	3.22	43	19	1,006.39	13.2	21,917
	Min	26.3	4.7	7.68	0.09	1	1	1,005.19	11.7	19,698
	Max	27.3	10.4	8.64	6.04	82	37	1,008.73	16.0	26,196
37a Reference	Average	27.1	6.7	8.26	5.65	76	19	1,005.58	12.1	20,316
	Min	26.3	4.9	7.67	2.88	39	1	1,005.21	11.7	19,694
	Max	27.3	9.5	8.65	7.40	100	37	1,007.96	15.0	24,658
37b Reference	Average	27.1	7.1	8.26	4.92	67	19	1,006.22	13.0	21,625
	Min	26.2	5.2	7.68	0.13	2	1	1,005.14	11.7	19,670
	Max	27.4	11.8	8.69	8.22	111	37	1,008.74	16.0	26,235
DMT Overall	Average	16.7	8.6	7.96	6.68	73	18	1,005.00	8.1	14,017
	Min	10.9	3.9	6.86	0.32	3	1	1,000.19	3.1	5,654
	Max	27.2	39.1	9.02	13.08	152	45	1,011.28	14.9	25,014
Reference Overall	Average	27.1	6.8	8.24	4.60	62	19	1,006.06	12.8	21,286
	Min	26.2	4.7	7.67	0.09	1	1	1,005.14	11.7	19,670
	Max	27.4	11.8	8.69	8.22	111	37	1,008.74	16.0	26,235

TABLE 4-3

Water Quality Characteristics

Dundalk Marine Terminal, Baltimore, Maryland

Quarter 2 (August 2007)										
		Temperature °C	Turbidity NTU	pH SU	Oxygen mg/L	Saturation %	Depth ft	(density) kg/m³	Salinity PSU	Conductance uS/cm
A Transect	Average	24.0	7.9	7.82	1.97	25	3	1,006.93	12.8	21,401
	Min	23.9	6.9	7.75	1.44	18	1	1,006.88	12.8	21,320
	Max	24.2	8.7	7.92	2.85	37	5	1,006.98	12.9	21,520
B Transect	Average	25.8	13.3	8.32	3.21	42	5	1,006.03	12.3	20,528
	Min	25.5	9.6	8.06	2.31	30	1	1,005.77	12.1	20,222
	Max	26.3	24.3	8.49	4.21	55	10	1,006.14	12.4	20,773
C Transect	Average	25.3	15.4	8.08	2.77	36	5	1,006.43	12.6	21,049
	Min	25.1	10.7	7.97	1.99	26	1	1,006.24	12.5	20,857
	Max	25.7	26.5	8.15	3.31	44	10	1,006.53	12.7	21,207
D Transect	Average	27.2	9.8	8.21	3.86	52	19	1,006.30	13.1	21,841
	Min	26.1	4.3	7.65	0.08	1	1	1,004.78	11.4	19,233
	Max	28.0	21.2	8.87	8.74	119	41	1,008.96	16.3	26,590
E Transect	Average	26.9	10.6	8.16	3.36	45	20	1,006.57	13.4	22,232
	Min	25.9	4.0	7.64	0.09	1	1	1,004.71	11.4	19,212
	Max	28.1	27.5	8.90	7.40	100	42	1,009.02	16.3	26,679
F Transect	Average	26.7	9.3	8.39	5.30	71	16	1,006.05	12.6	21,035
	Min	26.3	5.4	7.78	2.74	37	1	1,004.71	11.5	19,350
	Max	28.4	19.2	9.07	12.89	176	37	1,007.47	14.4	23,746
G Transect	Average	26.9	9.3	8.15	4.76	64	19	1,006.22	12.9	21,524
	Min	26.2	4.1	7.62	0.11	1	1	1,004.74	11.3	19,085
	Max	28.2	23.5	9.00	11.37	156	42	1,008.72	16.0	26,151
H Transect	Average	27.2	8.5	8.03	2.41	33	19	1,006.29	13.1	21,807
	Min	26.3	4.2	7.69	0.08	1	1	1,004.92	11.6	19,581
	Max	28.1	20.4	8.59	6.61	90	39	1,008.39	15.6	25,557
I Transect	Average	27.0	5.9	8.23	3.23	43	5	1,005.18	11.6	19,505
	Min	26.8	4.3	8.20	2.35	32	1	1,004.97	11.4	19,152
	Max	27.2	10.8	8.31	4.68	63	11	1,005.30	11.7	19,711
J Transect	Average	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Min	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Max	NA	NA	NA	NA	NA	NA	NA	NA	NA
37 Reference	Average	27.0	6.6	8.19	3.22	43	19	1,006.39	13.2	21,917
	Min	26.3	4.7	7.68	0.09	1	1	1,005.19	11.7	19,698
	Max	27.3	10.4	8.64	6.04	82	37	1,008.73	16.0	26,196
37a Reference	Average	27.1	6.7	8.26	5.65	76	19	1,005.58	12.1	20,316
	Min	26.3	4.9	7.67	2.88	39	1	1,005.21	11.7	19,694
	Max	27.3	9.5	8.65	7.40	100	37	1,007.96	15.0	24,658
37b Reference	Average	27.1	7.1	8.26	4.92	67	19	1,006.22	13.0	21,625
	Min	26.2	5.2	7.68	0.13	2	1	1,005.14	11.7	19,670
	Max	27.4	11.8	8.69	8.22	111	37	1,008.74	16.0	26,235
DMT Overall	Average	26.8	9.7	8.18	3.75	51	17	1,006.25	12.9	21,521
	Min	23.9	4.0	7.62	0.08	1	1	1,004.71	11.3	19,085
	Max	28.4	27.5	9.07	12.89	176	42	1,009.02	16.3	26,679
Reference Overall	Average	27.1	6.8	8.24	4.60	62	19	1,006.06	12.8	21,286
	Min	26.2	4.7	7.67	0.09	1	1	1,005.14	11.7	19,670
	Max	27.4	11.8	8.69	8.22	111	37	1,008.74	16.0	26,235

TABLE 4-3

Water Quality Characteristics

Dundalk Marine Terminal, Baltimore, Maryland

Quarter 3 (December 2007)										
		Temperature °C	Turbidity NTU	pH SU	Oxygen mg/L	Saturation %	Depth ft	(density) kg/m³	Salinity PSU	Conductance uS/cm
A Transect	Average	5.4	11.6	8.71	13.94	116	2	1,006.48	8.2	14,679
	Min	5.2	8.2	8.32	9.94	85	1	1,005.77	7.3	13,222
	Max	5.7	20.8	8.93	15.62	131	3	1,010.14	12.8	22,266
B Transect	Average	6.0	8.3	8.43	11.47	101	4	1,010.65	13.5	23,289
	Min	5.6	7.7	8.31	10.71	93	1	1,010.39	13.2	22,788
	Max	6.4	10.3	8.54	12.30	108	9	1,010.73	13.6	23,439
C Transect	Average	5.9	8.7	8.55	12.79	109	4	1,007.83	10.0	17,508
	Min	5.3	7.6	8.43	10.86	96	1	1,005.57	7.1	12,786
	Max	7.9	9.8	8.65	13.82	115	8	1,010.67	13.7	23,358
D Transect	Average	7.1	8.7	8.25	10.67	96	19	1,010.21	13.1	22,420
	Min	4.6	5.8	8.00	8.25	80	1	1,005.86	7.4	13,388
	Max	9.3	14.1	8.75	14.23	118	39	1,012.17	15.8	26,479
E Transect	Average	7.5	8.8	8.21	10.43	95	19	1,010.54	13.6	23,130
	Min	4.8	6.3	7.91	7.27	71	1	1,007.40	9.3	16,627
	Max	9.6	13.4	8.64	14.06	117	41	1,012.34	16.0	26,828
F Transect	Average	7.2	8.5	8.25	10.69	95	19	1,009.85	12.6	21,694
	Min	4.9	6.1	7.92	7.72	74	1	1,005.93	7.5	13,531
	Max	9.0	11.7	8.80	14.77	122	43	1,012.49	16.2	27,103
G Transect	Average	7.4	8.9	8.20	10.41	93	19	1,009.81	12.6	21,619
	Min	5.6	7.5	7.90	7.49	72	1	1,005.28	6.7	12,176
	Max	9.1	10.9	8.72	14.27	119	39	1,012.19	15.8	26,530
H Transect	Average	8.3	10.4	8.07	9.09	85	18	1,010.89	14.1	23,903
	Min	6.9	9.5	7.97	8.33	80	1	1,009.52	12.3	21,130
	Max	9.3	11.3	8.22	9.96	91	37	1,011.62	15.1	25,430
I Transect	Average	7.9	9.5	8.17	9.70	89	3	954.48	13.6	23,231
	Min	7.5	7.8	8.11	9.43	82	0	1.00	12.7	21,732
	Max	8.2	10.6	8.22	10.02	92	6	1,010.90	14.1	23,907
J Transect	Average	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Min	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Max	NA	NA	NA	NA	NA	NA	NA	NA	NA
37 Reference	Average	6.6	8.6	8.36	11.72	103	18	1,009.47	12.1	20,881
	Min	4.9	6.4	8.04	8.95	84	1	1,006.09	7.7	13,882
	Max	8.4	11.9	8.82	14.98	125	34	1,011.48	14.8	25,041
37a Reference	Average	7.0	8.8	8.27	11.01	98	17	1,009.70	12.4	21,387
	Min	5.5	7.7	8.03	8.59	81	1	1,006.68	8.5	15,123
	Max	8.4	11.6	8.80	14.26	120	33	1,011.35	14.7	24,784
37b Reference	Average	6.6	8.7	8.33	11.58	102	18	1,009.55	12.2	21,052
	Min	5.0	6.4	8.03	8.85	83	1	1,006.37	8.1	14,464
	Max	8.5	11.2	8.67	14.07	117	34	1,011.45	14.8	25,002
DMT Overall	Average	7.3	9.0	8.24	10.54	95	16	1,008.13	13.0	22,268
	Min	4.6	5.8	7.90	7.27	71	0	1.00	6.7	12,176
	Max	9.6	20.8	8.93	15.62	131	43	1,012.49	16.2	27,103
Reference Overall	Average	6.8	8.7	8.32	11.44	101	17	1,009.57	12.2	21,104
	Min	4.9	6.4	8.03	8.59	81	1	1,006.09	7.7	13,882
	Max	8.5	11.9	8.82	14.98	125	34	1,011.48	14.8	25,041

TABLE 4-3

Water Quality Characteristics

Dundalk Marine Terminal, Baltimore, Maryland

Quarter 4 (February 2008)										
		Temperature °C	Turbidity NTU	pH SU	Oxygen mg/L	Saturation %	Depth ft	(density) kg/m³	Salinity PSU	Conductance uS/cm
A Transect	Average	3.32	6.32	7.31	11.37	90.14	2.91	1006.62	8.31	15037.72
	Min	2.48	5.80	7.23	10.85	86.94	2.00	1006.28	7.87	14385.09
	Max	4.19	6.97	7.39	11.79	95.60	4.00	1006.84	8.58	15469.69
B Transect	Average	4.07	9.95	7.35	11.95	95.66	5.26	1005.37	6.75	12303.36
	Min	3.43	2.36	7.19	10.25	83.48	1.00	1003.34	4.21	7932.62
	Max	4.57	12.79	7.45	13.06	104.06	10.00	1007.35	9.23	16547.41
C Transect	Average	9.24	13.68	7.56	10.27	84.73	5.14	1004.63	6.92	12281.82
	Min	3.83	9.47	7.27	1.99	26.05	2.00	1003.24	4.07	7700.96
	Max	25.65	26.48	8.10	12.97	103.16	10.00	1006.50	12.69	21187.58
D Transect	Average	5.12	7.91	7.33	9.56	78.35	20.12	1008.01	10.25	18055.57
	Min	3.40	4.30	6.86	0.08	1.09	1.00	1004.31	5.42	10064.25
	Max	26.38	16.76	8.50	13.16	105.10	42.00	1011.16	15.73	25798.11
E Transect	Average	4.00	9.90	7.23	9.72	78.90	20.31	1007.76	9.74	17318.99
	Min	3.13	7.90	6.92	6.11	51.90	1.00	1004.53	5.69	10554.60
	Max	4.90	12.91	7.77	12.64	98.97	44.00	1010.23	12.85	22318.70
F Transect	Average	4.18	11.59	7.15	9.33	76.41	19.69	1009.11	11.50	20230.95
	Min	3.05	8.34	6.93	0.70	9.47	2.00	1007.16	8.98	16190.69
	Max	26.29	17.40	7.67	11.90	94.13	44.00	1010.71	15.27	25096.34
G Transect	Average	3.96	7.37	7.20	10.05	81.81	18.84	1007.98	10.01	17790.47
	Min	3.40	6.00	6.95	7.49	63.06	2.00	1006.08	7.63	13881.96
	Max	4.75	8.65	7.43	11.92	94.40	38.00	1009.85	12.36	21567.71
H Transect	Average	4.58	7.09	7.29	10.24	83.88	19.05	1007.68	9.72	17254.92
	Min	3.22	5.16	7.03	0.09	1.15	1.00	1005.18	6.56	11941.19
	Max	26.41	10.46	7.71	12.54	102.64	39.00	1010.48	15.12	24877.13
I Transect	Average	4.94	9.84	7.48	11.88	97.13	3.91	1005.44	6.87	12480.71
	Min	4.48	7.73	7.38	11.60	94.49	1.00	1004.88	6.17	11291.01
	Max	5.52	13.12	7.60	12.19	100.95	8.00	1005.84	7.35	13326.34
J Transect	Average	4.94	8.67	7.48	10.50	86.94	2.30	1007.16	9.06	16155.04
	Min	3.98	3.48	7.29	7.61	65.74	1.00	1006.36	8.19	14547.38
	Max	7.06	10.25	8.18	11.36	99.75	5.00	1007.31	9.27	16436.51
37 Reference	Average	4.17	8.45	7.13	9.53	78.30	19.00	1008.67	10.89	19207.77
	Min	3.63	5.92	6.96	7.02	59.65	2.00	1006.86	8.65	15508.51
	Max	4.65	13.59	7.31	11.80	95.71	36.00	1010.99	13.80	23887.26
37a Reference	Average	3.98	11.40	7.04	9.40	77.32	18.50	1009.23	11.59	20381.09
	Min	3.11	8.64	6.95	7.52	63.34	2.00	1007.54	9.46	16985.47
	Max	4.46	14.32	7.20	11.03	87.86	35.00	1010.43	13.09	22762.85
37b Reference	Average	3.97	11.01	7.08	9.25	75.96	19.00	1009.20	11.55	20321.91
	Min	2.81	8.80	6.93	7.24	60.85	2.00	1007.15	8.96	16188.57
	Max	4.51	14.94	7.29	11.60	91.23	36.00	1010.42	13.09	22760.80
DMT Overall	Average	4.68	9.04	7.29	10.06	82.09	16.64	1007.54	9.59	17022.94
	Min	2.48	2.36	6.86	0.08	1.09	1.00	1003.24	4.07	7700.96
	Max	26.41	26.48	8.50	13.16	105.10	44.00	1011.16	15.73	25798.11
Reference Overall	Average	4.04	10.28	7.09	9.39	77.19	18.84	1009.03	11.34	19966.30
	Min	2.81	5.92	6.93	7.02	59.65	2.00	1006.86	8.65	15508.51
	Max	4.65	14.94	7.31	11.80	95.71	36.00	1010.99	13.80	23887.26

°C	Degrees Celsius
ft	Feet
kg/m³	Kilograms per cubic meter
max	Maximum
mg/L	Milligrams per Liter
min	Minimum
NA	Not Analyzed
NTU	Nephelometric Turbidity Units
PSU	Practical Salinity Units
SU	Standard Units
uS/cm	Microsiemens per Centimeter
%	Percent

TABLE 4-4

Analytical Parameters for Pore Water, Surface Water, and Sediment Samples

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Method	Pore Water	Surface Water	Sediment
Total Cr	SW6010	X	X	X
Dissolved Total Cr	SW6010	X	X	--
Cr(VI)	SW7199	X	X	--
Al, Ca, Fe, Mg, Mn, V	SW6010	X	X	X
Dissolved Al, Ca, Fe, Mg, Mn, V	SW6010	X	X	
Fe(II)	SM20-3500-FeB	X	X	X
Mn(II)	SW7199-Mn	X	X	X
TOC	Lloyd Kahn	--	--	X
TOC	SM20-5310-C	--	X	--
DOC	SM20-5310-C	X	X	--
Sulfide	SM20-4500-S2D	X	--	--
Sulfide	SW-9030	--	--	X
Ammonia	SM20-4500-NH3D	X	--	--
Hardness	SM20-2340-C	X	X	--
pH	SM20-4500-HB	X	field	field
ORP	ASTM 1498	X	--	field
Grain size	ASTM D422	--	--	X
Total Solids	E160.3	--	--	X
Moisture content	SM20-2540-G	--	--	X
AVS/SEM	Draft EPA AVS/SEM	--	--	X
SEM-Cd, Cu, Fe, Pb, Ni, Zn	SW6010	--	--	X
SEM-Hg	SW7471	--	--	X

Cr – Chromium

Cr(VI) - Hexavalent chromium

Al, Ca, Fe, Mg, Mn, V - aluminum, calcium, iron, magnesium, manganese, vanadium

Fe(II) - ferrous iron

Mn(II) - divalent manganese

TOC - total organic carbon

DOC - dissolved organic carbon

ORP - oxidation reduction potential

AVS/SEM - acid volatile sulfides/simultaneously extracted metals

Cd, Cu, Fe, Pb, Ni, Zn - cadmium, copper, iron, lead, nickel, zinc

Hg - mercury

TABLE 4-5a

Summary of Surface Water Sample Collection and Analysis

Dundalk Marine Terminal, Baltimore, Maryland

Transect Location	Sample Depth	Total Cr	Cr(VI)	Dissolved Total Cr	Total and Dissolved COPR Metals	Fe(II)	Mn(II) modified	TOC	Hardness	DOC
DMT Locations										
A1	Surface	A, F	A, F	A, F	A, F	--	--	A, F	--	A, F
	Mid-depth	M,D	M,D	M,D	M,D	M,D	M	M,D	D	M,D
	Bottom	A, F	A, F	A, F	A, F	A, F	A	A, F	A, F	A, F
A2	Surface	A	A	A	A	--	--	A	--	A
	Mid-depth	M, D, F	M, D, F	M, D, F	M, D, F	M, D, F	M	M, D, F	--	M, D, F
	Bottom	A	A	A	A	A	A	A	--	A
A3	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
A4	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
B1	Surface	A, D, F	A, D, F	A, D, F	A, D, F	--	--	A, D, F	--	A, D, F
	Mid-depth	M	M	M	M	M	M	M	--	M
	Bottom	A, D, F	A, D, F	A, D, F	A, D, F	A, D, F	A	A, D, F	A, D, F	A, D, F
B2	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
B3	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	D	D	D	D	D	--	D	--	D
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, F	M, A	M, A, D, F	--	M, A, D, F
B4	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	A, D, F	A, D, F	A, D, F	A, D, F	A, D, F	A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M	M	M, A, D, F	--	M, A, D, F
B5	Surface	F	F	F	F	--	--	F	--	F
	Bottom	F	F	F	F	F	--	F	--	F
C1	Surface	A	A	A	A	--	--	A	--	A
	Mid-depth	M, D, F	M, D, F	M, D, F	M, D, F	M, D, F	M	M, D, F	D, F	M, D, F
	Bottom	A	A	A	A	A	A	A	A	A
C2	Surface	M, A, D	M, A, D	M, A, D	M, A, D	--	--	M, A, D	--	M, A, D
	Mid-depth	F	F	F	F	F	--	F	--	F
	Bottom	M, A, D	M, A, D	M, A, D	M, A, D	M, A, D	M, A	M, A, D	--	M, A, D
C3	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	A	A	A	A	A	A	A	--	A
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, D, F	M	M, A, D, F	--	M, A, D, F
C4	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	A	A	A	A	A	A	A	--	A
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, D, F	M	M, A, D, F	--	M, A, D, F
D1	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	A, D, F	M, A, D, F
D2	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
D3	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
D4	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, F	M, A, F	M, A, F	M, A, F	M, A, F	M, A	M, A, D, F	--	M, A, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	D	--	M, A, D, F	--	M, A, D, F
E1	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	A, D, F	M, A, D, F
E2	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
E3	Surface	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
	Mid-depth	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	M, A
	Bottom	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
E4	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
F1	Surface	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
	Mid-depth	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	M, A
	Bottom	M, A	M, A	M, A	M, A	--	--	M, A	A	M, A
F2	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	D, F	M, A, D, F
F3	Surface	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
	Mid-depth	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	M, A
	Bottom	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
F4	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F

TABLE 4-5a

Summary of Surface Water Sample Collection and Analysis

Dundalk Marine Terminal, Baltimore, Maryland

Transect Location	Sample Depth	Total Cr	Cr(VI)	Dissolved Total Cr	Total and Dissolved COPR Metals	Fe(II)	Mn(II) modified	TOC	Hardness	DOC
DMT Locations										
G1	Surface	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
	Mid-depth	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	M, A
	Bottom	M, A	M, A	M, A	M, A	--	--	M, A	A	M, A
G2	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	D, F	M, A, D, F
G3	Surface	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
	Mid-depth	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	M, A
	Bottom	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
G4	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, D, F	--	--	M, A, D, F	--	M, A, D, F
H1	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	A, D, F	M, A, D, F
H2	Surface	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
	Mid-depth	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	M, A
	Bottom	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
H3	Surface	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
	Mid-depth	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	M, A
	Bottom	M, A	M, A	M, A	M, A	--	--	M, A	--	M, A
H4	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
I1	Surface	A	A	A	A	--	--	A	--	A
	Mid-depth	M, D, F	M, D, F	M, D, F	M, D, F	M, D, F	M	M, D, F	D, F	M, D, F
	Bottom	A	A	A	A	A	A	A	A	A
I2	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	A	A	A	A	A	A	A	--	A
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, D, F	M	M, A, D, F	--	M, A, D, F
I3	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	M, A
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	F, D	--	M, A, D, F	--	M, A, D, F
I4	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	A	A	A	A	A	A	A	--	A
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, D, F	M	M, A, D, F	--	M, A, D, F
J1	Mid-depth	F	F	F	F	F	--	F	F	F
J2	Mid-depth	F	F	F	F	F	--	F	--	F
J3	Mid-depth	F	F	F	F	F	--	F	--	F
J4	Mid-depth	F	F	F	F	F	--	F	--	F
Reference Locations										
37	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	A, F, D	M, A, D, F
37A	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	A	M, A, D, F
37B	Surface	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	--	M, A, D, F
	Mid-depth	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	--	M, A, D, F
	Bottom	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	--	--	M, A, D, F	A	M, A, D, F

M - May; A - August; D - December; F - February

S - shallow; M - mid-depth; D - deep

Cr –chromium

Cr (VI) - hexavalent chromium

COPR metals - other constituents of chrome ore processing residue: aluminum, calcium, iron, magnesium, manganese, and vanadium

Fe(II) - ferrous iron

Mn(II) - divalent manganese

TOC -total organic carbon

DOC - dissolved organic carbon

TABLE 4-5b

Summary of Pore Water Sample Collection and Analysis

Dundalk Marine Terminal, Baltimore, Maryland

Transect Location	Sample Depth (feet)	Total Cr	Cr(VI)	Dissolved Total Cr	Total and Dissolved COPR metals	Fe(II)	Mn(II) modified	DOC	Sulfide	Ammonia	Hardness	ORP	pH
DMT Locations													
A1	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M	A, D, F	--	--	A, D, F	D, F	D, F
A2	0.0 - 0.5	M, D, F	M, D, F	M, D, F	M, D, F	D, F	--	M, D, F	--	--	--	D, F	M, D, F
A3	0.0 - 0.5	M, D, F	M, D, F	M, D, F	M, D, F	D, F	--	M, D, F	--	--	--	D, F	D, F
A4	0.0 - 0.5	D, F	D, F	D, F	D, F	D, F	--	D, F	--	--	--	D, F	D, F
B1	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	A, D, F	A	A	A, D, F	A, D, F	A, D, F
B2	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	A	M, A, D, F	A	M, A	--	A, D, F	M, A, D, F
B3	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
B4	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
B5	0.0 - 0.5	F	F	F	F	F	--	F	--	--	--	F	F
C1	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	A, D, F	A, D, F	M, A, D, F
C2	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D	M, A	M, A, D	M, A	M	--	D, F	M, A, D, F
C3	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
C4	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
D1	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	A, D, F	A, D, F	M, A, D, F
D2	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
D3	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
D4	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
E1	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	A, D, F	A, D, F	M, A, D, F
E2	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
E3	0.0 - 0.5	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	A	M, A
E4	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
F1	0.0 - 0.5	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	A	A	M, A
F2	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M	M, D, F	M, A	M	F	D, F	M, D, F
F3	0.0 - 0.5	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	A	M, A
F4	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
G1	0.0 - 0.5	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	A	A	M, A
G2	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	F	A, D, F	M, A, D, F
G3	0.0 - 0.5	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	A	M, A
G4	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
H1	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	A, D, F	A, D, F	M, A, D, F
H2	0.0 - 0.5	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	A	M, A
H3	0.0 - 0.5	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	M, A	--	A	M, A
H4	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	D	A, D, F	M, A, D, F
I1	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	A, D, F	A, D, F	M, A, D, F
I2	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
I3	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	--	A, D, F	M, A, D, F
I4	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	D	A, D, F	M, A, D, F
J1	0.0 - 0.5	F	F	F	F	F	--	F	--	--	F	F	F
J2	0.0 - 0.5	F	F	F	F	F	--	F	--	--	--	F	F
J3	0.0 - 0.5	F	F	F	F	F	--	F	--	--	--	F	F
J4	0.0 - 0.5	F	F	F	F	F	--	F	--	--	--	F	F
Reference Locations													
37	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	A, D, F	A, D, F	M, A, D, F
37A	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	A	A, D, F	M, A, D, F
37B	0.0 - 0.5	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A, D, F	M, A	M, A, D, F	M, A	M, A	A	A, D, F	M, A, D, F

M - May; A - August; D - December; F - February

Cr –chromium

Cr (VI) - hexavalent chromium

COPR metals - other constituents of chrome ore processing residue: aluminum, calcium, iron, magnesium, manganese, and vanadium

DOC - dissolved organic carbon

Fe(II) - ferrous iron

Mn(II) - divalent manganese

ORP - oxidation reduction potential

TABLE 4-5c
Summary of Sediment Sample Collection and Analysis
Dundalk Marine Terminal, Baltimore, Maryland

Transect	Collection Event	Sample Interval (ft)	Total Cr	COPR Metals	Fe(II)	Mn(II)	Sulfide	AVS/SEM	Grain Size	TOC
DMT Sampling Locations										
A1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.9 - 1.4	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X
A2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.9 - 1.4	X	X						
	August	2.5 - 3.0	X	X						
A3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
A4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
B1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.8 - 1.3	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X
B2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.6 - 1.1	X	X						
	August	1.9 - 2.4	X	X						
B3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
B4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
B5	February	0.0 - 0.5	X	X	X			X	X	X
	February	0.5 - 1.0	X	X	X			X	X	X
	February	2.3 - 2.9	X	X	X			X	X	X
C1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.8 - 1.3	X	X	X	X	X		X	X
	August	2.3 - 2.8	X	X	X	X	X		X	X
C2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.0 - 2.5	X	X						
C3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.4 - 2.9	X	X						
C4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
D1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X
D2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
D3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						

TABLE 4-5c

Summary of Sediment Sample Collection and Analysis

Dundalk Marine Terminal, Baltimore, Maryland

Transect	Collection Event	Sample Interval (ft)	Total Cr	COPR Metals	Fe(II)	Mn(II)	Sulfide	AVS/SEM	Grain Size	TOC
DMT Sampling Locations										
D4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.8 - 1.3	X	X						
	August	2.5 - 3.0	X	X						
E1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X
E2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
E3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
E4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
F1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X
F2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
F3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.2 - 1.7	X	X						
	August	2.5 - 3.0	X	X						
F4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
G1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.1 - 1.6	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X
G2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.8 - 1.3	X	X						
	August	2.5 - 3.0	X	X						
G3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
G4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
H1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X
H2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
H3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						

TABLE 4-5c

Summary of Sediment Sample Collection and Analysis

Dundalk Marine Terminal, Baltimore, Maryland

Transect	Collection Event	Sample Interval (ft)	Total Cr	COPR Metals	Fe(II)	Mn(II)	Sulfide	AVS/SEM	Grain Size	TOC
DMT Sampling Locations										
	August	2.5 - 3.0	X	X						
H4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
I1	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X
I2	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
I3	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
I4	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.8 - 1.3	X	X						
	August	2.1 - 2.6	X	X						
J1	February	0.0 - 0.5	X	X	X			X	X	X
	February	0.8 - 1.3	X	X	X			X	X	X
	February	2.5 - 3.0	X	X	X			X	X	X
J2	February	0.0 - 0.5	X	X	X			X	X	X
	February	1.0 - 1.5	X	X	X			X	X	X
	February	2.5 - 3.0	X	X	X			X	X	X
J3	February	0.0 - 0.5	X	X	X			X	X	X
	February	0.6 - 1.1	X	X	X			X	X	X
	February	2.5 - 3.0	X	X	X			X	X	X
J4	February	0.0 - 0.5	X	X	X			X	X	X
	February	0.5 - 1.0	X	X	X			X	X	X
	February	2.5 - 3.0	X	X	X			X	X	X
Reference Stations										
37	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
37A	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.0 - 1.5	X	X						
	August	2.5 - 3.0	X	X						
37B	May	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	0.0 - 0.5	X	X	X	X	X	X	X	X
	August	1.2 - 1.7	X	X	X	X	X		X	X
	August	2.5 - 3.0	X	X	X	X	X		X	X

AVS - acid volatile sulfide

Cr - chromium

Cr (VI) - hexavalent chromium

COPR metals - other constituents of chrome ore processing residue: aluminum, calcium, iron, magnesium, manganese, and vanadium

Fe(II) - ferrous iron

Mn(II) - divalent manganese

SEM - simultaneously extracted metals

TOC -total organic carbon

TABLE 4-6
In Situ Sediment Quality Parameters
Dundalk Marine Terminal, Baltimore, Maryland

	May-07				Aug-07				Dec-07				Feb-08			
Transect	Collected	pH	ORP (mV)	Eh [a] (mV)	Collected	pH	ORP (mV)	Eh (mV)	Collected	pH	ORP (mV)	Eh (mV)	Collected	pH	ORP (mV)	Eh (mV)
A1	5/12/2007	8.08	-283	-78	8/22/2007	7.4	-165	40	12/5/2007	7.70	100	305	2/24/2008	7.38	-93	112
A2	5/17/2007	7.63	58	263	8/22/2007	7.66	5 [b]	210	12/11/2007	7.71	73	278	2/24/2008	7.43	224	429
A3	5/27/2007	7.93	65	270	8/22/2007	7.6	-48	157	12/11/2007	7.64	87	292	2/24/2008	7.42	228	433
A4	5/27/2007	8.4	106	311	8/22/2007	7.6	-138	67	12/11/2007	7.66	-230	-25	2/24/2008	7.46	202	407
B1	5/17/2007	7.45	-11	194	8/20/2007	7.19	-300	-95	12/7/2007	6.70	320	525	2/27/2008	7.03	390	595
B2	5/18/2007	7.46	147	352	8/20/2007	7.45	-260	-55	12/7/2007	7.30	-120	85	2/27/2008	6.96	292	497
B3	5/13/2007	7.02	-95	110	8/20/2007	7.39	-250	-45	12/7/2007	7.35	-140	65	2/26/2008	6.50	35	240
B4	5/13/2007	6.81	75	280	8/20/2007	7.36	-240	-35	12/7/2007	7.33	-11	194	2/25/2008	7.24	75	280
B5	--	--	--	--	--	--	--	--	--	--	--	--	2/26/2008	7.13	186	391
C1	5/15/2007	8.07	-232	-27	8/21/2007	7.77	-192	13	12/6/2007	8.26	50	255	2/26/2008	8.09	180	385
C2	5/15/2007	7.94	-47	158	8/21/2007	7.55	-210	-5	12/7/2007	7.61	71	276	2/26/2008	7.36	37	242
C3	5/15/2007	7.26	15	220	8/21/2007	7.34	-251	-46	12/11/2007	7.19	17	222	2/26/2008	7.07	287	492
C4	5/15/2007	7.3	120	325	8/21/2007	7.36	-295	-90	12/11/2007	7.29	236	441	2/26/2008	6.78	-95	110
D1	5/14/2007	8.54	-210	-5	8/16/2007	7.88	-233	-28	12/5/2007	8.71	-320	-115	2/25/2008	8.61	-264	-59
D2	5/12/2007	7.57	-240	-35	8/16/2007	6.94	-263	-58	12/9/2007	7.18	-280	-75	2/25/2008	7.55	-178	27
D3	5/13/2007	7.22	-168	37	8/18/2007	6.95	-233	-28	12/10/2007	6.96	-370	-165	2/25/2008	7.49	-273	-68
D4	5/18/2007	7.11	75	280	8/19/2007	7.3	-202	3	12/9/2007	6.82	-95	110	2/25/2008	7.17	140	345
E1	5/11/2007	8.26	-255	-50	8/16/2007	7.96	-310	-105	12/5/2007	9.78	-311	-106	2/23/2008	9.30	-230	-25
E2	5/14/2007	7.31	-181	24	8/16/2007	7.42	-265	-60	12/9/2007	7.38	-84	121	2/23/2008	6.88	-180	25
E3	5/16/2007	6.67	-249	-44	8/18/2007	6.82	-293	-88	--	--	--	--	--	--	--	--
E4	5/18/2007	7.38	-170	35	8/19/2007	7.72	-165	40	12/9/2007	7.01	-12	193	2/25/2008	6.75	35	240
F1	5/14/2007	7.13	-109	96	8/19/2007	7.02	-260	-55	--	--	--	--	--	--	--	--
F2	5/14/2007	6.99	-79	126	8/19/2007	7.72	-290	-85	12/12/2007	7.45	-265	-60	2/29/2008	7.53	-327	-122
F3	5/14/2007	7.11	-160	45	8/19/2007	7.32	-325	-120	--	--	--	--	--	--	--	--
F4	5/18/2007	7.47	-231	-26	8/17/2007	7.18	-256	-51	12/10/2007	7.50	-335	-130	2/29/2008	7.59	-240	-35
G1	5/12/2007	7.22	-221	-16	8/15/2007	7.47	-247	-42	--	--	--	--	--	--	--	--
G2	5/12/2007	6.9	-140	65	8/18/2007	7.11	-239	-34	12/12/2007	6.91	-280	-75	2/23/2008	7.46	-201	4
G3	5/11/2007	7.16	-177	28	8/18/2007	6.88	-324	-119	--	--	--	--	--	--	--	--
G4	5/11/2007	7.27	-208	-3	8/18/2007	7.25	-274	-69	12/12/2008	7.23	210	415	2/23/2008	7.86	-260	-55
H1	5/8/2007	7.22	-170	35	8/14/2007	6.71	-346	-141	12/6/2007	7.07	-301	-96	2/19/2008	7.99	-185	20
H2	5/8/2007	7.1	-163	42	8/14/2007	7.18	-360	-155	--	--	--	--	--	--	--	--
H3	5/11/2007	7.31	-200	5	8/14/2007	6.33	-330	-125	--	--	--	--	--	--	--	--
H4	5/11/2007	7.14	-225	-20	8/14/2007	6.68	-360	-155	12/6/2007	7.00	-340	-135	2/23/2008	6.30	-560	-355
I1	5/9/2007	6.88	-170	35	8/15/2007	7.11	-240	-35	12/5/2007	7.49	-120	85	2/19/2008	8.30	50	255
I2	5/9/2007	6.41	151	356	8/15/2007	7.35	-335	-130	12/6/2007	7.27	-285	-80	2/19/2008	5.50	175	380
I3	5/9/2007	6.93	-62	143	8/15/2007	7.14	-341	-136	12/6/2007	7.30	-50	155	2/19/2008	7.50	140	345
I4	5/9/2007	7.18	-175	30	8/15/2007	7.22	-360	-155	12/5/2007	7.33	-100	105	2/19/2008	7.20	-140	65
J1	--	--	--	--	--	--	--	--	--	--	--	--	2/21/2008	8.70	-50	155
J2	--	--	--	--	--	--	--	--	--	--	--	--	2/21/2008	8.50	-128	77
J3	--	--	--	--	--	--	--	--	--	--	--	--	2/21/2008	8.45 [c]	220	425
J4	--	--	--	--	--	--	--	--	--	--	--	--	2/21/2008	8.69	70	275
Reference Locations																
37	5/16/2007	7.43	-161	44	8/17/2007	7.06	-300	-95	12/10/2007	7.34	-378	-173	2/24/2008	7.71	-264	-59
37A	5/16/2007	7.45	-244	-39	8/17/2007	6.98	-242	-37	12/11/2007	6.90	-310	-105	2/29/2008	7.70	-89	116
37B	5/16/2007	7.52	-236	-31	8/17/2007	6.97	-278	-73	12/10/2007	7.42	-282	-77	2/29/2008	7.74	-250	-45

NA - not recorded / not sampled

[a] ORP measurements converted to Eh by adding 205 mV (conversion from Ag/AgCl electrode to standard hydrogen electrode).

[b] difficult to penetrate probe into sand and get accurate reading

[c] The temperature when sediment from J3 was collected was very low and below the lower limit of the probe; the pH and eH values may be inaccurate due to the very low temperatures.

TABLE 4-7

Grain Size Distribution and Sediment Type

Dundalk Marine Terminal, Baltimore, Maryland

Station	Sample Interval (ft)	Date Collected	Total Water Depth (ft)	Gravel % >2 mm	Sand % 0.062 - 2.0 mm	Silt % 0.004 - 0.062 mm	Clay % <0.004 mm	Sediment Type
DMT Sampling Locations								
A1	0.0 - 0.5	8/22/2007	5.7	0.1	46.2	48.7	5.0	sandy silt
	0.0 - 0.5	5/12/2007	4.0	0.0	72.8	22.7	4.5	silty sand
	0.9 - 1.4	8/13/2007	5.7	0.2	59.2	17.6	23.0	clayey sand
	2.5 - 3.0	8/13/2007	5.7	0.0	97.8	0.2	2.0	sand
A2	0.0 - 0.5	8/22/2007	5.1	0.0	97.8	0.7	1.5	sand
	0.0 - 0.5	5/17/2007	3.9	0.0	96.1	3.4	0.5	sand
A3	0.0 - 0.5	8/22/2007	4.8	0.0	97.3	0.7	2.0	sand
	0.0 - 0.5	5/17/2007	3.2	0.0	97.9	1.1	1.0	sand
A4	0.0 - 0.5	8/22/2007	4.5	0.0	97.1	0.9	2.0	sand
	0.0 - 0.5	5/17/2007	4.2	0.0	98.1	0.4	1.5	sand
B1	0.0 - 0.5	8/21/2007	6.6	0.0	28.1	63.9	8.0	sandy silt
	0.0 - 0.5	5/17/2007	5.0	0.0	44.6	48.9	6.5	sandy silt
	0.8 - 1.3	8/10/2007	6.6	0.1	64.1	16.8	19.0	clayey sand
	2.5 - 3.0	8/10/2007	6.6	0.1	3.2	32.7	64.0	silty clay
B2	0.0 - 0.5	8/20/2007	8.7	0.0	65.2	23.8	11.0	silty sand
	0.0 - 0.5	5/18/2007	9.0	0.0	70.6	21.4	8.0	silty sand
B3	0.0 - 0.5	8/20/2007	9.9	0.0	11.6	19.4	69.0	silty clay
	0.0 - 0.5	5/13/2007	9.3	0.2	14.8	26.0	59.0	silty clay
B4	0.0 - 0.5	8/20/2007	10.6	0.0	23.4	28.6	48.0	silty clay
	0.0 - 0.5	5/13/2007	8.8	0.2	23.4	35.4	41.0	sandy clay
B5	0.0 - 0.5	2/21/2008	8.4	0.0	95.5	2.5	2.0	sand
	0.5 - 1.0	2/20/2008	8.4	0.0	90.6	6.9	2.5	sand
	2.3-2.9	2/20/2008	8.4	0.0	95.5	4.0	0.5	sand
C1	0.0 - 0.5	8/21/2007	5.7	0.0	52.2	35.8	12.0	silty sand
	0.0 - 0.5	5/15/2007	4.2	0.1	61.0	27.9	11.0	silty sand
	0.8 - 1.3	8/10/2007	5.7	0.1	42.3	23.1	34.5	sandy clay
	2.3 - 2.8	8/10/2007	5.7	0.1	69.0	9.9	21.0	clayey sand
C2	0.0 - 0.5	8/21/2007	7.3	0.0	72.2	15.8	12.0	silty sand
	0.0 - 0.5	5/15/2007	6.3	0.1	64.8	23.1	12.0	silty sand
C3	0.0 - 0.5	8/21/2007	10.1	0.1	35.4	33.5	31.0	sandy silt
	0.0 - 0.5	5/15/2007	8.9	0.1	45.7	26.2	28.0	sandy clay
C4	0.0 - 0.5	8/21/2007	11.0	0.0	34.8	26.7	38.5	sandy clay
	0.0 - 0.5	5/15/2007	9.6	0.2	35.2	29.6	35.0	sandy clay
D1	0.0 - 0.5	8/16/2007	42.5	0.1	32.1	36.8	31.0	sandy silt
	0.0 - 0.5	5/14/2007	34.0	0.7	43.5	26.3	29.5	sandy clay
	1.0 - 1.5	8/9/2007	42.5	0.2	51.5	24.3	24.0	silty sand
	2.5 - 3.0	8/9/2007	42.5	0.2	27.6	23.2	49.0	sandy clay
D2	0.0 - 0.5	8/16/2007	44.7	0.1	26.9	38.0	35.0	clayey silt
	0.0 - 0.5	5/12/2007	44.3	0.2	17.8	34.0	48.0	silty clay
D3	0.0 - 0.5	8/18/2007	41.5	0.2	11.3	45.5	43.0	clayey silt
	0.0 - 0.5	5/13/2007	42.3	0.2	10.3	32.5	57.0	silty clay
D4	0.0 - 0.5	8/19/2007	10.8	0.0	50.0	15.5	34.5	clayey sand
	0.0 - 0.5	5/18/2007	10.8	0.1	55.4	18.5	26.0	clayey sand
E1	0.0 - 0.5	8/16/2007	45.2	0.1	40.9	23.0	36.0	sandy clay
	0.0 - 0.5	5/11/2007	43.3	0.2	32.4	35.4	32.0	sandy silt
	1.0 - 1.5	8/9/2007	45.2	8.0	23.3	23.7	45.0	silty clay
	2.5 - 3.0	8/9/2007	45.2	0.1	3.3	17.6	79.0	silty clay
E2	0.0 - 0.5	8/16/2007	44.5	0.1	6.8	19.6	73.5	silty clay
	0.0 - 0.5	5/14/2007	44.8	0.1	4.9	12.0	83.0	silty clay
E3	0.0 - 0.5	8/18/2007	43.0	0.1	18.7	45.2	36.0	clayey silt
	0.0 - 0.5	5/17/2007	42.0	0.0	31.5	14.5	54.0	sandy clay
E4	0.0 - 0.5	8/20/2007	14.9	0.0	65.0	15.5	19.5	clayey sand
	0.0 - 0.5	5/18/2007	13.5	0.0	74.8	9.2	16.0	clayey sand
F1	0.0 - 0.5	8/19/2007	38.3	0.0	55.1	11.9	33.0	clayey sand
	0.0 - 0.5	5/14/2007	36.0	0.1	55.8	15.1	29.0	clayey sand
	1.0 - 1.5	8/11/2007	38.3	0.1	36.4	23.0	40.5	sandy clay
	2.5 - 3.0	8/11/2007	38.3	0.1	38.8	20.1	41.0	sandy clay
F2	0.0 - 0.5	8/19/2007	45.9	0.3	52.6	5.1	42.0	clayey sand
	0.0 - 0.5	5/14/2007	44.1	0.1	9.6	7.8	82.5	sandy clay
F3	0.0 - 0.5	8/19/2007	37.9	0.0	28.4	20.6	51.0	sandy clay
	0.0 - 0.5	5/14/2007	32.0	0.2	11.6	33.7	54.5	silty clay

TABLE 4-7

Grain Size Distribution and Sediment Type

Dundalk Marine Terminal, Baltimore, Maryland

Station	Sample Interval (ft)	Date Collected	Total Water Depth (ft)	Gravel % >2 mm	Sand % 0.062 - 2.0 mm	Silt % 0.004 - 0.062 mm	Clay % <0.004 mm	Sediment Type
DMT Sampling Locations								
F4	0.0 - 0.5	8/17/2007	26.7	0.1	17.8	41.1	41.0	clayey silt
	0.0 - 0.5	5/18/2007	26.5	0.1	14.8	35.1	50.0	silty clay
G1	0.0 - 0.5	8/15/2007	38.0	0.0	83.5	4.5	12.0	sand
	0.0 - 0.5	5/12/2007	34.2	0.0	78.1	5.9	16.0	clayey sand
	1.1 - 1.6	8/10/2007	38.0	0.1	25.8	35.1	39.0	silty clay
	2.5 - 3.0	8/10/2007	38.0	1.2	22.3	32.5	44.0	silty clay
G2	0.0 - 0.5	8/18/2007	39.3	0.1	25.0	39.9	35.0	clayey silt
	0.0 - 0.5	5/12/2007	37.0	0.5	43.5	30.0	26.0	sandy silt
G3	0.0 - 0.5	8/18/2007	42.3	0.1	25.9	43.0	31.0	clayey silt
	0.0 - 0.5	5/11/2007	43.5	0.2	34.9	21.4	43.5	sandy clay
G4	0.0 - 0.5	8/18/2007	26.5	0.2	45.0	24.8	30.0	sandy clay
	0.0 - 0.5	5/11/2007	29.1	2.4	35.3	26.3	36.0	sandy clay
H1	0.0 - 0.5	8/14/2007	37.3	0.1	33.4	29.5	37.0	sandy clay
	0.0 - 0.5	5/9/2007	38.8	0.1	29.4	41.5	29.0	sandy silt
	1.0 - 1.5	8/9/2007	37.3	0.3	26.6	35.1	38.0	silty clay
	2.5 - 3.0	8/9/2007	37.3	0.1	58.7	18.2	23.0	clayey sand
H2	0.0 - 0.5	8/14/2007	37.8	0.1	70.3	17.6	12.0	silty sand
	0.0 - 0.5	5/8/2007	31.4	0.1	79.6	6.8	13.5	clayey sand
H3	0.0 - 0.5	8/14/2007	38.0	0.1	31.3	29.6	39.0	sandy clay
	0.0 - 0.5	5/8/2007	34.2	0.2	52.3	27.5	20.0	silty sand
H4	0.0 - 0.5	8/14/2007	40.8	0.1	40.4	14.5	45.0	sandy clay
	0.0 - 0.5	5/8/2007	37.1	0.1	47.6	20.3	32.0	sandy clay
I1	0.0 - 0.5	8/15/2007	5.9	0.1	64.0	20.9	15.0	silty sand
	0.0 - 0.5	5/9/2007	3.6	0.1	64.0	18.4	17.5	silty sand
	1.0 - 1.5	8/12/2007	5.9	0.1	67.7	19.2	13.0	silty sand
	2.5 - 3.0	8/12/2007	5.9	0.0	72.6	13.4	14.0	clayey sand
I2	0.0 - 0.5	8/15/2007	10.8	0.1	47.8	36.6	15.5	sandy silt
	0.0 - 0.5	5/9/2007	9.0	0.2	52.6	27.2	20.0	silty sand
I3	0.0 - 0.5	8/15/2007	11.2	0.0	22.3	30.7	47.0	sitly clay
	0.0 - 0.5	5/9/2007	8.9	0.2	48.4	12.4	39.0	sandy clay
I4	0.0 - 0.5	8/15/2007	10.8	0.1	20.2	29.2	50.5	silty clay
	0.0 - 0.5	5/9/2007	7.8	0.3	31.1	23.6	45.0	sandy clay
J1	0.0 - 0.5	2/21/2008	1.8	0.0	92.2	6.8	1.0	sand
	0.8-1.3	2/21/2008	1.8	0.1	60.5	13.4	26.0	clayey sand
	2.5 - 3.0	2/21/2008	1.8	0.1	21.8	18.1	60.0	sandy clay
J2	0.0 - 0.5	2/21/2008	4.4	0.0	70.4	19.6	10.0	silty sand
	1.0 - 1.5	2/21/2008	4.4	0.1	58.3	11.6	30.0	clayey sand
	2.5 - 3.0	2/21/2008	4.4	0.0	91.5	3.5	5.0	sand
J3	0.0 - 0.5	2/21/2008	4.4	0.1	61.8	32.1	6.0	silty sand
	0.6 - 1.1	2/21/2008	4.4	0.0	73.1	18.9	8.0	silty sand
	2.5 - 3.0	2/21/2008	4.4	0.1	11.4	30.5	58.0	silty clay
J4	0.0 - 0.5	2/21/2008	1.4	0.0	93.2	5.8	1.0	sand
	0.5 - 1.0	2/20/2008	1.4	0.0	92.9	4.1	3.0	sand
	2.5 - 3.0	2/20/2008	1.4	0.0	97.5	0.5	2.0	sand
Reference Locations								
37	0.0 - 0.5	8/17/2007	39.9	0.3	17.1	39.6	43.0	silty clay
	0.0 - 0.5	5/16/2007	40.2	0.1	9.3	19.6	71.0	silty clay
37A	0.0 - 0.5	8/17/2007	38.0	0.1	14.7	36.2	49.0	silty clay
	0.0 - 0.5	5/16/2007	37.5	0.1	10.1	11.8	78.0	silty clay
37B	0.0 - 0.5	8/17/2007	38.2	0.2	8.5	45.3	46.0	silty clay
	0.0 - 0.5	5/16/2007	37.1	0.1	7.2	31.7	61.0	silty clay
	1.2 - 1.7	8/11/2007	38.2	0.1	0.7	14.2	85.0	silty clay
	2.5 - 3.0	8/11/2007	38.2	0.1	1.8	15.6	82.5	silty clay

TABLE 4-8

Statistical Summary of Groundwater Upwelling Survey Results

Dundalk Marine Terminal, Baltimore, Maryland

Statistic	December 2006				October-November 2007			
	Subsurface		Surface Water		Subsurface		Surface Water	
	Temperature (°C)	Conductivity (mS/cm)	Temperature (°C)	Conductivity (mS/cm)	Temperature (°C)	Conductivity (mS/cm)	Temperature (°C)	Conductivity (mS/cm)
Average	13.61	5.16	9.18	15.6	19.28	6.77	19.07	23.32
Minimum	8.38	1.64	5.46	6.56	17.18	1.7	16.86	15.03
Maximum	16.24	11.89	10.71	19.83	20.28	13.38	20.19	26.04
Standard deviation	2.05	1.97	1.37	2.56	0.63	2.73	0.87	2.45

mS/cm - millisiemens per centimeter

Legend

Water Depth in Feet (NAVD88)

-4 feet

-50 feet

Note: Bathymetric survey performed in December 2006 by Ocean Surveys, Inc.

N
W E
S

0 1,000 2,000 Feet

Figure 4-1
Bathymetric Map
Dundalk Marine Terminal
Baltimore, Maryland

ENVIRON
CH2MHILL

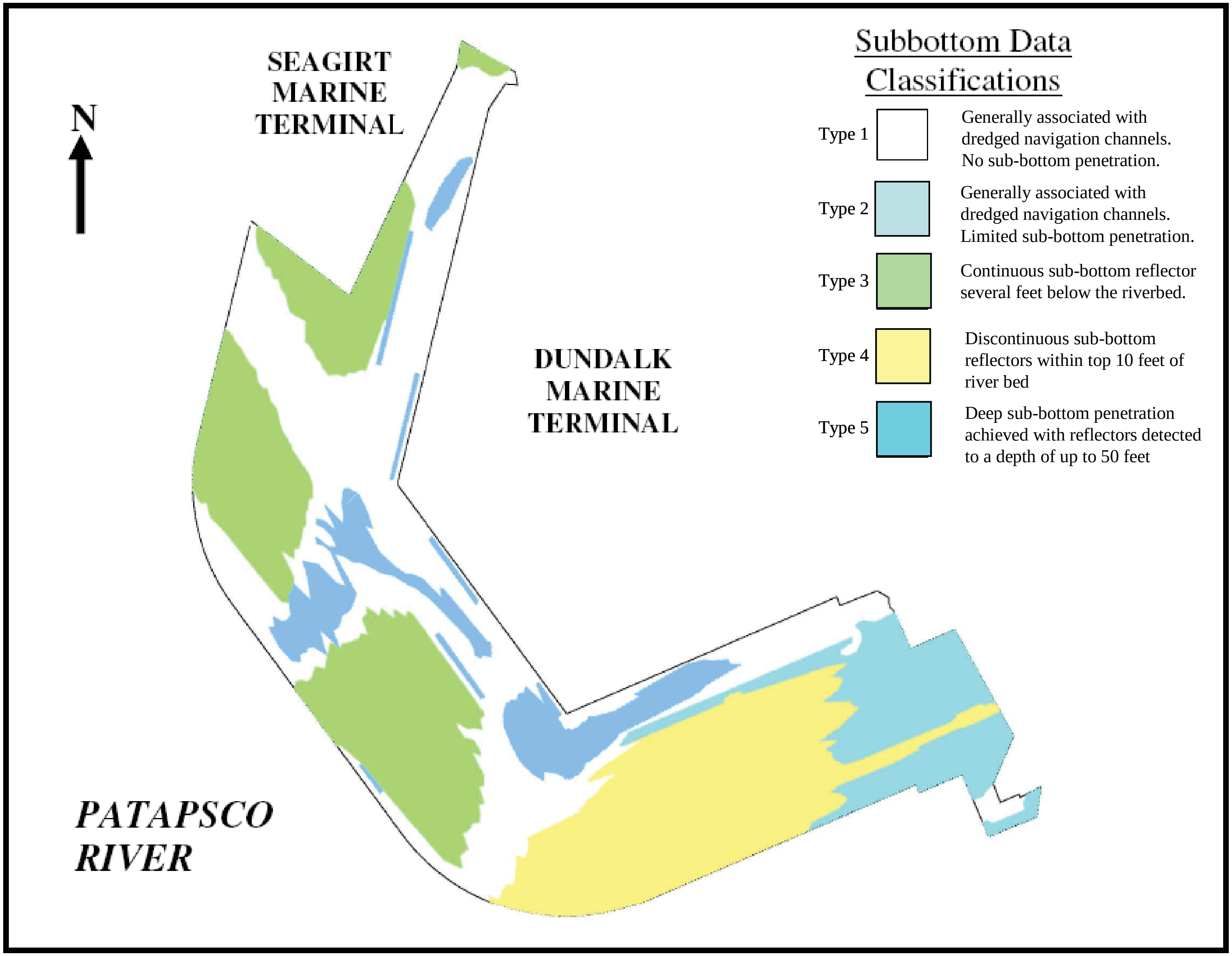
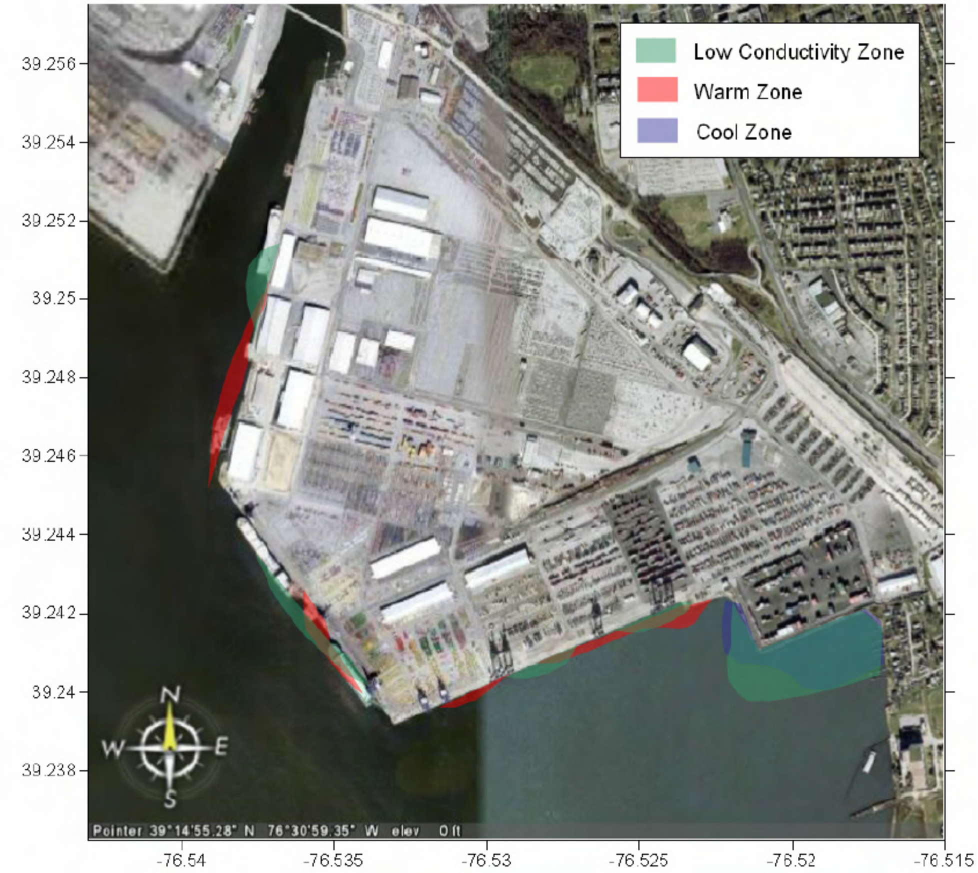
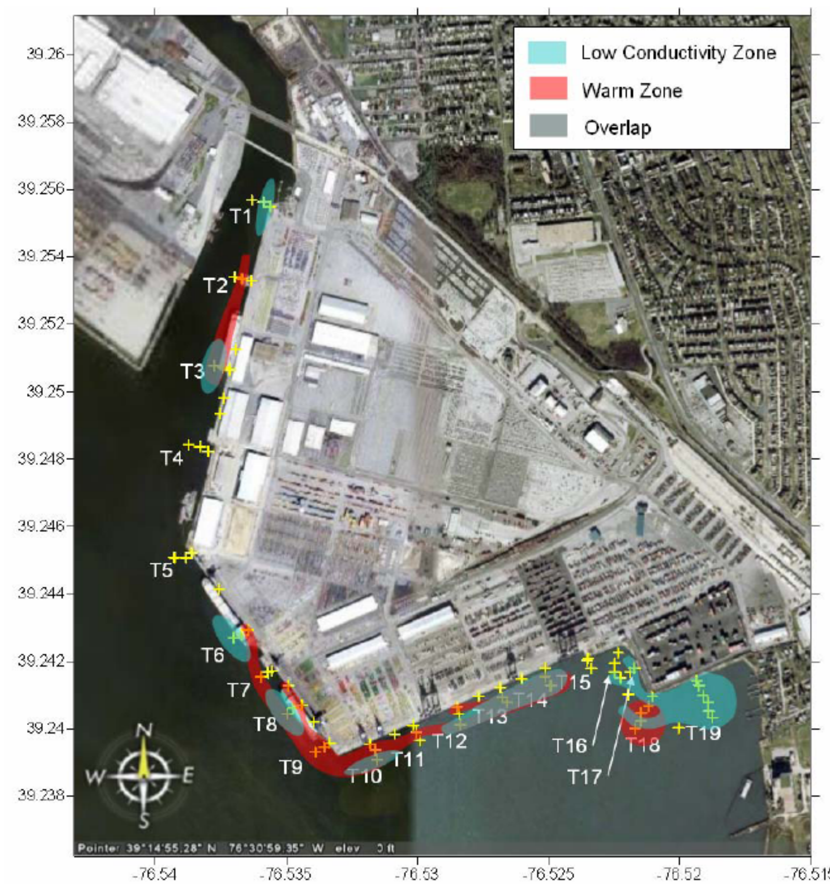


Figure 4-2
Bottom Sediment Types Bases on Acoustic Characteristics
Dundalk Marine Terminal
Baltimore, Maryland

CH2MHILL
ENVIRON



a. December 2006 groundwater upwelling survey results



b. October-November 2007 groundwater upwelling survey results

Figure 4-3
Groundwater Upwelling Survey Results
Dundalk Marine Terminal, Baltimore, Maryland

CH2MHILL
ENVIRON