Corrective Measures Alternatives Analysis, Dundalk Marine Terminal, Baltimore, Maryland

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Executive Summary

The Maryland Port Administration (MPA) and Honeywell are working in partnership, under the supervision of the Maryland Department of the Environment (MDE), to investigate, analyze, and address environmental conditions related to chromium at the Port of Baltimore's Dundalk Marine Terminal (DMT).

Using well-respected and experienced national scientific experts, MPA and Honeywell have conducted six extensive studies that have been overseen and reviewed by MDE. This document builds on those studies, describes corrective measures implemented to date, and presents five remedial alternatives for consideration.

From the early 1900s until the 1970s, a portion of DMT was constructed using chromium ore processing residue (COPR) as fill to create new land. At the time, similar fill operations were a common and accepted practice in Maryland and elsewhere.

MPA and Honeywell have completed thorough investigations of air, soil, groundwater, stormwater, and COPR at DMT as part of a 2006 Consent Decree. Sediment and water from the Patapsco River also have been investigated. More than 5,600 soil, water, and air samples have been collected under the supervision of MDE.

More than $76 million has been spent by MPA and Honeywell to investigate, quantify, address, and remediate the effects of COPR at DMT. Under MDE supervision, an accelerated program of interim remedies and pilot tests is underway.

As outlined in the Consent Decree, MDE will select the final remedy, after evaluating public comment on the remedial alternatives described in this document. The final remedy must meet the requirements of the Consent Decree, including first and foremost protecting human health and the environment. The potential impact of the remedy on Port operations will also be considered in the selection process.

The Port of Baltimore is one of the largest and busiest ports in the United States. Port activity creates about 16,700 direct jobs in the region, accounting for approximately $3.7 billion in wages and $3.2 billion in business revenue and local purchases each year. In 2009, the Port as a whole ranked as the 15th largest such facility in the United States, and DMT is an integral part of the Port's business. Both MPA and Honeywell are committed to implementing a remedy that will fully protect public health and the environment while allowing for the Port to continue its important role in the regional economy.

The investigations and work to date at DMT have produced the following findings:

- COPR fill is limited to 148 acres and is contained under asphalt surfaces. This prevents direct exposure, so the risk to workers at DMT and to the surrounding community is minimized. Precautions are taken when the COPR is exposed during construction activities.
- Current measures are protecting public health and the community:

  - The MPA and Honeywell have implemented an extensive, ongoing, air-monitoring program. No significant difference between upwind and downwind chromium concentrations has been observed in the data. These results support the finding that airborne transport of COPR dust from DMT is not significant.
  - A rigorous surface cover inspection and maintenance plan has been implemented to verify that COPR remains contained.
  - MPA's Health and Safety Plan for DMT, which includes a wide range of health and safety measures, has been updated to formalize procedures for air monitoring, drinking water monitoring, and work in COPR areas during routine construction projects. These enhancements provide additional protection for site workers and result in more robust COPR management and air monitoring programs.

- Investigations show that the only significant movement of hexavalent chromium is from groundwater flow into storm drains, and from storm drains to the Patapsco River. Hexavalent chromium has not been detected, however, at significant levels in the river because it naturally changes to a nonhazardous form (trivalent chromium) in surface water.
- Hexavalent chromium in groundwater also rapidly reduces to the nontoxic trivalent form before it reaches the river.
- Groundwater that enters the two largest storm drains during normal conditions of flow is being captured and treated.
- Accessible portions of other storm drains have been inspected to assess their integrity. To date, almost 2 miles of storm drains have been relined or replaced to prevent hexavalent chromium from entering the drains. Tests have shown that relining can significantly reduce groundwater infiltration into storm drains.
- The onsite water treatment plant has treated an average of 42 million gallons of stormwater per year since 2006, and plant discharges meet MDE permit requirements.
- COPR has been extensively studied in the last few years. These investigations have led to a fundamental understanding of COPR, its potential to harden and swell, and the engineering controls needed to effectively manage its hardening and swelling (expansion) process.
- Institutional and engineering controls in the form of pilot projects and interim remedial measures have demonstrated that COPR and hexavalent chromium can successfully be contained.
- Enhancements to the existing efforts will provide additional measures to protect health and the environment.

The following five remedial alternatives have been developed as part of the Corrective Measures Alternatives Analysis (CMAA) process. These alternatives include a containment alternative and a full excavation alternative, as stipulated in the Consent Decree, and a "No Further Action" alternative, as required under state law:

- Alternative 1: No Further Action
- Alternative 2: Basic Containment
- Alternative 3: Enhanced Isolation and Containment
- Alternative 4: Partial Excavation
- Alternative 5: Full Excavation

All the alternatives have been screened against the criteria required under the 2006 Consent Decree. The CMAA contains a comparative analysis of the corrective measures alternatives to assist MDE in the selection of the final remedy. The comparative analysis shows the following:

- Alternative 1, the No Further Action option, does not fully comply with applicable regulatory requirements.
- Alternatives 2 and 3, the containment options, better meet the Consent Decree selection criteria, such as protection of human health and the environment, implementability, and short-term and long-term effectiveness, than Alternatives 4 and 5, the excavation alternatives, do.
- Alternatives 4 and 5 (the excavation alternatives) will inordinately disrupt Port operations, resulting in well over $100 million of lost business and other negative economic impacts on the surrounding community.
- Alternative 3 is superior to Alternative 2 because Alternative 3 significantly enhances the existing corrective measures and is more protective of human health and the environment.

The Alternative 3 enhancements include the following:

- Installation of tidal exclusion vaults at the remaining storm drains constructed in COPR (the vaults will prevent flooding of the drains and allow them to be inspected, cleaned, and sampled);
- Relining of the affected storm drains to mitigate groundwater intrusion;
- Rigorous pavement inspections and repairs using new and improved methods to verify that COPR is being contained; and
- A Performance Management Program (PMP) to monitor the enhanced corrective measures (the plan will include regular testing of air, groundwater, stormwater, drinking water, river sediments and COPR movement).

Alternative 3 focuses on *preventing* contaminated groundwater from entering the storm drains, in contrast to Alternatives 1 and 2, which focus on *treating* contaminated groundwater that enters the storm drains. This focus on prevention is a more fundamental and environmentally sound approach to limiting the movement of hexavalent chromium into storm drains. While Alternatives 2 through 5 offer varying levels of effectiveness, Alternative 3 achieves effectiveness and additional protectiveness more rapidly and with significantly less short-term impacts to the community, port workers, and port business operations. Alternative 3 is fully protective of human health and the environment.

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Abbreviations and Acronyms

ABC	Articulated Block Concrete
ACL	Alternate Concentration Limit
APEN	Air Pollution Emission Notice
ARAR	Applicable or Relevant and Appropriate Requirement
BACT	Best Available Control Technology
BDAT	Best Demonstrated Available Technology
BLS	Bureau of Labor Statistics
CAA	Clean Air Act
CAMU	Correction Action Management Unit
CCTV	closed-circuit television
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	Chemicals of Potential Concern
CIP	cured-in-place
CMAA	Corrective Measures Alternatives Analysis
CMOs	Corrective Measures Objectives
COMAR	Code of Maryland Regulations
COPR	chromium ore processing residue
CSM	conceptual site model
CTS	Chromium Transport Study
CWA	Clean Water Act
DMT	Dundalk Marine Terminal
DON	Department of Navy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FR	*Federal Register*
FS	feasibility study
GB	Gray-Black (COPR)
GHG	greenhouse gas
GIS	Geographical Information System
HB	Hard-Brown (COPR)
HDPE	high-density polyethylene
HIMS	Heave Investigation and Minimization Study
HWCA	Hazardous Waste Control Act
IRM	Interim Remedial Measure

LAER	lowest achievable emission rate
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDE	Maryland Department of the Environment
MES	Maryland Environmental Services
MPA	Maryland Port Administration
MWH	megawatt hours
NAAQS	National Ambient Air Quality Standard
NAS	Naval Air Station
NCP	National Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRWQC	Nationally Recommended Water Quality Criteria
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PM	particulate matter
PMP	Performance Management Program
POTW	publicly owned treatment works
PPE	personal protective equipment
ppm	parts per million
ppmw	parts per million by weight
PRG	Preliminary Remediation Goals
PVC	polyvinyl chloride
RA	relevant and appropriate
RACT	Reasonably Available Control Technology
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
Ro-Ro	roll-on, roll-off
SCMP	Surface Cover and Inspection and Maintenance Plan
SDWA	Safe Drinking Water Act
SIP	state implementation plan
SMCL	secondary maximum contaminant level
SMCLs	Secondary Maximum Contaminant Levels
SOP	Standard Operating Procedure
SRT	strain relief trenches
TAP	toxic air pollutant
TBC	To Be Considered
TSCA	Toxic Substances Control Act
UIC	Underground Injection Control
USC	United States Code
USDW	underground source of drinking water

UST	underground storage tank
VOC	volatile organic compound
WWTP	wastewater treatment plant

SECTION 1

Introduction

1.1 Background

This Corrective Measures Alternatives Analysis (CMAA) has been prepared by the Maryland Port Administration (MPA) and Honeywell International Inc. (Honeywell) pursuant to the Consent Decree entered into by the Maryland Department of the Environment (MDE), MPA, and Honeywell on April 5, 2006. The CMAA evaluates several alternative remedies, or corrective measures, to address the presence of chromium ore processing residue (COPR) and its constituents (including hexavalent chromium, or Cr(VI)) at the Dundalk Marine Terminal (DMT).

Under the 2006 Consent Decree, MPA and Honeywell have undertaken and completed a wide range of comprehensive investigations of environmental conditions at DMT. These have included investigations of air, soils, sediments, groundwater, and surface water conditions; a comprehensive delineation of the COPR fill area; and both human health and ecological risk assessments. The CMAA is based upon the results of these studies:

- COPR Investigation
- Heave Investigation and Minimization Study
- Surface Water and Sediment Investigation
- Chromium Transport Study
- Plan to Quantify Chromium Discharges to the Patapsco River
- Human Health Risk Assessment
- Ecological Risk Assessment

Honeywell and MPA are also actively conducting a variety of maintenance and monitoring programs designed to maintain the effectiveness of existing controls and to ensure that COPR is not impacting human health and the environment. These measures are outlined in Section 3. The monitoring and maintenance programs include the inspection and maintenance of port infrastructure, the evaluation of the efficacy of existing pilot studies and corrective measures, and the monitoring of various media—such as air, groundwater, stormwater, surface water, sediment, and the potable water system.

Briefly, the major findings of these seven comprehensive investigation reports are the following:

- The extent of COPR within the fill area has been defined; the COPR is located beneath approximately 148 acres of the port's paved surface, it ranges in thickness from 1 foot to 32 feet, and it comprises approximately 2.5 million yd^3.
- Current measures used at DMT are protecting public health and the community:
  - An extensive, ongoing, 3-year air monitoring program at the perimeter of DMT has verified that COPR is not contributing to airborne hexavalent chromium concentrations.

  - An extensive, ongoing air monitoring program at the perimeter shows that results are well below levels established by the Occupational Safety and Health Administration (OSHA) for workers.
  - A rigorous surface cover inspection and maintenance plan has been implemented to verify that COPR remains contained.
  - The site health and safety plan has been updated to formalize procedures for air monitoring, drinking water monitoring, and penetration of the asphalt cover during routine construction projects; these enhancements provide additional protectiveness for site workers and result in more robust COPR management and air monitoring programs.
- Where the COPR is found, it is covered by non-COPR fill and pavement material that prevent the COPR from becoming airborne or from eroding. Pavement structures within the COPR fill area consist of conventional asphalt (i.e., bituminous concrete), roller-compacted concrete, low-permeability asphalt, and articulated block concrete (ABC) materials.
- The expansive properties of COPR have been identified, and heave mitigation measures have been developed. These measures have been applied successfully at multiple DMT locations to maintain the integrity of the surface cover and support ongoing business operations of MPA and its tenants, clients, and employees. It has been demonstrated that heave does not result in the exposure of COPR at the surface because appropriate protocols are in place to protect workers and others from exposure during any excavation activities.
- Chromium transport via groundwater, runoff, and air are not significant. The primary potential pathway for migration of chromium and other COPR constituents is storm drain discharge—primarily from the 12th through 15th Streets priority drains.
- Concentrations of Cr(VI) in shallow groundwater are limited to the COPR fill area. Deeper groundwater under the COPR and shallow groundwater outside of the COPR fill area are not impacted by Cr(VI) because of rapid, natural attenuation processes in the subsurface environment. When Cr(VI) enters the non-COPR environment, it is quickly reduced to nonhazardous trivalent chromium, or Cr(III).
- Groundwater flow rate from the site is very low and is not a significant pathway for Cr(VI) transport to the Patapsco River. No Cr(VI) was detected in sediment pore water of the Patapsco River offshore of DMT.
- Stormwater discharges from the 12th through 15th Streets' drain systems currently present a transport pathway to the Patapsco River. Portions of these drains are constructed within COPR fill, and infiltration of contaminated groundwater into the drains has been identified. However, these discharges have little to no measurable impact on surface water, owing to the rapid, natural attenuation of Cr (VI) to Cr(III) in the estuarine environment.
- A successful pilot study has been completed on the 13th Street storm drain. The storm drain was repaired and relined using commercially available materials and techniques.

The pilot study demonstrated the successful reduction of groundwater infiltration and Cr(VI) discharge. A similar pilot study is underway at the 15th Street storm drain.

- All surface water concentrations of Cr(VI) offshore of DMT are below Maryland ambient water quality criteria.
- The Human Health Risk Assessment results indicate no unacceptable risks for onsite receptors (DMT workers, visitors, construction workers, and utility workers) or recreational users potentially exposed to surface water and sediment in the cove adjacent to DMT. The air migration pathway was evaluated by a multi-station perimeter monitoring system that has operated since September 2007. Airborne transport of Cr(VI) from COPR has not been detected.
- The Ecological Risk Assessment established that chromium and other COPR constituents do not pose unacceptable risks to potentially exposed ecological receptors.

1.2 Development of Corrective Measures Alternatives

On the basis of these major findings, MPA and Honeywell developed five alternative corrective measures alternatives for addressing COPR at DMT. The CMAA includes an evaluation of these alternative corrective measures in accordance with the 2006 Consent Decree and Maryland regulations set forth at COMAR 26.14.02.06.

The development of corrective measures followed a stepwise process:

Identify and screen state and federal requirements	→	Identify site-specific corrective measures objectives	→	Identify and screen remedial technologies (implementability, effectiveness, cost)	→	Develop corrective measures alternatives

Five corrective measures alternatives, including a containment alternative and a full-excavation alternative, as stipulated in the Consent Decree, were developed:

1. **No Further Action.** This is a baseline remedy against which other remedies may be compared. It includes maintaining all current corrective measures and activities that were completed prior to the 2006 Consent Decree, such as collecting and treating dry-weather flow from the 14th and 15th Streets storm drains, monitoring groundwater, monitoring stormwater, and implementing institutional controls for workers encountering COPR.
2. **Basic Containment.** This remedy includes the elements of Alternative 1 and adds interim measures required under the 2006 Consent Decree, such as a formalized surface cover maintenance program and site drinking water monitoring.
3. **Enhanced Isolation and Containment.** This remedy includes the elements of Alternatives 1 and 2 and the rehabilitation and lining of storm drains constructed in COPR to mitigate discharges of Cr(VI) to stormwater, and the development and implementation of a Performance Management Program (PMP) that incorporates surface cover maintenance, sentinel groundwater monitoring, sentinel stormwater

monitoring, COPR-movement monitoring, institutional controls, and contingency planning.

4. **Partial Excavation.** This remedy includes the elements of Alternative 1 plus removal of all COPR above the groundwater table and replacement of all utilities in clean utility corridors to minimize the need for institutional controls.

5. **Full Excavation.** This remedy consists of the removal of all COPR at DMT and removal and replacement of all structures and utilities within the COPR fill area.

These alternatives were then screened against the criteria required under the 2006 Consent Decree, including:

- Protection of human health and the environment;
- Compliance with state and federal regulations (Applicable or Relevant and Appropriate Requirements, or ARARs);
- Long-term effectiveness and permanence;
- Potential for reducing toxicity, mobility, or volume through treatment;
- Short-term effectiveness of the remedy, including the short-term risks and impacts of the remedy;
- Ease or difficulty of implementing the remedy;
- Cost of the remedy; and
- Degree to which a remedy will interfere with the ongoing business operations of MPA and its tenants, clients, and employees.

The remedial approach for each alternative has been developed to be consistent with statutes and regulations governing Maryland cleanup programs and to take into account cleanup objectives, community interests, the reasonableness of cleanup timeframes, and the protectiveness of the cleanup actions.

1.3 MDE Selection of a Remedy

A comparative evaluation of the five corrective measures alternatives was completed to assist MDE in the selection of the corrective measure for DMT. Although this CMAA contains a comparative analysis of the corrective measures alternatives, MDE will ultimately select the remedy.

Pursuant to COMAR Chapter 26.14.02.06(F)(3)-(4), MDE will select a remedy using a three-step comparative analysis:

1. To be considered for selection, it is mandatory that the alternative is protective of human health and the environment and complies with ARARs.

2. The four effectiveness criteria (long-term effectiveness; reduction in toxicity, mobility, or volume through treatment; short-term effectiveness; and implementability) as well as the impact to port operations are then considered to determine overall effectiveness.

3. The lowest-cost remedy that provides an acceptable balance of the effectiveness criteria (including the impact to port operations) may be selected.

1.4 Comparison of Effectiveness of Corrective Measures Alternatives

All five alternatives are protective of human health and the environment. The No Further Action Alternative (Alternative 1) does not fully comply with ARARs because it does not address storm drain discharges. For the remaining alternatives, a comparison of their overall effectiveness using the four effectiveness criteria is as follows:

- Basic Containment (Alternative 2) technically complies with ARARs because storm water discharges are permitted under a National Pollutant Discharge Elimination System (NPDES) permit, but it is inferior to Enhanced Isolation and Containment (Alternative 3) because under Alternative 2, no mechanism is provided to contain and isolate sources of groundwater infiltration into the storm drains. In contrast to Alternatives 1 and 2, which focus on *treating* contaminated groundwater that enters the storm drains, Alternative 3 focuses on *preventing* contaminated groundwater from entering the storm drains. This focus on prevention represents a paradigm shift and is a more environmentally sound approach to limiting the movement of Cr(VI) into storm drains.
- None of the alternatives includes a treatment component that would reduce toxicity, mobility, or volume. Therefore, the containment alternatives (Alternatives 2 and 3) and the excavation alternatives (Alternatives 4 and 5) provide similar levels of reduction of toxicity, mobility, and volume.
- The excavation alternatives (Alternatives 4 and 5) are significantly inferior to the containment alternatives (Alternatives 2 and 3) in short-term effectiveness during implementation because Alternatives 4 and 5 present additional risks to human health, the environment, and the community during implementation without providing any substantial improvement in effectiveness or protectiveness. In addition, both excavation alternatives would take approximately 10 to 13 years to fully implement. In comparison, Enhanced Isolation and Containment (Alternative 3) can be completed within approximately 2 to 3 years.
- Major elements of the Enhanced Isolation and Containment (Alternative 3) have been successfully implemented at DMT with manageable disruption to port operations and with minimal economic impact. It is anticipated that the remaining elements of Alternative 3 can be implemented and completed with minimal impact to port operations and the community.
- Both excavation alternatives (Alternatives 4 and 5) have significant short-term impacts, including the following:
  - Substantial additional greenhouse gas emissions from the combustion of nonrenewable energy during the large-scale excavation, material handling, rail transport, and offsite disposal of COPR and COPR-impacted materials at a hazardous waste landfill;

  - Generation of other emissions associated with fuel combustion and power production, including particulate matter, SO_x, and NO_x;
  - Use of a significant volume of landfill capacity and backfill material (material intensity);
  - Increased potential for community impacts such as traffic congestion due to truck and railcar traffic to and from the port and noise and light pollution associated with night-shift activities, material transport via barge on the Patapsco River, onsite material handling and rail car transport primarily during night-time hours, and ingress/egress from the port; and
  - Increased potential for injury and fatalities to onsite workers and the community associated with increased vehicle traffic, significant additional hours worked, and the potential for train derailment, which would result in the release of hazardous materials.

- Both excavation alternatives (Alternatives 4 and 5) are significantly inferior to the containment alternatives (Alternatives 2 and 3) with respect to implementability. Excavation activities would have an unacceptably disruptive impact on port tenants, port operations, and the community. It is possible that MPA could permanently lose tenants to other states in the competitive marine port business to avoid the nuisance to their operations caused by these remedial alternatives:
  - At a minimum, a rolling 15-acre area would have to be taken out of the space available for leasing to tenants. This would result in a continual and rolling process of tenant relocation and disruption to ongoing port operations. Loss of port revenue as a result of the loss of the use of the minimum of a 15-acre area during remedy implementation is estimated to be on the order of $6.3 million over 7 years for Alternative 4 and on the order of $9 million over 10 years for Alternative 5. These losses in port revenue are in addition to the cost of the remedy.
  - Numerous onsite buildings would have to be demolished, and the tenants in those buildings would need to be relocated offsite, where new buildings would likely need to be obtained or constructed.
  - The infrastructure development necessary to support the excavation remedies is also likely to further disrupt port activities. The excavation remedies require significantly expanded trucking and rail loading facilities, significant changes in security structures and operations at DMT, and the reconfiguration of a key ship berth.
  - Together, the economic impact of these substantial disruptions to port operations is estimated to be roughly $67 million over 7 years for the Partial Excavation alternative (Alternative 4) and $96 million over 10 years for the Full Excavation alternative (Alternative 5). This economic impact is in addition to the cost of the remedy. These losses do not include lost leases from tenants relocating to other facilities.

- Further, direct and indirect economic impact to the local community from lost revenues from land lease and marine activity is estimated to be on the order of $14 million over 7 years for Alternative 4 and on the order of $20 million over 10 years for Alternative 5. This economic impact is also in addition to the cost of the remedy.

- Enhanced Isolation and Containment (Alternative 3), Partial Excavation (Alternative 4), and Full Excavation (Alternative 5) provide similar levels of long-term effectiveness, although Alternatives 4 and 5 would be considered to have greater permanence than Alternative 3 because they require less maintenance and reduce the need for institutional controls in the long term.

In summary, the containment alternatives (Alternatives 2 and 3) provide greater overall effectiveness than the excavation alternatives (Alternatives 4 and 5), including the timeframe to implement and the level of disruption to the port and the community. Of the containment alternatives, Alternative 3 is superior to Alternative 2 for the reasons set forth above. Implementing Alternative 3 (Enhanced Isolation and Containment) may cost up to $138 million (net present value) for all activities encompassed in the remedy, which is significantly less than Alternative 4 ($693 million [net present value]) or Alternative 5 ($1.36 billion [net present value]). Cost estimates for corrective measures alternatives are provided in Appendix A.

1.5 Report Organization

This CMAA is organized into the following sections:

1. **Introduction.** Includes the criteria for developing corrective measures, CMAA organization, and pertinent background information relative to the development of corrective measures.

2. **Results of Completed Site Studies.** Includes a summary of port operations and infrastructure and a summary of the studies that have been completed under the 2006 Consent Decree.

3. **Current Corrective Action Programs.** Includes descriptions of the ongoing maintenance and monitoring programs, interim corrective measures implemented at the site, and pilot studies of candidate remedial measures that have been completed or are ongoing at DMT.

4. **Corrective Measures Objectives.** Summarizes applicable, relevant, and appropriate federal and State of Maryland laws and regulations (ARARs) and corrective measures objectives to conform to ARARs.

5. **Response Actions and Screening of Remedial Technologies.** Presents the development of general and medium-specific response actions based on ARARs and corrective measures objectives and describes the identification and screening of candidate remedial technologies to satisfy the response actions.

6. **Corrective Measures Alternatives Development.** Summarizes the technology selection and Consent Decree screening criteria relative to the environmental media of concern and the development of corrective measure alternatives.

7. **Detailed Analysis of Corrective Measures Alternatives.** Presents the results of the technical evaluation of alternatives relative to ARARs, remedial objectives, and screening criteria identified in the Consent Decree. This section also presents a comparative analysis of the alternatives through a balance of overall effectiveness and cost.

8. **References.** Lists documents used in preparing the CMAA.

SECTION 2

Results of Completed Site Studies

2.1 Site Description

This section provides background information for the DMT site. It includes a brief description of existing port operations, construction, infrastructure, geology, hydrogeology, contaminant characteristics, fate and transport, and results of human and ecological risk assessments for the site.

2.1.1 Port Operations

The Port of Baltimore is a nationally significant port and serves as a vital economic asset for Baltimore, the State of Maryland, and the region. Port activity creates about 16,700 direct jobs in the region, accounting for approximately $3.7 billion in wages and $3.2 billion in business revenues and local purchases each year. In 2009, the Port ranked as the 15th largest port in the U.S., handling 22.4 million tons of foreign cargo valued at more than $30.2 billion; the Port ranked 12th in the nation in value of foreign cargo. The Port leads the nation in handling imported roll-on, roll-off (Ro-Ro) equipment, sugar, gypsum, and forest products. The MPA manages six marine terminals in the Port of Baltimore.

DMT comprises 580 acres on a peninsula bounded on the west by Colgate Creek, on the south and east by the Patapsco River, and on the north by Broening Highway (Figure 2-1).

FIGURE 2-1
Aerial Photograph of Dundalk Marine Terminal—Looking East

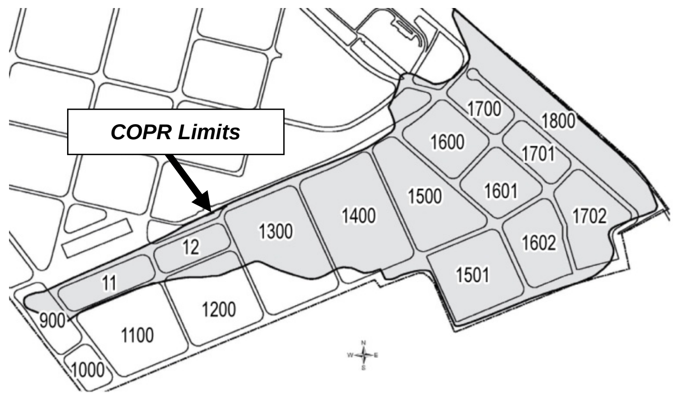
MPA leases facilities and real estate to tenants having maritime interests. Those tenants include vessel owners and operators, auto processors, terminal operators, and others with ancillary maritime business.

2.1.2 Site Construction

The DMT property is divided into two main areas separated generally by East Service Road. The portion of the port north of East Service Road, encompassing an area of approximately 372 acres, was constructed circa 1940 on reclaimed land.

A portion of the remaining 208 acres, south of East Service Road, make up what is known as the "COPR fill area," which was also constructed from reclaimed land (CH2M HILL, 2008). The fill material used to reclaim the land includes mixtures of both COPR and locally available non-COPR fill material. The CMAA is focused primarily on the 148-acre COPR fill area, shown in Figure 2-2.

FIGURE 2-2
Lateral Extent of COPR



DMT is divided into geographic areas associated with port operations. The southern and western boundaries of the COPR fill area contain a sheet pile wall and a pile-supported concrete platform that extends over the Patapsco River shoreline. To the southeast, along Areas 1501 and 1602, there is a riprap shoreline that slopes from the terminal area to the Patapsco River. This area includes an engineered clay containment cell that isolates and contains COPR with an 8-foot-thick layer of soil and asphalt surfacing placed on top. Along the northern extent of the COPR fill area is a railroad track and the East Service Road, which separate the original DMT land holdings from the COPR fill area. The eastward limit of the COPR fill area is bounded by Broening Highway. Figure 2-3 shows DMT tenants as of 2010, depicting each tenant and their real estate boundaries.

2.1.3 Port Infrastructure

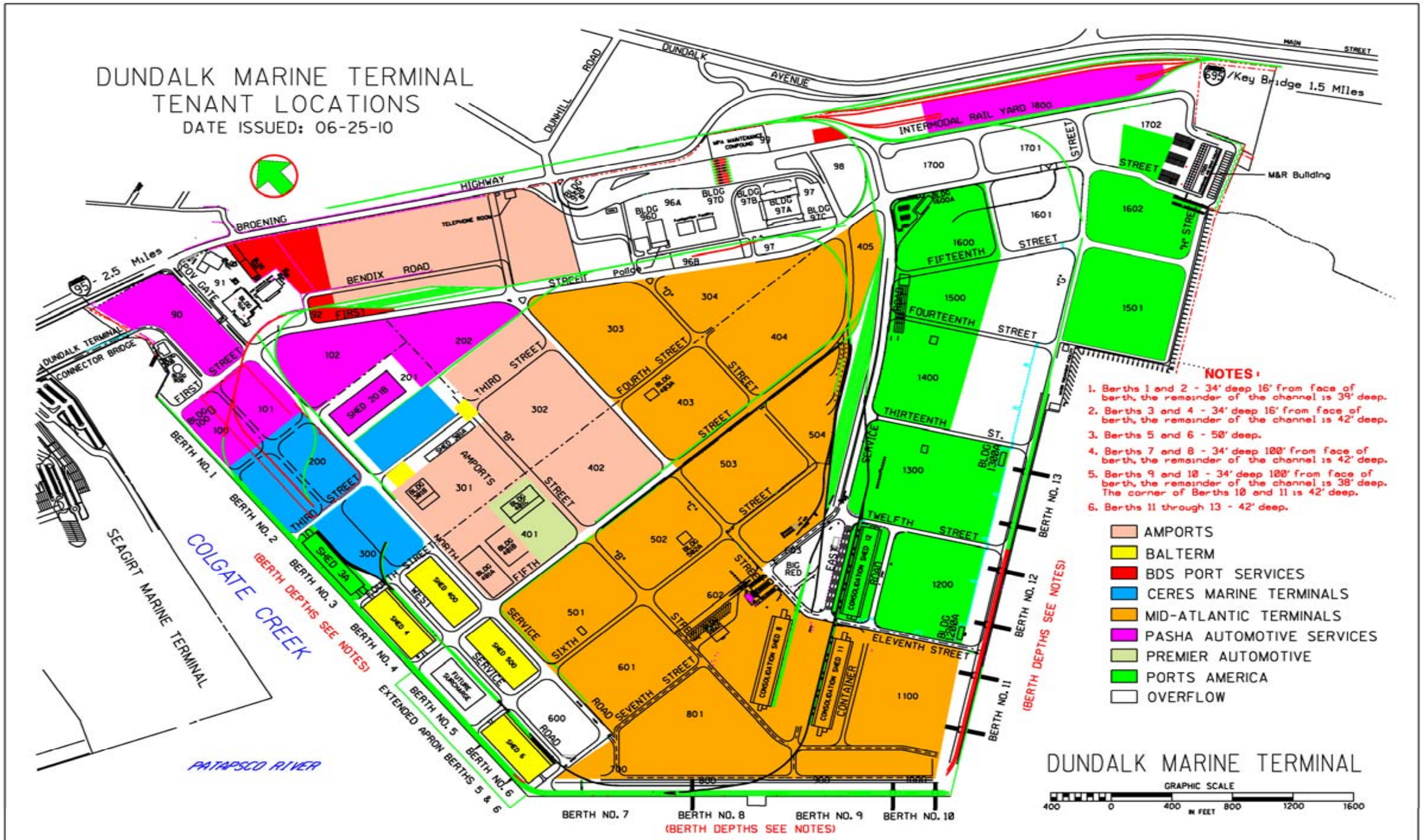
Existing Buildings and Structures

DMT includes 13 shipping berths, which occupy approximately 9,500 linear feet of wharf. A variety of building structures is present at the terminal, including the following principal structures:

- Freight consolidation sheds
- Transit sheds
- Gear shed
- MPA maintenance buildings
- Automobile-processing buildings
- Administration, office, and marine service buildings
- Temporary or modular canopies, buildings, trailers, and sheds

Major buildings and structures within the DMT fill area include Shed 11, Shed 12, two marine service buildings, a wastewater treatment plant (WWTP), and tenant maintenance buildings. The total area occupied by buildings within the COPR fill area is approximately 6.4 acres.

FIGURE 2-3
Map of DMT Tenants



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Port Operations

DMT is a large cargo-handling facility operated by the MPA. Over three million tons of general cargo, which represents approximately $20 million in revenue to the MPA, passes through DMT annually. The tenants at DMT include auto and Ro-Ro processors, stevedore companies, terminal operators, vessel owners and operators, and others with ancillary maritime business. All of this cargo activity at DMT is a major source of economic impact for the State of Maryland:

- There are approximately 5,900 jobs at DMT, broken down as follows:
  - 2,450 are direct jobs generated by cargo and vessel activities at the DMT. Examples include jobs with railroads, trucking companies, terminal operators, cargo handling (International Longshoremen's Association), manufacturing, towing, pilots, ocean carriers, and agents.
  - 2,700 are induced jobs consisting of employment created by the local purchase of goods and services by direct employees. These jobs would be lost in the short term if the direct jobs were terminated. Examples include sales clerks, mechanics, teachers, and government employees.
  - 750 are indirect jobs, which are those supported by the purchases of the local business employers who create the direct jobs. These jobs would also be lost in the short term if the direct jobs were lost. Examples include those who provide office supplies and equipment, utilities, communications, repair, and legal and financial services.
- DMT is a major source of personal wages and tax revenues in Maryland:
  - DMT is responsible for about $450 million in personal annual wage and salary income.
  - DMT activities generate about $50 million in state and local taxes every year.

MPA maintains significant infrastructure in support of DMT and tenant operations, including various marine service buildings, numerous canopies, and modular buildings that are used by or leased to tenants. DMT is a multiuse facility and has a host of ongoing operations, such as handling containers, break bulk, autos, Ro-Ro equipment, and forest products. DMT's infrastructure includes the following:

- Centralized access gate with five inbound container lanes, four inbound non-container lanes, four outbound container inspection lanes, and two outbound bypass lanes;
- Thirteen berths;
- Nine permanent container cranes and one mobile 300-ton Manitowoc crane;
- Ten warehouse sheds with a combined storage capacity of approximately 21 acres under roof (742,390 ft^2);
- Direct rail access to all berths and sheds and two rail storage yards, with total storage track of 9,300 feet and two storage tracks of 2,000 feet each, and five loading/unloading tracks;

- Stevedores at three locations (Balterm, Ceres, Ports America);
- Vehicle processors at Amports, BDS Port Services, Pasha, and WWL Vehicle Services Americas; and
- A network of storm drains and utilities, including water, sanitary, electric power, high mast lighting, and communication, that serves DMT (natural gas service is available along the North Service Road).

Critical intersections and roadways that pass through the COPR fill area must remain in service for the transport of maritime cargo to and from tenant warehouses and the berths. These include the following:

- The East Service Road is a two-lane inbound and outbound street used for truck transport to access the tenants on the eastern side of the terminal. Two-lane access for traffic along this road is essential for DMT's material-handling operations.
- Operations of the non-container (Ro-Ro and general cargo) area of Ports America and Mid-Atlantic Terminals involve conveying cargo to Sheds 11 and 12, which are accessed via 11th, 12th, and C Streets, where there is significant traffic flow. Other critical roadways such as G Street and 1st Street must remain unimpeded.
- Shared berth area along the east side of DMT is used by all tenants, so ingress and egress to this area is critical to meeting tenant cargo-handling requirements.

In summary, DMT is a large, complex facility; MPA manages and coordinates all aspects of cargo operation, berth and crane assignments, leasing of terminal acreage and sheds, and tenant interfacing and monitors terminal activities, including the stevedoring and vehicle-processing companies. MPA also regularly interfaces with the trucking and railroad communities, ensuring coordinated flow of traffic into and out of the terminal.

Existing Pavement Systems

The surface of DMT consists primarily of heavy-duty paved surfaces, with the exception of areas where building structures and railroad tracks exist. The total area of paved surface within the COPR fill area is approximately 148 acres, of which 6.4 acres are occupied by buildings.

Specific areas within the COPR fill area have undergone extensive testing of alternative pavement technologies. Pavement systems pilot tested at DMT consist of conventional asphalt (i.e., bituminous concrete), roller-compacted concrete (RCC), low-permeability asphalt (i.e., Matcon), and ABC. The pilot test programs are discussed in detail in Sections 3.2.7 and 3.2.8.

Pavements within the COPR fill area function as both a working surface for DMT operations and as a cover system for COPR-filled areas. The asphalt pavement has been in place for over 30 years and consists of a multilayer bituminous blend that is a minimum of 15 inches thick to support the equipment used for handling and transporting freight.[1] A rigorous

[1] Minimum asphalt pavement thickness at DMT is 15 inches, consisting of at least 8 inches of aggregate base and 7 inches of asphalt surfacing. The minimum asphalt surfacing component consists of 4 inches of asphaltic concrete base and 3 inches of asphaltic concrete wearing surface materials.

semiannual inspection, repair, and repaving program is being performed in which an average of $1 million per year is being expended maintaining and upgrading the pavement systems. Additional details regarding the inspection, repair, and repaving program are presented in Section 3.1.1.

Belowground and Aboveground Utilities

Utilities at DMT include the potable water supply system, sanitary wastewater conveyance systems, stormwater conveyance systems, electricity, high-mast lighting, and communications. Natural gas service is present along the North Service Road. Utilities within the COPR fill area include electrical and communication lines, storm drains, and potable water and sanitary sewer lines.

Major electrical service is located along East Service Road, within an interior corridor that extends from 10th Street to 15th Street. There are two major high-voltage loops: one servicing the area north of 15th Street and one servicing the area between 10th Street and 12th Street. Communication services are generally co-located with the electrical lines, within concrete-encased duct banks and manhole structures.

The main sanitary sewer lines include a force main along 15th Street and a force main extending from 10th Street to 15th Street along the extended alignment of Container Road. The force mains convey sewage to a gravity sewer line northwest of East Service Road. Sewer extensions include an extension into the area north of 15th Street, an extension along 10th Street and G Street to Marine Service Building No. 12, and an extension along 13th Street to Marine Service Building No. 13.

The utility infrastructure at DMT was surveyed, field verified, and spatially referenced on utility maps using geographic information system (GIS) software. These utility maps have been used for the development of remedial alternative scenarios.

Stormwater Collection System

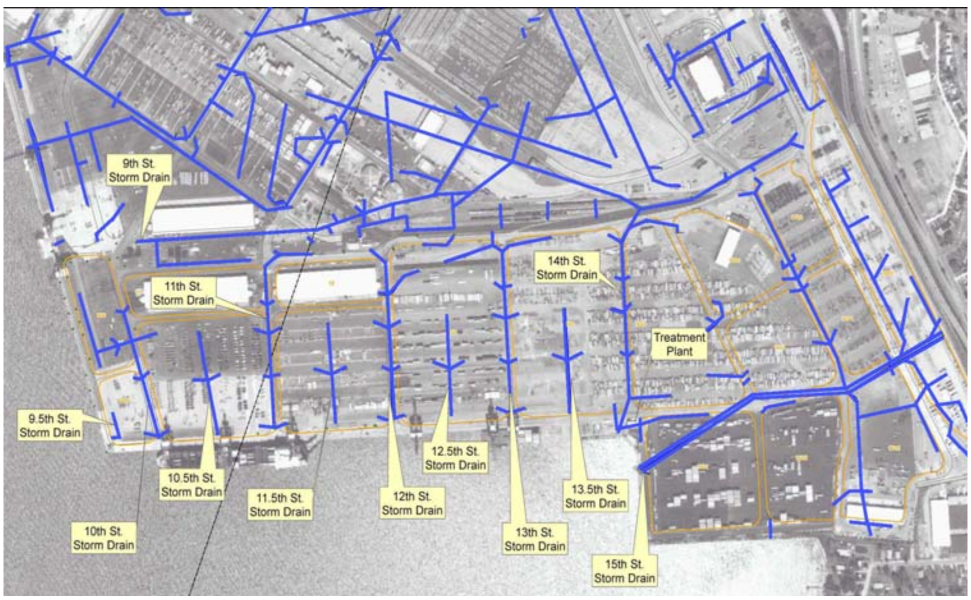
Stormwater at DMT is managed via a network of inlets and underground stormwater drains that collect and convey stormwater to the Patapsco River and Colgate Creek. The portion of the underground stormwater conveyance system within the COPR fill area consists of 12 storm drains: the 9th Street, 9.5th Street, 10th Street, 10.5th Street, 11th Street, 11.5th Street, 12th Street, 12.5th Street, 13th Street, 13.5th Street, 14th Street, and 15th Street storm drains. The locations and configurations of these storm drains are shown in Figure 2-4.

The 9th Street through the 13.5th Street storm drains were installed as the COPR fill area was being constructed. Portions of the 12th Street, 12.5th Street, 13th Street, 13.5th Street, 14th Street and 15th Street drains are constructed in COPR fill. The 9th Street, 9.5th Street, 10th Street, 10.5th Street, 11th Street, and 11.5th Street storm drains are constructed in non-COPR fill. Stormwater drainage into the drains is through brick or concrete inlets with surface gratings. Drainage is typically from the north to the south, terminating at an outfall. The outfalls exit beneath and through the sheet-pile bulkhead behind the pile-supported marine platform along the southern edge of the site. Some of the outfalls are partially submerged at mean high tide, and several have top-of-pipe elevations lower than mean low tide.

The 14th and 15th Streets storm drains were originally constructed in fill material consisting predominately of COPR. In the 1990s and as part of the 1992 Consent Order, MPA constructed outfall retention structures at these storm drains. These outfall structures were designed to (1) prevent the Patapsco River tidal waters from entering the 14th Street and 15th Street storm drains and (2) provide a means to capture and temporarily store infiltrated groundwater for subsequent treatment at the onsite WWTP. The 15th Street storm drain also receives surface water run-off from the Community of Dundalk through two 80-inch-diameter lines that extend beneath Broening Highway.

The WWTP is designed to adjust the hydrogen (ion) concentration (pH), remove chromium by precipitation, readjust the pH, and then discharge treated water to the Patapsco River pursuant to an NPDES permit (EA, 1987). Details on the WWTP operation are presented in Section 3.2.6.

FIGURE 2-4
Storm Drain System



Each storm drain was evaluated and categorized, with the results reported in the "Addendum to the Work Plan for Quantifying Chromium Transport from Stormwater Outfalls to the Patapsco River, Dundalk Marine Terminal, Baltimore, Maryland" (CH2M HILL, 2008). This report discusses the classification of each storm drain as "priority" or "nonpriority" on the basis of three key criteria:

- Location relative to the presence of COPR fill;
- Observed dry-weather flow and presence of chromium concentrations; and
- Degree of tidal influence and distance surface water extends into the storm drain.

Based on these criteria, the 12th, 12.5th, 13th, 13.5th, 14th, and 15th Streets' storm drains were determined to be priority drains, and the remaining six storm drains nonpriority. Nonpriority drains (9th through 11.5th Streets) do not factor into the remedy development approach because they are not located in COPR, they have minimal tidal influence, and chromium concentrations from dry-weather flow are absent or at de minimis levels. The priority drains do factor into the remedy development approach and are considered a migration pathway of concern. Investigation and pilot testing of priority storm drains is discussed in Sections 3.2.3 and 3.2.4.

2.2 Geology and Hydrogeology

Shallow soils beneath the site are composed of a westward-thickening sequence of anthropogenic fill, which includes both COPR fill and non-COPR material and native sediments. COPR fill originates from processing chrome-bearing ores to produce various chrome products. Unweathered COPR is composed fundamentally of small, subspherical nodules (0.2–2 mm in diameter) and has unique chemical, geotechnical, and mineralogical properties. After its burial at the fill site, interaction between COPR and water resulted in hydration of certain COPR constituents, causing chemical, geotechnical, and mineralogical changes in the COPR.

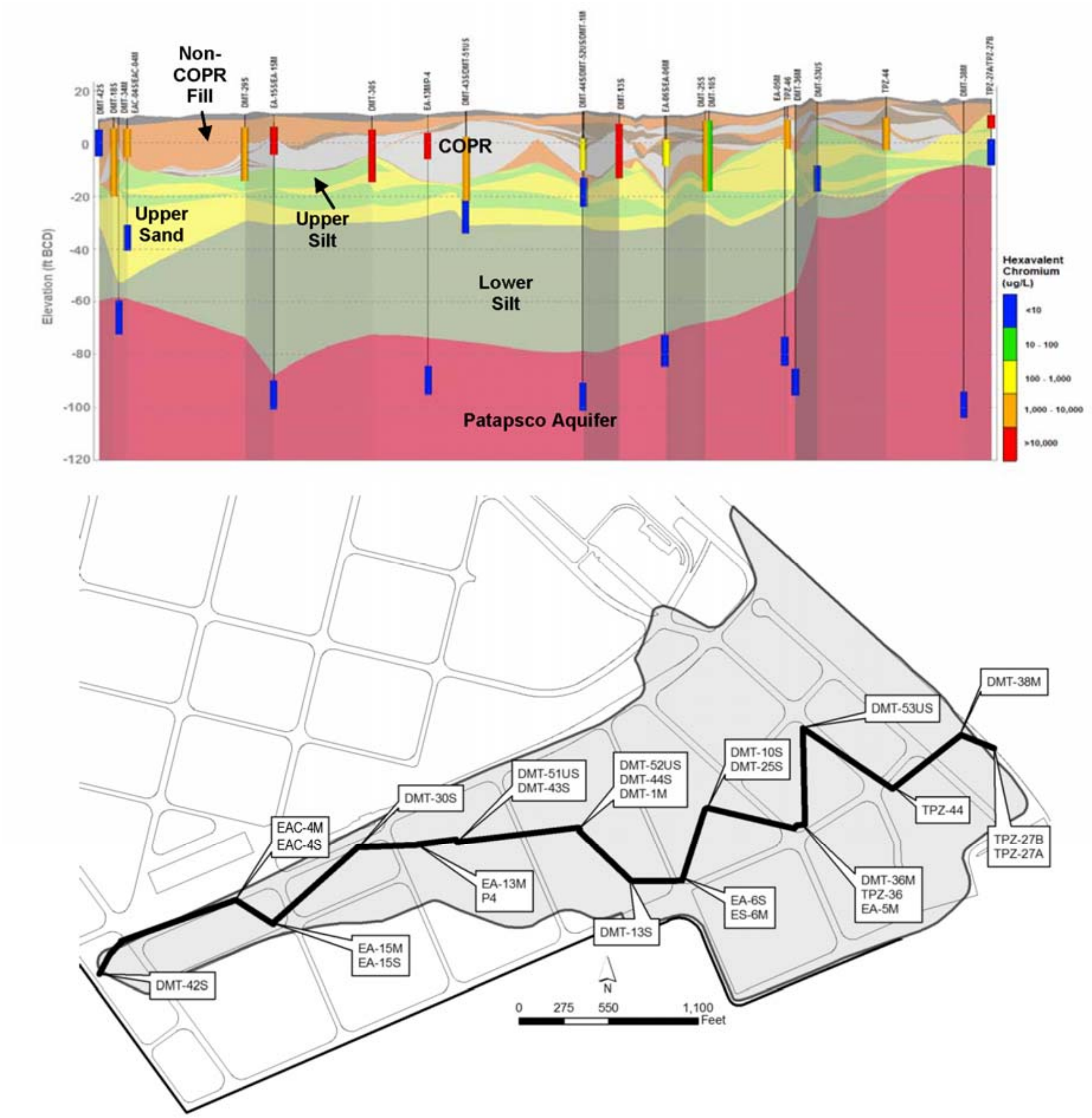
Two basic types of COPR have been identified at DMT based on physical, chemical, and mineralogical characteristics (GeoSyntec, 2004): hard-brown (HB) COPR, a moderately to strongly lithified (indurated) material, and gray-black (GB) COPR, a particulate material, grading to a weakly cemented appearance and very friable (i.e., easily crushed by hand pressure).

Underlying the COPR fill are alluvial sediments, which reflect a relatively low-energy environment of deposition within the Patapsco River basin. The alluvial sediments thicken westward and are composed of the Upper Silt, Upper Sand, and Lower Silt units. The deepest soil units encountered below the site are classified as Potomac Group sediments. Soil stratigraphy is detailed in the "COPR Investigation Report, Dundalk Marine Terminal, Baltimore, Maryland" (CH2M HILL, 2009a). Figure 2-5 illustrates the shallow soil stratigraphy beneath DMT.

The Upper Silt unit referenced above limits the migration of shallow groundwater into the Upper Sand unit and deeper Patapsco Aquifer. The Upper Sand unit exists as a relatively thin and discontinuous layer bounded above the Lower Silt. Along the southern and western property boundary of DMT, a vertical sheet pile bulkhead is driven into the Lower Silt, significantly limiting groundwater flow to the Patapsco River. The Lower Silt is thick (40–50 feet), contains a high percentage of fines, is a reducing horizon, and is characterized as having low permeability and limiting the vertical flow of groundwater from the shallow fill unit to the deeper Potomac Group sediments.

The Potomac Group sediments consist of stratified sand, silt, and clay. The clay unit is characterized as having low permeability ($\sim 9.2 \times 10^{-8}$ cm/sec) and was encountered at the site in a thickness up to 23 feet. The lithologic and geotechnical characteristics of the clay intervals are consistent with descriptions of the Arundel Formation in the greater Baltimore area, and all data collected to date from DMT and in the vicinity of DMT indicate that the Arundel Formation is continuous beneath DMT. Groundwater flow in the upper portion of the Potomac Group is to the south-southwest under an average gradient of 0.0015 ft/ft.

FIGURE 2-5
Northeast-to-Southwest Soil Stratigraphy Beneath DMT



The stratigraphy beneath Areas 1501 and 1602 consists of a relatively uniform thickness of COPR enclosed within a clay cell and clay cap. Approximately 6–10 feet of sand fill lies beneath the COPR and clay cell. Above the COPR and clay cell is approximately 8–10 feet of surcharge fill that was placed in 2000–2002. COPR beneath Areas 1501 and 1602 is characterized as being extremely dense and difficult to penetrate, which is consistent with the area being underlain by a thick sequence of HB COPR (CH2M HILL, 2009a).

2.3 COPR Fill Boundary and Characteristics

COPR is a byproduct of the production of dichromate from chromium-bearing ores. Summarized below are pertinent concepts related to the extent of COPR fill and the characteristics of chromium transport that relate to the development of remedial alternatives. A comprehensive description of COPR is provided in the COPR Investigation Report (CH2M HILL, 2009a).

2.3.1 COPR Fill Boundary

The extent of COPR at DMT has been defined by subsurface investigations consisting of over 400 borings, test pits, and monitoring wells and reviews of historical documents, aerial photographs, and construction records.

Investigation of the COPR fill area at DMT determined the following:

- The lateral extent of COPR within the fill area includes approximately 148 acres of DMT, as shown in Figure 2-2;
- COPR extends to a maximum depth of approximately 38.5 feet and ranges in thickness from 1 foot to 32 feet within the fill area;
- Approximately 2.5 million yd^3 of COPR exists within the COPR fill area; and
- COPR is covered by non-COPR fill and pavement material within the COPR fill area.

The bulk of the COPR fill material is encountered in a contiguous area south of the East Service Road (Figure 2-2). The northern COPR boundary mostly parallels the historic shoreline/bulkhead that was present in the vicinity of the East Service Road prior to land reclamation. The northern boundary is defined by subsurface data, and its position is also supported by the following evidence:

- The historic permitted COPR placement areas were south of the historic shoreline/ bulkhead, and aerial photographic evidence suggests that COPR placement was limited mainly to the permitted areas.
- Areas north of the historic shoreline/bulkhead were occupied by an operational airport and industrial facilities throughout much of the period that COPR was being placed within the permitted areas as land reclamation fill.
- Three small areas of COPR are located north of the historic shoreline and are identified in Figure 2-2. It is suspected that COPR may have been used to fill low-lying areas and for other grade adjustments in these small areas.

2.3.2 COPR Characteristics Related to Transport

Analytical results from the COPR investigation (CH2M HILL, 2009a) indicate there is limited horizontal and vertical transport of Cr(VI) from the COPR fill area. Cr(VI) concentrations in the alluvial soils that immediately underlie the COPR fill are typically decreased by two to three orders of magnitude within a few feet of the COPR mass. The observed trends can be explained by the fact that the soil units and, more importantly, the groundwater underlying DMT offer a reductive environment for the reduction of Cr(VI) to Cr(III), typically $Cr(OH)_3$, which is insoluble. Furthermore, the organic-rich sediments that underlie the COPR fill area act as a natural barrier to the migration of Cr(VI) due to their reducing environment.

2.3.3 Heave Monitoring and Evaluations

The Heave Investigation and Minimization Study (HIMS) (GeoSyntec, 2009) provides the results of field investigations, monitoring, laboratory studies, and pilot programs related to the factors that cause mineralogical transformation and volumetric expansion of COPR. Key findings of this report are presented below to provide the basis for developing remedial alternatives. The main findings and conclusions of the HIMS are as follows:

- *Extent and nature of COPR at DMT are well defined.* The results of field investigations and studies described in Section 4 of the HIMS report have been used to define the depth and lateral extent of COPR and the relative distribution of GB COPR and HB COPR at the site. In addition, an extensive program of field and laboratory testing was completed to characterize the chemical, mineralogical, and geomechanical properties of COPR. This information was used to develop a detailed conceptual site model describing the thickness, extent, chemical and mineralogical characteristics, and geomechanical properties of COPR.

- *Transformation and expansion mechanisms are well understood.* The field investigations, monitoring, field and laboratory testing, and pilot programs performed during the HIMS have provided information to develop a thorough understanding of COPR mineralogical transformation and volumetric expansion, which is presented in Section 5 of the HIMS. The investigation and study results described in the HIMS demonstrate that the transformation and expansion of COPR are primarily a function of the occurrence of wet–dry cycles in the vadose zone, the location of COPR relative to the groundwater table, specific geochemical conditions of the COPR pore water in the vadose zone, differences in geomechanical behavior between nonlithified GB COPR and lithified HB COPR, COPR particle size, and presence/absence of passivation effects. A validated and unifying conceptual model has been developed for the lithification and expansion of COPR at DMT to demonstrate that the mechanisms causing COPR transformation and expansion at DMT are well understood.

- *COPR movement and heave magnitudes and rates are well understood.* The results from the displacement monitoring of COPR at the site (HIMS Section 7) can be used to define the magnitudes and rates of COPR movement (lateral) and heave (vertical) at DMT. This information, together with the understanding of COPR transformation and expansion presented in HIMS Section 5 and the site conceptual model presented in HIMS Section 4, demonstrates that COPR movement and heave can be classified, quantified, monitored, and modeled.

- *COPR movement at DMT is not a significant environmental or public health issue.* It is demonstrated that heave manifestations do not result in the exposure of COPR at the surface, and appropriate protocols are in place to protect workers and others from exposure during any excavations into COPR.

- *Effective engineering measures exist to prevent or mitigate impacts associated with COPR movement and heave*. In HIMS Section 6, it is shown that special pavements, strain relief trenches (SRTs), routine pavement inspection, and repair and surcharge loads have been effectively used at DMT to prevent or mitigate damage (where required) that might result from COPR movement and heave. These engineering measures can be used individually or in combination to address the specific COPR movement and heave behavior revealed through monitoring for the specific infrastructure features to be maintained or protected.

- *COPR monitoring and maintenance programs have successfully managed heave.* As described in HIMS Section 7, monitoring and maintenance programs have been implemented at DMT over many years. Results from these programs have shown that COPR movement and heave occur slowly and can be detected before significant damage occurs to pavements or structures. Monitoring and maintenance programs conducted at DMT have been effective in preventing heave-related COPR exposure at the ground surface.

In summary, the extensive information and findings presented in the HIMS report are sufficient to strongly support the conclusion that COPR movement and heave can be monitored, that the rates of such movements and heave are sufficiently slow to provide ample time to respond to the monitoring results, that potentially damaging effects of these movements and heave can be monitored, prevented, or mitigated using engineering controls, and that COPR movement and heave do not pose a threat to the environment and human health.

A number of technologies have been used successfully at DMT to manage the effects of COPR lateral displacement and heave on site infrastructure:

- *Surcharge loading* (see Section 3.2.10) involves placing a thick layer of soil (i.e., surcharge fill) on top of COPR to provide vertical confinement. Surcharge loading has been used effectively to restrain heave in Areas 1501 and 1602.
- *Strain relief trenches* (SRTs) (see Section 3.2.9) are trenches filled with soft material that accommodates COPR lateral movement, thereby protecting nearby underground structures from those movements. Strain relief trenches have been used effectively at DMT in Areas 1501, 1602, and 1800.
- *Special pavements and modified conventional pavements* (see Sections 3.2.7 and 3.2.8) are less permeable and facilitate heave management better than conventional pavements. These pavements have been used effectively in Areas 1702 and 1800.

Evaluation of these technologies demonstrates that engineering measures are available and implementable to prevent or mitigate damage due to COPR lateral displacement and heave. Field evaluations demonstrate that these technologies can be used individually or customized in combination to address a specific area or infrastructure to be maintained or protected.

2.4 Fate and Transport of Chromium

The Chromium Transport Study (CTS) (CH2M HILL, 2009b) report presents the quantities and valence states of chromium potentially being transported via storm drain flow, groundwater, and tidal exchange with groundwater and storm drain flow in the storm drain system to the Patapsco River and Colgate Creek. Key elements of the CTS are presented below. These findings constitute an additional factual basis for evaluating and developing remedial alternatives in this CMAA.

2.4.1 Groundwater Transport

Reductive mechanisms and physical barriers to groundwater movement limit the offsite transport of chromium in groundwater. Groundwater is a secondary pathway for chromium transport to the river; however, deeper groundwater has not been impacted. These mechanisms and barriers have been effective since the time of COPR placement.

Concentrations of Cr(VI) in monitoring wells located at the downgradient perimeter of the site are all below MDE groundwater standards and the Environmental Protection Agency's (EPA) Nationally Recommended Water Quality Criteria (NRWQC). Cr(VI) transport by direct groundwater flow at the site boundary with the Patapsco River has been calculated at approximately 1.60 lbs/year from the shallow aquifer and does not constitute a major transport pathway to the river (CH2M HILL, 2009b). Further, the calculation does not take into account retardation and reduction of hexavalent chromium in the aquifer. Geochemical evidence collected at DMT demonstrates the reduction of hexavalent chromium in groundwater occurs very rapidly and within a short distance of leaving the COPR fill area. Therefore, these calculations are the most conservative representation of hexavalent chromium transport in groundwater from DMT.

2.4.2 Stormwater Transport

Portions of the storm drain system, primarily the 12th through 15th Streets storm drains, are the primary pathway for the transport of chromium to the river. No impact to the river has been observed because Cr(VI) is very quickly reduced by natural processes to Cr(III) when it enters the estuarine environment (Graham et al., 2009; Graham and Wadhawan, 2007a, b).

The results from four surface water monitoring events conducted over a 1-year period, where the samples were collected directly offshore from the storm drain outfalls, found no Cr(VI) above EPA's NRWQC (CH2M HILL and ENVIRON, 2009). While a detailed quantification of chromium mass flux in stormwater was not possible because of site conditions (storm drain outfalls located below the bulk head or at an elevation below mean low tide), sufficient data and information are available to assess corrective measures and evaluate human health and environmental risks.

Pilot studies and interim remedial measures currently underway on the 13th Street and 15th Street drains will provide means to quantify chromium mass flux and provide a mechanism to contain and isolate sources of groundwater infiltration into the drains. As an element of Alternative 3, the pilot program to install tidal exclusion vaults for the purpose of quantifying mass flux would be expanded to include the other priority drains (12th, 12.5th, and 13.5th Streets).

The overland flow/runoff pathway for stormwater is not complete under current site use because implementation of the Surface Cover Inspection and Maintenance Program (SCMP) (CH2M HILL, 2007a), which includes a rigorous inspection and repair program, prevents COPR from being exposed at the ground surface.

2.4.3 Airborne Transport

The air migration pathway was evaluated by a multi-station perimeter-monitoring system that has operated since September 2007. No significant difference between upwind and downwind total particulate and Cr(VI) concentrations in air samples has been observed during the 36 months that the monitoring has been performed. The results support the finding that airborne transport of COPR particulates from DMT is not significant. This finding is expected given that COPR is contained beneath the surface cover present across DMT.

2.4.4 Surface Water and Sediments

The sediment and surface water study results were presented in the "Sediment and Surface Water Study Report, Dundalk Marine Terminal, Baltimore, Maryland" (CH2M HILL and ENVIRON, 2009). The conclusions drawn from the surface water and sediment study are the following:

- Cr(VI) was not detected in pore water in any of the samples collected in any of the four quarterly sampling events.
- Cr(VI) was not detected in 97 percent of the surface water samples analyzed, and in those limited locations where it was detected, concentrations were well below EPA's NRWQC.
- Measurements of geochemical parameters in pore water, surface water, and sediment demonstrate that conditions are favorable for the presence of chromium in the nontoxic trivalent chromium species (Cr(III)) rather than Cr (VI).
- Based on the results of this study and other related studies with respect to chromium geochemistry, total chromium in sediment is unlikely to oxidize to Cr(VI) in the future because the geochemical conditions necessary for this process do not naturally occur in the estuarine environment.

2.4.5 Summary of Chromium Transport

In summary, chromium transport via groundwater, runoff, and air are not significant. The primary potential pathway for migration of chromium and other COPR constituents from the COPR fill area to the river is storm drain discharge—primarily from the 12th through 15th Streets priority drains. This storm drain discharge results from the following:

- Groundwater seepage into stormwater drains that discharge directly to the river via outfalls, where chromium can either remain in solution or precipitate as Cr(III), depending on geochemical conditions, and
- Tidal inundation of stormwater lines.

The magnitude of resulting impact to the river is rapidly attenuated owing to geochemical processes that act to reduce and immobilize the chromium in the estuarine environment. Attenuation of Cr(VI) that has been detected in perimeter monitoring wells likely occurs in soils at the boundary of the property prior to Cr(VI)'s reaching the river sediments. Sampling results over a 1-year period found no Cr(VI) detections above EPA's NRWQC in surface water transects located at the storm drain outfalls (CH2M HILL and ENVIRON, 2009).

2.5 Human Health Risk

The HHRA was conducted in accordance with EPA risk assessment guidance (EPA, 1989) using a four-step process. In Step 1 (data evaluation), analytical data for COPR-related constituents were identified and detected concentrations were compared to risk-based screening levels to select COPCs. In Step 2 (exposure assessment), potential current and future exposure points, receptors, exposure scenarios, and Exposure Point Concentrations (EPCs) were identified. In Step 3, relevant toxicity values were selected in accordance with EPA's hierarchy for toxicity value sources. In Step 4, a risk characterization was performed and significant uncertainties discussed.

Analytical data were available from various media: groundwater, soil, air, stormwater, surface water, and sediment. The COPR-related constituents were screened to identify COPCs through a conservative selection process in accordance with EPA guidance (EPA, 1989). The COPCs in each exposure medium were identified by comparing maximum detected concentrations to EPA Regional Screening Levels (EPA, 2009). Potentially complete exposure pathways were assessed for onsite receptors (DMT workers and visitors, utility workers, and construction workers) and offsite receptors (residents near the adjacent cove, recreational users in the cove, and anglers in the Patapsco River and Colgate Creek). The scenarios that were evaluated include those most likely to represent ways that a community member could come in contact with COPR or chromium at the port.

The HHRA results indicate no unacceptable risks for onsite receptors (DMT workers, visitors, construction workers, and utility workers) or for residents and recreational users exposed to surface water and sediment in the cove adjacent to the site.

The air migration pathway was evaluated by a multi-station perimeter air monitoring system that has measured particulate and Cr(VI) concentrations for 36 months since September 2007.[2] No significant difference between upwind and downwind total particulate and Cr(VI) concentrations in air samples was observed (CH2M HILL, 2009b). This finding is expected, given that COPR is contained beneath the surface cover present at DMT, and the SCMP includes a rigorous surface cover inspection and repair program that ensures that COPR remains contained, thereby limiting the potential for chromium transport via air (CH2M HILL, 2009b).

2.6 Ecological Risk

An ecological risk assessment (ERA) was performed to evaluate the potential for chromium and COPR constituents to cause unacceptable ecological risks to receptors in the Patapsco River near DMT. The investigation was conducted pursuant to the requirements of the Consent Decree (Section III.B.7), and the results are presented in the "Ecological Risk Assessment Report, Dundalk Marine Terminal, Baltimore Maryland" (CH2M HILL, 2009c). Key findings of the ERA are presented herein and serve as a basis for developing corrective measures at DMT.

[2] Air monitoring was performed at DMT from September 2007 through August 2008 and from January 2009 through December 2010.

The ERA, consistent with EPA guidance (EPA, 1997, 1998, 2000a, 2001, 2005), provides the results of an eight-step process with built-in critical management and decision points. Steps 1 and 2 are the screening level ecological risk assessment, while Step 3 is the initial step of the baseline ecological risk assessment. Step 1 consisted of the screening level problem formulation and effects evaluation. Step 2 comprised a screening level exposure estimate and risk calculation. In Step 2 of the ERA, chemical concentration data for pore water, surface water, and sediment for four quarterly sampling events conducted at DMT were compared to conservative ecological screening values. All measured concentrations of Cr(III) and Cr(VI) in pore water and surface water were below ecological screening values. Thus, in accordance with the EPA's approach, chromium was not retained for further evaluation.

Based on the results of Step 2, the following constituents of interest and media were evaluated in Step 3a: iron, magnesium, and manganese in pore water; magnesium and manganese in surface water; and aluminum, manganese, and vanadium in surface sediment. The Step 3a evaluation did not identify any refined constituents of interest.

In summary, the ERA data are sufficient to establish that chromium and other COPR constituents do not pose an unacceptable risk to ecological receptors near DMT, and as such, meet the requirements stipulated in the Consent Decree. Therefore, no further action is required to assess the environmental impacts of COPR constituents from the site. The two primary potential pathways for migration of chromium and other COPR constituents from the COPR fill area to the river are the following:

- Groundwater seepage into stormwater drains that discharge directly to the river through outfalls, where chromium can either remain in solution or precipitate as Cr(III), depending on geochemical conditions; and
- Tidal inundation of stormwater lines.

SECTION 3

Current Corrective Action Programs

Honeywell and MPA are actively conducting a variety of maintenance and monitoring programs at DMT designed to provide continued effectiveness of existing controls and to ensure that COPR is not impacting human health and the environment. In addition to the maintenance and monitoring programs, Honeywell and MPA have completed or are actively performing multiple pilot studies of corrective measures and have implemented multiple corrective measures pursuant to the 1992 Consent Order between MDE and MPA and the 2006 Consent Decree at DMT. Both the maintenance and monitoring programs and pilot corrective measures are being implemented with the goal of ensuring that COPR at DMT remains isolated and contained pending MDE's selection of a remedy in the CMAA to eliminate the potential for exposure of human and environmental receptors, both at the port and in the surrounding environment, to COPR or to media impacted by COPR.

The monitoring and maintenance programs include inspecting and maintaining port infrastructure, evaluating the efficacy of the existing pilot studies and corrective measures, and the monitoring of various media such as groundwater, stormwater, surface water, sediment, and the potable water system at DMT. Each of these programs has "triggers" for additional evaluation if it is determined that COPR could impact human health and the environment (i.e., a breakdown in the existing measures that are isolating and containing COPR). Should a "trigger" event occur, MPA and Honeywell will evaluate conditions and implement additional corrective measures or initiate and implement enhancements of existing measures in the shortest time frame practicable.

The pilot studies and existing corrective measures that have been put into place include various technologies designed to minimize the direct flow of impacted stormwater to the Patapsco River, multiple pavement technologies designed to be rigorous enough to withstand port traffic as well as COPR heave, and various COPR heave mitigation technologies designed to mitigate the effects of COPR heave on the surface cover and infrastructure at DMT. The performance of the corrective measures and their effectiveness as long-term solutions for isolating and containing COPR and COPR-affected media are continually evaluated through implementation of the monitoring and maintenance programs.

3.1 Inspection, Monitoring, and Maintenance Programs

The following sections briefly describe the various maintenance and monitoring programs being implemented at DMT with the goal of ensuring that human or environmental receptor exposure to COPR or COPR-impacted media is effectively mitigated.

3.1.1 Surface Cover Inspection and Maintenance Program

Honeywell and MPA are currently implementing the SCMP in accordance with the 2006 Consent Decree under the scope outlined in the MDE-approved "Surface Cover and 14th and 15th Streets Storm Drain Inspection and Maintenance Plan" (CH2M HILL, 2007a). The

SCMP requires procedures for routinely inspecting and performing regular maintenance on existing pavement systems that serve as surface cover for the COPR fill area. Based upon criteria established in the SCMP, damage to the surface cover noted during inspection activities is prioritized for repair, based upon the severity and nature of the damage. Consequently, areas where the potential for direct exposure to COPR exists are identified and repaired before significant damage to the surface cover occurs. This proactive program ensures that COPR fill at DMT is contained and isolated from human and environmental receptors.

The baseline surface cover inspection was conducted in March and April 2007. A summary of this work was submitted to MDE in the "Surface Cover System Baseline Inspection Report, Dundalk Marine Terminal" (CH2M HILL, 2007b).

In response to the baseline inspection, Honeywell and MPA retained a contractor to perform the recommended repairs, which were performed between July 2008 and May 2009. A summary of this work was submitted to MDE in "Summary Report for 2008 and 2009 Repairs, Surface Cover System, Dundalk Marine Terminal" (CH2M HILL, 2009d).

A second formal pavement inspection of DMT was conducted in June 2009. A summary of this work was submitted to MDE in the "Spring 2009 Surface Cover System and 14th and 15th Streets Storm Drain Inspection Report" (CH2M HILL, 2009e). Subsequent pavement repairs were performed through December 2009 and were documented in a report (CH2M HILL, 2010a) that was submitted to MDE in the second quarter of 2010. Preparations are being made to conduct the next surface cover inspection and maintenance cycle in 2011.

3.1.2 Open Pavement Excavation Inspection and Maintenance Plan

The MDE-approved SCMP specifies that all excavations and other intrusive work through existing cover systems be performed pursuant to project-specific work plans addressing, at a minimum, construction area security; project-specific health, air monitoring, safety, containment, and/or control measures for exposed or excavated COPR materials; water control requirements and protocols; and temporary and permanent cover measures. These requirements ensure that intrusive site activities do not result in site workers being exposed to COPR or contaminated media without proper protection. In addition, these requirements prevent site workers, port personnel, and the general public from being exposed to COPR or contaminated media during excavation or other intrusive work.

In accordance with the SCMP, contractors coordinate with the MPA Construction Management inspector, or MPA-approved designate, to coordinate, oversee, and document intrusive work activities and to demonstrate that appropriate control measures were followed. To assist contractors and MPA inspectors with the process of developing and implementing appropriate work planning for intrusive activities, Honeywell and MPA have developed the Standard Operating Procedure (SOP) "Surface Cover Penetration," which has been reviewed and approved by MDE. Use of the SOP ensures that proven and approved methods for protecting human health and the environment are implemented during site work at DMT.

3.1.3 Perimeter Air Monitoring Program

The MDE-approved SCMP also required implementation of a perimeter air-monitoring program to evaluate the effectiveness of the surface cover maintenance plan through the determination of the presence or absence of Cr(VI) in airborne particulates at the DMT site perimeter. The "Revised Dundalk Marine Terminal Hexavalent Chromium Air Monitoring Plan" (EA, 2007) was prepared for MPA by EA Engineering Science and Technology, Inc., of Sparks, Maryland, and was included as an attachment to the SCMP. Pursuant to this plan, air monitoring has been performed monthly over 36 months since September 2007.[3] The air-monitoring program performed to date has determined that there is no statistically significant difference between the levels of chromium upwind of DMT and those downwind. Consequently, these data indicate that the existing surface cover and maintenance of the cover systems contain and prevent airborne transport of COPR.

3.1.4 14th and 15th Streets Storm Drain Inspection and Maintenance Program

The MDE-approved SCMP establishes routine inspections of the 14th Street and 15th Street storm drains and requires conducting maintenance of those drains (e.g., repairs and relining) as necessary. The inspection and maintenance program includes procedures to identify and repair damage to the 14th and 15th Street storm drains to minimize infiltration of groundwater that would otherwise discharge through the drains to the Patapsco River. Under the SCMP, a visual inspection of the drains must be performed every 2 years.

Storm drain inspections performed in August 2006 and November 2006 identified the need for performing the following corrective measures:

- Lining the 15th Street drain system;
- Conducting follow-on inspection and maintenance of the 14th and 15th Streets storm drains in accordance with the approved SCMP; and
- Continuing to collect and treat the dry-weather flow from these storm drains.

The second inspection of the 14th and 15th Streets drain systems was completed in March 2009, and the results were detailed in the "Spring 2009 Surface Cover System and 14th and 15th Streets Storm Drains Inspection Report" (CH2M HILL, 2009e). The data collected from this inspection are addressed in the storm drain rehabilitation discussion in Sections 3.2.1 and 3.2.2.

3.1.5 Stormwater Drainage System Management

In accordance with the 2006 Consent Decree, Honeywell and MPA have conducted an inspection and sampling study of the 10 stormwater outfalls located at 9th through 13.5th Streets at DMT. The study was implemented to quantify the flux of chromium to the Patapsco River through these drains and to evaluate the feasibility of managing dry-weather flow from these drains. In the past, reliable measurements of the dry-weather flow quality or quantity at the 9th Street through 13.5th Street outfalls could not be obtained due to: (1) absence of monitoring vaults at appropriate locations; (2) access limitation to outfalls beneath the pile-supported marine platform; (3) safety of sampling personnel; (4) port

[3] Air monitoring was performed at DMT from September 2007 through August 2008 and from January 2009 through December 2010.

operational constraints; and (5) tidal influence from the Patapsco River, which results in partially submerged outfalls. Therefore, Honeywell and MPA implemented an MDE-approved modified sampling approach to obtaining reliable stormwater flow and quality data that allowed representative samples to be obtained from these outfalls (CH2M HILL, 2006).

The approved work plan (CH2M HILL, 2006) included a feasibility study and pilot testing process to develop and field-validate an effective and permanent means to excluding the influence of the tide at affected drains and facilitating the collection of dry-weather storm drain flow. The MDE-approved work plan also included modified sampling procedures that were developed to better quantify flow and collect water quality samples until a permanent means of tidal exclusion could be developed, field tested, and constructed at priority drains.

Preliminary results from performing the modified work plan indicated that some of the half-street outfalls exhibited no dry-weather flow. In addition, it was determined that the 9th Street through 11.5th Street storm drains had not been constructed within COPR fill. Near these storm drains, the COPR fill is well below the invert elevations of the storm drains.

Storm drain sampling, in accordance with the modified sampling procedure, began in March 2007. It resulted in one round of dry-weather flow data from the 9th Street through 13.5th Street storm drains but revealed that routine sampling is impractical due to the absence of tidal exclusion devices, sediment and debris in the storm drains, and health and safety concerns for personnel performing the sampling. In addition, the collected data were not representative of flows that would occur once the temporary tidal exclusion devices used during sampling were removed. In an addendum to the work plan (CH2M HILL, 2008), installation of tidal exclusion devices within the priority storm drains (e.g., 12th, 12.5th, 13th, and 13.5th Streets storm drains) was proposed to facilitate routine sampling and dry-weather flow measurements.

The 13th Street storm drain collection vault with a tidal exclusion device was completed in November 2008 (see Section 3.2.3). A design of storm drain collection vaults with tidal exclusion devices is currently being prepared for the 12th, 12.5th, and 13.5th Streets storm drains. It is expected that these vaults, like the 13th Street storm drain vault, will allow for more accurate quantification of dry-weather flow.

3.1.6 Routine Groundwater Monitoring

In accordance with the 1992 Consent Order, MPA performed routine (semiannual) groundwater monitoring at DMT under the “Environmental Sampling and Analysis Plan” (MES, 2000) from 2000 to 2006. The 2006 Consent Decree requires that groundwater monitoring be continued per the existing plan as an interim corrective measure. Accordingly, groundwater monitoring was continued in 2006 and 2007 by Honeywell and MPA in accordance with the MES plan. The groundwater monitoring program includes the sampling of both shallow and intermediate monitoring wells at DMT for chemical and hydraulic data to ensure that chromium-impacted groundwater is not discharging into the Patapsco River via a groundwater pathway or into deeper aquifers beneath DMT.

In 2008, routine groundwater monitoring was temporarily discontinued during finalization of the CTS (CH2M HILL, 2009b), which indicated that chromium-impacted groundwater beneath DMT was not impacting the Patapsco River (directly via a groundwater flow pathway) or the deeper aquifers of the Potomac Group. Groundwater monitoring resumed in 2009 under a new monitoring plan. Currently, a sentinel groundwater monitoring program is being developed for consideration as part of the corrective measures alternatives to provide the assurance that chromium-impacted groundwater beneath DMT remains isolated. The sentinel groundwater monitoring program will be designed so that there will be sufficient time to implement remedial measures, as appropriate, if Cr(VI) is detected above levels that are not protective of human health and the environment at the site boundary.

3.1.7 Drinking Water Monitoring

The 2006 Consent Decree required the preparation of a site drinking water monitoring plan to ensure that chromium-contaminated materials are not adversely impacting DMT's drinking water, thus potentially leading to exposure of port personnel to chromium. The site drinking water plan was submitted on June 29, 2006, and was approved on January 17, 2007. In accordance with the plan, a baseline assessment of chromium impacts on the terminal's drinking water system was performed. In addition, MPA monitors the system on a quarterly basis at a subset of rotating locations. The quarterly sampling is performed to identify potential line breaks within the water distribution system.

In the event of a water line break, MPA undertakes activities to isolate the break while simultaneously notifying the affected port personnel not to use water. An alternative water supply is provided to the tenants until the broken water line is repaired and placed back in service. Prior to doing so, the entire water distribution system is flushed and sampled to ensure that it is chromium free. Water quality sampling data collected in response to a pipeline break within the COPR fill area are provided to MDE within 30 days.

3.1.8 COPR Movement Monitoring

Inclinometers are used at DMT to measure the lateral displacement of the subsurface soil and to monitor the location, magnitude, and rate of horizontal movement of COPR. Inclinometers consist of a vertical casing installed in a boring that is subsequently embedded below the profile of expected horizontal movement. The data generated by inclinometers can be used to identify locations of surface cover, utilities, or other infrastructure that could potentially be compromised by COPR movement. Consequently, it is intended that inclinometers can be used to provide a limited, but advanced warning for the development of potential human health and environmental exposure pathways.

Over 40 inclinometers have been installed within or adjacent to COPR fill area according to the following criteria:

- On a widely spaced grid across the site to obtain the general trends for "interior" conditions;
- In the vicinity of select features to monitor movement near specific superficial and subsurface features; and

- In closely spaced arrays to track movement rate and direction in greater detail in selected areas.

At DMT, horizontal COPR movement is steady, slow, and measurable. Two types of horizontal movement conditions have been observed and monitored at DMT:

1. **Edge condition**. Exists at a physical edge of a COPR deposit. For example, the shoreline is a natural edge, an SRT is an engineered edge, and a utility conduit may be considered an edge.
2. **Interior or constrained condition**. Arises away from edges, where lateral displacement is restrained owing to the horizontal confinement produced by adjacent expanding COPR, a large mass of soil, or possibly a very rigid, massive structure that acts as a structural discontinuity.

Monitoring results of the shoreline and SRT inclinometer arrays in Area 1501 indicate that an edge condition's radius of influence can range from 110 to 170 feet. The magnitude and rate of horizontal COPR movement is influenced by boundary conditions. For interior conditions, the rate of COPR horizontal movement is relatively slow (typically less than 0.15 inches per year). The observed rate of COPR horizontal movement at edge locations has been up to 1.5 to 1.8 inches within an annual monitoring period. Therefore, interior inclinometers tend to reflect rates of movement that are slower (about 90 percent less) than edge inclinometers adjacent to a utility, SRT, or shoreline boundary.

Inclinometers at DMT are used to monitor the direction and magnitude of subsurface expansion. This information will also be used to monitor the effects of actions already taken and to identify locations where additional measures may be deemed necessary.

3.2 Current Interim Remedial Measures and Pilot Studies

The following sections provide a brief description of the various corrective measures that have been implemented at the site as part of the 1992 Consent Order or are currently being implemented at DMT with the goal of eliminating the potential for human or environmental receptor exposure to COPR or COPR-impacted media.

3.2.1 Storm Drain Inspection, Replacement, and Repair

MPA and Honeywell have been actively working for many years to reduce the flux of hexavalent chromium in stormwater that flows to the Patapsco River from DMT. Early evaluations of the stormwater discharge in the 1980s and 1990s indicated that the primary sources of discharge were the 14th and 15th Streets storm drains, and early efforts focused on addressing these principal discharges. The technologies available to address the problem at that time were limited from multiple standpoints, including approaches to storm drain monitoring and cleanout, storm drain repair technologies, and water treatment. As part of the 1992 Consent Order, MPA completed inspection, cleaning, repair, and/or replacement of portions of the storm drain system. This program was limited because of tidal intrusion, which rendered large portions of the main trunk lines of the 12.5th through 15th Street drains inaccessible. Specifically, the following measures were completed:

- 12.5th Street drain—two laterals relined with cured-in-place (CIP) pipe;

- 13th Street drain—five laterals relined with CIP pipe and two inlets relined with epoxy;
- 13.5th Street drain—replaced with high-density polyethylene (HDPE) piping and new concrete inlets;
- 14th Street drain—11 laterals relined with CIP pipe and nine inlets/manholes relined with epoxy; and
- 15th Street drain—portions of four laterals relined with CIP pipe and 12 inlets/manholes relined with epoxy.

While these efforts were limited by access restrictions, reduction in groundwater intrusion into the storm drains was achieved but could not be reliably quantified because of tidal influences.

3.2.2 14th and 15th Streets Storm Drain Outfall Structures

The impact of COPR movement on certain storm drains at DMT historically has allowed groundwater containing chromium to enter the storm drains and directly mix with Patapsco River tidal waters. The 14th and 15th Streets storm drain systems are the longest drain systems at DMT installed within the COPR fill area. As part of the 1992 Consent Order, stormwater outfall retention structures were installed at the 14th Street and 15th Street storm drain outfalls in 1991 and 1992, respectively. The retention structures are designed to (1) isolate the Patapsco River tidal waters from the 14th Street and 15th Street storm drains and (2) provide a means to contain, capture, and temporarily store storm drain flow for subsequent treatment and discharge. Figure 3-1 is a photograph of the 14th Street outfall structure.

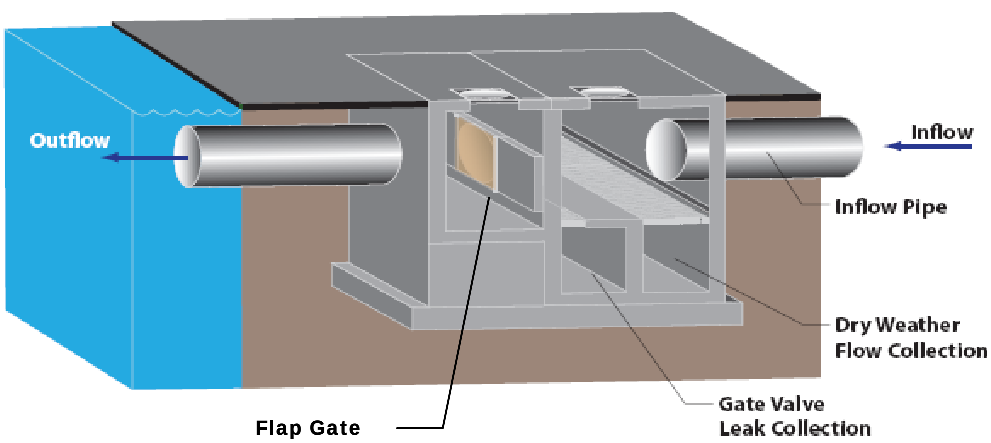
FIGURE 3-1
14th Street Outfall Structure

3.2.3 13th Street Storm Drain Tidal Exclusion Vault Pilot Study

As part of the 2006 Consent Decree and 2005 NPDES permit, more reliable sampling of the dry-weather flow from the 13th Street drain was achieved through temporary tidal exclusion. The preliminary results of dry-weather flow sampling from the 13th Street storm drain indicated that chromium-contaminated groundwater was still infiltrating the storm drain. As a result, the 13th Street storm drain was selected for pilot testing an interim remedial measure (IRM) designed to contain and isolate the dry-weather flow in the 13th Street drain from the tidal waters of the Patapsco River. By isolating the 13th Street drain from the tidal waters of the river, the IRM allows for substantially more accurate calculation of the flow and chromium concentrations of dry-weather flow within the drain.

The IRM consisted of a subsurface storm drain collection vault installed approximately 100 feet upstream of the discharge outfall for the 13th Street storm drain. The vault has two chambers separated by a flap gate. The upstream chamber collects dry-weather flow. The downstream chamber provides a clear operating area for the flap gate that prevents tidal water from entering the upstream chamber. Both chambers are accessible for drain cleaning and maintenance through aboveground man way hatches. Figure 3-2 illustrates the 13th Street tidal isolation vault concept.

FIGURE 3-2
13th Street Tidal Isolation Vault Concept



3.2.4 13th and 15th Street Storm Drain Rehabilitation Pilot Studies

Honeywell and MPA are currently evaluating the effectiveness of storm drain system relining technologies at the 13th and 15th Streets storm drains to minimize, to the extent technically feasible, chromium discharges to surface water. The storm drain rehabilitation activities included repairing storm drains and lining manholes and drainage structures. This pilot study focuses on significantly reducing infiltration of contaminated groundwater into stormwater structures. The 13th Street storm drain contains approximately 1,800 linear feet of pipe ranging from 18 to 54 inches in diameter. The entire drainage system has been relined using a CIP liner technology. Inlet and manholes were rehabilitated by sealing joints and cracks as needed. Performance monitoring of the 13th Street system is ongoing; however, preliminary data suggest that groundwater intrusion into the storm drain has been significantly reduced.

The 15th Street storm drain contains approximately 16,000 linear feet of pipe ranging from 10 to 96 inches in diameter. Due to the size of the 15th Street system, rehabilitation is proceeding in a phased approach. Phase 1 consists of relining of the trunk line and laterals using an advanced spiral-wound liner technology. With the exception of the lower reaches of the main trunk line, those portions of the drainage system where inspection results indicated damage or leakage have been relined. The lower reaches of the south trunk line had significant damaged and were repaired in 2010 with the placement of sealed, steel liner plates covered with concrete. Therefore, Phase 1 rehabilitation is complete, and Phase 2, which will encompass rehabilitation of inlets and manholes, will be completed in 2011.

It is anticipated that rehabilitation of the storm drains, once complete, will effectively reduce dry weather flow to de minimis levels, thus addressing potential impacts to surface water and reducing or eliminating the volume of water to be treated at the onsite WWTP. Rehabilitation of additional priority storm drain systems (i.e., 12th Street, 12.5 Street, 13.5 Street, 14th Street, and the remaining portions of the 15th Street drain) are considered part of a corrective measures alternative in Section 6.

The effect of storm drain relining on groundwater gradients and groundwater flow has been examined using the calibrated groundwater model. This analysis is provided as Appendix B. The effect of relining the 13th Street drain only was simulated using the model and validated based on post relining groundwater monitoring in the vicinity of the drain. The results confirmed that the model provides an accurate representation of groundwater changes following relining. Further, the analysis demonstrates that only a marginal increase in chromium flux to the river will occur from groundwater following completion of relining of the remaining priority storm drains. The increase in chromium flux from groundwater is significantly less than the reduction of chromium flux from repaired storm drains.

3.2.5 14th Street Groundwater Recovery System Rehabilitation

The Site Feasibility Study completed by EA in 1992 (EA, 1992) recommended that the 14th Street groundwater extraction system be installed as a backup system to other recommended remedial activities. In July 1993, six extraction wells were installed along the 14th Street central storm drain in a configuration similar to the three-well design that was recommended in the original Feasibility Study. The wells were installed on approximately 250-foot centers, starting at the outfall and extending 1,250 feet inland. The 14th Street storm drain trunk line increases substantially in size from beginning to end, varying from a 28-inch-diameter pipe at the head of the storm drain to a 63-inch-by-98-inch elliptical pipe at the outfall. These extraction wells were constructed of 4-inch-diameter PVC pipe and were set to a common depth of 15 feet below ground surface (NFE Inc., 1993). Groundwater was typically encountered at 8.5 feet below grade when the extraction wells were installed. No extraction system to remove and treat groundwater from the six wells was installed at that time.

The extraction system was originally envisioned to be a backup system to other remedial measures. The performance of the system was evaluated according to the "Work Plan for the 14th Street Groundwater Collection System Evaluation, Dundalk Marine Terminal, Baltimore, Maryland" (CH2M HILL, 2006). Honeywell and MPA have determined that the 14th Street extraction system is not a viable long-term approach or final corrective measure to eliminate the infiltration of groundwater into the 14th Street storm drain for the following reasons:

- The existing groundwater extraction system is not operational, and it would take substantial resources and time to return it to service.
- Pumping tests undertaken at DMT have shown that even if the extraction system were restored to operational status, carbonate fouling would render the system non-operational within a period of hours. Costs to maintain such a system in an operational state are prohibitive and would be very disruptive to port operations.
- Operation of an active groundwater extraction system would decrease the site groundwater table into lower deposits of COPR and cycle the groundwater level, resulting in COPR weathering and heave.
- Groundwater that enters the 14th Street storm drain is currently being collected in the outfall retention basin and transferred to the treatment plant, thereby achieving the original purpose of the extraction system.
- Based on pilot studies of the 13th Street storm drain IRM, repair of the 14th Street drainage system is a viable long-term corrective measure for groundwater infiltration.

3.2.6 Onsite Wastewater Treatment Plant

As part of the 1992 Consent Order, MPA completed the design, construction, startup, and operation of an onsite treatment plant. The WWTP is designed to remove Cr(VI) from groundwater extracted through the 14th groundwater extraction system and stormwater collected within outfall retention structures at the 14th Street and 15th Street storm drain outfalls before the water is discharged to the Patapsco River under a NPDES permit. The WWTP presently treats Cr(VI)-impacted water through a chemical precipitation process that uses gaseous SO_2 to lower the pH of the high-pH groundwater to 3 for the reduction of Cr(VI). Once the chromium-impacted water is neutralized, SO_2 is injected and controlled by monitoring oxidation-reduction potential. Recently, a design was completed to upgrade the treatment process by replacing the current chromium reductant, SO_2, with sodium hydrosulfide. The upgrade is expected to provide increased operations safety while maintaining the plant's ability to effectively remove Cr(VI) from the effluent water.

3.2.7 Area 1800 Cover System Pilot Study

One of the primary components for containing COPR at DMT is the existing cover of asphalt and non-COPR fill that exists between the COPR and ground surface. Degradation of the surface cover from routine port operations or from surficial expressions of COPR heave is the primary means for potential direct human exposure to COPR. Honeywell and MPA have actively engaged in the evaluation of multiple types of surface cover systems to determine which are most suitable for use at DMT (i.e., which is durable, minimizes infiltration to control heave, and accommodates stresses imposed by heave while maintaining protectiveness of site workers from exposure to COPR).

Area 1800 is a 15.5-acre paved parking and storage area along the northeastern side of DMT, adjacent to Broening Highway. Much of the eastern end of Area 1800 had become damaged owing to early manifestations of COPR heave shortly after construction of the area.

Honeywell and MPA completed a 7.2-acre reconstruction pilot project in January 2008 in an area of heave to evaluate the constructability and performance of the various cover systems being considered for use at DMT. The pilot test included the construction of the following cover systems:

- A 1.0-acre ABC pilot test section;
- A 1.8-acre low-permeability (MATCON™) asphalt pilot test section; and
- A 4.4-acre modified conventional asphalt pilot test section with the upgraded asphalt mix currently used for DMT paving projects.

In addition, the following ancillary subsurface components were installed within the pilot area with the intention of mitigating existing COPR heave or reducing the potential for additional heave:

- Strategically placed SRTs (discussed further in Section 3.2.9);
- Near-surface drainage trenches;
- Near-surface utility trenches; and
- Rail bed and drainage structure waterproofing membranes.

The size and configuration of the various cover systems were selected to provide pilot areas with representative construction and operational conditions. Figure 3-3 shows the location of the Area 1800 pilot study. To evaluate the design components' performance, subsurface instrumentation was also installed within the pilot area:

- To evaluate pavement permeability and changes in subsurface conditions beneath the test sections, instrument clusters (barometers, piezometer sensors, soil-moisture sensors, carbon dioxide sensors, temperature sensors, and lysimeters) were installed in the low-permeability asphalt pavement section, the ABC pavement section, and a control area.

- To measure flow characteristics within the near-surface trench drain sections, weirs with pressure transducers were installed.

Construction of the 7.2-acre pilot area was completed between September 2007 and January 2008. The pilot test met the objectives stated in the "Heave Mitigation Pilot Testing Work Plan, Dundalk Marine Terminal, Baltimore, Maryland" (CH2M HILL, 2007c). The most recent evaluation of performance data was provided in two reports, the "Area 1800 Pilot Test Report, Dundalk Marine Terminal, Baltimore, Maryland" (CH2M HILL, 2009f) and the fourth semiannual report, submitted to MDE in September 2010 (CH2M HILL, 2010b). These reports provide the results of periodic visual inspections, topographic survey data collection and evaluation, and pavement performance evaluations. These test data indicate that each of the cover systems being tested within Area 1800 is performing well. Based on routine inspections that have been part of the SCMP, conventional pavements would be suitable for the vast majority of the COPR fill area at DMT. Application of advanced pavement systems such as ABC and MATCON™ does not appear warranted under present conditions, given the equivalent performance of conventional pavement systems.

FIGURE 3-3
Area 1800 Pilot Study

3.2.8 Area 1702 Roller-Compacted Concrete Pavement Studies

RCC is an additional pavement technology that has been pilot tested at DMT as a surface cover capable of maintaining its integrity under stresses caused by the expansion of COPR. RCC consists of a thick section of dry-applied concrete designed to suppress heave by its surcharge mass. This technology was installed in 1999 in a portion of Area 1702, and the effectiveness of the RCC system is currently under evaluation. Performance monitoring in the form of periodic surveys and condition assessment is ongoing.

The baseline cover inspection in 2007 (CH2M HILL, 2007b) revealed that Area 1702, a 9.8-acre area with a 12-inch-thick RCC pavement overlain by 3 inches of hot-mixed asphalt surfacing, had no heave-related pavement damage features requiring repair. The predominant damage features within Area 1702 were small surface cracks, potholes, and similar surface damage features within the asphalt overlay. These are the kinds of normal surface damage expected from port use of the area. These features were repaired as part of the surface maintenance program conducted in 2008 and early 2009.

The results of the recent surface cover inspections of Area 1702 indicate that the RCC pavement is performing well and appears to be a durable cover system, well suited for containing thin deposits of COPR in areas prone to heave. Surface repair requirements after 10 years of operation are relatively small; most repairs are related to port operations (i.e., conditions other than surface heave).

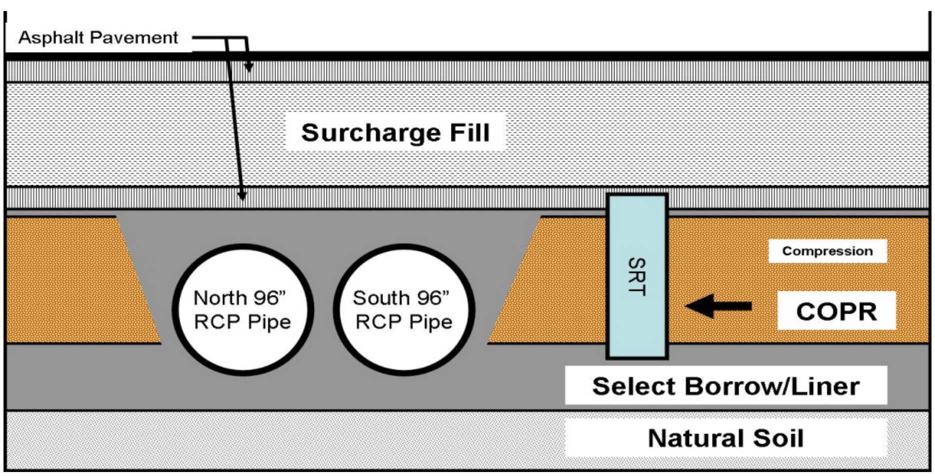
3.2.9 Strain Relief Trench Studies

SRTs have been installed at various DMT locations (Areas 1501, 1602, and 1800) as a mitigation measure to accommodate the expansive behavior of COPR and resultant effects of COPR heave. SRTs are trenches filled with highly compressible backfill material that can accommodate the lateral movement of COPR. SRTs offer significantly less resistance than native soil or COPR to accommodate COPR expansion and thereby can redirect COPR expansion effects.

SRTs are being pilot tested at DMT as a method to protect infrastructure systems (e.g., storm drains, utility conduits, and surface cover) from the effects of COPR expansion and heave. Based on inspections of storm drains and other utilities at DMT, application of SRTs may be necessary only in limited circumstances, where damage from COPR expansion cannot otherwise be managed.

The SRT in Area 1501 was installed in 2004 to relieve the pressure from COPR expansion on a large concrete stormwater drain (Figure 3-4) and to protect the drain from being damaged. Monitoring of pipe deflection and rebound since then has shown that the SRT is effectively absorbing ground movement and relieving high compressive stresses, which had damaged the stormwater drain prior to the 2004 SRT installation. The Area 1501 SRT has been extended in 2010 to protect additional sections of the 15th Street storm drain.

FIGURE 3-4
Area 1501 SRT Application



Three SRTs were installed in Area 1800 in late 2007 to examine the geotechnical effects of relief trenches in an area of mature COPR weathering. Monitoring of inclinometers within

Area 1800 since the SRT installation indicates that COPR expansion is still occurring beneath the pavement, with the general direction of COPR movement being toward the SRTs. Surface observations and data from surveying of benchmarks since completion of pilot area construction have not shown the presence of bulges or heave ridges within the areas protected by the SRTs.

An SRT was installed in Area 1602 in late 2007 to stabilize a concrete sound barrier. To date, field observations of the repaired wall indicate that it has been stabilized as a result of the SRT installation.

3.2.10 Surcharge Restraint

Areas 1501 and 1602 were developed in 1982 by encapsulating COPR and dredge spoils within a clay liner. Soon after construction, heave was observed in both of these areas. Due to the unique manifestation of COPR expansion within the clay liner, these two areas have historically posed distinctive geotechnical challenges. In 2001, a 6- to 7-foot-thick layer of non-COPR surcharge fill was placed over the existing paved section to provide restraint against vertical heave. The top of the surcharge fill was then paved with asphalt. The principle behind this approach is that a significant weight resistance and moderation of the vertical expression of COPR expansion can be achieved by raising the grades. The added surcharge fill also encapsulates the COPR fill.

The lifecycle for the pavement over the surcharge fill can be expected to be equal to or much longer than that in other non-surcharge-loaded areas. Field observations indicate that the surcharge loading has performed well in Areas 1501 and 1602, as no surface cover damage related to heave has been observed in recent inspections (one small heave ridge was observed in Area 1602 in 2009). In general, vertical movement has been limited.

SECTION 4
Corrective Measures Objectives

4.1 Introduction

Section III.B.8.b.i of the Consent Decree requires that the CMAA include the identification of Corrective Measures Objectives (CMOs) to support the development of corrective measures alternatives at DMT. CMOs are measurable and achievable media- or area-specific goals for protecting human health and the environment. CMOs should be designed so that the implementation and completion of corrective measures can meet the appropriate regulatory requirements applicable to each specific medium and intended use at DMT as well as any nonpromulgated, nonenforceable guidelines or criteria that may be useful for evaluating protection of human health or the environment at DMT. These regulatory requirements are defined as Applicable or Relevant and Appropriate Requirements (ARARs); the nonpromulgated, nonenforceable guidelines or criteria are defined as "to be considered" (TBC) criteria.

This section contains the CMOs that have been developed using information currently available from the investigations, studies, and implemented corrective actions discussed in Sections 2 and 3, and a list of identified ARARs and TBC criteria.

4.1.1 ARARs

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, environmental action, or location.

Additional applicable requirements are those limitations promulgated under federal or state law that directly address the operation of a port of call.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at the site, and thus their use is well suited (appropriate) to the particular site. ARARs are grouped into three types: chemical specific, action specific, and location specific.

Chemical-Specific ARARs

Chemical-specific ARARs include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health or Risk-Based Concentration (RBC) limits or discharge limitations for specific hazardous substances.

Action-Specific ARARs

Action-specific ARARs are requirements that apply to specific actions potentially associated with site remediation. Action-specific ARARs often define acceptable handling, treatment, and disposal procedures for hazardous substances. These requirements are triggered by the particular remedial activities selected to accomplish a remedy. Examples of action-specific ARARs include requirements applicable to hazardous waste disposal and emissions of air pollutants.

Location-Specific ARARs

Location-specific ARARs are those requirements that relate to the geographical or physical position of the site rather than to the nature of the contaminants or the proposed site corrective measures. These ARARs may limit the corrective measure and may impose additional constraints on the cleanup action. For example, location-specific ARARs may refer to activities in the vicinity of wetlands, endangered species habitat, or areas of historical or cultural significance.

COMAR 26.14.02.06.E.(2) specifies that MDE "shall determine the applicability of cleanup standards and state or federal laws, regulations, and other requirements" at sites in evaluating releases or threats of releases of hazardous substances. A list of ARARs has been tabulated from the known federal and State of Maryland regulations as further discussed below.

4.1.2 TBC Criteria

TBC criteria are nonpromulgated, nonenforceable guidelines or criteria that may be useful for developing corrective measures alternatives or for evaluating what is protective of human health and/or the environment. Examples of TBC criteria include risk-based exposure determinations and MDE cleanup standards (MDE, 2008).

4.2 Summary of ARARs and TBC Criteria Applicable to DMT

Potential chemical-specific, location-specific, and action-specific ARARs for DMT are summarized in Tables 4-1 through 4-5. TBC criteria are included as appropriate for each classification. The corrective measures alternatives developed in this report were analyzed for compliance with federal and state ARARs. The analysis involved identifying potential requirements for each of the alternatives evaluating their applicability or relevance, and determining whether they can achieve the ARARs. Results of that analysis are presented in Sections 6 and 7 of this CMAA.

4.3 Site-Specific CMOs and Their Development

CMOs are the measurable and achievable goals for which corrective measures at DMT will be evaluated and undertaken to ensure protection of human health and the environment. To fully define the goals for corrective measures, the impacts to various media from the placement of COPR at DMT must be defined. In addition, potential human and environmental receptors of chromium-impacted media and the point at which such receptors may be adversely affected should be identified. Potential human and ecological receptors are determined in the risk assessments discussed in Sections 2.5 and 2.6.

CMOs are then developed to protect those potential receptors from chromium-impacted media. ARARs and TBC criteria are used in the development of CMOs to identify the acceptable media-specific exposure levels for potential receptors.

CMOs have been developed based on the current investigation results and are presented in Table 4-6. In accordance with COMAR 26.14.02.06, MDE will select the final CMOs.

TABLE 4-1
Potential Chemical-Specific ARARs

Chemicals & Relevant Media	Requirement	Prerequisites	Citation	ARAR or TBC	Comments
Groundwater, residential water supplies	Meet National Primary Drinking Water Standards for maximum contaminant levels (MCLs).	Drinking water source or potential potable source	Safe Drinking Water Act (SDWA): 40 CFR 141 National Primary Drinking Water Regulations, CERCLA, RCRA	Applicable to Patuxent Aquifer	Regulation does not apply where groundwater quality has a concentration of total dissolved solids greater than 2,500 mg/L or where local ordinance prohibits use as drinking water source.
Surface waters of the state	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges. Limitations and policy for antidegradation of the state's surface water.	Activities that will pollute the state's surface waters	COMAR 26.08, Chapters 1 through 7	Applicable	The design for the corrective measures will incorporate the requirements of this regulation.
Surface water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water or aquatic life.	Activities that affect or may affect the surface water	40 CFR 131	Applicable	The design for the corrective measures will incorporate the requirements of this regulation.
Groundwater and surface water	Provides for the regulation of water supply, sewerage and refuse disposal. Provides for the adoption of water quality standards. Prohibits discharge of pollutants into waters of the state.	Water pollution control as implemented by COMAR 26.08	State of Maryland Annotated Code—Title 9	Applicable	The design for the corrective measures will incorporate the requirements of this regulation.
Soil and groundwater contamination	Provides guidance on cleanup standards for soil and groundwater under residential and non-residential scenarios. Provides guidance for development of site-specific risk assessment and determination of site-specific cleanup standards in lieu of default cleanup standards. Provides methodology for field screening to attain cleanup standards.	Potential exposure to soil and groundwater	Maryland Department of the Environment Cleanup Standards for Soil and Groundwater (March 2008). COMAR 26.14.02.06(E)(2), cleanup standards under the Maryland Hazardous Substance Response Plan. Annotated Code of Maryland, Environment Article, 7-508(b), criteria to protect human health and the environment. Annotated Code of Maryland, Environment Article, 7-208(e), standards for controlled hazardous substances	Applicable	The design for the corrective measures will incorporate the requirements of this regulation.
Soil as a source of groundwater contamination	Regulated substances are not to exceed the soil-to-groundwater pathway numeric value throughout the soil column.	Potential exposure to groundwater	Maryland Department of the Environment Cleanup Standards for Soil and Groundwater (March 2008)	TBC	This will be considered in the development of the corrective measures.
Carcinogens in groundwater and in surface water	Not to exceed media-specific concentration that causes a lifetime carcinogenic risk of between 1 in 10,000 and 1 in 100,000	Potential exposure	NCP	TBC	These will be considered in the development of the corrective measures.
Systemic toxicants in groundwater and in surface water	Not to exceed media-specific levels where people could be exposed by direct ingestion or inhalation on a daily basis without appreciable risk of deleterious effects.	Potential exposure	NCP	TBC	These will be considered in the development of the corrective measures.
Air quality	Provides ambient air quality standards general emissions standards and restrictions for air emissions from construction activities, vents and treatment technologies	Any activities on property that result in the emission of fluoride, particulate matter, sulfur oxide, carbon monoxide, ozone, nitrogen dioxide, and lead	COMAR 26.11.04 (for fluoride) and 40 CFR 50	Applicable	Construction activities will emit particulate matter into the ambient air. The design will incorporate the requirement of this regulation.

ARAR, applicable or relevant and appropriate requirement; CERCLA, Comprehensive Environmental Response, Compensation, and Liability Act; RCRA, Resource Conservation and Recovery Act ; PRGs, Preliminary Remediation Goals; CFR, Code for Federal Regulations ; SDWA, Safe Drinking Water Act; CWA, Clean Water Act; SMCLs, Secondary Maximum Contaminant Levels; EPA, U.S. Environmental Protection Agency; TBC, To Be Considered; OSHA, Occupational Safety and Health Administration.

TABLE 4-2
Potential Federal Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Handling and Disposal of Certain Hazardous Wastes					
Remediation, release, and polychlorinated biphenyls (PCBs)	Requirements governing the remediation, release, and disposal of PCBs must be met.	Remediation, release, and disposal of PCBs.	40 CFR 761	Not applicable	PCBs are not contaminants of concern at DMT.
Resource Conservation and Recovery Act (RCRA) 42 USC 6901 et seq.*					
Onsite waste generation	Waste generator shall determine if that waste is hazardous waste.	Generator of hazardous waste.	40 CFR 262.10 (a), 262.11	Potentially applicable	Applicable for any operation where waste is generated. Portions of the extracted material may be characteristic RCRA hazardous waste.
Hazardous waste accumulation	Generator may accumulate waste onsite for 90 days or less or must comply with requirements for operating a storage facility.	Accumulate hazardous waste.	40 CFR 262.34	Potentially applicable	If waste generated at DMT is determined to be hazardous, any storage of the hazardous waste will not exceed 90 days. Accumulation of hazardous wastes onsite for longer than 90 days would be subject to the substantive RCRA requirements for storage facilities.
Container storage	Containers of RCRA hazardous waste must be: • Maintained in good condition. • Compatible with hazardous waste to be stored • Closed during storage except to add or remove waste.	Storage of RCRA hazardous waste not meeting small quantity generator criteria held for a temporary period greater than 90 days before treatment, disposal or storage elsewhere, in a container.	40 CFR 264.171, 172, 173	Potentially applicable	Container storage requirements are applicable only if hazardous wastes are generated during remedial activities and are stored onsite for greater than 90 days.
	Inspect container storage areas weekly for deterioration.	Storage of RCRA hazardous waste not meeting small quantity generator criteria held for a temporary period greater than 90 days before treatment, disposal or storage elsewhere, in a container.	40 CFR 264.174	Potentially applicable	
	Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. Keep containers of ignitable or reactive waste at least 50 feet from the facility property line. Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier. At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers, liners.	Storage of RCRA hazardous waste not meeting small quantity generator criteria held for a temporary period greater than 90 days before treatment, disposal or storage elsewhere, in a container.	40 CFR 264.175(a) and (b) 40 CFR 264.176 40 CFR 264.177 40 CFR 264.178	Potentially applicable Potentially applicable Potentially applicable Potentially applicable	Container storage requirements are applicable only if hazardous wastes are generated during remedial activities and are stored onsite for greater than 90 days.
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions that are placed in another unit.	40 CFR 268.40	Potentially applicable	Applicable to disposal of soil containing land disposal restricted RCRA hazardous waste. The wastes generated from the corrective measures at DMT may be RCRA-designated hazardous wastes.
Waste pile	Use single liner and leachate collection system. Place waste into waste pile, subject to land-disposal restriction regulations.	RCRA hazardous waste, non-containerized accumulation of solid, nonflammable hazardous waste that is used for treatment or storage.	40 CFR 264.251 (except 251(j), 251(e)(11))	Potentially applicable	Applicable to staging of soil containing RCRA hazardous waste for ex situ treatment or disposal.

TABLE 4-2
Potential Federal Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Closure with no post-closure care	General performance standard requires the elimination of need for further maintenance and control; elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products.	Land-based unit containing hazardous waste. RCRA hazardous waste placed at site, or placed in another unit. Cleanup to health-based standards that will not require long-term management. Not applicable to material treated, stored, or disposed only before the effective date of the requirements, or if treated in situ, or consolidated within area of contamination.	40 CFR 264.111	Potentially applicable	Applicable to excavated subsoils that are determined to be a RCRA hazardous waste. Not applicable to material treated, stored, or disposed only before the effective date of the requirements, or if treated in situ, or consolidated within area of contamination.
Clean closure	Removal or decontamination of all waste residues, contaminated containment system components, contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste.	Surface impoundment, container of tank liners and hazardous waste residues, or contaminated soil (including soil from dredging or soil disturbed in the course of drilling or excavation) returned to land.	40 CFR 264.111 and 264.228 (a, b, e through k, m, o, p, q).	Potentially applicable	Applicable to excavated subsoils that are determined to be a RCRA hazardous waste.
Use of equipment that contacts hazardous waste with organic concentrations greater than 10 percent by weight	Air emission standards for process vents or equipment leaks.	Equipment that contains or contacts hazardous waste with organic concentrations of at least 10 percent by weight or process vents associated with specified operations the manage hazardous wastes with organic concentrations of at least 10 percent by weight.	40 CFR 264.1030 through 1034 (excluding 1030(c), 1033(j), 1034(c)(2), 1034 (d)(2)); 40 CFR 264.1050 through 1063 (excluding 1015(c), 1050(d), 1057(g)(2), 1061(d), 1063(d)(3)	Not applicable	Organic contaminants of concern are not present at DMT.
U.S. Department of Transportation, 49 USC 1802					
Hazardous materials transportation	No person shall represent that a container or package is safe unless it meets the requirements of 49 USC 1802, et seq., or represent that a hazardous material is present in a package or motor vehicle if it is not.	Interstate carriers transporting hazardous waste and substances by motor vehicle. Transportation of hazardous material under contract with any department of the executive branch of the federal government.	49 CFR 171.2(f)	Potentially applicable	Substantive portions of these requirements would be ARARs for transport of hazardous materials onsite. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	No person shall unlawfully alter or deface labels, placards, or descriptions, packages, containers, or motor vehicles used for transportation of hazardous materials.		49 CFR 171.2(g)	Potentially applicable	
Hazardous materials marking, labeling, and placarding	Each person who offers hazardous material for transportation or each carrier that transports it shall mark each package, container, and vehicle in the manner required.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.300	Potentially applicable	Substantive portions of these requirements would be ARARs for transport of hazardous materials onsite. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	Each person offering non-bulk hazardous materials for transportation shall mark the proper shipping name and identification number (technical name) and consignee's name and address.		49 CFR 172.301	Potentially applicable	

TABLE 4-2
Potential Federal Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous materials marking, labeling, and placarding (con't.)	Hazardous materials for transportation in bulk packages must be labeled with proper identification (ID) number, specified in 49 CFR 172.101 table, with required size of print. Packages must remain marked until cleaned or refilled with material requiring other marking.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.302	Potentially applicable	Substantive portions of these requirements would be ARARs for transport of hazardous materials onsite. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	No package marked with a proper shipping name or ID number may be offered for transport or transported unless the package contains the identified hazardous material or its residue.		49 CFR 172.303	Potentially applicable	Substantive portions of these requirements would be ARARs for transport of hazardous materials onsite. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	The marking must be durable, written in English, appear in contrasting colors, unobscured, and away from other markings.		49 CFR 172.304	Potentially applicable	
	Labeling of hazardous material packages shall be as specified in the list.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.400	Potentially applicable	
	Non-bulk combination packages containing liquid hazardous materials must be packed with closures upward, and marked with arrows pointing upward.		49 CFR 172.312	Potentially applicable	
	Each bulk packaging or transport vehicle containing any quantity of hazardous material must be placarded on each side and each end with the type of placards listed in Tables 1 and 2 of 49 CFR 172.504.		49 CFR 172.504	Potentially applicable	
Waste Disposal					
Onsite reuse of excavated material	Excavated material must meet a specific land disposal restriction (LDR) for placement or disposal onsite.	Placement or disposal of excavated soil onsite	40 CFR 268.49 and 268.48	Applicable	This is applicable to excavated material that will be placed or disposed onsite if it is determined to be hazardous waste.
Occupational Safety and Health Administration (OSHA)					
Hazardous waste work	Requirements for hazardous waste workers, such as training, personal protective equipment (PPE), and clothing must be met.	Hazardous waste work.	29 CFR 1904, 29 CFR 1910, 29 CFR 1926	Applicable	The corrective measures at DMT may involve hazardous waste workers; therefore, the requirements of OSHA must be met.

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that EPA considers the entire statutes or policies as potential ARARs; only substantive requirements of the specific citations are considered potential ARARs. Specific potential ARARs are addressed in the table below each general heading.

ACLS, alternate concentration limits; APEN, Air Pollution Emission Notice; ARAR, applicable or relevant and appropriate requirement; BACT, best available control technology; BDAT, best demonstrated available technologies; CAA, Clean Air Act; CAMU, correction action management unit; RCRA, Resource Conservation and Recovery Act; CFR, Code for Federal Regulations; CWA, Clean Water Act; DOT, U.S. Department of Transportation; EPA, U.S. Environmental Protection Agency; LAER, lowest achievable emission rate; MCLs, maximum contaminant levels; MCLGs, maximum contaminant level goals; NAS, Naval Air Station; NAAQS, National Ambient Air Quality Standards (primary and secondary); NESHAP, National Emission Standards for Hazardous Air Pollutants; NCP, National Contingency Plan; NPDES, National Pollutant Discharge Elimination System; OSHA, Occupational Safety and Health Administration; PCBs, polychlorinated biphenyls; POTW, publicly owned treatment works; PPE, personal protective equipment; ppm, parts per million; ppmw, parts per million by weight; RA, relevant and appropriate; RACT, reasonably available control technology; CERCLA, Comprehensive Environmental Response, Compensation, and Liability Act; SDWA, Safe Drinking Water Act; SIP, state implementation plan; SMCLs, secondary maximum contaminant levels; TBC, to be considered; TSCA, Toxic Substances Control Act; UIC, underground injection control; USC, United States Code; USDW, underground source of drinking water; VOC, volatile organic compound.

TABLE 4-3
Potential State Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Transportation, Disposal of Hazardous Waste					
Storage, treatment or disposal, and transportation of hazardous waste	Regulations and procedures for the identification, listing, transportation, treatment, storage, and disposal of hazardous wastes must be met.	Handling of hazardous wastes.	COMAR 26.13.02, COMAR 26.13.04, Annotated Code of Maryland, Environmental Article, Title 7, Hazardous Materials, and Hazardous Substances	Applicable	Any hazardous waste found during site remediation will be disposed of according to regulations. Any residues or byproducts from treatment systems that are hazardous will be disposed of properly.
Solid Waste and Water Supply Regulations					
Well construction and abandonment	Specifications for well construction and abandonment must be met. Also provides a mechanism to provide the State of Maryland with a database of existing and abandoned wells. Permits are required for construction.	Installation or abandonment of monitoring wells	COMAR 26.04.03 COMAR 26.04.04	Applicable	—
Stormwater Management					
Design and construction	Regulations require the design and construction of a system necessary to control stormwater.	Design and construction	COMAR 26.17.02 COMAR 26.17.02.01 COMAR 26.17.02.03(A&B) COMAR 26.17.02.05(A) COMAR 26.17.02.06 COMAR 26.17.02.08 COMAR 26.17.02.10	Applicable	The corrective measures will incorporate measures to control and manage stormwater (i.e., erosion control measures will be implemented).
Erosion and Sediment Control					
Land clearing, grading, and earth disturbances	Regulations require the preparation and implementation of a plan to control erosion and sediment for activities involving land clearing and grading and earth disturbances. Erosion and sediment control criteria are also established.	Land clearing, grading, and earth disturbances	COMAR 26.17.01 COMAR 26.17.01.04 COMAR 26.17.01.05 COMAR 26.17.01.06 COMAR 26.17.01.07 COMAR 26.17.01.11	Applicable	The corrective measures will incorporate the standards required for clearing, grading, and other earth disturbances, including compliance with county and municipal erosion and sediment control ordinances, and the Commission's erosion and sedimentation control regulations.
Maryland Drinking Water Law					
Actions that affect state drinking water	Ensures that the state has the primary enforcement responsibility for drinking water standards under the Federal Safe Drinking Water Act.	Action causing pollution of drinking water supply	Annotated Code of Maryland, Environment Article, Title 9—Water, Ice, and Sanitary Facilities, Subtitle 4—Drinking Water	Potentially applicable	—
Maryland Tidal Wetlands Dredging and Filling					
Dredging and upland disposal of dredged material	Regulations require the preparation and implementation of a plan to perform dredging in state or private tidal wetlands and upland disposal of dredged material.	Dredging and upland disposal of dredged material	COMAR 26.24.03 COMAR 26.24.03.02 COMAR 26.24.03.03 COMAR 26.24.03.04	Not applicable	Corrective measures at DMT will not include dredging.

TABLE 4-3
Potential State Action-Specific ARARs

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Oil Pollution and Tank Management					
Disposal of oil or other matter containing oil	Provides that oil or other matter containing oil or matter containing oil may not be discharged, dumped, spilled, drained, thrown, or deposited into, near, or in an area likely to pollute the waters of the state (surface and underground waters within the boundaries of the state, including the Chesapeake Bay and its tributaries, and all ponds, lakes, rivers, streams, public ditches, and public drainage systems within the state other than those designed to collect, convey, or dispose of sanitary sewer).	Disposal of oil or other matter containing oil.	COMAR 26.10.01.02, Annotated Code of Maryland, Environmental Article, Title 5, Water Resources.	Not applicable	Oil or oil-containing matter is not a contaminant of concern at DMT under the Consent Decree
Air Quality					
Ambient air quality control	Maintains the degree of purity of air necessary to protect the health, the general welfare, and property of people of the state.	Action that will affect air quality standards.	Annotated Code of Maryland, Environmental Article, Title 2, Ambient Air quality.	Applicable	These regulations are applicable at DMT in connection with earthwork activities.
Visible air emissions	Provides Emission Standards for Visible Air Emissions.	Action resulting in visible air emissions.	COMAR 26.11.06.02 Annotated Code of Maryland, Environmental Article, Title 2, Ambient Air Quality.	Potentially applicable	These regulations are applicable at DMT in connection with activities that remove/ transport/survey debris and/or excavated materials; disturb the soil during excavation; disturb soil or other exposed surfaces during construction.
Particulate air emissions	Provides General Emission Standards, Prohibitions, and Restrictions for particulates.	Action that will result in the emission of particulates.	COMAR 26.11.06.03 Annotated Code of Maryland, Environmental Article, Title 2, Ambient Air Quality.	Applicable	These regulations are applicable at DMT in connection with activities that remove/ transport/survey debris and/or excavated materials; disturb the soil during excavation; disturb soil or other exposed surfaces during construction.
Nuisance control	Prohibits nuisance or air pollution.	Action causing a nuisance or air pollution.	COMAR 26.11.06.08	Applicable	
Odor control	May not cause or permit the discharge into the atmosphere of gases, vapors, or odors beyond the property line in such a manner that a nuisance or air pollution is created.	Action causing odors, nuisance, or air pollution.	COMAR 26.11.06.09 Annotated Code of Maryland, Environmental Article, Title 2, Ambient Air Quality.	Applicable	
Occupational, Industrial, and Residential Hazards					
Action that will generate noise	Limits set on the levels of noise must be met; these limits are protective of the health, welfare, and property of the people in the State of Maryland. The maximum permitted levels for construction activities may not exceed 90 dBA during the day and 75 dBA during night.	Action that will generate noise.	COMAR 26.02.03.02A (2) and B(2), COMAR 26.02.03.02.03A, Annotated Code of Maryland, Environmental Article, Title 3, Noise Control.	Applicable	Remedial activities at DMT are not expected to exceed noise levels of routine operation at the terminal.

ARAR, applicable or relevant and appropriate requirement; TAP, toxic air pollutant; USTs, underground storage tanks; VOCs, volatile organic compounds.

TABLE 4-4
Potential Federal Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
National Archaeological and Historical Preservation Act					
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts.	Construction on previously undisturbed land would require an archaeological survey of the area.	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archaeological data.	Substantive requirements of 36 CFR 65; 16 USC 469	Not applicable	None of the corrective measures being considered for DMT include the disturbance of previously undisturbed land.
Federal National Historic Preservation Act, Section 106					
Historic project owned or controlled by federal agency.	Action to preserve historic properties; planning of action to minimize harm to properties listed on or eligible for listing on the National Register of Historic Places.	Property included in or eligible for the National Register of Historic Places.	Substantive Requirements of 36 CFR 800; 16 USC 470	Not applicable	No historic buildings are located at DMT.
Historic Sites, Buildings, and Antiquities Act					
Historic sites	Avoid undesirable impacts on landmarks.	Areas designated as historic sites.	16 USC 461-467; 40 CFR 6.301 (a)	Not applicable	No such structures are present at DMT.
Endangered Species Act of 1973					
Critical habitat upon which endangered species or threatened species depend.	Action to conserve endangered species or threatened species, including consultation with the Department of the Interior. Reasonable mitigation and enhancement measures must be taken, including live propagation, transplantation, and habitat acquisition and improvement.	Determination of effect upon endangered or threatened species or its habitat by conducting biological assessments.	16 USC 1531; 16 USC 1536(a); 50 CFR 81, 225, 402	Potentially applicable	There are no records of endangered plant and animal species located at DMT. This regulation is only applicable if the situation changes.
Migratory Bird Treaty Act of 1972					
Migratory bird area	Protects almost all species of native birds in the United States from unregulated "take."	Presence of migratory birds.	16 USC Section 703	Applicable	—
Marine Mammal Protection Act					
Marine mammal area	Protects any marine mammal in the U.S. except as provided by international treaties from unregulated "take."	Presence of marine mammals.	16 USC 1372(2)	Applicable	—
Wilderness Act					
Wilderness area	Area must be administered in such a manner as will leave it unimpaired as wilderness and preserve its wilderness character.	Federally-owned area designated as wilderness area.	16 USC 1131 et seq.; 50 CFR 35.1 et seq.	Not applicable	DMT is not located in or adjacent to an area designated as part of the National Wildlife Refuge System.
National Wildlife Refuge System					
Wildlife refuge	Only actions allowed under the provisions of 16 USC Section 688 dd(c) may be undertaken in areas that are part of the National Wildlife Refuge System.	Area designated as part of National Wildlife Refuge System.	16 USC 668; 50 CFR 27	Not applicable	DMT is not located in or adjacent to an area designated as part of the National Wildlife Refuge System.
Fish and Wildlife Coordination Act, Fish and Wildlife Improvement Act of 1978, Fish and Wildlife Conservation Act of 1980					
Area affecting stream or other water body	Provides protection for actions that would affect streams, wetlands, other water bodies or protected habitats. Any action taken should protect fish or wildlife.	Diversion, channeling or other activity that modifies a stream or other water body and affects fish or wildlife.	16 USC 661; 16 USC 662; 16 USC 742a; 16 USC 2901; 50 CFR 83	Applicable	Corrective measures will incorporate protection against any area water body, wetlands, or protected habitats.

TABLE 4-4
Potential Federal Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act and Executive Order 11990, Protection of Wetlands					
Wetland	Action to minimize the destruction, loss, or degradation of wetlands. Wetlands of primary ecological significance must not be altered so that ecological systems in the wetlands are unreasonably disturbed.	Wetlands as defined by Executive Order 11990 Section 7.	40 CFR 6, Appendix A excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Not applicable	Wetlands are not present in the vicinity of DMT.
Clean Water Act, Section 404					
Wetland	The degradation section requires degradation or destruction of wetlands and other aquatic sites be avoided to the extent possible. Dredged or fill material must not be discharged to navigable waters if the activity: contributes to the violation of Maryland water quality standards; CWA Sec. 307; jeopardizes endangered or threatened species; or violates requirements of the Title III of the Marine Protection, Research, and Sanctuaries Act of 1972.	Wetland as defined by Executive Order 11990 Section 7.	40 CFR 230.10; 40 CFR 231 (231.1, 231.2, 231.7, 231.8)	Applicable	Navigable waters exist adjacent to DMT. Remedial activities will comply with the requirements of this section of the Clean Water Act.
Surface Water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water or aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	Applicable	The design for the corrective measures will incorporate the requirements of this regulation.
Wild and Scenic Rivers Act					
Within area affecting national wild, scenic, or recreational rivers.	Avoid taking or assisting in action that will have direct adverse effect on national, wild, or scenic recreational rivers.	Activities that affect or may affect any of the rivers specified in Section 1276(a).	16 USC 1271 et seq. and Section 7(a); 36 CFR 297; 40 CFR 6.302 (e)	Not applicable	DMT is not known to be on a national, wild, or scenic recreational river.
Coastal Zone Management Act					
Within coastal zone	Regulates activities affecting the coastal zone, including lands there under and adjacent shoreline. The coastal zone is rich in a variety of natural, commercial, recreational, ecological, industrial, and esthetic resources of immediate and potential value to the present and future well-being of the nation. Must conduct activities in a manner consistent with the approved state management programs.	Activities affecting the coastal zone including lands there under and adjacent shore land.	Section 307(c) of 16 USC 1456(c); 16 USC 1451 et seq.; 15 CFR 930; 15 CFR 923.45	Applicable	
Coastal Barrier Resources Act, Section 3504					
Within designated coastal barrier	Prohibits any new federal expenditure within the Coastal Barrier Resource System. A coastal barrier is defined as habitats providing habitats for migratory birds and other wildlife, habitats which are essential spawning, nursery, nesting, and feeding areas for commercially and recreationally important species of finfish and shellfish, as well as other aquatic organisms such as sea turtles; contain resources of extraordinary scenic, scientific, recreational, natural, historic, archeological, cultural, and economic importance; serve as natural storm protective buffers and are generally unsuitable for development.	Activity within the Coastal Barrier Resource System.	16 USC 3504	Not applicable	DMT is not known to be within a designated coastal barrier.
Navigation and Navigable Waters					
Navigable waters	Establishes regulations pertaining to activities that affect the navigation of the waters of the United States.	Activities affecting navigable waters.	33 CFR 320-329	Not applicable	Response activities at DMT will not affect navigation of the river.

TABLE 4-4
Potential Federal Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Magnuson Fishery Conservation and Management Act					
Managed fisheries	Provides for conservation and management of specified fisheries within specified fishery conservation zones (in federal waters).	Presence of managed fisheries in federal waters.	16 USC 1801, et seq.	Applicable	Corrective measures will incorporate protection against any specified fishery zones.
Hazardous Waste Control Act (HWCA)					
Within 61 meters (200 feet) of a fault displaced in Holocene time	New treatment, storage, or disposal of hazardous waste prohibited.	Resource Conservation and Recovery Act (RCRA) hazardous waste; treatment, storage, or disposal of hazardous waste.	40 CFR 264.18 (a)	Not applicable	DMT is not known to be within 61 meters of a fault displaced in Holocene time.
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	RCRA hazardous waste; treatment, storage, or disposal of hazardous waste.	40 CFR 264.18 (b)	Not Applicable	DMT is outside the 100-year flood zone.
Within salt dome formation, underground mine, or cave	Placement of non-containerized or bulk liquid hazardous waste prohibited.	RCRA hazardous waste; placement.	40 CFR 264.18 (c)	Not applicable	Response activities will not involve the storage of hazardous waste within underground, naturally occurring formations.
Executive Order 11988, Protection of Floodplains					
Within floodplain	Actions taken should avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Not Applicable	DMT is outside the 100-year flood zone.
Rivers and Harbors Act of 1972					
Navigable waters	Permits are required for structures or work affecting navigable waters.	Activities affecting navigable waters.	33 USC 403	Not applicable	Response activities at DMT will not affect navigation of the river.

ARARs, Applicable or relevant and appropriate requirements; FR, Federal Register; RCRA, Resource Conservation and Recovery Act; HWCA, Hazardous Waste Control Act; CFR, Code of Federal Regulations; NAS, Naval Air Station; CWA- Clean Water Act; USC, United States Code; DON, Department of Navy; TBC, To Be Considered.

TABLE 4-5
Potential State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Threatened and Endangered Species					
Critical habitat upon which endangered species or threatened species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on. May not reduce the likelihood of either the survival or recovery of a listed species in the wild by reducing the reproduction, numbers or distribution of a listed species or otherwise adversely affect the species.	Determination of effect upon endangered or threatened species or its habitat.	COMAR 08.03.08	Potentially applicable	These regulations are applicable if corrective measures may jeopardize endangered or threatened fish species and their habitats.
Threatened and Endangered Fish Species					
Critical habitat upon which endangered or threatened fish species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on.	Determination of effect upon endangered or threatened fish species or its habitat.	COMAR 08.02.12	Potentially applicable	These regulations are applicable if corrective measures may jeopardize endangered or threatened fish species.
Fish and Fisheries					
Fisheries, locations where species of fish exist	Requirements to conserve species of fish for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon fish species or its habitat.	Annotated Code of Maryland, *Natural Resource Article*, Title 4—Fish and Fisheries	Applicable	Fish species inhabit the Patapsco River. If corrective measures may affect these species, the requirements of this title are applicable.
Wildlife					
Areas inhabited by wildlife	Requirements to conserve species of wildlife for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon wildlife species or its habitat.	Annotated Code of Maryland, *Natural Resource Article*, Title 10—Wildlife	Potentially applicable	No known wild animal species exist at DMT. This regulation is only applicable if the situation changes.
Chesapeake Bay Critical Protection Law					
Area 1,000 feet landward from tidal waters of the Chesapeake Bay and its tributaries and land under these waters	Minimize impacts of the bay's water quality and to conserve plant, fish, and wildlife habitat.	Activities that will occur in the area 1,000 feet landward from tidal waters of the Chesapeake Bay and its tributaries and land under these waters.	Annotated Code of Maryland, *Natural Resource Article*, Title 8—Waters, Subtitle 18—Chesapeake Bay Area Critical Protection Program	Applicable	DMT is within the Chesapeake Bay Critical Area; as such, all land-disturbing activities are guided by specific provisions in the state-adopted critical area criteria and local critical area program.
Nontidal Wetlands Protection Act, Maryland Nontidal Wetlands Regulations					
Wetland	Provides regulations for activities on or near nontidal wetlands (an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions). Must obtain a permit from the state to conduct certain regulated activities in a non-tidal wetland, or within a buffer or an expanded buffer.	Activities that will occur on or near non-tidal wetlands.	COMAR 26.23; Annotated Code of Maryland, *Environmental Article*, Title 5—Water Resources	Not applicable	Nontidal wetlands are not present at DMT.
Maryland Wetland Law, Wetlands Tidal Wetlands Regulations					
Tidal Wetland	Tidal wetlands are state and private tidal wetlands, marshes, submerged aquatic vegetation, lands, and open water affected by the daily and periodic rise and fall of the tide within the Chesapeake Bay and its tributaries, the coastal bays adjacent to Maryland's coastal barrier islands, and the Atlantic Ocean to a distance of 3 miles offshore of the low water mark. Provides that activities such as dredging, filling, removing, constructing, reconstruction, or activities otherwise altering tidal wetlands must be permitted by the state.	Activities that will alter tidal wetlands.	COMAR 26.24; Annotated Code of Maryland, *Environmental Article*, Title 5—Water Resources; Annotated Code of Maryland, *Environmental Article*, Title 16—Wetlands and Riparian Rights	Not applicable	Tidal wetlands are not present at DMT.

TABLE 4-5
Potential State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Wetlands and Riparian Rights					
Wetlands	Requirements to preserve wetlands and prevent their destruction; requires a license for dredging or filling of wetlands.	Activities that can affect the integrity of wetlands, such as dredging or filling.	Annotated Code of Maryland, *Environmental Article*, Title 16—Wetlands and Riparian Rights	Not applicable	Wetlands (tidal and nontidal) are not present at DMT.
Construction on Nontidal Waters and Floodplains					
Nontidal waters and floodplains	Protect and maintain non-tidal waterways and/or state of Maryland floodplains must follow these regulations	Activities that affect non-tidal waterways and floodplains	COMAR 26.17.04	Not applicable	There are no floodplains at DMT.
Maryland Water Pollution Control Regulations					
Surface waters of the state	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges limitations and policy for antidegradation of the state's limitations and policy for antidegradation of the state's surface water.	Activities that will pollute the surface waters of the state.	COMAR 26.08, Chapters 01-07	Applicable	The design for the corrective measures will incorporate the requirements of this regulation.
Water Management					
Water resources of the state	Provides for the conservation and protection of the water resources of the state by requiring that any land-clearing, grading, or other earth disturbances require an erosion and sediment control plan. Also provides that stormwater must be managed to prevent offsite sedimentation and maintain current site conditions.	Activities that affect the water resources of the state.	COMAR 26.17.01 COMAR 26.17.02, Annotated Code of Maryland, *Environment Article*, Title 4—Water Management	Applicable	The design for the corrective measures will incorporate the requirements of this regulation.

ARARs, Applicable or relevant and appropriate requirements; FR, Federal Register; RCRA, Resource Conservation and Recovery Act; HWCA, Hazardous Waste Control Act; CFR, Code of Federal Regulations; NAS, Naval Air Station; CWA- Clean Water Act; USC, United States Code; DON, Department of Navy; TBC, To Be Considered; EO, Executive Order.

TABLE 4-6
Corrective Measures Objectives by Environmental Medium

CMO	Potential Chemical of Concern	Corrective Measures Objectives
COPR		
		Protection of Human Health
1	Cr(III), Cr(VI)	Prevent incidental human ingestion or direct contact with COPR or Cr(VI) in soils that pose an excess cancer risk greater than 10^{-5}or Cr(III) in soils that pose a Hazard Index in excess of 1
2	Cr(III), Cr(VI)	Prevent human inhalation of Cr(VI) that poses an excess cancer risk greater than 10^{-5} or Cr(III) at concentrations in excess of a Hazard Index of 1
		Protection of the Environment
3	NA	Ensure offsite transport and disposal of excavated COPR in accordance with State and federal regulations
		Maintenance of Port Operations
4	NA	Minimize impacts to port operations.
Groundwater		
		Protection of Human Health
5	Cr(VI)	Prevent human ingestion of groundwater having concentrations of Cr(VI) greater than a cancer risk of 10^{-5}
6	Cr(III)	Prevent human ingestion of groundwater having concentrations of Cr(III) greater than a Hazard Index of 1
		Protection of the Environment
7	Cr(III), Cr(VI)	Prevent the offsite migration of Cr(III) and Cr (VI) in groundwater above criteria established in federal and State of Maryland Applicable and Relevant or Appropriate Requirements
		Maintenance of Port Operations
8	NA	Minimize impacts to port operations.
Stormwater		
		Protection of Human Health
9	Cr(VI)	Prevent human ingestion of stormwater having concentrations of Cr(VI) greater than a cancer risk of 10^{-5}

TABLE 4-6
Corrective Measures Objectives by Environmental Medium

CMO	Potential Chemical of Concern	Corrective Measures Objectives
		Protection of the Environment
10	Cr(III), Cr(VI)	Prevent impacts to surface water Cr (VI) above criteria established in federal and State of Maryland Applicable and Relevant or Appropriate Requirements
		Maintenance of Port Operations
11	NA	Minimize impacts to port operations.
Surface Water and Sediment		
		Protection of Human Health
12	Cr(VI)	Prevent incidental human ingestion of surface water having concentrations of Cr(VI) greater than a cancer risk of 10^{-5}
13	Cr(III)	Prevent incidental human ingestion of surface water having concentrations of Cr(III) greater than a Hazard Index of 1
14	Cr(III), Cr(VI)	Prevent incidental human ingestion or direct contact with sediment containing Cr(VI) posing an excess cancer risk greater than 10^{-5} or Cr(III) in sediments that pose a Hazard Index in excess of 1
		Protection of the Environment
15	Cr(III), Cr(VI)	Prevent impacts to surface water by Cr (VI) above criteria established in federal and State of Maryland ARARs
		Maintenance of Port Operations
16	NA	Minimize impacts to port operations

SECTION 5

Response Actions and Screening of Remedial Technologies

5.1 General Response Actions

General response actions are media-specific actions that may individually or in combination be used to develop corrective measures alternatives that will meet the overall requirements of the Consent Decree.

This section describes general response actions for the four environmental media at DMT: COPR fill, stormwater (including surface water), groundwater, and sediment. These response actions will be used as the basis of identifying and screening technologies that will be used in the subsequent development and evaluation of applicable corrective measures alternatives.

5.1.1 General Response Actions

Response actions potentially applicable to the four media at DMT include the following general categories.

Administrative Controls

Actions using physical, legal, or administrative mechanisms, or environmental monitoring to restrict the use of, limit access to, or monitor the transport and concentrations of contaminants of concern.

Containment

Actions that result in contaminated soil, sediment, or groundwater being contained or controlled, minimizing or eliminating the migration of contaminants and preventing direct exposure to contamination.

Heave Management

Actions that reduce the effects of COPR heave and expansion and thereby reduce the risk of damage to site infrastructure or potential exposure to COPR that might otherwise result from COPR expansion and heave.

Segregation

Actions taken to physically separate media to reduce or eliminate contamination of one media through contact with another.

Infiltration Control

Actions taken to minimize the infiltration of water into an area to minimize leaching of contaminants or to control groundwater levels.

Extraction

Actions taken to extract contaminated groundwater beneath the site.

Removal

Actions taken to physically excavate and remove COPR, contaminated soil, solid waste, or sediment from the site.

Disposal

Actions taken to transport and dispose of contaminated soil, solid waste, or sediment at an offsite disposal facility that is licensed or permitted to accept such materials.

Treatment

Actions taken to treat contaminated soil , solid waste, surface water, groundwater, and/or sediment to reduce the toxicity, mobility, and/or volume of contaminants, or to change specific properties of the materials.

5.1.2 Media-Specific Response Actions COPR Fill Media

Specific response actions that may be applicable to each of the media of concern at DMT include the following:

- **COPR fill:** administrative controls, containment, heave mitigation, removal, disposal, and treatment
- **Stormwater (including surface water):** administrative controls, segregation, isolation/containment, and treatment
- **Groundwater:** administrative controls, containment, infiltration control, extraction and treatment
- **Sediment:** administrative controls, containment/capping, removal, disposal, and treatment

Each media-specific response action is further developed and evaluated in the following sections.

5.2 Identification and Screening of Remedial Technologies

This section includes the identification of the technologies associated with medium-specific response actions discussed above, as well as related process options. This section includes the screening of the technologies and process options to select those retained for further consideration in the assembly of corrective measures alternatives. Technologies or process options retained during the screening process but not used in specific corrective measures alternatives will be maintained for consideration in addressing contingency conditions, if any, that are identified during implementation and long-term monitoring of the selected corrective measures alternative(s). Technologies not retained as a result of the screening process will not be considered further.

5.2.1 Identification of Potentially Applicable Technologies and Process Options

The identification of remedial technologies is organized by grouping the remedial technologies into a three-tier hierarchical system for describing the remedial processes. This system uses the following categories, in order of increasing specificity: general response action, remedial technology, and process option.

For example, containing stormwater is a general response action, one of the containment technologies is relining storm drains, and one of the several process options is installing a CIP liner.

Tables 5-1, 5-2, 5-3, and 5-4 summarize the remedial technologies and process options selected, respectively, for the COPR fill, surface water, groundwater, and sediment media.

5.2.2 Screening Process

The candidate remedial technologies were screened using three broad criteria to judge the suitability of each technology for the DMT site. The criteria include effectiveness, implementability, and relative cost. Each are described below:

Effectiveness

The EPA guidance (EPA, 1988) for conducting a feasibility study (FS) uses "effectiveness" as the most important criterion at this stage. Less weight is given to implementability and cost. The technologies and process options retained following screening for effectiveness, implementability, and cost are assembled into corrective measures alternatives and subjected to detailed evaluation under an expanded set of evaluation criteria.

In accordance with EPA guidance, representative process options were selected to simplify the development and evaluation of remedial technologies. However, the specific process option used to implement a corrective measure may not be selected until the remedial design phase has been completed. Selection of a representative process option does not preclude the application of other retained process options at the site.

In the screening process, effectiveness pertains to the following:

- Capability of the technology to attain corrective measures objectives, including protection of human health and the environment;
- Capability of a technology to address the estimated areas or volumes targeted for remediation to prevent or minimize the release of hazardous substances to potential receptors;
- Degree of protection afforded to human health and the environment during construction and implementation of the remedial technology; and
- Reliability and performance of the technology with respect to the site conditions.

The potential impacts of the alternatives during their implementation were evaluated as part of the "short-term effectiveness" criterion and to determine that the alternatives were consistent with statutes and regulations governing Maryland cleanup programs, without compromising cleanup objectives, community interests, the reasonableness of cleanup timeframes, or the protectiveness of the cleanup actions.

Short-term effectiveness of each corrective measure encompasses air emissions, potential for safety impacts (community and worker), energy use, land use, and materials intensity (i.e., material handling, use, and transport) as presented in the table below and presented in detail in Section 7.2.5. For a basic data compilation of the short-term effectiveness impact assessment, see Appendix C.

Short-Term Impacts	Types of Impacts
Environment	
Climate change	Greenhouse gases
Air quality	NO_x, SO_x, VOCs, particulate matter
Energy	Fuel, power
Land	Acres impacted
Materials intensity	Clean fill, hazardous and nonhazardous waste
Social	
Aesthetics	Increase in traffic volume
Health and safety	Worker injury/fatality, community injury/fatality, train accident/release

Implementability

Implementability pertains to the following:

- Availability and capacity of treatment, storage, and disposal services;
- Constructability of the remedial technology under facility conditions; and
- Time needed to implement the remedial technology, to achieve beneficial results, and to satisfy the CMOs.

Cost

Relative cost screening considers the general capital and operations and maintenance (O&M) costs associated with the process options. The screening phase relies on order-of-magnitude costs based on typical unit costs, cost curves, unit costs from similar applications, etc., because detailed cost information is developed only for the screened options. Relative costs for a particular process option in the screening tables are expressed as “low,” “moderate,” “high,” and “very high” based on the order-of-magnitude cost of that process option relative to the order-of-magnitude costs of other comparatively effective or implementable process options.

Tables 5-5 through 5-8 summarize the screening process for candidate technologies and related process options for COPR fill, surface water, groundwater, and sediment media, respectively, relative to the screening criteria discussed above.

5.2.3 Technology and Process Options Screening

Tables 5-9 through 5-12 summarize the technologies and process options screening results. All remedial technologies and process options, except those associated with in situ or ex situ COPR stabilization, were maintained for further consideration, where appropriate, as potential components of corrective measures alternatives.

COPR stabilization technologies and process options were not retained because they are unproven with respect to large volumes of COPR (as opposed to chromium soils). In addition, stabilization technologies would result in substantial port disruption, and would be very expensive as compared with other options. Removal and disposal technologies and process options were retained to support the full excavation alternative required by the Consent Decree.

The results of the technology screening in Tables 5-9 through 5-12 are not intended to eliminate or preclude consideration of other remedial technologies that may become available during the subsequent remedial alternatives analysis or design processes. The screening is intended to show the selection rationale for the technology and process options.

TABLE 5-1
Identification of Candidate Remedial Technologies—COPR Fill

General Remedial Response	Remedial Technology	Process Option	Description of Technology
Administrative controls	Institutional controls	Security	Fences, signs, gate security, procedures, security patrols, and other procedures to prevent unauthorized access by the general public or other unauthorized persons.
		Standard operating procedures	Standardized procedures and requirements for performing identified operational or construction activities where COPR materials may be encountered or uncovered.
		Deed restrictions	Recorded real estate documents restricting or putting specific requirements on future use of the property.
		Inspection, monitoring, and maintenance	Routine inspection and maintenance of pavements and other cover systems to identify and correct conditions that may lead to release of COPR-fill constituents if not alleviated.
	Environmental monitoring	Air monitoring	Site wide or project-specific air monitoring to detect dust and/or specific constituents generated from operational and construction activities at the port.
Containment	Capping	Conventional pavements	Conventional asphalt, modified asphalt, concrete, and paver block pavement systems currently existing at the port.
		Roller compacted concrete pavements	Low-slump portland cement concrete pavements system consisting of 10 inches of installed in compacted lifts in a manner like compacted earth fill.
		MATCON™ or similar low-permeability pavements	Low-permeability asphalt concrete pavement system consisting of 4 inches of polymer-modified asphaltic concrete installed over a prepared stone base.
		Articulated block pavements	Flexible pavement system consisting of a geomembrane barrier, low profile drainage piping, 18 inches of coarse stone aggregate, and a cable-stabilized concrete block wearing surface.
Heave mitigation	Heave damage controls	Strain relief trenches	Trenches or zones of compressible fill adjacent to or below utilities and other facilities to absorb lateral expansion of COPR materials.
		Surcharging	Placement of thick engineered fill over the area to contain vertical expansion of COPR materials.
		Utility relocation	Relocation of utilities outside COPR fill zones or replacement within engineered structures in COPR to prevent damage or displacement from subsurface COPR expansion.
Removal	Excavation	Conventional excavation	Excavation and removal of COPR fill materials by conventional excavation methods.
Disposal	Disposal	Offsite landfill disposal	Transportation and disposal of excavated materials at an offsite landfill licensed to accept such materials.
	Onsite stabilization	Ex situ treatment	Application of stabilizing agents by pug mill or other ex situ mixing method to decrease the heave potential, and to reduce the toxicity, and mobility of constituents in the COPR.

TABLE 5-2
Identification of Candidate Remedial Technologies—Stormwater (Including Surface Water)

General Remedial Response	Remedial Technology	Process Option	Description of Technology
Administrative controls	Institutional controls	Inspection and maintenance	Routine inspection and maintenance of the storm drain systems to identify and correct conditions that may lead to impacted groundwater or surface water intrusion into the system.
		Standard operating procedures	Standardized procedures and requirements for performing identified operational or construction activities where impacted water may be encountered on the surface or in the storm drain system.
	Environmental monitoring	Stormwater monitoring	Sitewide or project-specific stormwater monitoring to detect the presence of COPR constituents within the storm drain system.
Segregation	Surface water segregation	ABC pavement system	Flexible pavement system consisting of a geomembrane barrier, low profile drainage piping, 18 inches of coarse stone aggregate, and a cable-stabilized concrete block wearing surface, specifically designed to collect and transport surface water above the ground surface.
		Asphalt or concrete pavement systems	Stabilized pavement providing physical barrier to prevent contact of surface water with underlying contaminants and a graded surface for draining surface water to associated drainage system.
	Groundwater segregation	In situ pipe relining	Installation of linings in existing stormwater pipes to reduce infiltration and contact with contaminated groundwater.
		Pipe replacement	Replacement of existing stormwater piping in clean utility corridors to reduce infiltration and contact with contaminated groundwater.
Containment	Collection	Collection vaults	Containment and collection of surface water flows within collection boxes at the ends of identified storm sewers containing COPR-impacted water.
Treatment	Ex situ treatment	Collection and treatment	Collection of surface water flow and treatment at an onsite treatment plant.

TABLE 5-3
Identification of Candidate Remedial Technologies—Groundwater

General Remedial Response	Remedial Technology	Process Option	Description of Technology
Administrational controls	Institutional controls	Standard operating procedures	Standardized procedures and requirements for performing identified operational or construction activities at where impacted groundwater may be encountered.
	Environmental monitoring	Groundwater monitoring	Sitewide groundwater monitoring to monitor the movement or changes in movement of COPR-related constituents in the groundwater.
Containment	Vertical barriers	Soil-bentonite slurry wall	Three-foot-wide (approx.) soil-bentonite barrier extending vertically from near the ground surface to and into the top of the nearest low-permeability confining layer.
		Soil-bentonite grout curtain	A jet-grouted barrier consisting of interlocking soil-bentonite panels or secant piles extending vertically from the ground surface to and into the top of the nearest low-permeability confining layer.
		Conventional steel sheet pile wall	A vertical hydraulic barrier consisting of interlocking steel sheet piles driven vertically from the ground surface into a low-permeability confining layer.
		Sealed joint steel sheet pile wall	A vertical hydraulic barrier consisting of interlocking and sealed-joint steel sheet piles driven vertically from the ground surface into a low-permeability confining layer.
		Sealed joint plastic sheet pile wall	A vertical hydraulic barrier consisting of interlocking plastic sheet piles installed vertically by driving or inserting in a slurry trench from the ground surface into a low-permeability confining layer.
	Gradient controls	Extraction wells	A series of wells extending into an aquifer, along with pumping system(s), to remove water sufficiently to create a linear groundwater depression and inward gradient to control migration of constituents.
		Drainage trench	An excavated trench extending into the aquifer, along a granular drainage layer, piping, sumps, and pumping system to remove groundwater sufficiently to create a linear groundwater depression and inward gradient to control migration of constituents.
		Directional drilled drainage pipe	A perforated pipe installed at an angle from the surface and then horizontally within an aquifer and associated pumping system to remove contaminated groundwater sufficiently to create a linear groundwater depression and inward gradient to control migration of constituents.
		Recharge wells, trenches, or pits	A series of wells, trenches, pits, etc., into which water is introduced to increase the gradient back to a collection system or other gradient control measure.
Infiltration control	Capping	Conventional asphalt and concrete pavements	Conventional asphalt similar to those that have historically been installed at the port.
		Low-permeability asphalt or ABC pavements	Pavement systems constructed with a membrane or low-permeability asphalt materials or conventional asphalt treated with additives to reduce permeability
Treatment	In situ treatment	Reactive barrier—zero valence iron	Vertical high-permeability panels in conventional vertical barriers with zero valent iron materials to react with and convert constituents such as Cr(VI) into less toxic constituents that can be released into outside groundwater or surface water.
		Reactive barrier—other reactive agents	Vertical high-permeability panels in conventional vertical barriers with other reactive agents that react with and convert constituents such a Cr(VI) into less toxic constituents which can be released into outside groundwater or surface water.
	Ex situ treatment	Collection and treatment	Collection of groundwater and treatment at an onsite treatment plant.

TABLE 5-4
Identification of Candidate Remedial Technologies—Sediment

General Remedial Response	Remedial Technology	Process Option	Description of Technology
Administrative controls	Institutional controls	Standard operating procedures	Standardized procedures and requirements for performing identified operational or construction activities at the port that may come into contact with impacted sediment.
		Inspection and maintenance	Periodic inspections for sediment in the stormwater system and removal of sediment, if needed, to prevent transport of COPR-related materials into the Patapsco River.
	Environmental monitoring	Sediment monitoring	Sitewide sediment monitoring to monitor the presence of COPR-related constituents in sediment in the Patapsco River.
Containment	Capping	Soil cover	Installation of granular cover over existing sediment to prevent migration and to minimize contact by fish and other aquatic organisms.
Removal	Excavation	Conventional dredging or wet excavation techniques	Excavation of impacted sediment in the Patapsco River by standard dredging methods.
Disposal	Disposal	Offsite disposal	Removal of excavated sediment and disposal in a landfill or dredge disposal area licensed to accept the materials.
Treatment	In situ treatment	Natural attenuation	Detoxification of sediment by natural chemical of physical processes.
		In situ treatment	Application or injection of chemical or biological constituents to detoxify in-place sediment.

TABLE 5-5
Remedial Technology Screening Process Summary—COPR Fill

General Remedial Response	Remedial Technology	Process Option	Comments: Effectiveness	Comments: Implementability	Relative Estimated Cost
Administrative controls	Institutional controls	Security	Effective in preventing unauthorized personnel from entering the port.	Is currently being implemented by existing security measures, personnel, and procedures.	Low to moderate
		Standard operating procedures	Effective in providing controls and procedures for all port personnel, contractors, and tenants to follow. Requires oversight to maintain compliance.	Is currently implemented for various activities at the port.	Low to moderate
		Deed restrictions	Effective in preventing and restricting future use and disturbance at the site. Requires long-term post-operational administration and oversight. Facilitates beneficial reuse.	Can be implemented with appropriate legal documents and real estate transfer requirements.	Low
		Inspection, monitoring and maintenance	Effective in monitoring COPR movement (via inclinometers) and maintaining an effective cover system if inspection and maintenance program is actively followed.	Both cover (pavement) system inspection and maintenance and inclinometer monitoring program already in place.	Low to moderate
	Environmental monitoring	Air monitoring	Effective in monitoring site-wide and project-specific air quality and identifying conditions were dust and other constituents may be present.	Air monitoring is already in place.	Low
Containment	Capping	Conventional pavements	Effective in preventing contact with COPR. Infiltration protection depends upon permeability and condition of asphalt component. May require maintenance and reconstruction where active heave is present.	Can be implemented by readily available contractors, equipment, and materials. Onsite and offsite impacts similar to current operations. Includes consideration of conventional pavements modified by addition of sealants to reduce permeability.	Moderate
		Roller-compacted concrete pavements	Effective in preventing contact with COPR. Infiltration protection depends upon long-term condition. Maintenance and some reconstruction may be necessary in active heave areas.	Can be implemented by readily available contractors, equipment, and materials. Minimal increase in onsite and offsite impacts.	Moderate to high
		MATCON™ or similar low-permeability pavements	Effective in preventing contact with COPR. Infiltration protection depends on long-term condition of asphalt layer. May require considerable maintenance and reconstruction where active heave is present.	Requires some special materials, but can be implemented by trained contractors. Minimal increase in onsite and offsite impacts. Significant seasonal and spatial limitations.	Moderate to high
		Articulated block pavements	Effective in preventing contact. Maintenance and some reconstruction may be necessary in active heave areas.	Can be implemented with existing construction practices. Requires some special materials and equipment. Temporary increase in onsite and offsite traffic during implementation. Difficult to implement in areas where surface grade must be maintained.	Moderate to high

TABLE 5-5
Remedial Technology Screening Process Summary—COPR Fill

General Remedial Response	Remedial Technology	Process Option	Comments: Effectiveness	Comments: Implementability	Relative Estimated Cost
Heave Mitigation	Heave Damage Controls	Relief Trenches	Effective in protecting utilities and structures, provided that compressible zones are of sufficient size to absorb amount of long-term expansion. Can be combined with reactive agents.	Can be implemented with common construction practices by operational considerations in an area. Minimal increase in onsite and offsite impacts.	Moderate
		Surcharging	Effective in controlling vertical expansion, but could lead to greater horizontal expansion. Effectiveness limited to areas exhibiting unusual/excessive heave behavior.	Can be implemented with common earthwork practices. May be limited by operational considerations in an area (grade constraints). Temporary increase in onsite and offsite traffic during implementation.	Moderate
		Utility Relocation	Effective in minimizing effects of COPR expansion on utility systems.	Can be implemented, but may require special design features. May be limited. Highly disruptive - could have major onsite operational and offsite transportation impacts depending upon COPR removal and disposal requirements.	High
Removal	Excavation	Conventional Excavation	Effective in removing most residual contaminants.	Can be implemented by normal construction practices. Would be very disruptive of port operations. Major impacts to onsite operations impacts due to disturbance and transportation of excavated materials and backfill.	Very high
Disposal	Disposal	Offsite Landfill Disposal	Effective in containing contaminants in an environmentally sound manner at an offsite location.	Can be implemented; however, would require transportation of major volumes of contaminated materials over local and interstate roads and/or railways. Would have increased offsite impacts.	Very high
Treatment	Stabilization	Ex Situ Treatment	Could be effective if appropriate stabilization agents could be identified to eliminate heave potential and decrease toxicity and mobility of constituents. Untried technology.	Can be implemented by normal construction practices. Would be very disruptive of port operations. Would require extensive controls to prevent onsite and offsite environmental impacts.	Very high

TABLE 5-6
Remedial Technology Screening Process Summary—Stormwater (Including Surface Water and Stormwater)

General Remedial Response	Remedial Technology	Process Option	Comments: Effectiveness	Comments: Implementability	Relative Estimated Cost
Administrative controls	Institutional controls	Inspection and maintenance	Effective in maintaining an effective cover system and stormwater conveyance system if inspection and maintenance program is actively followed.	Cover (pavement) system inspection and maintenance program provides for inspection of 14th and 15th Street drains.	Low to moderate
		Standard operating conditions	Effective in providing controls and procedures for all port personnel, contractors, and tenants to follow. Requires oversight to maintain compliance.	Is currently implemented for various activities at the port.	Low to moderate
	Environmental monitoring	Surface and stormwater monitoring	Effective in monitoring sitewide and project-specific surface and stormwater quality.	Surface water monitoring is easily implemented and has been conducted at DMT as part of the Surface Water and Sediment Study. Stormwater monitoring is infeasible without tidal exclusion vaults.	Low to moderate
Segregation	Surface water segregation	ABC pavement system	Can be effective in segregating stormwater and dealing with heave. Could be susceptible to siltation and clogging which could restrict flows into the system. Pilot program indicates no demonstrable benefit over conventional pavement systems under current conditions.	Limited applicability due to surface grades required for port operations. Can be implemented with existing construction practices. Requires some special materials and equipment. Temporary increase in onsite and offsite traffic during implementation.	Moderate to high
		Asphalt or concrete pavement systems	Can be effective in segregating stormwater. Requires separate drainage system with appropriate controls. May be susceptible to minor damage from heave.	Can be implemented with existing construction practices. Minimal additional onsite and offsite impacts. MATCON™ requires special materials and has limited applicability due to temperature constraints and large minimum surface area required for installation.	Low to high
	Groundwater segregation	In situ pipe relining	Can be effective in preventing infiltration of groundwater into the stormwater system. May be susceptible to damage from heave.	Can be implemented with current construction practices. Can be difficult for small pipes if appropriate access cannot be achieved. Temporary disruption in port operations within area where work is occurring. Potential increase in VOC releases depending upon re-lining method used. The effect of relining on groundwater gradients and flow is expected to be minimal and manageable based on groundwater modeling (Appendix B).	Moderate to high
		Pipe replacement	Can be effective in preventing infiltration of groundwater into the stormwater system. May be susceptible to damage from heave.	Can be implemented with current construction practices. Would be very disruptive to port operations. Impacts of transportation and offsite disposal of COPR materials could have major onsite and offsite transportation related impacts.	High
Containment	Collection	Collection vaults	Can be effective in collecting contaminated dry-weather flows. Insufficient capacity to collect and contain stormwater flows from wet weather events.	Can be implemented with current construction practices. Can be disruptive of existing port operations, depending upon location.	Moderate
Treatment	Ex situ treatment	Collection and treatment	Can be effective in collecting and treating contaminated dry-weather flows. Insufficient capacity to collect and treat stormwater flows from wet-weather events.	Can be implemented with existing construction practices and water treatment system. Treatment of additional flows would require increased plant capacity and operating requirements.	Low to moderate

TABLE 5-7
Remedial Technology Screening Process Summary—Groundwater

General Remedial Response	Remedial Technology	Process Option	Comments: Effectiveness	Comments: Implementability	Relative Estimated Cost
Administrative controls	Institutional controls	Standard operating conditions	Effective in providing controls and procedures for all port personnel, contractors, and tenants to follow. Requires oversight to maintain compliance.	Is currently implemented for various activities at the port.	Low to moderate
	Environmental monitoring	Groundwater monitoring	Effective in evaluating changes in groundwater and contaminant movement conditions.	Is currently implemented with existing groundwater-monitoring wells and groundwater monitoring program.	Low
Containment	Vertical barriers	Soil-bentonite slurry wall	Hexavalent chromium is rapidly reduced under present groundwater redox conditions. Under oxidizing conditions would be effective in stopping release of COPR constituents if bentonite is compatible with fluids, may require gradient controls.	Can be implemented with conventional equipment and methods, but requires specialty contractor. Increased onsite and offsite transportation-related impacts for offsite disposal. Would require groundwater controls that would be very difficult to implement and maintain due to carbonate precipitation and fouling. Would be permanently disruptive to port operations in the areas affected due to need for continual maintenance.	Moderate to high
		Soil-bentonite grout curtain	Hexavalent chromium is rapidly reduced under present groundwater redox conditions. Under oxidizing conditions would be effective in retarding release of COPR constituents if bentonite is compatible with fluids, a continuous system can be formed, and may require gradient controls.	Requires specialty contractors with specialty equipment and techniques. Would be temporarily disruptive to port operations in the areas affected. Would require groundwater controls that would be very difficult to implement and maintain due to carbonate precipitation and fouling. Would be permanently disruptive to port operations in the areas affected due to need for continual maintenance.	High
		Conventional steel sheet pile wall	Technology can be effective in reducing seepage where contaminant transport is an exposure pathway. Hexavalent chromium is rapidly reduced under present groundwater redox conditions.	Can be implemented with conventional sheet pile construction equipment, methods, and materials. Would require groundwater controls that would be very difficult to implement and maintain due to carbonate precipitation and fouling. Would be permanently disruptive to port operations in the areas affected due to need for continual maintenance.	High
		Sealed-joint steel sheet pile wall	Can be more effective in reducing seepage than conventional sheet pile wall. Hexavalent chromium is rapidly reduced under present groundwater redox conditions.	Can be implemented with conventional sheet pile construction equipment and methods, but requires special and potentially proprietary sheet pile system. Would require groundwater controls that would be very difficult to implement and maintain due to carbonate precipitation and fouling. Would be permanently disruptive to port operations in the areas affected due to need for continual maintenance.	High
		Sealed-joint plastic sheet pile wall	Similar to Sealed Joint Steel Sheet Pile Wall. Capable of providing low-permeability barrier. May be susceptible to degradation if sheets are not compatible with chemical constituents in the ground.	Generally limited to soft or loose formations, or must be installed in conjunction with other technologies such as slurry trenches. Would require groundwater controls that would be very difficult to implement and maintain due to carbonate precipitation and fouling. Would be permanently disruptive to port operations in the areas affected due to need for continual maintenance.	Moderate to high

TABLE 5-7
Remedial Technology Screening Process Summary—Groundwater

General Remedial Response	Remedial Technology	Process Option	Comments: Effectiveness	Comments: Implementability	Relative Estimated Cost
Containment	Gradient controls	Extraction wells	Not very effective due to precipitation of calcium carbonate in highly alkaline system (scaling).	Can be implemented using normal well installation techniques. May exacerbate COPR heave. Potential impacts of moisture content changes in COPR may cause heave and would have to be assessed. Would be temporarily disruptive to port operations in the areas affected. Sustainability of groundwater controls questionable due to carbonate precipitation and fouling.	Moderate
		Drainage trench	Not very effective due to precipitation of calcium carbonate in highly alkaline system (scaling).	Can be constructed using conventional construction methods. May be difficult to install at depth or where utilities or other facilities are present. Potential impacts of moisture content changes in COPR may cause heave and would have to be assessed. Would be temporarily disruptive to port operations in the areas affected. Increased onsite and offsite transportation-related impacts for offsite disposal. Sustainability of groundwater controls questionable due to carbonate precipitation and fouling.	Moderate to high
		Directional drilled drainage trench	Not very effective due to precipitation of calcium carbonate in highly alkaline system (scaling)	Requires specialty construction. May be difficult to implement without sufficient space to emplace horizontal well. Potential impacts of moisture content changes in COPR may cause heave and would have to be assessed. Would be temporarily disruptive to port operations in the areas affected. Sustainability of groundwater controls questionable due to carbonate precipitation and fouling.	Moderate to high
		Recharge wells, trenches, and pits	Does not present material benefit over natural reductive processes in aquifer system and will cause localized increase in groundwater gradient, thereby decreasing residence time of chromate molecule in reducing aquifer system.	Can be implemented using available well, trench, or directional drilling technologies. Potential impacts of moisture content changes in COPR may cause heave and would have to be assessed. Would be temporarily disruptive to port operations in the areas affected.	Moderate to high
Infiltration control	Capping	Conventional asphalt and concrete pavements	Can be effective in reducing infiltration if properly maintained. May or may not affect overall groundwater levels, depending upon recharge from surrounding areas.	Currently implemented at the port	Moderate to high
		Low-permeability asphalt or ABC pavements	Can be effective in preventing infiltration if properly maintained. May or may not affect overall groundwater levels, depending upon recharge from surrounding areas.	Has been successfully demonstrated in Area 1800 but has not presented material benefit over conventional pavement systems. Potentially suitable for limited applications in areas of highly active heave attributable to surface water infiltration. Port operations require preservation of existing grades.	Moderate to high

TABLE 5-7
Remedial Technology Screening Process Summary—Groundwater

General Remedial Response	Remedial Technology	Process Option	Comments: Effectiveness	Comments: Implementability	Relative Estimated Cost
Treatment	In situ treatment	Reactive barrier—zero valent iron	Present redox conditions in aquifer are highly effective in reducing hexavalent chromium and therefore reactive barriers present no material benefits. Has been found to be effective in reducing Cr(VI) to less toxic form in some laboratory experiments, but has not been proven in the field. May not be applicable in high-pH environment.	Can be implemented with slurry wall and similar technologies. However, would require extensive bench scale and field testing to evaluate implementation requirements under proposed field conditions.	Moderate to high
		Reactive barrier—other agents	Present redox conditions in aquifer are highly effective in reducing hexavalent chromium and therefore reactive barriers present no material benefits. May impact permeability of aquifer system which would require detailed assessment. Long-term effectiveness dependent upon agent and use rate.	Can be implemented with slurry wall and similar technologies. However, would require extensive bench scale and field testing to evaluate potential reagents and other under proposed field conditions.	Moderate to high
	Ex situ treatment	Collection and treatment	Can be effective in removing contaminants from groundwater. Presents no material benefit over present reductive processes in aquifer system.	Currently being implemented as an interim measure in the existing groundwater treatment plant for contaminated groundwater infiltrating into storm drain system. Would be temporarily disruptive to port operations in the areas affected by additional collection and transport system installation. Maintenance intensive due to effects of calcification of collection and transport system. Cycling of groundwater table would induce additional COPR weathering and heave manifestation.	Moderate to high

TABLE 5-8
Remedial Technology Screening Process Summary—Sediment

General Remedial Response	Remedial Technology	Process Option	Comments: Effectiveness	Comments: Implementability	Relative Estimated Cost
Administrative controls	Institutional Controls	Sediment monitoring	Presents no material benefit given the highly reducing conditions of Patapsco River sediments. .	Can be readily incorporated using well established monitoring and sampling procedures.	Moderate
Containment	Capping	Soil Cover	Presents no material benefit given absence of hexavalent chromium in sediments. May be susceptible to erosion by tides, currents, and port-dredging operations.	Can be implemented using current construction methods. May be difficult to implement near bulkhead and dredge channels. Would be disruptive to port operations in areas where work is being done. Temporary onsite and offsite impacts of transporting materials to the site.	Moderate to high
Removal	Excavation	Conventional dredging or wet excavation techniques	Presents no material benefit given absence of hexavalent chromium in sediments.	Can be implemented using current construction methods. May be difficult to implement near bulkhead. Would be disruptive to current port operations during implementation. Will materially impact available capacity at currently permitted dredge disposal sites. Will adversely impact the existing ecosystem.	Moderate to high
Disposal	Transportation and disposal	Offsite landfill disposal	Presents no material benefit given absence of hexavalent chromium in sediments. Effective in containing contaminants in an environmentally sound manner at an offsite location.	Can be implemented; however, would require stabilization and offsite disposal. Will materially impact available capacity at currently permitted disposal facilities. Would have temporary onsite and offsite impacts associated with stabilization and offsite transportation.	Moderate to high
Treatment	In situ treatment	Natural attenuation	Can be effective due to natural reduction processes seen at the site.	Is currently being implemented by natural processes.	None
		In situ treatment	Presents no material benefit given absence of hexavalent chromium in sediments.	Can be implemented using current construction methods. May be difficult to implement near bulkhead. Could be disruptive to current port operations during implementation. Could have potential impacts to the existing ecosystem if not properly controlled.	Moderate to high

TABLE 5-9
Remedial Technology Screening Summary—COPR Fill

General Remedial Response	Remedial Technology	Process Option	Comments
Administrative controls	Institutional controls	Security	Retain for further consideration.
		Standard operating procedures	Retain for further consideration.
		Deed restrictions	Retain for further consideration.
		Inspection, monitoring, and maintenance	Retain for further consideration.
	Environmental monitoring	Air monitoring	Retain for further consideration.
Containment	Capping	Conventional pavements	Retain for further consideration.
		Roller compacted concrete pavements	Exclude under present conditions; retain for possible future application.
		MATCON™ or similar low permeability pavements	Exclude from further consideration due to spatial and temperature limitations.
		Articulated block pavements	Exclude under present conditions; retain for possible future application.
Treatment: heave mitigation	Heave damage controls	Relief trenches	Retain for further consideration.
		Surcharging	Exclude from further consideration under present conditions.
		Utility relocation	Retain for further consideration.
Removal	Excavation	Conventional excavation	Retain to support removal alternative required by the Consent Decree.
Disposal	Disposal	Offsite landfill disposal	Retain to support removal alternative required by the Consent Decree.
Treatment	Stabilization	Ex situ treatment	Exclude from further consideration. Untried technology; would be very disruptive to port operations.

TABLE 5-10
Remedial Technology Screening Summary—Stormwater (Including Surface Water and Stormwater)

General Remedial Response	Remedial Technology	Process Option	Comments
Administrative controls	Institutional controls	Inspection and maintenance	Retain for further consideration.
		Standard operating conditions	Retain for further consideration.
	Environmental monitoring	Stormwater monitoring	Retain for further consideration.
Segregation	Surface water segregation	ABC pavement system	Exclude under present conditions; retain for possible future application.
		Asphalt or concrete pavement systems	Retain for further consideration.
	Groundwater segregation	In situ pipe relining	Retain for further consideration.
		Pipe replacement	Retain for further consideration.
Containment	Collection	Collection vaults	Retain for further consideration.
Treatment	Ex situ treatment	Collection and treatment	Exclude under present conditions; retain for possible future application.

TABLE 5-11
Remedial Screening Summary—Groundwater

General Remedial Response	Remedial Technology	Process Option	Comments
Administrative controls	Institutional controls	Standard operating procedures	Retain for further consideration.
	Environmental monitoring	Groundwater monitoring	Retain for further consideration.
Containment	Vertical barriers	Soil-bentonite slurry wall	Exclude from further consideration under present conditions
		Soil-bentonite grout curtain	Exclude from further consideration under present conditions
		Conventional steel sheet pile wall	Exclude from further consideration under present conditions
		Sealed joint steel sheet pile wall	Exclude from further consideration under present conditions
		Sealed joint plastic sheet pile wall	Exclude from further consideration under present conditions.
	Gradient controls	Extraction wells	Retain for further consideration as part of excavation remedy only.
		Drainage trench	Retain for further consideration as part of excavation remedy only.
		Directional drilled drainage trench	Retain for further consideration as part of excavation remedy only.
		Recharge wells, trenches, or pits	Excluded from further consideration.
Infiltration control	Capping	Conventional asphalt and concrete pavements	Retain for further consideration.
		Low-permeability asphalt or ABC pavements	Exclude under present conditions; retain for possible future application.
Treatment	In situ treatment	reactive barrier—zero valence iron	Exclude from further consideration under present conditions
		reactive barrier—other reactive agents	Exclude from further consideration under present conditions
	Ex situ treatment	collection and treatment	Retain for further consideration as part of excavation remedies.

TABLE 5-12
Remedial Technology Screening Summary—Sediment

General Remedial Response	Remedial Technology	Process Option	Comments
Administrative controls	Institutional Controls	Sediment monitoring	Exclude from further consideration under present conditions. Confirm sediment conditions have not changed upon five year review.
Containment	Capping	Soil cover	Exclude from further consideration under present conditions
Removal	Excavation	Conventional dredging or wet excavation techniques	Exclude from further consideration under present conditions
Disposal	Transportation and disposal	Offsite disposal	Exclude from further consideration.
Treatment	In situ treatment	Natural attenuation	Exclude from further consideration under present conditions
		In situ treatment	Exclude from further consideration

SECTION 6

Corrective Measures Alternatives Development

6.1 Rationale for Corrective Measures Development

Five corrective measures alternatives were developed within four categories:

- **Category 1: No Further Action.** Corresponds to the "No Action" alternative required by EPA guidance for developing feasibility studies to represent the baseline alternative against which improvements provided by other corrective action alternatives may be judged.
- **Category 2: Maintain Existing Measures.** Includes an alternative that evaluates the current containment and operational conditions at DMT.
- **Category 3: Isolation and Containment.** Includes alternatives with containment enhancements that could be implemented to augment existing containment measures.
- **Category 4: Excavation.** Includes alternatives representing partial and full excavation and removal of impacted materials. This category addresses the excavation alternative required by the Consent Decree.

This arrangement of corrective measures provides for the scoping, cost analysis, and technical evaluation of a wide variety of technologies and process options, as well as a logical progression of corrective measures that can be applied in the event that the existing remedy does not adequately address issues related to the COPR fill, surface water, groundwater, and sediment media. In addition, the arrangement of categories and associated alternatives provides for evaluation of the benefits of combining various technologies. Where more than one process option is applicable to a particular technology being evaluated, representative and most-applicable process options were selected to conform to specific site conditions or needs. For example, a containment alternative may include multiple capping options applied in specific areas where certain benefits are required.

Five corrective measures alternatives have been identified and evaluated for consideration:

- Alternative 1: No Further Action
- Alternative 2: Basic Containment
- Alternative 3: Enhanced Isolation and Containment
- Alternative 4: Partial Excavation
- Alternative 5: Full Excavation

6.2 Description of Corrective Measures Alternatives

This section summarizes the major components of the corrective measures alternatives listed in the previous section. All permitting and regulatory requirements would be met for each of the alternatives described herein.

6.2.1 Alternative 1: No Further Action

Corrective Measures Alternative 1 represents no further action beyond the continuation of historical operational and maintenance activities that were completed at DMT prior to the 2006 Consent Decree as part of the 1992 MPA–MDE Consent Order. Its purpose is to represent the alternative against which all other alternatives are compared.

Medium-specific components of Alternative 1 include the following:

- COPR fill
  - Maintain surface cover systems (pavements) to meet operational needs at DMT and to contain COPR;
  - Continue asphalt pavement repair and replacement on as-needed basis at the historic level of effort; and
  - Maintain institutional controls to minimize worker exposure.
- Groundwater
  - Continue semiannual groundwater monitoring; and
  - Maintain institutional controls to minimize worker exposure.
- Stormwater
  - Sustain and continue to operate the WWTP for flows from the 14th Street and 15th Street storm drains;
  - Monitor dry- and wet-weather flow per the 2005 NPDES permit;
  - Continue monitoring treated effluent from the WWTP per the NPDES permit; and
  - Maintain institutional controls to minimize worker exposure.
- Surface water and sediment
  - No additional monitoring of surface water or sediment.
- Utilities and structures
  - Continue repair and replacement on an as-needed basis at the historical level of effort; and
  - Maintain institutional controls to minimize worker exposure.

The primary drivers for Alternative 1 include the 1992 MPA-MDE Consent Order, the 2005 NPDES Permit, and requirements for maintaining port facilities in a serviceable condition. A major component is paving and maintaining the surface cover to the extent necessary to cover COPR materials and to support continued port operations. Under this alternative, pavement repairs within the COPR fill area would continue to be initiated as surface disruptions are observed. No routine pavement-condition-monitoring program would be performed, except in response to observations reported by port personnel and tenants as they perform their normal port functions. Annual repair and repaving operations would be conducted on an as-needed basis in response to these reported observations, including filling of potholes and cracks, removing and repairing identified heave-related features that adversely affect safe port operations, and repaving areas that have become damaged.

According to MPA engineering personnel, the current service life of pavement systems at DMT is in the range of 20 to 25 years. Assuming an average life of 22.5 years, an average of 6.2 acres of the 148-acre paved area in COPR fill area would have become damaged and require replacement each year to maintain ongoing port operations. The typical pavement replacement operation at DMT includes removal of the old wearing surface by milling and replacement with a new layer of asphalt.

The groundwater medium would continue to be addressed through monitoring of select wells at DMT. Semiannual monitoring at 20 monitoring wells would continue to be performed per the requirements of the existing groundwater monitoring program.

The surface water medium would be addressed by the continued capture and treatment of dry-weather flows from the 14th and 15th Street storm drains and by monitoring of dry-weather flow in the other priority storm drains (i.e., 12th, 12.5th, 13th, and 13.5th Street storm drains) which are located at least partially within COPR fill. The onsite WWTP would continue to operate on a full-time basis to treat dry-weather flow collected from the 14th Street and 15th Street storm drains and other chromium-affected water collected during utility system repairs, dewatering of excavations, and heave repairs within the COPR fill area.

Under the No Further Action alternative, the repair and replacement of utilities within the COPR fill area would be performed on an as-needed basis in support of port operations. Routine repair and replacement of underground utilities generally include underground water lines, drainage structures, and electrical duct banks that have become damaged because of port loading operations, subsurface heave, weather, corrosive subsurface environment, or end of service life. Damage to utility service typically occurs as small, relatively isolated events identified by visible leaks, loss of service, or observations from port personnel. Historically, they have occurred at a rate of about seven events per year.

6.2.2 Alternative 2: Basic Containment

Corrective Measures Alternative 2 includes maintaining or upgrading all of the elements that have been completed under the 1992 Consent Order plus the interim corrective measures stipulated in the 2006 Consent Decree. The purpose of this alternative is to represent corrective measures that are currently being performed at DMT per the 2006 Consent Decree.

Medium-specific components of Alternative 2 include the following:

- COPR fill
  - Monitor, maintain, and inspect existing cover systems and perform proactive repair and replacement of damaged pavement using a formalized approach;
  - Perform annual pavement inspections early in the year to prioritize maintenance activities (e.g., crack and pothole repairs) to be performed during the annual construction season (consistent with the SCMP); and

  - Maintain institutional controls to minimize worker exposure.
- Groundwater
  - Perform semiannual groundwater monitoring; and
  - Maintain institutional controls to minimize worker exposure.
- Stormwater
  - Continue NPDES sampling of storm drains (i.e., 12th, 12.5th, 13th, 13.5th, 14th, and 15th Streets storm drains);
  - Continue to capture and treat contaminated groundwater infiltrating into the 14th and 15th Streets storm drain system;
  - Operate and maintain the existing WWTP for the 14th Street and 15th Street storm drains and perform NPDES compliance monitoring; and
  - Maintain institutional controls to minimize worker exposure.
- Surface water and sediment
  - No additional monitoring of surface water or sediment.
- Utilities and structures
  - Perform drinking water distribution system monitoring;
  - Continue repair and replacement on an as-needed basis at the historical level of effort; and
  - Continue implementation of the Site Drinking Water Plan.

With Alternative 2, interim measures specified in the 2006 Consent Decree would become permanent. These measures would include a more formal surface cover inspection program (which provides a higher standard of care for the cover), groundwater monitoring, formalized storm drain inspections, site drinking water monitoring, COPR expansion monitoring using installed inclinometers, use of SOPs for intrusive work, and institutional controls.

A primary component of Alternative 2 is an enhanced and formalized surface cover inspection and maintenance program that would facilitate proactive repairs (e.g., cracks, potholes, heaved areas) to enhance the environmental containment function of the pavement system. The formalized inspection and maintenance program, performed according to the approved SCMP (CH2M HILL, 2007a), would be more effective than the prior surface cover maintenance program. The program would include annual inspections to identify, scope, and prioritize pavement maintenance needs to facilitate contractor procurement and subsequent execution of repairs. In the event that repairs could not be completed by the end of any given year, the repairs would resume concurrently with the following annual inspection. Inspection and maintenance reports would be generated and submitted at the end of each annual inspection-and-repair cycle.

Pavement repair and replacement activities to support continued port operations, as included in Alternative 1, would occur simultaneously as needed. Although some decrease in repair and replacement requirements may occur over time as the formal cover system inspection and maintenance program progresses, annual repair and replacement requirements, at least in the interim, are expected to occur at the rate described for Alternative 1.

Alternative 2 addresses groundwater through monitoring a network of existing wells that could be used to establish a point-of-compliance perimeter for the COPR fill area.

Stormwater from the 14th Street and 15th Street storm drains is addressed by the continued capture and treatment of dry-weather flows from the 14th and 15th Street storm drains, continued operation of the WWTP, and NPDES sampling of the remaining priority storm drains (12th, 12.5th, 13th, and 13.5th Streets storm drains). In addition, Alternative 2 includes an inspection and maintenance program for the 14th and 15th Street storm drains in accordance with the SCMP. This program includes a visual inspection of the drains at least every 2 years to determine damage features such as cracking, spalling, joint displacement, and corrosion, and the prioritization and implementation of repairs that are determined to be necessary (CH2M HILL, 2007a).

Under Alternative 2, the repair and replacement of utilities within the COPR fill area would be performed on an as-needed basis to sustain port operations. These repairs and replacement activities would be the same as those in Alternative 1. In addition, Alternative 2 would include monitoring of the drinking water distribution system in accordance with the Site Drinking Water Monitoring Plan required by the 2006 Consent Decree. Drinking water would be sampled on a quarterly basis from two main water supply points and 24 buildings with water service on a rotating basis. The sampling schedule provides for sampling at each of the 24 buildings at least once per year. Reports would be provided to MDE on a quarterly basis.

Inspection and monitoring data from the surface cover and storm drain inspection and maintenance program will be incorporated, along with other inspection and monitoring data, into an O&M program. The O&M program will provide the procedures and methods for the site-wide collection, warehousing, and reporting of inspection, maintenance, and monitoring data.

6.2.3 Alternative 3: Enhanced Isolation and Containment

Corrective Measures Alternative 3 incorporates, upgrades, and expands upon Corrective Measures Alternative 2. Like Alternative 2, Corrective Measures Alternative 3 is predicated on the continued use of the surface cover system to isolate and control the COPR. However, Corrective Measures Alternative 3 contains several significant enhancements. In contrast to Alternatives 1 and 2, which focus on *treating* contaminated groundwater that enters the storm drains before it is discharged, Alternative 3 represents a "paradigm shift" in that it focuses on *preventing* contaminated groundwater from entering the storm drains in order to mitigate hexavalent chromium from storm drain discharges. This would be accomplished by repairing and relining the damaged portions of the 12th, 12.5th, 13th, 13.5th, 14th, and 15th Streets storm drains to address the intrusion of chromium-impacted water into the storm drains. Alternative 3 provides for the addition of tide-exclusion vaults in the 12th through 13.5th Streets storm drains to enable reliable monitoring of stormwater and to facilitate storm drain repairs. The objective of the Enhanced Isolation and Containment Alternative is to complete the COPR containment system at DMT by maintaining and improving the surface cover over the long term while also isolating contaminated groundwater and preventing its infiltration into the priority storm drains within the COPR fill area.

A second significant difference enhancement imbedded in Alternative 3 is the establishment of a formal PMP for identifying conditions requiring corrective measures (e.g., "trigger" events). The PMP provides a comprehensive framework for maintaining remedy performance and imposes rigorous controls for remedy protection in the future. The PMP, to be developed as a component of the Remedial Action Work Plan, will define the basis for developing, implementing, and monitoring the performance of corrective measures in response to identified trigger events. The PMP is an observational-based process that represents a formalized and comprehensive approach for identifying, evaluating, and implementing contingent corrective measures in response to conditions when further action is triggered within the COPR fill area. The PMP is intended to formally link monitoring and maintenance programs so that if a trigger is activated, an evaluation of additional corrective measures or enhancement of existing measures is initiated and implemented in the shortest timeframe reasonably practicable.

The PMP would achieve the following:

- Develop, implement, and monitor the effectiveness of existing corrective measures;
- Identify changes in the conceptual site model (CSM) that could potentially warrant evaluation of additional corrective measures;
- Set the triggers by medium and/or location for additional corrective measures;
- Establish criteria for focused data collection and alternatives analyses to identify and select appropriate remedies for identified trigger conditions; and
- Document the ongoing effectiveness of corrective measures through routine reporting.

As part of the PMP, a sentinel groundwater monitoring network would be installed at the shoreline perimeter, as close to the water's edge as possible, to measure groundwater quality at the property boundary.

Medium-specific components of this alternative include the following:

- COPR fill
  - Monitor, maintain, and inspect existing cover systems and perform proactive repair and replacement of damaged pavement using a formal approach and a variety of potential surface cover systems, including conventional asphalt, modified asphalt systems, and ABC systems where appropriate and consistent with site conditions and port operations;
  - Maintain collected data and observations from the inspection and maintenance activities in an electronic database and a GIS (i.e., location, nature of damage, and repairs implemented) for use in planning and implementing future maintenance system inspection and/or repairs;

  - Perform annual pavement inspections early in the year to prioritize resurfacing and maintenance activities (e.g., crack and pothole repairs) to be performed during the annual construction season (consistent with the SCMP); and
  - Maintain institutional controls to minimize worker exposure.
- Groundwater
  - Perform groundwater monitoring from a network of sentinel wells;
  - Address potential trigger events identified during monitoring through the PMP and evaluate and implement further remedial controls as appropriate depending on the nature of the trigger event; and
  - Maintain institutional controls to minimize worker exposure.
- Stormwater
  - Install tide isolation vaults at the 12th Street, 12.5th Street, 13th Street, and 13.5th Street and reline the 12th Street, 12.5th Street, 13th Street, 13.5th Street, 14th Street, and 15th Street storm drain systems to limit infiltration of contaminated groundwater into the affected storm drains, facilitate reliable sampling and monitoring of the repaired drainage systems, eliminate the need for dry-weather flow collection for treatment at the onsite WWTP, and perform periodic groundwater elevation surveys to confirm effects on groundwater gradients and flow are consistent with the predictions on the groundwater model (Appendix B);
  - Perform post-lining storm drain inspections;
  - Monitor stormwater quality at the tidal isolation vaults;
  - Establish criteria for storm drain maintenance based upon the inspection and monitoring program;
  - Perform NPDES sampling until operation of the WWTP is phased out (performed as part of site O&M activities); and
  - Maintain institutional controls to minimize worker exposure.
- Surface water and sediment
  - Confirm sediment reducing conditions every 5 years.
- Utilities and structures
  - Continue implementation of the Site Drinking Water Plan;
  - Evaluate engineering feasibility of installing isolation valves on drinking water lines; and
  - Continue routine repair and replacement on an as-needed (observational approach) basis at the historical level of effort.

A PMP document would be prepared for MDE approval as part of the Remedial Action Work Plan to establish procedures to verify continued isolation and containment of COPR, and establish criteria for assessment and performance of further corrective measures, as required.

The third major isolation and containment upgrade incorporated in Alternative 3 is the upgrade of priority storm drains, including the 12th Street through 15th Street storm drains, with tidal exclusion vaults (where not present already), internal repairs, and/or partial or full relining. Damaged storm drain pipe and inlet structure repairs and pilot testing of in situ, spiral-wound PVC and a CIP lining technology has been completed on the 13th Street storm drain in early 2010. Portions of the 15th Street storm drain are undergoing repair and relining using spiral-wound PVC.

Relining of the remaining priority storm drains, including the 12th, 12.5th, and 13.5th Streets storm drains, would require the installation of access vaults with tide exclusion devices to prevent tidal flooding during construction. Tide exclusion devices are already installed on the 13th, 14th, and 15th Street storm drain systems. Tide exclusion devices for the 12th, 12.5th, and 13.5th Street storm drains would need to be designed and installed. Design and installation of the 13.5 Street vault is presently in progress. These vaults would be similar to the previously installed 13th Street storm drain vault.

Repair of damaged pipe sections, repair of damaged inlet structures, and relining within the 12th, 12.5th, 13.5th, and 14th Street would be similar to repair and relining activities in the 13th Street and 15th Street storm drains. Prior to rehabilitation activities, dry-weather flow/tide exclusion devices would be installed, except in the 14th Street storm drain where a tidal exclusion device already exists. It is anticipated that the tide exclusion devices in the remaining storm drains would be installed in succession. The order of installation would be coordinated with MPA to minimize the impacts on port operations during construction. It is anticipated that the installation of the tide exclusion devices would be completed during the first two years of implementation of the corrective measures.

Following the installation of the tide exclusion devices, each drain would be cleaned and inspected using closed-circuit television (CCTV) to assess the condition of the main trunk lines and laterals. The resulting condition assessment would specify the method of manhole rehabilitation (i.e., relining, joint repairs, and crack sealing) and the relining material to be used (e.g., CIP or spiral-wound lining techniques).

Specific storm drains or portions of storm drains could require different rehabilitation methods depending upon the condition of the drains and the potential for impact on the drains from COPR movement. Details for rehabilitation of the 12th, 12.5th, and 13.5th, and 14th Street storm drains are shown in Table 6-1. These storm drain details are based on a conditions assessment that was conducted previously within these storm drain systems and include repair requirements for portions of the storm drains located within and outside the limits of the COPR fill area.

To assess the continued functionality of the rehabilitated storm drains, a monitoring program to evaluate the structural integrity of the pipe would be implemented as part of the new PMP. The structural integrity of the pipe would be evaluated through monitoring of changes in pipe shape (i.e., laser profiling or other devices) or ground movement towards the pipe (i.e., inclinometers). In addition, the integrity of the storm drain rehabilitation would be evaluated through the monitoring of dry-weather flow and in-pipe inspections performed at a regular frequency. Information from the post-construction monitoring program would be evaluated and managed as part of the PMP, and any required maintenance, modifications, or other measures determined to be necessary would be developed, implemented, and added to the monitoring program per the PMP.

The existing WWTP would continue to treat dry-weather flows from the 14th and 15th Streets storm drains until relining of these drains has been completed. Upon completion of the relining, the WWTP would continue to treat COPR-impacted water from other sources at DMT until the plant is phased out.

The approach for addressing the groundwater medium in Alternative 3 would be the same as for Alternative 2, except that potential trigger events identified during compliance monitoring would be addressed through the PMP process. The PMP process includes provisions for identifying groundwater-related trigger events, defining and identifying appropriate corrective measures, and implementing and evaluating the performance of these measures. The existing network of monitoring wells could be used for this purpose, and would be augmented with additional sentinel monitoring wells.

In summary, Alternative 3 provides enhanced isolation and containment with:

- A fundamental shift in the remedial approach by focusing on preventing contaminated groundwater from entering the priority drain system comprising the 12th Street, 12.5th Street, 13th Street, 13.5th Street, 14th Street, and 15th Street storm drains;
- A secure cover system maintained with a formalized cover (pavement) system inspection and maintenance program, and as defined and currently implemented with the approved SCMP; and
- A formal PMP that establishes a comprehensive framework for maintaining remedy performance and rigorous controls for remedy protection.

Alternative 3 represents a “paradigm shift” in that it focuses on *preventing* contaminated groundwater from entering the storm drains. In further contrast to Alternatives 1 and 2, it establishes a formal PMP for identifying conditions requiring future corrective measures. Finally, it enables eventual phase-out of the WWTP and associated requirements for NPDES permitting of plant discharges.

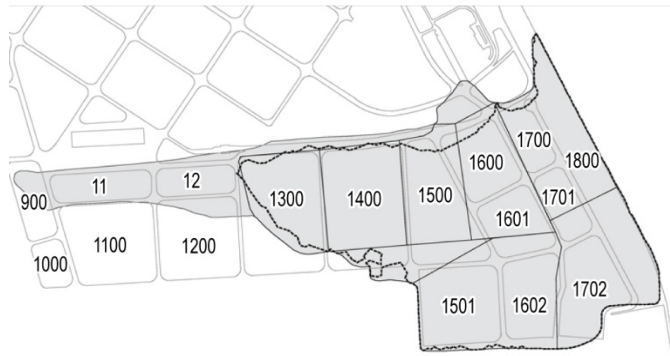
6.2.4 Alternative 4: Partial Excavation

Corrective Measures Alternative 4 includes excavation of all COPR fill and COPR-impacted materials to the groundwater table within a 130-acre area, as illustrated in Figure 6-1 by the dotted line. This alternative also includes the relocation of subsurface utilities and portions of the 12th through 15th Streets storm drains that are located within the COPR fill area into lined utility corridors. Relocating utilities and storm drains into clean corridors will minimize future impacts on port operations, including the need for environmental monitoring, containment system inspection and maintenance, and institutional controls.

Medium-specific components of this alternative include the following:

- COPR fill
  - Remove COPR to the groundwater table and relocate subsurface utilities within the DMT fill area;
  - Remove additional COPR to the extent necessary to remove and replace the portions of the storm drain systems that are located in the COPR fill area into geomembrane-lined trenches;

FIGURE 6-1
Alternative 4 Conceptual Excavation Boundaries



  - Monitor, maintain, and inspect existing cover systems and perform proactive repair and replacement of damaged pavement using a formalized approach; and
  - Perform annual pavement inspections and repairs as described in the SCMP.
- Groundwater
  - Perform compliance monitoring form a network of monitoring wells; and
  - Collect, treat, and dispose of contaminated groundwater in active excavations below the water table.
- Stormwater
  - Collect, treat, and dispose of contaminated stormwater in active work areas;
  - Remove and replace storm drains as COPR excavation and backfill operations progress; and
  - Perform NPDES sampling until operation of the WWTP is phased out (performed as part of site O&M activities).
- Surface water and sediment
  - No additional monitoring of surface water or sediment.
- Utilities and structures
  - Perform drinking water distribution system monitoring until COPR removal is completed;
  - Remove and replace utilities within limits of the excavation;
  - Remove and replace surface structures within limits of the excavation;
  - Continue routine repair and replacement on an as-needed basis until utilities and storm drains have been relocated to lined trenches; and

- Maintain institutional controls for work in COPR or COPR-contaminated materials until their replacement in non-COPR materials.

This alternative includes removal and offsite disposal of all COPR fill and COPR-impacted materials located above the groundwater table. Within select areas, some COPR fill and COPR-impacted materials will be removed below the groundwater table to facilitate removal and replacement of portions of the 12th through 15th Streets storm drains that are located within COPR fill. The volume of excavation below the groundwater table will be limited to the minimum volume necessary to remove the storm drains and replace them in lined corridors.

The total area requiring excavation is approximately 130 acres, including most of the delineated COPR fill area, except for Areas 1100 and 1200 and a portion of Area 1300, where COPR fill is located entirely below the groundwater table. In addition to excavation, activities to be performed would include: (1) demolition and removal of utilities, pavement systems, affected storm drains, and structures; (2) management, treatment, and disposal of stormwater and groundwater from the excavated areas; (3) backfill of excavations with clean fill; and (4) replacement of affected structures, pavement systems, and utilities.

Alternative 4 would require the excavation and disposal of asphalt, COPR, and COPR-impacted material. Non-COPR-impacted soils would be staged onsite for reuse as backfill. Table 6-2 provides a summary of the volumes associated with the major excavation work elements related to Alternative 4.

All COPR and COPR-impacted materials would have to be transported to and disposed of at an offsite hazardous waste disposal facility. The closest hazardous waste disposal facility with the capacity to accept 1,751,040 tons of hazardous COPR materials by direct rail shipment is located in Indiana. Asphalt would be trucked to a local asphalt pavement-recycling facility for reclamation and reuse.

This alternative would also require removal and in-kind replacement of storm drains, utilities, and structures within the areas to be excavated. Approximately 18,500 linear feet of concrete storm pipe would be removed and replaced in clean backfill encapsulated by geomembrane liners. These storm drains would be removed and replaced concurrently with excavation and backfill operations. Existing subsurface utilities would be removed and replaced in approximately 15,000 linear feet of geomembrane-lined utility corridors, including a 9,200-foot-long primary loop and approximately 5,800 feet of interior corridors extending to buildings, lighting fixtures, communication locations, and hydrants within the COPR fill area. The lined utility corridors would contain approximately 23,000 linear feet of 12-inch HDPE water and sewer pipe and approximately 14,500 linear feet of reinforced concrete duct bank consisting of approximately 5,900 yd^3 of concrete, 174,000 linear feet of plastic conduit, and up to 174,000 linear feet of electrical or communications cable. Three existing buildings—Shed 1702, Office Building 1600A, and the WWTP building—would require removal and replacement. To the extent possible, affected storm drains, utilities, Shed 1702, and Office Building 1600A would remain in operation until the area(s) in which they reside are excavated. They would be replaced and put back in service as part of backfilling and site restoration activities.

Alternative 4 would require approximately 10 years to perform: 3 years for design, bidding, and permitting; 2 years for site preparation; and 5 years for material excavation, disposal, and site restoration. For conceptual purposes, the work area has been divided into nine work zones, as illustrated in Figure 6-1, which that would be developed in ascending order as listed in Table 6-3.

The conceptual work zone layout and sequence provides for:

- The establishment of a single load-out area in the northern end of Area 1600 (Work Zone 1) where rail spurs exist for loading of materials into 100-ton gondola rail cars;
- A near-continuous working face that minimizes, to the extent possible, impact on port operations and provides for site restoration without the need to go back into a previously excavated and restored area;
- The installation of utilities, above-grade and below-grade structures, and storm drains in a sequence with the material excavation and restoration of activities; and
- Continued operation of the existing WWTP until near the end of the entire sequence of excavation, filling, and site restoration activities.

The conceptual work zone layout and sequence would provide a continuous working face where excavation, backfilling, and restoration operations occur in a manner that controls the size of the area where contaminated materials are exposed and minimizes the potential for recontamination of previously backfilled and restored areas. Once operations begin, work zone development would include the following:

- An active working face where COPR materials are excavated and loaded out ("excavation zone");
- A clean backfill area ("clean zone") that is separated from the excavation zone by a dike; and
- A backfilled zone where clean, compacted backfill soil is placed, new storm drain sections and utilities are installed, and the ground surface is prepared for paving.

Once the backfilled zone becomes large enough for efficient paving operations, it would be paved and the area would be placed back into service for active port operations.

Materials-handling operations would consist generally of the following:

- Excavated materials requiring offsite disposal would be trucked from the excavation to a load-out area at the northern end of Area 1600, where the materials would then be loaded into 100-ton gondola rail cars for transportation to the offsite disposal facility;
- Trucks used for the transfer of excavated materials would be decontaminated at an onsite truck decontamination facility prior to leaving the excavation work zone;
- Excavated asphalt pavement would be transported in over-the-road dump trucks to a local asphalt-materials-recycling facility for recycling and reuse;

- Excavated clean materials would be used as clean backfill or temporarily stockpiled for use in subsequent backfilling. Appropriate erosion and sediment controls would be provided for the stockpiled materials;
- Imported backfill materials would be delivered to the site by barge from a local borrow source. The unloading facility would utilize berth 13 of the port's existing cargo-handling facility, after modification to the Ro-Ro platform;
- Imported backfill would be transported from the barge-unloading area to the backfill area in dump trucks; and
- Other materials required for restoration (e.g., storm drain pipe, utility components, asphalt paving, and structural components) would be obtained from local sources and delivered to the site by truck using public roadways.

Groundwater extraction and management for this alternative would be limited to localized areas during removal and replacement of portions of the 12th through 15th Streets storm drains which are located below the groundwater table. Dewatering within these areas would be performed as necessary with trenches, sumps, well points, or other measures within the excavation to maintain the groundwater level to facilitate construction of the new storm drains and surrounding containment system "in the dry." To minimize the volume of contaminated water to be extracted, all trenches would be excavated and backfilled in short segments. Even with these measures, it is expected that the volume of extracted groundwater may exceed the capacity of the existing WWTP, and that temporary water treatment units may be necessary. These units would be brought onsite and used on an as-needed basis.

Stormwater management during the excavation process would include diversion, collection, and treatment of stormwater within the open excavations above the water table and temporary stormwater bypass systems during removal and replacement of storm drains. The conceptual diversion, collection, and treatment program within the open excavations would include the following:

- Diversion of surface water away from the open excavations with dikes, grading, and other engineering controls;
- Excavation sequencing in a down-slope direction to minimize recontamination of completed areas;
- Segregation of clean and contact water through use of membranes;
- Diversion and collection of clean water in under-drains and sumps for direct discharge to the river (water may require filtering prior to being discharged); and
- Collection, storage, and treatment of contact water at the existing WWTP, which might have to be supplemented with temporary treatment units to accommodate the additional flow from dewatering.

Drainage from upstream areas would have to be bypassed while storm drains are being removed and replaced. Depending upon the size of the storm drain and upstream drainage conditions, one of the following methods of temporary stormwater bypass would be incorporated:

- Bypass pumping during removal and replacement of the storm drain;
- Bypass of stormwater through the existing storm drain piping while replacement piping is being installed in a separate trench; and/or
- Bypass pumping during small rainfall events and temporary bypass of large storm events through temporarily lined open excavation sections.

Surface water or sediment controls would not be necessary, except for construction erosion controls and water management practices designed to prevent the release of contaminated sediment, groundwater, or surface water outside the work area during the excavation activities. These controls would be implemented and maintained in accordance with current MDE erosion and sediment control standards for construction sites.

In general, demolition of pavements, structures, and other facilities would occur immediately prior to excavating the areas in which they are located. Prior to demolition, these facilities would remain in-service to support port operations. Construction of replacement facilities would occur as part of restoration activities.

Underground utilities would be taken out of service and removed as the areas in which they are located are excavated. Temporary utilities and bypasses would be installed, where necessary, to maintain service to areas supported by the affected utilities. The utilities would be reconstructed and reconnected as part of the excavation and backfill and restoration operations. During the interim period, drinking water distribution system monitoring would occur. In addition, isolation valves would be installed to isolate portions of the water system within the COPR fill area and to facilitate shutdown of portions of the system during water line removal operations.

Since the work would occur over a number of years, portions of the existing pavement systems, utilities, monitoring systems, and WWTP operations area would continue to be operated in support of ongoing port operations. As a result, existing environmental controls, monitoring, and maintenance would continue and be phased out in the following manner:

- The current pavement system inspection and maintenance program would continue until existing pavement systems over COPR fill are replaced and cover maintenance is no longer necessary;
- Air monitoring would continue until construction was complete;
- The current utility inspection and maintenance program would continue until all existing subsurface utilities have been replaced in lined corridors;
- Stormwater sampling would continue until all storm drains in COPR fill have been replaced in lined corridors;
- WWTP operations and maintenance would continue until excavation and backfilling operations are completed and treatment of COPR-impacted water is no longer necessary;

- Groundwater monitoring would continue throughout construction and into the post-construction period per MDE requirements, since COPR fill materials would remain below the water table;
- Drinking water isolation valves would be installed and maintained until the drinking water lines have been replaced and isolation valves are no longer required; and
- Current drinking water monitoring would continue until all drinking water lines have been replaced within lined corridors and monitoring is no longer necessary.

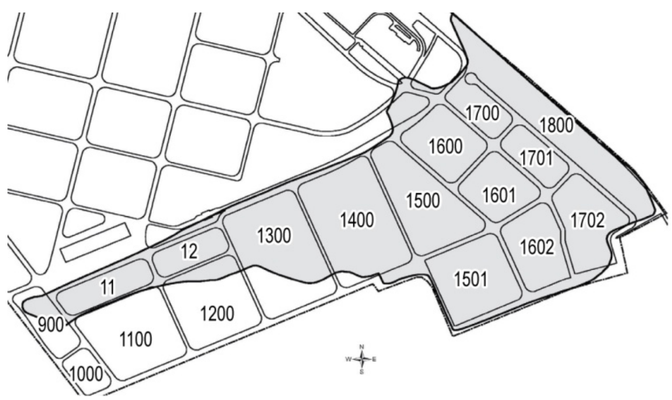
6.2.5 Alternative 5: Full Excavation

Alternative 5 includes excavation and offsite disposal of all COPR fill and COPR-impacted materials at DMT, replacement with clean fill, and replacement of all utilities, structures, pavements, and other port facilities affected by the COPR excavation as illustrated in Figure 6-2.

Primary components of Corrective Measures Alternative 5 include the following:

- COPR fill
  - Excavate and remove all COPR fill materials at DMT and continue air monitoring until excavation is complete;
  - Transport and dispose of all excavated COPR fill and associated COPR-impacted materials to a licensed offsite landfill facility; and
  - Monitor, maintain, and inspect existing cover systems and perform repairs on an as-needed basis to maintain port operations.
- Groundwater
  - Perform compliance monitoring from wells until excavation is complete; and
  - Collect, treat, and dispose of contaminated groundwater from active excavations.
- Stormwater
  - Remove and replace storm drains as COPR removal and backfill operations are performed;
  - Collect, treat, and dispose of contaminated stormwater from active work areas; and
  - Perform NPDES sampling until operation of the WWTP is phased out.

FIGURE 6-2
Alternative 5 Conceptual Excavation Boundaries



- Surface water and sediment
  - No additional monitoring of surface water or sediment.
- Utilities and structures
  - Monitor the drinking water distribution system until construction is complete;
  - Remove utilities and structures within areas to be excavated;
  - Replace all essential utilities and structures during site backfill and restoration operations;
  - Continue routine repair and replacement on an as-needed basis in areas not yet excavated; and
  - Maintain institutional controls for work in COPR or COPR-contaminated materials.

This alternative includes removal and offsite disposal of all COPR fill and COPR-impacted materials within the 148-acre COPR fill area. In addition to excavation and disposal, activities within the work area would include: (1) demolition and removal of utilities, pavement systems, and structures in areas to be excavated; (2) management, treatment, and disposal of stormwater and groundwater from the excavated areas; (3) backfill of excavations with clean fill; and (4) replacement of structures, pavement systems, and utilities.

Full excavation of COPR-impacted materials would require the excavation and disposal of asphalt, COPR, and COPR-impacted material. Non-COPR-impacted soils would be staged onsite for reuse as backfill. Table 6-4 summarizes the volumes associated with the major excavation work elements related to Alternative 5.

Approximately 6,243,840 tons of COPR and COPR-impacted materials would require transport to and disposal at an offsite hazardous waste disposal facility. The closest hazardous waste disposal facility with the capacity to accept this volume of materials by direct rail is located in Indiana. Asphalt would be trucked to a local asphalt pavement recycling facility for reclamation and reuse for subsequent paving at DMT or other sites in the Baltimore area.

The perimeter of the area to be excavated would be shored with a sheet pile bulkhead with tie-backs. The boundaries between excavation areas would be established with bulkheads consisting of two sheet pile walls connected with tie rods. This alternative would also require removal and in-kind replacement of storm drains, utilities, and structures within the areas to be excavated:

- Approximately 18,500 linear feet of storm drain;
- 22,700 feet of water line;
- 30,700 feet of electrical lines;
- Nine hydrants;
- 77 light poles; and
- Five existing buildings (Shed 11, Shed 12, Shed 1702, Office Building 1600A, and the WWTP building).

To the extent possible, affected storm drains, utilities, and structures would remain in operation until the area(s) in which they reside are excavated. They would be replaced and put back in service as part of backfilling and site restoration activities. The WWTP building would be removed near the end of construction and would not be replaced.

Alternative 5 would occur over a 13-year period to conform to the completion schedule in the 2006 Consent Decree: 3 years for design, bidding, and permitting; 2 years for site preparation; and 8 years for excavation The approach for developing this full excavation alternative would be similar to that of Alternative 4, except for differences required to address greater excavation and backfill volumes, greater excavation depths, and a substantially greater portion of the work being below the groundwater table.

The conceptual layout and operational areas are listed in Table 6-5 and illustrated in Figure 6-2.

This layout and general sequence of development for this alternative is similar to that of Alternative 4, except that there is a greater number of work areas to be excavated. As with Alternative 4, the development concept provides for early construction of a single load-out area, a continuous working face that minimizes, to the extent possible, impacts to ongoing port operations, and logical and efficient removal and restoring of storm drains, utilities, and structures. Site preparation, excavation, backfill, and restoration operations within each work area would also be similar to those in Alternative 4, except for the following:

- The total disturbed area and effects on port operations would be greater since the footprint of the excavation is larger (i.e., unlike in Alternative 4, not all COPR being addressed is above the water table);
- Excavation depths across the site would be greater since much of the COPR and COPR-impacted materials at DMT extends below the water table;
- Internal and perimeter shoring systems would extend deeper and be more robust due to the extra depths of excavation;
- Excavation rates and volumes would be substantially greater due to the increased volume of excavation;
- The working face would be larger due to the increased depth of the excavation; and
- Greater volumes of potentially saturated materials may require special handling, dewatering, and stabilization, depending upon the effectiveness of dewatering systems installed within the excavation.

Groundwater control, dewatering, and water treatment measures would be substantially greater for this alternative than for Alternative 4 due the depth of excavations below the water table. In addition to the groundwater controls included in Alternative 4, the following measures would be implemented and maintained throughout excavation and backfill operations beneath the water table:

- Installation of a sheet pile wall along the perimeter of the excavation area(s) to isolate the excavation from adjacent groundwater and to minimize pumping and treatment of clean groundwater from outside the excavation;

- Installation and operation of vacuum well points to extract groundwater to depths of 22 feet or less;
- Installation and use of sump pumps to extract groundwater at depths below 22 feet;
- Collection and treatment of recovered groundwater in the existing WWTP; and
- Mobilization of portable WWTP units would be required to treat groundwater volumes in excess of the capacity of the existing WWTP.

These control measures are estimated to require approximately 770,200 ft^2 of shallow slurry wall, 244,300 ft^2 of deep slurry wall, 500 vacuum well points, 153 deep wells with pumps, 12,000 linear feet of temporary conveyance piping, and a pumping system.

Stormwater management measures for Alternative 5 would also be similar to those for Alternative 4, including surface water diversion around open excavations, erosion and sediment controls, excavation in a down-slope direction, segregation of contact and noncontact water, diversion, collection, and discharge of clean water, and collection and treatment of contact water in the WWTP. The primary difference would be the additional measures that would be necessary to divert stormwater flows when excavation depths are below existing storm drain invert elevations. These measures would include one or more of the following:

- Bypass pumping while a storm drain segment is removed;
- Temporary underpinning to maintain existing storm drain pipe operation; or
- Excavation, backfill, and construction of the new storm drain pipe adjacent to the existing pipe, diversion of flows into the new pipe, and removal of the old pipe after diversion is complete.

As with Alternative 4, pavements, structures, utilities, and other facilities would be maintained in service until immediately prior to excavating the areas in which they are located and would be reconstructed and reconstructed and put back into service as part of backfilling and restoration operations. While the facilities are out of service, temporary utilities and bypasses would be installed, where necessary, to maintain service to the adjacent operational areas.

Since the work would occur over a number of years, portions of the existing pavement systems, utilities, monitoring systems, and WWTP operations area would continue to be operated in support of ongoing port operations. As a result, existing environmental controls, monitoring, and maintenance would continue and be phased out in the following manner:

- The current pavement system inspection and maintenance program would continue until existing pavement systems over COPR fill are replaced and cover maintenance is no longer necessary;
- The current utility inspection and maintenance program would continue until all existing subsurface utilities have been replaced in lined corridors;

- Stormwater sampling would continue until all storm drains in COPR fill have been replaced within lined corridors;
- WWTP operations and maintenance would continue until excavation and backfilling operations are completed and treatment of COPR-impacted water is no longer necessary;
- Groundwater monitoring would continue throughout the construction period and end following completion of construction; and
- Current drinking water monitoring would continue until all drinking water lines have been replaced in lined corridors and monitoring is no longer necessary.

TABLE 6-1
Storm Drain–Relining Details

	Pipe	
Drain	**Diameter (Inches)**	**Length (Feet)**
12th Street	18	785
	24	150
	36	190
	48	515
	76 × 48	455
12.5 Street	18	470
	30	300
	36	15
13.5 Street	18	170
	24	290
	30	250
	36	15
14th Street	15	25
	18	300
	21	240
	24	80
	27	480
	30	275
	33	460
	42	205
	68 × 43	275
	76 × 48	205
	85 × 53	280
	91 × 58	295
	98 × 63	195

TABLE 6-2
Alternative 4 Major Work Scope Elements

Work Scope Element	Value
Excavation	
Asphalt (yd^3)	117,000
Non-COPR-impacted soil (yd^3)	465,000
COPR-impacted soil (yd^3)	116,000
GB COPR (yd^3)	495,000
HB COPR (yd^3)	605,000
Disposal	
Asphalt (tons)	234,000
COPR/impacted soils (tons)	1,751,040
Backfill	
Nonimpacted soils (staged onsite) (yd^3)	465,000
Imported soils (includes road base) (tons)	1,945,600
Asphalt (tons)	234,000

TABLE 6-3
Alternative 4 Conceptual Work Zones

Work Zone	DMT Operational Areas
1	Northern portion of Area 1600 and Dunmar Bldg.
2	Area 1300
3	Area 1400
4	Area 1500
5	Remainder of Areas 1600 and 1601
6	Area 1700 and northern portions of Areas 1800 and 1701
7	Area 1702 and remainder of Areas 1800 and 1701
8	Areas 1501 and 1602
9	WWTP Area

TABLE 6-4
Alternative 5 Major Work Scope Elements

Work Scope Element	Value
Excavation	
Asphalt (yd^3)	132,000
Non-COPR-impacted soil (yd^3)	1,109,000
COPR-impacted soil (yd^3)	1,195,000
GB COPR (yd^3)	2,120,000
HB COPR (yd^3)	1,021,000
Disposal	
Asphalt (tons)	264,000
COPR/impacted soils (tons)	6,243,840
Backfill	
Nonimpacted soils (staged onsite) (yd^3)	1,109,000
Imported soils (includes road base) (tons)	6,937,600
Asphalt (tons)	264,000

TABLE 6-5
Alternative 5 Conceptual Work Zones

Work Zone	DMT Operational Areas
1	Northern portion of Area 1600
2	Areas 1000 and 1100
3	Area 1200
4	Area 1300
5	Area 1400
6	Area 1500
7	Remainder of Areas 1600 and 1601
8	Area 1700 and northern portions of Areas 1800 and 1701
9	Area 1702 and remainder of Areas 1800 and 1701
10	Areas 1501 and 1602
11	WWTP Area

SECTION 7

Detailed Analysis of Corrective Measures Alternatives

7.1 Introduction

This section evaluates the corrective measures alternatives relative to the performance criteria stated in Provision III.B.8.viii of the Consent Decree. It includes a brief description of the evaluation criteria, an evaluation of each alternative relative to these criteria, and a comparison of the various alternatives relative to these criteria. Specific emphasis will be given to performance relative to the media-specific remedial objectives.

Some comparison is provided between Alternatives 1, 2, and 3 in the detailed evaluation of Section 7.3 because each of these alternatives progressively builds on the other. The comparative analysis of the alternatives pursuant to COMAR Chapter 26.14.02.06(F)(4), is presented in Section 7.5.

7.2 Evaluation Criteria

7.2.1 Overall Protection of Human Health and the Environment

This threshold evaluation criterion is an assessment of whether each alternative achieves and maintains adequate protection of human health and the environment. To be considered in this CMAA, an alternative must be protective of human health and the environment. Although this criterion must be satisfied before a remedial alternative is considered against other criteria, the overall appraisal of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Another consideration is the statutory preference for onsite corrective measures.

7.2.2 Compliance with ARARs

Like protection of human health and the environment, compliance with ARARs is a threshold criterion. This criterion is used to determine whether an alternative would meet federal, state, and local ARARs. A discussion of the compliance of each alternative with chemical-, location-, and action-specific ARARs and TBC guidance is included. (See Sections 4.1.1 and 4.1.2 for a detailed explanation of ARARs and TBCs).

7.2.3 Long-Term Effectiveness and Permanence

Under this criterion, the results of a corrective measures alternative are evaluated in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the measures or controls that may be required to manage the risk posed by treatment residuals or untreated wastes. Factors to be considered and addressed are magnitude of residual risk, adequacy of controls, and reliability of controls.

Magnitude of residual risk is the evaluation of the risk remaining from untreated waste or treatment residuals after remediation. Adequacy and reliability of controls is the evaluation of the controls that can be used to manage treatment residuals or untreated wastes that remain at the facility. The evaluation may include an assessment of containment systems and institutional controls to determine whether they are sufficient to ensure that any exposure to human and environmental receptors is protective; of the potential need to replace technical components of the alternative, such as a cover system, a vertical barrier, or a treatment system; and of the potential exposure pathway and the risks posed should the corrective measure require replacement.

7.2.4 Reduction in Toxicity, Mobility, or Volume

This evaluation criterion addresses the statutory preference for selecting corrective measures that, as their principal element, use technologies that permanently remediate and significantly reduce the toxicity, mobility, or volume of the hazardous substances through treatment. This criterion considers reduction of the toxicity, mass, mobility, or volume of contaminants using a treatment technology onsite. Factors considered in this analysis include the following:

- Remediation processes employed by the remedy;
- Amount of hazardous materials that would be remediated;
- Degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction;
- Degree to which the remediation would be irreversible; and
- Type and quantity of residuals that would remain following remediation.

7.2.5 Short-Term Effectiveness

This evaluation criterion addresses the effects of a corrective measures alternative during the construction and implementation phase until the CMOs are met. Alternatives are evaluated with respect to the risks they would impose on human health and the environment during implementation of the corrective measure, including the following:

- Protection of the community during remedial actions;
- Protection of workers during remedial actions;
- Environmental impacts during remedial actions; and
- Time until CMOs are achieved.

Short-term effectiveness of each corrective measure encompasses air emissions, potential for safety impacts (community and worker), energy use, land use, and materials intensity (i.e., material handling, use, and transport).

Short-term effectiveness from an environmental perspective consists of energy consumption from material transportation, treatment of stormwater, climate change and greenhouse-gas (GHG) emissions, and materials intensity from implementation of each of the corrective measures alternatives.

- *Energy* was evaluated in the form of electrical power used obtained from the grid for operating the WWTP, and fossil fuels used for operating vehicles and equipment and conducting site operations related to each of the corrective measures alternatives. Since fossil fuels are the main source of energy consumed at DMT, these energy impacts were also categorized as Natural Resource Consumption.
- *Climate change* was evaluated based on the generation of GHGs.
- *Water* was evaluated from the standpoint of managing stormwater collected and treated at the existing WWTP and the resulting short-term impact of energy and chemical usage associated with operation of the WTTP.
- *Air quality* was evaluated based on estimated emissions of volatile organic compounds (VOCs), particulate matter (PM), and sulfur dioxide and related emissions (SO_x) and nitrogen oxide emissions (NO_x) for each of the corrective measures alternatives.
- *Land* was evaluated in terms of total acres impacted during the implementation of each of the five corrective measures alternatives.
- *Materials intensity* relates to the volume of materials requiring handling for each of the corrective measures alternatives, including hazardous and nonhazardous material excavation, and transporting and filling excavated areas with clean material obtained from an offsite borrow source.
- *Transportation* short-term factors were considered either as part of the energy consumption (e.g., fossil fuels for rail and truck transport of materials) or potential social impacts associated with vehicle miles driven, including congestion associated with increased rail, road, and barge traffic. Energy consumption associated with the transport of WWTP-generated sludge for offsite disposal is considered part of this evaluation criterion.

Short-term effectiveness from a social impacts perspective consists of potential risks to onsite workers and the community, including traffic safety and disruption, and aesthetic considerations, such as noise and light.

- *Health and safety* were evaluated in terms of potential risks to onsite construction workers, tenants, and visitors (occupational) and potential risks to the community.
- *Accident impacts* include occupational and community safety as well as the potential for train derailments and accidental releases of hazardous materials associated with excavation.
- *Occupational safety*, based on worker safety statistics, was evaluated because there is a correlation between the number of hours worked and the potential for injury to and fatality of site workers (i.e., alternatives with more labor hours have a greater potential for worker injury or fatality).
- *Community safety*, based on offsite truck and rail miles, was evaluated because there is a correlation between the miles of transportation accrued for each corrective measures alternative (e.g., offsite trucking, rail, and barge) and the potential for injury and fatality

(i.e., alternatives that require more transport miles have a greater potential for offsite injury or fatality).

- *Aesthetics* involves quantification of potential incremental social impacts resulting from increased train traffic on rail lines, barge traffic on the Patapsco River, and truck traffic on roadways that would impact the aesthetics for communities neighboring the various local and interstate material transport routes.
- *Traffic disruptions,* based on increase volume and frequency of trucks, trains, and barges, were evaluated to assess the potential effects of increased traffic flow on transportation routes for each of the five corrective measures alternatives.
- *Noise* is a subjective qualitative impact that was evaluated to assess the potential for a given corrective measures alternative to generate unacceptable levels of noise within a work area; and
- *Light* is a subjective qualitative impact that was evaluated to assess the potential for a given corrective measures alternative to generate unacceptable levels of light when night shifts are required.

With respect to accident impacts (occupational and community safety), the potential for injury, fatality, and accidental releases were based on rates applicable to the United States and are based on all activities within the group considered (e.g., fatality rates for workers represent all construction activities). The factors used include incidents across a large number of sectors and is inclusive of organizations that are and are not vigilant in minimizing safety impacts. It is anticipated that the injury/fatality rates for organizations that focus on health and safety could be significantly less due to benefits associated with their training, planning, monitoring, and reporting programs.

7.2.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of executing a corrective measures alternative and the availability of various services and materials required during its implementation. Technical feasibility includes construction, operation, reliability of technology, ease of undertaking additional corrective measures, and monitoring. Administrative feasibility refers to the activities needed to coordinate with other offices and agencies (e.g., federal, state, and local permits). Availability of services and materials includes availability of adequate off-facility treatment, storage capacity, and disposal services; necessary equipment and specialists; services and materials; and prospective technologies.

7.2.7 Cost

For the cost analysis of corrective measures alternatives, both remedial costs already incurred by Honeywell and MPA and the costs required to complete each corrective measure were included in the analysis. Costs incurred to date include capital and O&M costs spent to comply with the 1992 Consent Order as well as those spent to implement interim remedial measures and pilot studies under the 2006 Consent Decree. The remedial costs incurred since 1992 total approximately $73.4 million dollars and include the following:

- $22.1 million to construct, operate, and maintain the 14th and 15th Streets storm drain outfall structures and the WWTP and to operate each system;
- $8 million to perform pilot studies of stormwater IRMs, including rehabilitation of the 13th and 15th Streets storm drains and installing a tidal exclusion device on the 13th Street storm drain;
- $14.4 million to perform pilot testing of various heave mitigation technologies;
- $4.4 million to repair and maintain the surface cover; and
- $24.5 million to perform general site operations and maintenance, including handling and disposal of COPR.

The expenditures required to complete each corrective measure are estimated in terms of both capital and annual O&M costs. A net-present-value calculation for capital and O&M costs to complete each alternative was made for use in the comparative analysis. The comparative analysis uses the total cost of each remedy, defined as the costs incurred to date, and the net present value to complete each alternative.

Capital costs consist of direct and indirect costs. Direct costs include the costs of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses, license or permit costs, and contingency allowances.

Annual O&M costs are the postconstruction costs required to ensure the continued effectiveness of the corrective measure. Components include operating labor, maintenance materials and labor, auxiliary materials and energy, residue disposal, purchased services, administration, insurance, taxes, licensing, rehabilitation, monitoring, and periodic site reviews.

Expenditures that occur over a time period are analyzed using present worth, which discounts all future costs to a common base year. Present-value analysis allows the cost of corrective measures alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the corrective measure. Assumptions associated with the present-worth calculations include a discount rate of 7 percent (EPA, 2000b), cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity but would not exceed 30 years.

The cost estimates to complete each alternative presented in this CMAA are conceptual-level costs as outlined in EPA guidance and with an expected degree of accuracy of +50 percent to -30 percent (EPA, 2000b). The cost estimates were developed based on the 2010 unit costs and on high-level design concepts from information available at the time of this evaluation. The actual cost of a project would depend on the final scope and design of the selected corrective measure, the schedule of implementation, competitive market conditions, and other variables. Most of these factors are not expected to affect the relative cost differences between corrective measures alternatives. The cost estimates were prepared in general conformance with the EPA guidance referenced above.

7.2.8 Degree of Interference with Port Operations

This criterion addresses the short-term and long-term impacts of the corrective measures alternatives to ongoing port operations. Examples include, but are not limited to, cessation, relocation, and operational changes in port or tenant functions during the corrective actions; short-term impacts to utilities, roadways, and other infrastructure serving port operations and port tenants; and interference of constructed measures with long-term port operations.

Estimated costs for loss of port revenues due to loss of tenant lease space, offsite relocation of tenants, and potential economic impacts to the local community were also evaluated. However, these costs are not included in the engineering cost estimate for each corrective measures alternative.

7.3 Detailed Evaluation of the Corrective Measures Alternatives

This section evaluates each of the corrective measures alternatives with respect to the eight evaluation criteria discussed in Section 7.2. The potential impacts to human health and the environment, impacts to port operations and potential human health and safety impacts to onsite workers and the surrounding community were considered as part of this evaluation.

7.3.1 Alternative 1: No Further Action

This alternative represents no further action beyond the continuation of historical operational and maintenance activities that were completed at DMT prior to the 2006 Consent Decree in accordance with the 1992 MPA–MDE Consent Order. Its purpose is to represent the alternative against which all other alternatives are compared.

Overall Protectiveness of Human Health and the Environment

COPR is contained by the asphalt/concrete surface cover, which has been and would continue to be maintained on an as-needed basis for port operations purposes. Air-monitoring data collected prior to semiannual surface cover inspections and repairs indicate no Cr(VI) contribution to the air from COPR. Institutional controls required by the 1992 Consent Order protect workers when the surface cover is penetrated, when subsurface utility infrastructure is entered, and when groundwater is encountered from monitoring well sampling.

Stormwater that leaves the site from the 9th Street through 15th Street storm drain outfalls is released into the Patapsco River. These outfalls are sampled quarterly as part of the current NPDES permit during wet- and dry-weather flow periods. Dry-weather flow at the outfalls where such flow can be reliably quantified (13th Street, 14th Street, and 15th Street outfalls) has exhibited concentrations of Cr(VI) in excess of ambient water quality criteria. Significant repairs to the storm drain systems were made by MPA as part of the 1992 Consent Order, but the effectiveness of this effort has been difficult to quantify at drains without tidal exclusion devices. However, dry-weather flow from the 14th Street and 15th Street outfalls is captured and treated prior to being discharged to the Patapsco River. Surface water, sediment pore water, and sediment sampling that was completed as part of the Consent Order demonstrate that Cr(VI) is rapidly reduced to Cr(III), as no surface water or pore water samples had concentrations of Cr(VI) in excess of AWQC (CH2M HILL and ENVIRON, 2009).

Groundwater is not used for drinking water or any other purpose at the site and is prohibited by city and county ordinances from being accessed for use. Shallow groundwater beneath the site contains concentrations of Cr(VI) that are in excess of maximum contaminant levels (MCLs) within the COPR fill. Groundwater sampling has continued to demonstrate that Cr(VI) is rapidly reduced to Cr(III) as the groundwater leaves COPR fill and enters a non-COPR fill area. This transformation occurs for both the lateral flow of groundwater to non-COPR fill areas and for vertical migration of groundwater to native soil beneath COPR fill. Since the COPR fill is located only onsite, groundwater leaving the site would be rapidly reduced to Cr(III). Again, the transformation has been demonstrated both onsite (through sampling of monitoring wells) and offsite (through sampling of pore water and surface water in the Patapsco River adjacent to the site).

Any risk from COPR, groundwater, or stormwater within the site boundary is managed through measures mandated by the 1992 Consent Order and routine, as-needed surface cover repair and replacement to sustain port operations. The residual risks from stormwater at the outfall locations have been determined to be minimal and acceptable. Therefore, this alternative is deemed to be protective of human health and the environment.

Compliance with ARARs

As discussed above, this alternative complies with all ARARs except for stormwater discharges to the Patapsco River at the outfall locations of the 12th Street, 12.5th Street, 13th Street, 13.5th Street, 14th Street, and 15th Street storm drains, although such discharges presently can only be reliably quantified at the 13th, 14th, and 15th Streets outfalls. Dry-weather flow sampling at these outfall locations has periodically shown concentrations of Cr(VI) in excess of AWQC. (Sampling of surface water near these outfalls has not shown concentrations in excess of AWQC because of the rapid reduction of Cr(VI) upon its entering the river.) Because these discharges were not covered under an NPDES permit until 2005, this alternative is deemed to not meet ARARs.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of this alternative depends on the continued compliance with groundwater monitoring, routine surface cover maintenance, WWTP operation, and institutional controls for worker protection and prohibition of groundwater use. If these measures and activities are executed effectively, this alternative would be permanent and effective over the long term. Because these measures have been executed effectively to date, it is reasonable to expect that they could continue to be maintained.

Reduction in Toxicity, Mobility, or Volume

This alternative includes treatment of dry-weather flow from the 14th and 15th Streets outfalls. The ongoing transformation of Cr(VI) to Cr(III) that occurs by natural processes as groundwater passes from a COPR fill area to a non-COPR fill area provides for reduction in both mobility (e.g., Cr(III) is much less soluble than the hexavalent form) and toxicity. Over the long term, the volume of Cr(VI) in the COPR fill and groundwater would decrease because there is no ongoing contribution to the mass of Cr(VI). Rather, all natural processes occurring at the site lead to the eventual chemical reduction of Cr(VI).

Short-Term Effectiveness

This alternative is currently being implemented at the site and therefore provides immediate effectiveness. Institutional controls, groundwater monitoring, surface cover maintenance, and WWTP operation have been executed without unacceptable risks to human health and the environment.

Alternative 1 is representative of baseline conditions that have the following short-term effectiveness impacts:

- The gasoline/diesel fuels and water treatment chemicals used for this alternative and the power generated for pumping and treating water results in GHGs being emitted to the atmosphere.
- The total GHGs emitted over the 30-year operational life of this alternative is estimated to be approximately 14,010 tons of carbon dioxide equivalents, which is equivalent to a year's worth of emissions from 2,320 automobiles (based on EPA's average passenger vehicle emission of 6.04 tons/year for a vehicle traveling 12,000 miles at 20 mpg); the GHG emissions associated with the manufacturing of chemicals used in the WWTP operations is the most significant component of the GHG emissions.
- VOC emissions result from the combustion of gasoline used during the implementation of Alternative 1 and are estimated to be 10.1 tons.
- NO_x and SO_x emissions have been estimated as 72.5 and 78 tons, respectively. These emissions are the result of fuel combustion and emissions associated with power production.
- Particulate matter emissions have been estimated as 1.30 tons and result from the combustion of fuel.
- The operations required for this alternative are estimated to require the use of 969,400 gallons of nonrenewable fuel used to supply service vehicles and 1,420 megawatt hours (MWH) of electricity for the pumping and treating of dry-weather storm drain flow.
- The estimated risk from injury and fatality to onsite workers, based on the total labor hours required to implement this alternative, is estimated to be on the order of 11.97 injuries and 0.022 fatalities over the 30-year project life.
- The potential to the community (including truck drivers) for injury and fatality offsite, based on the total miles driven offsite, is estimated to be 0.26 injuries and 0.0073 fatalities over the project life.

Implementability

This alternative is currently being implemented at the site. Maintenance, monitoring, and worker protection and training measures have been developed and refined over time and are now institutionalized at DMT. A significant amount of experience has been gained by site personnel in managing COPR-related activities and very little, if any, additional training or awareness is necessary to effectively implement this alternative.

Cost

The total present-value cost of this alternative is estimated to be $103 million, including the cost incurred to date and the net present value of costs to complete the alternative (capital and O&M). Capital costs to complete the alternative are $0, and the average annual O&M costs are $2.0 million as calculated using 2010 unit costs.

Degree of Interference with Port Operations

This alternative has been implemented for many years at DMT. Operational activities at the port have adjusted to allow for the periodic interference caused by pavement repair, groundwater monitoring, and access to subsurface infrastructures needed for inspections and maintenance. Although interference with operations is manageable, it is not insignificant. Therefore, close coordination with port operations personnel and tenant activities is necessary within a very busy marine port operation to implement remedial activities.

7.3.2 Alternative 2: Basic Containment

Alternative 2 includes all the activities and impacts defined previously for Alternative 1, with the addition of making permanent the interim corrective measures stipulated in the 2006 Consent Decree.

Overall Protectiveness of Human Health and the Environment

Interim corrective measures under Alternative 2 include (1) the implementation of a drinking-water-monitoring plan, (2) the implementation of the enhanced annual inspection and repair program for the surface cover known as the SCMP, (3) groundwater monitoring, and (4) operation of the WWTP.

While previous surface cover maintenance measures have been demonstrated to be protective of human health and the environment, the more-detailed inspection and maintenance program under the SCMP process provides the framework for formalized inspection, data management, and reporting, which results in a greater level of cover care and would further reduce, if not eliminate, the potential for COPR-related constituents to be exposed at the surface. There is also the potential that the more rigorous and formalized system of inspections and prioritized corrective actions, as determined though a feasibility evaluation process, could reduce infiltration of stormwater through the cover and into the COPR fill. Reduced infiltration could retard the COPR expansion processes, thereby reducing damage to the surface cover and other subsurface infrastructure that is caused by COPR heave.

Any risk from COPR, groundwater, or stormwater within the site boundary is managed through measures, such as the formalized SCMP process, mandated by the 1992 Consent Order and the 2006 Consent Decree. The residual risks from stormwater at the 14th Street and 15th Street outfall locations have been determined to be minimal and acceptable. Therefore, this alternative is deemed to be as protective of human health and the environment as Alternative 1, but it adds an additional level of protection through a more formal inspection and maintenance process for the surface cover.

Compliance with ARARs

Unlike Alternative 1, this alternative complies with all ARARs because since 2005, stormwater discharges to the Patapsco River have been permitted under NPDES Permit No. MD0066818, State Discharge Permit No. 99-DP-3060.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of this alternative depends on the continued compliance with groundwater monitoring, regular inspection and repair of the surface cover, WWTP operation, and institutional controls for worker protection and prohibition of groundwater use. If these measures and activities are executed effectively, this alternative would be permanent and effective over the long term. Because these measures have been executed effectively to date, it is reasonable to expect that they could continue to be maintained.

Reduction in Toxicity, Mobility, or Volume

This alternative includes treatment of dry-weather flow from the 14th and 15th Streets outfalls at the WWTP. The ongoing transformation of Cr(VI) to Cr(III) that occurs by natural processes as groundwater passes from a COPR fill area to a non-COPR fill area provides for reduction in both mobility (Cr(III) is much less soluble than the hexavalent form) and toxicity. Over the long-term, the volume of Cr(VI) in the COPR fill and groundwater would decrease because there is no ongoing contribution to the mass of Cr(VI). Rather, all natural processes occurring at the site lead to the eventual chemical reduction of Cr(VI).

Short-Term Effectiveness

Alternative 2 includes all the activities and short-term impacts defined previously for Alternative 1, with the addition of the interim corrective measures stipulated in the 2006 Consent Decree. Institutional controls, groundwater monitoring, surface cover maintenance, and WWTP operation have been executed without unacceptable risks to human health and the environment.

This alternative uses more fossil fuel than Alternative 1, primarily due to the additional equipment required to repair and replace storm drains and monitor and repair cracked asphalt. The following potential short-term impacts over the 30-year operational life are as follows:

- The gasoline and diesel fuels and water treatment chemicals used for this alternative and the power generated for pumping and treating water result in GHGs being emitted to the atmosphere.
- The total GHGs emitted over the 30-year operational life of this alternative is estimated to be 15,310 tons of carbon dioxide equivalents. This is equivalent to a year's worth of emissions from 2,530 automobiles. The GHG emissions associated with the manufacturing of chemicals used in the WWTP operations is the single largest component of the GHG emissions.
- VOC emissions result from the combustion of gasoline used during the implementation of Alternative 2 and are estimated to be 10.8 tons. The individual components of the

VOC emissions have not been identified; however, many VOC emissions are considered priority pollutants.

- NO_x and SO_x emissions have been estimated as 81.5 and 78.2 tons, respectively. These emissions are the result of fuel combustion and emissions associated with power production.
- Particulate matter emissions have been estimated at 1.46 tons and result from the combustion of fuel.
- The operations needed for this alternative are estimated to require 1,077,000 gallons of nonrenewable fuel used to supply service vehicles and 1,420 MWH of electricity for the pumping and treating of dry-weather storm drain flow.
- The potential for injury and fatality to onsite workers based on the total labor hours required to implement this alternative over 30 years is estimated to be on the order of 13.16 injuries and 0.024 fatalities over the project life.
- The potential to the community (including truck drivers) for injury and fatality offsite (associated with transport of asphalt to the local recycling facility), based on the total miles driven offsite in this alternative over 30 years, is estimated to be 0.31 injuries and 0.0086 fatalities over the project life.

Implementability

This alternative is currently being implemented at the site. Maintenance, monitoring, and worker protection and training measures have been developed and refined over time and are now institutionalized at DMT. A significant amount of experience has been gained by site personnel in managing COPR-related activities and very little, if any, additional training or awareness is necessary to effectively implement this alternative.

Cost

The total present-value cost of this alternative is estimated to be $112 million, including the cost incurred to date and the net present-value cost to complete the alternative (i.e., capital and the cost of O&M). Capital costs to complete the alternative are $0, and the average annual O&M costs are estimated to be $3.0 million, as calculated using 2010 unit costs.

Degree of Interference with Port Operations

Major components of this alternative, including cover system inspection and maintenance per the SCMP, have been implemented for the past 3 years at DMT. Operational activities at the port have been adjusted to allow for the periodic interference caused by pavement inspections and repair, groundwater monitoring, and access to subsurface infrastructure needed for inspections and maintenance. Although interference with operations is manageable, it is not insignificant and is slightly greater than for Alternative 1. Therefore, close coordination with port operations and tenant activities is necessary to implement the elements of Alternative 2 within a very busy marine port operation.

7.3.3 Alternative 3: Enhanced Isolation and Containment

This alternative consists of the continued use of the surface cover system to isolate and contain the COPR and the repair and lining of priority storm drains within the COPR fill area to address the infiltration and discharge of COPR-impacted water. This approach represents a significant paradigm shift in that it focuses on *preventing* contaminated groundwater from entering the storm drains, in contrast to Alternatives 1 and 2, which focus on *treating* contaminated groundwater that enters the storm drains. In further juxtaposition to Alternatives 1 and 2, a formal PMP is also included for ensuring attainment and management of remedial performance objectives.

Overall Protectiveness of Human Health and the Environment

Corrective Measures Alternative 3 includes maintaining all of the elements of Alternative 2 but provides for application of advanced containment and isolation technologies and enhanced controls for a higher level of protection of human health and the environment than is provided by Alternatives 1 and 2. This alternative would establish a comprehensive framework for maintaining remedy performance and would impose rigorous controls for protection of the remedy. Infiltration of chromium into the priority storm drain system would be mitigated by isolating the drains from COPR through a relining program. The future integrity of the storm drain system would be routinely monitored through the application of inspection programs and periodic CCTV, and possibly more-advanced sensing technologies. All priority drains (i.e., 12th, 12.5th, 13th, and 13.5th Street storm drains) would be cut off from tidal influence by the installation of tidal exclusion vault equipped with a mechanical device such as a flap gate or duck-billed gate. The vaults would also provide for safe and reliable access for monitoring of storm drain flow and quality. The continuing integrity of the surface cover would be ensured through an enhanced and expanded SCMP as described in Alternative 2. A robust sentinel groundwater monitoring program would be implemented to monitor groundwater quality. Institutional and engineering controls would be integrated into a PMP, which would establish procedures to verify continued isolation and containment of COPR and Cr(VI) and establish criteria for assessment and performance of further corrective measures in the event of remedy failure.

Any risk associated with storm drain discharges from the priority drains would be mitigated through repairing and in situ lining of the damaged storm drain sections and manholes to eliminate groundwater intrusion and installing tidal exclusion vaults that would facilitate reliable, routine sampling to confirm that repairs are permanent. Any risk from COPR, groundwater, or stormwater within the site boundary would be managed through the PMP, which would incorporate and enhance measures mandated by the 1992 Consent Order and the 2006 Consent Decree. Further, in the event of a change in site conditions that could compromise the effectiveness of the remedy, additional corrective measures would be evaluated and considered for implementation. Therefore, this alternative is deemed to be more protective of human health and the environment than Alternative 2, because it includes an additional level of protectiveness by significantly reducing the quantity of dry-weather storm drain flow.

Compliance with ARARs

This alternative complies with all ARARs and goes further than Alternative 2 by implementing a rigorous PMP, by addressing storm drain discharges to the Patapsco River at the outfall locations of the 12th Street, 12.5th Street, 13th Street, 13.5th Street, 14th Street, and 15th Street storm drains, and by monitoring groundwater quality through a sentinel monitoring network.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of this alternative depends on regular inspection, repair, monitoring, and replacement of the surface cover under the PMP and on the effectiveness of storm drain relining in reducing or eliminating Cr(VI) in dry-weather storm drain flow.

The relining of the 13th Street and 15th Street storm drains has demonstrated the short-term effectiveness of this corrective measure for storm drains. The service life of the installed liner—over 50 years—conforms to ASTM standards. Minor patch repairs may be needed to extend the effective life span of the relining. The long-term effectiveness of relining can be confirmed through routine inspection programs, which include periodically using CCTV and, possibly, one or more advanced sensing technologies to monitor changes from baseline storm drain conditions. There has been periodic monitoring of stormwater quality to detect the presence of dry-weather flow and Cr(VI). A storm-drain-monitoring program plan would be prepared and submitted to MDE for approval. Installation of the tidal-exclusion devices and sample collection vaults facilitate repeatable and reliable access to the storm drain for sampling to confirm the long-term effectiveness and permanence of the relining program and to indicate the need for any repairs. The periodic inspection, sampling, and maintenance program that is part of this alternative would provide long-term effectiveness of the storm drain corrective measure.

This alternative would include establishing a PMP, which would provide the institutional and engineering framework for maintaining remedy performance, impose criteria for verifying the protectiveness of the remedy, establish procedures to monitor continued isolation and containment of COPR and Cr(VI), and establish criteria for assessment and performance of further corrective measures in the event of remedy failure.

If these measures and activities are executed effectively, this alternative would be permanent and effective over the long term. Because these measures have been executed effectively to date, it is reasonable to expect that they could continue to be maintained.

Reduction in Toxicity, Mobility, or Volume

This alternative includes a treatment element in the form of the temporary treatment of dry-weather storm drain flow from the 14th Street and 15th Street outfalls until such flow is curtailed through storm drain repair and maintenance. The ongoing transformation of Cr(VI) to Cr(III) that occurs by natural processes as groundwater passes from a COPR fill area to a non-COPR fill area provides for reduction in both mobility (Cr(III) is much less soluble than the hexavalent form) and toxicity. Over the long term, the volume of Cr(VI) in the COPR fill and groundwater would decrease because there is no ongoing contribution to the mass of Cr(VI). Rather, all natural processes occurring at the site lead to the eventual chemical reduction of Cr(VI).

Short-Term Effectiveness

Alternative 3 maintains all the elements of Alternative 2 and also provides for the application of advanced containment and isolation technologies and enhanced controls for superior protection of human health and the environment. Most importantly, groundwater infiltration of chromium into the storm drain system, the primary potential exposure pathway at DMT, would be mitigated or significantly reduced within the first 2 to 3 years of remedy implementation.

Most of the elements of this alternative are currently being implemented at the site and therefore provide immediate effectiveness. Implementation of storm drain rehabilitation and relining activities, combined with tidal exclusion and sample collection vault manholes on the priority storm drains, would be completed. Based on experience with the 13th Street and 15th Street storm drain pilots, this corrective measure can be implemented within a period of approximately 3 years without significant impact to human health, the environment, or port operations. Institutional controls, groundwater monitoring, surface cover maintenance, and WWTP operation have been executed without unacceptable risks to human health and the environment and would be expected to continue without such risks.

Alternative 3 has a relatively small environmental footprint over the 5-year operational life of this alternative, as described below:

- GHGs would be emitted to the atmosphere from the consumption of gasoline, diesel fuel, and water treatment chemicals for pumping and treating water. However, as this alternative involves only power and water treatment chemicals for a total of 5 years, the total estimated GHGs emitted is 11,310 tons of carbon dioxide equivalents, which is equivalent to a year’s worth of emissions from 1,873 automobiles.
- CIP lining of storm drains would result in the release of VOCs to the atmosphere (styrene emitted during liner curing). The estimated VOC emissions for the 2- to 3-year expected life of this project is 0.183 tons. An additional 10.07 tons of VOCs is estimated to be emitted as a result of gasoline combustion.
- NO_x and SO_x have been estimated at 70.8 and 9.40 tons, respectively. These emissions are the result of fuel combustion and emissions associated with power production.
- PM emissions have been estimated at 0.930 tons and result from the combustion of fuel and power production.
- The operations required for this alternative are estimated to require the use of 1,019,000 gallons of nonrenewable fuel used to supply service vehicles. Also, 130 MWH of nonrenewable power is estimated to be used for this alternative.
- The potential for injury and fatality to onsite workers, based on the total labor hours required to implement this alternative, is estimated to be on the order of 10.40 injuries and 0.019 fatalities over the project life.
- The potential for injury and fatality offsite to the community (including truck drivers) based on the total miles driven offsite is estimated to be 0.025 injuries and 0.0007 fatalities over the project life.

Implementability

Most of the elements of this alternative are currently being implemented at the site. Maintenance, monitoring, and worker protection and training measures have been developed and refined over time and are now institutionalized at DMT. A significant amount of experience has been gained by MPA personnel in managing COPR-related activities and very little, if any, additional training or awareness would be necessary to effectively implement this alternative. Installation of tidal exclusion devices and sample collection vault manholes followed by the and relining of the storm drain system can be implemented in phases, as was demonstrated during implementation of pilot program corrective measure at the 13th Street storm drain.

Cost

The net-present-value cost of this alternative may be up to $138 million for all activities encompassed in the remedy, including the cost incurred to date and the net-present-value cost to complete the alternative (capital and the cost of O&M). The capital cost to complete this alternative is estimated to be $15 million; average annual O&M costs are estimated to be $3.7 million as calculated using 2010 unit costs.

Degree of Interference with Port Operations

The construction sequencing and phasing of a typical relining project was demonstrated to the satisfaction of MPA and its tenants within an active area of the port during the 13th Street pilot program. All construction-related activities would be coordinated with port operations to allow for periodic site maintenance and monitoring activities, such as pavement inspections and repair, groundwater monitoring, storm drain relining, and manhole installation. Although the potential for port interference with operations is manageable, it is greater with Alternative 3 than with Alternative 2 and is not insignificant. Previously completed pilot programs and interim remedial measures have established a defined working process acceptable to the port that can be applied to manage interferences resulting from Alternative 3. Nonetheless, close coordination with port operations personnel and tenants is necessary to implement the elements of Alternative 3 within a very busy marine port operation.

7.3.4 Alternative 4: Partial Excavation

This alternative includes the removal of all subsurface utilities and storm drains within COPR fill, excavation of COPR fill to the groundwater table, and replacement of the utilities and storm drains within clean utility corridors to eliminate institutional controls for utility workers.

Overall Protectiveness of Human Health and the Environment

This alternative would pose potentially significant risk to human health and safety and to the environment during implementation but once completed would be protective of human health and the environment. Stormwater discharges would be addressed after the storm drain systems were replaced. Groundwater is addressed through monitoring and use prohibition. COPR is addressed through a periodic inspection and repair program. Utility workers are protected in the near term through institutional controls and in the longer term through removal and replacement of utilities, including storm drains, in clean utility corridors.

Compliance with ARARs

This alternative complies with all ARARs. The means for compliance with utility worker protection would eventually change from institutional controls to no action because utilities would be replaced in clean corridors. Institutional controls would still be required for excavations that reach the groundwater table, where COPR fill would remain.

Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence of this alternative depends on the effectiveness of lined storm drain trenches in preventing Cr(VI) intrusion into the new storm systems installed in remaining COPR materials and the continued compliance with groundwater monitoring, regular inspection and repair of the surface cover, WWTP operation until it is no longer needed, institutional controls for worker protection, and prohibition of groundwater use. Once utilities and storm drains are replaced in clean corridors, long-term effectiveness depends on the durability of this containment measure in mitigating Cr(VI) intrusion into the clean backfill surrounding the utility.

If these measures and activities were executed effectively, this alternative would be permanent and effective over the long term.

Reduction in Toxicity, Mobility, or Volume

This alternative does not include an onsite treatment element other than the temporary treatment of dry-weather storm drain flow and water produced during construction dewatering. The volume of COPR removal that would be associated with the installation of clean utility corridors and removal of COPR to the groundwater table does not provide any significant reduction in toxicity or volume. However, the containment of both COPR and Cr(VI) that is provided by the lining systems of the clean corridors could be considered to reduce their mobility.

The ongoing transformation of Cr(VI) to Cr(III) that occurs by natural processes as groundwater passes from a COPR fill area to a non-COPR fill area provides for both reduction in mobility (Cr(III) is much less soluble than the hexavalent form) and toxicity. Over the long-term, the volume of Cr(VI) in the COPR fill and groundwater would decrease, as there is no ongoing contribution to the mass of Cr(VI). Rather, all natural processes occurring at the site lead to the eventual elimination of Cr(VI).

Short-Term Effectiveness

The process for designing, bidding, and subsequently performing a partial removal action of this magnitude is lengthy; therefore it does not provide immediate short-term effectiveness. The design, design approval, permitting, and bidding process is estimated at 3 years, and pre-excavation activities (preparation of staging and transfer facilities) are estimated at 2 years, resulting in a 5-year period before excavation would begin.

Once excavation begins, there would be limited immediate short-term effectiveness because Alternative 4 would take 10 years to complete, of which approximately 3 years would be for design, permitting, and procurement activities, 2 for preconstruction site preparation, and 5 for the excavation and handling of approximately 1,216,000 yd^3 of COPR and impacted soil and importing of 1,172,000 yd^3 of clean material.

Excavation operations are estimated to require significant amounts of nonrenewable energy, including 6,070,000 gallons of fuel. The main uses of fuel are rail transport, barge transport, and onsite trucking and earthmoving operations. This alternative also uses an estimated quantity of approximately 490 MW of electricity from nonrenewable sources.

As previously noted, discharge of Cr(VI) to the river would continue during the 10-year remedy implementation. Environmental considerations associated with a long-term removal program include the potential for traffic fatalities, congestion and noise in the local community, and exposure to construction workers and site employees, further diminishing the effectiveness.

Significant quantities of GHG emissions to the atmosphere would result from diesel fuel combustion associated primarily with material excavation and transport by earthmoving equipment, rail, trucks, and barges but also, to a lesser extent, from chemicals used for wastewater treatment and power for the WWTP. The total GHGs emitted over the 5-year life cycle of this project is estimated to be on the order of 75,300 tons. This is equivalent to a year's worth of emissions from 12,500 automobiles and GHG emission avoidance associated with providing solar power to 6,580 homes for approximately 1 year.

PM would be produced from the combustion of diesel fuel associated with trucks, support vehicles, and excavation equipment. PM emissions are also associated with power production and the demand for electricity by the WWTP, in addition to PM emissions at the power plant. The 35.2 tons of PM estimated to be generated over the 5 years of construction is primarily from diesel emissions and power production. Additionally, NO_x and SO_x estimated as 1,460 and 42 tons, respectively, are the result of fuel combustion and emissions associated with offsite power production.

This alternative involves the disposal of approximately 1,751,040 tons of excavated COPR and impacted soil that would be managed as hazardous waste and require land filling in a permitted RCRA hazardous waste landfill. This alternative also includes bringing in approximately 1,945,600 tons of clean fill from an offsite borrow source.

For a project of this magnitude, the use of rail as the main conveyance for excavated materials to an offsite disposal facility in the Midwest (approximately 750 miles from DMT) includes risks associated with train derailment and potential release of waste. Using commonly available DOT statistics for rail transport that quantify these risks per rail mile, the risks of train derailment and of release of hazardous material from rail transport over the 5-years of construction are estimated to be approximately 0.254 and 0.0047, respectively.

The offsite risks associated with truck traffic can be derived by vehicle miles driven. The majority of the offsite vehicle miles are associated with conveying asphalt for recycling at a local facility in the City of Baltimore over a period of 5 years. The number of injuries and fatalities are estimated to be on the order of 0.97 and 0.027, respectively, over the project life cycle.

Several components of this alternative would increase traffic on existing congested transportation routes:

- Approximately 175 trains with approximately 100 cars each would be used to transport excavated material from the port to the disposal facility over the 5 years of construction. This additional rail traffic would increase the potential for traffic delays and train traffic on the route the train takes to the disposal facility. Rail activities would have to occur at night to minimize disruptions to port operations.

- Increased local traffic congestion associated with trucks hauling asphalt to a Baltimore-based recycling facility located 10 miles from the site (and round-trip return of empty trucks) is estimated to result in 11,700 additional truck trips on local roadways.
- The import of borrow material by barge would increase traffic on the Patapsco River by about 884 loads over the 5-year construction phase of the project. The estimated injury and fatality to onsite workers based on the total labor hours required to implement this alternative is estimated to be on the order of 30.8 injuries and 0.056 fatalities over the project life. The potential for injury and fatality to onsite workers is based on data from the U.S. Bureau of Labor Statistics (BLS) for years 2006 and 2007, respectively, and is specific to the construction industry. The BLS data represent construction across a large number of sectors and includes organizations that may not focus on preventing construction incidents. It is anticipated that the injury/fatality rates for organizations that focus on health and safety as part of construction implementation could be significantly less due to benefits associated with worker training, project planning, health and safety monitoring, and contractor oversight and routine reporting.
- Equipment intensive excavation activities would create additional noise that would adversely impact surrounding communities 5 days a week throughout the 5-year excavation phase of the project.

Implementability

Partial excavation is a difficult geotechnical project to implement based on the following factors:

- Removing 1.8 million yd^3 of COPR and clean spoils would require approximately 15 acres of tenant space (at any given time) for establishing excavation zones, staging zones, exclusion zones, and decontamination areas and for stockpiling materials and clean fill.
- Maintaining utilities and critical corridors during construction would require temporary above-grade water, electrical, and communication transmission lines, which would affect port operations and traffic patterns.
- Construction of an onsite roll-off lining facility, covered transfer facility, and construction entrance would require extended use of tenant space and multiple agency approvals.
- Increased traffic congestion, above-grade temporary utility corridors, changing traffic patterns, and proximity to hazardous excavation activities would require significant changes to tenant cargo operations and would increase health and safety concerns.
- A 10-year implementation schedule is complex; it would require significant planning and coordination activities that have a higher potential for delays, resulting in a protracted excavation timeframe.

The alternative would also pose logistical challenges. Excavation would proceed along a progression of excavation cells. Shoring of each cell would be required in most areas of the terminal. Temporary relocation of tenant operations and utilities would be required as the partial removal operations proceed through the terminal.

Significant controls would be required to manage and mitigate stormwater runoff, airborne dust, and groundwater in the excavation. Excavation beneath the groundwater table in storm drain corridors would require driving of temporary sheeting and the installation of groundwater extraction points. Extracted groundwater would be conveyed to the WWTP by temporary aboveground piping protected against traffic damage. Careful planning would be required to manage and control truck traffic to keep disruption of port commercial traffic and the community to a minimum.

In addition to the geotechnical and logistical challenges, there are significant risks associated with delays during project planning and implementation. Each of these work elements could experience schedule delays due to state and local approvals, complex coordination, weather impacts, and port operations requiring alternative work hours. Availability of landfill capacity, clean fill, trucking, and other resources may limit the pace at which this alternative could be implemented.

Cost

The total present-value cost of this alternative would be $693 million. The capital cost to complete this alternative is estimated to be $1.15 billion, and the average annual O&M cost is estimated to be $2.2 million using 2010 unit costs.

Degree of Interference with Port Operations

The partial-excavation alternative would significantly impact port operations based on the logistics of performing a removal program of this magnitude, which would require the excavation of 1.8 million yd^3 of asphalt, clean soil, and COPR and the import of 1.2 million yd^3 of clean materials. This alternative would require 10 years to complete—3 years of logistics planning, design, permitting, and procurement; 2 years of site preparation; and 5 years of site excavation—which would interfere with port operations in the following ways:

- Additional infrastructure would need to be constructed at the port for the implementation of Alternative 4. For example, Alternative 4 would require the construction of a new truck entrance to handle remedy-related truck traffic. Berth 13's Ro-Ro facilities would need to be modified to enable the off-loading of clean soil from barges required for filling the excavated areas. The existing MasTec property buildings, approximately 120,000 ft^2 of warehouse space, would need to be demolished to accommodate temporary placement of construction trailers and contractor parking during remedy implementation. Increased costs associated with railroad fees and road maintenance would also be incurred. The construction of additional infrastructure necessary for a removal action of this magnitude would result in an estimated $26 million (2010 value) over 7 years of onsite site preparation and excavation activity. These costs are included in the cost of the remedy.
- Loss of port revenue is estimated to be $6.3 million over a 7-year period resulting from 15 acres of tenant lease space being taken out of service. This includes 5 acres within a given excavation zone and 10 acres used for support services (e.g., material stockpiles, rail car loading, equipment lay-down, additional wastewater storage/treatment, truck decontamination, and use of Berth 13 for clean soil off-loading) related to implementing the remedy. Further revenue losses would be incurred from tenants who choose to

relocate to avoid the nuisance caused to their operations during implementation of Alternative 4.

- In order for MPA to fulfill its tenant lease obligation for warehouses and office space, MPA would have to lease offsite replacement facilities, which is estimated to result in a reduction of port income of $61 million over 7 years.
- Tenant operations (i.e., cargo staging) would need to be adjusted each time the excavation is sequenced across the site due to changes in critical access corridors, traffic patterns, and temporary utility corridors.

From a community economic development standpoint, the disruption to port operations during the 7-year period of site preparation and intensive site excavation would result in a loss of revenue, in the form of state and local taxes, estimated to be $14 million (2010 value). This estimate, based on a loss of 158 jobs per 15 acres of land leased and marine activity, could include 77 direct jobs generated from cargo and vessel activities (e.g., longshoreman, manufacturing personnel, maritime positions associated with towing and piloting of ocean carriers), 25 induced jobs in the local community (e.g., sales clerks, mechanics, teachers, government employees), and 77 indirect jobs (e.g., local companies that provide supplies, equipment, utilities, communications, repair services, and legal and financial services to the port).

In summary, Alternative 4 would mean an approximately $67 million loss of revenue to the port resulting from the temporary disturbances of port tenants, as well as $14 million of lost state and local tax revenue. In addition, the temporary displacement of port operations during the performance of Alternative 4 would also likely result in a permanent loss of business for the port. The port's business is highly competitive; customers faced with disrupted operations at DMT may choose to move their operations out of Maryland permanently. Although the potential economic impact of such permanent losses is not readily quantifiable, the probability that such losses will occur during the implementation of Alternative 4 must be considered.

7.3.5 Alternative 5: Full Excavation

This alternative consists of the excavation and offsite disposal of all COPR fill and COPR-impacted materials at DMT, their replacement with clean fill, and the replacement of all utilities, structures, pavements, and other port facilities affected by the COPR excavation.

Overall Protectiveness of Human Health and the Environment

This alternative would pose potentially significant risk to human health and safety and the environment during implementation but, once completed, would be protective of human health and the environment. Potential risks to human health during the 13 years of remedy implementation (of which approximately 3 years would be for design, permitting, and procurement activities; 2 years for preconstruction site preparation; and 8 years for excavation activity) include a potential increase in injuries and fatalities from ingress and egress of vehicle traffic though local communities, an increased carbon footprint (particulate and carbon dioxide emissions), and increased occupational safety hazards to onsite workers.

Storm drain discharges would be addressed as excavation progressed and storm drain systems were replaced in clean fill. Groundwater would be addressed in the near term through monitoring and use prohibition. COPR would be addressed in the near term through a periodic inspection and repair program until all COPR could be excavated for offsite disposal. Utility workers are protected in the near term through institutional controls and in the longer term through removal and replacement of utilities while COPR is being excavated and replaced with clean fill.

Compliance with ARARs

Full removal of all COPR from the site, once completed, would comply with ARARs because all issues related to COPR and Cr(VI) would be mitigated at the site.

Long-Term Effectiveness and Permanence

This alternative would provide long-term effectiveness and permanence after all COPR materials are excavated and removed from the site.

Reduction in Toxicity, Mobility, or Volume

This alternative does not include a treatment element other than the temporary treatment of dry-weather storm drain flow and water produced from construction dewatering. The significant removal of COPR that would be associated with this alternative does not provide any reduction in toxicity, mobility, or volume onsite because the COPR material would be transferred to another location for pretreatment and containment.

Short-Term Effectiveness

The process for designing, design approval, permitting, bidding, and subsequently performing a removal action of this magnitude is lengthy; therefore, full excavation does not provide immediate short-term effectiveness. For example, the design, design approval, permitting, and bidding process is estimated at 3 years, and pre-excavation activities (WWTP upgrade, dewatering system installation, preparation of staging and transfer facilities) is estimated at 2 years, resulting in a 5-year period before excavation would begin. Once excavation began, there would be limited short-term effectiveness since the removal program would take 8 years to complete. Environmental actions associated with a long-term removal program include the potential for traffic fatalities, congestion, and noise in the local community and exposure to construction workers and site employees, further diminishing the effectiveness of Alternative 5, as described in more detail below.

Alternative 5 has the following potential adversely impacts over the 8-year period when site excavation would be performed: excavation and handling of approximately 4,340,000 yd^3 of COPR and impacted soils and importing of approximately 4,330,000 yd^3 of clean materials:

- Excavation operations would require a significant amount of nonrenewable energy, including an estimated 20,170,000 gallons of fuel. The main uses of fuel would be rail transport, barge transport, and onsite trucking and earthmoving operations. This alternative is also estimated to use approximately 5,930 MWH of electricity from offsite nonrenewable sources.

- GHG emissions generated over the 8 years of material excavation and transport is estimated to be approximately 263,000 tons. Diesel combustion, primarily associated with rail transport, trucks, barges, and earthmoving equipment, would generate the most significant amount of the GHG emissions. GHG emissions would also be generated from chemicals used for groundwater treatment and power for the WWTP.

The total GHG emissions for this alternative would be equivalent to a year's worth of emissions from 43,500 automobiles (based on EPA average passenger vehicle emission of 6.04 tons/year for a vehicle traveling 12,000 miles at 20 mpg and the GHG emission avoidance associated with providing solar power to 23,000 homes for one year.

- An estimated 130 tons of PM generated over the 8-year excavation period would be primarily from diesel emissions associated with fuel used to power trucks, support vehicles, and excavation equipment. PM emissions are also associated with power production, and the demand of electricity by the WWTP operations results in additional emissions from an offsite power plant.
- An estimated 5,300 tons of NO_x and 370 tons of SO_x would also result from fuel combustion and emissions associated with offsite power production.
- The excavation and disposal of 6,250,000 tons of excavated material would require disposal at a RCRA-permitted landfill. This alternative also includes importation of 6,930,000 tons of clean fill from an offsite borrow source.
- For a project of this magnitude, rail transport would likely be used to convey the excavated materials to an offsite disposal facility. The nearest disposal facility with sufficient capacity is located in the Midwest, approximately 750 miles from DMT. Risks associated with rail transport include the potential for train derailment and potential release of waste. The number of train derailments and release of wastes from rail transport is estimated to be on the order of approximately 0.907 and 0.017, respectively, over the 8-year excavation phase of the project.
- Risks associated with vehicle miles driven are attributed to the transport of asphalt for recycling at a Baltimore-based facility over a period of 8 years. The number of injuries is estimated to be on the order of 2.07, with the estimated fatalities to be on the order of 0.059.
- The potential for injury and fatality to onsite workers, based on the total labor hours required to implement this alternative over 10 years, is estimated to be on the order of 75.6 injuries and 0.138 fatalities over the project life cycle. The potential for injury and fatality to onsite workers is based on BLS data for years 2006 and 2007, respectively, and is specific to the construction industry. The BLS data represent construction across a large number of sectors and includes organizations that may not focus on preventing construction incidents. It is anticipated that the injury/fatality rates for organizations that focus on health and safety as part of construction implementation could be significantly less due to benefits associated with worker training, project planning, health and safety monitoring, and contractor oversight and routine reporting.
- Equipment-intensive excavation activities would create additional noise, which would adversely impact surrounding communities as part of the double-shift operations that would be required to complete this alternative in 8 years. The double-shift operations associated with Alternative 5 would require the support of lighting in the working area during evening hours that could be a nuisance to the local community.

Several components of this alternative would increase traffic on existing congested transportation routes:

- Approximately 624 trains with approximately 100 cars each would be required to transport excavated materials from the port to the disposal facility over the 8-year excavation phase of the project. This additional rail traffic would increase the potential for delays on the route the train takes to and from the disposal facility. Rail activities would have to occur at night to minimize disruption to port operations.
- Truck transport of asphalt to a Baltimore-based recycling facility approximately 10 miles from the site would result in approximately 13,200 additional truck trips across local roads.
- The import of borrow material via barge would increase traffic on the Patapsco River by a total of 3,153 loads over the life of the project.

These factors greatly diminish the short-term effectiveness of this component of Alternative 5.

Implementability

The following factors would make full excavation very difficult to implement:

- Excavations up to 35 feet deep require special materials and nonstandard equipment.
- Inadequate stability of the excavation base, due to soft compressible soils at the site, would require a 25-foot-deep, double-row cofferdam/sheet pile system with groundwater control.
- The schedule would require two excavation crews working simultaneously, removing a total of 3,098 tons per day for approximately 2,100 days.
- Construction of a dewatering system comprising 68,000 linear feet of vacuum header, 13,650 well points for shallow soils, and 128 deep wells for excavations below 25 feet. This system would be routed aboveground to the WWTP.
- Dewatering requirements would increase the need for an onsite storage capacity of 2 million gallons and a WWTP upgrade to handle 350 gpm.
- The WWTP and storage tanks would need to be relocated prior to being excavated from the area in which they are currently located.
- Demolition and reconstruction of Shed 11, Shed 12, Shed 1702, and Building 1600A, representing 219,800 ft^2 of building space, would require offsite space and relocation of personnel.
- Maintaining utilities and critical corridors during construction would require temporary, above-grade water, electrical, and communication transmission lines, which would disrupt current cargo operations and traffic patterns.
- Construction of an onsite rail transfer station, truck- and railcar-lining facility, two covered transfer facilities, and 12,000 linear feet of new onsite rail sidings would require permanent space from port tenants, resulting in reduced revenue to the port.

The alternative also poses logistical challenges. Excavation would proceed along a progression of excavation cells. Shoring of each cell would be required in most areas of the terminal. Continual temporary relocation of tenant operations and utilities would be required as the removal operations preceded through the terminal. Significant controls would be required to manage and mitigate stormwater runoff, air borne dust, and groundwater in the excavation. Excavation beneath the groundwater table in storm drain corridors would require driving of temporary sheeting and the installation of groundwater extraction points. Extracted groundwater would be conveyed to the wastewater treatment plant by temporary aboveground piping protected against traffic damage. Careful planning would be required to manage and control truck traffic to keep disruption of port commercial traffic and the community to a minimum.

In addition to the construction challenges, there are significant risks associated with delays during project planning and implementation. Each of these work elements could experience schedule delays due to state and local approvals, complex coordination, weather impacts, and port operations requiring alternative work hours. Availability of landfill capacity, clean fill, trucking, and other resources may limit the pace at which this alternative could be implemented. Further, it is likely that port entry infrastructure, security, road and highway improvements, WWTP permit modification, and construction of new facilities would require approvals from multiple government agencies.

Cost

The present-value cost of this alternative is estimated to be $1.36 billon. Capital costs to complete this alternative would be $2.9 billion, and the average annual O&M costs would be $3 million for using 2010 unit costs.

Degree of Interference with Port Operations

Disruption to port operations would intensify for Alternative 5, given the significantly larger volume of materials requiring handling and transport. This alternative requires the excavation of 5.6 million yd^3 of asphalt, clean soil, and COPR and the import of 4.3 million yd^3 of clean soil to be performed over 13 years, including 3 years for logistics planning, design, permitting, and procurement; 2 years for site preparation; and 8 years of site excavation. Consequently, there is a significant potentially adverse impact to the port's revenue-generating activities and related employment opportunities. Furthermore, as a result of disruption to port operations and the need for tenant relocation, the potential exists for a downturn in both port-generated state and local taxes and employment.

Implementation of the full-excavation alternative is disruptive to port operations in the following ways:

- Additional infrastructure would need to be constructed at the port for the implementation of Alternative 5. For example, Alternative 5 would require the construction of a new truck entrance to handle remedy-related truck traffic. Berth 13's Ro-Ro facilities would need to be modified to enable the off-loading of clean soil from barges required for filling the excavated areas. In addition, several substantial structures would need to be demolished and replaced, including Sheds 11 and 12, which are used for storing marine cargo; each has a capacity of 94,000 ft^2. The existing MasTec property buildings, approximately 120,000 ft^2 of warehouse space, would need to be demolished to accommodate temporary placement of construction trailers and contractor parking during remedy implementation. Increased costs associated with railroad fees and road maintenance would also be incurred. These infrastructure activities have been estimated to cost $34 million and are included in the cost of the remedy.

- Approximately 5 acres within a given excavation zone and 10 acres used for remedy-implementation-related support services would be used throughout implementation of Alternative 5. The resulting loss of port revenue from 15 acres of tenant lease space being taken out of service is estimated to be $9 million (2010 value) over a 10-year period. Further revenue losses would be incurred from tenant leases if they chose to relocate to avoid the nuisance to their operations that would be caused during implantation of Alternative 5.
- Tenant operations (i.e., cargo staging) would need to be adjusted each time the excavation is sequenced across the site due to changes in critical access corridors, traffic patterns, and temporary utility corridors.
- In order for MPA to fulfill its tenant lease obligation for warehouses and office space, MPA would have to lease offsite replacement facilities during the demolition and reconstruction of the consolidation sheds and administration building. This is estimated to cost $87 million over 10 years.
- From a community economic development standpoint, the disruption to port operations during the 8-year period of intensive site excavation would limit revenue-generating activities, which in turn would adversely impact job creation opportunities, resulting in a loss of state and local taxes estimated to be $20 million (2010 value) over 10 years. This estimate is based a loss of 255 jobs per 15 acres of land leased and marine activity could include 110 direct jobs generated from cargo and vessel activities (e.g., longshoreman, manufacturing personnel, maritime positions associated with towing and piloting of ocean carriers), 35 induced jobs in the local community (e.g., sales clerks, mechanics, teachers, government employees), and 110 indirect jobs (e.g., local companies that provide supplies, equipment, utilities, communications, repair services, legal and financial services to the port).

In summary, Alternative 5 would mean an approximately $96 million loss of revenue to the port resulting from the temporary disturbances of port tenants, as well as $20 million of lost state and local tax revenue. In addition, the temporary displacement of port operations during the performance of Alternative 5 would also likely result in a permanent loss of business for the port. The port's business is highly competitive; customers faced with disrupted operations at DMT may choose to move their operations out of Maryland permanently. Although the potential economic impact of such permanent losses is not readily quantifiable, the probability that such losses will occur during the implementation of Alternative 5 must be considered.

7.4 Short-Term Effectiveness Comparative Analysis of Corrective Measures Alternatives

A comparative analysis of short-term effectiveness factors that were quantified for each of the corrective measures alternatives was performed and is described below.

7.4.1 Emissions Intensity

Emissions intensity involved the evaluation of carbon dioxide equivalents and emissions of NO_x, SO_x, VOCs, and PM associated with activities for each corrective measures alternative. As part of the emission intensity assessment, VOCs and GHGs were evaluated for (1) VOCs associated with the storm drain CIP relining process, (2) VOCs associated with energy production and fuel combustion, and (3) GHG emissions.

With the exception of VOCs, Alternative 3 has the least emissions intensity, followed by Alternatives 1, 2, 4, and 5, in order of increasing emissions intensity. Furthermore, Alternative 3 has the fewest emissions, since the remedy involves storm drain repair and relining that is assumed (for emissions projection estimating) to result in the WWTP being taken out of service within 5 years. The WWTP is assumed to operate for 30 years for Alternatives 1 and 2, 10 years for Alternative 4, and 13 years for Alternative 5.

VOC emissions are associated with relining storm drains with CIP liners, which use styrene as a wetting agent that is emitted during the liner-curing process. However, emission intensity for Alternative 3 is an order-of-magnitude lower than either partial or full excavation alternatives, both of which have significant emissions associated with excavation and transportation of materials from the port to offsite disposal or recycling facilities.

Graphs illustrating the levels of emission for each of the five corrective measures alternatives for GHGs, PM and VOCs, and SO_x and NO_x are presented as Figures 7-1, 7-2, and 7-3, respectively.

FIGURE 7-1
Emissions Intensity: Greenhouse Gas Emissions

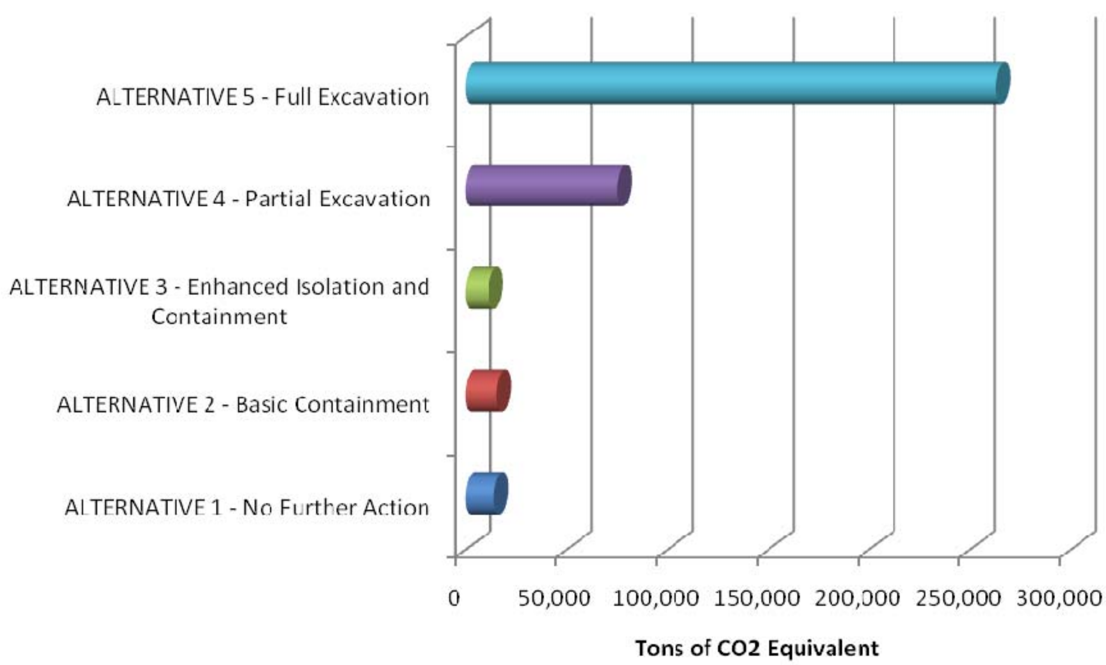


FIGURE 7-2
Emissions Intensity: Particulate Matter and VOCs

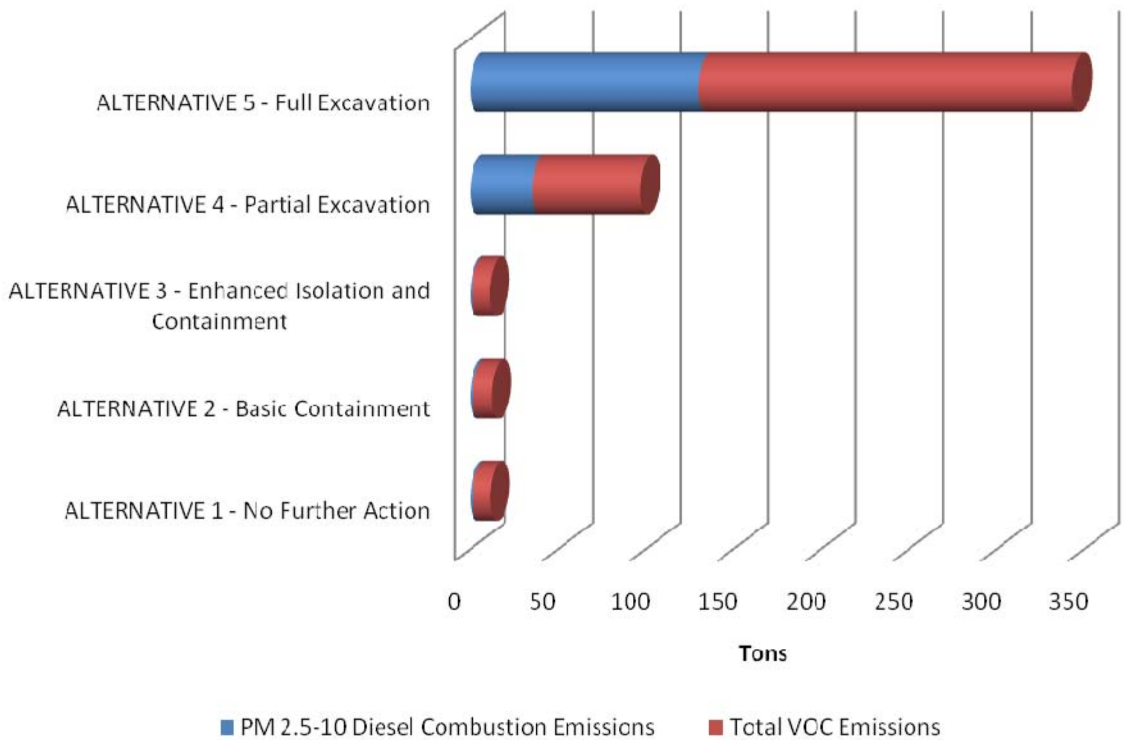
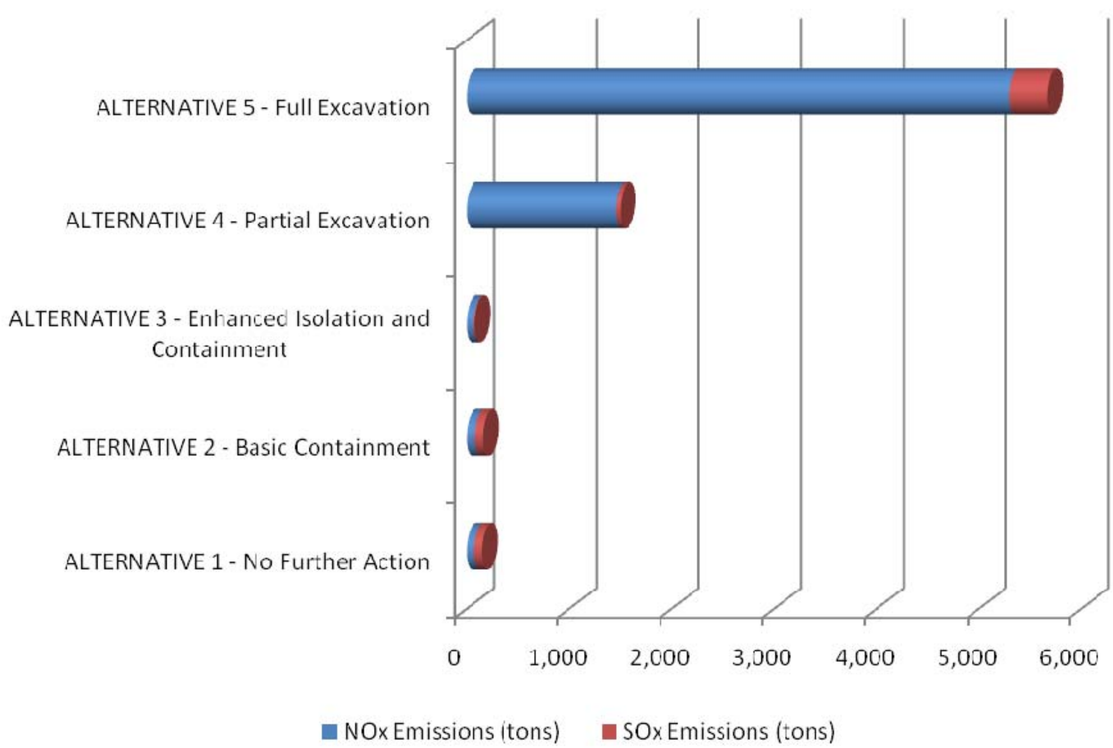


FIGURE 7-3
Emissions Intensity: NO_x and SO_x Emissions



7.4.2 Accident Impacts

Accident impact includes occupational and community safety and the potential for train derailments and accidental releases of hazardous materials associated with Alternatives 4 and 5. Graphs for comparing the community injury/fatality and worker injury/fatality for the five corrective measures alternatives are presented as Figures 7-4 and 7-5, respectively.

FIGURE 7-4
Accident Impacts: Potential Risk of Community Injury/Fatality

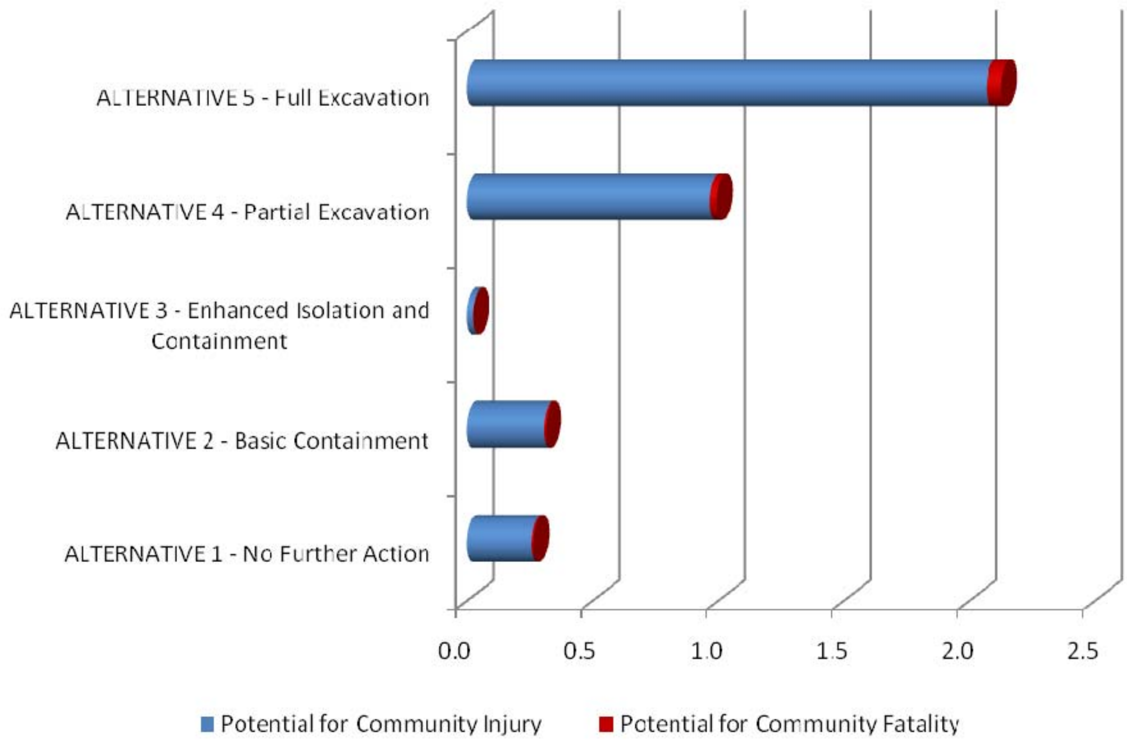
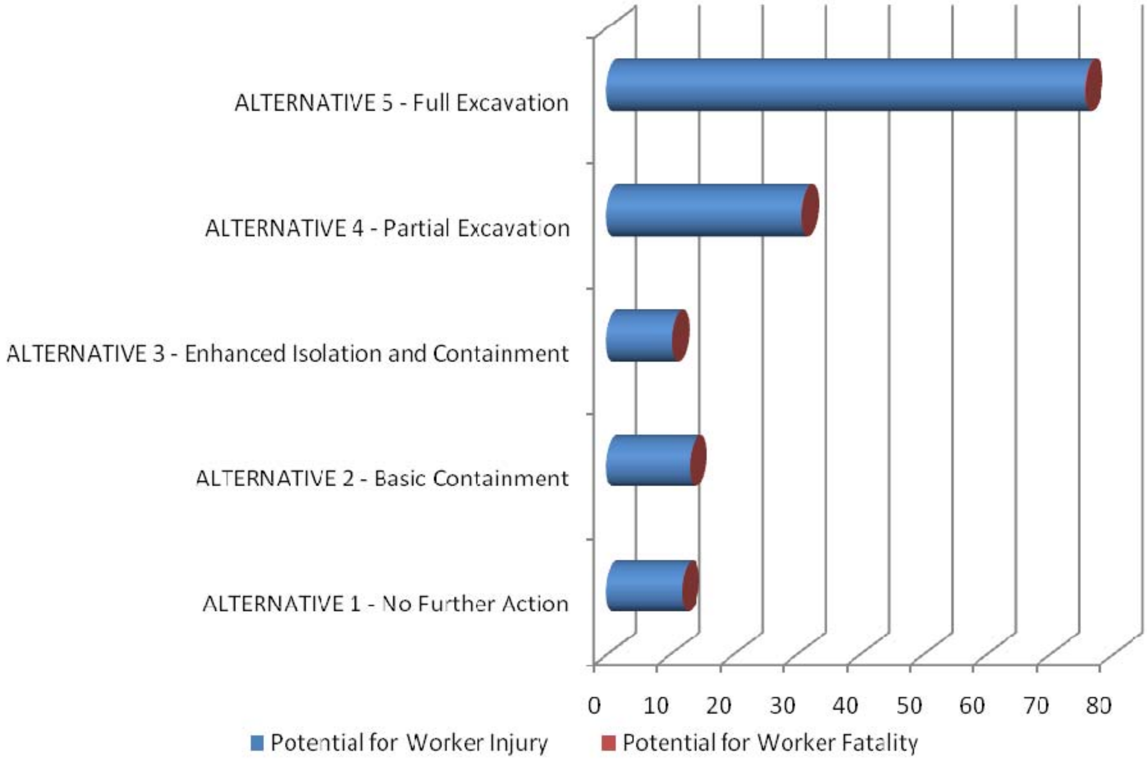


FIGURE 7-5
Accident Impacts: Potential Risk of Worker Injury/Fatality



Key observations include the following:

- The potential for accident impacts is relatively low for Alternatives 1 and 2, as they consist of smaller-scale construction and other activities that are currently being implemented at the site (e.g., groundwater monitoring, surface cover inspection and maintenance, and WWTP operation) without safety incident.
- Alternative 3 involves limited-scale construction activities, such as repair and relining of storm drains that have been successfully and safely performed at the site. The potential for accident impacts increases significantly for partial and full-scale excavation (Alternatives 4 and 5, respectively) due to the increased construction labor hours involved with implementation of these large-scale construction programs over an extended time period.
- The potential community impacts are related to miles of offsite truck traffic. Since Alternatives 4 and 5 involve substantial increases in offsite truck traffic and labor hours worked, the potential for accidents are commensurately larger.
- Partial and full excavation (Alternatives 4 and 5, respectively) are the only alternatives that utilize rail to transport excavated materials to an offsite location with direct rail off-loading and pretreatment facilities and the required landfill capacity. The impacts of accidents and potential releases of hazardous materials are directly proportional to rail miles used for transportation, which in this case are approximately 750 one-way miles from the site. Since Alternative 5 involves significantly greater volume of excavated

material to be managed offsite over a longer time period (8 years), the potential for accident impacts for rail are greater than for Alternative 4.

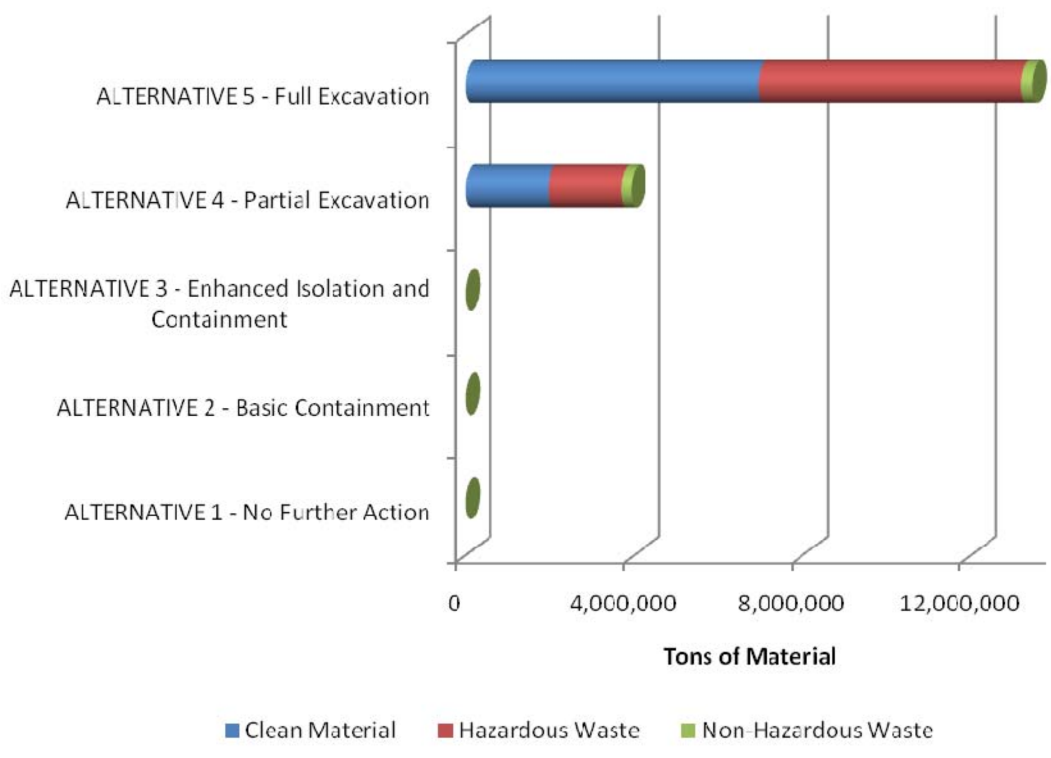
7.4.3 Materials Intensity

Materials intensity addresses clean material brought to DMT and the amount of hazardous and nonhazardous materials requiring transport to and from the port. Key observations include the following:

- Alternative 3 generates the least amount of materials requiring management because it involves storm-drain-relining activities that will reduce both the volume of stormwater to be treated and the long-term operation of the WWTP;
- Alternatives 1 and 2 require more materials handling than Alternative 3 because of the continued operation of the WWTP, which generates sludge that requires offsite transport and disposal over an assumed 30-year period; and
- Alternatives 4 and 5 have the greatest materials intensity owing to the large volumes of hazardous and nonhazardous materials to be excavated and the corresponding amount of clean material needing to be obtained from an offsite borrow source to fill in the excavations.

A comparison of materials intensity impacts for the five corrective measures alternatives is illustrated in Figure 7-6.

FIGURE 7-6
Materials Intensity: Clean Material (Fill), Hazardous Material, and Nonhazardous Material



7.4.4 Energy (Nonrenewable)

Nonrenewable energy use is from fossil fuels used to operate construction equipment for excavation and onsite transport of materials; trucks, trains, and barges for offsite transport of materials; and the WWTP. Electrical power for DMT is obtained from the electrical grid, where power plants use various fossil fuels for power generation.

The overall amount of nonrenewable energy used for each alternative increases from Alternative 1 (least) through Alternative 5 (most). Key energy consumption findings include the following:

- Electricity consumption is the least for Alternative 3 because repair and relining of the storm drains would result in decreased operation of the WWTP, which consumes 130,000 kilowatt-hours per 62.3 million gallons of treated water.
- Implementation of Alternative 1 or 2 results in the same level of energy consumption because of the continued operation of the WWTP over an assumed 30-year period.
- Alternative 4 has the second highest fuel use but the second lowest electricity use due to the WWTP operating for only 10 years.
- Alternative 5 has the highest overall energy consumption due to the large volume of materials that would be excavated and then transported offsite. Continued operation of the WWTP over 13 years would address both the large volume of water that would be collected during dewatering of excavations and the continued treatment of existing stormwater.

Comparison of the five corrective measures alternatives with respect to fuel and power consumption is illustrated in Figure 7-7 and Figure 7-8, respectively.

FIGURE 7-7
Energy (Nonrenewable Resources): Fuel Consumption

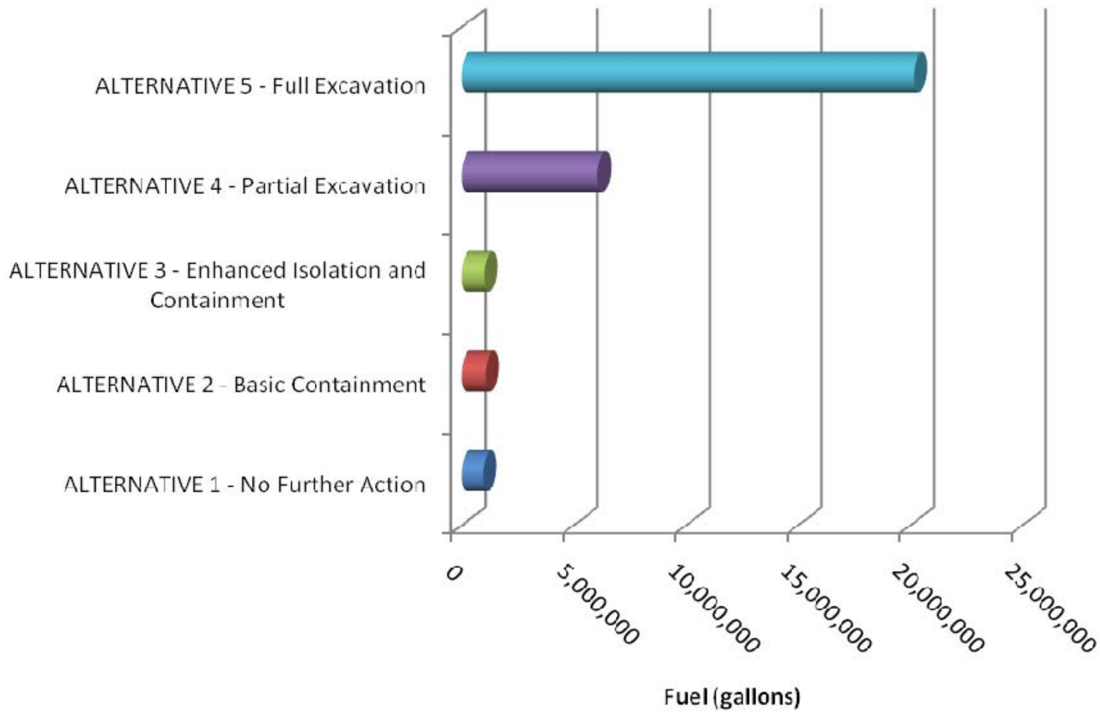
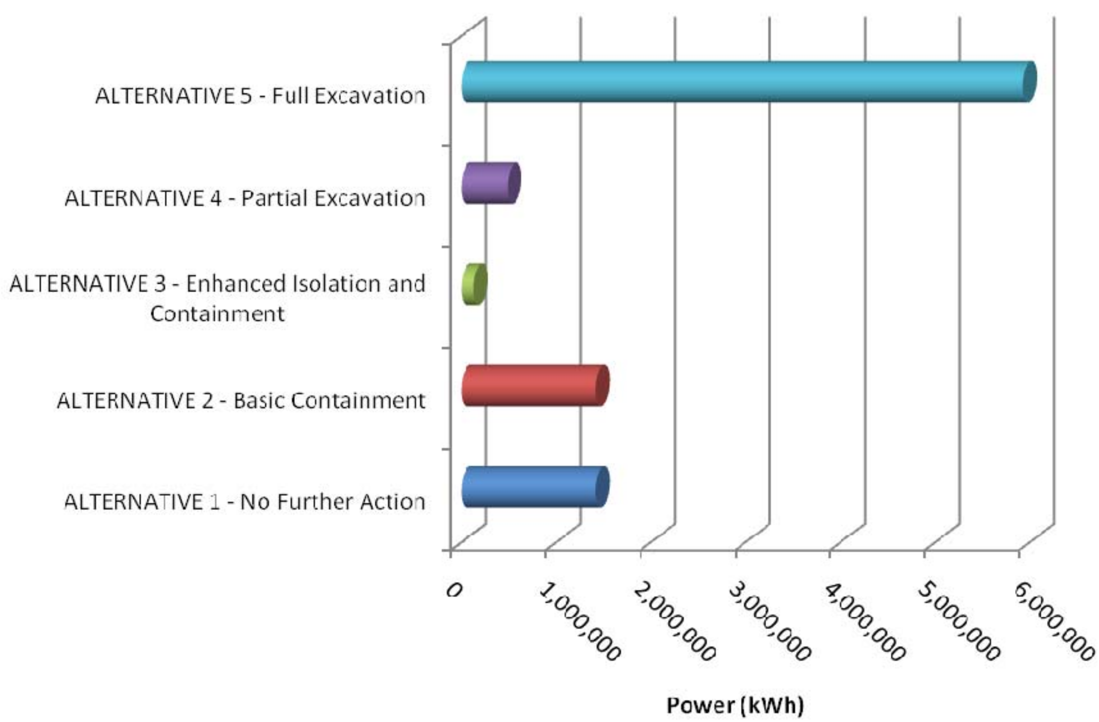


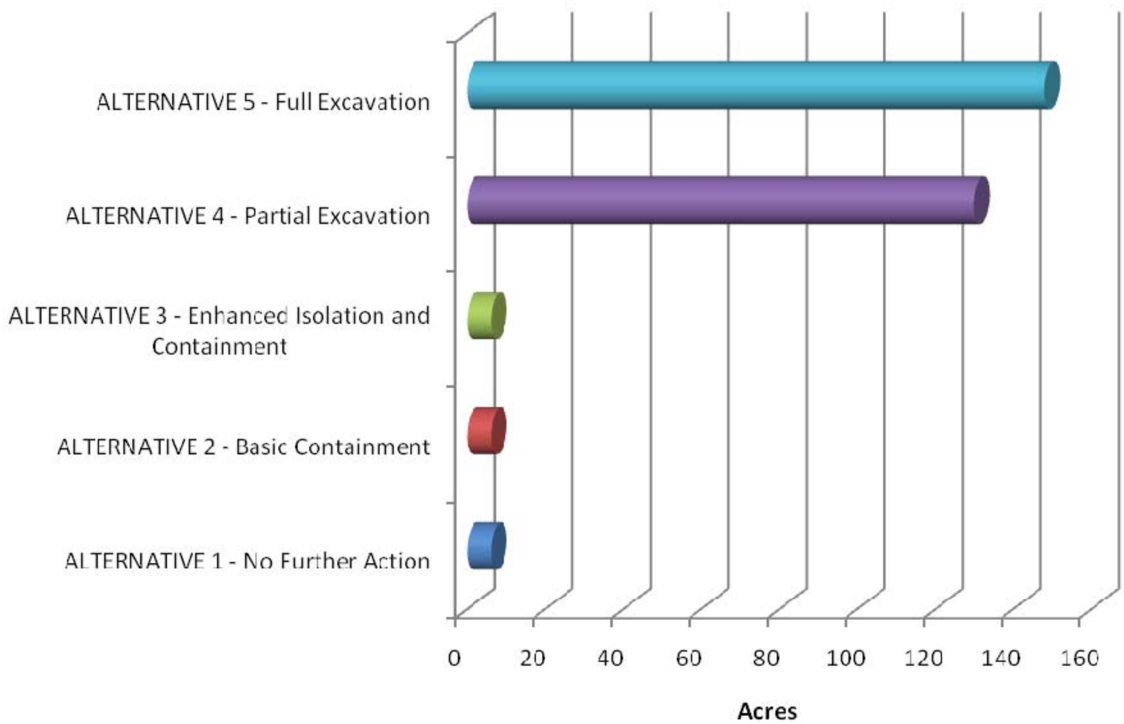
FIGURE 7-8
Energy (Nonrenewable Resources): Power



7.4.5 Land

The land category value is based on the anticipated land area impacted under each of the five corrective measures alternatives, expressed as acres. Alternatives 1, 2, and 3 involve activities similar to those being performed at DMT currently and would impact a relatively small area of DMT (about 6.2 acres). Alternatives 4 and 5 would have significant impacts to land use: partial excavation (Alternatives 4) would impact approximately 130 acres of the COPR fill area, and full excavation (Alternative 5) would impact the entire 148-acre COPR fill area. A comparison of land use impacts for the five corrective measures alternatives is illustrated in Figure 7-9.

FIGURE 7-9
Total Land Area Impacted



7.4.6 Aesthetics

Aesthetics includes quantification of potential incremental social impacts resulting from increased traffic on rail lines, the Patapsco River, and roadways, which would affect the aesthetic quality of life for communities along and near the various local and interstate materials transport routes. Other aesthetic factors, such as noise and light, are qualitatively addressed in Section 7.3.

The excavation alternatives would have the largest potential social impacts to communities resulting from additional truck traffic. For example, Alternative 4 would result in an additional 11,700 truck trips from DMT over 5 years of active materials removal, whereas Alternative 5 would have 13,312 additional truck trips over 8 years of active materials removal. Alternatives 1, 2, and 3 would have modest traffic associated with their implementation; these aesthetic impacts were considered nominal and were not quantified.

Potential aesthetic impacts to the community associated with materials transport by rail apply only to the excavation alternatives. Additional rail traffic would increase the potential for traffic delays and train traffic along routes the trains would use to and from the disposal facility. To minimize disruption to port operations (e.g., delay shipment of tenant cargo) owing to increased rail traffic, transporting removed materials would have to occur at night, which would create noise and light aesthetic impacts to the local community.

Alternative 4 (partial excavation) would require approximately 242 trains with approximately 100 cars each to transport excavated material from the port to the disposal facility over the 5 years of material removal. For Alternative 5 (full excavation), approximately 856 trains with approximately 100 cars each would be required to transport excavated materials from the port to the disposal facility over the 8-year period of excavation. Both of the excavation alternatives would require barging clean soil from an offsite borrow source to fill the excavated areas. Alternative 4 would require about 879 barge loads over the 5-year excavation period; Alternative 5 would require 3,148 barge loads over the 8-year excavation period.

In summary, Alternative 5 (full excavation) has the most adverse short-term impacts on the environment, workers, and the community of all of the short-term evaluation criteria due to the large-scale construction performed under this corrective measure alternative. Alternative 4 has a similar, albeit less adverse, footprint, but it too is significant when compared to those of all three of the non-excavation alternatives.

Alternative 3 has the least-adverse short-term impact, even when compared to Alternatives 1 and 2, because under Alternative 3, the WWTP would have a reduced period of operation (5 years instead of 30 years) once the priority storm drains are relined. This would eliminate the need for collecting and treating impacted stormwater. The WWTP has a significant footprint due to chemical usage for treatment, electricity consumption, and the offsite transport and disposal of sludge generated from operation of the WWTP.

7.5 Comparative Evaluation of the Corrective Measures Alternatives

This section of the CMAA provides a comparative evaluation of the five corrective measures alternatives. Pursuant to COMAR Chapter 26.14.02.06(F)(3)-(4), MDE will select a remedy using a three-step comparative analysis:

1. To be considered for selection, it is mandatory that the alternative is protective of human health and the environment and complies with ARARs.
2. The four effectiveness criteria (long-term effectiveness; reduction in toxicity, mobility, or volume through treatment; short-term effectiveness; and implementability) are then considered to determine overall effectiveness.
3. The lowest-cost remedy that provides an acceptable balance of the effectiveness criteria may be selected.

Table 7-1 compares side-by-side the five corrective measures alternatives with the eight evaluation criteria. All five alternatives are protective of human health and the environment. Compared to the others, Alternative 1 does not satisfy ARARs. Although

Alternative 2 technically meets all ARARs, it is inferior to Alternative 3 because under Alternative 2, no mechanism is provided to contain and isolate sources of groundwater infiltration into storm drains.

A comparison of the overall effectiveness of Alternatives 2 through 5 using the four effectiveness criteria is as follows: Alternative 3 provides a greater level of long-term effectiveness than Alternative 2 through the implementation of a rigorous PMP and by addressing stormwater discharges to the Patapsco River at the outfall locations of the 12th Street, 12.5th Street, 13th Street, 13.5th Street, 14th Street, and 15th Street storm drains. Alternatives 3, 4, and 5 provide similar levels of long-term effectiveness, although Alternatives 4 and 5 would be considered to have greater permanence than Alternative 3 because they require less maintenance and reduce the need for long-term institutional controls.

None of the alternatives includes onsite treatment as a primary element; therefore they provide similar levels of reduction of toxicity, mobility, or volume.

Alternatives 2, 4, and 5 are significantly inferior to Alternative 3 in terms of short-term effectiveness. Although Alternative 2 is currently being implemented and is providing immediate effectiveness, including institutional controls, groundwater monitoring, cover maintenance, and WWTP operation, Alternative 3 provides additional protection by addressing storm drain discharges from the priority storm drains. Alternatives 4 and 5 present unnecessary risks to human health, the environment, and the community without providing any substantial improvement to effectiveness or protectiveness over Alternative 3. In addition, Alternatives 4 and 5 would take over 10 years to fully implement versus Alternative 3, which could be completed within several years.

Alternatives 2 and 3 have been demonstrated to be implementable and have been incorporated into routine port operations, training, and institutional controls with manageable, but not insignificant, disruption to port operations. Alternatives 4 and 5 are significantly inferior to Alternative 3 for implementability. Both alternatives would result in an unacceptable disruption to port tenants and operations associated with the excavation activities as well as require additional infrastructure development to support the increased trucking, site security, and facility access components of an excavation remedy. Restricting and eliminating space for cargo handling over an extended period of time would place an economic burden on the port's tenants and their employees. All of the elements of Alternative 3 have been successfully implemented at the site with minimal disruption and with no economic impact.

In summary, Alternative 3 is superior to Alternatives 2, 4, and 5 in overall effectiveness. Alternative 3 may cost up to $138 million (net present value) for all activities encompassed in the remedy, which is less than Alternatives 4 and 5. Although implementation of Alternative 3 is estimated to cost approximately $26 million more than Alternative 2, it provides an additional level of protectiveness by implementing a PMP and by addressing discharges from the 12th Street, 12.5th Street, 13th Street, 13.5th Street, 14th Street, and 15th Street storm drains. Alternative 3 can be implemented more rapidly than Alternatives 4 and 5 and presents significantly less short-term impacts to the community, port workers and port business operations. Alternative 3 is fully protective of human health and the environment.

TABLE 7-1
Alternatives Evaluation Summary

Evaluation Criteria	1 No Further Action	2 Basic Containment	3 Enhanced Isolation and Containment	4 Partial Excavation	5 Full Excavation
Overall protection of human health and the environment	Risks to human health and the environment from COPR, groundwater, and stormwater are managed through measures completed under the 1992 Consent Order and as-needed cover system maintenance. This alternative is considered protective.	Protectiveness of this alternative is similar to that of Alternative 1; except that risks to human health and the environment from COPR are further reduced through the more formalized and structured cover system inspection and maintenance program. This alternative is protective.	Risks to human health and the environment from COPR, groundwater, and stormwater are managed through measures completed under the 1992 Consent Order and 2006 Consent Decree, a formalized Performance Management Program, and repair and relining of storm drains in COPR fill. This alternative is fully protective.	This alternative provides long-term protection to human health and the environment after 10 years, once COPR has been excavated and the lined utility corridors and storm drains are completed. Additional risks to onsite workers, the community and the environment during implementation of this alternative can be managed through appropriate institutional controls. This alternative is protective in the long term but presents the potential for additional risk to the community, on site workers and the environment in the short term.	Protectiveness of this alternative is similar to that of Alternative 4, except it will take 13 years, and the level of risk to onsite workers, the community and the environment would be greater due to the additional scope of full excavation.
Compliance with ARARs	Does not comply with ARARs	Complies with ARARs.	Complies with ARARs.	Complies with ARARs, but 10-year remedial construction period	Complies with ARARs, but 13-year remedial construction period.
Long-term effectiveness and permanence	Provides long-term and effectiveness and permanence as long as continued compliance with groundwater monitoring, WWTP operation, and institutional controls are maintained.	Same as Alternative 1.	Provides long-term effectiveness and permanence through application of PMP elements.	Equivalent to Alternative 3 except for potentially greater long-term permanence and effectiveness if clean corridor containment systems for storm drains and utilities are properly installed and are durable under operating conditions.	Equivalent to Alternative 4 with additional long term permanence and effectiveness with complete removal of COPR-related materials.
Reduction of toxicity, mobility, and volume through treatment	This alternative does not include treatment except for treatment of dry weather flow treatment; however, natural processes are expected to decrease the volume of Cr (VI) in the COPR fill and groundwater.	Same as Alternative 1.	This alternative does include temporary treatment of dry weather flow. Once storm drain linings are complete, release of Cr(VI) to the Patapsco River will decrease substantially. In addition, natural processes are expected to decrease the volume of Cr(VI) in the COPR fill and groundwater.	Equivalent to Alternative 3.	Equivalent to Alternative 3.
Short-term effectiveness	Is currently being implemented and is providing immediate effectiveness. Institutional controls, groundwater monitoring, cover maintenance, and WWTP operation have been executed without unacceptable risks to human health or the environment.	Same as Alternative 1.	Remedy will be complete within 2 to 3 years. Most elements of this alternative are currently being implemented without unacceptable risks to human health and the environment. Storm drain lining and tidal exclusion installation has and can be done without significant impact to human health, the environment, or port operations.	Partial removal of COPR will result in substantially greater risk to onsite workers, greater risk to the public and the environment due to transport of large volumes of COPR and restoration materials on public streets and road, and greater impacts to port operations during the 10-year period of time required to implement this alternative.	Similar to Alternative 4, except that the potential impacts to site workers, the public, the environment, and port operations will be substantially higher due the increased timeframe (i.e., 13 years), scope and volumes from full excavation of COPR materials at DMT. Remedy will take 13 years to complete.

TABLE 7-1
Alternatives Evaluation Summary

Evaluation Criteria	1 No Further Action	2 Basic Containment	3 Enhanced Isolation and Containment	4 Partial Excavation	5 Full Excavation
Implementability	Elements of this alternative are currently being implemented at the site and have been incorporated into routine port operations, training, and institutional controls.	Same as Alternative 1.	Most of the elements of this alternative are currently being implemented at the site and have been incorporated into routine port operations training and institutional controls. Storm drain lining and tidal exclusion components can be implemented using procedures that have been used for similar work at the port.	Partial excavation of COPR and utility and storm drain replacement into clean corridors would be difficult to implement due to port operations, port security and infrastructure limitations, the added volumes of trucks on off the site, and limitations of available landfill capacity.	Similar to Alternative 4 except that implementation would be extremely difficult to implement due the increased scope of work required for full COPR removal.
Cost (total cost)	$103 million	$112 million	$138 million	$693 million	$1.36 billion
Degree of interference with port operations	This alternative has been implemented for many years with appropriate adjustments having been made to port operations to accommodate the work. Although manageable, it is not insignificant. Therefore, close coordination is necessary to avoid interference with very busy port operations.	This alternative has been implemented for 2 years at DMT. It is similar to Alternative 1 but requires slightly greater coordination due to the increased level of cover system inspections and maintenance.	This alternative is similar to Alternative 2 in that interruptions in port operations are manageable, but not insignificant. Therefore, a greater level of coordination is required with port operations due to the added disturbance required for storm drain relining and tidal exclusion device installation. Pilot tests at 13th and 15th Streets demonstrated the installation of lining technologies can be done without disrupting port operations.	This alternative would cause significant interference to port operations due to the excavation space requirements, continually moving tenant operations, changing traffic patterns and disruption to utilities. For excavation, staging, exclusion zones, stockpile area, additional trucks, etc. The continual temporary loss of areas for construction will result in loss of revenue to the port and may require tenants to seek temporary offsite storage areas.	This alternative should be similar to Alternative 4 except that the impacts would be much greater due to the removal of COPR from the entire port. Permanent and continual disruption to port operations will result in significant revenue loss, require substantial new infrastructure to be built, and impact the community economically. It is possible that the some tenants may divert cargo to other ports, thus resulting in the loss of substantial port revenue for at least the duration of the project.

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Appendix A
Cost Estimates for Corrective Measures Alternatives

Engineering Cost Estimate

Detailed descriptions of the five corrective measures alternatives are presented in Section 4 of the Corrective Measures Alternative Analysis (CMAA) prepared for the Dundalk Marine Terminal (DMT), Baltimore, Maryland. Engineering budgetary cost estimates were prepared for each of the five alternatives and are provided herein. The following provides a general description of the construction of the engineering cost estimates.

Major work elements were defined to complete the five corrective measures alternative for each of the following mediums: chromite ore processing residue (COPR), groundwater, stormwater, surface water and sediment, and utilities and structures. Implementation or sequencing of work elements has been developed to ensure the following objectives were met:

- Maintain shipping berth access;
- Maintain critical intersections for inbound traffic;
- Maintain critical traffic corridors (e.g., East Service Road), if possible, or provide temporary alternate route for traffic flow;
- Sequence work with an understanding of tenant operations to minimize work areas requiring displacement of cargo; and
- Consider permanent staging area in Area 1702 (5 acres) to minimize the footprint of affected area during the implementation of each remedial alternative.

The engineering cost estimates include both remedial costs already incurred by Honeywell and MPA and the future capital and annual operation and maintenance (O&M) costs for implementing the alternative, if selected. The previously expended costs (e.g., "sunk costs") are included in the cost estimating sheets as a single line item for each of the alternatives.

All costs in this document are conceptual level costs as outlined in U.S. Environmental Protection Agency guidance[1] and are expected to have a degree of accuracy of +50 to -30 percent. The cost estimates were developed based on the 2010 unit costs in U.S. dollars and estimated quantities for major work items derived from information available at the time of this study, conceptual means and methods, historical costs associated with DMT, and budgetary cost estimates provided by vendors. The format of the cost estimates, including contingencies, construction markups, and cost escalation factors, is in general conformance with the aforementioned EPA guidance document.

[1] EPA. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. *EPA 540-R-00-002, OSWER 9355.0-75*. Washington, D.C. July.

Alternative Cost Summary - Annual Budget

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Sep-10

Alternative	Capital (2010 $)	Total O&M (2010 $)	Total O&M (PV $)	Total Cost (PV $)[a]
Alternative 1: No Further Action	$0	$63,000,000	$30,000,000	$103,000,000
Alternative 2: Basic Containment	$0	$82,000,000	$39,000,000	$112,000,000
Alternative 3: Enhanced Isolation and Containment	$15,000,000	$111,000,000	$52,000,000	$138,000,000
Alternative 4: Partial Excavation	$1,150,000,000	$66,000,000	$35,000,000	$693,000,000
Alternative 5: Full Excavation	$2,959,000,000	$92,000,000	$59,000,000	$1,360,000,000

[a] Includes capital costs spent to date.

Alternative Cost Summary - Annual Budget

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Jan-09

Alternative 1: No Further Action

		COPR	Groundwater	Stormwater	Utilities Structures	Surface Water	Total Capital	O&M	Periodic	Total
		$0	$0	$0	$0	$0	$0	$0		$0
1	2011						$0	$2,989,040		$2,989,040
2	2012						$0	$2,989,040		$2,989,040
3	2013						$0	$2,989,040		$2,989,040
4	2014						$0	$2,989,040		$2,989,040
5	2015						$0	$2,989,040	$15,000	$3,004,040
6	2016						$0	$2,540,684		$2,540,684
7	2017						$0	$2,540,684		$2,540,684
8	2018						$0	$2,540,684		$2,540,684
9	2019						$0	$2,540,684		$2,540,684
10	2020						$0	$2,540,684	$40,000	$2,580,684
11	2021						$0	$2,159,581		$2,159,581
12	2022						$0	$2,159,581		$2,159,581
13	2023						$0	$2,159,581		$2,159,581
14	2024						$0	$2,159,581		$2,159,581
15	2025						$0	$2,159,581	$15,000	$2,174,581
16	2026						$0	$1,835,644		$1,835,644
17	2027						$0	$1,835,644		$1,835,644
18	2028						$0	$1,835,644		$1,835,644
19	2029						$0	$1,835,644		$1,835,644
20	2030						$0	$1,835,644	$40,000	$1,875,644
21	2031						$0	$1,560,297		$1,560,297
22	2032						$0	$1,560,297		$1,560,297
23	2033						$0	$1,560,297		$1,560,297
24	2034						$0	$1,560,297		$1,560,297
25	2035						$0	$1,560,297	$15,000	$1,575,297
26	2036						$0	$1,560,297		$1,560,297
27	2037						$0	$1,560,297		$1,560,297
28	2038						$0	$1,560,297		$1,560,297
29	2039						$0	$1,560,297		$1,560,297
30	2040						$0	$1,560,297	$15,000	$1,575,297
							$0	$63,227,716	$140,000	$63,367,716
								$2,107,591		

Alternative Cost Summary - Annual Budget

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Jan-09

Alternative 2: Basic Containment

		COPR	Groundwater	Stormwater	Utilities Structures	Surface Water	Total Capital	O&M	Periodic	Total
		$0	$0	$0	$0	$0	$0			$0
1	2011	$0		$0	$0		$0	$3,892,133		$3,892,133
2	2012				$0		$0	$3,892,133		$3,892,133
3	2013						$0	$3,892,133		$3,892,133
4	2014						$0	$3,892,133		$3,892,133
5	2015						$0	$3,892,133	$15,000	$3,907,133
6	2016						$0	$3,308,313		$3,308,313
7	2017						$0	$3,308,313		$3,308,313
8	2018						$0	$3,308,313		$3,308,313
9	2019						$0	$3,308,313		$3,308,313
10	2020						$0	$3,308,313	$40,000	$3,348,313
11	2021						$0	$2,812,066		$2,812,066
12	2022						$0	$2,812,066		$2,812,066
13	2023						$0	$2,812,066		$2,812,066
14	2024						$0	$2,812,066		$2,812,066
15	2025						$0	$2,812,066	$15,000	$2,827,066
16	2026						$0	$2,390,256		$2,390,256
17	2027						$0	$2,390,256		$2,390,256
18	2028						$0	$2,390,256		$2,390,256
19	2029						$0	$2,390,256		$2,390,256
20	2030						$0	$2,390,256	$40,000	$2,430,256
21	2031						$0	$2,031,718		$2,031,718
22	2032						$0	$2,031,718		$2,031,718
23	2033						$0	$2,031,718		$2,031,718
24	2034						$0	$2,031,718		$2,031,718
25	2035						$0	$2,031,718	$15,000	$2,046,718
26	2036						$0	$2,031,718		$2,031,718
27	2037						$0	$2,031,718		$2,031,718
28	2038						$0	$2,031,718		$2,031,718
29	2039						$0	$2,031,718		$2,031,718
30	2040						$0	$2,031,718	$15,000	$2,046,718
							$0	$82,331,027	$140,000	$82,471,027
								$2,744,368		

Alternative Cost Summary - Annual Budget

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Jan-09

Alternative 3: Enhanced Isolation and Containment

		COPR	Groundwater	Stormwater	Utilities Structures	Surface Water	Total Capital	O&M	Periodic	Total
		$0	$0	$14,167,725	$578,565	$0	$14,746,290			$14,746,290
1	2011	$0	$0	$7,083,863	$578,565	$0	$7,662,428	$5,246,774		$12,909,202
2	2012			$7,083,863			$7,083,863	$5,246,774		$12,330,637
3	2013						$0	$5,246,774		$5,246,774
4	2014						$0	$5,246,774		$5,246,774
5	2015						$0	$5,246,774	$15,000	$5,261,774
6	2016						$0	$4,459,758		$4,459,758
7	2017						$0	$4,459,758		$4,459,758
8	2018						$0	$4,459,758		$4,459,758
9	2019						$0	$4,459,758		$4,459,758
10	2020						$0	$4,459,758	$40,000	$4,499,758
11	2021						$0	$3,790,794		$3,790,794
12	2022						$0	$3,790,794		$3,790,794
13	2023						$0	$3,790,794		$3,790,794
14	2024						$0	$3,790,794		$3,790,794
15	2025						$0	$3,790,794	$15,000	$3,805,794
16	2026						$0	$3,222,175		$3,222,175
17	2027						$0	$3,222,175		$3,222,175
18	2028						$0	$3,222,175		$3,222,175
19	2029						$0	$3,222,175		$3,222,175
20	2030						$0	$3,222,175	$40,000	$3,262,175
21	2031						$0	$2,738,849		$2,738,849
22	2032						$0	$2,738,849		$2,738,849
23	2033						$0	$2,738,849		$2,738,849
24	2034						$0	$2,738,849		$2,738,849
25	2035						$0	$2,738,849	$15,000	$2,753,849
26	2036						$0	$2,738,849		$2,738,849
27	2037						$0	$2,738,849		$2,738,849
28	2038						$0	$2,738,849		$2,738,849
29	2039						$0	$2,738,849		$2,738,849
30	2040						$0	$2,738,849	$15,000	$2,753,849
							$14,746,290	$110,985,994	$140,000	$125,872,284
								$3,699,533		

Alternative Cost Summary - Annual Budget

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Jan-09

Alternative 4: Partial Excavation

		COPR	Groundwater	Stormwater	Utilities Structures	Surface Water	Total Capital	O&M	Periodic	Total
		$1,104,756,697	$4,266,848	$15,123,733	$26,199,504	$0	$1,150,346,781			$1,150,346,781
1	2011	$110,475,670	$426,685	$1,512,373	$2,619,950		$115,034,678	$4,077,368		$119,112,046
2	2012	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$4,077,368		$119,112,046
3	2013	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$4,077,368		$119,112,046
4	2014	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$4,077,368		$119,112,046
5	2015	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$4,077,368	$15,000	$119,127,046
6	2016	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$3,465,763		$118,500,441
7	2017	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$3,465,763		$118,500,441
8	2018	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$3,465,763		$118,500,441
9	2019	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$3,465,763		$118,500,441
10	2020	$110,475,670	$426,685	$1,512,373	$2,619,950	$0	$115,034,678	$3,465,763	$40,000	$118,540,441
11	2021					$0	$0	$1,732,881		$1,732,881
12	2022					$0	$0	$1,732,881		$1,732,881
13	2023					$0	$0	$1,732,881		$1,732,881
14	2024					$0	$0	$1,732,881		$1,732,881
15	2025					$0	$0	$1,732,881	$15,000	$1,747,881
16	2026					$0	$0	$1,472,949		$1,472,949
17	2027					$0	$0	$1,472,949		$1,472,949
18	2028					$0	$0	$1,472,949		$1,472,949
19	2029					$0	$0	$1,472,949		$1,472,949
20	2030					$0	$0	$1,472,949	$40,000	$1,512,949
21	2031					$0	$0	$1,252,007		$1,252,007
22	2032					$0	$0	$1,252,007		$1,252,007
23	2033					$0	$0	$1,252,007		$1,252,007
24	2034					$0	$0	$1,252,007		$1,252,007
25	2035					$0	$0	$1,252,007	$15,000	$1,267,007
26	2036					$0	$0	$1,252,007		$1,252,007
27	2037					$0	$0	$1,252,007		$1,252,007
28	2038					$0	$0	$1,252,007		$1,252,007
29	2039					$0	$0	$1,252,007		$1,252,007
30	2040					$0	$0	$1,252,007	$15,000	$1,267,007
							$1,150,346,781	$66,264,874	$140,000	$1,216,751,655
								$2,208,829		

Alternative Cost Summary - Annual Budget

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Jan-09

Alternative 5: Full Excavation

		COPR	Groundwater	Stormwater	Utilities Structures	Surface Water	Total Capital	O&M	Periodic	Total
		$2,828,779,437	$87,575,039	$19,384,830	$23,618,693	$0	$2,959,357,999	$8,022,558		$2,967,380,557
1	2011	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$8,022,558		$235,665,481
2	2012	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$8,022,558		$235,665,481
3	2013	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$8,022,558		$235,665,481
4	2014	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$8,022,558		$235,665,481
5	2015	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$8,022,558	$15,000	$235,680,481
6	2016	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$6,819,175		$234,462,098
7	2017	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$6,819,175		$234,462,098
8	2018	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$6,819,175		$234,462,098
9	2019	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$6,819,175		$234,462,098
10	2020	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$6,819,175	$40,000	$234,502,098
11	2021	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$5,796,298		$233,439,221
12	2022	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$5,796,298		$233,439,221
13	2023	$217,598,418	$6,736,541	$1,491,141	$1,816,823		$227,642,923	$5,796,298		$233,439,221
14	2024						$0	$0		$0
15	2025						$0	$0	$15,000	$15,000
16	2026						$0	$0		$0
17	2027						$0	$0		$0
18	2028						$0	$0		$0
19	2029						$0	$0		$0
20	2030						$0	$0	$40,000	$40,000
21	2031						$0	$0		$0
22	2032						$0	$0		$0
23	2033						$0	$0		$0
24	2034						$0	$0		$0
25	2035						$0	$0	$15,000	$15,000
26	2036						$0	$0		$0
27	2037						$0	$0		$0
28	2038						$0	$0		$0
29	2039						$0	$0		$0
30	2040						$0	$0	$15,000	$15,000
							$2,959,357,999	$91,597,560 $3,053,252	$140,000	$3,051,095,559

Alternative 1: No Further Action

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Sep-10

Description: No Further Action

Capital **(2010 $)**

CAPITAL COSTS

WBS	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	Costing Basis	Assumptions
	General						
	N/A						
	TOTAL CAPITAL COST GENERAL				**$0**		
1000	**COPR**						
	N/A						
	TOTAL CAPITAL COST COPR				**$0**		
2000	**Groundwater**						
	N/A						
	TOTAL CAPITAL COST GROUNDWATER				**$0**		
3000	**Stormwater**						
	N/A						
	TOTAL CAPITAL COST STORMWATER				**$0**		
4000	**Utilities/Structures**						
	N/A						
	TOTAL CAPITAL COST UTILITIES & STRUCTURES				**$0**		
5000	**Surface Water and Sediment**						
	N/A						
	TOTAL PERIODIC COST SURFACE WATER & SEDIMENT				**$0**		

Alternative 1: No Further Action

6000	O&M						
	O&M Surface Cover Maintenance						
	Semi Annual Inspection	0	EA	$50,000	$0	CH2M Historical	
	Maintenance and Repair	6	AC	$121,000	$750,200	CH2M Historical	Assumes addition of 3 in. of pavement over existing surface
	Utilities - Maintenance and Repair	1	LS	$150,000	$150,000	CH2M Est.	Historical 7 events per year
	SUBTOTAL				$900,200		
	O&M Groundwater Plant						
	Labor	4,320	HR	$60	$259,200	CH2M Est.	
	Utilities	12	MO	$15,000	$180,000	CH2M Est.	
	Replacement Parts	1	LS	$5,000	$5,000	CH2M Allowance	
	Major Equipment Replacement	1	LS	$10,000	$10,000	CH2M Allowance	
	SUBTOTAL				$454,200		
	Compliance Monitoring and Health & Safety						
	Groundwater Monitoring	2	LS	$25,000.00	$50,000	CH2M Historical	20 Wells, biennially
	Stormwater Monitoring	1	LS	$25,000.00	$25,000	CH2M Historical	Sample all drains per NPDES Permit
	Lab Analysis	12	MO	$2,000.00	$24,000	CH2M Historical	
	Data Validation	60	HR	$100.00	$6,000	CH2M Historical	
	Reports	4	EA	$3,000.00	$12,000	CH2M Historical	
	Misc	1	LS	$5,000.00	$5,000	CH2M Historical	
	PPE Provisions for Workers (Worker·Days)	520	EA	$25.00	$13,000	CH2M Historical	
	SUBTOTAL				$135,000		
	SUBTOTAL - ALL TASKS - O & M				**$1,489,400**		
	Mobilization/Demobilization	5%			$74,470		
	Subcontractor General Conditions	25%			$372,350		
	SUBTOTAL				**$1,936,220**		
	Contingency	25%			$484,055	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$2,420,275**		
	Escalation to Mid-Pt	4%			$96,811		
	Project Management	5%			$121,014	**USEPA 2000, p. 5-13**	
	Remedial Design	8%			$193,622	**USEPA 2000, p. 5-13**	
	Construction Management	0%			$0	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$2,831,722**		
	Contractor Fees						
	ODC & Subs	5%		$ 2,517,086	$ 125,854		
	Labor	10%	max	$ 314,636	$ 31,464		
	SUBTOTAL				**$ 157,318**		
	TOTAL O&M				**$2,989,040**		

Alternative 1: No Further Action

Periodic Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review & Surface Water	5	1	LS	$15,000	$15,000	
5 year Review & Surface Water	10	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	10	1	LS	$25,000	$25,000	
5 year Review & Surface Water	15	1	LS	$15,000	$15,000	
5 year Review & Surface Water	20	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	20	1	LS	$25,000	$25,000	
5 year Review & Surface Water	25	1	LS	$15,000	$15,000	
5 year Review & Surface Water	30	1	LS	$15,000	$15,000	
				Total	$140,000	
TOTAL ANNUAL PERIODIC COST					**$140,000**	

Discount Rate = 7.0%

Source: USEPA 2000, page 4-5. This rate represents a "real" discount rate approximating interest rates

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST TO DATE	0	$73,380,000	$73,380,000	1.00	$73,380,000	
ANNUAL O&M COST - All Components	1 to 5	$14,945,198	$2,989,040	4.10	$12,255,653	
ANNUAL O&M COST - All Components	6 to 10	$12,703,418	$2,540,684	0.58	$7,393,505	
ANNUAL O&M COST - All Components	11 to 15	$10,797,906	$2,159,581	0.41	$4,480,747	
ANNUAL O&M COST - All Components	16 to 20	$9,178,220	$1,835,644	0.30	$2,715,504	
ANNUAL O&M COST - All Components	21 to 30	$15,602,974	$1,560,297	0.18	$2,874,835	
PERIODIC COST	1	$0	$0	0.93	$0	
PERIODIC COST	2	$0	$0	0.87	$0	
PERIODIC COST	3	$0	$0	0.82	$0	
PERIODIC COST	4	$0	$0	0.76	$0	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$40,000	$40,000	0.51	$20,334	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$40,000	$40,000	0.26	$10,337	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
					$103,151,780	

TOTAL PRESENT VALUE FOR ALTERNATIVE 1	**$103,150,000**
Present Value Capital	**$73,380,000**
Present Value O&M and Periodic	**$29,770,000**
	$103,150,000

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2a. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA. (Includes materials, equipment, and labor)
2b. R.S. Means Company. 2007. 26th Edition.
2c. ECHOS (Environmental Cost Handling Options and Solutions). 2006. 12th Edition.
3. Historical CH2M HILL project cost information
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Alternative 2: Basic Containment

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Sep-10

Description: Maintain Existing Containment Measures, Monitoring w/Contingent Remedies and Existing Institutional Controls

Capital **(2010 $)**

CAPITAL COSTS

WBS	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	Costing Basis	Assumptions
	General						
	N/A						
	TOTAL CAPITAL COST GENERAL				**$0**		
1000	**COPR**						
	Existing Costs to Date						
	Crack Repair and Sealing- To Date Costs	0	LS	$2,500,000.00	$0		
	IRM Costs to Date (Area 1800 and SRTs)	0	LS	$5,450,000.00	$0		
	SUBTOTAL				$0		
	SUBTOTAL - ALL TASKS - GENERAL & COPR				**$0**		
	Mobilization/Demobilization	5%			$0		
	Subcontractor General Conditions	10%			$0		
	SUBTOTAL				**$0**		
	Contingency	25%			$0	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$0**		
	Escalation to Mid-Pt	0%			$0		
	Project Management	0%			$0	**USEPA 2000, p. 5-13**	
	Remedial Design	0%			$0	**USEPA 2000, p. 5-13**	
	Construction Management	0%			$0	**USEPA 2000, p. 5-13**	
	SUBTOTAL (Additional Capital)				**$0**		
	Contractor Fees						
	ODC & Subs	5%		$ -	$ -		
	Labor	10%	max	$ -	$ -		
	SUBTOTAL				**$ -**		
	TOTAL CAPITAL COST COPR				**$0**		

Alternative 2: Basic Containment

2000	**Groundwater**						
	N/A						
	TOTAL CAPITAL COST GROUNDWATER					**$0**	
3000	**Stormwater**						
	Existing Costs to Date						
	2006 CMIPP Upgrades and IRMs (minus 13th and 15th Street Rehabilitation)	0	LS	$5,500,000		$0	Actual Cost
	SUBTOTAL					$0	
	SUBTOTAL - ALL TASKS - STORMWATER					**$0**	
	Mobilization/Demobilization	5%				$0	
	Subcontractor General Conditions	25%				$0	
	SUBTOTAL					**$0**	
	Contingency	25%				$0	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11
	SUBTOTAL					**$0**	
	Escalation to Mid-Pt	0%				$0	
	Project Management	0%				$0	**USEPA 2000, p. 5-13**
	Remedial Design	0%				$0	**USEPA 2000, p. 5-13**
	Construction Management	0%				$0	**USEPA 2000, p. 5-13**
	SUBTOTAL (Additional Capital)					**$0**	
	Contractor Fees						
	ODC & Subs	5%		$ -		$ -	
	Labor	10%	max	$ -		$ -	
	SUBTOTAL					**$ -**	
	TOTAL CAPITAL COST STORMWATER					**$0**	

Alternative 2: Basic Containment

4000	**Utilities/Structures**					
	Existing Costs to Date					
	Misc. Repairs	0	LS	$700,000	$0	Actual Cost
	Preventive Maintenance	0	MO	$40,000	$0	
	SUBTOTAL				$0	
	SUBTOTAL - ALL TASKS - UTILITIES & STRUCTURES				**$0**	
	Mobilization/Demobilization	5%			$0	
	Subcontractor General Conditions	25%			$0	
	SUBTOTAL				**$0**	
	Contingency	25%			$0	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11
	SUBTOTAL				**$0**	
	Escalation to Mid-Pt	0%			$0	
	Project Management	0%			$0	**USEPA 2000, p. 5-13**
	Remedial Design	0%			$0	**USEPA 2000, p. 5-13**
	Construction Management	0%			$0	**USEPA 2000, p. 5-13**
	SUBTOTAL				**$0**	
	Contractor Fees					
	ODC & Subs	5%		$ -	$ -	
	Labor	10%	max	$ -	$ -	
	SUBTOTAL				**$ -**	
	TOTAL CAPITAL COST UTILITIES & STRUCTURES				**$0**	
5000	**Surface Water and Sediment**					
	N/A					
	TOTAL PERIODIC COST SURFACE WATER & SEDIMENT				**$0**	

Alternative 2: Basic Containment

6000	O&M						
	O&M Surface Cover Maintenance Plan						
	Annual Inspection	2	EA	$50,000	$100,000	CH2M Historical	
	Maintenance and Repair	6	AC	$121,000	$750,200	MPA Historical	140 acres, average life of 22.5 years
	Crack Repair and Sealing	1	LS	$300,000	$300,000	MPA Historical	recent repair costs
	Stormwater IRM's	0	LS	$500,000	$0	CH2M Est.	
	Utilities - Maintenance and Repair	1	LS	$150,000	$150,000	CH2M Est.	Historical 7 events per year
	SUBTOTAL				$1,300,200		
	O&M Groundwater Plant						
	Labor	4,320	HR	$60	$259,200	CH2M Est.	
	Utilities	12	MO	$15,000	$180,000	CH2M Est.	
	Replacement Parts	1	LS	$5,000	$5,000	CH2M Allowance	
	Major Equipment Replacement	1	LS	$10,000	$10,000	CH2M Allowance	
	SUBTOTAL				$454,200		
	Compliance Monitoring and Health & Safety						
	Stormwater Monitoring	1	LS	$25,000.00	$25,000	CH2M Historical	
	Groundwater Monitoring	2	LS	$25,000.00	$50,000	CH2M Historical	
	Drinking Water Monitoring	1	LS	$50,000.00	$50,000	CH2M Historical	
	Lab Analysis	12	MO	$2,000.00	$24,000	CH2M Historical	
	Data Validation	60	HR	$100.00	$6,000	CH2M Historical	
	Reports	4	EA	$3,000.00	$12,000	CH2M Historical	
	Misc	1	LS	$5,000.00	$5,000	CH2M Historical	
	PPE Provisions for Workers (Worker-Days)	520	EA	$25.00	$13,000	CH2M Historical	
	SUBTOTAL				$185,000		
	SUBTOTAL - ALL TASKS - O & M				**$1,939,400**		
	Mobilization/Demobilization	5%			$96,970		
	Subcontractor General Conditions	25%			$484,850		
	SUBTOTAL				**$2,521,220**		
	Contingency	25%			$630,305	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$3,151,525**		
	Escalation to Mid-Pt	4%			$126,061		
	Project Management	5%			$157,576	**USEPA 2000, p. 5-13**	
	Remedial Design	8%			$252,122	**USEPA 2000, p. 5-13**	
	Construction Management	0%			$0	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$3,687,284**		
	Contractor Fees						
	ODC & Subs	5%		$ 3,277,586	$ 163,879		
	Labor	10%	max	$ 409,698	$ 40,970		
	SUBTOTAL				**$ 204,849**		
	TOTAL O&M				**$3,892,133**		

Alternative 2: Basic Containment

Periodic Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	10	1	LS	$25,000	$25,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	20	1	LS	$25,000	$25,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
				Total	$140,000	
TOTAL ANNUAL PERIODIC COST					**$140,000**	

Discount Rate = 7.0%

Source: USEPA 2000, page 4-5. This rate represents a "real" discount rate approximating interest rates

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST- Costs to Date	0	$73,380,000	$73,380,000	1.00	$73,380,000	
ANNUAL O&M COST - All Components	1 to 5	$19,460,667	$3,892,133	0.82	$15,885,701	
ANNUAL O&M COST - All Components	6 to 10	$16,541,567	$3,308,313	0.58	$9,627,343	
ANNUAL O&M COST - All Components	11 to 15	$14,060,332	$2,812,066	0.41	$5,834,538	
ANNUAL O&M COST - All Components	16 to 20	$11,951,282	$2,390,256	0.30	$3,535,953	
ANNUAL O&M COST - All Components	21 to 30	$20,317,179	$2,031,718	0.18	$3,743,424	
PERIODIC COST	1	$0	$0	0.93	$0	
PERIODIC COST	2	$0	$0	0.87	$0	
PERIODIC COST	3	$0	$0	0.82	$0	
PERIODIC COST	4	$0	$0	0.76	$0	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$40,000	$40,000	0.51	$20,334	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$40,000	$40,000	0.26	$10,337	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
					$112,058,495	
TOTAL PRESENT VALUE FOR ALTERNATIVE 2					**$112,060,000**	
Present Value Capital					**$73,380,000**	
Present Value O&M and Periodic					**$38,680,000**	
					$112,060,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2a. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA. (Includes materials, equipment, and labor)
2b. R.S. Means Company. 2007. 26th Edition.
2c. ECHOS (Environmental Cost Handling Options and Solutions). 2006. 12th Edition.
3. Historical CH2M HILL project cost information
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Alternative 3: Enhanced Isolation and Containment

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Sep-10

Description: Maintain Existing Containment Measures, Monitoring w/Contingent Remedies and Existing Institutional Controls

Capital **(2010 $)**

CAPITAL COSTS

WBS	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	Costing Basis	Assumptions
	General						
	N/A						
	TOTAL CAPITAL COST GENERAL				**$0**		
1000	**COPR**						
	Existing Costs to Date						
	Crack Repair and Sealing- To Date Costs	0	LS	$2,500,000.00	$0		
	IRM Costs to Date (Area 1800 and SRTs)	0	LS	$5,450,000.00	$0		
	SUBTOTAL				$0		
	SUBTOTAL - ALL TASKS - GENERAL & COPR				**$0**		
	Mobilization/Demobilization	5%			$0		
	Subcontractor General Conditions	10%			$0		
	SUBTOTAL				**$0**		
	Contingency	25%			$0	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$0**		
	Escalation to Mid-Pt	0%			$0		
	Project Management	0%			$0	**USEPA 2000, p. 5-13**	
	Remedial Design	0%			$0	**USEPA 2000, p. 5-13**	
	Construction Management	0%			$0	**USEPA 2000, p. 5-13**	
	SUBTOTAL (Additional Capital)				**$0**		
	Contractor Fees						
	ODC & Subs	5%		$ -	$ -		
	Labor	10%	max	$ -	$ -		
	SUBTOTAL				**$ -**		
	TOTAL CAPITAL COST COPR				**$0**		

Alternative 3: Enhanced Isolation and Containment

2000	**Groundwater**					
	N/A					
	TOTAL CAPITAL COST GROUNDWATER				**$0**	
3000	**Stormwater**					
	Existing Costs to Date					
	2006 CMIPP Upgrades and IRMs	0	LS	$11,500,000	$0	Actual Cost
	SUBTOTAL				$0	
	WWTP Upgrade					
	Upgrade WWTP Process	1	LS	$400,000	$400,000	CH2M HILL Est.
	SUBTOTAL				$400,000	
	Install IRMs on Priority Drains					
	12th Street	1	LS	$1,200,000	$1,200,000	CH2M HILL Est.
	12.5th Street	1	LS	$1,000,000	$1,000,000	CH2M HILL Est.
	13.5th Street	1	LS	$1,000,000	$1,000,000	CH2M HILL Est.
	SUBTOTAL				$3,200,000	
	Repair and Line Existing Storm Drains					
	12th Street Relining	1	LS	$1,000,000	$1,000,000	CH2M HILL Est.
	12.5th Street Relining	1	LS	$500,000	$500,000	CH2M HILL Est.
	13.5th Street Relining	1	LS	$500,000	$500,000	CH2M HILL Est.
	14th Street Relining	1	LS	$1,000,000	$1,000,000	CH2M HILL Est.
	SUBTOTAL				$3,000,000	
	Install SRT's					
	Strain Relief Trench	6,000	LF	$970	$5,820,000	Historical Cost - Dundalk Test , Assume 20% of Utility corridors
	COPR/Cont Soil T/D	20,000	TN	$200	$4,000,000	CH2M HILL Est.
	On-Site Water Management	1	LS	$1,000,000	$1,000,000	CH2M HILL Est.
	SUBTOTAL				$0	
	SUBTOTAL - ALL TASKS - STORMWATER				**$6,600,000**	
	Mobilization/Demobilization	5%			$330,000	
	Subcontractor General Conditions	25%			$1,650,000	
	SUBTOTAL				**$8,580,000**	
	Contingency	25%			$2,145,000	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11
	SUBTOTAL				**$10,725,000**	
	Escalation to Mid-Pt	8%			$858,000	
	Project Management	5%			$536,250	**USEPA 2000, p. 5-13**
	Remedial Design	6%			$643,500	**USEPA 2000, p. 5-13**
	Construction Management	6%			$643,500	**USEPA 2000, p. 5-13**
	SUBTOTAL				**$13,406,250**	

Alternative 3: Enhanced Isolation and Containment

	Contractor Fees						
	ODC & Subs	5%		$ 11,583,000	$ 579,150		
	Labor	10%	max	$ 1,823,250	$ 182,325		
	SUBTOTAL				**$ 761,475**		
	TOTAL CAPITAL COST STORMWATER				**$14,167,725**		
4000	**Utilities/Structures**						
	Existing Costs to Date						
	Misc. Repairs	0	LS	$700,000	$0	Actual Cost	
	Preventive Maintenance	0	MO	$40,000	$0		
	SUBTOTAL				$0		
	Install Isolation Drinking Water Isolation Valves						
	Drinking Water Isolation Valves	1	LS	$300,000	$300,000		
	SUBTOTAL				$300,000		
	SUBTOTAL - ALL TASKS - UTILITIES & STRUCTURES				**$300,000**		
	Mobilization/Demobilization	5%			$15,000		
	Subcontractor General Conditions	25%			$75,000		
	SUBTOTAL				**$390,000**		
	Contingency	15%			$58,500	10% Scope +5% bid contingency USEPA 2000, p.5-10 & 5-11; already bid	
	SUBTOTAL				**$448,500**		
	Escalation to Mid-Pt	4%			$17,940		
	Project Management	8%			$35,880	**USEPA 2000, p. 5-13**	
	Remedial Design	0%			$0	**Design already complete**	
	Construction Management	10%			$44,850	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$547,170**		
	Contractor Fees						
	ODC & Subs	5%		$ 466,440	$ 23,322		
	Labor	10%	max	$ 80,730	$ 8,073		
	SUBTOTAL				**$ 31,395**		
	TOTAL CAPITAL COST UTILITIES & STRUCTURES				**$578,565**		
5000	**Surface Water and Sediment**						
	N/A						
	TOTAL PERIODIC COST SURFACE WATER & SEDIMENT				**$0**		

Alternative 3: Enhanced Isolation and Containment

6000	O&M						
	O&M Surface Cover Maintenance Plan						
	Annual Inspection	2	EA	$50,000	$100,000	CH2M Historical	
	Maintenance and Repair	6	AC	$121,000	$750,200	MPA Historical	140 acres, average life of 22.5 years
	Crack Repair and Sealing	1	LS	$300,000	$300,000	MPA Historical	recent repair costs
	Stormwater IRM's	1	LS	$500,000	$500,000	CH2M Est.	
	Utilities - Maintenance and Repair	2	LS	$150,000	$300,000	CH2M Est.	Historical 7 events per year
	SUBTOTAL				$1,950,200		
	O&M Groundwater Plant						
	Labor	4,320	HR	$60	$259,200	CH2M Est.	
	Utilities	12	MO	$15,000	$180,000	CH2M Est.	
	Replacement Parts	1	LS	$5,000	$5,000	CH2M Allowance	
	Major Equipment Replacement	1	LS	$10,000	$10,000	CH2M Allowance	
		0	CY	$0	$0		
	SUBTOTAL				$454,200		
	Compliance Monitoring and Health & Safety						
	Stormwater Monitoring	1	LS	$25,000.00	$25,000	CH2M Historical	
	Groundwater Monitoring	2	LS	$25,000.00	$50,000	CH2M Historical	
	Monitoring Well Network Maintenance	1	LS	$25,000.00	$25,000	CH2M Est.	
	Drinking Water Monitoring	1	LS	$50,000.00	$50,000	CH2M Historical	
	Lab Analysis	12	MO	$2,000.00	$24,000	CH2M Historical	
	Data Validation	60	HR	$100.00	$6,000	CH2M Historical	
	Reports	4	EA	$3,000.00	$12,000	CH2M Historical	
	Misc	1	LS	$5,000.00	$5,000	CH2M Historical	
	PPE Provisions for Workers (Worker-Days)	520	EA	$25.00	$13,000	CH2M Historical	
	SUBTOTAL				$210,000		
	SUBTOTAL - ALL TASKS - O & M				**$2,614,400**		
	Mobilization/Demobilization	5%			$130,720		
	Subcontractor General Conditions	25%			$653,600		
	SUBTOTAL				**$3,398,720**		
	Contingency	25%			$849,680	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$4,248,400**		
	Escalation to Mid-Pt	4%			$169,936		
	Project Management	5%			$212,420	**USEPA 2000, p. 5-13**	
	Remedial Design	8%			$339,872	**USEPA 2000, p. 5-13**	
	Construction Management	0%			$0	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$4,970,628**		
	Contractor Fees						
	ODC & Subs	5%		$ 4,418,336	$ 220,917		
	Labor	10%	max	$ 552,292	$ 55,229		
	SUBTOTAL				**$ 276,146**		
	TOTAL O&M				**$5,246,774**		

Alternative 3: Enhanced Isolation and Containment

Periodic Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	10	1	LS	$25,000	$25,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	20	1	LS	$25,000	$25,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
				Total	$140,000	
TOTAL ANNUAL PERIODIC COST					**$140,000**	

Discount Rate = 7.0%

Source: USEPA 2000, page 4-5. This rate represents a "real" discount rate approximating interest rates

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST- Costs to Date	0	$73,380,000	$73,380,000	1.00	$73,380,000	
CAPITAL COST	2	$14,746,290	$14,746,290	0.87	$12,879,981	
ANNUAL O&M COST - All Components	1 to 5	$26,233,870	$5,246,774	0.82	$21,414,652	
ANNUAL O&M COST - All Components	6 to 10	$22,298,790	$4,459,758	0.58	$12,978,099	
ANNUAL O&M COST - All Components	11 to 15	$18,953,971	$3,790,794	0.41	$7,865,224	
ANNUAL O&M COST - All Components	16 to 20	$16,110,875	$3,222,175	0.30	$4,766,627	
ANNUAL O&M COST - All Components	21 to 30	$27,388,488	$2,738,849	0.18	$5,046,306	
PERIODIC COST	1	$0	$0	0.93	$0	
PERIODIC COST	2	$0	$0	0.87	$0	
PERIODIC COST	3	$0	$0	0.82	$0	
PERIODIC COST	4	$0	$0	0.76	$0	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$40,000	$40,000	0.51	$20,334	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$40,000	$40,000	0.26	$10,337	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
					$138,382,425	$65,002,425
TOTAL PRESENT VALUE FOR ALTERNATIVE 3					**$138,380,000**	
Present Value Capital					**$86,260,000**	
Present Value O&M and Periodic					**$52,120,000**	
					$138,380,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

2a. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA. (Includes materials, equipment, and labor)

2b. R.S. Means Company. 2007. 26th Edition.

2c. ECHOS (Environmental Cost Handling Options and Solutions). 2006. 12th Edition.

3. Historical CH2M HILL project cost information

4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Alternative 4: Partial Excavation

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Sep-10

Description: Maintain Existing Containment Measures, Partial Excavation in Heave Areas, Partial Replacement of Stormdrains, Replace Utilities, Monitoring w/Contingent Remedies and Existing Institutional Controls

Capital (2010 $)

CAPITAL COSTS

WBS	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	Costing Basis	Assumptions
	General						
	Site Establishment						
	Trailer Installation & Setup	4	EA	$2,000.00	$8,000	CCI Historical	Tie-downs, stairs, power
	Survey	400	DY	$1,500.00	$600,000	CCI Historical	
	Fencing	20000	LF	$15.00	$300,000	CCI Historical	
	Support Area Establishment and Site Offices	120	MO	$4,000.00	$480,000	CCI Historical	Includes 2 trailers, utilities, temp. lavatories
	Demo Shed 1702	1	LS	$4,130,000	$4,130,000	MRCE Estimate	350' x 100' = 35,000 sf
	Reconstruct Shed 1702	1	LS	$4,860,000	$4,860,000	MRCE Estimate	
	Demo Office Building 1600A	1	LS	$1,060,000	$1,060,000	MRCE Estimate	120' x 40' = 4800 sf
	Reconstruct Office Building 1600A	1	LS	$1,680,000	$1,680,000	CH2M Est.	Means $250/sf Structure, $100/sf equip/furni
	Demo Rail	1	LS	$270,000	$270,000	MRCE Estimate	
	Demo WWTP	1	LS	$500,000	$500,000	CH2M Est.	
	Reconstruct Rail & New Rail Sidings	1	LS	$6,190,000	$6,190,000	MRCE Estimate	
	Two Rail Transfer Stations/Dumping Boards	1	LS	$12,000,000	$12,000,000	MRCE Estimate	
	Two Truck Lining and Decon Facilities	1	LS	$2,000,000	$2,000,000	MRCE Estimate	
	SUBTOTAL				$34,078,000		
	MPA Associated Infrastructure Costs						
	MPA labor to manage rail operations	7	years	$120,000.00	$840,000	MPA Estimate	Addition of 1.5 pins
	Norfolk and Southern Rail operations	7	years	$1,950,000.00	$13,650,000	MPA Estimate	Three shifts / day @$7500 5 days/week
	MPA labor to manage construction gate	7	years	$120,000.00	$840,000	MPA Estimate	Addition of 1.5 pins
	Demo Maestek Property	1	LS	$1,800,000.00	$1,800,000	MPA Estimate	
	Road Maintenacne	7	years	$709,000.00	$4,963,000	MPA Estimate	50' X 6,000' paved area 3"mill, paving, striping
	Additional RO/RO platform	1	LS	$3,500,000.00	$3,500,000	MPA Estimate	MPA Contract No.506227
	SUBTOTAL				$25,593,000		
	Institutional Controls						
	Limit Access to Site						
	Signs	200	EA	$500.00	$100,000	CH2M Est.	
	Barricades/Temp Fencing	1	LS	$100,000	$100,000	CH2M Est.	
	SUBTOTAL				$200,000		

Alternative 4: Partial Excavation

1000	**COPR**						
	Existing Costs to Date						
	Crack Repair and Sealing- To Date Costs	0	LS	$2,500,000.00	$0		
	IRM Costs to Date	0	LS	$5,450,000.00	$0		
	SUBTOTAL				$0		
	Excavate COPR/Backfill						
	Prep Pavement	100	CD	$5,000.00	$500,000	CH2M Est.	
	Remove Improvements	100	CD	$5,000.00	$500,000	CH2M Est.	
	Install Temporary GW Discharge Pipeline	1	LS	$175,000.00	$175,000	CH2M Est.	
	Asphalt Removal	117,000	CY	$10	$1,170,000	Historical Cost - Dundalk Test Area	
	Non-COPR Soil Excavation	581,000	CY	$8	$4,648,000	Historical Cost - Dundalk Test Area	
	Excavate HB COPR	605,000	CY	$37.50	$22,687,500	MRCE Estimate	
	Excavate GB COPR	495,000	CY	$6.70	$3,316,500	MRCE Estimate	
	Operate Shallow Excavation Dewatering System	216	WK	$6,000.00	$1,296,000	CH2M Est.	
	Operate Deep Excavation Dewatering System	24	WK	$18,500.00	$444,000	CH2M Est.	Assume 10% of excavation
	Off-Site Asphalt Disposal	234,000	TN	$40	$9,360,000	Historical Cost - Dundalk Test Area	Conv factor 2 tons/cy
	Temporary Stockpile of Clean Materials	465,000	CY	$6	$2,790,000	CH2M Est.	
	Off-Site COPR/ Impacted Soil Disposal	1,751,040	TN	$200	$350,208,000	Historical Cost - Dundalk Test Area	conv factor 1.44 tons/cy
	Backfill Stockpiled Materials	465,000	CY	$12	$5,580,000	CH2M Est.	
	Imported Backfill and Compaction	1,731,200	TN	$25	$43,280,000	Historical Cost - Dundalk Test Area	Import fill 1.6 tons/cy; excludes road base
	Aggreg Rd Base	214,400	TN	$30	$6,432,000	CH2M Est.	
	Asphalt Pavement	234,000	TN	$155	$36,270,000	CH2M Est.	
	Dust Prevention, Misc	1	LS	$2,400,000.00	$2,400,000	MRCE Estimate	
	Replace Improvements	100	CD	$5,000.00	$500,000	CH2M Est.	
	Pavement Striping	1	LS	$80,000.00	$80,000	CH2M Est.	
		0	xx	$0.00	$0		
		0	xx	$0.00	$0		
	SUBTOTAL				$491,637,000		
	SUBTOTAL - ALL TASKS - GENERAL & COPR				**$551,508,000**		
	Mobilization/Demobilization	5%			$27,575,400		
	Subcontractor General Conditions	10%			$55,150,800	Historical cost includes partial markup	
	SUBTOTAL				**$634,234,200**		
	Contingency	25%			$158,558,550	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$792,792,750**		
	Escalation to Mid-Pt	17%			$134,774,768		
	Project Management	4%			$31,711,710	**USEPA 2000, p. 5-13**	Reduced guideline due to volume
	Remedial Design	5%			$39,639,638	**USEPA 2000, p. 5-13**	Reduced guideline due to volume
	Construction Management	6%			$47,567,565	**USEPA 2000, p. 5-13**	
	SUBTOTAL (Additional Capital)				**$1,046,486,430**		
	Contractor Fees						
	ODC & Subs	5%		$ 927,567,518	$ 46,378,376		
	Labor	10%	max	$ 118,918,913	$ 11,891,891		
	SUBTOTAL				**$ 58,270,267**		
	TOTAL CAPITAL COST COPR				**$1,104,756,697**		
2000	**Groundwater/Dewatering**						
	Preconstruction Investigations						
	TBD	1	LS	$30,000	$30,000	CH2M HILL Allowance	
		0	LS	$75,000	$0		
		0	LS	$150,000	$0		
	SUBTOTAL				$30,000		

Alternative 4: Partial Excavation

Hydraulic Barrier						
Hydraulic Barrier - Slurry Wall	0	SF	$12.00	$0	MRCE Estimate	
Hydraulic Barrier - Deep Slurry Wall	0	SF	$102.00	$0	MRCE Estimate	
SUBTOTAL				$0		
GW Extraction Well System/Dewatering						
Well Point System - Wells	20	EA	$2,500.00	$50,000	CH2M HILL Est	Assume 25 ft deep, 50 wells or sumps
Well Pumps/Dewatering Pumps	20	EA	$12,000.00	$240,000	CH2M HILL Est	
Deep Pump and Wells	0	EA	$14,000	$0	MRCE Estimate	
Temporary Conveyance Piping	6,000	LF	$25.00	$150,000	CH2M HILL Est	
Booster Pumps	5	EA	$8,000.00	$40,000	CH2M HILL Est	
SUBTOTAL				$480,000		
Wastewater Treatment Plant						
Tanks	2	EA	$150,000	$300,000	CH2M HILL Est	Provides 8-hrs of storage at 50gpm
Treatment Vessels	2	EA	$120,000	$240,000	CH2M HILL Est	
Pumps	6	EA	$25,000	$150,000	CH2M HILL Est	
Piping	1000	LF	$45	$45,000	CH2M HILL Est	
Electrical	1	LS	$50,000	$50,000	CH2M HILL Est	
Instrumentation	1	LS	$30,000	$30,000	CH2M HILL Est	
Chemical feed systems	2	EA	$10,000	$20,000	CH2M HILL Est	
SUBTOTAL				$835,000		
Compliance Monitoring						
Air Monitoring	0	LS	$0.00	$0		
Groundwater Monitoring	60	MO	$2,000.00	$120,000	CCI Historical	Sixty wells
Lab Analysis	60	MO	$5,000.00	$300,000	CCI Historical	Monthly
Data Validation	600	HR	$100.00	$60,000	CCI Historical	
Reports	10	EA	$2,500.00	$25,000	CCI Historical	
Misc	1	LS	$5,000.00	$5,000	CCI Historical	
SUBTOTAL				$510,000		
SUBTOTAL - ALL TASKS - GROUNDWATER				**$1,855,000**		
Mobilization/Demobilization	5%			$92,750		
Subcontractor General Conditions	25%			$463,750		
SUBTOTAL				**$2,411,500**		
Contingency	25%			$602,875	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
SUBTOTAL				**$3,014,375**		
Escalation to Mid-Pt	17%			$512,444		
Project Management	5%			$150,719	**USEPA 2000, p. 5-13**	
Remedial Design	6%			$180,863	**USEPA 2000, p. 5-13**	
Construction Management	6%			$180,863	**USEPA 2000, p. 5-13**	
SUBTOTAL				**$4,039,263**		
Contractor Fees						
ODC & Subs	5%		$ 3,526,819	$ 176,341		
Labor	10%	max	$ 512,444	$ 51,244		
SUBTOTAL				**$ 227,585**		
TOTAL CAPITAL COST GROUNDWATER/DEWATERING				**$4,266,848**		

Alternative 4: Partial Excavation

3000	**Stormwater**						
	Existing Costs to Date						
	2006 CMIPP Upgrades and IRMs	0	LS	$11,500,000	$0	Actual Cost	
	SUBTOTAL				$0		
	WWTP Upgrade/Stormwater Handling						
	Upgrade WWTP Process	1	LS	$400,000	$400,000	CH2M HILL Allowance	Additional mechanical for stormwater/decon water
	Additional Storage Capacity	1	LS	$300,000	$300,000	CH2M HILL Allowance	Additional Storage for storm/decon water
	Stormwater Pumps	4	EA	$25,000	$100,000	CH2M HILL Allowance	Portable Sump Pumps
	Temporary Piping	3000	LF	$25	$75,000	CH2M HILL Allowance	
	SUBTOTAL				$875,000		
	Relocate Storm Drains						
	12th Street Storm Drain system	1	LS	$900,000	$900,000	CH2M Est.	Excavation and backfill quantities are
	12.5th/13.5th Street Storm Drain system	1	LS	$300,000	$300,000	CH2M Est.	included in Item 1000, COPR
	13th Street Storm Drain system	1	LS	$500,000	$500,000	CH2M Est.	
	14th Street Storm Drain system	1	LS	$1,500,000	$1,500,000	CH2M Est.	
	15th Street Storm Drain system	1	LS	$2,000,000	$2,000,000	CH2M Est.	
	On-Site Stormwater Diversion	1	LS	$500,000	$500,000	Historical Cost - Dundalk Test Area	
	On-Site Water Management	0	GAL	$1.00	$0	Handled in items above	
	SUBTOTAL				$5,700,000		
	SUBTOTAL - ALL TASKS - STORMWATER				**$6,575,000**		
	Mobilization/Demobilization	5%			$328,750		
	Subcontractor General Conditions	25%			$1,643,750		
	SUBTOTAL				**$8,547,500**		
	Contingency	25%			$2,136,875	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$10,684,375**		
	Escalation to Mid-Pt	17%			$1,816,344		
	Project Management	5%			$534,219	**USEPA 2000, p. 5-13**	
	Remedial Design	6%			$641,063	**USEPA 2000, p. 5-13**	
	Construction Management	6%			$641,063	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$14,317,063**		
	Contractor Fees						
	ODC & Subs	5%		$ 12,500,719	$625,036		
	Labor	10%	max	$ 1,816,344	$181,634		
	SUBTOTAL				**$806,670**		
	TOTAL CAPITAL COST STORMWATER				**$15,123,733**		
4000	**Utilities/Structures**						
	Existing Costs to Date						
	Misc. Repairs	0	LS	$700,000	$0	Actual Cost	
	SUBTOTAL				$0		
	Install Isolation Drinking Water Isolation Valves						
	Drinking Water Isolation Valves	1	LS	$300,000	$300,000		
	SUBTOTAL				$300,000		
	Preconstruction Investigations						
	Utility Markout / Locating Service	1	LS	$25,000	$25,000	CH2M HILL Allowance	
	SUBTOTAL				$25,000		

Alternative 4: Partial Excavation

	Relocate Utilities						
	Temporary Utilities	1	LS	$1,885,000	$1,885,000	MRCE Estimate	
	80 mil LLDPE Memb	727,000	SF	$1	$727,000	CH2M Est.	Excavation and backfill quantities are
	12 geotextile	162,000	SY	$3	$405,000	CH2M Est.	included in Item 1000, COPR
	Cast-in-Place Duct Bank	5,900	CY	$350	$2,065,000	CH2M Est.	
	3-inch PVC Conduit Piping	174,000	LF	$8	$1,461,600	CH2M Est.	
	Cable	174,000	LF	$17	$2,871,000	CH2M Est.	
	12" HDPE Water Pipe	11,600	LF	$41	$475,600	CH2M Est.	
	12" HDPE Sewer Pipe	11,600	LF	$41	$475,600	CH2M Est.	
	12" pipe fittings (allow)	120	EA	$788	$94,560	CH2M Est.	
	Pipe Valves (allowance)	60	EA	$1,000	$60,000	CH2M Est.	
	4-foot-Diam, 4 ' Deep	120	EA	$3,100	$372,000	CH2M Est.	
	4' Dam, 6' Dp Manholes	48	EA	$3,600	$172,800	CH2M Est.	
	On-Site Stormwater Diversion	0	LS	$0	$0	Handled in items above	
	On-Site Water Management	0	GAL	$1.00	$0	Handled in items above	
	SUBTOTAL				$11,065,160		
	SUBTOTAL - ALL TASKS - UTILITIES & STRUCTURES				**$11,390,160**		
	Mobilization/Demobilization	5%			$569,508		
	Subcontractor General Conditions	25%			$2,847,540		
	SUBTOTAL				**$14,807,208**		
	Contingency	25%			$3,701,802	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$18,509,010**		
	Escalation to Mid-Pt	17%			$3,146,532		
	Project Management	5%			$925,451	**USEPA 2000, p. 5-13**	
	Remedial Design	6%			$1,110,541	**USEPA 2000, p. 5-13**	
	Construction Management	6%			$1,110,541	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$24,802,073**		
	Contractor Fees						
	ODC & Subs	5%		$ 21,655,542	$ 1,082,777		
	Labor	10%	max	$ 3,146,532	$ 314,653		
	SUBTOTAL				**$ 1,397,430**		
	TOTAL CAPITAL COST UTILITIES & STRUCTURES				**$26,199,504**		
5000	**Surface Water and Sediment**						
	N/A						
	TOTAL PERIODIC COST SURFACE WATER & SEDIMENT				**$0**		

Alternative 4: Partial Excavation

6000	**O&M**						
	O&M Surface Cover Maintenance Plan						
	Annual Inspection	2	EA	$50,000	$100,000	CH2M Historical	
	Maintenance and Repair	6	AC	$121,000	$750,200	MPA Historical	140 acres, average life of 22.5 years
	Crack Repair and Sealing	1	LS	$300,000	$300,000	MPA Historical	recent repair costs
	Stormwater IRM's	0	LS	$250,000	$0	CH2M Est.	
	Utilities - Maintenance and Repair	1	LS	$150,000	$150,000	CH2M Est.	Historical 7 events per year
	SUBTOTAL				$1,300,200		
	O&M Groundwater Plant						
	Labor	4,320	HR	$60	$259,200	CH2M Est.	
	Utilities	12	MO	$10,000	$120,000	CH2M Allowance	
	Sludge disposal	127	CY	$400	$50,800	CH2M Allowance	
	Chemicals	245	TN	$300	$73,500	CH2M Allowance	
	Replacement Parts	1	LS	$6,000	$6,000	CH2M Allowance	
	Major Equipment Replacement	1	LS	$12,000	$12,000	CH2M Allowance	
	SUBTOTAL				$521,500		
	Compliance Monitoring and Health & Safety						
	Groundwater Monitoring	2	LS	$25,000.00	$50,000	CCI Historical	
	Monitoring Well Network Maintenance	1	LS	$25,000.00	$25,000	CH2M Est.	
	Stormwater Monitoring	1	LS	$25,000.00	$25,000	CCI Historical	
	Drinking Water Monitoring	1	LS	$50,000.00	$50,000	CH2M Historical	
	Lab Analysis	12	MO	$1,500.00	$18,000	CCI Historical	
	Data Validation	120	HR	$100.00	$12,000	CCI Historical	
	Reports	4	EA	$3,000.00	$12,000	CCI Historical	
	Misc	1	LS	$5,000.00	$5,000	CCI Historical	
	PPE Provisions for Workers (Worker-Days)	520	EA	$25.00	$13,000		
	SUBTOTAL				$210,000		
	SUBTOTAL - ALL TASKS - O & M				**$2,031,700**		
	Mobilization/Demobilization	5%			$101,585		
	Subcontractor General Conditions	25%			$507,925		
	SUBTOTAL				**$2,641,210**		
	Contingency	25%			$660,303	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$3,301,513**		
	Escalation to Mid-Pt	4%			$132,061		
	Project Management	5%			$165,076	**USEPA 2000, p. 5-13**	
	Remedial Design	8%			$264,121	**USEPA 2000, p. 5-13**	
	Construction Management	0%			$0	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$3,862,770**		
	Contractor Fees						
	ODC & Subs	5%		$ 3,433,573	$ 171,679		
	Labor	10%	max	$ 429,197	$ 42,920		
	SUBTOTAL				**$ 214,598**		
	TOTAL O&M				**$4,077,368**		

Alternative 4: Partial Excavation

Periodic Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	10	1	LS	$25,000	$25,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	20	1	LS	$25,000	$25,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
				Total	$140,000	
TOTAL ANNUAL PERIODIC COST					**$140,000**	

Discount Rate = 7.0%

Source: USEPA 2000, page 4-5. This rate represents a "real" discount rate approximating interest rates adjusted for inflation. Annual &

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST- Costs to Date	0	$73,380,000	$73,380,000	1.00	$73,380,000	
CAPITAL COST-COPR	10	$1,109,023,545	$1,109,023,545	0.51	$563,771,334	
CAPITAL COST-STORMWATER	10	$15,123,733	$15,123,733	0.51	$7,688,139	
CAPITAL COST- UTILITIES	10	$26,199,504	$26,199,504	0.51	$13,318,499	
ANNUAL O&M COST - All Components	1 to 5	$20,386,840	$4,077,368	0.82	$16,641,734	
ANNUAL O&M COST - All Components	6 to 10	$17,328,814	$3,465,763	0.58	$10,085,527	
ANNUAL O&M COST - All Components	11 to 15	$8,664,407	$1,732,881	0.41	$3,595,421	
ANNUAL O&M COST - All Components	16 to 20	$7,364,746	$1,472,949	0.30	$2,178,963	
ANNUAL O&M COST - All Components	21 to 30	$12,520,068	$1,252,007	0.18	$2,306,812	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$40,000	$40,000	0.51	$20,334	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$40,000	$40,000	0.26	$10,337	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
		$1,290,131,655			$693,017,965	$619,637,965
TOTAL PRESENT VALUE FOR ALTERNATIVE 4					**$693,020,000**	
Present Value Capital					**$658,157,972**	
Present Value O&M and Periodic					**$34,859,993**	
					$693,017,965	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2a. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA. (Includes materials, equipment, and labor)
2b. R.S. Means Company. 2007. 26th Edition.
2c. ECHOS (Environmental Cost Handling Options and Solutions). 2006. 12th Edition.
3. Historical CH2M HILL project cost information
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Alternative 5: Full Excavation

Site: Dundalk Marine Terminal, Baltimore, MD
Media COPR
Phase: Feasibility Study
Base Year: 2011
Date: Sep-10

Description: Full Excavation

Capital (2010 $)

CAPITAL COSTS

WBS	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	Costing Basis	Assumptions
	General						
	Site Establishment/Relocate Facilities/Rail Improvements						
	Trailer Installation & Setup	4	EA	$2,000.00	$8,000	CCI Historical	Tie-downs, stairs, power
	Survey	720	DY	$1,500.00	$1,080,000	CCI Historical	
	Support Area Establishment and Site Offices	120	MO	$8,000.00	$960,000	CCI Historical	Includes 4 trailers, utilities, temp. lavatories
	Demo Shed 11	1	LS	$4,700,000	$4,700,000	MRCE Estimate	630' X 150' = 94,500SF
	Reconstruct Shed 11	1	LS	$13,670,000	$13,670,000	MRCE Estimate	
	Demo Shed 12	1	LS	$4,700,000	$4,700,000	MRCE Estimate	630' X 150' = 94,500SF
	Reconstruct Shed 12	1	LS	$13,670,000	$13,670,000	MRCE Estimate	
	Demo Shed 1702	1	LS	$4,130,000	$4,130,000	MRCE Estimate	350' x 100' = 35,000 sf
	Reconstruct Shed 1702	1	LS	$4,860,000	$4,860,000	MRCE Estimate	
	Demo Office Building 1600A	1	LS	$1,060,000	$1,060,000	MRCE Estimate	120' x 40' = 4800 sf
	Reconstruct Office Building 1600A	1	LS	$1,680,000	$1,680,000	CH2M HILL Est.	Means $250/sf Structure, $100/sf equip/furni
	Demo Rail	1	LS	$270,000	$270,000	MRCE Estimate	
	Reconstruct Rail & New Rail Sidings	1	LS	$6,190,000	$6,190,000	MRCE Estimate	
	Demo WWTP	1	LS	$500,000	$500,000	CH2M Est.	
	Two Rail Transfer Stations/Dumping Boards	1	LS	$12,000,000	$12,000,000	MRCE Estimate	
	Two Truck Lining and Decon Facilities	1	LS	$2,000,000	$2,000,000	MRCE Estimate	
	Fencing	20000	LF	$15.00	$300,000	CCI Historical	
				$0.00	$0	CCI Historical	
	SUBTOTAL				**$71,778,000**		
	MPA Associated Infrastructure Costs						
	MPA labor to manage rail operations	10	years	$120,000.00	$1,200,000	MPA Estimate	Addition of 1.5 pins
	Norfolk and Southern Rail operations	10	years	$1,950,000.00	$19,500,000	MPA Estimate	Three shifts / day @$7500 5 days/week
	MPA labor to manage construction gate	10	years	$120,000.00	$1,200,000	MPA Estimate	Addition of 1.5 pins
	Demo Maestek Property	1	LS	$1,800,000.00	$1,800,000	MPA Estimate	
	Road Maintenacne	10	years	$709,000.00	$7,090,000	MPA Estimate	50' X 6,000' paved area 3"mill, paving, striping
	Additional RO/RO platform	1	LS	$3,500,000.00	$3,500,000	MPA Estimate	MPA Contract No.506227
	SUBTOTAL				**$34,290,000**		
	Institutional Controls						
	Limit Access to Site						
	Signs	200	EA	$500.00	$100,000	CH2M Est.	
	Barricades/Temp Fencing	1	LS	$100,000	$100,000	CH2M Est.	
	SUBTOTAL				**$200,000**		

Alternative 5: Full Excavation

1000	**COPR**						
	Crack Repair and Sealing						
	Crack Repair and Sealing	50	AC	$14,375.00	$718,750	Historical Cost - Dundalk Test Area	Required due to Staging
		0	xx	$0.00	$0		Use 1/3 area
	SUBTOTAL				$718,750		
	Excavate COPR/Backfill						
	Prep Pavement	120	CD	$5,000.00	$600,000	CH2M Est.	
	Remove Improvements	120	CD	$5,000.00	$600,000	CH2M Est.	
	Steel Sheet Piling	1,761,800	SF	$49.00	$86,328,200	MRCE Estimate	
	Interlock Welding and Sealant	255,300	LF	$12.00	$3,063,600	MRCE Estimate	
	Tierods	600	EA	$1,200.00	$720,000	MRCE Estimate	
	Wales	101,800	LF	$130.00	$13,234,000	MRCE Estimate	
	Struts	39,000	LF	$142.00	$5,538,000	MRCE Estimate	
	Excavate Pavement	132,000	CY	$88.00	$11,616,000	MRCE Estimate	CH2M Hill quantity
	Excavate HB COPR	1,021,000	CY	$37.50	$38,287,500	MRCE Estimate	
	Excavate GB COPR	2,120,000	CY	$6.70	$14,204,000	MRCE Estimate	
	Excavate Non-COPR, Impacted	1,195,000	CY	$6.70	$8,006,500	MRCE Estimate	
	Excavate Non-Impacted	1,109,000	CY	$7.00	$7,763,000	CH2M Est.	
	Off-Site Asphalt Disposal	264,000	TN	$40	$10,560,000	Historical Cost - Dundalk Test Area	Conv factor 2 tons/cy
	T&D- COPR	4,523,040	TN	$200.00	$904,608,000	CH2M HILL Historical	conv factor 1.44 tons/cy
	T&D- Non-COPR, Impacted	1,720,800	TN	$200.00	$344,160,000	CH2M HILL Historical	conv factor 1.44 tons/cy
	T&D- Non-Haz	0	TN	$40.00	$0	CH2M HILL Historical	
	Stockpile, reuse Non-Impacted (soil only)	1,109,000	CY	$6.00	$6,654,000	CH2M Est.	
	Dust Prevention, Misc	1	LS	$2,400,000.00	$2,400,000	MRCE Estimate	
	Backfill and Compaction	6,937,600	TN	$25.00	$173,440,000	CH2M HILL Historical	Conv factor 1.6 tons/cy
	Backfill and Compaction, Stockpiled Material	1,109,000	CY	$12.00	$13,308,000	CH2M HILL Historical	
	Asphalt Pavement	264,000	TN	$155.00	$40,920,000	CH2M HILL Historical	Conv factor 2 tons/cy
	Replace Improvements	120	CD	$5,000.00	$600,000	CH2M Est.	
	Pavement Striping	1	LS	$80,000.00	$80,000	CH2M Est.	
		0	xx	$0.00	$0		
		0	xx	$0.00	$0		
	SUBTOTAL				$1,686,690,800		
	SUBTOTAL - ALL TASKS - GENERAL & COPR				**$1,793,677,550**		
	Mobilization/Demobilization	2%	Base Const Cost	$669,790,000	$13,395,800	Const. Cost + 10% T&D	
	Subcontractor General Conditions	10%		$669,790,000	$66,979,000	Historical cost includes partial markup	
	SUBTOTAL				**$1,874,052,350**		
	Contingency	15%			$281,107,853	5% Scope + 10% Bid	
	SUBTOTAL				**$2,155,160,203**		
	Escalation to Mid-Pt	17%			$366,377,234	5 years @ 3%	
	Project Management	4%			$86,206,408	**USEPA 2000, p. 5-13**	Reduced guideline due to volume
	Remedial Design	5%			$107,758,010	**USEPA 2000, p. 5-13**	Reduced guideline due to volume
	Construction Management	6%		$669,790,000	$40,187,400	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$2,755,689,255**		
	Contractor Fees						
	ODC & Subs	5%		$993,500,000	$49,675,000		
	Labor	10%	max	$234,151,818	$23,415,182		
	SUBTOTAL				**$73,090,182**		
	TOTAL CAPITAL COST COPR				**$2,828,779,437**		

Alternative 5: Full Excavation

2000	**Groundwater/Dewatering**					
	Preconstruction Investigations					
	TBD	1	LS	$150,000	$150,000	CH2M HILL Allowance	
	SUBTOTAL				$150,000		
	Hydraulic Barrier					
	Hydraulic Barrier - Slurry Wall	770,200	SF	$12.00	$9,242,400	MRCE Estimate	Excavation and backfill quantities are
	Hydraulic Barrier - Deep Slurry Wall	244,300	SF	$102.00	$24,918,600	MRCE Estimate	included in Item 1000, COPR
	SUBTOTAL				$34,161,000		
	GW Extraction Well System/Dewatering						
	Well Point System - Wells	50	EA	$2,500.00	$125,000	CH2M HILL Est	Assume 25 ft deep, 50 wells or sumps
	Well Pumps/Dewatering Pumps	50	EA	$12,000.00	$600,000	CH2M HILL Est	
	Deep Pump and Wells	10	EA	$14,000	$140,000	MRCE Estimate	
	Temporary Conveyance Piping	12,000	LF	$25.00	$300,000	CH2M HILL Est	
	Booster Pumps	5	EA	$8,000.00	$40,000	CH2M HILL Est	
	SUBTOTAL				$1,205,000		
	<u>**Wastewater Treatment Plant**</u>						
	Tanks	4	EA	$150,000	$600,000	CH2M HILL Est	Provides 8-hrs of storage at 50gpm
	Treatment Vessels	4	EA	$120,000	$480,000	CH2M HILL Est	
	Pumps	12	EA	$25,000	$300,000	CH2M HILL Est	
	Piping	2000	LF	$45	$90,000	CH2M HILL Est	
	Electrical	1	LS	$200,000	$200,000	CH2M HILL Est	
	Instrumentation	1	LS	$150,000	$150,000	CH2M HILL Est	
	Chemical feed systems	2	EA	$10,000	$20,000	CH2M HILL Est	
	SUBTOTAL				$1,840,000		
	Compliance Monitoring						
	Air Monitoring	0	LS	$0.00	$0		
	Groundwater Monitoring	84	MO	$2,000.00	$168,000	CCI Historical	Sixty wells
	Lab Analysis	84	MO	$5,000.00	$420,000	CCI Historical	Monthly
	Data Validation	840	HR	$100.00	$84,000	CCI Historical	
	Reports	16	EA	$2,500.00	$40,000	CCI Historical	
	Misc	1	LS	$5,000.00	$5,000	CCI Historical	
	SUBTOTAL				$717,000		
	SUBTOTAL - ALL TASKS - GROUNDWATER				**$38,073,000**		
	Mobilization/Demobilization	5%			$1,903,650		
	Subcontractor General Conditions	25%			$9,518,250		
	SUBTOTAL				**$49,494,900**		
	Contingency	25%			$12,373,725	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$61,868,625**		
	Escalation to Mid-Pt	17%			$10,517,666		
	Project Management	5%			$3,093,431	**USEPA 2000, p. 5-13**	
	Remedial Design	6%			$3,712,118	**USEPA 2000, p. 5-13**	
	Construction Management	6%			$3,712,118	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$82,903,958**		
	Contractor Fees						
	ODC & Subs	5%		$ 72,386,291	$ 3,619,315		
	Labor	10%	max	$ 10,517,666	$ 1,051,767		
	SUBTOTAL				**$ 4,671,081**		
	TOTAL CAPITAL COST GROUNDWATER				**$87,575,039**		

Alternative 5: Full Excavation

3000	**Stormwater**						
	Existing Costs to Date						
	2006 CMIPP Upgrades and IRMs	0	LS	$11,500,000	$0	Actual Cost	
	SUBTOTAL				$0		
	Preconstruction Investigations						
	Utility Markout / Locating Service	1	LS	$30,000	$30,000	CH2M HILL Allowance	
	SUBTOTAL				$30,000		
	WWTP Upgrade/Stormwater Handling						
	Upgrade WWTP Process	1	LS	$400,000	$400,000	CH2M HILL Allowance	Additional mechanical for stormwater/decon water
	Additional Storage Capacity	1	LS	$300,000	$300,000	CH2M HILL Allowance	Additional Storage for storm/decon water
	Stormwater Pumps	4	EA	$25,000	$100,000	CH2M HILL Allowance	Portable Sump Pumps
	Temporary Piping	3000	LF	$25	$75,000	CH2M HILL Allowance	
	SUBTOTAL				$875,000		
	Replace Remaining Storm Drains						
	15th Street Storm Drain system	11000	LF	$220	$2,420,000	MRCE Estimate	
	14th Street Storm Drain system	3100	LF	$220	$682,000	MRCE Estimate	
	13.5th Street Storm Drain system	800	LF	$160	$128,000	MRCE Estimate	
	13th Street Storm Drain system	2200	LF	$220	$484,000	MRCE Estimate	
	12.5th Street Storm Drain system	800	LF	$160	$128,000	MRCE Estimate	
	12th Street Storm Drain system	1800	LF	$220	$396,000	MRCE Estimate	
	11.5th Street Storm Drain system	800	LF	$160	$128,000	MRCE Estimate	
	11th Street Storm Drain system	1850	LF	$220	$407,000	MRCE Estimate	
	Manholes/Vaults	60	EA	$8,000	$480,000	CH2M Est.	
	Abandon Existing Main Storm Drains	22350	LF	$50	$1,117,500	CH2M Est.	
	Operate Dry Weather Flow	36	MO	$32,000	$1,152,000	CH2M Est.	
		1	LS	$0	$0		
	SUBTOTAL				$7,522,500		
	Compliance Monitoring						
	Air Monitoring	0	LS	$0.00	$0		
	Stormwater Monitoring	10	YR	$6,000.00	$60,000	CCI Historical	
	Lab Analysis	120	MO	$1,500.00	$180,000	CCI Historical	Monthly
	Data Validation	1200	HR	$100.00	$120,000	CCI Historical	
	Reports	24	EA	$2,500.00	$60,000	CCI Historical	
	Misc	1	LS	$5,000.00	$5,000	CCI Historical	
	SUBTOTAL				$425,000		
	SUBTOTAL - ALL TASKS - STORMWATER				**$8,427,500**		
	Mobilization/Demobilization	5%			$421,375		
	Subcontractor General Conditions	25%			$2,106,875		
	SUBTOTAL				**$10,955,750**		
	Contingency	25%			$2,738,938	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$13,694,688**		
	Escalation to Mid-Pt	17%			$2,328,097		
	Project Management	5%			$684,734	**USEPA 2000, p. 5-13**	
	Remedial Design	6%			$821,681	**USEPA 2000, p. 5-13**	
	Construction Management	6%			$821,681	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$18,350,881**		
	Contractor Fees						
	ODC & Subs	5%		$ 16,022,784	$ 801,139		
	Labor	10%	max	$ 2,328,097	$ 232,810		
	SUBTOTAL				**$ 1,033,949**		
	TOTAL CAPITAL COST STORMWATER				**$19,384,830**		

Alternative 5: Full Excavation

4000	Utilities/Structures	Quantity	Unit	Unit Cost	Cost	Source	Notes
	Preconstruction Investigations						
		0	LS	$25,000	$0		
	Utility Markout / Locating Service	1	LS	$35,000	$35,000	CH2M HILL Allowance	
	SUBTOTAL				$35,000		
	Install Isolation Drinking Water Isolation Valves						
	Drinking Water Isolation Valves	1	LS	$300,000	$300,000		
	SUBTOTAL				$300,000		
	Relocate Utilities						
	Temporary Utilities	1	LS	$1,885,000	$1,885,000	MRCE Estimate	
	Cast-in-Place Duct Bank	5,900	CY	$350	$2,065,000	CH2M Est.	Staged with COPR excavation
	3-inch PVC Conduit Piping	174,000	LF	$8	$1,461,600	CH2M Est.	Excavation and backfill quantities are
	Cable	174,000	LF	$17	$2,871,000	CH2M Est.	included in Item 1000, COPR
	12" HDPE Water Pipe	11,600	LF	$41	$475,600	CH2M Est.	
	12" HDPE Sewer Pipe	11,600	LF	$41	$475,600	CH2M Est.	
	12" pipe fittings (allow)	120	EA	$788	$94,560	CH2M Est.	
	Pipe Valves (allowance)	60	EA	$1,000	$60,000	CH2M Est.	
	4-foot-Diam, 4 ' Deep	120	EA	$3,100	$372,000	CH2M Est.	
	4' Dam, 6' Dp Manholes	48	EA	$3,600	$172,800	CH2M Est.	
	SUBTOTAL				$9,933,160		
	Install SRT's						
	Strain Relief Trench	0	LF	$860	$0	Historical Cost - Dundalk Test Area	Assume 20% of Utility corridors
	SUBTOTAL				$0		
	Offsite Treatment / Disposal						
	Off-Site Waste Management - Soil	0	TN	$120	$0	CH2M Est.	Soil from Utilities and SRT
	On-Site Waste Management - Water	0	GAL	$1	$0	CH2M Est.	
	Off-site Disposal of Contaminated Water	0	GAL	$2	$0	Dewatering of Excavated Soil & Trench Dewatering & Decon Water	
	SUBTOTAL				$0		
	SUBTOTAL - ALL TASKS - UTILITIES & STRUCTURES				**$10,268,160**		
	Mobilization/Demobilization	5%			$513,408		
	Subcontractor General Conditions	25%			$2,567,040		
	SUBTOTAL				**$13,348,608**		
	Contingency	25%			$3,337,152	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
	SUBTOTAL				**$16,685,760**		
	Escalation to Mid-Pt	17%			$2,836,579		
	Project Management	5%			$834,288	**USEPA 2000, p. 5-13**	
	Remedial Design	6%			$1,001,146	**USEPA 2000, p. 5-13**	
	Construction Management	6%			$1,001,146	**USEPA 2000, p. 5-13**	
	SUBTOTAL				**$22,358,918**		
	Contractor Fees						
	ODC & Subs	5%		$ 19,522,339	$ 976,117		
	Labor	10%	max	$ 2,836,579	$ 283,658		
	SUBTOTAL				**$ 1,259,775**		
	TOTAL CAPITAL COST UTILITIES & STRUCTURES				**$23,618,693**		

Alternative 5: Full Excavation

5000	Surface Water and Sediment					
	Preconstruction Investigations					
	Sediment Removal	0	LS	$25,000	$0	
	SWWP	0	LS	$20,000	$0	
		0	LS	$0	$0	
		0	LS	$0	$0	
	SUBTOTAL				$0	
	Offsite Treatment / Disposal					
	On-Site Waste Management - Soil	0	TN	$120	$0	
	On-Site Waste Management - Water	0	GAL	$1	$0	
	Off-site Disposal of Contaminated Water	0	GAL	$1	$0	
	Off-site Disposal of Soil	0	TN	$205	$0	
	Off-site Disposal of Municipal Waste	0	CY	$130	$0	
	SUBTOTAL				$0	
	Compliance Monitoring					
	Air Monitoring	0	LS	$0.00	$0	
	Groundwater Monitoring	0	LS	$60,000.00	$0	
	Lab Analysis	0	MO	$1,500.00	$0	
	Data Validation	0	HR	$100.00	$0	
	Reports	0	EA	$2,500.00	$0	
	Misc	0	LS	$5,000.00	$0	
		0	EA	$0.00	$0	
	SUBTOTAL				$0	
	SUBTOTAL - ALL TASKS - SURFACE WATER & SEDIMENT				**$0**	
	Mobilization/Demobilization	5%			$0	
	Subcontractor General Conditions	10%			$0	
	SUBTOTAL				**$0**	
	Contingency	25%			$0	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11
	SUBTOTAL				**$0**	
	Escalation to Mid-Pt	8%			$0	
	Project Management	6%			$0	**USEPA 2000, p. 5-13**
	Remedial Design	12%			$0	**USEPA 2000, p. 5-13**
	Construction Management	8%			$0	**USEPA 2000, p. 5-13**
	SUBTOTAL				**$0**	
	Contractor Fees					
	ODC & Subs	5%		$ -	$ -	
	Labor	10%	max	$ -	$ -	
	SUBTOTAL				**$ -**	
	TOTAL CAPITAL COST SURFACE WATER & SEDIMENT				**$0**	

Alternative 5: Full Excavation

6000	**O&M**					
O&M						
Surface Cover Maintenance Plan						
Annual Inspection	2	EA	$50,000	$100,000	CH2M Historical	
Maiantenance and Repari	6	AC	$121,000	$750,200	MPA Historical	140 acres, average life of 22.5 years
Crack Repair and Sealing	1	LS	$300,000	$300,000	MPA Historical	recent repair costs
Utilities Repair and Mint	1	LS	$150,000	$150,000		
Stormwater IRM's	0	LS	$250,000	$0	CH2M Est.	
SUBTOTAL				$1,300,200		
O&M Groundwater Plant						
	0	YR	$0	$0		
Labor	4,320	HR	$60	$259,200	CH2M Est.	
Utilities	12	MO	$20,000	$240,000	CH2M Allowance	
Sludge disposal	1,746	CY	$400	$698,400	CH2M Allowance	
Chemicals	3,471	TN	$300	$1,041,300	CH2M Allowance	
Replacement Parts	1	LS	$10,000	$10,000	CH2M Allowance	
Major Equipment Replacement	1	LS	$15,000	$15,000	CH2M Allowance	
Misc Supplies	12	MO	$4,000	$48,000	CH2M Allowance	
SUBTOTAL				$2,311,900		
Compliance Monitoring and Health & Safety						
Groundwater Monitoring	2	LS	$25,000.00	$50,000	CCI Historical	
Stormwater Monitoring	1	LS	$25,000.00	$25,000	CCI Historical	
Drinking Water Monitoring	1	LS	$50,000.00	$50,000	CH2M Historical	
Lab Analysis	12	MO	$4,000.00	$48,000	CCI Historical	
Data Validation	120	HR	$100.00	$12,000	CCI Historical	
Reports	4	EA	$3,000.00	$12,000	CCI Historical	
Misc	1	LS	$5,000.00	$5,000	CCI Historical	
PPE Provisions for Workers (Worker-Days)	520	EA	$25.00	$13,000		
SUBTOTAL				$215,000		
SUBTOTAL - ALL TASKS - O & M				**$3,827,100**		
Mobilization/Demobilization	5%			$191,355		
Subcontractor General Conditions	25%			$956,775		
SUBTOTAL				**$4,975,230**		
Contingency	25%			$1,243,808	10% Scope + 15% Bid, USEPA 2000, p.5-10 & 5-11	
SUBTOTAL				**$6,219,038**		
Escalation to Mid-Pt	4%			$248,762		
Project Management	6%			$373,142	**USEPA 2000, p. 5-13**	
Remedial Design	12%			$746,285	**USEPA 2000, p. 5-13**	
Construction Management	0%			$0	**USEPA 2000, p. 5-13**	
SUBTOTAL				**$7,587,226**		
Contractor Fees						
ODC & Subs	5%		$ 6,467,799	$ 323,390		
Labor	10%	max	$ 1,119,427	$ 111,943		
SUBTOTAL				**$ 435,333**		
TOTAL O&M				**$8,022,558**		

Alternative 5: Full Excavation

Periodic Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review & Surface Water	5	1	LS	$15,000	$15,000	
5 year Review & Surface Water	10	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	10	1	LS	$25,000	$25,000	
5 year Review & Surface Water	15	1	LS	$15,000	$15,000	
5 year Review & Surface Water	20	1	LS	$15,000	$15,000	
Reapplication for NPDS Permit	20	1	LS	$25,000	$25,000	
5 year Review & Surface Water	25	1	LS	$15,000	$15,000	
5 year Review & Surface Water	30	1	LS	$15,000	$15,000	
				Total	$140,000	
TOTAL ANNUAL PERIODIC COST					**$140,000**	

Discount Rate = 7.0%

Source: USEPA 2000, page 4-5. This rate represents a "real" discount rate approximating interest rates adjusted for inflation. Annual &

PRESENT VALUE ANALYSIS

COST TYPE	YEAR		TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST to date	0	$73,380,000	$73,380,000	1.00	$73,380,000	
ANNUAL O&M COST	1 to 5	$40,112,792	$8,022,558	0.82	$32,892,489	
ANNUAL O&M COST	6 to 10	$34,095,873	$6,819,175	0.58	$19,775,606	
ANNUAL O&M COST	11 to 13	$14,490,746	$4,830,249	0.41	$5,941,206	
CAPITAL STORMWATER	13	$19,384,830	$19,384,830	0.41	$8,044,015	
CAPITAL COST-GW	13	$87,575,039	$87,575,039	0.41	$36,340,528	
PERIODIC COST	6	$15,000	$15,000	0.67	$9,995	
CAPITAL COST-COPR,	13	$2,828,779,437	$2,828,779,437	0.41	$1,173,842,897	
CAPITAL COST- UTILITIES	13	$23,618,693	$23,618,693	0.41	$9,800,918	
PERIODIC COST	10	$40,000	$40,000	0.51	$20,334	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$40,000	$40,000	0.26	$10,337	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
		$3,121,577,410	$3,121,577,410		$1,360,068,497	$1,286,688,497
TOTAL PRESENT VALUE FOR ALTERNATIVE 5					**$1,360,070,000**	
Present Value Capital					**$1,301,408,358**	
Present Value O&M and Periodic					**$58,660,138**	
					$1,360,068,497	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

2a. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA. (Includes materials, equipment, and labor)

2b. R.S. Means Company. 2007. 26th Edition.

2c. ECHOS (Environmental Cost Handling Options and Solutions). 2006. 12th Edition.

3. Historical CH2M HILL project cost information

4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Appendix B
Groundwater Modeling of Rehabilitated Storm Drains

Model Simulations of Storm Drain Relining, Dundalk Marine Terminal Baltimore, Maryland

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January 2011

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SECTION 1

Introduction

One of the corrective measures being considered for the Dundalk Marine Terminal (DMT) is relining selected storm drains that may be subject to infiltration of groundwater contaminated with hexavalent chromium Cr(VI). Two of the storm drains, those on 13th Street and 15th Street, are presently in the process of being relined, and additional drains may be relined in the future. The purpose of this memorandum is to report the results of a groundwater modeling investigation of the potential effects of storm drain relining on shallow groundwater elevations, groundwater flow, and Cr(VI) transport to the Patapsco River.

This groundwater model calculates the transport of hexavalent chromium from the site assuming no retardation or reduction of hexavalent chromium that occurs in the aquifer. Geochemical evidence collected at DMT as part of the Chromium Transport Study demonstrates that hexavalent chromium reduction to trivalent chromium occurs rapidly as the groundwater leaves the main COPR fill area. Therefore the model depicts the most conservative representation of hexavalent chromium transport calculations.

The modeling was performed using the groundwater flow model developed for the DMT Chromium Transport Study (CTS) and documented in Appendix B of that document. It is a three-layer finite-difference model, in which the upper layer represents the shallow fill aquifer. It includes the hydraulic effects of the submerged portions of the storm drains by including them as boundary conditions with invert elevations based on field survey data and leakage coefficients based on model calibration to field observations of dry-weather flow in the pipes. Calibration of the model was also based on measured groundwater levels in numerous monitoring wells and piezometers installed in the shallow fill aquifer and in two underlying flow zones. The groundwater levels that have been measured in several monitoring rounds in the past four years have always been influenced to some extent by leakage into the storm drains. At present, the extent to which shallow groundwater levels and flow patterns would differ from past observations if the storm drains did not leak can only be estimated using the model.

This modeling investigation consisted of four simulation scenarios that compared the effects of different levels of storm drain relining. The scenarios were as follows:

- Scenario 1—current groundwater conditions with no storm drain relining
- Scenario 2—relining of the 13th Street and 15th Street storm drains (currently in progress)
- Scenario 3—relining of the 13th, 14th, and 15th Street storm drains
- Scenario 4—relining of all the "priority" storm drains (12th , 12.5th, 13th, 13.5th, 14th, and 15th Streets)

For each of the scenarios it was assumed that relining would be 100-percent effective, and the calibrated drain leakage coefficients in the model were set to zero for the affected drains. The results of each scenario were examined in the following ways:

- Plotting contour maps of the simulated water-table elevations.
- Plotting contour maps of the changes in water-table elevations for Scenarios 2 through 4 relative to the current conditions simulated in Scenario 1.
- Tracking simulated water particles backwards and forwards from selected starting locations in the shallow fill aquifer.
- Calculating simulated mass flux of Cr(VI) dissolved in the shallow-aquifer groundwater into the Patapsco River using the most recent available water-quality sampling results from monitoring wells positioned along the river bank.

These results are presented in figures and tables so that the estimated effects of different levels of storm drain relining can be directly compared.

SECTION 2

Scenarios

2.1 Scenario 1—Current Conditions

This scenario is the same as the groundwater and storm drain flow regime used to calibrate the groundwater model, as documented in the CTS. It corresponds approximately to groundwater elevations that were measured at the DMT on June 2, 2009. The calibrated model simulated the water levels measured on that date in 88 shallow aquifer wells quite accurately, with the standard deviation of the model residuals being less than 0.25 feet and a mean residual of less than 0.01 feet. The simulated rates of groundwater leakage into storm drains were also within the range of measured values in those drains where field measurements were available.

Among other things, Figure 1 shows contours of the simulated water table elevations for this scenario. Drawdown of the water table along the 13th, 14th, and 15th Street storm drains is clearly shown. The simulated rates of groundwater leakage into the drains were 12.7 gallons per minute (gpm) at 13th Street, 18 gpm at 14th Street, and 22 gpm for the 15th Street drain.

Figure 1 also shows the flow paths followed by water particles migrating as dictated by the simulated flow vector field. An assumed effective porosity of 0.25 was used in calculating migration velocities. Most of these simulated particles were placed into the flow field at the screens of shallow aquifer monitoring wells located either near the Patapsco River bank or between the river and the COPR fill. From each of these locations, particles were tracked both upgradient toward their points of recharge or downgradient toward their discharge locations. Downgradient particle tracks were terminated after 100 years of simulated migration. A few additional particles were started at locations inside the COPR fill area that did not correspond to monitoring wells. These particles were only tracked downgradient in the direction of flow. Each of the particle tracks have blue travel-time marks indicating the distance covered in 5 years of migration, either upgradient or downgradient. Note that the simulation was quasi-three-dimensional and that particles released in the top layer of the model may move between layers through the semi-confining units that separate them. This often results in sharp bends in the vertically projected path lines and in zones where the travel-time marks are closely spaced.

Figure 1 shows that most of the particles that were released outside the COPR fill in the western part of the site migrated to the river through the bulkhead. Particles started at monitoring wells next to the bulkhead discharged to the river through the bulkhead either in the shallow aquifer (Layer 1) or the alluvial sands (Layer 2). Travel times for the particles penetrating the bulkhead in Layer 1 were less than 5 years, but those that migrated downward into Layer 2 required up to 20 years to pass through the bulkhead. Particles tracked backward from these starting locations reached the COPR fill area in less than 30 years of travel. For particles started approximately half way between the COPR fill and the river, the backward travel time to the fill was less than 5 years. These starting locations correspond to wells that have been sampled without detecting Cr(VI) above 5 micrograms per liter (µg/L). The four particles started at locations within the COPR fill all discharged to leaking storm drains.

Table 1 shows the calculated mass discharge of Cr(VI) from the shallow fill aquifer to the Patapsco River for the Scenario 1 simulation. The mass flux calculations were performed using the simulated volumetric flux of groundwater through 15 segments of the river bank in combination with Cr(VI) concentrations measured at monitoring wells spaced along the river bank. The same calculations were presented in the CTS, which includes a figure showing the river-bank segments and monitoring wells (CTS Figure 6-1). For Scenario 1 flow conditions, the simulated shallow groundwater flux through approximately 6500 feet of river bank was approximately 18.55 gpm. When combined with the measured Cr(VI) concentrations from 14 shallow monitoring wells near the river, the estimated Cr(VI) mass flux was approximately 2 grams per day, or 1.6 pounds per year. Note that the sampled concentrations at all but three of the wells were less than the 5 µg/L detection limit. A concentration of half the detection limit was used for these non-detect wells in the flux calculations.

2.2 Scenario 2—Relining 13th and 15th Street Storm Drains

Figure 2 shows the simulated water table elevations and particle tracks for the case in which leakage to the 13th Street and 15th Street drains has been eliminated by relining. Figure 3 shows the simulated rise in the water table caused by relining these drains. Along the 13th Street drain the water table rises by as much as 2.8 feet; however, along most of the drain the rise is less than 2 feet.

Along the 15th Street drain the simulated rise in the water table is up to 5 feet. However, it should be mentioned that the maximum increase occurs at the site boundary, which is also the boundary of the model. To run this simulation, it was necessary to estimate the change in model boundary conditions that would occur when drawdown from leakage to the 15th Street drain was eliminated. This was performed by smoothing the distribution of boundary head values in the area that appeared to be affected by drawdown from the 15th Street drain. Hence, the estimated 5 feet of water table rise at the boundary is based on hydrogeologic judgment rather than calculation by the calibrated model.

The particle tracks shown in Figure 2 can be compared with those in Figure 1 to see the effects of the changed flow pattern caused by lining the 14th and 15th Street drains. In the western part of the site, the changes are minimal. In the east, the velocity of flow from the 15th Street area toward the river was slightly increased, as indicated by the greater distances between 5-year travel-time marks.

Table 2 shows the calculated groundwater and Cr(VI) discharges to the river for this scenario. Groundwater discharge to the river from the shallow aquifer was increased from 18.55 to 22.23 gpm. Mass flux of Cr(VI) discharging to the river from the shallow aquifer increased from 1.6 to 2.09 pounds per year.

Elimination of groundwater leakage into the 13th and 15th Street storm drains changed the simulated water balance by removing approximately 33 gpm of outflow from the top layer of the model (Layer 1) to those drains. The resulting increases in water-table elevation produced the following changes in the shallow aquifer water budget:

- Groundwater leakage to the remaining un-lined drains increased by approximately 6 gpm, most of which was intercepted by the 14th Street drain.
- Groundwater flow to the river in Layer 1 increased by approximately 4 gpm (see Table 1 and Table 2).
- Downward flow from Layer 1 to Layer 2 (the alluvial sands) increased by approximately 15 gpm. (Deep downward flow to the Patapsco Aquifer increased by only 0.15 gpm.)
- The net horizontal inflow of shallow groundwater from outside the model area decreased by approximately 8 gpm.

2.3 Scenario 3—Relining 13th, 14th, and 15th Street Storm Drains

The simulated flow conditions in the shallow aquifer for relining Scenario 3 are shown on Figure 4. The pattern of shallow groundwater flow in the area between 13th Street and 15th Street is significantly changed in this scenario because of the substantial volumes of estimated leakage into the 14th Street drain prior to lining (18 gpm in Scenario 1 and 24 gpm in Scenario 2). In Scenario 1, the 14th Street drain captured shallow groundwater as far west as 13.5th Street and from beyond 15th Street in the east. In Scenario 2, the capture zone of the 14th Street drain extended westward as far as 13th Street. Under Scenario 3, with the 14th Street storm also relined, the simulated hydraulic gradients on the west side of 14th Street reversed, and groundwater from the area that was previously being captured flowed to the west and south.

Figure 5 shows contours of the simulated rise in the water table, comparing the relining of the 13th, 14th, and 15th Street drains with the current (model calibration) flow conditions. Along 13th Street, the typical rise was increased from approximately 1.8 feet in Scenario 2 to approximately 3 feet in Scenario 3. Along 14th Street the rise in the water table was typically 3.8 to 4 feet. Along 15th Street, the simulated water-table rise was 3 to 5 feet.

Comparing the simulated particle tracks on Figure 4 with those on Figure 2, the most obvious differences are in the area of 14th Street. Particles near 14th Street, which were previously captured by the leaking 14th Street storm drain, flow to the west and discharge through the sheet-pile bulkhead. In other areas of the site, travel velocities are increased relative to the Scenario 2 flows, as indicated by the slightly greater distances between the 5-year travel-time marks.

Table 3 shows the calculations of groundwater discharge and Cr(VI) mass flux from the shallow aquifer to the river for Scenario 3. In this scenario, the shallow groundwater discharge to the river increased to approximately 24.31 gpm and the mass flux of dissolved Cr(VI) to 2.28 pounds per year.

The rate of simulated groundwater leakage to the 13th, 14th, and 15th Street drains under calibrated flow conditions (Scenario 1) totaled approximately 51 gpm. When this leakage was eliminated in Scenario 3, the water budget for the shallow aquifer changed, compared to Scenario 1, in the following ways:

- Total leakage to the remaining un-lined drains increased by approximately 1 gpm.
- Shallow groundwater flow to the river increased by approximately 6 gpm (see Tables 1 and 3).
- Downward flow from Layer 1 to Layer 2 increased by approximately 24 gpm. (The increase in deep vertical flow to the Patapsco Aquifer was only 0.3 gpm)
- The net horizontal inflow from outside the model decreased by approximately 20 gpm.

2.4 Scenario 4—All Priority Drains Relined

In this scenario, simulated groundwater leakage to the 12th, 12.5th, 13th, 13.5th, 14th, and 15th Street storm drains was eliminated by setting the leakage coefficients to zero. Figure 6 shows the simulated water-table elevations and particle tracks for this simulation. The flow condition is very similar to Scenario 3, differing only in that the water table is slightly higher. Figure 7 shows the simulated water-table rise for this scenario compared to Scenario 1. Compared with the corresponding figure for Scenario 3 (Figure 5), the increase in water-table rise is generally less than 0.2 feet.

Table 4 shows the calculations of groundwater discharge and Cr(VI) mass flux from the shallow aquifer to the Patapsco River. Groundwater flow to the from the shallow aquifer to the river increased to approximately 24.53 gpm, and Cr(VI) mass flux increased to approximately 2.29 pounds per year. The flow and concentration differ very little from the estimates for Scenario 3.

Total simulated groundwater leakage to all of the priority drains in Scenario 1 (calibration conditions) was approximately 53 gpm. When this flow was eliminated by the storm drain relining simulated in Scenario 4, the shallow water budget changed in comparison to Scenario 1 as follows:

- Total groundwater leakage to the remaining un-lined storm drains, mainly along 10th and 11th Streets increased by slightly more than 1 gpm.
- Shallow groundwater discharge to the river increased by approximately 6 gpm (see Table 1 and Table 4).
- Downward flow from Layer 1 to Layer 2 increased by approximately 25 gpm. (The increase in deep vertical flow to the Patapsco Aquifer was only 0.3 gpm)
- The net horizontal inflow from outside the model decreased by approximately 21 gpm.

Table 1: Scenario 1—Prelining Flow Conditions
Calculation of Chrome-VI Discharge to River via Groundwater Transport in the Shallow Aquifer

GW Flux to River			Zone Boundary Wells				Mass Flux		
Flow Zone	cfd	gpm	Well	Conc (ug/l)	Well	Conc (ug/l)	g/day	lbs/day	lbs/yr
1	61.498	0.32	DMT-42S	2.5	DMT-42S	2.5	0.00435	0.00001	0.00351
2	141.21	0.73	DMT-42S	2.5	DMT-17S	2.5	0.01000	0.00002	0.00805
3	877.4	4.56	DMT-17S	2.5	EA-11S	2.5	0.06211	0.00014	0.05002
4	483.6	2.51	EA-11S	2.5	DMT-31S	2.5	0.03424	0.00008	0.02757
5	57.722	0.30	DMT-31S	2.5	DMT-16S	2.5	0.00409	0.00001	0.00329
6	81.833	0.43	DMT-16S	2.5	DMT-32S	2.5	0.00579	0.00001	0.00466
7	146.97	0.76	DMT-32S	2.5	DMT-15S	2.5	0.01040	0.00002	0.00838
8	194.55	1.01	DMT-15S	2.5	DMT-14S	2.5	0.01377	0.00003	0.01109
9	73.246	0.38	DMT-14S	2.5	DMT-12S	2.5	0.00519	0.00001	0.00418
10	20.123	0.10	DMT-12S	2.5	DMT-56S	2.5	0.00142	0.00000	0.00115
11	118.66	0.62	DMT-56S	2.5	DMT-57S	2.5	0.00840	0.00002	0.00676
12	103.17	0.54	DMT-57S	2.5	DMT-58S*	2.5	0.00730	0.00002	0.00588
13	238.8	1.24	DMT-58S*	2.5	DMT-45S	124	0.42770	0.00094	0.34440
14	397.97	2.07	DMT-45S	124	DMT-63S	45	0.95225	0.00210	0.76679
15	573.84	2.98	DMT-63S	45	DMT-39S	9.9	0.44604	0.00098	0.35917
Layer-1 Totals		**18.55**					**1.99**	**0.00439**	**1.60**

Notes:

1. Volumetric flux of groundwater through bulkheads and river bank calculated by the calibrated groundwater flow model for Layer 1 (Shallow Fill Aquifer)
2. Dissolved Cr-Vi concentrations are the most recent available at each river boundary monitoring well.
3. * Concentration at DMT-58S is the analytical result for 9/27/07 (ND) because the well was subsequently damaged.
4. Calculations involving wells having non-detect (ND) results use half of the detection limit.

Table 2: Scenario 2—13th and 15th Street Storm Drains Relined
Calculation of Chrome-VI Discharge to River via Groundwater Transport in the Shallow Aquifer

GW Flux to River			Zone Boundary Wells				Mass Flux		
Flow Zone	cfd	gpm	Well	Conc (ug/l)	Well	Conc (ug/l)	g/day	lbs/day	lbs/yr
1	63.783	0.33	DMT-42S	2.5	DMT-42S	2.5	0.00452	0.00001	0.00364
2	148.24	0.77	DMT-42S	2.5	DMT-17S	2.5	0.01049	0.00002	0.00845
3	938.98	4.88	DMT-17S	2.5	EA-11S	2.5	0.06647	0.00015	0.05353
4	526.82	2.74	EA-11S	2.5	DMT-31S	2.5	0.03729	0.00008	0.03003
5	64.577	0.34	DMT-31S	2.5	DMT-16S	2.5	0.00457	0.00001	0.00368
6	98.607	0.51	DMT-16S	2.5	DMT-32S	2.5	0.00698	0.00002	0.00562
7	190.55	0.99	DMT-32S	2.5	DMT-15S	2.5	0.01349	0.00003	0.01086
8	271.38	1.41	DMT-15S	2.5	DMT-14S	2.5	0.01921	0.00004	0.01547
9	102.117	0.53	DMT-14S	2.5	DMT-12S	2.5	0.00723	0.00002	0.00582
10	21.991	0.11	DMT-12S	2.5	DMT-56S	2.5	0.00156	0.00000	0.00125
11	159.21	0.83	DMT-56S	2.5	DMT-57S	2.5	0.01127	0.00002	0.00908
12	139.24	0.72	DMT-57S	2.5	DMT-58S*	2.5	0.00986	0.00002	0.00794
13	323.82	1.68	DMT-58S*	2.5	DMT-45S	124	0.57997	0.00128	0.46702
14	534.61	2.78	DMT-45S	124	DMT-63S	45	1.27920	0.00282	1.03006
15	695.44	3.61	DMT-63S	45	DMT-39S	9.9	0.54056	0.00119	0.43528
Layer-1 Totals		**22.23**					**2.59**	**0.00572**	**2.09**

Notes:

1. Volumetric flux of groundwater through bulkheads and river bank calculated by the calibrated groundwater flow model for Layer 1 (Shallow Fill Aquifer)
2. Dissolved Cr-Vi concentrations are the most recent available at each river boundary monitoring well.
3. * Concentration at DMT-58S is the analytical result for 9/27/07 (ND) because the well was subsequently damaged.
4. Calculations involving wells having non-detect (ND) results use half of the detection limit.

Table 3: Scenario 3—13th, 14th, and 15th Street Storm Drains Relined
Calculation of Chrome-VI Discharge to River via Groundwater Transport in the Shallow Aquifer

GW Flux to River			Zone Boundary Wells				Mass Flux		
Flow Zone	cfd	gpm	Well	Conc (ug/l)	Well	Conc (ug/l)	g/day	lbs/day	lbs/yr
1	65.296	0.34	DMT-42S	2.5	DMT-42S	2.5	0.00462	0.00001	0.00372
2	152.9	0.79	DMT-42S	2.5	DMT-17S	2.5	0.01082	0.00002	0.00872
3	980.73	5.09	DMT-17S	2.5	EA-11S	2.5	0.06943	0.00015	0.05591
4	556.23	2.89	EA-11S	2.5	DMT-31S	2.5	0.03938	0.00009	0.03171
5	69.231	0.36	DMT-31S	2.5	DMT-16S	2.5	0.00490	0.00001	0.00395
6	109.82	0.57	DMT-16S	2.5	DMT-32S	2.5	0.00777	0.00002	0.00626
7	219.27	1.14	DMT-32S	2.5	DMT-15S	2.5	0.01552	0.00003	0.01250
8	320.96	1.67	DMT-15S	2.5	DMT-14S	2.5	0.02272	0.00005	0.01830
9	159.373	0.83	DMT-14S	2.5	DMT-12S	2.5	0.01128	0.00002	0.00908
10	29.17	0.15	DMT-12S	2.5	DMT-56S	2.5	0.00207	0.00000	0.00166
11	183.93	0.96	DMT-56S	2.5	DMT-57S	2.5	0.01302	0.00003	0.01048
12	159.74	0.83	DMT-57S	2.5	DMT-58S*	2.5	0.01131	0.00002	0.00911
13	367.44	1.91	DMT-58S*	2.5	DMT-45S	124	0.65810	0.00145	0.52993
14	586.4	3.05	DMT-45S	124	DMT-63S	45	1.40312	0.00309	1.12985
15	718.28	3.73	DMT-63S	45	DMT-39S	9.9	0.55832	0.00123	0.44958
Layer-1 Totals		**24.31**					**2.83**	**0.00624**	**2.28**

Notes:

1. Volumetric flux of groundwater through bulkheads and river bank calculated by the calibrated groundwater flow model for Layer 1 (Shallow Fill Aquifer)
2. Dissolved Cr-Vi concentrations are the most recent available at each river boundary monitoring well.
3. * Concentration at DMT-58S is the analytical result for 9/27/07 (ND) because the well was subsequently damaged.
4. Calculations involving wells having non-detect (ND) results use half of the detection limit.

Table 4: Scenario 4—Priority Drains Relined
Calculation of Chrome-VI Discharge to River via Groundwater Transport in the Shallow Aquifer

GW Flux to River			Zone Boundary Wells				Mass Flux		
Flow Zone	cfd	gpm	Well	Conc (ug/l)	Well	Conc (ug/l)	g/day	lbs/day	lbs/yr
1	65.649	0.34	DMT-42S	2.5	DMT-42S	2.5	0.00465	0.00001	0.00374
2	154.01	0.80	DMT-42S	2.5	DMT-17S	2.5	0.01090	0.00002	0.00878
3	990.75	5.15	DMT-17S	2.5	EA-11S	2.5	0.07014	0.00015	0.05648
4	563.35	2.93	EA-11S	2.5	DMT-31S	2.5	0.03988	0.00009	0.03211
5	70.374	0.37	DMT-31S	2.5	DMT-16S	2.5	0.00498	0.00001	0.00401
6	112.59	0.58	DMT-16S	2.5	DMT-32S	2.5	0.00797	0.00002	0.00642
7	226.13	1.17	DMT-32S	2.5	DMT-15S	2.5	0.01601	0.00004	0.01289
8	331.63	1.72	DMT-15S	2.5	DMT-14S	2.5	0.02348	0.00005	0.01890
9	161.241	0.84	DMT-14S	2.5	DMT-12S	2.5	0.01141	0.00003	0.00919
10	29.251	0.15	DMT-12S	2.5	DMT-56S	2.5	0.00207	0.00000	0.00167
11	184.18	0.96	DMT-56S	2.5	DMT-57S	2.5	0.01304	0.00003	0.01050
12	159.96	0.83	DMT-57S	2.5	DMT-58S*	2.5	0.01132	0.00002	0.00912
13	367.9	1.91	DMT-58S*	2.5	DMT-45S	124	0.65892	0.00145	0.53059
14	586.94	3.05	DMT-45S	124	DMT-63S	45	1.40441	0.00310	1.13089
15	718.53	3.73	DMT-63S	45	DMT-39S	9.9	0.55851	0.00123	0.44973
Layer-1 Totals		**24.53**					**2.84**	**0.00626**	**2.29**

Notes:

1. Volumetric flux of groundwater through bulkheads and river bank calculated by the calibrated groundwater flow model for Layer 1 (Shallow Fill Aquifer)
2. Dissolved Cr-Vi concentrations are the most recent available at each river boundary monitoring well.
3. * Concentration at DMT-58S is the analytical result for 9/27/07 (ND) because the well was subsequently damaged.
4. Calculations involving wells having non-detect (ND) results use half of the detection limit.

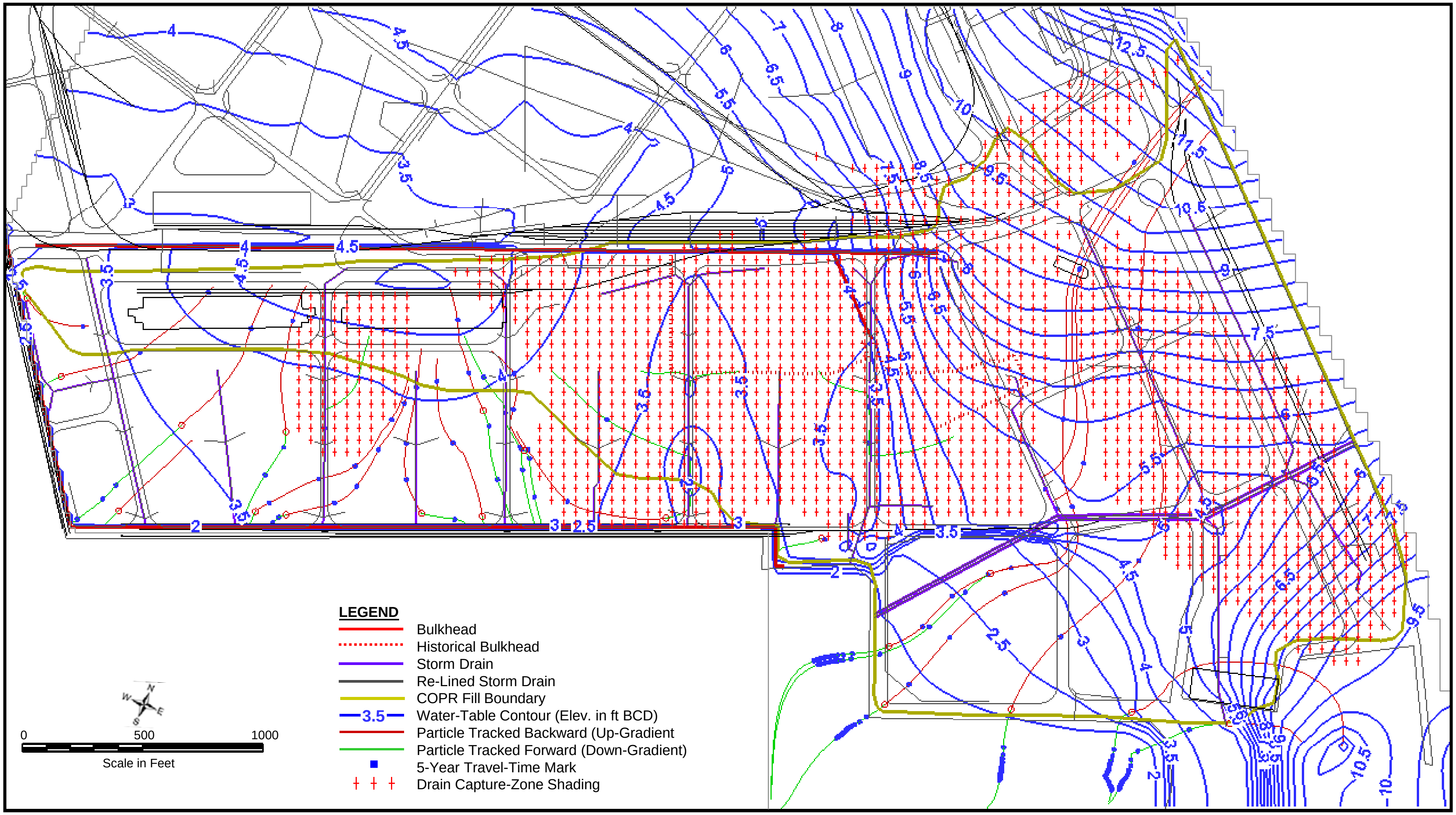

FIGURE 1
Water-Table Elevation and Particle Tracks
for Simulation Scenario 1—Prelining
Dundalk Marine Terminal, Baltimore, Maryland

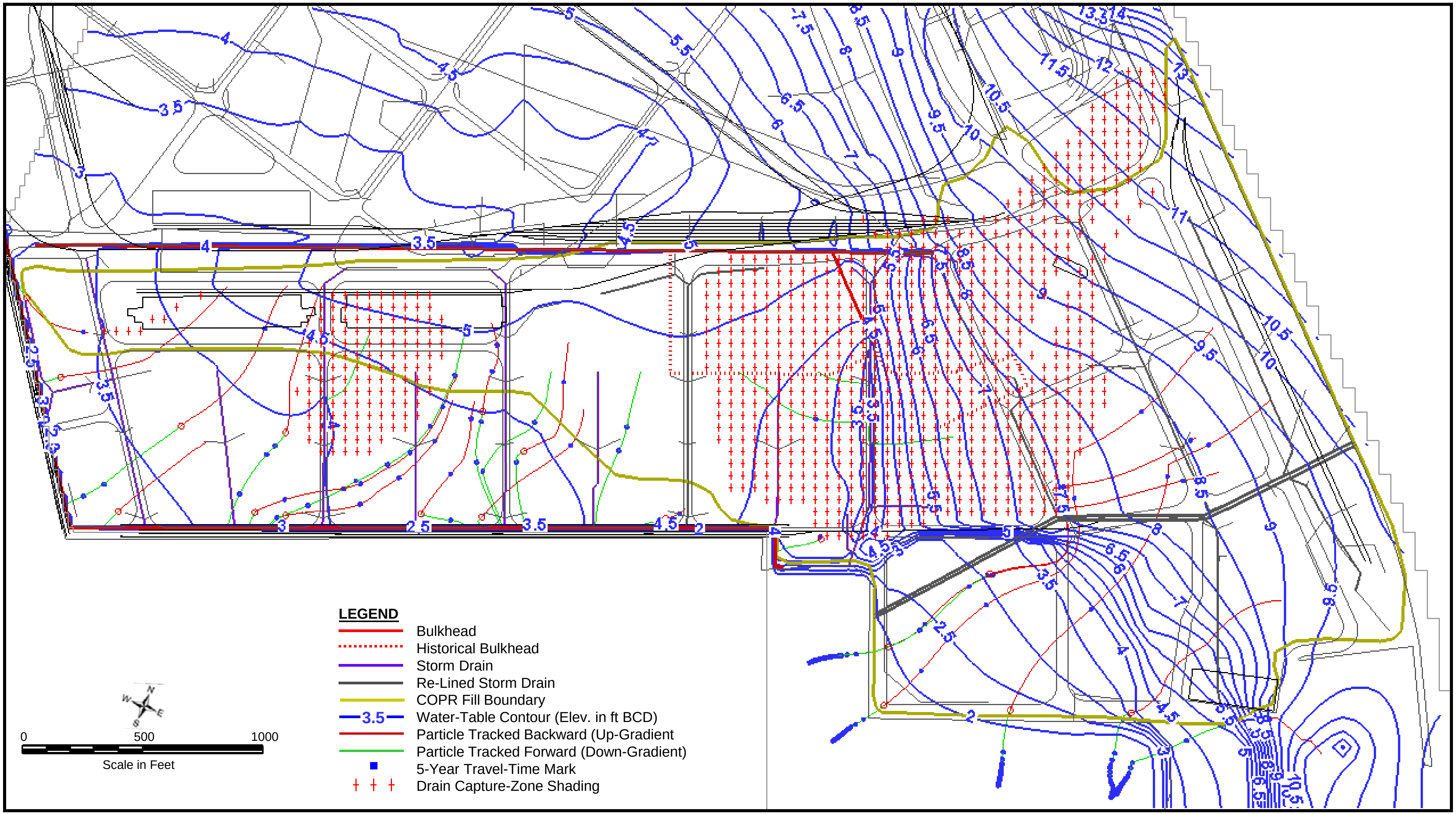

FIGURE 2
Water-Table Elevation and Particle Tracks
for Simulation Scenario 2—13th and 15th
Street Drains Relined
Dundalk Marine Terminal, Baltimore, Maryland

CH2M HILL

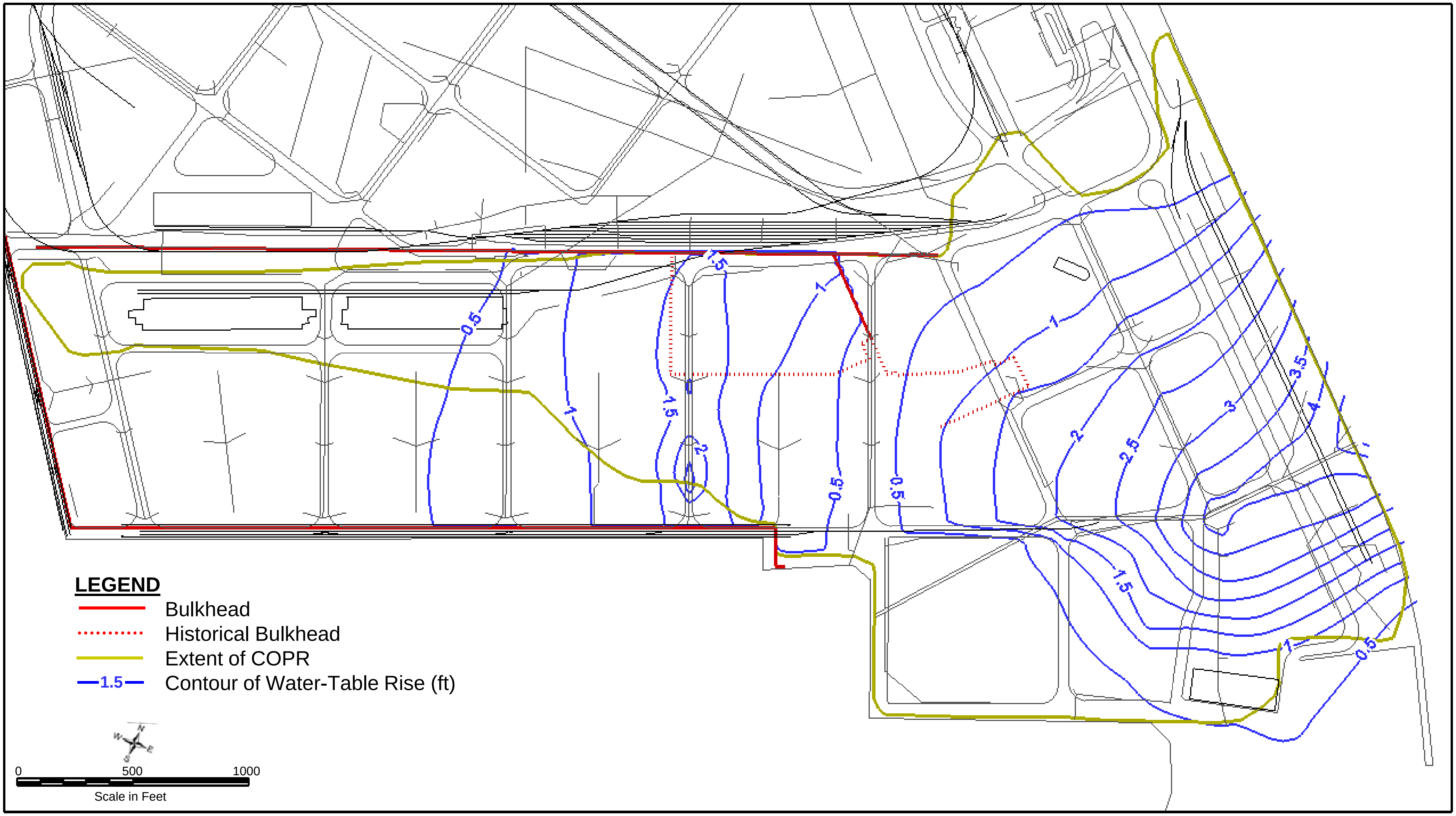

FIGURE 3
Simulated Water-Table Rise for Scenario 2—
13th and 15th Street Drains Relined
Dundalk Marine Terminal, Baltimore, Maryland

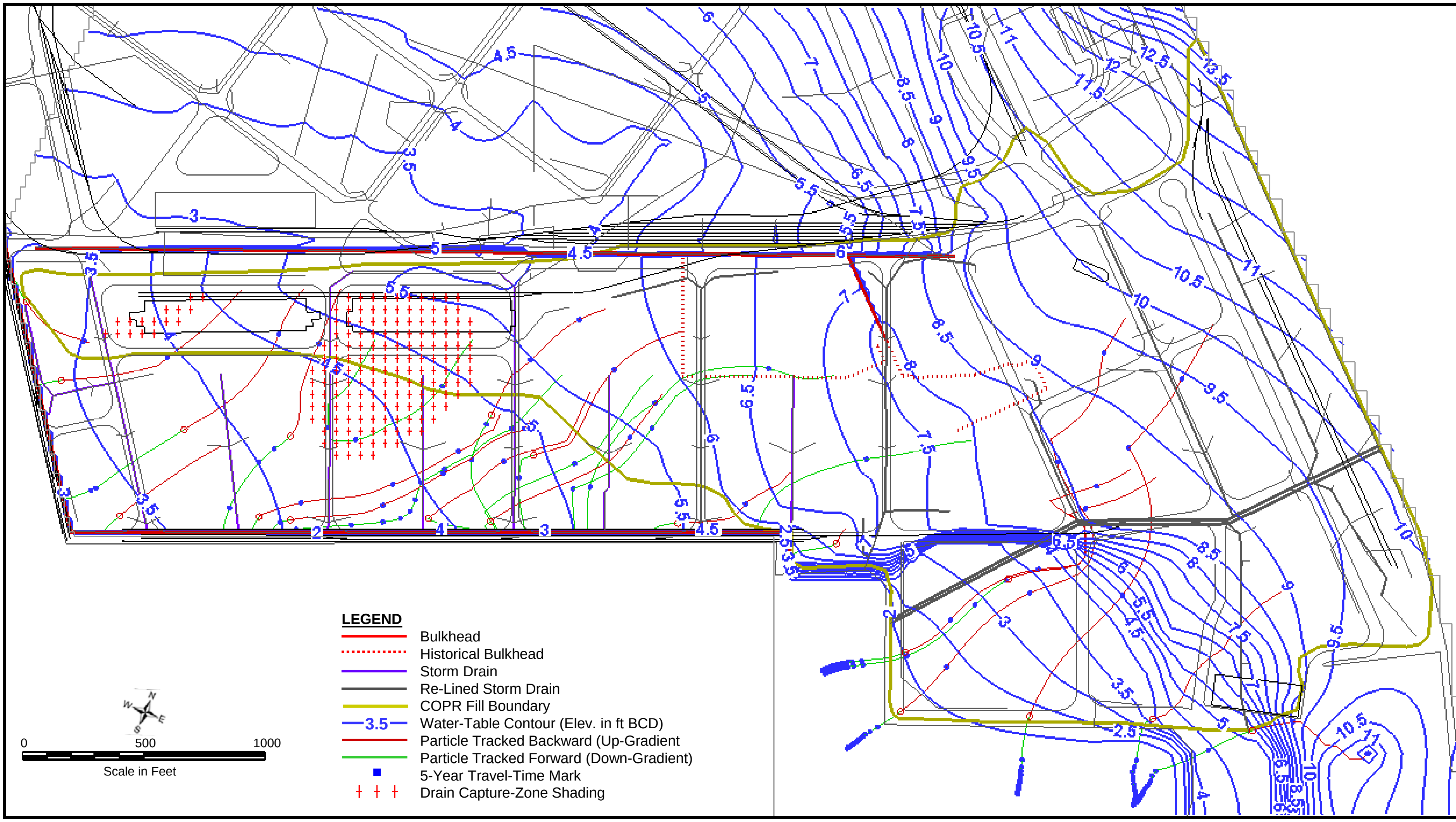

FIGURE 4
Water-Table Elevation and Particle Tracks for Simulation Scenario 3—13th,14th, and 15th Street Drains Relined
Dundalk Marine Terminal, Baltimore, Maryland

CH2M HILL

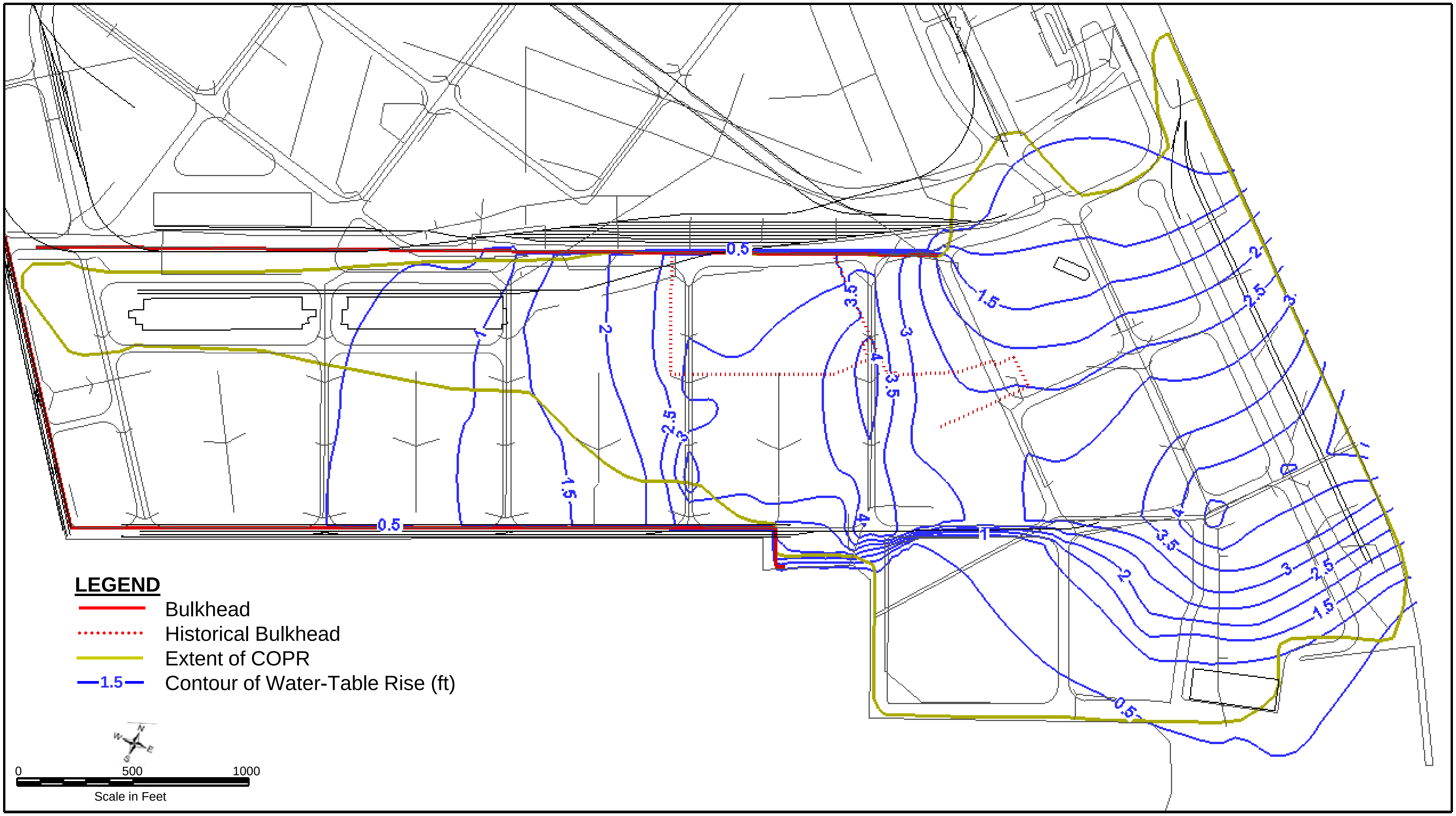

FIGURE 5
Simulated Water-Table Rise for Scenario 3—
13th, 14th, and 15th Street Drains Relined
Dundalk Marine Terminal, Baltimore, Maryland

CH2M HILL

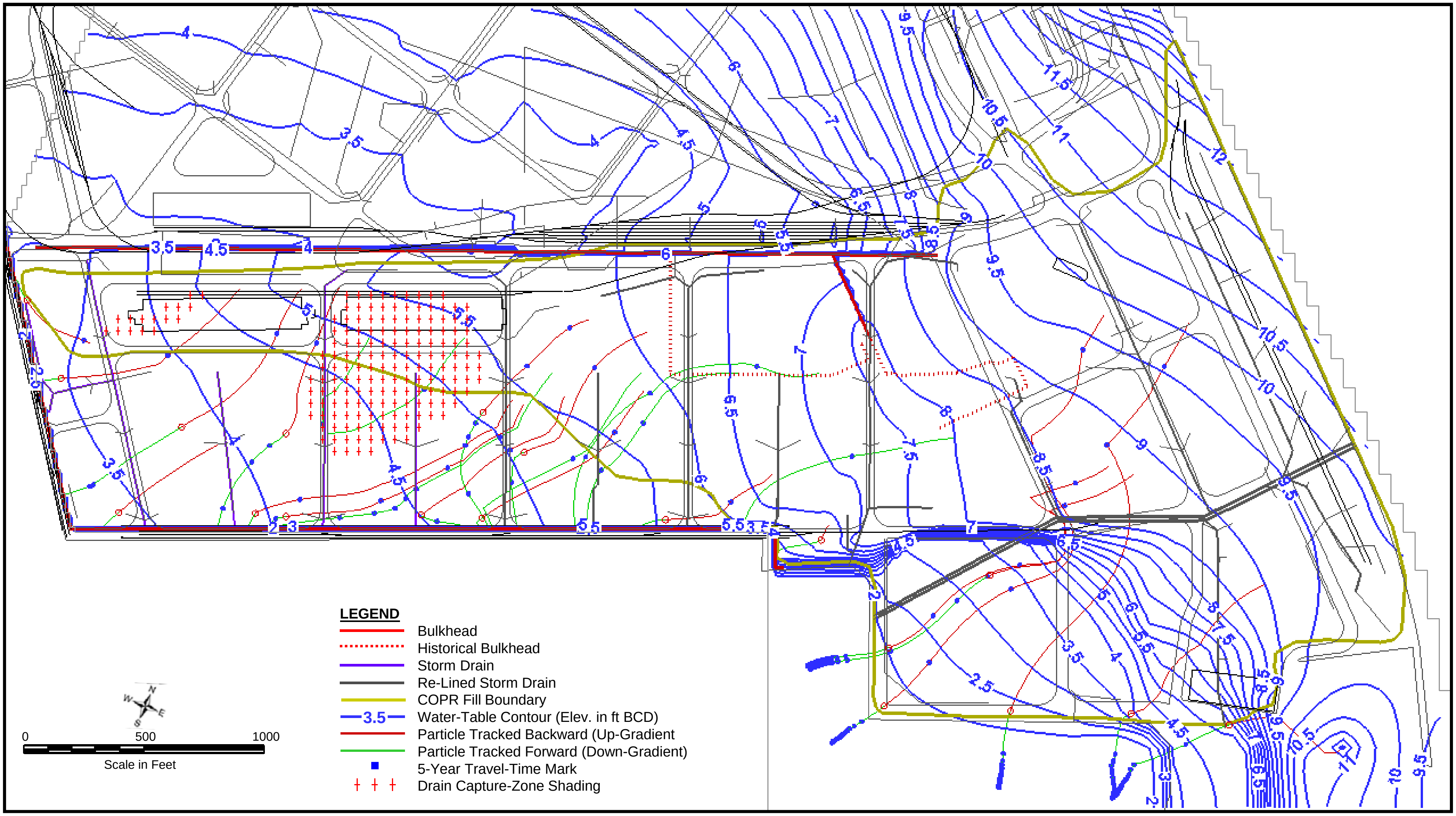

FIGURE 6
Water-Table Elevation and Particle Tracks for Simulation Scenario 4—Priority Drains Relined (12th, 12.5th,13th,13.5th,14th, and 15th Streets)
Dundalk Marine Terminal, Baltimore, Maryland

CH2M HILL

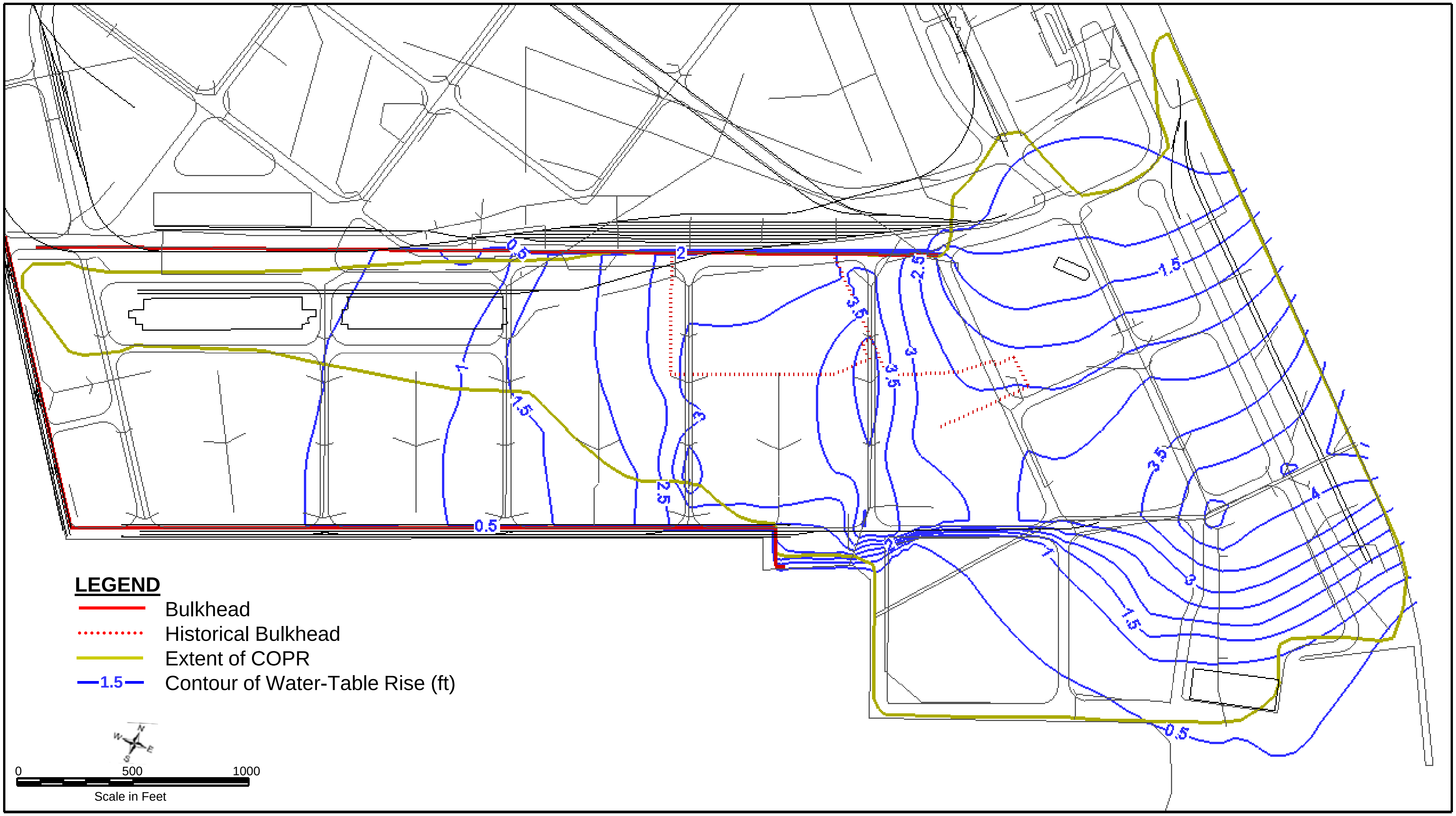

FIGURE 7
Simulated Water-Table Rise for Scenario 4—Priority Drains Relined (12th, 12.5th,13th, 13.5th, 14th, and 15th Streets)
Dundalk Marine Terminal, Baltimore, Maryland

Appendix C
Basic Data Compilation: Short-Term Effectiveness Impact Assessment

TABLE 1a

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 1 - No Further Action

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
General Conditions		1	FTE	Engineers	Pickup			1	Gasoline	2,600	2,600	2,600	2,600	dy	1	hr/day	2,600	10 years (52 weeks x 5 days/week) x 1 hours per day
		0.2	FTE	PM/CM	Pickup			1	Gasoline	2,600	2,600	520						
		0	FTE	Laborers	Pickups			1	Gasoline	-	-	-						
		0	FTE	Mech	Flatbed Trk			3	Diesel	-	-	-						
		0	LS		Pumps/Forklift/Misc			5	Diesel	-	-	-						
Bldg Demolition		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	Track Loader	CAT 973	239	6	Diesel									
		0	LS		Pumps			3	Gasoline									
		0	FTE	Teamster	Dump Trucks			10	Diesel									
Bldg Const - Civil		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 345	345	12	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	LS		Pumps			3	Gasoline									
Bldg Const		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Crane/Loader			10	Diesel									
		0	FTE	Carp/Elect	Pickup/Forklift			6	Diesel									
		0	FTE	Plum/HVAC	Pickup/Forklift			6	Diesel									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	FTE	Lab	Pumps/Gen			4	Gasoline									
		0	FTE	Teamster	Delivery Trucks			8	Diesel									
Rail Work		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickups			2	Gasoline									
		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Iron	Pumps/Gen/Welders			5	Gasoline									
		0	FTE	Teamster	Delivery Trucks			8	Diesel									
Excavation		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 345	345	12	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	LS		Pumps			3	Gasoline									
Trench Excavation		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
Trench Excavation - Rubber Tired Backhoe		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
Trench Backfill		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Compactor			5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	EA		Walk Behind Compactor			2	Diesel									
		0	FTE	Teamster	Semi End Dump			15	Diesel									
Drive Sheetpile		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Crane			9	Diesel									
		0	FTE	Oper	Vibratory Hammer			5	Diesel									
		0	FTE	Piledrivers	Pickup			1	Gasoline									
		0	FTE	Laborers	Welder			2	Diesel									
		0	FTE	Oper	Forklift			3	Diesel									
Pull Sheetpile		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Crane			9	Diesel									
		0	FTE	Oper	Vibratory Hammer			5	Diesel									
		0	FTE	Piledrivers	Pickup			1	Gasoline									
		0	FTE	Laborers	Welder			2	Diesel									
		0	FTE	Oper	Forklift			3	Diesel									
Haul to Stockpile		0	FTE	Teamster	Semi End Dump			15	Diesel									
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Rail Transport		0	FTE	TrainOp	Train			Calculation is gal/1000 miles	Diesel									
Rail Crew		0	FTE	TrainOp	Train			Labor only for this item	Diesel									
Stockpile Management		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Load Barge/Truck		0	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Conveyors			8	Diesel									
Barge/Truck Transport		0	EA	Fuel only this item	Barge/Semi End Dump			Fuel only this item	Diesel									
Barge/Truck Crew		0	FTE	Pilot/Deck	Barge			Labor only this item	Diesel									

TABLE 1a

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 1 - No Further Action

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Haul Backfill (Loading Dock or clean stockpile to excavation)		0	FTE	Teamster	Semi End Dump			15	Diesel									
Backfill		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Compactor			5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	EA		Walk Behind Compactor			2	Diesel									
Asphalt Pavement		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Paving Machine			8	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	Roller			5	Diesel									
		0	FTE	Oper	Roller			5	Diesel									
Haul Asphalt		0	Truck Drivers	Teamster	Semi End Dump			15	Diesel									
Concrete Placement		0	FTE	Foreman	Pickup			1	Gasoline									
		0	EA		Generator			2	Gasoline									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	LS		Vibrators			3	Diesel									
		0	FTE	Cement Mason					0									
Storm Drain/Utility Replacement																		
Trench Excavation		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
Trench Excavation		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0																
Trench Backfill		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Compactor			5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	EA		Walk Behind Compactor			2	Diesel									
		0	FTE	Teamster	Semi End Dump			15	Diesel									
Haul to Stockpile		0	FTE	Teamster	Semi End Dump			15	Diesel									
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Rail Transport		0	Train Operators	TrainOp	Train			Calculation is gal/1000 miles	Diesel									
Rail Crew		0	FTE	Laborers	Train			Labor only for this item	Diesel									
Stockpile Management		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Load Barge/Truck		0	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Conveyors			8	Diesel									
Barge/Truck Transport		0	FTE	Fuel only for this row	Barge/Semi End Dump			15	Diesel									
Barge/Truck Crew		0	FTE	Pilot/Deck	Barge			Labor only this row	Diesel		Labor only this row							
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Haul Backfill (Loading Dock to excavation)		0	FTE	Teamster	Semi End Dump			15	Diesel									
Backfill		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Compactor			5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	EA		Walk Behind Compactor			2	Diesel									
Asphalt Pavement		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Paving Machine			8	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	Roller			5	Diesel									
		0	FTE	Oper	Roller			5	Diesel									
Haul Asphalt			Truck Driver	Teamster	Semi End Dump			15	Diesel									
Relining, Stormdrains, Asphalt Repair Crew		1	FTE	Foreman	Pickup			1	Gasoline	19,500	19,500	19,500	195,000	lf	10	ln ft/hr	19,500	Engineer's Estimate 10 linear feet per hour. 30 Year Duration.
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	19,500	58,500	19,500						
		2	FTE	Oper	Relining Equip	TBD	50	3	Diesel	19,500	58,500	39,000						
		9	FTE	Laborers	Pickup/Misc	Boiler		25	Gasoline	19,500	487,500	175,500						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	19,500	97,500	19,500						
O&M		2	FTE	Tech	Pickup/Misc			2	Gasoline	64,800	129,600	129,600	8,100	dy	8	hr/day	64,800	270 days for 30 years. Engineer's Estimate.

TABLE 1a

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 1 - No Further Action

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Relining Drain Emissions		0	pounds of Styrene															See Estimated Styrene Air Emissions Excel File in Reference Docs File. Computed estimated quantities for styrene air emission released per cured-in-place installation. This weight totals include the exposed manhole area previously submitted and an estimated mass of styrene based upon the total mass of the vinyl ester resin per installation described within your attached shot schedule and an estimated diffusion rate suggested by the Insituform Technologies, Inc. research and development group in Chesterfield, MO.
Waste Water Treatment Plant																		
	Predicted Volume of Untreated Water	679,274,490	gallons (over the life of the project, assume WTP runs for __30__ yrs)															
Chemicals																		
		Rate	Units	Volume of Substrate	Units	Load Size (tn)	Number of Loads	Delivery Distance	Total One-Way Mileage	Tons of Sustrate	Comments							
	Sulfuric Acid-93%	0.000487072	gal substrate/gal treated water	330,855.30	Gallon	7.5	331.3	20	6,627	2,485	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-25%	0.000454374	gal substrate/gal treated water	308,644.52	Gallon	10	270.5	20	5,409	2,705	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-50%	0.000176898	gal substrate/gal treated water	120,162.13	Gallon	12	87.7	20	1,755	1,053	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Ferric Chloride	5.86543E-05	gal substrate/gal treated water	39,842.35	Gallon	6	80.3	20	1,606	482	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer- Settling	2.28811E-05	gal substrate/gal treated water	15,542.53	Gallon	19	3.55	85	302	67	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer-Sludge	2.28811E-05	gal substrate/gal treated water	15,542.53	Gallon	19	3.55	85	302	67	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sulfur Dioxide Gas	0.001350721	pounds substrate/gal treated water	917,510.53	Pound	14	32.8	85	2,785	459	Tons of Substrate = Pounds* (1 ton/2000lbs)							
							Subtotal Substrate Mileage	335	18,785	7,318	tons							
							Subtotal Substrate Diesel Gallon		55,159									
Sludge																		
	Rate	Units	Mass of Sludge	Units	Density of Sludge	Units	Volume of Sludge	Units	Load Size	Units	Number of Loads	Delivery Distance	Total One-Way Mileage	Total One-Way Diesel Gallons				
Sludge	707,717	gallons of water processed/ ton of sludge cake	960	tons	0.27571	tons/CY	3,481	CY	10	CY	349	65	22,685	1,404				
											GAL							
Haul Chemical/Sludge									Diesel		56,563							

General Activities		
General Conditions Diesel Use	-	gal
General Conditions Gasoline Use	5,200	gal
Bldg Demolotion/Construction Diesel Use	-	gal
Bldg Demolotion/Construction Gasoline Use	-	gal
Rail Work Diesel Use	-	gal
Rail Work Gasoline Use	-	gal
Excavation Diesel Use	-	gal
Excavation Gasoline Use	-	gal
Trench Excavation/Backfill Diesel Use	-	gal
Trench Excavation/Backfill Gasoline Use	-	gal
Drive/Pull Sheetpile Diesel Use	-	gal
Drive/Pull Sheetpile Gasoline Use	-	gal
Stockpile Loadout/Management Diesel Use	-	gal
Stockpile Loadout/Management Gasoline Use	-	gal
Rail Transport Diesel Use	-	gal
Load Barge/Truck Diesel Use	-	gal
Barge/Truck Transport Diesel Use	-	gal
Haul Chemical/Sludge Diesel Use	56,563	gal
Haul Chemical/Sludge Gasoline Use	-	gal
Backfilling Diesel Use	-	gal
Backfilling Gasoline Use	-	gal
Asphalt Pavement/Concrete Placement Diesel Use	-	gal
Asphalt Pavement/Concrete Placement Gasoline Use	-	gal
Haul Stockpile/Backfill/Asphalt Diesel Use	-	gal
Storm Drain/Utility Replacement Activities		
Trench Excavation/Backfill Diesel Use	-	gal
Trench Excavation/Backfill Gasoline Use	-	gal
Stockpile Loadout/Management Diesel Use	-	gal
Stockpile Loadout/Management Gasoline Use	-	gal
Rail Transport Diesel Use	-	gal
Load Barge/Truck Diesel Use	-	gal
Barge/Truck Transport Diesel Use	-	gal
Backfilling Diesel Use	-	gal
Backfilling Gasoline Use	-	gal
Asphalt Pavement Diesel Use	-	gal
Asphalt Pavement Gasoline Use	-	gal
Haul Stockpile/Backfill/Asphalt Diesel Use	-	gal
Relining Crew Diesel Use	214,500	gal
Relining Crew Gasoline Use	507,000	gal
O&M Activities		
O&M Gasoline Use	129,600	gal
Chemical Delivery Diesel Use	55,159	gal
Sludge Disposal Diesel Use	1,404	gal
Total Diesel Use	327,626	gal
Total Gasoline Use	641,800	gal
Total Fuel Use	856,300	gal

TABLE 1a

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 1 - No Further Action

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
General Manhours	3,120	hours																
Storm Drain/Utility Replacement Manhours	402,600	hours																
Total Manhours	405,720	hours																
Remedial Timeframe:	30	yrs																
Remedial Timeframe	360	months																
Total Land Area Impacted:	6.2	acres																
Volume of Truck	20	tons																
Offsite Truck Traffic Mileage for Ashpalt Hauling	-	gal																
Offsite Truck Traffic Mileage for Importing Backfill	-	gal																
Offsite Truck Traffic Mileage for Chemical/Sludge Hauling	56,563	gal																
Offsite Truck Traffic Mileage (asphalt hauling)	418,564	miles		Assume 7.4 miles per gallon.														
Rail Transport Volume to Hazardous Waste Facility	0	tons																
Rail Capacity	10,000	tons		Assume 100 ton capacity per car and 100 cars per load														
Rail Mileage to Hazardous Waste Facility	748	miles		one-way mileage from Baltimore, MD to Heritage Environmental Services in Indianaplois, IN														
Total Rail Mileage to Hazardous Waste Facility	0	miles																
Truck Transport Volume to Recycling Facility	0	tons																
Truck Capacity	20	tons		Assume 20 ton capacity per truck														
Truck Mileage to Recycling Facility	11	miles		mileage from Potts and Callaghan Recycling Facility is 11 miles														
Total Truck Mileage to Recycling Facility	0	miles																
Transport Volume for Backfill Material	0	tons																
Impacted water treated at WWTP	1,421,997.97	kWh		Assumption of 0.002093407 kWh/gal from G. Mah-Hing Estimate 01.19.2010. Since water volume reported as total in this alternative (instead of annual), multiplication of a year value is not necessary.														
Sludge generated at WWTP	960	tons																

TABLE 1b

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 2 - Basic Containment

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
General Conditions		1	FTE	Engineers	Pickup			1	Gasoline	5,200	5,200	5,200	2,600	dy	2	hr/day	5,200	10 years (52 weeks x 5 days/week) x 2 hours per day
		0.2	FTE	PM/CM	Pickup			1	Gasoline	5,200	5,200	1,040						
		0	FTE	Laborers	Pickups			1	Gasoline	-	-	-						
		0	FTE	Mech	Flatbed Trk			3	Diesel	-	-	-						
		0	LS		Pumps/Forklift/Misc			5	Diesel	-	-	-						
Bldg Demolition		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	Track Loader	CAT 973	239	6	Diesel									
		0	LS		Pumps			3	Gasoline									
		0	FTE	Teamster	Dump Trucks			10	Diesel									
Bldg Const - Civil		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 345	345	12	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	LS		Pumps			3	Gasoline									
Bldg Const		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Crane/Loader			10	Diesel									
		0	FTE	Carp/Elect	Pickup/Forklift			6	Diesel									
		0	FTE	Plum/HVAC	Pickup/Forklift			6	Diesel									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	FTE	Lab	Pumps/Gen			4	Gasoline									
		0	FTE	Teamster	Delivery Trucks			8	Diesel									
Rail Work		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickups			2	Gasoline									
		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Iron	Pumps/Gen/Welders			5	Gasoline									
		0	FTE	Teamster	Delivery Trucks			8	Diesel									
Excavation		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 345	345	12	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	LS		Pumps			3	Gasoline									
Trench Excavation		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
Trench Excavation - Rubber Tired Backhoe		1	FTE	Foreman	Pickup			1	Gasoline	1,400	1,400	1,400	35,000	lf	25		1,400	This crew assists the mainline excavation crew. 7areas to fix each year 500 ln ft per area for 10 years
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	1,400	4,200	1,400						
		5	FTE	Laborers	Pickup			1	Gasoline	1,400	1,400	7,000						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	1,400	7,000	1,400						
Trench Backfill		1	FTE	Foreman	Pickup			1	Gasoline	1,400	1,400	1,400						Backfill crew.
		1	FTE	Oper	Compactor			5	Diesel	1,400	7,000	1,400						
		3	FTE	Laborers	Pickup			1	Gasoline	1,400	1,400	4,200						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	1,400	7,000	1,400						
		1	EA		Walk Behind Compactor			2	Diesel	1,400	2,800	1,400						
		8	FTE	Teamster	Semi End Dump			15	Diesel	2,075	31,125	2,075	41,500	tn	0.05	mh/tn	2,075	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S65 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation. Linked to trench excavation. Assumptions inclue: 4 ft wide, 5 ft deep, 27 is for conversion to yds, 1.6 tons/CY Vulcan Materials Estimate. Assume trench backfill will be hauled in.
Drive Sheetpile		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Crane			9	Diesel									
		0	FTE	Oper	Vibratory Hammer			5	Diesel									
		0	FTE	Piledrivers	Pickup			1	Gasoline									
		0	FTE	Laborers	Welder			2	Diesel									
		0	FTE	Oper	Forklift			3	Diesel									
Pull Sheetpile		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Crane			9	Diesel									
		0	FTE	Oper	Vibratory Hammer			5	Diesel									
		0	FTE	Piledrivers	Pickup			1	Gasoline									
		0	FTE	Laborers	Welder			2	Diesel									
		0	FTE	Oper	Forklift			3	Diesel									
Haul to Stockpile		6	FTE	Teamster	Semi End Dump			15	Diesel	160	2,402	961	28,819	cy	180	cy/hr	160	Assumed 30 minute round trip. (6 trucks haul 15 cy per load - 12 loads per hour) 1.44 tons/CY (Email w/ Brett Lester).
												-						
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	144	937	144	28,819	cy	200	cy/hr	144	Loader to load railcar or trucks hauling from clean stockpile.
		2	FTE	Laborers	Pickup			1	Gasoline	144	144	288						
Rail Transport			FTE	TrainOp	Train			Calculation is gal/1000 miles	Diesel									

TABLE 1b

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 2 - Basic Containment

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Rail Crew			FTE	TrainOp	Train			Labor only for this item	Diesel									
Stockpile Management		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	100	650	100	25	dy	4	hrs/day	100	Estimators Assumption: Alloted time to maintain stockpile.
		2	FTE	Laborers	Pickup			1	Gasoline	100	100	200						
Load Barge/Truck		0	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Conveyors			8	Diesel									
Barge/Truck Transport		0	EA	Fuel only this item	Barge/Semi End Dump			Fuel only this item	Diesel									
Barge/Truck Crew		0	FTE	Pilot/Deck	Barge			Labor only this item	Diesel									
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Haul Backfill (Loading Dock or clean stockpile to excavation)		8	FTE	Teamster	Semi End Dump			15	Diesel	1,375	20,625	11,000	27,500	tn	0.05	tns/hr	1,375	Assumed 20 minute round trip. (8 trucks haul 20 ton per load - 24 loads per hour) which is roughly 3 loads per hour per truck. 24 loads per hour. Each load about 20 tons.
Backfill		1	FTE	Foreman	Pickup			1	Gasoline	43	43	43	17,188	cy	400	cy/crew hr	43	Production rate assumption is 400 cy/crew hour. Quantity stated in cost estimate. 1.6 tons/CY Vulcan Materials Estimate.
		1	FTE	Oper	Compactor			5	Diesel	43	215	43						
		3	FTE	Laborers	Pickup			1	Gasoline	43	43	129						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	43	215	43						
		1	EA		Walk Behind Compactor			2	Diesel	43	86	43						
Asphalt Pavement		1	FTE	Foreman	Pickup			1	Gasoline	70	70	70	14,000	tn	200	tn/crew hr	70	Production rate assumption is 200 tn/crew hour. Quantity stated in cost estimate. 8 in thick asphalt / 160 (asphalt qty. factor)
		1	FTE	Oper	Paving Machine			8	Diesel	70	560	70						
		5	FTE	Laborers	Pickup			1	Gasoline	70	70	350						
		1	FTE	Oper	Roller			5	Diesel	70	350	70						
		1	FTE	Oper	Roller			5	Diesel	70	350	70						
													-					
Haul Asphalt			Truck Drivers	Teamster	Semi End Dump			15	Diesel	700	10,500	700	14,000	tn	0.05	mh/tons	700	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S113 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation.
Concrete Placement		0	FTE	Foreman	Pickup			1	Gasoline									
		0	EA		Generator			2	Gasoline									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	LS		Vibrators			3	Diesel									
		0	FTE	Cement Mason	Hand Tools				0									
Storm Drain/Utility Replacement																		
Trench Excavation		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
Trench Excavation		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
Trench Backfill		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Compactor			5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	EA		Walk Behind Compactor			2	Diesel									
		0	FTE	Teamster	Semi End Dump			15	Diesel									
Haul to Stockpile		0	FTE	Teamster	Semi End Dump			15	Diesel									
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Rail Transport		0	Train Operators	TrainOp	Train			Calculation is gal/1000 miles	Diesel									
Rail Crew		0	FTE	Laborers	Train			Labor only for this item	Diesel									
Stockpile Management		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Load Barge/Truck		0	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Conveyors			8	Diesel									
Barge/Truck Transport		0	FTE	Fuel only for this row	Barge/Semi End Dump			15	Diesel									

TABLE 1b

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 2 - Basic Containment

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Barge/Truck Crew		0	FTE	Pilot/Deck	Barge			Labor only this row	Diesel		Labor only this row							
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Haul Backfill (Loading Dock to excavation)		0	FTE	Teamster	Semi End Dump			15	Diesel									
Backfill		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Compactor			5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	EA		Walk Behind Compactor			2	Diesel									
Asphalt Pavement		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Paving Machine			8	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	Roller			5	Diesel									
		0	FTE	Oper	Roller			5	Diesel									
Haul Asphalt		0	Truck Driver	Teamster	Semi End Dump			15	Diesel									
Relining, Stormdrains, Asphalt Repair Crew		1	FTE	Foreman	Pickup			1	Gasoline	19,500	19,500	19,500	195,000	lf	10	ln ft/hr	19,500	Engineer's Estimate 10 linear feet per hour. 30 Year Duration.
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	19,500	58,500	19,500						
		2	FTE	Oper	Relining Equip	TBD	50	3	Diesel	19,500	58,500	39,000						
		9	FTE	Laborers	Pickup/Misc	Boiler		25	Gasoline	19,500	487,500	175,500						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	19,500	97,500	19,500						
O&M		2	FTE	Tech	Pickup/Misc			2	Gasoline	64,800	129,600	129,600	8,100	dy	8	hr/day	64,800	270 days for 30 years. Engineer's Estimate.
Relining Drain Emissions		0	pounds of Styrene															See Estimated Styrene Air Emissions Excel File in Reference Docs File. Computed estimated quantities for styrene air emission released per cured-in-place installation. This weight totals include the exposed manhole area previously submitted and an estimated mass of styrene based upon the total mass of the vinyl ester resin per installation described within your attached shot schedule and an estimated diffusion rate suggested by the Insituform Technologies, Inc. research and development group in Chesterfield, MO.
Waste Water Treatment Plant																		
	Predicted Volume of Untreated Water	679,274,490	gallons (over the life of the project, assume WTP runs for __30__ yrs)															
Chemicals																		
		Rate	Units	Volume of Substrate	Units	Load Size (tn)	Number of Loads	Delivery Distance	Total One-Way Mileage	Tons of Sustrate	Comments							
	Sulfuric Acid-93%	0.000487072	gal substrate/gal treated water	330,855.30	Gallon	7.5	331.3	20	6,627	2,485	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-25%	0.000454374	gal substrate/gal treated water	308,644.52	Gallon	10	270.5	20	5,409	2,705	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-50%	0.000176898	gal substrate/gal treated water	120,162.13	Gallon	12	87.7	20	1,755	1,053	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Ferric Chloride	5.86543E-05	gal substrate/gal treated water	39,842.35	Gallon	6	80.3	20	1,606	482	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer- Settling	2.28811E-05	gal substrate/gal treated water	15,542.53	Gallon	19	3.55	85	302	67	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer-Sludge	2.28811E-05	gal substrate/gal treated water	15,542.53	Gallon	19	3.55	85	302	67	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sulfur Dioxide Gas	0.001350721	pounds substrate/gal treated water	917,510.53	Pound	14	32.8	85	2,785	459	Tons of Substrate = Pounds* (1 ton/2000lbs)							
							Subtotal Substrate Mileage	335	19,120	7,318	tons							
							Subtotal Substrate Diesel Gallon		55,159									
Sludge																		
	Rate	Units	Mass of Sludge	Units	Density of Sludge	Units	Volume of Sludge	Units	Load Size	Units	Number of Loads	Delivery Distance	Total One-Way Mileage	Total One Way Diesel Gallons				
Sludge	707,717	gallons of water processed/ ton of sludge cake	960	tons	0.27571	tons/CY	3,481	CY	10	CY	349	65	22,685	1,404				
											GAL							
Haul Chemical/Sludge									Diesel		56,563							

TABLE 1b

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 2 - Basic Containment

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
General Activities																		
General Conditions Diesel Use	-	gal																
General Conditions Gasoline Use	10,400	gal																
Bldg Demolotion/Construction Diesel Use	-	gal																
Bldg Demolotion/Construction Gasoline Use	-	gal																
Rail Work Diesel Use	-	gal																
Rail Work Gasoline Use	-	gal																
Excavation Diesel Use	-	gal																
Excavation Gasoline Use	-	gal																
Trench Excavation/Backfill Diesel Use	59,125	gal																
Trench Excavation/Backfill Gasoline Use	5,600	gal																
Drive/Pull Sheetpile Diesel Use	-	gal																
Drive/Pull Sheetpile Gasoline Use	-	gal																
Stockpile Loadout/Management Diesel Use	1,587	gal																
Stockpile Loadout/Management Gasoline Use	244	gal																
Rail Transport Diesel Use	-	gal																
Load Barge/Truck Diesel Use	-	gal																
Barge/Truck Transport Diesel Use	-	gal																
Haul Chemical/Sludge Diesel Use	56,563	gal																
Haul Chemical/Sludge Gasoline Use	-	gal																
Backfilling Diesel Use	516	gal																
Backfilling Gasoline Use	86	gal																
Asphalt Pavement/Concrete Placement Diesel Use	1,260	gal																
Asphalt Pavement/Concrete Placement Gasoline Use	140	gal																
Haul Stockpile/Backfill/Asphalt Diesel Use	33,527	gal																
Storm Drain/Utility Replacement Activities																		
Trench Excavation/Backfill Diesel Use	-	gal																
Trench Excavation/Backfill Gasoline Use	-	gal																
Stockpile Loadout/Management Diesel Use	-	gal																
Stockpile Loadout/Management Gasoline Use	-	gal																
Rail Transport Diesel Use	-	gal																
Load Barge/Truck Diesel Use	-	gal																
Barge/Truck Transport Diesel Use	-	gal																
Backfilling Diesel Use	-	gal																
Backfilling Gasoline Use	-	gal																
Asphalt Pavement Diesel Use	-	gal																
Asphalt Pavement Gasoline Use	-	gal																
Haul Stockpile/Backfill/Asphalt Diesel Use	-	gal																
Relining Crew Diesel Use	214,500	gal																
Relining Crew Gasoline Use	507,000	gal																
O&M Activities																		
O&M Gasoline Use	129,600	gal																
Chemical Delivery Diesel Use	55,159	gal																
Sludge Disposal Diesel Use	1,404	gal																
Total Diesel Use	423,639	gal																
Total Gasoline Use	653,070	gal																
Total Fuel Use	963,584	gal																
General Manhours	43,639	hours																
Storm Drain/Utility Replacement Manhours	402,600	hours																
Total Manhours	446,239	hours																
Remedial Timeframe:	30	yrs																
Remedial Timeframe	360	months																
Total Land Area Impacted:	6.2	acres																
Volume of Truck	20	tons																
Offsite Truck Traffic Mileage for Ashpalt Hauling	10,500	gal																
Offsite Truck Traffic Mileage for Importing Backfill	-	gal																
Offsite Truck Traffic Mileage for Chemical/Sludge Hauling	56,563	gal																
Offsite Truck Traffic Mileage	496,264	miles		Assume 7.4 miles per gallon.														
Rail Transport Volume to Hazardous Waste Facility	0	tons																
Rail Capacity	10,000	tons		Assume 100 ton capacity per car and 100 cars per load														
Rail Mileage to Hazardous Waste Facility	748	miles		one-way mileage from Baltimore, MD to Heritage Environmental Services in Indianaplois, IN														
Total Rail Mileage to Hazardous Waste Facility	0	miles																
Truck Transport Volume to Recycling Facility	0	tons																
Truck Capacity	20	tons		Assume 20 ton capacity per truck														
Truck Mileage to Recycling Facility	11	miles		mileage from Potts and Callaghan Recycling Facility is 11 miles														
Total Truck Mileage to Recycling Faciility	0	miles																
Transport Volume for Backfill Material	0	tons																
Impacted water treated at WWTP	1,421,997.97	kWh		Assumption of 0.002093407 kWh/gal from G. Mah-Hing Estimate 01.19.2010. Since water volume reported as total in this alternative (instead of annual), multiplication of a year value is not necessary.														
Sludge generated at WWTP	960	tons																

TABLE 1c

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 3 - Enhanced Isolation and Containment

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
General Conditions		1	FTE	Engineers	Pickup			1	Gasoline	20,800	20,800	20,800	2,600	dy	8	hr/day	20,800	10 years (52 weeks x 5 days/week) x 8 hours per day
		1	FTE	PM/CM	Pickup			1	Gasoline	20,800	20,800	20,800						
		0	FTE	Laborers	Pickups			1	Gasoline	20,800	20,800	-						
		0	FTE	Mech	Flatbed Trk			3	Diesel	20,800	62,400	-						
		0	LS		Pumps/Forklift/Misc			5	Diesel	20,800	104,000	-						
Bldg Demolition		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	Track Loader	CAT 973	239	6	Diesel									
		0	LS		Pumps			3	Gasoline									
		0	FTE	Teamster	Dump Trucks			10	Diesel									
Bldg Const - Civil		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator	CAT 345	345	12	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	LS		Pumps			3	Gasoline									
Bldg Const		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Crane/Loader			10	Diesel									
		0	FTE	Carp/Elect	Pickup/Forklift			6	Diesel									
		0	FTE	Plum/HVAC	Pickup/Forklift			6	Diesel									
		0	FTE	Oper	RT Loader	CAT 950	216	5	Diesel									
		0	FTE	Lab	Pumps/Gen			4	Gasoline									
		0	FTE	Teamster	Delivery Trucks			8	Diesel									
Rail Work		0	FTE	Supt	Pickup			1	Gasoline									
		0	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel									
		0	FTE	Laborers	Pickups			2	Gasoline									
		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Iron	Pumps/Gen/Welders			5	Gasoline									
		0	FTE	Teamster	Delivery Trucks			8	Diesel									
Excavation		1	FTE	Foreman	Pickup			1	Gasoline	77	77	77	13,900	cy	180	cy/hr	77	[cy/180 CY per hour = crew hours] Quantity from current cost estimate. Should also match Appendix A. 10 truckloads at 22 tons per truck per hour 1.44 tons/CY (Email w/ Brett Lester).
		1	FTE	Oper	Excavator	CAT 345	345	12	Diesel	77	927	77						
		5	FTE	Laborers	Pickup			1	Gasoline	77	77	386						
		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	77	502	77						
		1	LS	Fuel only this item	Pumps			3	Gasoline	77	232	-						
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	-	-	-	-	lf	25	ln ft/ crew hour	-	[linear feet/linear ft per hour = crew hours] Quantity from the Mueser Rutledge estimate on excavations.
		1	FTE	Oper	Excavator	CAT 330	268	10	Diesel	-	-	-						
		5	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	-	-	-						
Trench Excavation - Rubber Tired Backhoe		1	FTE	Foreman	Pickup			1	Gasoline	-	-	-		lf				This crew assists the mainline excavation crew.
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	-	-	-						
		5	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	-	-	-						
Trench Backfill		1	FTE	Foreman	Pickup			1	Gasoline	-	-	-						Backfill crew.
		1	FTE	Oper	Compactor			5	Diesel	-	-	-						
		3	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	-	-	-						
		1	EA		Walk Behind Compactor			2	Diesel	-	-	-						
		8	FTE	Teamster	Semi End Dump			15	Diesel	-	-	-	-	tn	0.05	mh/tn	-	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S65 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation. Linked to trench excavation. Assumptions inclue: 4 ft wide, 5 ft deep, 27 is for conversion to yds, 1.6 tons/CY Vulcan Materials Estimate. Assume trench backfill will be hauled in.
Drive Sheetpile		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Crane			9	Diesel									
		0	FTE	Oper	Vibratory Hammer			5	Diesel									
		0	FTE	Piledrivers	Pickup			1	Gasoline									
		0	FTE	Laborers	Welder			2	Diesel									
		0	FTE	Oper	Forklift			3	Diesel									
Pull Sheetpile		0	FTE	Foreman	Pickup			1	Gasoline									
		0	FTE	Oper	Crane			9	Diesel									
		0	FTE	Oper	Vibratory Hammer			5	Diesel									
		0	FTE	Piledrivers	Pickup			1	Gasoline									
		0	FTE	Laborers	Welder			2	Diesel									
		0	FTE	Oper	Forklift			3	Diesel									
Haul to Stockpile		6	FTE	Teamster	Semi End Dump			15	Diesel	77	1,158	463	13,900	cy	180	cy/hr	77	Assumed 30 minute round trip. (6 trucks haul 15 cy per load - 12 loads per hour) COPR and trench spoils 1.44 tons/CY (Email w/ Brett Lester).
												-						

TABLE 1c

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 3 - Enhanced Isolation and Containment

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	70	452	70	13,900	cy	200	cy/hr	70	Loader to load railcar or trucks hauling from clean stockpile.
		2	FTE	Laborers	Pickup			1	Gasoline	70	70	139						
Rail Transport		0	FTE	TrainOp	Train			Calculation is gal/1000 miles	Diesel									
Rail Crew		0	FTE	TrainOp	Train			Labor only for this item	Diesel									
Stockpile Management		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Load Barge/Truck		0	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Conveyors			8	Diesel									
Barge/Truck Transport		0	EA	Fuel only this item	Barge/Semi End Dump			Fuel only this item	Diesel									
		0																
Barge/Truck Crew		0	FTE	Pilot/Deck	Barge			Labor only this item	Diesel									
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Haul Backfill (Loading Dock or clean stockpile to excavation)		8	FTE	Teamster	Semi End Dump			15	Diesel	1,112	16,680	8,896	22,240	tn	0.05	tns/hr	1,112	Assumed 20 minute round trip. (8 trucks haul 20 ton per load - 24 loads per hour) which is roughly 3 loads per hour per truck. 24 loads per hour. Each load about 20 tons. In this case the "crew hours equals manhours". 1.6 tons/CY Vulcan Materials Estimate.
Backfill		1	FTE	Foreman	Pickup			1	Gasoline	35	35	35	13,900	cy	400	cy/crew hr	35	Production rate assumption is 400 cy/crew hour. Quantity stated in cost estimate. 1.6 tons/CY Vulcan Materials Estimate.
		1	FTE	Oper	Compactor			5	Diesel	35	174	35						
		3	FTE	Laborers	Pickup			1	Gasoline	35	35	104						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	35	174	35						
		1	EA		Walk Behind Compactor			2	Diesel	35	70	35						
Asphalt Pavement		1	FTE	Foreman	Pickup			1	Gasoline	-	-	-	-	tn	200	tn/crew hr	-	Production rate assumption is 200 tn/crew hour. Quantity stated in cost estimate.
		1	FTE	Oper	Paving Machine			8	Diesel	-	-	-						
		5	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
		1	FTE	Oper	Roller			5	Diesel	-	-	-						
		1	FTE	Oper	Roller			5	Diesel	-	-	-						
Haul Asphalt			Truck Drivers	Teamster	Semi End Dump			15	Diesel	-	-	-	-	tn	0.05	mh/tons	-	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S113 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation.
Concrete Placement		1	FTE	Foreman	Pickup			1	Gasoline	60	60	60	15	dy	4	hr/day	60	Assume 15 days total.
		1	EA		Generator			2	Gasoline	60	120	60						
		4	FTE	Laborers	Pickup			1	Gasoline	60	60	240						
		2	LS		Vibrators			3	Diesel	60	180	120						
		2	FTE	Cement Mason					Hand Tools	60	-	120						
Storm Drain/Utility Replacement																		
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	88	88	88	2,200	lf	25	ln ft/crew hr	88	[linear feet/linear ft per hour = crew hours] Quantity from cost estimate, found under replace remaining storm drains section. Does not include the lateral lines.
		1	FTE	Oper	Excavator	CAT 330	268	10	Diesel	88	880	88						
		5	FTE	Laborers	Pickup			1	Gasoline	88	88	440						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	88	440	88						
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	34	34	34	1,200	lf	35	ln ft/ cr hour	34	This crew installs the laterals to the mainline. Includes utility relocation. Quantity from cost estimate. Production rate assumed to be 35 linear feet per crew hour. (53,400 for utility relocation) (5700 for lateral lines off of storm drains)
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	34	103	34						
		5	FTE	Laborers	Pickup			1	Gasoline	34	34	171						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	34	171	34						

TABLE 1c

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 3 - Enhanced Isolation and Containment

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Trench Backfill		1	FTE	Foreman	Pickup			1	Gasoline	105	105	105						Backfill crew. Hours based on mainline crew hours plus one-half lateral crew hours.
		1	FTE	Oper	Compactor			5	Diesel	105	526	105						
		3	FTE	Laborers	Pickup			1	Gasoline	105	105	315						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	105	526	105						
		1	EA		Walk Behind Compactor			2	Diesel	105	210	105						
		8	FTE	Teamster	Semi End Dump			15	Diesel	200	3,000	200	4,000	tn	0.05	mh/tn	200	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S65 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation. Linked to trench excavation. Assumptions inclue: 4 ft wide, 5 ft deep, 27 is for conversion to yds, 1.6 tons/CY Vulcan Materials Estimate. Assume trench backfill will be hauled in.
Haul to Stockpile		6	FTE	Teamster	Semi End Dump			15	Diesel	93	1,389	556	2,778	cy	180	cy/hr	15	Assumed 30 minute round trip. (6 trucks haul 15 cy per load - 12 loads per hour) 1.44 tons/CY (Email w/ Brett Lester).
												-						
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	7	45	7	2,778	cy	400	cy/hr	7	Loader to load railcar. 1.44 tons/CY (Email w/ Brett Lester).
		2	FTE	Laborers	Pickup			1	Gasoline	7	7	14						
Rail Transport			Train Operators	TrainOp	Train			Calculation is gal/1000 miles	Diesel									
Rail Crew			FTE	Laborers	Train			Labor only for this item	Diesel									
Stockpile Management		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	422	2,746	422	106	dy	4	hrs/day	422	Engineers Allowance Estimate.
		2	FTE	Laborers	Pickup			1	Gasoline	422	422	845						
Load Barge/Truck		0	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Conveyors			8	Diesel									
Barge/Truck Transport		0	FTE	Fuel only for this row	Barge/Semi End Dump			15	Diesel									
		0																
Barge/Truck Crew		0	FTE	Pilot/Deck	Barge			Labor only this row	Diesel		Labor only this row							
Stockpile Loadout		0	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel									
		0	FTE	Laborers	Pickup			1	Gasoline									
Haul Backfill (Loading Dock to excavation)		8	FTE	Teamster	Semi End Dump			15	Diesel	183	2,738	1,460	3,650	tn	0.05	tons/hr	183	Assumed 20 minute round trip. (8 trucks haul 20 ton per load - 24 loads per hour) which is roughly 3 loads per hour per truck. 24 loads per hour. Each load about 20 tons.
Backfill		1	FTE	Foreman	Pickup			1	Gasoline	6	6	6	2,281	cy	400	cy/crew hr	6	Production rate assumption is 400 cy/crew hour. 1.6 tons/CY Vulcan Materials Estimate.
		1	FTE	Oper	Compactor			5	Diesel	6	29	6						
		3	FTE	Laborers	Pickup			1	Gasoline	6	6	17						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	6	29	6						
		1	EA		Walk Behind Compactor			2	Diesel	6	11	6						
Asphalt Pavement		1	FTE	Foreman	Pickup			1	Gasoline	7	7	7	350	tn	50	tn/crew hr	7	Production rate assumption is 50 tn/crew hour. Ln ft of Main Line (8 ft in width) + Ln ft of Lateral Lines (4 ft in width) * 8 in thick asphalt / 160 (asphalt qty. factor)
		1	FTE	Oper	Paving Machine			8	Diesel	7	56	7						
		5	FTE	Laborers	Pickup			1	Gasoline	7	7	35						
		1	FTE	Oper	Roller			5	Diesel	7	35	7						
		1	FTE	Oper	Roller			5	Diesel	7	35	7						
Haul Asphalt			Truck Driver	Teamster	Semi End Dump			15	Diesel	18	263	18	350	tn	0.05	mh/tn	18	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S171is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation.
Relining, Stormdrains, Asphalt Repair Crew		1	FTE	Foreman	Pickup			1	Gasoline	19,500	19,500	19,500	195,000	lf	10	ln ft/hr	19,500	Engineer's Estimate 10 linear feet per hour. 30 Year Duration.
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	19,500	58,500	19,500						
		2	FTE	Oper	Relining Equip	TBD	50	3	Diesel	19,500	58,500	39,000						
		9	FTE	Laborers	Pickup/Misc	Boiler		25	Gasoline	19,500	487,500	175,500						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	19,500	97,500	19,500						
O&M		2	FTE	Tech	Pickup/Misc			2	Gasoline	10,800	21,600	21,600	1,350	dy	8	hr/day	10,800	270 days for 5 years. Engineer's Estimate.
Relining Drain Emissions		365.3	pounds of Styrene															See Estimated Styrene Air Emissions Excel File in Reference Docs File. Computed estimated quantities for styrene air emission released per cured-in-place installation. This weight totals include the exposed manhole area previously submitted and an estimated mass of styrene based upon the total mass of the vinyl ester resin per installation described within your attached shot schedule and an estimated diffusion rate suggested by the Insituform Technologies, Inc. research and development group in Chesterfield, MO.
Waste Water Treatment Plant																		
	Predicted Volume of Untreated Water	62,266,828	gallons (over the life of the project, assume WTP runs at the same capacity of Alt 1 volume for 2 years, and then 25% of Alt 1 volume for 3 years, and then is shut off). Email w/ Bob Steele 1/22/2010															

TABLE 1c

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 3 - Enhanced Isolation and Containment

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Chemicals																		
		Rate	Units	Volume of Substrate	Units	Load Size (tn)	Number of Loads	Delivery Distance	Total One-Way Mileage	Tons of Sustrate	Comments							
	Sulfuric Acid-93%	0.000487072	gal substrate/gal treated water	30,328.40	Gallon	7.5	30.4	20	607	228	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-25%	0.000454374	gal substrate/gal treated water	28,292.41	Gallon	10	24.8	20	496	248	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-50%	0.000176898	gal substrate/gal treated water	11,014.86	Gallon	12	8.0	20	161	97	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Ferric Chloride	5.86543E-05	gal substrate/gal treated water	3,652.22	Gallon	6	7.4	20	147	44	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer- Settling	2.28811E-05	gal substrate/gal treated water	1,424.73	Gallon	19	0.33	85	28	6	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer-Sludge	2.28811E-05	gal substrate/gal treated water	1,424.73	Gallon	19	0.33	85	28	6	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sulfur Dioxide Gas	0.001350721	pounds substrate/gal treated water	84,105.13	Pound	14	3.0	85	255	42	Tons of Substrate = Pounds* (1 ton/2000lbs)							
							Subtotal Substrate Mileage	335	1,722	671	tons							
							Subtotal Substrate Diesel Gallon		5,056									
Sludge																		
	Rate	Units	Mass of Sludge	Units	Density of Sludge	Units	Volume of Sludge	Units	Load Size	Units	Number of Loads	Delivery Distance	Total One-Way Mileage	Total One Way Diesel Gallons				
Sludge	707,717	gallons of water processed/ ton of sludge cake	88	tons	0.27571	tons/CY	319	CY	10	CY	32	65	2,080	129				
											GAL							
Haul Chemical/Sludge									Diesel		5,185							

General Activities		
General Conditions Diesel Use	166,400	gal
General Conditions Gasoline Use	62,400	gal
Bldg Demolotion/Construction Diesel Use	-	gal
Bldg Demolotion/Construction Gasoline Use	-	gal
Rail Work Diesel Use	-	gal
Rail Work Gasoline Use	-	gal
Excavation Diesel Use	1,429	gal
Excavation Gasoline Use	386	gal
Trench Excavation/Backfill Diesel Use	-	gal
Trench Excavation/Backfill Gasoline Use	-	gal
Drive/Pull Sheetpile Diesel Use	-	gal
Drive/Pull Sheetpile Gasoline Use	-	gal
Stockpile Loadout/Management Diesel Use	452	gal
Stockpile Loadout/Management Gasoline Use	70	gal
Rail Transport Diesel Use	-	gal
Load Barge/Truck Diesel Use	-	gal
Barge/Truck Transport Diesel Use	-	gal
Haul Chemical/Sludge Diesel Use	5,185	gal
Haul Chemical/Sludge Gasoline Use	-	gal
Backfilling Diesel Use	417	gal
Backfilling Gasoline Use	70	gal
Asphalt Pavement/Concrete Placement Diesel Use	180	gal
Asphalt Pavement/Concrete Placement Gasoline Use	240	gal
Haul Stockpile/Backfill/Asphalt Diesel Use	17,838	gal
Storm Drain/Utility Replacement Activities		
Trench Excavation/Backfill Diesel Use	5,856	gal
Trench Excavation/Backfill Gasoline Use	455	gal
Stockpile Loadout/Management Diesel Use	2,791	gal
Stockpile Loadout/Management Gasoline Use	429	gal
Rail Transport Diesel Use	-	gal
Load Barge/Truck Diesel Use	-	gal
Barge/Truck Transport Diesel Use	-	gal
Backfilling Diesel Use	68	gal
Backfilling Gasoline Use	11	gal
Asphalt Pavement Diesel Use	126	gal
Asphalt Pavement Gasoline Use	14	gal
Haul Stockpile/Backfill/Asphalt Diesel Use	4,389	gal
Relining Crew Diesel Use	214,500	gal
Relining Crew Gasoline Use	507,000	gal
O&M Activities		
O&M Gasoline Use	21,600	gal
Chemical Delivery Diesel Use	5,056	gal
Sludge Disposal Diesel Use	1,404	gal
Total Diesel Use	426,091	gal
Total Gasoline Use	592,675	gal
Total Fuel Use	1,007,120	gal
General Manhours	52,629	hours
Storm Drain/Utility Replacement Manhours	299,938	hours
Total Manhours	352,567	hours
Remedial Timeframe:	5	yrs
Remedial Timeframe	60	months
Total Land Area Impacted:	6.2	acres
Volume of Truck	20	tons

TABLE 1c
DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 3 - Enhanced Isolation and Containment
PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Offsite Truck Traffic Mileage for Ashpalt Hauling	263	gal																
Offsite Truck Traffic Mileage for Importing Backfill	-	gal																
Offsite Truck Traffic Mileage for Chemical/Sludge Hauling	5,185	gal																
Offsite Truck Traffic Mileage	40,311	miles		Assume 7.4 miles per gallon.														
Rail Transport Volume to Hazardous Waste Facility	0	tons																
Rail Capacity	10,000	tons		Assume 100 ton capacity per car and 100 cars per load														
Rail Mileage to Hazardous Waste Facility	748	miles		one-way mileage from Baltimore, MD to Heritage Environmental Services in Indianaplois, IN														
Total Rail Mileage to Hazardous Waste Facility	0	miles																
Truck Transport Volume to Recycling Facility	0	tons																
Truck Capacity	20	tons		Assume 20 ton capacity per truck														
Truck Mileage to Recycling Facility	11	miles		mileage from Potts and Callaghan Recycling Facility is 11 miles														
Total Truck Mileage to Recycling Facility	0	miles																
Transport Volume for Backfill Material	0	tons																
Impacted water treated at WWTP	130,349.81	kWh		Assumption of 0.002093407 kWh/gal from G. Mah-Hing Estimate 01.19.2010. Since water volume reported as total in this alternative (instead of annual), multiplication of a year value is not necessary.														
Sludge generated at WWTP	88	tons																

TABLE 1d

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 4 - Partial Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
General Conditions		2	FTE	Engineers	Pickup			1	Gasoline	20,800	20,800	41,600	2,600	dy	8	hr/day	20,800	10 years (52 weeks x 5 days/week) x 8 hours per day
		4	FTE	PM/CM	Pickup			1	Gasoline	20,800	20,800	83,200						
		2	FTE	Laborers	Pickups			1	Gasoline	20,800	20,800	41,600						
		2	FTE	Mech	Flatbed Trk			3	Diesel	20,800	62,400	41,600						
		0	LS		Pumps/Forklift/Misc			5	Diesel	20,800	104,000	-						
Bldg Demolition		1	FTE	Supt	Pickup			1	Gasoline	1,600	1,600	1,600	200	dy	8	hr/day	1,600	1 year (40 weeks x 5 days/week) x 8 hours per day
		1	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel	1,600	16,000	1,600						
		5	FTE	Laborers	Pickup			1	Gasoline	1,600	1,600	8,000						
		1	FTE	Oper	Track Loader	CAT 973	239	6	Diesel	1,600	9,600	1,600						
		2	LS		Pumps			3	Gasoline	1,600	4,800	3,200						
		4	FTE	Teamster	Dump Trucks			10	Diesel	1,600	16,000	6,400						
Bldg Const - Civil		1	FTE	Foreman	Pickup			1	Gasoline	800	800	800	100	dy	8	hr/day	800	20 week duration
		1	FTE	Oper	Excavator	CAT 345	345	12	Diesel	800	9,600	800						
		7	FTE	Laborers	Pickup			1	Gasoline	800	800	5,600						
		2	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	800	5,200	1,600						
		2	LS		Pumps			3	Gasoline	800	2,400	1,600						
Bldg Const		4	FTE	Supt	Pickup			1	Gasoline	4,160	4,160	16,640	520	dy	8	hr/day	4,160	2 years (52 weeks x 5 days/week) x 8 hours per day
		3	FTE	Oper	Crane/Loader			10	Diesel	4,160	41,600	12,480						
		15	FTE	Carp/Elect	Pickup/Forklift			6	Diesel	4,160	24,960	62,400						
		10	FTE	Plum/HVAC	Pickup/Forklift			6	Diesel	4,160	24,960	41,600						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	4,160	20,800	4,160						
		8	FTE	Lab	Pumps/Gen			4	Gasoline	4,160	16,640	33,280						
		6	FTE	Teamster	Delivery Trucks			8	Diesel	4,160	33,280	24,960						
Rail Work		1	FTE	Supt	Pickup			1	Gasoline	1,440	1,440	1,440	180	dy	8	hr/day	1,440	36 week duration
		1	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel	1,440	14,400	1,440						
		8	FTE	Laborers	Pickups			2	Gasoline	1,440	2,880	11,520						
		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	1,440	9,360	1,440						
		2	FTE	Iron	Pumps/Gen/Welders			5	Gasoline	1,440	7,200	2,880						
		3	FTE	Teamster	Delivery Trucks			8	Diesel	1,440	11,520	4,320						
Excavation		1	FTE	Foreman	Pickup			1	Gasoline	10,000	10,000	10,000	1,800,000	cy	180	cy/hr	10,000	[cy/180 CY per hour = crew hours] Quantity from current cost estimate. Should also match Appendix A. 10 truckloads at 22 tons per truck per hour
		1	FTE	Oper	Excavator	CAT 345	345	12	Diesel	10,000	120,000	10,000						
		5	FTE	Laborers	Pickup			1	Gasoline	10,000	10,000	50,000						
		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	10,000	65,000	10,000						
		2	LS		Pumps			3	Gasoline	10,000	30,000	20,000						
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	428	428	428	10,700	lf	25	ln ft/ crew hour	428	[linear feet/linear ft per hour = crew hours] Quantity from the Mueser Rutledge estimate on excavations.
		1	FTE	Oper	Excavator	CAT 330	268	10	Diesel	428	4,280	428						
		5	FTE	Laborers	Pickup			1	Gasoline	428	428	2,140						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	428	2,140	428						
Trench Excavation - Rubber Tired Backhoe		1	FTE	Foreman	Pickup			1	Gasoline	428	428	428		lf				This crew assists the mainline excavation crew.
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	428	1,284	428						
		5	FTE	Laborers	Pickup			1	Gasoline	428	428	2,140						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	428	2,140	428						
Trench Backfill		1	FTE	Foreman	Pickup			1	Gasoline	428	428	428						Backfill crew.
		1	FTE	Oper	Compactor			5	Diesel	428	2,140	428						
		3	FTE	Laborers	Pickup			1	Gasoline	428	428	1,284						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	428	2,140	428						
		1	EA		Walk Behind Compactor			2	Diesel	428	856	428						
		8	FTE	Teamster	Semi End Dump			15	Diesel	635	9,525	635	12,700	tn	0.05	mh/tn	635	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S65 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation. Linked to trench excavation. Assumptions inclue: 4 ft wide, 5 ft deep, 27 is for conversion to yds, 1.6 tons/CY Vulcan Materials Estimate. Note that this volume is deducted from the barge volume assuming work will be sequenced to allow trenching to be performed without requiring additional volume of import and export. Assume trench backfill will be hauled in.
Drive Sheetpile		1	FTE	Foreman	Pickup			1	Gasoline									
		1	FTE	Oper	Crane			9	Diesel									
		1	FTE	Oper	Vibratory Hammer			5	Diesel									
		4	FTE	Piledrivers	Pickup			1	Gasoline									
		2	FTE	Laborers	Welder			2	Diesel									
		1	FTE	Oper	Forklift			3	Diesel									
Pull Sheetpile		1	FTE	Foreman	Pickup			1	Gasoline									
		1	FTE	Oper	Crane			9	Diesel									
		1	FTE	Oper	Vibratory Hammer			5	Diesel									
		4	FTE	Piledrivers	Pickup			1	Gasoline									
		2	FTE	Laborers	Welder			2	Diesel									
		1	FTE	Oper	Forklift			3	Diesel									

TABLE 1d

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 4 - Partial Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Haul to Stockpile		6	FTE	Teamster	Semi End Dump			15	Diesel	10,000	150,000	60,000	1,800,000	cy	180	cy/hr	10,000	Assumed 30 minute round trip. (6 trucks haul 15 cy per load - 12 loads per hour)
												-						
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	9,000	58,500	9,000	1,800,000	cy	200	cy/hr	9,000	Loader to load railcar or trucks hauling from clean stockpile.
			FTE	Laborers	Pickup			1	Gasoline									
		2								9,000	-	18,000						
Rail Transport			FTE	TrainOp	Train			Calculation is gal/1000 miles	Diesel	Fuel only for this row	3,248,175		1,309,748,000	ton/miles	2.48	gal/1,000 ton miles	Fuel only for this row	Value from Table 13 in this tool (NREL Table). Units [gallons per 1000 ton-miles]. Assuming 748 miles per trip one way trip for Heritiage Assume rail-off haul for disposal is 1751000 tons. 1.44 tons/CY (Email w/ Brett Lester)
Rail Crew		6	FTE	TrainOp	Train			Labor only for this item	Diesel	7,800	Labor only for this item	46,800	Labor only for this item		10		7,800	Assume train crew will need to move railcars, estimate 30 crew hours per week for this task. (52 weeks, 5 years, 30 crew hrs per week)
Stockpile Management		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	5,000	32,500	5,000	1,250	dy	4	hrs/day	5,000	Estimators Assumption: Alloted time to maintain stockpile.
		2	FTE	Laborers	Pickup			1	Gasoline	5,000	5,000	10,000						
Load Barge/Truck		2	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel	1,946	12,646	3,891	1,945,600	tn	1000	tons/day	1,946	Replace off-hauled material. 1.6 conversion [Excavated material - clean spoils - asphalt material = amount that needs to be imported.] Eight hour day assumed.
		4	FTE	Laborers	Conveyors			8	Diesel	1,946	15,565	7,782						
Barge/Truck Transport		0	EA	Fuel only this row	Barge/Semi End Dump			Calculation is gal/1000 miles	Diesel		719,872		194,560,000	ton/miles	3.7	gal/1,000 ton miles	Fuel only this row	Value from Table 13 in this tool (NREL Table). Units [gallons per 1000 ton-miles]. 50 miles from quarry, 100 miles roundtrip
Barge/Truck Crew		4	FTE	Pilot/Deck	Barge			Labor only for this item	Diesel	15,565		62,259	1,297	loads	12	hrs/load	15,565	1,500 tons per barge load. (Assumption from email correspondance between Bob Steele and John Smack, the regional Sales Representative for Vulcan Materials)
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	4,691	30,489	4,691	2,345,300	tn	500	tns/hr	4,691	Loader to load trucks. This value is exactly equal to the excavated quantity. Reference cost estimate for value. 1.44 tons/CY (Email w/ Brett Lester).
		2	FTE	Laborers	Pickup			1	Gasoline	4,691	4,691	9,381						
Haul Backfill (Loading Dock or clean stockpile to excavation)		8	FTE	Teamster	Semi End Dump			15	Diesel	4,691	562,872	37,525	2,345,300	tn	500	tns/hr	4,691	Assumed 20 minute round trip. (8 trucks haul 20 ton per load - 24 loads per hour) which is roughly 3 loads per hour per truck. 24 loads per hour. Each load about 20 tons. 1.44 tons/CY (Email w/ Brett Lester).
Backfill		1	FTE	Foreman	Pickup			1	Gasoline	4,208	4,208	4,208	1,683,000	cy	400	cy/crew hr	4,208	Production rate assumption is 400 cy/crew hour. Quantity stated in cost estimate.
		1	FTE	Oper	Compactor			5	Diesel	4,208	21,038	4,208						
		3	FTE	Laborers	Pickup			1	Gasoline	4,208	4,208	12,623						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	4,208	21,038	4,208						
		1	EA		Walk Behind Compactor			2	Diesel	4,208	8,415	4,208						
Asphalt Pavement		1	FTE	Foreman	Pickup			1	Gasoline	1,170	1,170	1,170	234,000	tn	200	tn/crew hr	1,170	Production rate assumption is 200 tn/crew hour. Quantity stated in cost estimate.
		1	FTE	Oper	Paving Machine			8	Diesel	1,170	9,360	1,170						
		5	FTE	Laborers	Pickup			1	Gasoline	1,170	1,170	5,850						
		1	FTE	Oper	Roller			5	Diesel	1,170	5,850	1,170						
		1	FTE	Oper	Roller			5	Diesel	1,170	5,850	1,170						
Haul Asphalt			Truck Drivers	Teamster	Semi End Dump			15	Diesel	11,700	175,500	11,700	234,000	tn	0.05	mh/tons	11,700	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S113 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation.
Concrete Placement		1	FTE	Foreman	Pickup			1	Gasoline	400	400	400	100	dy	4	hr/day	400	Assume 100 days total.
		1	EA		Generator			2	Gasoline	400	800	400						
		4	FTE	Laborers	Pickup			1	Gasoline	400	400	1,600						
		2	LS		Vibrators			3	Diesel	400	1,200	800						
		2	FTE	Cement Mason					Hand Tools	400	-	800						
Storm Drain/Utility Replacement																		
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	228	228	228	5,700	lf	25	ln ft/crew hr	228	[linear feet/linear ft per hour = crew hours] Quantity from cost estimate, found under replace remaining storm drains section. Does not include the lateral lines.
		1	FTE	Oper	Excavator	CAT 330	268	10	Diesel	228	2,280	228						
		5	FTE	Laborers	Pickup			1	Gasoline	228	228	1,140						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	228	1,140	228						
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	1,689	1,689	1,689	59,100	lf	35	ln ft/ cr hour	1,689	This crew installs the laterals to the mainline. Includes utility relocation. Quantity from cost estimate. Production rate assumed to be 35 linear feet per crew hour. (53,400 for utility relocation) (5700 for lateral lines off of storm drains)
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	1,689	5,066	1,689						
		5	FTE	Laborers	Pickup			1	Gasoline	1,689	1,689	8,443						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	1,689	8,443	1,689						

TABLE 1d

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 4 - Partial Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Trench Backfill		1	FTE	Foreman	Pickup			1	Gasoline	1,072	1,072	1,072						Backfill crew. Hours based on mainline crew hours plus one-half lateral crew hours.
		1	FTE	Oper	Compactor			5	Diesel	1,072	5,361	1,072						
		3	FTE	Laborers	Pickup			1	Gasoline	1,072	1,072	3,217						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	1,072	5,361	1,072						
		1	EA		Walk Behind Compactor			2	Diesel	1,072	2,145	1,072						
		8	FTE	Teamster	Semi End Dump			15	Diesel	-	-	-	-	tn	0.05	mh/tn	-	Import is covered in main excavation and backfill quantity.
Haul to Stockpile		6	FTE	Teamster	Semi End Dump			15	Diesel	326	4,895	1,958	58,741	cy	180	cy/hr	326	Assumed 30 minute round trip. (6 trucks haul 15 cy per load - 12 loads per hour) 1.44 tons/CY (Email w/ Brett Lester).
												-						
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	-	-	-	-	cy	88	cy/hr	-	Import is covered in main excavation and backfill quantity.
		2	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
Rail Transport			Train Operators	TrainOp	Train			Calculation is gal/1000 miles	Diesel	Fuel only for this row	-	Fuel only for this row	-	ton/miles	3.7	gal/1,000 ton miles	Fuel only for this row	Import is covered in main excavation and backfill quantity.
Rail Crew		6	FTE	Laborers	Train			Labor only for this item	Diesel	7,800	Labor only for this item	46,800	Labor only for this item		10		7,800	Assume train crew will need to move railcars, estimate 30 crew hours per week for this task. (52 weeks, 8 years, 30 crew hrs per week)
Stockpile Management		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	1,094	7,114	1,094	274	dy	4	hrs/day	1,094	Engineers Allowance Estimate.
		2	FTE	Laborers	Pickup			1	Gasoline	1,094	1,094	2,189						
Load Barge/Truck		2	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel	-	-	-	-	tn	1000	tons/day	-	Import is covered in main excavation and backfill quantity.
		4	FTE	Laborers	Conveyors			8	Diesel	-	-	-						Additional crew to load barge
Barge/Truck Transport		0	FTE	Fuel only for this row	Barge/Semi End Dump			15	Diesel	Fuel only for this row	-		-	ton/miles	2.48	gal/1,000 ton miles		Import is covered in main excavation and backfill quantity.
Barge/Truck Crew		4	FTE	Pilot/Deck	Barge			Labor only this row	Diesel	-	Labor only this row	-	-	loads	12	hrs/load	-	Import is covered in main excavation and backfill quantity.
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	-	-	-	-	tn	500	tons/hr	-	Import is covered in main excavation and backfill quantity.
		2	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
Haul Backfill (Loading Dock to excavation)		8	FTE	Teamster	Semi End Dump			15	Diesel	-	-	-	-	tn	500	tons/hr	-	Import is covered in main excavation and backfill quantity.
Backfill		1	FTE	Foreman	Pickup			1	Gasoline	-	-	-	-	cy	400	cy/crew hr	-	Import is covered in main excavation and backfill quantity.
		1	FTE	Oper	Compactor			5	Diesel	-	-	-						
		3	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	-	-	-						
		1	EA		Walk Behind Compactor			2	Diesel	-	-	-						
Asphalt Pavement		1	FTE	Foreman	Pickup			1	Gasoline	-	-	-	-	tn	50	tn/crew hr	-	Import is covered in main excavation and backfill quantity.
		1	FTE	Oper	Paving Machine			8	Diesel	-	-	-						
		5	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
		1	FTE	Oper	Roller			5	Diesel	-	-	-						
		1	FTE	Oper	Roller			5	Diesel	-	-	-						
Haul Asphalt			Truck Driver	Teamster	Semi End Dump			15	Diesel	-	-	-	-	tn	0.05	mh/tn	-	Import is covered in main excavation and backfill quantity.
Relining, Stormdrains, Asphalt Repair Crew		1	FTE	Foreman	Pickup			1	Gasoline	1,800	1,800	1,800	18,000	lf	10	ln ft/hr	1,800	Engineer's Estimate 10 linear feet per hour. 10 year Duration.
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	1,800	5,400	1,800						
		2	FTE	Oper	Relining Equip	TBD	50	3	Diesel	1,800	5,400	3,600						
		9	FTE	Laborers	Pickup/Misc	Boiler		25	Gasoline	1,800	45,000	16,200						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	1,800	9,000	1,800						
O&M		2	FTE	Tech	Pickup/Misc			2	Gasoline	21,600	43,200	43,200	2,700	dy	8	hr/day	21,600	270 days for 10 years. Engineer's Estimate.
Relining Drain Emissions		0	pounds of Styrene															See Estimated Styrene Air Emissions Excel File in Reference Docs File. Computed estimated quantities for styrene air emission released per cured-in-place installation. This weight totals include the exposed manhole area previously submitted and an estimated mass of styrene based upon the total mass of the viny ester resin per installation described within your attached shot schedule and an estimated diffusion rate suggested by the Insituform Technologies, Inc. research and development group in Chesterfield, MO.
Waste Water Treatment Plant																		
	Predicted Volume of Untreated Water	234,230,000	gallons (over the life of the project). Assume 22,000,000 gal/yr for 10 years WWTP, 7,000,000 gal excavation dewatering over 5 years, 7,230,000 gal rain flow into excavations over 5 years. Engineers Estimate: CH2M HILL Email Jan 22, 2010. Edward Underwood/WDC.															

TABLE 1d

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 4 - Partial Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Chemicals																		
		Rate	Units	Volume of Substrate	Units	Load Size (tn)	Number of Loads	Delivery Distance	Total One-Way Mileage	Tons of Sustrate	Comments							
	Sulfuric Acid-93%	0.000487072	gal substrate/gal treated water	114,086.78	Gallon	7.5	114.3	20	2285	857	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-25%	0.000454374	gal substrate/gal treated water	106,427.97	Gallon	10	93.3	20	1865	933	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-50%	0.000176898	gal substrate/gal treated water	41,434.76	Gallon	12	30.3	20	605	363	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Ferric Chloride	5.86543E-05	gal substrate/gal treated water	13,738.59	Gallon	6	27.7	20	554	166	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer- Settling	2.28811E-05	gal substrate/gal treated water	5,359.43	Gallon	19	1.22	85	104	23	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer-Sludge	2.28811E-05	gal substrate/gal treated water	5,359.43	Gallon	19	1.22	85	104	23	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sulfur Dioxide Gas	0.001350721	pounds substrate/gal treated water	316,379.45	Pound	14	11.3	85	960	158	Tons of Substrate = Pounds* (1 ton/2000lbs)							
							Subtotal Substrate Mileage	335	6,478	2,523	tons							
							Subtotal Substrate Diesel Gallons		19,020									
Sludge																		
	Rate	Units	Mass of Sludge	Units	Density of Sludge	Units	Volume of Sludge	Units	Load Size	Units	Number of Loads	Disposal Distance	Total One-Way Mileage	Total One-Way Diesel Gallons				
Sludge	707,717	gallons of water processed/ ton of sludge cake	331	tons	0.27571	tons/CY	1,200	CY	10	CY	121	65	7,865	484				
											GAL							
Haul Chemical/Sludge									Diesel		19,504							

6,032,065 1,043,131

General Activities		
General Conditions Diesel Use	166,400	gal
General Conditions Gasoline Use	62,400	gal
Bldg Demolotion/Construction Diesel Use	202,000	gal
Bldg Demolotion/Construction Gasoline Use	32,800	gal
Rail Work Diesel Use	35,280	gal
Rail Work Gasoline Use	11,520	gal
Excavation Diesel Use	185,000	gal
Excavation Gasoline Use	50,000	gal
Trench Excavation/Backfill Diesel Use	24,505	gal
Trench Excavation/Backfill Gasoline Use	2,568	gal
Drive/Pull Sheetpile Diesel Use	-	gal
Drive/Pull Sheetpile Gasoline Use	-	gal
Stockpile Loadout/Management Diesel Use	121,489	gal
Stockpile Loadout/Management Gasoline Use	9,691	gal
Rail Transport Diesel Use	3,248,175	gal
Load Barge/Truck Diesel Use	28,211	gal
Barge/Truck Transport Diesel Use	719,872	gal
Haul Chemical/Sludge Diesel Use	19,504	gal
Haul Chemical/Sludge Gasoline Use	-	gal
Backfilling Diesel Use	50,490	gal
Backfilling Gasoline Use	8,415	gal
Asphalt Pavement/Concrete Placement Diesel Use	22,260	gal
Asphalt Pavement/Concrete Placement Gasoline Use	3,940	gal
Haul Stockpile/Backfill/Asphalt Diesel Use	888,372	gal
Storm Drain/Utility Replacement Activities		
Trench Excavation/Backfill Diesel Use	29,796	gal
Trench Excavation/Backfill Gasoline Use	5,978	gal
Stockpile Loadout/Management Diesel Use	7,114	gal
Stockpile Loadout/Management Gasoline Use	1,094	gal
Rail Transport Diesel Use	-	gal
Load Barge/Truck Diesel Use	-	gal
Barge/Truck Transport Diesel Use	-	gal
Backfilling Diesel Use	-	gal
Backfilling Gasoline Use	-	gal
Asphalt Pavement Diesel Use	-	gal
Asphalt Pavement Gasoline Use	-	gal
Haul Stockpile/Backfill/Asphalt Diesel Use	4,895	gal
Relining Crew Diesel Use	19,800	gal
Relining Crew Gasoline Use	46,800	gal
O&M Activities		
O&M Gasoline Use	43,200	gal
Chemical Delivery Diesel Use	19,020	gal
Sludge Disposal Diesel Use	1,404	gal
Total Diesel Use	5,793,587	gal
Total Gasoline Use	278,406	gal
Total Fuel Use	6,032,065	gal
General Manhours	899,851	hours
Storm Drain/Utility Replacement Manhours	143,280	hours
Total Manhours	1,043,131	hours
Remedial Timeframe:	10	yrs
Remedial Timeframe	120	months
Total Land Area Impacted:	130	acres

TABLE 1d

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 4 - Partial Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Qty	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Volume of Truck	20	tons																
Offsite Truck Traffic Mileage for Ashpalt Hauling	175,500	gal		Associated with 234,000 tons of imported asphalt paving activities														
Offsite Truck Traffic Mileage for Importing Backfill	-	gal																
Offsite Truck Traffic Mileage for Chemical/Sludge Hauling	19,504	gal																
Offsite Truck Traffic Mileage	1,443,031	miles		Assume 7.4 miles per gallon.														
Rail Transport Volume to Hazardous Waste Facility	1,751,040	tons		Includes 1,681,000 cy of COPR/ COPR-impacted, 1.44														
Rail Capacity	10,000	tons		Assume 100 ton capacity per car and 100 cars per load														
Rail Mileage to Hazardous Waste Facility	748	miles		one-way mileage from Baltimore, MD to Heritage Environmental Services in Indianaplois, IN														
Total Rail Mileage to Hazardous Waste Facility	130,978	miles																
Truck Transport Volume to Recycling Facility	234,000	tons		Includes excavated ashpalt material														
Truck Capacity	20	tons		Assume 20 ton capacity per truck														
Truck Mileage to Recycling Facility	11	miles		mileage from Potts and Callaghan Recycling Facility is 11 miles														
Total Truck Mileage to Recycling Facility	128,700	miles																
Transport Volume for Backfill Material	1,945,600	tons		Assume 1.6 tons per cubic yard														
Impacted water treated at WWTP	490,338.72	kWh		Assumption of 0.002093407 kWh/gal from G. Mah-Hing Estimate 01.19.2010. Since water volume reported as total in this alternative (instead of annual), multiplication of a year value is not necessary.														
Sludge generated at WWTP	331	tons																

Hauling Calculations

Barge Calcs		
Amount of replacement material	1945600	tons
Barge Load Size	2200	tons/barge
Number of Barge Trips	884	barge trips
Barge Frequency	1.7	shipments/week

Train Calcs		
Train Detail	100	cars/train
Train Detail	100	tons/car
Train Detail	10000	tons/train
Loading Rate	1,347	tons/day
	7.42	days to fill train
Work Period	5	days/week
Train Frequency	0.67	trains/week

Truck Calcs		
Amount of material	234000	tons
Truck Load Size	20	tons/load
Number of Truck Trips	11700	truck trips
Truck Frequency	22.5	trucks/week

	Volume of Material (CY)	Mass of Material (tons)	Gondola Car (cars)	Time (yrs)	Gondola Cars/Year	Gondola Cars/Day	Tons/Day	CY/Day	Tons/Hr	CY/Hr
Alt 4- Backcalcs	1,216,000	1,751,040	17,510	5	3,502	13.47	1,347	935	168	117
Alt 4- Value used in Hauling calcs							2,304	1,600	288	200

*Note 200 CY/hr was used in the tool.

Assumptions

1.44 tons/CY
100 tons/gondola car
260 days/year (Alt 4)
260 days/year (Alt 5)
1 shifts/day (Alt 4)
2 shifts/day (Alt 5)
8 hours/shift

TABLE 1e

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 5 - Full Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Duration	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
General Conditions		3	FTE	Engineers	Pickup			1	Gasoline	20,800	20,800	62,400	2,600	dy	8	hr/day	20,800	10 years (52 weeks x 5 days/week) x 8 hours per day
		6	FTE	PM/CM	Pickup			1	Gasoline	20,800	20,800	124,800						
		3	FTE	Laborers	Pickups			1	Gasoline	20,800	20,800	62,400						
		3	FTE	Mech	Flatbed Trk			3	Diesel	20,800	62,400	62,400						
		0	LS		Pumps/Forklift/Misc			5	Diesel	20,800	104,000	-						
Bldg Demolition		1	FTE	Supt	Pickup			1	Gasoline	2,080	2,080	2,080	260	dy	8	hr/day	2,080	1 year (52 weeks x 5 days/week) x 8 hours per day
		1	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel	2,080	20,800	2,080						
		5	FTE	Laborers	Pickup			1	Gasoline	2,080	2,080	10,400						
		1	FTE	Oper	Track Loader	CAT 973	239	6	Diesel	2,080	12,480	2,080						
		2	LS		Pumps			3	Gasoline	2,080	6,240	4,160						
		4	FTE	Teamster	Dump Trucks			10	Diesel	2,080	20,800	8,320						
Bldg Const - Civil		1	FTE	Foreman	Pickup			1	Gasoline	960	960	960	120	dy	8	hr/day	960	24 week duration
		1	FTE	Oper	Excavator	CAT 345	345	12	Diesel	960	11,520	960						
		7	FTE	Laborers	Pickup			1	Gasoline	960	960	6,720						
		2	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	960	6,240	1,920						
		0	LS		Pumps			3	Gasoline	960	2,880	-						
Bldg Const		4	FTE	Supt	Pickup			1	Gasoline	6,240	6,240	24,960	780	dy	8	hr/day	6,240	3 years (52 weeks x 5 days/week) x 8 hours per day
		3	FTE	Oper	Crane/Loader			10	Diesel	6,240	62,400	18,720						
		15	FTE	Carp/Elect	Pickup/Forklift			6	Diesel	6,240	37,440	93,600						
		10	FTE	Plum/HVAC	Pickup/Forklift			6	Diesel	6,240	37,440	62,400						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	6,240	31,200	6,240						
		8	FTE	Lab	Pumps/Gen			4	Gasoline	6,240	24,960	49,920						
		6	FTE	Teamster	Delivery Trucks			8	Diesel	6,240	49,920	37,440						
Rail Work		1	FTE	Supt	Pickup			1	Gasoline	1,440	1,440	1,440	180	dy	8	hr/day	1,440	36 week duration
		1	FTE	Oper	Excavator/Breaker/Shear	CAT 330	268	10	Diesel	1,440	14,400	1,440						
		8	FTE	Laborers	Pickups			2	Gasoline	1,440	2,880	11,520						
		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	1,440	9,360	1,440						
		2	FTE	Iron	Pumps/Gen/Welders			5	Gasoline	1,440	7,200	2,880						
		3	FTE	Teamster	Delivery Trucks			8	Diesel	1,440	11,520	4,320						
Excavation		1	FTE	Foreman	Pickup			1	Gasoline	30,983	30,983	30,983	5,577,000	cy	180	tons/crew hour	30,983	[cy/180 cy per hour = crew hours] Quantity from current cost estimate. Should also match Appendix A. 10 truckloads at 22 tons per truck per hour
		1	FTE	Oper	Excavator	CAT 345	345	12	Diesel	30,983	371,800	30,983						
		5	FTE	Laborers	Pickup			1	Gasoline	30,983	30,983	154,917						
		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	30,983	201,392	30,983						
		2	LS		Pumps			3	Gasoline	30,983	92,950	61,967						
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	480	480	480	12,000	lf	25	ln ft/ crew hour	480	[linear feet/linear ft per hour = crew hours] Quantity from the Mueser Rutledge estimate on excavations.
		1	FTE	Oper	Excavator	CAT 330	268	10	Diesel	480	4,800	480						
		5	FTE	Laborers	Pickup			1	Gasoline	480	480	2,400						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	480	2,400	480						
Trench Excavation - Rubber Tired Backhoe		1	FTE	Foreman	Pickup			1	Gasoline	480	480	480		lf				This crew assists the mainline excavation crew.
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	480	1,440	480						
		5	FTE	Laborers	Pickup			1	Gasoline	480	480	2,400						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	480	2,400	480						
Trench Backfill		1	FTE	Foreman	Pickup			1	Gasoline	480	480	480						Backfill crew.
		1	FTE	Oper	Compactor			5	Diesel	480	2,400	480						
		3	FTE	Laborers	Pickup			1	Gasoline	480	480	1,440						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	480	2,400	480						
		1	EA		Walk Behind Compactor			2	Diesel	480	960	480						
		8	FTE	Teamster	Semi End Dump			15	Diesel	635	9,525	635	12,700	tn	0.05	mh/tn	635	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S65 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation. Linked to trench excavation. Assumptions inclue: 4 ft wide, 5 ft deep, 27 is for conversion to yds, 1.6 tons/CY Vulcan Materials Estimate. Assume trench backfill will be hauled in.
												-						
Drive Sheetpile		1	FTE	Foreman	Pickup			1	Gasoline	8,000	8,000	8,000	1,000	dy	8	hour/day	8,000	Engineer's estimate: 1,000 days to drive all sheetpile.
		1	FTE	Oper	Crane			9	Diesel	8,000	72,000	8,000						
		1	FTE	Oper	Vibratory Hammer			5	Diesel	8,000	40,000	8,000						
		4	FTE	Piledrivers	Pickup			1	Gasoline	8,000	8,000	32,000						
		2	FTE	Laborers	Welder			2	Diesel	8,000	16,000	16,000						
		1	FTE	Oper	Forklift			3	Diesel	8,000	24,000	8,000						

TABLE 1e

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 5 - Full Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Duration	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Pull Sheetpile		1	FTE	Foreman	Pickup			1	Gasoline	8,000	8,000	8,000	1,000	dy	8	hour/day	8,000	Assumed that pulling crew will work the same hours a driving crew.
		1	FTE	Oper	Crane			9	Diesel	8,000	72,000	8,000						
		1	FTE	Oper	Vibratory Hammer			5	Diesel	8,000	40,000	8,000						
		4	FTE	Piledrivers	Pickup			1	Gasoline	8,000	8,000	32,000						
		2	FTE	Laborers	Welder			2	Diesel	8,000	16,000	16,000						
		1	FTE	Oper	Forklift			3	Diesel	8,000	24,000	8,000						
Haul to Stockpile		6	FTE	Teamster	Semi End Dump			15	Diesel	24,089	361,333	144,533	4,336,000	cy	180	cy/hr	24,089	Assumed 30 minute round trip. (6 trucks haul 15 cy per load - 12 loads per hour) 1.44 tons/CY (Email w/ Brett Lester).
												-						
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	21,680	140,920	21,680	4,336,000	cy	200	cy/hr	21,680	Loader to load railcar or trucks hauling from clean stockpile. 1.44 tons/CY (Email w/ Brett Lester).
		2	FTE	Laborers	Pickup			1	Gasoline	21,680	21,680	43,360						
Rail Transport			FTE	TrainOp	Train			Calculation is gal/1000 miles	Diesel		11,675,981		4,670,392,320	ton/miles	2.5	gal/1,000 ton miles		Value from Table 13 in this tool (NREL Table). Units [gallons per 1000 ton-miles]. Assuming 748 miles per trip one way trip for Heritiage Recycled material is transported via truck in this alternatve, not rail. 1.44 tons/CY (Email w/ Brett Lester)
Rail Crew		6	FTE	TrainOp	Train			Labor only for this item	Diesel	12,480		74,880					12,480	Assume train crew will need to move railcars, estimate 30 crew hours per week for this task. (52 weeks, 8 years, 30 crew hrs per week)
Stockpile Management		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	8,000	52,000	8,000	2,000	dy	4	hrs/day	8,000	Estimators Assumption: Alloted time to maintain stockpile.
		2	FTE	Laborers	Pickup			1	Gasoline	8,000	8,000	16,000						
Load Barge/Truck		2	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel	55,501	360,755	111,002	6,937,600	tn	1000	tons/day	55,501	Replace off-hauled material. [Excavated material - clean spoils - asphalt material = amount that needs to be imported.] Eight hour day assumed.
		4	FTE	Laborers	Conveyors			8	Diesel	55,501	444,006	222,003						
Barge/Truck Transport		0	EA	Equipment only in this row	Barge/Semi End Dump			Calculation is gal/1000 miles	Diesel		2,566,912		693,760,000	ton/miles	3.7	gal/1,000 ton miles		Value from Table 13 in this tool (NREL Table). Units [gallons per 1000 ton-miles]. 50 miles from quarry, 100 miles roundtrip
Barge/Truck Crew		4	FTE	Pilot/Deck	Barge			Labor only for this item	Diesel	55,501		222,003	4,625	loads	12	hrs/load	55,501	1,500 tons per barge load. (Assumption from email correspondance between Bob Steele and John Smack, the regional Sales Representative for Vulcan Materials)
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	13,875	90,189	13,875	6,937,600	tn	500	tns/hr	13,875	Loader to load trucks. This value is exactly equal to the excavated quantity. Reference cost estimate for value.
		2	FTE	Laborers	Pickup			1	Gasoline	13,875	13,875	27,750						
Haul Backfill (Loading Dock or clean stockpile to excavation)		8	FTE	Teamster	Semi End Dump			15	Diesel	13,875	1,665,024	111,002	6,937,600	tn	500	tns/hr	13,875	Assumed 20 minute round trip. (8 trucks haul 20 ton per load - 24 loads per hour) which is roughly 3 loads per hour per truck. 24 loads per hour. Each load about 20 tons.
Backfill		1	FTE	Foreman	Pickup			1	Gasoline	10,840	10,840	10,840	4,336,000	cy	400	cy/crew hr	10,840	Production rate assumption is 400 cy/crew hour. Quantity stated in cost estimate.
		1	FTE	Oper	Compactor			5	Diesel	10,840	54,200	10,840						
		3	FTE	Laborers	Pickup			1	Gasoline	10,840	10,840	32,520						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	10,840	54,200	10,840						
		1	EA		Walk Behind Compactor			2	Diesel	10,840	21,680	10,840						
Asphalt Pavement		1	FTE	Foreman	Pickup			1	Gasoline	1,320	1,320	1,320	264,000	tn	200	tn/crew hr	1,320	Production rate assumption is 200 tn/crew hour. Quantity stated in cost estimate.
		1	FTE	Oper	Paving Machine			8	Diesel	1,320	10,560	1,320						
		5	FTE	Laborers	Pickup			1	Gasoline	1,320	1,320	6,600						
		1	FTE	Oper	Roller			5	Diesel	1,320	6,600	1,320						
		1	FTE	Oper	Roller			5	Diesel	1,320	6,600	1,320						
Haul Asphalt		6	Truck Drivers	Teamster	Semi End Dump			15	Diesel	13,200	198,000	13,200	264,000	tn	0.05	mh/tons	13,200	0.05 mh/tn - assumes one hour haul for 20 ton load. Note the value in S113 is really in man hours/ton not crew hrs /ton. This is correct for the way that this equation was derived. It is also ok that the quantity of FTEs isn't included in equation.
Concrete Placement		1	FTE	Foreman	Pickup			1	Gasoline	800	800	800	100	dy	8	hr/day	800	Assume 100 days total.
		1	EA		Generator			2	Gasoline	800	1,600	800						
		4	FTE	Laborers	Pickup			1	Gasoline	800	800	3,200						
		2	LS		Vibrators			3	Diesel	800	2,400	1,600						
		2	FTE	Cement Mason					Hand Tools	800	-	1,600						
Storm Drain/Utility Replacement																		
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	228	228	228	5,700	lf	25	ln ft/crew hr	228	[linear feet/linear ft per hour = crew hours] Quantity from cost estimate, found under replace remaining storm drains section. Does not include the lateral lines.
		1	FTE	Oper	Excavator	CAT 330	268	10	Diesel	228	2,280	228						
		5	FTE	Laborers	Pickup			1	Gasoline	228	228	1,140						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	228	1,140	228						

TABLE 1e

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 5 - Full Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Duration	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Trench Excavation		1	FTE	Foreman	Pickup			1	Gasoline	1,689	1,689	1,689	59,100	lf	35	ln ft/ cr hour	1,689	This crew installs the laterals to the mainline. Includes utility relocation. Quantity from cost estimate. Production rate assumed to be 35 linear feet per crew hour. (53,400 for utility relocation) (5700 for lateral lines off of storm drains)
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	1,689	5,066	1,689						
		5	FTE	Laborers	Pickup			1	Gasoline	1,689	1,689	8,443						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	1,689	8,443	1,689						
Trench Backfill		1	FTE	Foreman	Pickup			1	Gasoline	1,072	1,072	1,072						Backfill crew. Hours based on mainline crew hours plus one-half lateral crew hours.
		1	FTE	Oper	Compactor			5	Diesel	1,072	5,361	1,072						
		3	FTE	Laborers	Pickup			1	Gasoline	1,072	1,072	3,217						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	1,072	5,361	1,072						
		1	EA		Walk Behind Compactor			2	Diesel	1,072	2,145	1,072						
		8	FTE	Teamster	Semi End Dump			15	Diesel	-	-	-	-	tn	0.05	mh/tn	-	Import is covered in main excavation and backfill quantity.
Haul to Stockpile		6	FTE	Teamster	Semi End Dump			15	Diesel	324	4,861	1,944	58,333	cy	180	cy/hr	324	Assumed 30 minute round trip. (6 trucks haul 15 cy per load - 12 loads per hour) 1.44 tons/CY (Email w/ Brett Lester).
												-						
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	-	-	-	-	cy	250	cy/hr	-	Import is covered in main excavation and backfill quantity.
		2	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
Rail Transport		6	Train Operators	TrainOp	Train			Calculation is gal/1000 miles	Diesel		-		-	ton/miles	3.7	gal/1,000 ton miles		Import is covered in main excavation and backfill quantity.
Rail Crew		This labor is covered in above item	FTE	Laborers	Train			Labor only for this item	Diesel									Assume train crew will need to move railcars, estimate 30 crew hours per week for this task. (52 weeks, 8 years, 30 crew hrs per week)
Stockpile Management		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	1,094	7,114	1,094	274	dy	4	hrs/day	1,094	Engineers Allowance Estimate.
		2	FTE	Laborers	Pickup			1	Gasoline	1,094	1,094	2,189						
Load Barge/Truck		2	FTE	Oper	RT Loader (2)	CAT 966	283	6.5	Diesel	-	-	-	-	tn	1000	tons/day	-	Import is covered in main excavation and backfill quantity.
		4	FTE	Laborers	Conveyors			8	Diesel	-	-	-						
Barge/Truck Transport		0	FTE	Equipment only in this row	Barge/Semi End Dump			Calculation is gal/1000 miles	Diesel		-		-	ton/miles	2.48	gal/1,000 ton miles	-	Import is covered in main excavation and backfill quantity.
Barge/Truck Crew		4	FTE	Pilot/Deck	Barge			Labor only this row	Diesel	-	Labor only this row	-	-	loads	12	hrs/load	-	Import is covered in main excavation and backfill quantity.
Stockpile Loadout		1	FTE	Oper	RT Loader	CAT 966	283	6.5	Diesel	-	-	-	-	tn	500	tons/hr	-	Loader to load trucks
		2	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
Haul Backfill (Loading Dock to excavation)		8	FTE	Teamster	Semi End Dump			15	Diesel	-	-	-	-	tn	500	tons/hr	-	Import is covered in main excavation and backfill quantity.
Backfill		1	FTE	Foreman	Pickup			1	Gasoline	-	-	-	-	cy	400	cy/crew hr	-	Import is covered in main excavation and backfill quantity.
		1	FTE	Oper	Compactor			5	Diesel	-	-	-						
		3	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	-	-	-						
		1	EA		Walk Behind Compactor			2	Diesel	-	-	-						
Asphalt Pavement		1	FTE	Foreman	Pickup			1	Gasoline	-	-	-	-	tn	50	tn/crew hr	-	Import is covered in main excavation and backfill quantity.
		1	FTE	Oper	Paving Machine			8	Diesel	-	-	-						
		5	FTE	Laborers	Pickup			1	Gasoline	-	-	-						
		1	FTE	Oper	Roller			5	Diesel	-	-	-						
		1	FTE	Oper	Roller			5	Diesel	-	-	-						
Haul Asphalt		6	Truck Driver	Teamster	Semi End Dump			15	Diesel	-	-	-	-	tn	0.05	mh/tn	-	Import is covered in main excavation and backfill quantity.
Relining, Stormdrains, Asphalt Repair Crew		1	FTE	Foreman	Pickup			1	Gasoline	2,340	2,340	2,340	23,400	lf	10	ln ft/hr	2,340	Engineer's Estimate 10 linear feet per hour. 13 year duration.
		1	FTE	Oper	RT Backhoe	CAT 416	78	3	Diesel	2,340	7,020	2,340						
		2	FTE	Oper	Relining Equip	TBD	50	3	Diesel	2,340	7,020	4,680						
		9	FTE	Laborers	Pickup/Misc	Boiler		25	Gasoline	2,340	58,500	21,060						
		1	FTE	Oper	RT Loader	CAT 950	216	5	Diesel	2,340	11,700	2,340						
O&M	GW Plant	6	FTE	Tech	Pickup/Misc			2	Gasoline	37,960	75,920	227,760	4,745	dy	8	hr/day	37,960	365 days for 13 years. Engineer's Estimate. Crew size is larger due to handling of dewatering water.
Relining Drain Emissions		0	pounds of Styrene															See Estimated Styrene Air Emissions Excel File in Reference Docs File. Computed estimated quantities for styrene air emission released per cured-in-place installation. This weight totals include the exposed manhole area previously submitted and an estimated mass of styrene based upon the total mass of the vinyl ester resin per installation described within your attached shot schedule and an estimated diffusion rate suggested by the Insituform Technologies, Inc. research and development group in Chesterfield, MO.
Waste Water Treatment Plant																		
	Predicted Volume of Untreated Water	2,835,000,000	2,725,000,000 gallons (over the life of the project) + 22,000,000 gallons/year for five years. Engineers Estimate: CH2M HILL email Jan 19th, 2010. Edward Underwood/WDC & Discussion w/ Paul Favara on how to add the "extra" five years.															

TABLE 1e

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 5 - Full Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Duration	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Chemicals																		
		Rate	Units	Volume of Substrate	Units	Load Size (tn)	Number of Loads	Delivery Distance	Total One-Way Mileage	Tons of Sustrate	Comments							
	Sulfuric Acid-93%	0.000487072	gal substrate/gal treated water	1,380,847.93	Gallon	7.5	1382.8	20	27,657	10,371	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-25%	0.000454374	gal substrate/gal treated water	1,288,149.70	Gallon	10	1128.8	20	22,575	11,288	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sodium Hydroxide-50%	0.000176898	gal substrate/gal treated water	501,505.11	Gallon	12	366.2	20	7,324	4,395	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Ferric Chloride	5.86543E-05	gal substrate/gal treated water	166,284.86	Gallon	6	335.1	20	6,703	2,011	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer- Settling	2.28811E-05	gal substrate/gal treated water	64,867.84	Gallon	19	14.82	85	1,259	282	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Polymer-Sludge	2.28811E-05	gal substrate/gal treated water	64,867.84	Gallon	19	14.82	85	1,259	282	Tons of Substrate = Gallons * 3,785.412cm^3/gal*Density (g/cm^3)*(1ton/907184.7g)							
	Sulfur Dioxide Gas	0.001350721	pounds substrate/gal treated water	3,829,294.91	Pound	14	136.8	85	11,625	1,915	Tons of Substrate = Pounds* (1 ton/2000lbs)							
							Subtotal Substrate Mileage	335	78,402	30,542	tons							
							Subtotal Substrate Diesel Gallon		230,210									
Sludge																		
	Rate	Units	Mass of Sludge	Units	Density of Sludge	Units	Volume of Sludge	Units	Load Size	Units	Number of Loads	Delivery Distance	Total One-Way Mileage	Total One-Way Diesel Gallons				
Sludge	707,717	gallons of water processed/ ton of sludge cake	4,006	tons	0.27571	tons/CY	14,529	CY	10	CY	1453	65	94,445	5,859				
											GAL							
Haul Chemical/Sludge									Diesel		236,069							
											19,699,332	2,563,143						

General Activities		
General Conditions Diesel Use	166,400	gal
General Conditions Gasoline Use	62,400	gal
Bldg Demolotion/Construction Diesel Use	290,240	gal
Bldg Demolotion/Construction Gasoline Use	46,400	gal
Rail Work Diesel Use	35,280	gal
Rail Work Gasoline Use	11,520	gal
Excavation Diesel Use	573,192	gal
Excavation Gasoline Use	154,917	gal
Trench Excavation/Backfill Diesel Use	26,325	gal
Trench Excavation/Backfill Gasoline Use	2,880	gal
Drive/Pull Sheetpile Diesel Use	304,000	gal
Drive/Pull Sheetpile Gasoline Use	32,000	gal
Stockpile Loadout/Management Diesel Use	283,109	gal
Stockpile Loadout/Management Gasoline Use	43,555	gal
Rail Transport Diesel Use	11,675,981	gal
Load Barge/Truck Diesel Use	804,762	gal
Barge/Truck Transport Diesel Use	2,566,912	gal
Haul Chemical/Sludge Diesel Use	236,069	gal
Haul Chemical/Sludge Gasoline Use	-	gal
Backfilling Diesel Use	130,080	gal
Backfilling Gasoline Use	21,680	gal
Asphalt Pavement/Concrete Placement Diesel Use	26,160	gal
Asphalt Pavement/Concrete Placement Gasoline Use	5,840	gal
Haul Stockpile/Backfill/Asphalt Diesel Use	2,224,357	gal
Storm Drain/Utility Replacement Activities		
Trench Excavation/Backfill Diesel Use	29,796	gal
Trench Excavation/Backfill Gasoline Use	5,978	gal
Stockpile Loadout/Management Diesel Use	7,114	gal
Stockpile Loadout/Management Gasoline Use	1,094	gal
Rail Transport Diesel Use	-	gal
Load Barge/Truck Diesel Use	-	gal
Barge/Truck Transport Diesel Use	-	gal
Backfilling Diesel Use	-	gal
Backfilling Gasoline Use	-	gal
Asphalt Pavement Diesel Use	-	gal
Asphalt Pavement Gasoline Use	-	gal
Haul Stockpile/Backfill/Asphalt Diesel Use	4,861	gal
Relining Crew Diesel Use	25,740	gal
Relining Crew Gasoline Use	60,840	gal
O&M Activities		
O&M Gasoline Use	75,920	gal
Chemical Delivery Diesel Use	230,210	gal
Sludge Disposal Diesel Use	1,404	gal
Total Diesel Use	19,641,990	gal
Total Gasoline Use	525,024	gal
Total Fuel Use	19,699,332	gal
General Manhours	2,274,557	hours
Storm Drain/Utility Replacement Manhours	288,586	hours
Total Manhours	2,563,143	hours
Remedial Timeframe:	13	yrs
Remedial Timeframe	156	months
Total Land Area Impacted:	148	acres
Volume of Truck	20	tons

TABLE 1e

DATA ENTRY FORM FOR CORRECTIVE MEASURES ALTERNATIVE 5 - Full Excavation

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Activity		Qty	Units	Labor	Equipment	Model	HP	Fuel (gal)/HR	Fuel Type	Total Crew Hrs	Fuel Total	Total MH	Total Duration	Units	Hrs/Day Units/hr	Unit Detail	Total Crew Hrs	Comments
Offsite Truck Traffic Mileage for Ashpalt Hauling	198,000	gal		Associated with 264,000 tons of imported asphalt paving activities														
Offsite Truck Traffic Mileage for Importing Backfill	-	gal																
Offsite Truck Traffic Mileage for Chemical/Sludge Hauling	236,069	gal																
Offsite Truck Traffic Mileage	3,212,108	miles		Assume 7.4 miles per gallon.														
Rail Transport Volume to Hazardous Waste Facility	6,243,840	tons		Assume 1.44 tons per cubic yard for COPR/ COPR-impacted material with 4,336,000 cubic yards														
Rail Capacity	10,000	tons		Assume 100 ton capacity per car and 100 cars per load														
Rail Mileage to Hazardous Waste Facility	748	miles		one-way mileage from Baltimore, MD to Heritage Environmental Services in Indianaplois, IN														
Total Rail Mileage to Hazardous Waste Facility	467,039	miles																
Truck Transport Volume to Recycling Facility	264,000	tons		pavement material to be reused as backfill														
Truck Capacity	20	tons		Assume 20 ton capacity per truck														
Truck Mileage to Recycling Facility	11	miles		mileage from Potts and Callaghan Recycling Facility is 11 miles														
Total Truck Mileage to Recycling Facility	145,200	miles																
Transport Volume for Backfill Material	6,937,600	tons																
Impacted water treated at WWTP	5,934,808.85	kWh		Assumption of 0.002093407 kWh/gal from G. Mah-Hing Estimate 01.19.2010. Since water volume reported as total in this alternative (instead of annual), multiplication of a year value is not necessary.														
Sludge generated at WWTP	4,006	tons																

Hauling Calculations

Barge Calcs		
Amount of replacement material	6937600	tons
Barge Load Size	2200	tons/barge
Number of Barge Trips	3153.45	barge trips
Barge Frequency	4.66	shipments/week

Train Calcs		
Train Detail	100	cars/train
Train Detail	100	tons/car
Train Detail	10000	tons/train
Loading Rate	3002	tons/day
	3.33	days to fill train
Work Period	5.00	days/week
Train Frequency	1.50	trains/week

Truck Calcs		
Amount of material	264000	tons
Truck Load Size	20	tons/load
Number of Truck Trips	13200	truck trips
Truck Frequency	19.53	trucks/week

	Volume of Material (CY)	Mass of Material (tons)	Gondola Car (cars)	Time (yrs)	Gondola Cars/Year	Gondola Cars/Day	Tons/Day	CY/Day	Tons/Hr	CY/Hr
Alt 5- Backcalcs	4,336,000	6,243,840	62,438	8	7,805	30.02	3,002	2,085	188	130
Alt 5- Value used in Hauling calcs							4,608	3,200	288	200

*Note 200 CY/hr was used in the tool.

Assumptions

1.44 tons/CY
100 tons/gondola car
260 days/year (Alt 4)
260 days/year (Alt 5)
1 shifts/day (Alt 4)
2 shifts/day (Alt 5)
8 hours/shift

TABLE 2

SUMMARY OF NON-RENEWABLE ENERGY FOOTPRINT METRICS FOR SHORT-TERM EFFECTIVENESS

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Item/Activity	Impact	Unit	Net LC Impact	Unit	Comments and References for Data Entry
ALTERNATIVE 1 - No Further Action					
General Activities					
General Conditions Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
General Conditions Gasoline Use	5,200	gal	16	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Bldg Demolotion/Construction Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Bldg Demolotion/Construction Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Work Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Work Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Excavation Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Excavation Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Trench Excavation/Backfill Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Trench Excavation/Backfill Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Drive/Pull Sheetpile Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Drive/Pull Sheetpile Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Load Barge/Truck Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Barge/Truck Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Haul Chemical/Sludge Diesel Use	56,563	gal	189	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Haul Chemical/Sludge Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement/Concrete Placement Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement/Concrete Placement Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Haul Stockpile/Backfill/Asphalt Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Storm Drain/Utility Replacement Activities					
Trench Excavation/Backfill Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Trench Excavation/Backfill Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Load Barge/Truck Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Barge/Truck Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Haul Stockpile/Backfill/Asphalt Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Relining Crew Diesel Use	214,500	gal	719	tons	Activity not applicable for alternative.
Relining Crew Gasoline Use	507,000	gal	1,572	tons	Activity not applicable for alternative.
Chemical Delivery Diesel Use	55,159	gal	185	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Sludge Disposal Diesel Use	1,404	gal	5	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
O&M Activities					
O&M Gasoline Use	129,600	gal	402	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Power Usage for Wastewater Treatment	1,421,998	kWh	1,421,998	kWh	Assume 30 year duration of water treatment.
Alternative 1 - Total General Diesel Use (Single Unit Truck)	56,563	gal	189	tons	
Alternative 1 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	271,063	gal	908.1	tons	
Alternative 1 - Total Barge Transport Diesel Use	0	gal	0	tons	
Alternative 1 - Total Railway Transport Diesel Use	0	gal	0	tons	
Alternative 1 - Total Diesel Use	327,626	gal	1,097.5	tons	
Alternative 1 - Total General Gasoline Use	5,200	gal	16	tons	
Alternative 1 - Total Storm Draining/Utility Replacement Gasoline Use	507,000	gal	1,572	tons	
Alternative 1 - Total O&M Gasoline Use	129,600	gal	402	tons	
Alternative 1 - Total Gasoline Use	641,800	gal	1,990	tons	
Alternative 1 - Total Fuel Use	**969,426**	**gal**	**3,087**	**tons**	
Alternative 1 - Total Power Use	**1,421,998**	**kWh**	**1,421,998**	**kWh**	

TABLE 2

SUMMARY OF NON-RENEWABLE ENERGY FOOTPRINT METRICS FOR SHORT-TERM EFFECTIVENESS

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Item/Activity	Impact	Unit	Net LC Impact	Unit	Comments and References for Data Entry
ALTERNATIVE 2 - Basic Containment					
General Activities					
General Conditions Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
General Conditions Gasoline Use	10,400	gal	32	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Bldg Demolotion/Construction Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Bldg Demolotion/Construction Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Work Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Work Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Excavation Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Excavation Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Trench Excavation/Backfill Diesel Use	59,125	gal	198	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Gasoline Use	5,600	gal	17	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Drive/Pull Sheetpile Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Drive/Pull Sheetpile Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Diesel Use	1,587	gal	5	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Gasoline Use	244	gal	0.76	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Load Barge/Truck Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Barge/Truck Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Haul Chemical/Sludge Diesel Use	56,563	gal	189	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Haul Chemical/Sludge Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	516	gal	2	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Backfilling Gasoline Use	86	gal	0.27	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Asphalt Pavement/Concrete Placement Diesel Use	1,260	gal	4	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Asphalt Pavement/Concrete Placement Gasoline Use	140	gal	0.43	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Haul Stockpile/Backfill/Asphalt Diesel Use	33,527	gal	112	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Storm Drain/Utility Replacement Activities					
Trench Excavation/Backfill Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Trench Excavation/Backfill Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Load Barge/Truck Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Barge/Truck Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Haul Stockpile/Backfill/Asphalt Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Relining Crew Diesel Use	214,500	gal	719	tons	Activity not applicable for alternative.
Relining Crew Gasoline Use	507,000	gal	1,572	tons	Activity not applicable for alternative.
Chemical Delivery Diesel Use	55,159	gal	185	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Sludge Disposal Diesel Use	1,404	gal	5	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
O&M Activities					
O&M Gasoline Use:	129,600	gal	402	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Power Usage for Wastewater Treatment	1,421,998	kWh	1,421,998	kWh	Assume 30 year duration of water treatment.
Alternative 2 - Total General Diesel Use (Single Unit Truck)	152,577	gal	511	tons	
Alternative 2 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	271,063	gal	908.1	tons	
Alternative 2 - Total Barge Transport Diesel Use	0	gal	0	tons	
Alternative 2 - Total Railway Transport Diesel Use	0	gal	0	tons	
Alternative 2 - Total Diesel Use	423,639	gal	1,419	tons	
Alternative 2 - Total General Gasoline Use	16,470	gal	51	tons	
Alternative 2 - Total Storm Draining/Utility Replacement Gasoline Use	507,000	gal	1,572	tons	
Alternative 2 - Total O&M Gasoline Use	129,600	gal	402	tons	
Alternative 2 - Total Gasoline Use	653,070	gal	2,025	tons	
Alternative 2 - Total Fuel Use	**1,076,709**	gal	**3,444**	**tons**	
Alternative 2 - Total Power Use	**1,421,998**	**kWh**	**1,421,998**	**kWh**	

TABLE 2
SUMMARY OF NON-RENEWABLE ENERGY FOOTPRINT METRICS FOR SHORT-TERM EFFECTIVENESS
PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Item/Activity	Impact	Unit	Net LC Impact	Unit	Comments and References for Data Entry
ALTERNATIVE 3 - Enhanced Isolation and Containment					
General Activities					
General Conditions Diesel Use	166,400	gal	557	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
General Conditions Gasoline Use	62,400	gal	193	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Bldg Demolotion/Construction Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Bldg Demolotion/Construction Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Work Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Rail Work Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Excavation Diesel Use	1,429	gal	5	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Excavation Gasoline Use	386	gal	1	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Diesel Use	0	gal	NA	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Gasoline Use	0	gal	NA	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Drive/Pull Sheetpile Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Drive/Pull Sheetpile Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Diesel Use	452	gal	2	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Gasoline Use	70	gal	0.22	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Load Barge/Truck Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Barge/Truck Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Haul Chemical/Sludge Diesel Use	5,185	gal	17	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Haul Chemical/Sludge Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	417	gal	1	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Backfilling Gasoline Use	70	gal	0.22	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Asphalt Pavement/Concrete Placement Diesel Use	180	gal	1	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Asphalt Pavement/Concrete Placement Gasoline Use	240	gal	1	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Haul Stockpile/Backfill/Asphalt Diesel Use	17,838	gal	60	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Storm Drain/Utility Replacement Activities					
Trench Excavation/Backfill Diesel Use	5,856	gal	20	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Gasoline Use	455	gal	1	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Diesel Use	2,791	gal	9	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Gasoline Use	429	gal	1	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Load Barge/Truck Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Barge/Truck Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	68	gal	0.23	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Backfilling Gasoline Use	11	gal	0.035	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Asphalt Pavement Diesel Use	126	gal	0.42	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Asphalt Pavement Gasoline Use	14	gal	0.043	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Haul Stockpile/Backfill/Asphalt Diesel Use	4,389	gal	15	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Relining Crew Diesel Use	214,500	gal	719	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Relining Crew Gasoline Use	507,000	gal	1,572	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Chemical Delivery Diesel Use	5,056	gal	17	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Sludge Disposal Diesel Use	1,404	gal	5	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
O&M Activities					
O&M Gasoline Use:	21,600	gal	67	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Power Usage for Wastewater Treatment	130,350	kWh	130,350	kWh	Assume 5 year duration of water treatment.
Alternative 3 - Total General Diesel Use (Single Unit Truck)	191,901	gal	643	tons	
Alternative 3 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	234,190	gal	785	tons	
Alternative 3 - Total Barge Transport Diesel Use	0	gal	0	tons	
Alternative 3 - Total Railway Transport Diesel Use	0	gal	0	tons	
Alternative 3 - Total Diesel Use	426,091	gal	1,427	tons	
Alternative 3 - Total General Gasoline Use	63,165	gal	196	tons	
Alternative 3 - Total Storm Draining/Utility Replacement Gasoline Use	507,910	gal	1,575	tons	
Alternative 3 - Total O&M Gasoline Use	21,600	gal	67	tons	
Alternative 3 - Total Gasoline Use	592,675	gal	1,837	tons	
Alternative 3 - Total Fuel Use	**1,018,765**	gal	**3,265**	**tons**	
Alternative 3 - Total Power Use	**130,350**	**kWh**	**130,350**	**kWh**	

TABLE 2

SUMMARY OF NON-RENEWABLE ENERGY FOOTPRINT METRICS FOR SHORT-TERM EFFECTIVENESS

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Item/Activity	Impact	Unit	Net LC Impact	Unit	Comments and References for Data Entry
ALTERNATIVE 4 - Partial Excavation					
General Activities					
General Conditions Diesel Use	166,400	gal	557	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
General Conditions Gasoline Use	62,400	gal	193	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Bldg Demolotion/Construction Diesel Use	202,000	gal	677	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Bldg Demolotion/Construction Gasoline Use	32,800	gal	102	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Work Diesel Use	35,280	gal	118	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Rail Work Gasoline Use	11,520	gal	36	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Excavation Diesel Use	185,000	gal	620	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Excavation Gasoline Use	50,000	gal	155	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Diesel Use	24,505	gal	82	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Gasoline Use	2,568	gal	8	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Drive/Pull Sheetpile Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Drive/Pull Sheetpile Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Stockpile Loadout/Management Diesel Use	121,489	gal	407	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Gasoline Use	9,691	gal	30	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Transport Diesel Use	3,248,175	gal	10,881	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Load Barge/Truck Diesel Use	28,211	gal	95	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Barge/Truck Transport Diesel Use	719,872	gal	2,412	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Haul Chemical/Sludge Diesel Use	19,504	gal	65	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Haul Chemical/Sludge Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	50,490	gal	169	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Backfilling Gasoline Use	8,415	gal	26	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Asphalt Pavement/Concrete Placement Diesel Use	22,260	gal	75	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Asphalt Pavement/Concrete Placement Gasoline Use	3,940	gal	12	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Haul Stockpile/Backfill/Asphalt Diesel Use	888,372	gal	2,976	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Storm Drain/Utility Replacement Activities					
Trench Excavation/Backfill Diesel Use	29,796	gal	100	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Gasoline Use	5,978	gal	19	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Diesel Use	7,114	gal	24	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Gasoline Use	1,094	gal	3	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Load Barge/Truck Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Barge/Truck Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Haul Stockpile/Backfill/Asphalt Diesel Use	4,895	gal	16	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Relining Crew Diesel Use	19,800	gal	66	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Relining Crew Gasoline Use	46,800	gal	145	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Chemical Delivery Diesel Use	19,020	gal	64	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Sludge Disposal Diesel Use	1,404	gal	5	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
O&M Activities					
O&M Gasoline Use:	43,200	gal	134	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Power Usage for Wastewater Treatment	490,339	kWh	490,339	kWh	Assume 10 year duration of water treatment.
Alternative 4 - Total General Diesel Use (Single Unit Truck)	1,715,300	gal	5,746	tons	
Alternative 4 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	82,029	gal	275	tons	
Alternative 4 - Total Barge Transport Diesel Use	748,083	gal	2,506	tons	
Alternative 4 - Total Railway Transport Diesel Use	3,248,175	gal	10,881	tons	
Alternative 4 - Total Diesel Use	5,793,587	gal	19,409	tons	
Alternative 4 - Total General Gasoline Use	181,334	gal	562	tons	
Alternative 4 - Total Storm Draining/Utility Replacement Gasoline Use	53,872	gal	167	tons	
Alternative 4 - Total O&M Gasoline Use	43,200	gal	134	tons	
Alternative 4 - Total Gasoline Use	278,406	gal	863	tons	
Alternative 4 - Total Fuel Use	**6,071,993**	gal	**20,272**	**tons**	
Alternative 4 - Total Power Use	**490,339**	**kWh**	**490,339**	**kWh**	

TABLE 2

SUMMARY OF NON-RENEWABLE ENERGY FOOTPRINT METRICS FOR SHORT-TERM EFFECTIVENESS

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Item/Activity	Impact	Unit	Net LC Impact	Unit	Comments and References for Data Entry
ALTERNATIVE 5 - Full Excavation					
General Activities					
General Conditions Diesel Use	166,400	gal	557	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
General Conditions Gasoline Use	62,400	gal	193	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Bldg Demolotion/Construction Diesel Use	290,240	gal	972	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Bldg Demolotion/Construction Gasoline Use	46,400	gal	144	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Work Diesel Use	35,280	gal	118	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Rail Work Gasoline Use	11,520	gal	36	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Excavation Diesel Use	573,192	gal	1,920	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Excavation Gasoline Use	154,917	gal	480	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Diesel Use	26,325	gal	88	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Gasoline Use	2,880	gal	9	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Drive/Pull Sheetpile Diesel Use	304,000	gal	1,018	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Drive/Pull Sheetpile Gasoline Use	32,000	gal	99	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Diesel Use	283,109	gal	948	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Gasoline Use	43,555	gal	135	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Transport Diesel Use	11,675,981	gal	39,115	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Load Barge/Truck Diesel Use	804,762	gal	2,696	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Barge/Truck Transport Diesel Use	2,566,912	gal	8,599	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Haul Chemical/Sludge Diesel Use	236,069	gal	791	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Haul Chemical/Sludge Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	130,080	gal	436	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Backfilling Gasoline Use	21,680	gal	67	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Asphalt Pavement/Concrete Placement Diesel Use	26,160	gal	88	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Asphalt Pavement/Concrete Placement Gasoline Use	5,840	gal	18	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Haul Stockpile/Backfill/Asphalt Diesel Use	2,224,357	gal	7,452	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Storm Drain/Utility Replacement Activities					
Trench Excavation/Backfill Diesel Use	29,796	gal	100	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Trench Excavation/Backfill Gasoline Use	5,978	gal	19	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Diesel Use	7,114	gal	24	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Stockpile Loadout/Management Gasoline Use	1,094	gal	3	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Rail Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Load Barge/Truck Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Barge/Truck Transport Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Backfilling Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement Diesel Use	0	gal	NA	tons	Activity not applicable for alternative.
Asphalt Pavement Gasoline Use	0	gal	NA	tons	Activity not applicable for alternative.
Haul Stockpile/Backfill/Asphalt Diesel Use	4,861	gal	16	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Relining Crew Diesel Use	25,740	gal	86	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Relining Crew Gasoline Use	60,840	gal	189	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Chemical Delivery Diesel Use	230,210	gal	771	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
Sludge Disposal Diesel Use	1,404	gal	5	tons	Assume density of diesel fuel oil is 6.7 lbs/gal (Ref: API, 2004).
O&M Activities					
O&M Gasoline Use:	75,920	gal	235	tons	Assume density of unleaded gasoline is 6.2 lbs/gal (Ref: API, 2004).
Power Usage for Wastewater Treatment	5,934,809	kWh	5,934,809	kWh	Assume 13 year duration of water treatment.
Alternative 5 - Total General Diesel Use (Single Unit Truck)	4,295,211	gal	14,389	tons	
Alternative 5 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	299,125	gal	1,002	tons	
Alternative 5 - Total Barge Transport Diesel Use	3,371,674	gal	11,295	tons	
Alternative 5 - Total Railway Transport Diesel Use	11,675,981	gal	39,115	tons	
Alternative 5 - Total Diesel Use	19,641,990	gal	65,801	tons	
Alternative 5 - Total General Gasoline Use	381,192	gal	1,182	tons	
Alternative 5 - Total Storm Draining/Utility Replacement Gasoline Use	67,912	gal	211	tons	
Alternative 5 - Total O&M Gasoline Use	75,920	gal	235	tons	
Alternative 5 - Total Gasoline Use	525,024	gal	1,628	tons	
Alternative 5 - Total Fuel Use	**20,167,014**	gal	**67,428**	**tons**	
Alternative 5 - Total Power Use	**5,934,809**	**kWh**	**5,934,809**	**kWh**	

Key:
API = American Petroleum Institute; gal = gallon; lbs = pounds; LC = life cycle;
NA = not applicable; O&M = operation and maintenance

TABLE 3

EMISSIONS INTENSITY METRICS FOR SHORT-TERM EFFECTIVENESS

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Alternative	Greenhouse Gas Emissions			Total Greenhouse Gas Emissions (tons CO_2 equivalent)	NO_x Emissions (tons)	$PM_{2.5\text{-}10}$ Diesel Combustion Emissions (tons)	SO_x Emissions (tons)	VOC Emissionsa (tons)	VOC Slip Lining Emissions (tons)
	CO_2 Emissions (tons)	N_2O Emissions (tons CO_2 equivalent)	CH_4 Emissions (tons CO_2 equivalent)						
ALTERNATIVE 1 - No Further Action									
Alternative 1 - Total General Diesel Use (Single Unit Truck)	692	8	0	700	5	0	0	0	
Alternative 1 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	3,314	37	2	3,353	24	0	1	2	
Alternative 1 - Total Barge Transport Diesel Use	0	0	0	0	0	0	0	0	
Alternative 1 - Total Rail Transport Diesel Use	0	0	0	0	0	0	0	0	
Alternative 1 - Total Diesel Use	4,006	45	2	4,053	29	1	1	2	
Alternative 1 - Total General Gasoline Use	49	0.64	0.22	50	0.29	0.0014	0.012	0.066	
Alternative 1 - Total Storm Draining/Utility Replacement Gasoline Use	4,785	63	22	4,870	28	0	1	6	
Alternative 1 - Total O&M Gasoline Use	1,223	16.0	5.5	1,245	7.2	0.0351	0.293	1.64	
Alternative 1 - Total Gasoline Use	6,058	79.38	27.47	6,165	35.57	0.1739	1.450	8.123	
Alternative 1 - Total Power Use	810	NA	NA	810	1	NA	6	NA	
Alternative 1 - Total Waste Water Treated at WWTP	2,957	23	2	2,983	7	0.6	70	NA	
Alternative 1 - Total Emissions	**13,830**	**148**	**32**	**14,010**	**72**	**1.3**	**78**	**10.1**	**0**
ALTERNATIVE 2 - Basic Containment									
Alternative 2 - Total General Diesel Use (Single Unit Truck)	1,866	21	0.95	1,887	13.3	0.26	0.41	0.92	
Alternative 2 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	3,314	37	2	3,353	24	0	1	2	
Alternative 2 - Total Barge Transport Diesel Use	0	0	0	0	0	0	0	0	
Alternative 2 - Total Rail Transport Diesel Use	0	0	0	0	0	0	0	0	
Alternative 2 - Total Diesel Use	5,180	58	2.63	5,241	37	0.71	1.14	2.55	
Alternative 2 - Total General Gasoline Use	155	2.0	0.70	158	0.91	0.0045	0.037	0.21	
Alternative 2 - Total Storm Draining/Utility Replacement Gasoline Use	4,785	63	22	4,870	28	0	1	6	
Alternative 2 - Total O&M Gasoline Use	1,223	16.0	5.5	1,245	7.2	0.0351	0.293	1.64	
Alternative 2 - Total Gasoline Use	6,164	80.8	27.9	6,273	36.2	0.177	1.48	8.27	
Alternative 2- Total Power Use	810	NA	NA	810	1	NA	6	NA	
Alternative 2 - Total Waste Water Treated at WWTP	2,957	23	2	2,983	7	0.6	70	NA	
Alternative 2 - Total Emissions	**15,111**	**162**	**33**	**15,306**	**81**	**1.5**	**78**	**11**	**0**
ALTERNATIVE 3 - Enhanced Isolation and Containment									
Alternative 3 - Total General Diesel Use (Single Unit Truck)	2,346	26	1.2	2,374	17	0.32	0.52	1.2	
Alternative 3 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	2,864	32.1	1.45	2,897	20.4	0.394	0.631	1.41	
Alternative 3 - Total Barge Transport Diesel Use	0	0.0	0	0	0	0	0	0	
Alternative 3 - Total Rail Transport Diesel Use	0	0	0	0	0	0	0	0	
Alternative 3 - Total Diesel Use	5,210	58	2.6	5,271	37	0.72	1.15	2.6	
Alternative 3 - Total General Gasoline Use	596	7.8	2.7	607	3.5	0.017	0.14	0.80	
Alternative 3 - Total Storm Draining/Utility Replacement Gasoline Use	4,794	62.8	21.74	4,879	28.15	0.1376	1.148	6.43	
Alternative 3 - Total O&M Gasoline Use	204	2.7	0.9	207	1.2	0.0059	0.049	0.27	
Alternative 3 - Total Gasoline Use	5,594	73	25.4	5,693	32.8	0.161	1.34	7.5	
Alternative 3 - Total Power Use	74	NA	NA	74	0.1	NA	0.52	NA	
Alternative 3 - Total Waste Water Treated at WWTP	271	2	0	273	1	0.1	6	NA	
Alternative 3 - Total Emissions	**11,149**	**134**	**28**	**11,311**	**71**	**0.9**	**9**	**10**	**0.18**
ALTERNATIVE 4 - Partial Excavation									
Alternative 4 - Total General Diesel Use (Single Unit Truck)	20,973	235	11	21,219	150	2.9	4.6	10.3	
Alternative 4 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	1,003	11	0.51	1,015	7	0.14	0.22	0.49	
Alternative 4 - Total Barge Transport Diesel Use	9,099	103	9.1	9,211	240	5.97	2.0	8.9	
Alternative 4 - Total Rail Transport Diesel Use	39,507	308	40	39,855	1,043.08	26	9	39	
Alternative 4 - Total Diesel Use	70,583	657	60	71,300	1,440	35	16	58	
Alternative 4 - Total General Gasoline Use	1,712	22	7.8	1,742	10.0	0.049	0.41	2.3	
Alternative 4 - Total Storm Draining/Utility Replacement Gasoline Use	508	6.7	2.31	517	2.99	0.0146	0.122	0.68	
Alternative 4 - Total O&M Gasoline Use	408	5.3	1.8	415	2.4	0.0117	0.098	0.55	
Alternative 4 - Total Gasoline Use	2,628	34	11.9	2,674	15	0.075	0.63	3.5	
Alternative 4 - Total Power Use	279	NA	NA	279	0.5	NA	1.96	NA	
Alternative 4 - Total Waste Water Treated at WWTP	1,020	8	1	1,028	2	0.2	24	NA	
Alternative 4 - Total Emissions	**74,509**	**700**	**73**	**75,282**	**1,458**	**35**	**42**	**62**	**0**
ALTERNATIVE 5 - Full Excavation									
Alternative 5 - Total General Diesel Use (Single Unit Truck)	52,519	589	27	53,135	375	7.2	12	26	
Alternative 5 - Total Storm Draining/Utility Replacement Diesel Use (Single Unit Truck)	3,657	41	1.86	3,700	26	0.50	0.81	1.80	
Alternative 5 - Total Barge Transport Diesel Use	41,009	463	41	41,513	1,083	26.9	9.1	40	
Alternative 5 - Total Rail Transport Diesel Use	142,014	1,106	143	143,263	3,749	93	31	139	
Alternative 5 - Total Diesel Use	239,200	2,199	213	241,612	5,233	128	53	207	
Alternative 5 - Total General Gasoline Use	3,598	47	16	3,661	21	0.10	0.86	4.8	
Alternative 5 - Total Storm Draining/Utility Replacement Gasoline Use	641	8.4	2.91	652	3.76	0.0184	0.153	0.86	
Alternative 5 - Total O&M Gasoline Use	717	9.4	3.2	729	4.2	0.021	0.17	0.96	
Alternative 5 - Total Gasoline Use	4,955	65	22	5,043	29	0.14	1.2	6.6	
Alternative 5 - Total Power Use	3,380	NA	NA	3,380	5.9	NA	23.74	NA	
Alternative 5 - Total Waste Water Treated at WWTP	12,341	98	9	12,448	29	2.4	292	NA	
Alternative 5 - Total Emissions	**259,876**	**2,362**	**244**	**262,483**	**5,297**	**130**	**370**	**213**	**0**

Notes:
CO_2 = carbon dioxide
N_2O = nitrous oxide
CH_4 = methane
CO = carbon monoxide
NO_x = nitrogen oxides
$PM_{2.5\text{-}10}$ = particulate matter greater than 2.5 micrometers and less than 10 micrometers
SO_x = sulfur oxides
VOC = volatile organic compound
NA = not applicable
O&M = operation and maintenance
WWTP = waste water treatment plant
[a]Train diesel transport emissions reported as non-methane volatile organic compound

TABLE 4
SUMMARY OF HUMAN HEALTH IMPACT METRICS FOR SHORT-TERM EFFECTIVENESS

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Assumptions:
1. A passenger vehicle is defined as a car or light truck (including pickups, vans, and sport utility vehicles).
2. A single-unit truck is defined as a medium or heavy truck in which the engine, cab, drive train, and cargo area are all on one chassis.

3. Construction worker labor injury rate =	2.95E-05	injuries/work-hour. Assumes 5.9 recordable injury per 200,000 work hours for construction workers based on 2006 Bureau of Labor Statistics.
4. Construction worker labor fatality rate =	5.40E-08	fatalities/work-hour. Assume 10.8 fatalities per 200,000,000 work hours (100,000 workers) for construction based on 2007 Bureau of Labor Statistics.
5. Passenger vehicle driving injury rate =	9.55E-07	injuries/mile. Assume 95.5 injuries per 100 million vehicle miles; Passenger vehicles, from U.S. DOT, 2007. Large Truck Crash Facts 2005. February.
6. Passenger vehicle driving fatality rate =	1.41E-08	fatalities/mile. Assume 1.41 fatalities per 100 million vehicle miles; Passenger vehicles, from U.S. DOT, 2007. Large Truck Crash Facts 2005. February.
7. Single-unit truck driving injury rate =	6.16E-07	injuries/mile. Assume 61.6 injuries per 100 million vehicle miles; Single-unit trucks, from U.S. DOT, 2007. Large Truck Crash Facts 2005. February.
8. Single-unit truck driving fatality rate =	1.74E-08	fatalities/mile. Assume 1.74 fatalities per 100 million vehicle miles; Single-unit trucks, from U.S. DOT, 2007. Large Truck Crash Facts 2005. February.
9. Train derailment frequency =	1.94E-06	derailments/mile. Assume 2.75 accidents per 1,000,000 miles, 70.62% of accidents are derailments; Statisic from http://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/statsSas.aspx
10. Train hazardous material release frequency =	3.60E-08	hazardous release/mile. Assume 2.75 accidents/ per 1,000,000 miles, 1.31% of accidents result in a hazardous release; Statisic from http://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/statsSas.aspx

Item/Activity	Qty	Unit	Impact Per Unit	Unit	Net LC Impact	Unit	Comments and References for Data Entry
ALTERNATIVE 1 - No Further Action							
Collateral Risk							
Risk of injury associated with increased offsite truck traffic	418,564	miles	6.16E-07	injuries/mile	0.258	injuries	Single-unit truck driving injury statistic.
Risk of injury associated with onsite worker hours during remedy implementation	405,720	hrs	2.95E-05	injuries/work-hour	12.0	injuries	Construction worker labor injury statistic
Alternative 1 - Total Injuries					**12.2**	**injuries**	
Risk of fatality associated with increased offsite truck traffic	418,564	miles	1.74E-08	fatalities/mile	0.007	fatalities	Single-unit truck driving fatality statistic
Risk of fatality associated with onsite worker hours during remedy implementation	405,720	hrs	5.40E-08	fatalities/work-hour	0.02	fatalities	Construction worker labor fatality statistic
Alternative 1 - Total Fatalities					**0.03**	**fatalities**	
Risk of derailment during train transport	0	miles	1.94E-06	derailments/mile	NA	derailments	Train derailment frequency statistic
Risk of hazardous release of chemicals due to train accident	0	miles	3.60E-08	hazardous release/mile	NA	hazardous releases	Train hazardous material release frequency statistic
ALTERNATIVE 2 - Basic Containment							
Collateral Risk							
Risk of injury associated with increased offsite truck traffic	496,264	miles	6.16E-07	injuries/mile	0.306	injuries	Single-unit truck driving injury statistic.
Risk of injury associated with onsite worker hours during remedy implementation	446,239	hrs	2.95E-05	injuries/work-hour	13.2	injuries	Construction worker labor injury statistic
Alternative 2 - Total Injuries					**13.5**	**injuries**	
Risk of fatality associated with increased offsite truck traffic	496,264	miles	1.74E-08	fatalities/mile	0.0086	fatalities	Single-unit truck driving fatality statistic
Risk of fatality associated with onsite worker hours during remedy implementation	446,239	hrs	5.40E-08	fatalities/work-hour	0.02	fatalities	Construction worker labor fatality statistic
Alternative 2 - Total Fatalities					**0.03**	**fatalities**	
Risk of derailment during train transport	0	miles	1.94E-06	derailments/mile	NA	derailments	Train derailment frequency statistic
Risk of hazardous release of chemicals due to train accident	0	miles	3.60E-08	hazardous release/mile	NA	hazardous releases	Train hazardous material release frequency statistic
ALTERNATIVE 3 - Enhanced Isolation and Containment							
Collateral Risk							
Risk of injury associated with increased offsite truck traffic	40,311	miles	6.16E-07	injuries/mile	0.0248	injuries	Single-unit truck driving injury statistic.
Risk of injury associated with onsite worker hours during remedy implementation	352,567	hrs	2.95E-05	injuries/work-hour	10.4	injuries	Construction worker labor injury statistic
Alternative 3 - Total Injuries					**10.4**	**injuries**	
Risk of fatality associated with increased offsite truck traffic	40,311	miles	1.74E-08	fatalities/mile	0.00070	fatalities	Single-unit truck driving fatality statistic
Risk of fatality associated with onsite worker hours during remedy implementation	352,567	hrs	5.40E-08	fatalities/work-hour	0.02	fatalities	Construction worker labor fatality statistic
Alternative 3 - Total Fatalities					**0.02**	**fatalities**	
Risk of derailment during train transport	0	miles	1.94E-06	derailments/mile	NA	derailments	Train derailment frequency statistic
Risk of hazardous release of chemicals due to train accident	0	miles	3.60E-08	hazardous release/mile	NA	hazardous releases	Train hazardous material release frequency statistic
ALTERNATIVE 4 - Partial Excavation							
Collateral Risk							
Risk of injury associated with increased offsite truck traffic	1,571,731	miles	6.16E-07	injuries/mile	1.0	injuries	Single-unit truck driving injury statistic.
Risk of injury associated with onsite worker hours during remedy implementation	1,043,131	hrs	2.95E-05	injuries/work-hour	31	injuries	Construction worker labor injury statistic
Alternative 4 - Total Injuries					**32**	**injuries**	
Risk of fatality associated with increased offsite truck traffic	1,571,731	miles	1.74E-08	fatalities/mile	0.027	fatalities	Single-unit truck driving fatality statistic
Risk of fatality associated with onsite worker hours during remedy implementation	1,043,131	hrs	5.40E-08	fatalities/work-hour	0.1	fatalities	Construction worker labor fatality statistic
Alternative 4 - Total Fatalities					**0.1**	**fatalities**	
Risk of derailment during train transport	130,978	miles	1.94E-06	derailments/mile	0.25	derailments	Train derailment frequency statistic
Risk of hazardous release of chemicals due to train accident	130,978	miles	3.60E-08	hazardous release/mile	0.0047	hazardous releases	Train hazardous material release frequency statistic
ALTERNATIVE 5 - Full Excavation							
Collateral Risk							
Risk of injury associated with increased offsite truck traffic	3,357,308	miles	6.16E-07	injuries/mile	2.1	injuries	Single-unit truck driving injury statistic.
Risk of injury associated with onsite worker hours during remedy implementation	2,563,143	hrs	2.95E-05	injuries/work-hour	76	injuries	Construction worker labor injury statistic
Alternative 5 - Total Injuries					**78**	**injuries**	
Risk of fatality associated with increased offsite truck traffic	3,357,308	miles	1.74E-08	fatalities/mile	0.058	fatalities	Single-unit truck driving fatality statistic
Risk of fatality associated with onsite worker hours during remedy implementation	2,563,143	hrs	5.40E-08	fatalities/work-hour	0	fatalities	Construction worker labor fatality statistic
Alternative 5 - Total Fatalities					**0**	**fatalities**	
Risk of derailment during train transport	467,039	miles	1.94E-06	derailments/mile	0.91	derailments	Train derailment frequency statistic
Risk of hazardous release of chemicals due to train accident	467,039	miles	3.60E-08	hazardous release/mile	0.017	hazardous releases	Train hazardous material release frequency statistic

Key:
Qty = quantity
LC = life cycle
hrs = hours
NA = not applicable
NAICS = North American Industry Classification System
U.S. DOT = United States Department of Transportation
O&M = operation and maintenance
MNA = monitored natural attenuation

TABLE 5

SUMMARY OF MATERIAL INTENSITY METRICS FOR SHORT-TERM EFFECTIVENESS

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

Assumptions:
1. Waste quantities and weights taken from cost estimates provided by CH2M HILL engineers.
2. Assume using a 30 cubic yard roll-off dumpster for soil and 21,000 gallon liquid frac tank each with a maximum transportation capacity of 20,000 lbs (10 tons)
3. VGAC offgas treatment material is transported to a regeneration facility and none is disposed.

Item/Activity	Net LC Impact	Unit	Comments and References for Data Entry
ALTERNATIVE 1 - No Further Action			
Waste			
Hazardous Waste Material	0	tons	
Non-Hazardous Waste Material	0	tons	
Hazardous Sludge Waste Material	960	tons	
Alternative 1 - Total Waste Disposal	**960**	**tons**	
ALTERNATIVE 2 - Basic Containment			
Waste			
Hazardous Waste Material	0	tons	
Non-Hazardous Waste Material	0	tons	
Hazardous Sludge Waste Material	960	tons	
Alternative 2 - Total Waste Disposal	**960**	**tons**	
ALTERNATIVE 3 - Enhanced Isolation and Containment			
Waste			
Hazardous Waste Material	0	tons	
Non-Hazardous Waste Material	0	tons	
Hazardous Sludge Waste Material	88	tons	
Alternative 3 - Total Waste Disposal	**88**	**tons**	
ALTERNATIVE 4 - Partial Excavation			
Waste			
Hazardous Waste Material	1,751,040	tons	
Non-Hazardous Waste Material	234,000	tons	
Hazardous Sludge Waste Material	331	tons	
Alternative 4 - Total Waste Disposal	**1,985,371**	**tons**	
ALTERNATIVE 5 - Full Excavation			
Waste			
Hazardous Waste Material	6,243,840	tons	
Non-Hazardous Waste Material	264,000	tons	
Hazardous Sludge Waste Material	4,006	tons	
Alternative 5 - Total Waste Disposal	**6,511,846**	**tons**	

Notes:
LC = life cycle

TABLE 6

SHORT-TERM EFFECTIVENESS IMPACT ESTIMATE SUMMARY

PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

LCA Impact Summary (Totals for Project Life)

	Emission Intensity (EI)										Aesthetics		
Alternative	Greenhouse Gases[1] (tons CO_2 equivalent)	Passenger Car GHG Emission Equivalents[2]	Household GHG Emission Equivalents[10]	Percent Increase of Green House Gas Emissions Over the life of the project (tons CO_2 equivalent) in the City of Baltimore[5,7]	NO_x Emissions (tons)	$PM_{2.5-10}$ Diesel Combustion Emissions (tons)	SO_x Emissions (tons)	VOC Emissions[3] (tons)	VOC Slip Lining Emissions (tons)	Total VOC Emissions	Increase of Truck Traffic (trucks/week)[11]	Increase of Train Traffic (trains/week)[11]	Increase of Barge Traffic (shipments/week)[11]
ALTERNATIVE 1 - No Further Action	14,010	2,320	1,225	0.00349%	72.5	1.300	78.0	10.095	0.000	10.095	NA	NA	NA
ALTERNATIVE 2 - Basic Containment	15,310	2,530	1,338	0.00381%	81.5	1.460	78.2	10.82	0.00	10.82	NA	NA	NA
ALTERNATIVE 3 - Enhanced Isolation and Containment	11,310	1,873	989	0.01689%	70.8	0.930	9.40	10.07	0.183	10.25	NA	NA	NA
ALTERNATIVE 4 - Partial Excavation	75,300	12,500	6,580	0.056%	1,458	35.2	42.3	61.9	0.0	61.9	23	0.67	1.7
ALTERNATIVE 5 - Full Excavation	263,000	43,500	23,000	0.151%	5,300	130.3	370	213	0	213	20	1.5	4.7

Key:
LCA = Life Cycle Analysis
GHG= Greenhouse Gas
CO_2 = carbon dioxide
CO = carbon monoxide
N_2O = nitrous oxide
$PM_{2.5-10}$ = particulate matter greater than 2.5
NO_x = nitrogen oxides
SO_x = sulfur oxides
VOC = volatile organic compound
U.S. = United States
NA = not applicable
Kwh = kilowatt-hour
yrs = years

Notes:
[1]Greenhouse Gas emissions were calculated from the impacts of carbon dioxide, nitrous oxide, and methane gases converted to carbon dioxide equivalents.
[2]12,080 pounds(6.04 tons) CO_2 for the average passenger vehicle, assuming 12,000 miles per year at 20.3 mpg; Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle (http://www.epa.gov/otaq/climate/420f05004.htm#step4).
[3]Train diesel transport emissions reported as non-methane volatile organic compound
[5]Total vehicle miles traveled from Conformity Determination of Transportation Outlook 2035 and the 2010-2013 Transportation Improvement Program Prepared by the Baltimore Regional transportation Board, the Metropolitan Planning Organization for the Baltimore Region July 2009. Used the 2013 estimate.
[6]Residental Energy Consumption of 10,656 kWh/single-family home-year reported by the U.S. Department of Energy in 2006. http://www.eia.doe.gov/emeu/recs/recs2001/enduse2001/enduse2001.html
[7]Equation uses the following factor: 26,597,027,000 annual vehicle miles/(12,000 miles/car))*6.04 tons of CO_2 per car = City of Baltimore Annual GHG emissions (1.33872e+07 tons of CO_2/year)
[8]Potential for Community Injury and Fatality based on offsite mileage.
[9]Potential for Work Injury and Fatality based on worker hours.
[10]Annual household total energy emissions 22,880 pounds of CO_2 per year (11.44 tons/yr). EPA's Unit Conversions, Emissions Factors, and Other Reference Data Report (Nov 2004), EIA/DOE 2002.
[11]Alternatives 1, 2, 3 do not include traffic increase percentages due to the low impact of truck, river, and train, traffic.

TABLE 6
SHORT-TERM EFFECTIVENESS IMPACT ESTIMATE SUMMARY
PROJECT: Honeywell
SITE: Dundalk Marine Terminal
DESCRIPTION: Short-Term Effectiveness Metrics
PREPARED BY: CH2M HILL
PROJECT NUMBER: 392429

LCA Impact Summary (Totals for Project Life)

Alternative	Accident Impacts						Material Intensity			Energy (Non Renewable Resources)			Total Land Area Impacted (acres)	Remediation Timeframe (yrs)
	Potential for Community Injuries[8]	Potential for Worker Injuries[9]	Potential for Community Fatalities[8]	Potential for Worker Fatalities[9]	Potential for Train Derailments	Potential for Train Accidents Resulting in Hazardous Releases	Clean Material Needed (ton)	Hazardous Waste (ton)	Non-Hazardous Waste (ton)	Fuel Consumption (gallons)	Power Consumption (kWh)	U.S. Household Power Consumption Equivalents[6] (households)		
ALTERNATIVE 1 - No Further Action	2.58E-01	11.97	7.28E-03	0.022	NA	NA	0	960	0	969,400	1,420,000	133	6.20	30
ALTERNATIVE 2 - Basic Containment	3.06E-01	13.16	8.64E-03	0.024	NA	NA	0	960	0	1,077,000	1,420,000	133	6.20	30
ALTERNATIVE 3 - Enhanced Isolation and Containment	2.48E-02	10.40	7.01E-04	0.019	NA	NA	0	88.0	0	1,019,000	130,000	12.2	6.20	5
ALTERNATIVE 4 - Partial Excavation	0.97	30.8	2.73E-02	0.056	0.254	4.72E-03	1,950,000	1,750,000	234,000	6,070,000	490,000	46.0	130	10
ALTERNATIVE 5 - Full Excavation	2.07	75.6	5.84E-02	0.138	0.907	1.68E-02	6,940,000	6,250,000	264,000	20,170,000	5,930,000	556	148	13

Key:
LCA = Life Cycle Analysis
GHG= Greenhouse Gas
CO_2 = carbon dioxide
CO = carbon monoxide
N_2O = nitrous oxide
$PM_{2.5\text{-}10}$ = particulate matter greater than 2.5
NO_x = nitrogen oxides
SO_x = sulfur oxides
VOC = volatile organic compound
U.S. = United States
NA = not applicable
Kwh = kilowatt-hour
yrs = years

Notes:
[1]Greenhouse Gas emissions were calculated from the impacts of carbon dioxide, nitrous oxide, and methane gases converted to carbon dioxide equivalents.
[2]12,080 pounds(6.04 tons) CO_2 for the average passenger vehicle, assuming 12,000 miles per year at 20.3 mpg; Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle (http://www.epa.gov/otaq/climate/420f05004.htm#step4).
[3]Train diesel transport emissions reported as non-methane volatile organic compound
[5]Total vehicle miles traveled from Conformity Determination of Transportation Outlook 2035 and the 2010-2013 Transportation Improvement Program Prepared by the Baltimore Regional transportation Board, the Metropolitan Planning Organization for the Baltimore Region July 2009. Used the 2013 estimate.
[6]Residental Energy Consumption of 10,656 kWh/single-family home-year reported by the U.S. Department of Energy in 2006. http://www.eia.doe.gov/emeu/recs/recs2001/enduse2001/enduse2001.html
[7]Equation uses the following factor: 26,597,027,000 annual vehicle miles/(12,000 miles/car))*6.04 tons of CO_2 per car = City of Baltimore Annual GHG emissions (1.33872e+07 tons of CO_2/year)
[8]Potential for Community Injury and Fatality based on offsite mileage.
[9]Potential for Work Injury and Fatality based on worker hours.
[10]Annual household total energy emissions 22,880 pounds of CO_2 per year (11.44 tons/yr). EPA's Unit Conversions, Emissions Factors, and Other Reference Data Report (Nov 2004), EIA/DOE 2002.
[11]Alternatives 1, 2, 3 do not include traffic increase percentages due to the low impact of truck, river, and train, traffic.

TABLE 7

GREENHOUSE GAS GLOBAL WARMING POTENTIALS

Greenhouse Gas Global Warming Potentials			
Greenhouse Gas	**Formula**	**Atmospheric Lifetime[a]**	**Global Warming Potential[a]**
Carbon Dioxide	CO_2	50-200[b]	1
Methane	CH_4	12	21
Nitrous Oxide	N_2O	114	310

[a] From Intergovernmental Panel on Climate Change, Second Assessment Report (SAR) (IPCC, 2005).

[b]Average value from internet data

TABLE 8

NATIONAL RENEWABLE ENERGY LABORATORY U.S. LIFE-CYCLE INVENTORY DATABASE

	Barge Transport		Train Transport		Single Unit Truck Transport		Single Unit Truck Transport	
Pollutant	**Diesel Powered Emission Rate (3) (kg/tkm)**	**Fuel Consumption Rate (2) (gal/1,000 ton-miles)**	**Diesel Powered Emission Rate (kg/tkm)**	**Fuel Consumption Rate (1) (gal/1,000 ton-miles)**	**Diesel Powered Emission Rate (kg/tkm)**	**Fuel Consumption Rate (1) (gal/1,000 ton-miles)**	**Gasoline Powered Emission Rate (kg/tkm)**	**Fuel Consumption Rate (1) (gal/1,000 ton-miles)**
CO_2	2.80E-02	3.70	1.89E-02	2.50	1.71E-01	22.5	1.32E-01	22.5
CO	7.27E-05		4.91E-05		2.46E-04		2.38E-03	
N_2O	7.03E-07		4.75E-07		6.19E-06		5.58E-06	
CH_4	1.34E-06		9.05E-07		4.13E-06		2.85E-05	
NO_x	7.39E-04		4.99E-04		1.22E-03		7.75E-04	
$PM_{2.5-10}$	1.84E-05		1.24E-05		2.35E-05		3.79E-06	
SO_x	6.20E-06		4.19E-06		3.77E-05		3.16E-05	
VOC[a]	2.74E-05		1.85E-05		8.42E-05		1.77E-04	

Notes:

CO_2 = carbon dioxide

CO = carbon monoxide

N_2O = nitrous oxide

CH_4 = methane

NO_x = nitrogen oxides

$PM_{2.5-10}$ = particulate matter greater than 2.5 micrometers and less than 10 micrometers

SO_x = sulfur oxides

VOC = volatile organic compound

kg = kilogram

tkm = metric ton-kilometer

gal = gallon

NA = not applicable

Reference: NREL: U.S. Life-Cycle Inventory Database: http://nrel.gov/lci/database.asp

(1) = calculated based on NREL emissions of L fule
per tkm output

(2) = from USEPA GREET AP42 guidance

(3) = NREL data unavailable - pro-rated against train diesel emissions based on fuel used per Ton-mile

[a]Train diesel transport emissions reported as non-methane volatile organic compound

TABLE 9
EPA POWER PROFILER POWER PLANT EMISSION FACTORS

Impact Type	Baltimore Gas & Electric Co - MD Emissions[a] (lbs/MWh)
CO_2	1139
NO_x	2
SO_x	8

Notes:
CO_2 = carbon dioxide
NO_x = nitrogen oxides
SO_x = sulfur oxides
lbs = pounds
MWh = megawatt-hour
[a]Baltimore Gas & Electric Co - MD electric district utility using zip code 21222, http://oaspub.epa.gov/powpro/ept_pack.charts

TABLE 10
CHEMICAL PRODUCTION EMISSION

Pollutant	Chemcial Emissions (kg/gallon)
CO_2	3.95E-03
N_2O	1.01E-07
CH_4	1.44E-07
NO_x	9.21E-06
$PM_{2.5-10}$	7.63E-07
SO_x	9.34E-05
VOC[a]	NA

Note that these outputs are from SimaPro software

Notes:
CO_2 = carbon dioxide
N_2O = nitrous oxide
CH_4 = methane
NO_x = nitrogen oxides
$PM_{2.5-10}$ = particulate matter greater than 2.5 micrometers and less than 10 micrometers
SO_x = sulfur oxides
VOC = volatile organic compound
kg = kilogram
NA = not applicable
Sima Pro Data