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October 26, 2009

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Mr. James Carroll
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Maryland Department of the Environment
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**Re: Draft Human Health Risk Assessment, Dundalk Marine Terminal, Baltimore, Maryland**

Dear Messrs. Dye and Carroll:

Honeywell International Inc. (Honeywell) and the Maryland Port Administration (MPA) are submitting the enclosed document titled draft "Human Health Risk Assessment, Dundalk Marine Terminal, Baltimore, Maryland." This document provides the results of the human health risk assessment that was conducted pursuant to the requirements of Section III.B.7 of the Consent Decree entered into by Maryland Department of the Environment (MDE), the Maryland Port Administration (MPA) and Honeywell. A full digital copy of the report is also attached on CD ROM.

If you have any questions or comments, please contact me at 973-455-4131.

Very truly yours,

**HONEYWELL INTERNATIONAL INC.**

Christopher M. French
Project Coordinator

Attachment (2 copies)

cc: Mr. Horacio Tablada/MDE (letter only)
Mr. Matthew Zimmerman/MDE
Mr. Robert Munroe/MPA
Mr. Mark Kreafle/MPA
Mr. Michael Daneker/Arnold & Porter

HONEYWELL SITE#: R37825
DOCUMENT FILE LOC: 4.3.5

*Draft*

# Human Health Risk Assessment, Dundalk Marine Terminal, Baltimore, Maryland

Prepared for

**Honeywell**

**101 Columbia Rd.**
**Morristown, N. J.**

**Maryland Port Administration**

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October 2009

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CH2MHILL

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# Executive Summary

## Summary

This Human Health Risk Assessment (HHRA) was prepared pursuant to the requirements of Section III.B.7 of the April 5, 2006, Consent Decree entered into by and among the Maryland Department of the Environment (MDE), Maryland Port Administration (MPA), and Honeywell International Inc. (Honeywell) for Dundalk Marine Terminal (DMT), located within Baltimore City and Baltimore County, Maryland. The HHRA has been prepared pursuant to the work plan submitted to MDE in July 2009.

Although the Consent Decree focuses exclusively on chromium, other constituents related to chromium ore processing residue (COPR) (aluminum, calcium, iron, magnesium, manganese, and vanadium) in various environmental media (groundwater, soil, air, stormwater, surface water, and sediment) were also assessed.

The HHRA results establish that chromium and other COPR constituents do not pose an unacceptable risk to DMT workers, construction workers, or utility workers; nor do they pose an unacceptable risk to recreational users of the cove adjacent to DMT. 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 data and conclusions provided in the HHRA meet the requirements stipulated in the Consent Decree. No additional sampling or analysis is required to assess the environmental impacts of COPR constituents from the site.

## Technical Approach

The scope of the HHRA is to evaluate potential current and future risks associated with chromium and other COPR constituents in accordance with the standard U.S. Environmental Protection Agency (EPA) Region 3 approach for conducting HHRAs. In general, the basic approach for the HHRA follows the EPA's four-step risk assessment process (EPA, 1989): (1) data evaluation, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization.

Step 1 consists of the data evaluation in which analytical data are used to identify risk based screening levels and select chemicals of potential concern (COPCs). In Step 2, the exposure assessment is conducted and potential current and future exposure points, receptors, exposure scenarios, and exposure point concentrations (EPCs) are identified. In Step 3, relevant toxicity values are selected in accordance with EPA's hierarchy for toxicity value sources. In Step 4, a risk characterization is performed and an uncertainty analysis of the results is conducted.

Analytical data used in the HHRA were collected from various environmental media at or from DMT. The following environmental media were evaluated in the HHRA:

- Shallow groundwater (0 to 10 feet below ground surface (bgs))

- Surface soil (less than 0.5 foot bgs)
- Total soil (0 to 10 feet bgs)
- Air (collected at the perimeter and near the center of the site)
- Stormwater
- Surface water/sediment (in the cove adjacent to the site)

The COPR-related constituents were screened to identify the COPCs using a conservative COPC selection process in accordance with EPA (1989) guidance. The COPCs in each exposure medium were identified by comparing the maximum detected concentrations to EPA regional screening levels (RSLs) (EPA, 2009a).

The following potential exposure populations are discussed in the HHRA:

| Onsite | Offsite |
|---|---|
| • DMT workers | • Residents in homes at the adjacent cove |
| • DMT visitors | • Recreational users in the cove |
| • Utility workers | • Anglers in the Patapsco River and Colgate Creek |
| • Construction workers | |

To evaluate the potential health risks associated with exposure to COPCs, potentially complete exposure pathways were identified. The following exposure scenarios were quantified in the HHRA:

- **Groundwater.** Hypothetical future dermal contact with shallow groundwater in excavations by construction workers

- **Surface soil.** Hypothetical future ingestion, dermal contact, and inhalation by DMT workers

- **Total soil.** Hypothetical future ingestion, dermal contact, and inhalation by DMT workers and construction workers

- **Stormwater.** Hypothetical future dermal contact by utility workers

- **Surface water.** Current and future ingestion and dermal contact by offsite residents (adult, adolescent, and child)

- **Sediment:** Ingestion and dermal contact by offsite residents (adult, adolescent, and child); 0 to 1 foot bgs was used for the current scenario, whereas 0 to 3 feet bgs was used for the future scenario

The HHRA results under current exposure scenarios indicate acceptable risks (target-organ-specific hazard indices (HIs) < 1.0) for recreational users (adult, adolescent, and child) exposed to surface water and sediment in the cove adjacent to DMT.

The evaluation of the air transport pathway found no significant difference between upwind and downwind concentrations of Cr(VI) in air. This finding is expected, given that COPR is contained beneath the surface cover present at DMT. The surface cover inspection and maintenance program includes a rigorous inspection and repair program for surface cover which ensures that COPR remains contained, thereby limiting the potential for chromium transport via air.

The HHRA indicated acceptable risk levels (all target-organ-specific HIs < 1.0) for recreational users (adult, adolescent, child) exposed to sediment and surface water under a future scenario whereby the cove is dredged, allowing contact with sediments currently situated 0 to 3 feet bgs.

Using a conservative approach and assumptions, risk estimates were calculated for current and future potential exposures by recreational users in the cove adjacent to the site; risk estimates were within acceptable levels.

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# Acronyms and Abbreviations

| | |
|---|---|
| $ABS_{GI}$ | gastrointestinal absorption factor |
| AF | adherence factor |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| AVS | acid volatile sulfide |
| BAF | bioaccumulation factor |
| bgs | below ground surface |
| CEM | conceptual exposure model |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COPC | constituent of potential concern |
| COPR | chromium ore processing residue |
| Cr(III) | trivalent chromium |
| Cr(total) | nonspeciated chromium |
| Cr(VI) | hexavalent chromium |
| CSF | cancer slope factor |
| DMT | Dundalk Marine Terminal |
| DRI | Dietary Reference Intake |
| ELCR | excess lifetime cancer risk |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| HASP | health and safety plan |
| HAZWOPER | Hazardous Waste Operations and Emergency Response |
| HHRA | human health risk assessment |
| HI | hazard index |
| HQ | hazard quotient |
| IRIS | Integrated Risk Information System |
| IUR | inhalation unit risk |
| MDE | Maryland Department of the Environment |
| MDEP | Massachusetts Department of Environmental Protection |
| MPA | Maryland Port Administration |
| NAWQC | National Ambient Water Quality Criteria |
| NJDEP | New Jersey Department of Environmental Protection |
| PCB | polychlorinated biphenyl |
| PEF | particulate emission factor |
| PM | particulate matter |
| PPRTV | Provisional Peer-Reviewed Toxicity Value |
| RAGS | Risk Assessment Guidance for Superfund |
| RfC | reference concentration |

| | |
|---|---|
| RfD | reference dose |
| RME | reasonable maximum exposure |
| RSL | Regional Screening Level |
| SCMP | surface cover inspection and maintenance plan |
| SSHSP | site-specific health and safety plan |
| UCL | upper confidence limit |

SECTION 1

# Introduction

## 1.1 Background

This Human Health Risk Assessment (HHRA) was prepared pursuant to the requirements of Section III.B.7 of the April 5, 2006, Consent Decree entered into by and among the Maryland Department of the Environment (MDE), the Maryland Port Administration (MPA), and Honeywell International Inc. (Honeywell) for the Dundalk Marine Terminal (DMT), located within Baltimore City and Baltimore County, Maryland (Figure 1-1). The HHRA has been prepared pursuant to the work plan submitted to MDE in July 2009.

## 1.2 Purpose and Scope

Section III.B.7 of the Consent Decree requires that an HHRA be performed to assess the potential impacts on human health of chromium at or from the site. Potential risks associated with other chromium ore processing residue (COPR) constituents—aluminum, calcium, iron, magnesium, manganese, and vanadium—were also evaluated (CH2M HILL, 2007b, 2008a). The scope of the HHRA is to evaluate potential current and future risks associated with COPR constituents in the absence of institutional controls and other remedial measures in accordance with the standard U.S. Environmental Protection Agency (EPA) Region 3 approach for conducting HHRAs. Most COPR constituents (those 5 percent or more by mass) at DMT are refractory elements including aluminum, chromium, iron, magnesium, and silica, as shown in Table 1-1 (which presents results for four samples of COPR at DMT). Calcium and trace amounts of other chemicals (including manganese and vanadium) are also present in COPR.

The basic approach for the HHRA is in accordance with EPA (1989) risk assessment guidance. In general, this is a four-step process:

1. Identifying existing analytical data for COPR-related constituents (as defined in prior submittals to MDE, e.g., the Phase 1 COPR Investigation Data Report (CH2M HILL, 2007c)) in environmental media with potentially complete exposure pathways and comparing detected concentrations with risk-based screening levels to select constituents of potential concern (COPCs) for the HHRA

2. Identifying potential current and future exposure points, receptors, exposure scenarios, and exposure point concentrations (EPCs) and refining the preliminary conceptual exposure model (CEM) as necessary

3. Identifying relevant toxicity values for COPCs in accordance with EPA's hierarchy for toxicity value sources

4. Estimating potential risks associated with exposures to COPCs, including an uncertainty analysis

**TABLE 1-1**
COPR Constituents
*Dundalk Marine Terminal, Baltimore, MD*

| | | Percent by Mass | | | | |
|---|---|---|---|---|---|---|
| **Oxide Form** | **Element** | **1** | **2** | **3** | **4** | **Average** |
| $Fe_2O_3$ | Iron | 17.15 | 18.05 | 18.06 | 18 | 17.82 |
| $Al_2O_3$ | Aluminum | 11.22 | 12.34 | 12.32 | 12.34 | 12.06 |
| MgO | Magnesium | 11.65 | 11.27 | 11.33 | 11.3 | 11.4 |
| $SiO_2$ | Silica | 8.4 | 4.36 | 4.39 | 4.4 | 5.39 |
| $Cr_2O_3$ | Chromium | 4.31 | 4.81 | 4.75 | 4.78 | 4.66 |
| $Na_2O$ | Sodium | 0.36 | 0.52 | 0.55 | 0.53 | 0.49 |
| $K_2O$ | Potassium | 0.12 | 0.03 | 0.02 | 0.02 | 0.048 |
| $TiO_2$ | Titanium | 0.38 | 0.39 | 0.4 | 0.39 | 0.39 |
| $MnO_2$ | Manganese | 0.21 | 0.21 | 0.21 | 0.22 | 0.21 |
| $P_2O_5$ | Phosphorus | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 |
| SrO | Strontium | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| BaO | Barium | <0.01 | 0.01 | <0.01 | <0.01 | 0.01 |
| *Lost on ignition* | | *12.8* | *11.3* | *11.3* | *11.15* | *11.64* |
| *Totals* | | *99.19* | *99.36* | *99.31* | *99.08* | *99.24* |

\\APHRODITE\PROJ\HONEYWELLINC\DUNDALKMARINETERMINAL\MAPFILES\WORKPLAN\FIGURE 1 - SITE MAP.MXD BHATHAWA 4/16/2009 10:00:27

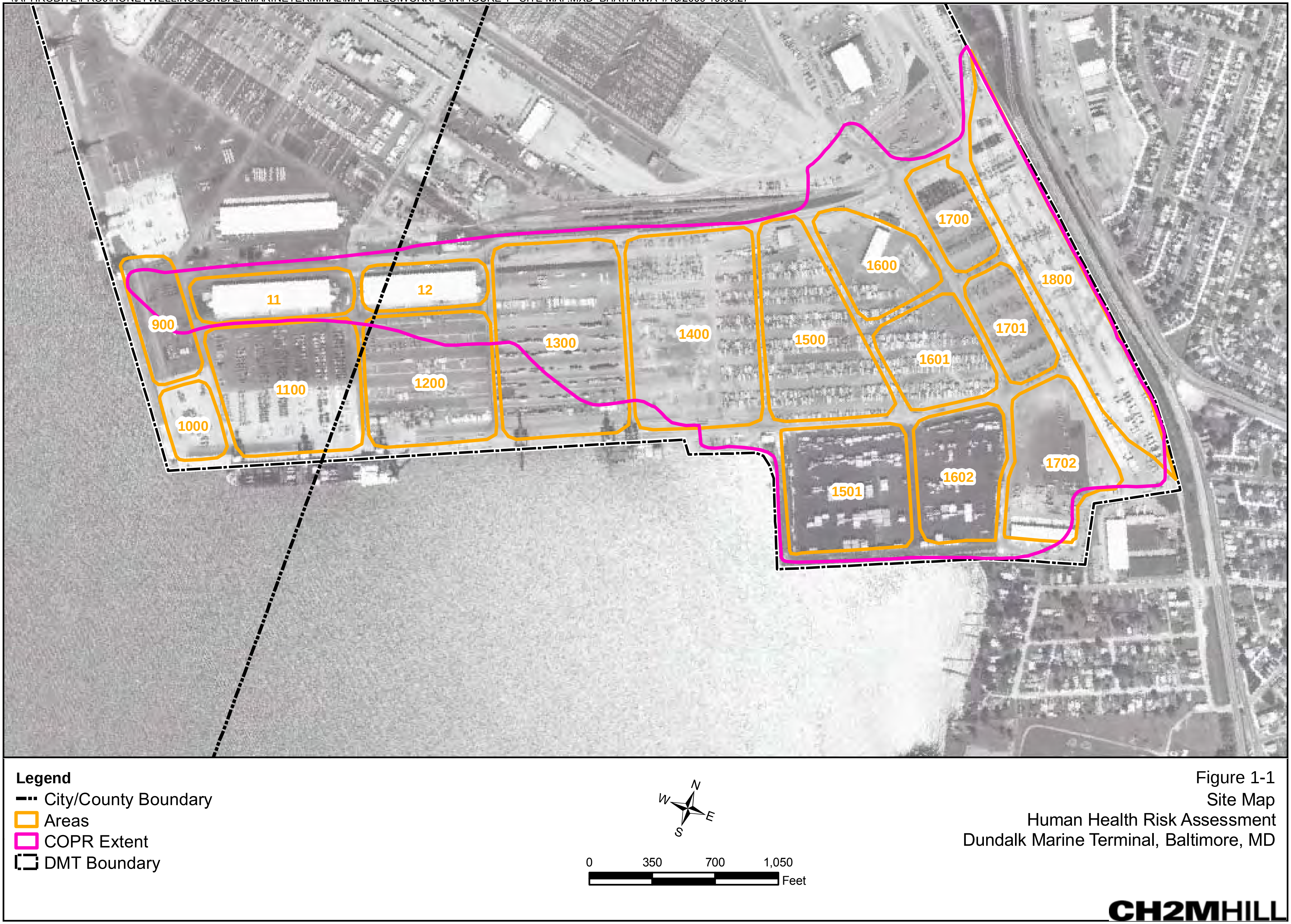


Figure 1-1
Site Map
Human Health Risk Assessment
Dundalk Marine Terminal, Baltimore, MD

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SECTION 2

# Data Evaluation

## 2.1 Approach

The scope of the HHRA is to evaluate potential current and future risks associated with potentially complete exposure pathways to COPCs in COPR-impacted media at or from DMT. Analytical data are available from various environmental matrices: groundwater, soil, air, stormwater, surface water, and sediment.

## 2.2 Identification of COPCs

The COPR-related constituents were screened to select the COPCs in accordance with EPA (1989) guidance. The COPC selection process was conservative to ensure that potential risks are not inadvertently underestimated or discounted at an early step in the assessment. When data for duplicate samples are available, the higher of the parent sample and the duplicate result was used. Additionally, when both total chromium (Cr(total)) (nonspeciated) and hexavalent chromium (Cr(VI)) concentrations were available for a given sample, the trivalent chromium concentration (Cr(III)) was calculated by subtracting the Cr(VI) concentration from the Cr(total) concentration. When the Cr(VI) concentrations were greater than Cr(total), a concentration of zero was assigned to Cr(III) and the concentration was considered "nondetected"; otherwise, calculated Cr(III) concentrations were noted as detected concentrations. The calculated Cr(III) results were consolidated with measured Cr(III) results and were treated as if they were measured concentrations.

### 2.2.1 Groundwater

Groundwater samples collected from 2006 through 2009 at monitoring wells representing groundwater 0 to 10 feet below ground surface (bgs) (the depth of potential excavation activities) were screened in the HHRA. The list of groundwater samples used in the HHRA is provided in Table 1.1 of Appendix A, and sampling locations are shown in Figure 2-1. The COPCs in groundwater were identified by comparing the maximum detected concentrations to the EPA regional screening levels (RSLs) for tap water (EPA, 2009a). In this conservative screening step, the noncarcinogenic RSL values were reduced tenfold to account for the presence of multiple COPR-related constituents potentially affecting the same target organ or having the same critical effect.

RSLs are not available for calcium and magnesium. Although these constituents are considered essential nutrients and not typically treated as environmental pollutants, screening levels were calculated using the dietary reference intakes (DRIs) published by the National Academy of Sciences (2004) and EPA's (2009a) standard exposure assumptions used to derive RSLs.

Groundwater data are available for total vanadium at DMT. The pH and environmental conditions (i.e., pH, reducing versus oxidizing conditions) were evaluated to determine the form of vanadium most likely to be present so that the appropriate RSL could be identified.

Because of the high pH of groundwater in the COPR area, vanadium is not likely to be present as vanadium pentoxide, vanadium sulfate, or metallic vanadium; therefore, the "vanadium and compounds" RSL was used to screen vanadium groundwater data.

If the maximum detected concentration of a constituent in groundwater exceeded its respective screening value, the constituent was identified as a COPC in groundwater and retained for quantitative evaluation in the HHRA. Results of the COPC screening process are presented in Table 2.1 of Appendix A; the following eight COPCs were identified for groundwater: aluminum, calcium, Cr(III), Cr(VI), iron, magnesium, manganese, and vanadium.

### 2.2.2 Soil

Soil samples collected from the 0- to 10-feet-bgs interval from 2005 through 2009 were used in the HHRA. To estimate exposures at applicable exposure points, the available soil data were grouped into two datasets. The surface soil data grouping (i.e., samples collected from a starting depth of 0 feet) was used to evaluate hypothetical future exposures to soil and COPR (which are assumed to be consistently present at the site surface within and adjacent to the railroad ballast) by DMT workers. Total soil (0 to 10 feet bgs) was used to evaluate hypothetical future exposures by construction workers and DMT workers. The list of soil samples used in the HHRA is provided in Tables 1.2 and 1.3 of Appendix A, and sampling locations are shown in Figures 2-2 and 2-3. To characterize potential risks from exposure to future COPR blooms that are assumed to be consistently present on the site surface, the soil datasets used in the HHRA include soil samples collected from COPR blooms that have been removed from the site. No subsurface soil samples are available from Areas 1501 and 1602 since approximately 8 feet of fill is present atop these areas; however, surface soil samples are available from the side slopes of these areas.

The COPCs in each soil data group were identified by comparing the maximum detected concentrations with the RSLs for industrial soil (EPA, 2009a). In this conservative screening step, the noncarcinogenic RSL values were reduced tenfold to account for the presence of multiple COPR-related constituents potentially affecting the same target organ or having the same critical effect.

RSLs are not available for calcium, magnesium, potassium, and sodium. Although these constituents are considered essential nutrients and not typically treated as environmental pollutants, screening levels were calculated using the DRIs published by the National Academy of Sciences (2004) and EPA's standard exposure assumptions used to derive RSLs (EPA, 2009a). The calculated screening levels for these constituents exceed the theoretical ceiling limit (i.e., $10^{+5}$ mg/kg) discussed in the RSL user's guide (EPA, 2009a); therefore, the ceiling limit (rather than the calculated screening level) was used as the screening level.

At the DMT site, soil data are available for total vanadium. The pH and environmental conditions (i.e., pH, reducing versus oxidizing conditions) were evaluated to determine the form of vanadium most likely to be present so that the appropriate RSL could be identified. In dry soils (i.e., those at the soil–air interface and at a depth of 1 to 2 inches into the soil, away from the soil–air interface), vanadium pentoxide associated with iron oxyhydroxides could be present; in deeper soils, the form is more likely to be "vanadium and compounds." The vanadium pentoxide RSL was used to screen vanadium soil data.

If the maximum detected concentration of a constituent exceeds its screening level, the constituent was identified as a COPC and retained for quantitative evaluation in the HHRA. Results of the COPC screening process are presented for surface and total soil in Tables 2.2 and 2.3 of Appendix A, respectively. The following five COPCs were identified both for surface soil and total soil: calcium, Cr(VI), iron, manganese, and vanadium.

### 2.2.3 Air

Air samples collected at the perimeter and near the center of the site as part of the SCMP in 2007 through 2009 were screened in the HHRA. The list of air samples used in the HHRA is provided in Table 1.4 of Appendix A and sampling locations are shown in Figure 2-4.

Cr(VI) is the only chemical-specific analyte measured in the air-monitoring program. The maximum detected concentration was compared with the RSL for residential land use (EPA, 2009a) because most air-monitoring locations are at the site perimeter. Results of the COPC screening process are presented in Table 2.4 of Appendix A. Because the maximum detected concentration exceeds the RSL, Cr(VI) was identified as a COPC in outdoor air and retained for quantitative evaluation in the HHRA. Background (upwind) concentrations in outdoor air were not considered when identifying Cr(VI) as a COPC in outdoor air, which is consistent with direction provided by the MDE toxicologist (MDE, 2009).

### 2.2.4 Stormwater

Stormwater samples collected between 2004 and 2009 (depending on the stormwater outfall) were screened in the HHRA. Wet-weather stormwater samples collected by Maryland Environmental Services at National Pollution Discharge Elimination System monitoring points were included. The available stormwater data were grouped into two datasets: the “nonpriority drains” (9th Street to 11.5th Street Outfalls, which contribute de minimis mass flux) and the “priority drains” (12th Street to 15th Street outfalls). The list of stormwater samples used in the HHRA is provided in Table 1.5 (nonpriority drains) and Table 1.6 (priority drains) of Appendix A, and sampling locations are shown in Figure 2-5. Additional samples were collected from the 13th Street storm drain as part of an interim remedial measure pilot test in 2009 and were included in the stormwater dataset for the HHRA.

The COPCs in stormwater were identified by comparing the maximum detected concentrations against the RSLs for tap water (EPA, 2009a). In this conservative screening step, the noncarcinogenic RSL values were reduced tenfold to account for the presence of multiple COPR-related constituents potentially affecting the same target organ or having the same critical effect.

At the DMT site, stormwater data are available for total vanadium. The pH and environmental conditions (i.e., pH, reducing versus oxidizing conditions) were evaluated to determine the form of vanadium most likely to be present so that the appropriate RSL could be identified. The pH is high (up to 12) in some sewer lines (the “priority drains”) as a result of groundwater infiltration and, therefore, vanadium is not likely to be present as vanadium pentoxide, vanadium sulfate, or metallic vanadium. Therefore, the RSL for “vanadium and compounds” was used to screen vanadium stormwater data.

If the maximum detected concentration of a constituent exceeded its respective screening value, the constituent was identified as a COPC and retained for quantitative evaluation in the HHRA. Results of the COPC screening process are presented in Table 2.5 (nonpriority drains) and Table 2.6 (priority drains) of Appendix A. One COPC was identified for nonpriority drain stormwater—Cr(VI)—whereas the following four COPCs were identified for priority drain stormwater: calcium, Cr(III), Cr(VI), and vanadium.

### 2.2.5 Surface Water

Surface water samples collected at locations A1, A2, A3, A4, and J4 (Figure 2-6) are those closest to the residences along the cove adjacent to the site. The surface water samples collected at these locations in May, August, and December 2007 and February 2008 were screened in the HHRA. The list of surface water samples used in the HHRA is provided in Table 1.7 of Appendix A and sampling locations are shown in Figure 2-6.

The COPCs in surface water were identified by comparing the maximum detected concentrations at the five locations against the EPA RSLs for tap water (EPA, 2009a). In this conservative screening step, the noncarcinogenic RSL values were reduced tenfold to account for the presence of multiple COPR-related constituents potentially affecting the same target organ or having the same critical effect.

RSLs are not available for calcium and magnesium. Although these constituents are considered essential nutrients and not typically treated as environmental pollutants, screening levels were calculated using the DRIs published by the National Academy of Sciences (2004) and EPA’s standard exposure assumptions used to derive RSLs (EPA, 2009a).

At the DMT site, surface water data are available for total vanadium. The pH and environmental conditions (i.e., pH, reducing versus oxidizing conditions) were evaluated to determine the form of vanadium most likely to be present so that the appropriate RSL could be identified. Because the pH of surface water is circumneutral, detected vanadium is likely to be present as vanadium pentoxide; therefore, the vanadium pentoxide RSL was used to screen vanadium surface water data.

If the maximum detected concentration of a constituent exceeds its respective screening value, the constituent was identified as a COPC and retained for quantitative evaluation in the HHRA. Results of the COPC screening process are presented in Table 2.7 of Appendix A, and the following three COPCs were identified for surface water: calcium, magnesium, and manganese. Cr(VI) was not detected in the surface water samples collected from the five locations in the cove.

### 2.2.6 Sediment

Sediment samples collected in the cove at locations A1, A2, A3, A4, and J4 (Figure 2-6) in May and August 2007 and February 2008 were screened in the HHRA. Two sediment data groups were evaluated in the HHRA. Surface sediments (0 to 1 foot bgs) were used to evaluate potential sediment exposures by nearby residents (recreators) for the current exposure scenario. However, sediments in the 0- to 3-foot-bgs interval were used to evaluate potential future exposures to sediments based on the assumption that dredging operations may be conducted in the future and bring deeper sediments to the surface, where contact may occur. The list of sediment samples used in the HHRA is provided in Table 1.8 (0 to 1 foot bgs) and Table 1.9 (0 to 3 feet bgs) of Appendix A and sampling locations are shown in Figure 2-6.

The COPCs in each sediment group were identified by comparing the maximum detected concentrations against the RSLs for residential soil (EPA, 2009a). In this conservative screening step, the noncarcinogenic RSL values were reduced tenfold to account for the presence of multiple COPR-related constituents potentially affecting the same target organ or having the same critical effect.

RSLs are not available for calcium and magnesium. Although these constituents are considered essential nutrients and not typically treated as environmental pollutants, screening levels were calculated using the DRIs published by the National Academy of Sciences (2004) and EPA's standard exposure assumptions used to derive RSLs (EPA, 2009a). The calculated screening concentration for calcium exceeds the theoretical ceiling limit (i.e., $10^{+5}$ mg/kg) discussed in the RSL user's guide (EPA, 2009a); therefore, the ceiling limit (instead of the calculated screening level) was used for calcium in the screening comparison.

Based on the results of the sediment and surface water study conducted by CH2M HILL and ENVIRON (2009) and other related studies with respect to chromium geochemistry, chromium in sediment is in the Cr(III) form.

The presence of Cr(III) was measured via total chromium measurements and the presence of Cr(VI) in the solid phase was determined based on the presence (and absence) of Cr(VI) in pore water, based on the following precedents and procedures:

- The evaluation of Cr(VI) in DMT sediments was undertaken through pore water extraction methods and analysis of the aqueous phase as recommended by EPA (2005a) and determined by MDE as the appropriate approach for the MDE Water Quality Analyses of Chromium in the Inner Harbor/Northwest Branch and Bear Creek Portions of Baltimore Harbor in Baltimore City and Baltimore County, Maryland (2004). The sediment and surface water investigation approach followed EPA's *Procedures for the Derivation of Equilibrium Partitioning (EqP) Sediment Benchmarks for the Protection of Benthic Organisms: Metal Mixtures* (EPA, 2005a), and incorporates concepts identified in the *Issue Paper on the Bioavailability and Bioaccumulation of Metals* submitted to EPA by the Eastern Research group (McGeer et al., 2004) and USEPA's *Framework for Metals Risk Assessment* (EPA, 2007). According to USEPA, geochemical processes govern the reduction of relatively toxic Cr(VI) to relatively non-toxic Cr(III) in estuarine sediments. Specifically, geochemical parameters such as sulfide and ferrous iron [Fe(II)] are lines of evidence that document the reducing conditions of the sediment wherein chromium exists thermodynamically as Cr(III) rather than Cr(VI).
- Direct measures of Cr(VI) in solid phase were not performed in sediment because Cr(VI) solid phase measures have a tendency to produce false positive measures, as has been documented by EPA where researchers refer to traces of Cr(VI) up to 4mg/kg as artifacts from separation techniques inherent in the laboratory analytical procedures. The Standard Operating Procedures for EPA Method 3060A (1986a; solid phase digestion prior to Cr(VI) analysis) provides language regarding the method interferences/uncertainties; see Section 3.3 (p. 2): "For waste materials or soils

containing soluble Cr(III) concentrations greater than four times the laboratory Cr(VI) reporting limit, Cr(VI) results obtained using this method may be biased high due to method-induced oxidation."

- Work by Zatka (1985), cited in Method 3060, initially identified that Cr(III) can be oxidized to Cr(VI) during a digestion using a hot alkaline solution of sodium hydroxide and sodium carbonate (a solution similar to that used in the EPA alkaline digestion performed in these studies). Zatka states that up to 4.5 µg Cr(VI) (as a false positive) can be found in samples where magnesium is not used to suppress this method induced oxidation. A quantity of 4.5 µg in a 2.5-g sample is 1.8 ppm (well above the method reporting limit of 0.4 ppm). So it is possible to obtain results above the laboratory reporting limit from method induced oxidation alone. While Mg2+ addition aids in suppressing oxidation the method makes no claim that the suppression is 100 percent effective. These findings of Zatka (1985) and EPA researchers (2005a) are confirmed by work from Pettine and Capris (2005).
- Additional studies have also been published that isolate this oxidation to that of "freshly precipitated" Cr(III) to Cr(VI) during this digestion creating a false positive Cr(VI) result. The "freshly precipitated" Cr(III) has been discussed by James et al. (1983) and is more reactive toward method induced oxidation because the Cr(III) is not stabilized by a more crystalline form—favored with age. Given the proximity of the intertidal zone of DMT to the stormwater outfalls where Cr(VI) has been released in the past, it is reasonable to conclude that the Cr(III) present in these areas could reflect recently precipitated Cr(III) that has not yet been exposed to years or decades of weathering.

No Cr(VI) was detected in pore water samples collected during the four quarterly sampling events (May, August, and December 2007 and February 2008). The Cr(III) is unlikely to oxidize to Cr(VI) because the geochemical conditions necessary for this process do not naturally occur in the estuarine environment. Geochemical measures of acid volatile sulfide (AVS) and Fe(II) showed very strong evidence that there was adequate AVS and/or Fe(II) throughout the site study area and during all seasons to maintain the reducing conditions that would ensure the presence of chromium as Cr(III). Additionally, the study report concluded the following regarding the speciation of chromium in sediments (CH2M HILL and ENVIRON, 2009):

- Cr(III) is favored in Baltimore Harbor waters because reducing agents are ubiquitous and abundant, resulting in the reduction of Cr(VI) to Cr(III).
- The kinetics of Cr(VI) reduction to Cr(III) is much faster than the kinetics of Cr(III) oxidation to Cr(VI); therefore, reduction processes easily overwhelm the more limited oxidation processes in Baltimore Harbor sediments.
- Cr(III) was shown to be highly stable in reducing Baltimore Harbor sediments. Manipulated laboratory conditions would be required to catalyze the formation of Cr(VI) from Cr(III). In environmentally relevant conditions, oxidation of Cr(III) to Cr(VI) would be highly unlikely even in response to dredging to other episodic events that disrupt and suspend contaminated sediment.

These multiple lines of evidence suggest that chromium in sediments exists almost exclusively in the Cr(III) form. Therefore, chromium concentrations reported in sediment samples were assessed as Cr(III) and were screened against the RSL for Cr(III). At the DMT site, sediment data are available for total vanadium. The pH and environmental conditions (i.e., pH, reducing versus oxidizing conditions) were evaluated to determine the form of vanadium most likely to be present so that the appropriate RSL could be identified. Reducing conditions are present, and the most likely form present is vanadate; therefore, the RSL for "vanadium and compounds" was used to screen vanadium sediment data.

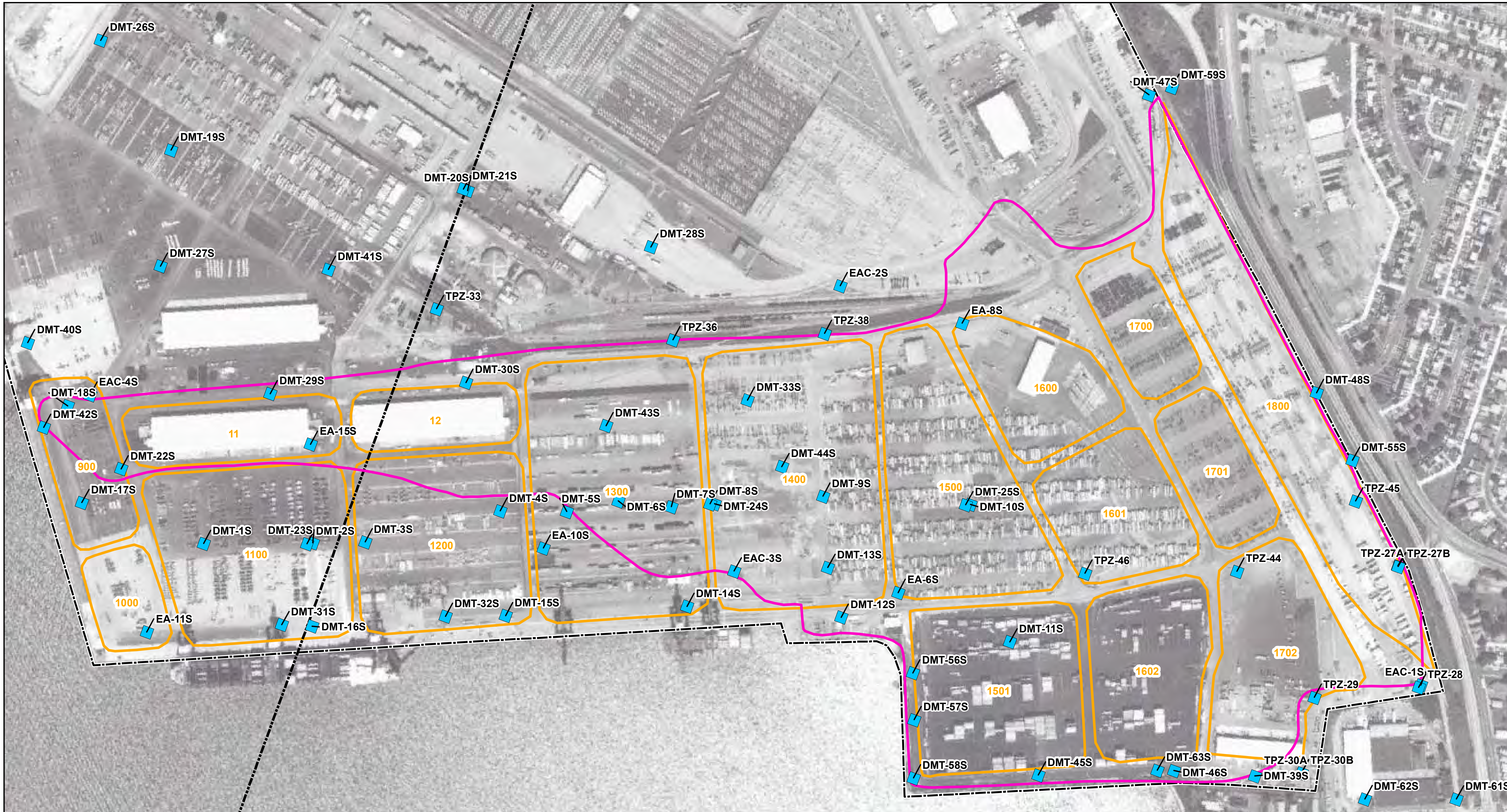
If the maximum detected concentration of a constituent exceeds its respective screening value, the constituent was identified as a COPC and retained for quantitative evaluation in the HHRA. Results of the COPC screening process are presented in Tables 2.8 and 2.9 of Appendix A. The following four COPCs were identified for both surface sediment (0 to 1 foot bgs) and deeper sediment (0 to 3 feet bgs): aluminum, iron, manganese, and vanadium.

## 2.3 Modifications to the HHRA Approach

A few modifications were made to the HHRA approach presented in the work plan; major modifications are noted below:

- Current potential outdoor air exposures by DMT workers were evaluated based on results of the perimeter air-monitoring data.
- Additional soil samples historically collected within the COPR boundary were added to the soil data groupings. Although some of these samples were collected at locations that were subsequently excavated, the COPR material has a fairly consistent composition, and therefore these samples are expected to represent COPR areas not sampled.
- Total soil (0–10 feet) exposures by future DMT workers were evaluated in addition to the proposed exposures to surface soil.

Additionally, potential "surface soil" exposures by DMT workers to small deposits of evaporated chromium salts ("chromium blooms" or "COPR blooms") derived from underlying areas of COPR were reclassified from "current DMT workers" (as presented in the work plan) to "future DMT workers." This change was made because of the high exposure frequency (250 days/year) and duration (25 years) assumed in this HHRA, which does not reflect current exposures due to the existing surface cover typically atop COPR-impacted areas; the current program, in which surficial COPR blooms are removed as soon as they are observed (in accordance with the surface cover inspection and maintenance plan, or SCMP (CH2M HILL, 2007a); and current site health and safety requirements




**Legend**
- Groundwater Sampling Locations
- COPR Extent
- Areas
- DMT Boundary
- City/County Boundary

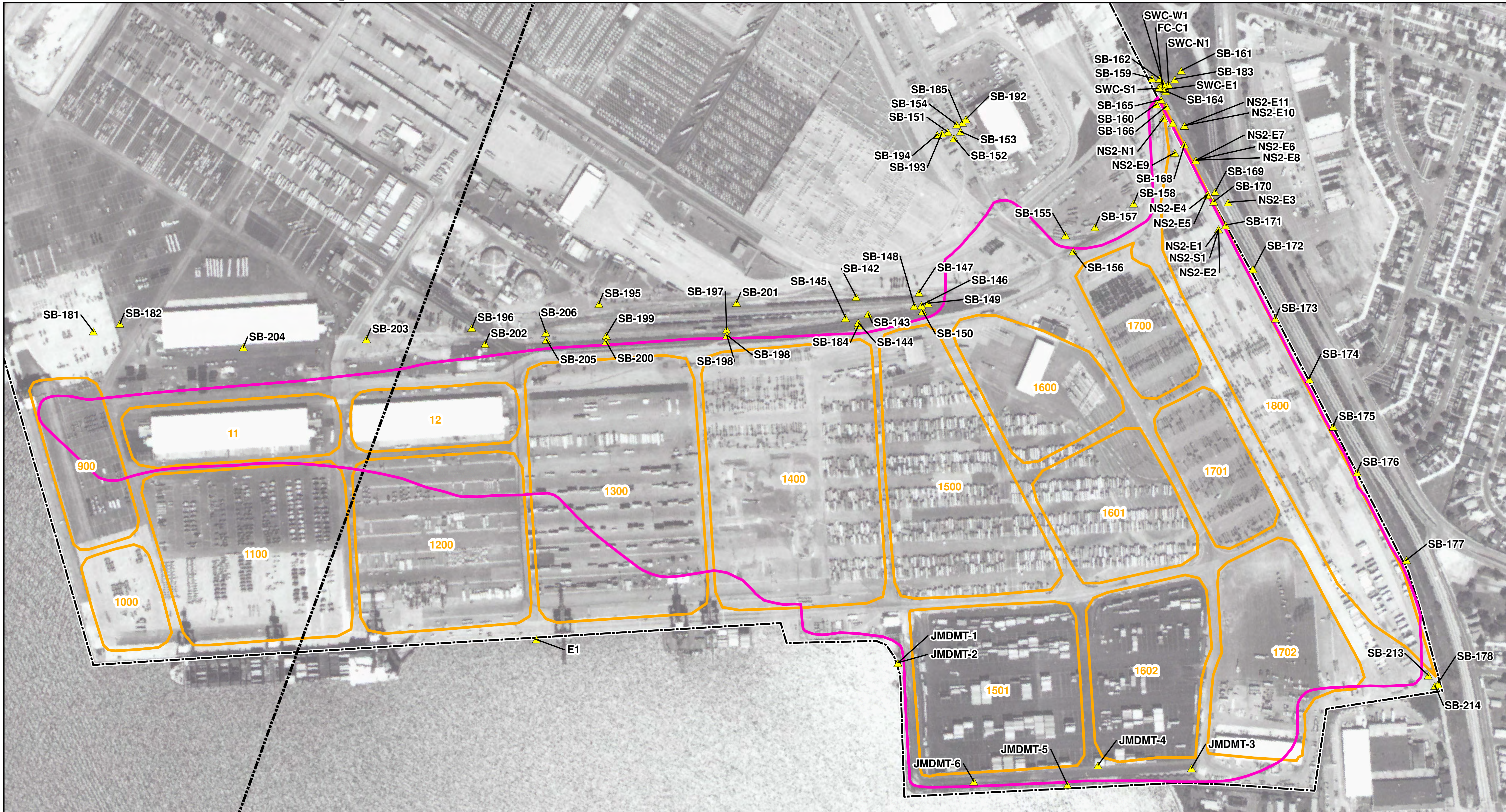
N W E S

0 200 400 600 Feet

Figure 2-1
Groundwater Sampling Locations
Human Health Risk Assessment
Dundalk Marine Terminal, Baltimore, MD

CH2MHILL

\\APHRODITE\PROJ\HONEYWELLINC\DUNDALKMARINETERMINAL\MAPFILES\HHRA_WP\FIGURE 3 - SURFACE SOIL SAMPLING LOCATIONS.MXD BWARD 9/3/2009 18:02:44




**Legend**

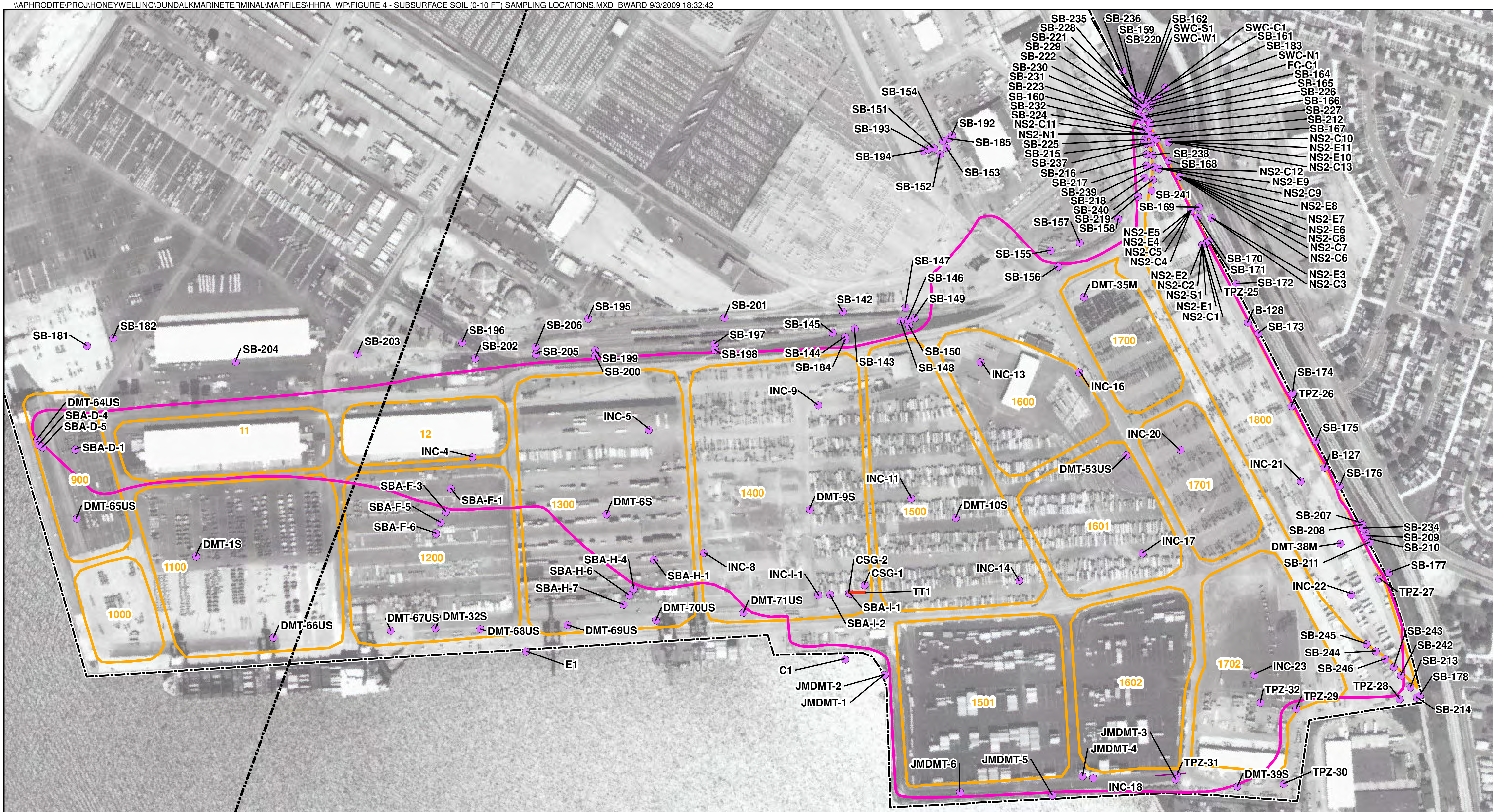
- Surface Soil Sampling Locations
- COPR Extent
- Areas
- DMT Boundary
- City/County Boundary

0 200 400 600 800 Feet

Figure 2-2

Surface Soil (<0.5 feet) Sampling Locations
Human Health Risk Assessment
Dundalk Marine Terminal, Baltimore, MD

CH2MHILL




**Legend**

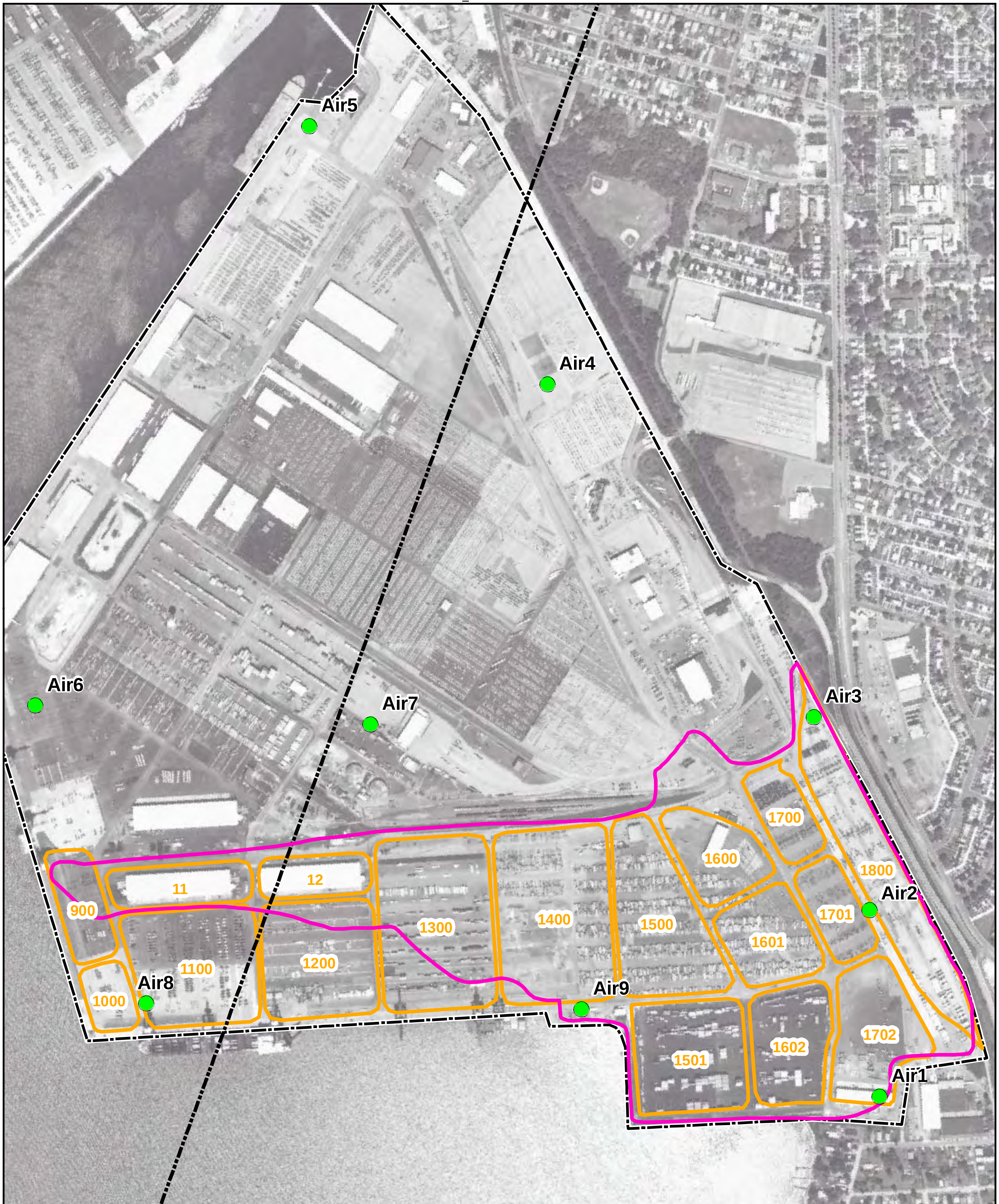
- Subsurface Soil Location
- Test Trench
- COPR Extent
- Areas
- DMT Boundary
- City/County Boundary

0 200 400 600 800 Feet

Figure 2-3
Subsurface Soil (0-10 feet) Sampling Locations
Human Health Risk Assessment
Dundalk Marine Terminal, Baltimore, MD

CH2MHILL

\\APHRODITE\PROJ\HONEYWELLINC\DUNDALKMARINETERMINAL\MAPFILES\HHRA_WP\FIGURE 6 - AIR MONITORING LOCATIONS.MXD 5/27/2009




**Legend**

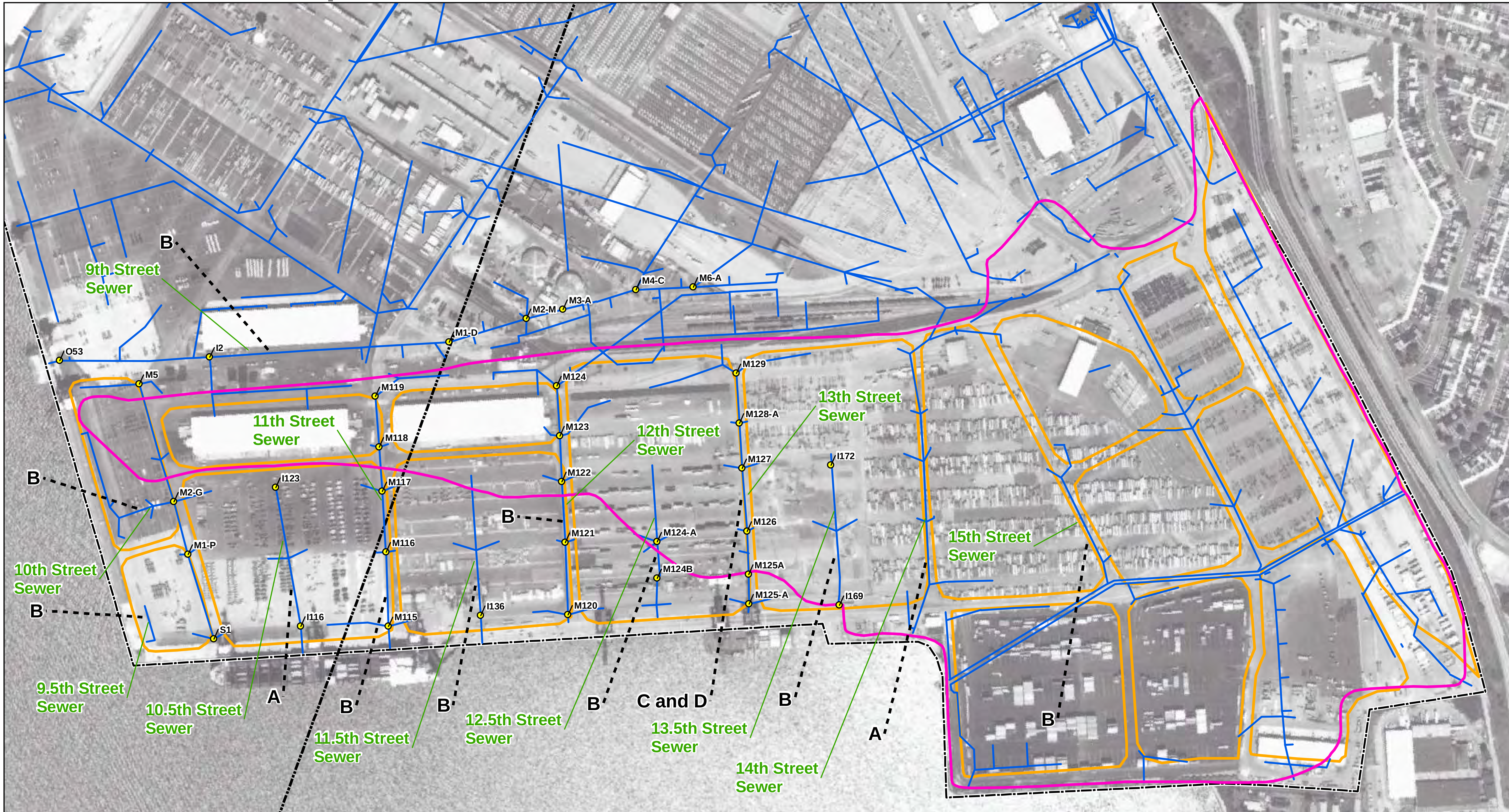
- Air Monitoring Locations
- COPR Extent
- Areas
- DMT Boundary
- City/County Boundary

0 425 850 Feet

Figure 2-4
Air-Monitoring Locations
Human Health Risk Assessment
Dundalk Marine Terminal, Baltimore, MD

CH2MHILL

\\APHRODITE\PROJ\HONEYWELLINC\DUNDALKMARINETERMINAL\MAPFILES\HHRA_WP\FIGURE 7 - STORM WATER SAMPLING LOCATIONS.MXD KJACKSO5 6/1/2009 12:09:28




**Legend**

- Storm Water Sample Location
- Storm Sewer Main
- COPR Extent
- Areas
- DMT Boundary
- City/County Boundary

A. The exact sampling location of 2004 samples is unknown.
B. The exact sampling location of 2005 samples is unknown.
C. The exact sampling location of 2008 samples is unknown.
D. The exact sampling location of 2009 samples is unknown.

N E S W

0 200 400 600 800 Feet

Figure 2-5
Stormwater-Sampling Locations
Human Health Risk Assessment
Dundalk Marine Terminal, Baltimore, MD

CH2MHILL

\\APHRODITE\PROJ\HONEYWELLINC\DUNDALKMARINETERMINAL\MAPFILES\HHRA_WP\FIGURE 8 - SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS.MXD KJACKSO5 5/29/2009 07:55:30


**Legend**

- Sample Locations
- COPR Extent
- Areas
- Road Centerline
- Railroad Centerline
- County/City Boundary

Note: Gray channel areas are greater than 18.2 ft.

**Depth in Meters (NOAA, 2006)**

- -0.3 - 0
- 0 - 1.8
- 1.8 - 3.6
- 3.6 - 5.4
- 5.4 - 9.1
- 9.1 - 18.2

N W E S

0 500 1,000 2,000 Feet

Figure 2-6
Surface Water and Sediment Sampling Locations
Human Health Risk Assessment
Dundalk Marine Terminal, Baltimore, MD

CH2MHILL

SECTION 3

# Exposure Assessment

The objective of the exposure assessment was to estimate the types and magnitude of potential current or future exposures to COPR-related constituents at (or potentially migrating from) DMT. The exposure assessment was conducted in two major steps:

1. Characterizing the exposure setting
2. Identifying potential exposure pathways for each environmental medium

## 3.1 Conceptual Exposure Model

The preliminary human health CEM (Figure 3-1) was used to qualitatively depict the types of potential exposures to COPCs at or migrating from the site. The CEM presents the onsite source, the affected environmental media, the chemical fate and transport mechanisms that might be involved, the potentially exposed receptor groups, and potential exposure pathways. The CEM considers existing site characterization data and current and future site conditions and activities to identify potentially complete exposure pathways. The source of contamination associated with the site is COPR, which was used as fill when a portion of DMT was constructed.

## 3.2 Exposure Setting

Characterizing an exposure setting consists of two parts: (1) identifying the physical characteristics of the site as they relate to exposure and (2) characterizing human populations on or near the site (the potentially exposed populations).

The DMT property is a peninsula bounded by Colgate Creek and the Patapsco River, except for the north side, where it is bounded by Broening Highway and the Norfolk Southern Railroad. The land uses surrounding DMT consist of commercial, industrial, and residential. The residential neighborhood of Carnegie Plats is adjacent to the southeastern boundary of DMT. Communities near DMT also include Turners Station and Logan Village. Other residential areas near DMT include St. Helena and the greater Dundalk community. The commercial area closest to DMT is the Logan Village Shopping Center, on Dundalk Avenue. Industrial facilities located within ¼ to ½ mile of DMT include Baltimore Gas and Electric and Millennium Chemicals. The 120-year-old steel plant at Sparrows Point (currently owned by OAO Severstal) is also in the vicinity of DMT.

Potentially exposed populations are identified in Section 3.3 on the basis of their locations relative to the site, their activity patterns, and the presence of potentially sensitive subpopulations.

## 3.3 Potential Exposure Pathways

To evaluate the potential health risks associated with exposure to COPCs, potentially complete exposure pathways were identified. An exposure pathway is a mechanism by which a receptor can be exposed to COPCs at or originating from the site. An exposure pathway must be complete for exposure to occur. A complete exposure pathway has four elements:

- Source or release from a source
- Environmental transport medium
- Exposure point (receptor location)
- Route of intake (inhalation, direct contact, or incidental ingestion)

The following populations are present onsite and are discussed in the HHRA:

- DMT workers—those involved in shipping and receiving activities and other onsite activities
- DMT visitors—those involved in dropping off and picking up cargo
- Utility workers—those periodically involved in repairing and maintaining water, stormwater, electrical, and communication lines at the DMT
- Construction workers—those periodically involved in maintaining the surface cover on the COPR-impacted areas or constructing or modifying buildings

The following populations are present offsite and were addressed in the HHRA:

- Residents in homes at the adjacent cove
- Recreational users in the cove
- Anglers in the Patapsco River and Colgate Creek

There is a high level of security at DMT, including security fencing, full-time police surveillance, continuous perimeter monitoring, and a Maryland Transportation Authority police station; access is limited to authorized personnel only through guarded security gates. Therefore, trespassers cannot gain access to the site and were not evaluated as a potential receptor population in the HHRA.

In compliance with the Consent Decree, an MPA Master Health and Safety Plan (HASP) (Emilcott, 2006) was prepared for DMT and approved by MDE. It addresses all projects at the site that involve work performed in areas that might have COPR-impacted soil or water. The overall purpose for the MPA HASP is to ensure that minimum requirements and procedures are in place to protect workers, the public, and the environment from possible chromium-related exposures associated with activities conducted onsite and establish health and safety management systems to maintain regulatory compliance, worker safety, and environmental protection. The contractor site-specific health and safety plan (SSHSP) must meet or exceed the requirements of the MPA master HASP. Each SSHSP must include provisions for controlling the project work site to ensure that only authorized personnel are permitted access to the site and obtain an approved air-monitoring plan of the work site (Emilcott, 2006).

Also in compliance with the Consent Decree, the SCMP was prepared for the site and approved by MDE (CH2M HILL, 2007a, 2008b). The plan contains inspection and maintenance procedures for the cover system, open pavement excavation, and the 14th and 15th Streets storm drain system at DMT. The plan describes inspection and maintenance procedures, training, and monitoring requirements in areas where COPR is present at DMT for the following:

- Routine inspection and repair of surface cover materials (based on historical inspections, heaves occur slowly, and when cracks occur, they are less than 1 inch wide and are surficial only)
- Semiannual inspection along the railroad tracks within the DMT property boundaries
- Routine inspection and repair of the existing 14th Street and 15th Street storm drain systems
- Mitigation of events, if any, where the 14th Street and 15th Street storm drains are damaged or are likely to be damaged

Currently, surface cover penetration is controlled pursuant to the surface cover penetration SOP (CH2M HILL, 2009). All excavations and other intrusive work through existing cover systems currently require work plans addressing, at a minimum, construction area security, project-specific health, safety, containment, and/or control measures for exposed or excavated COPR materials, water control requirements, and temporary and permanent cover measures. The plans must include the following:

- A HASP that includes health and safety and air-monitoring requirements at least as stringent as those in the MPA master HASP
- A security plan that includes the locations of barriers, security points, and other measures required to prevent inadvertent intrusion and exposure within the work areas
- An environmental control plan that includes provisions for preventing the spread of contaminants by air or water

Site activities are currently conducted under the MPA master HASP and the SCMP. Therefore, current exposures to COPR-impacted soil, groundwater, stormwater, and air are not likely to occur by persons who are not Hazardous Waste Operations and Emergency Response (HAZWOPER)-trained and protected.

### 3.3.1 Groundwater

#### Current Scenario

The shallow and deep groundwater units under the site have been investigated. Barriers (clay and organic silt units) are present that impede vertical migration of constituents of concern in the shallow groundwater unit to the deeper underlying potable groundwater unit (the Patuxent Aquifer). Therefore, the shallow groundwater unit was assessed further in the HHRA.

Site groundwater is not a potable supply. In the State of Maryland, wherever the local jurisdiction provides municipal water, private potable wells cannot be installed. Potable water is supplied to DMT by the City of Baltimore. As the operator of DMT, the MPA is responsible for maintaining the potable water system at the DMT.

The site drinking water plan (CH2M HILL, 2007d) was prepared in response to Section III.B.9.c of the April 2006 Consent Decree and was approved by MDE. The plan ensures that chromium-contaminated materials are not adversely impacting the drinking water at the DMT. The plan establishes a routine sampling program to test for chromium in the water distribution system, a contingency plan for operating the water system in the event of a pipe break (including returning the system to normal operation after a break has been repaired), and purging procedures to remove potential impact. Therefore, the potable water exposure pathway is incomplete for current site conditions.

Groundwater is present approximately 10 feet bgs. If workers excavate in COPR-impacted areas to the depth of groundwater, workers operate under a SSHSP and are HAZWOPER-trained; such workers are not addressed in HHRAs. Therefore, dermal contact with groundwater during excavations is an incomplete exposure pathway for current site conditions.

#### Assumed Future Scenario

The site drinking water plan that has been implemented will continue to be used in the future. The contingency plan implemented during line breakage will remain in place in the foreseeable future, and the local regulations prohibiting the installation of private wells will remain in place. Therefore, the potable water exposure pathway is considered incomplete for future site conditions.

As a hypothetical future scenario, it was assumed that an SSHSP is no longer required and construction workers could contact shallow groundwater while performing excavation activities. Therefore, dermal contact with shallow groundwater in excavations was assumed to be a complete exposure pathway for hypothetical future site conditions.

### 3.3.2 Soil

#### Current Scenario

With the exception of the rail yard and rail spur areas, a cover approximately 2 feet thick is typically present atop COPR-impacted areas (CH2M HILL, 2007c, 2009b). The cover typically consists of clay or silty sand, road base, asphalt, or concrete. When invasive activities are conducted in COPR-impacted areas, workers perform their activities under an SSHSP and are HAZWOPER trained; such current workers subject to the institutional and engineering controls currently in place are not addressed in the HHRA. Within limited areas of the railroad ballast, when small “COPR blooms” are observed during implementation of the SCMP, they are immediately addressed. Therefore, the surface soil (less than 0.5 foot bgs) exposure pathway may occasionally be complete for DMT workers. However, because of the likely low exposure frequency and short exposure duration, this exposure scenario was not quantified in the HHRA for current conditions but rather was quantified as part of a hypothetical future scenario.

#### Assumed Future Scenario

As a hypothetical future scenario, it was assumed that the institutional/engineering controls currently in place (e.g., the SSHSP and SCMP) are no longer required and COPR blooms occur at the site surface (at a depth less than 0.5 foot bgs) and are contacted by DMT workers. In addition, it was assumed that construction workers could contact soil (0 to 10 feet bgs) without institutional/engineering controls during excavation activities, and deeper soils could be brought to the surface during construction activities and contacted by future

DMT workers. Therefore, surface soil (0 to 0.5 foot bgs) exposures by DMT workers (through ingestion, dermal contact, and inhalation) and total soil (0 to 10 feet bgs) exposures by construction workers and DMT workers (through ingestion, dermal contact, and inhalation) were quantified in the HHRA under hypothetical future scenarios.

### 3.3.3 Air

#### Current Scenario

Most of the DMT surface is covered with asphalt or concrete. In addition, cover materials (approximately 2 feet thick) are typically present atop COPR-impacted areas, and an MDE-approved SCMP with perimeter air monitoring is being implemented. Therefore, outdoor air is not a viable transport pathway because the site is covered, and the SCMP includes routine inspection and repair of the surface cover, which has been effective at controlling this potential pathway.

When invasive activities are conducted in COPR-impacted areas, work is conducted under an SSHSP that includes air monitoring. Work operations in the COPR-impacted area may be stopped when total dust measurements at the Exclusion Zone perimeter meet or exceed 1 $mg/m^3$ (30-minute time-weighted average) (Emilcott, 2006). Therefore, invasive activities are not expected to contribute significant concentrations of Cr(VI) to air.

The purpose of the perimeter air-monitoring program is to evaluate the effectiveness of the surface cover and maintenance systems in the COPR fill area through measuring Cr(VI) in airborne particulates. As stated above, within limited areas of the railroad ballast, small COPR blooms occasionally are manifested at the site surface and are observed during implementation of the SCMP and immediately addressed. Therefore, the outdoor air exposure pathway may occasionally be complete for DMT workers. However, due to the likely low exposure frequency and short exposure duration, this exposure scenario was not quantified in the HHRA for current conditions but rather was quantified as part of a hypothetical future scenario.

Potential site-related impacts on DMT workers and offsite residents were evaluated in the HHRA. The Cr(VI) concentrations measured in outdoor air during the perimeter air-monitoring program were evaluated to assess whether the Cr(VI) concentrations detected in outdoor air are indicative of a site release or attributed to local background levels. A comparison was also made between the measured Cr(VI) concentrations and particulate matter (PM) concentrations to assess whether the measured Cr(VI) concentrations are associated with potential fugitive dust either from the site or from offsite sources.

#### Assumed Future Scenario

As a hypothetical future scenario, it was assumed that the institutional/engineering controls currently in place (e.g., the SSHSP and SCMP) are no longer required and DMT workers and construction workers could inhale fugitive dust from COPR materials (currently situated at 0 to 10 feet bgs) every day while onsite. This inhalation exposure pathway was evaluated using a calculated particulate emission factor (PEF) and soil data.

### 3.3.4 Stormwater

#### Current Scenario

Subsurface stormwater lines are present in portions of the site. When storm sewer cleaning or inspection occurs in COPR-impacted areas, workers/inspectors operate under an SSHSP and are HAZWOPER-trained; such current workers are not evaluated in the HHRA. The nonpriority drains (9th Street to 11.5th Street Outfalls, which contribute de minimis mass flux) are cleaned/inspected on an irregular basis. The priority drains (12th Street to 15th Street Outfalls) are also cleaned on an irregular basis; however, the 14th and 15th Street lines are visually inspected annually as part of the SCMP. The visual inspections consist of entering the pipe through manholes and walking from manhole to manhole inside the pipe. Each storm drain system takes approximately 2 to 4 days to inspect. At the points where stormwater enters the Patapsco River, the public has no access. Therefore, the stormwater exposure pathway is incomplete for current site conditions.

#### Assumed Future Scenario

For the hypothetical future scenario, it was assumed that the current SSHSP is no longer implemented and utility workers could come in contact with stormwater within the pipelines. Therefore, dermal contact with stormwater by utility workers was quantified in the HHRA under a hypothetical future scenario.

### 3.3.5 Surface Water and Sediment

Because of the high level of security at DMT (including full-time police surveillance with continuous perimeter monitoring) and the extensive commercial ship operations, people do not engage in recreational activities (swimming, waterskiing, or wading) in most areas near DMT. The high level of port activity (i.e., consistent movement of ships, large vessels, tugs, and barges) results in an area that is both undesirable and unsafe for individuals to engage in recreational activities. In addition, the surface of DMT is inaccessible to swimmers and small craft due to the height of the docks. Shipping lanes around DMT allow access for large hulled vessels, and bathymetric imaging indicates that the lanes extend to a depth of approximately 45 feet near the berths at DMT. Therefore, even if individuals were to engage in recreational activities in the waters adjacent to DMT, most sediments would be inaccessible due to water depth. Currently, there are no complete exposure pathways to surface water or sediment in most areas near DMT, nor are there expected to be in the future should the level of port security decrease (which is unlikely).

A few residences with boat docks are situated immediately adjacent to DMT on its southeastern boundary. Residents may enter the Patapsco River at their docks in the cove and not be intercepted or stopped by DMT police. It was assumed that residents in this area might occasionally wade and swim in the cove near the docks. Therefore, the surface water and sediment (incidental ingestion and dermal contact) exposure pathways are potentially complete for offsite residents adjacent to the site under current and future site conditions.

During the sediment study, it was noted that sediments in this area of the cove are very sandy, and if a person were to walk in this area of the cove, they would not sink into the sediment more than approximately 6 inches. Also during the sediment study, grain size analysis was performed on the samples and the sediment type determined. As indicated in

Table 3-1, one location (A1) was characterized as sandy silt and silty sand, whereas the remaining sampling locations were categorized as sand.

### 3.3.6 Biota

Fish and crab consumption advisories issued by MDE are in effect for Patapsco River and the Baltimore Harbor. The advisory recommends that eel and catfish not be consumed because of impact by polychlorinated biphenyls (PCBs) and pesticides, and crab and fish consumption be limited because of PCBs, pesticides, and methylmercury.

People have been observed fishing and crabbing in Colgate Creek around the Broening Highway Bridge crossing the creek near DMT. The city has posted signs prohibiting fishing from the bridge. People also catch fish and crab in the Patapsco River and Colgate Creek at locations farther from DMT. However, for purposes of the HHRA, fish and crab ingestion are incomplete exposure pathways because of the lack of a significant site-related source in edible tissue.

The Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles (ATSDR, 1992, 2000a, 2000b, and 2006) and Argonne National Laboratory sources (2001) indicate that COPR constituents do not significantly accumulate in the food chain. The aquatic bioaccumulation factors (BAFs) for freshwater are provided in Table 3-2. Although these BAFs are for fresh water and the Patapsco River and Colgate Creek are marine water, the values indicate that the COPR constituents have low bioaccumulation potential (BAFs below 1,000 are not considered to be bioaccumulative) and COPR constituents are not included in EPA's list of bioaccumulative compounds (EPA, 2000a, b).

Overall, the COPR constituents are not expected to biomagnify in the aquatic food chain and be present at levels significant for fish or shellfish consumers. A summary of chemical-specific information is provided in the following paragraphs.

#### Aluminum

When present in an aquatic ecosystem, most aluminum-containing compounds do not dissolve to a large extent in water unless the water is acidic or very alkaline; therefore, bioavailability is often decreased. As a result, aluminum does not biomagnify in the food web, and consumption of aquatic biota is not a significant exposure pathway for aluminum (ATSDR, 2006).

#### Calcium

Information available for bioaccumulation of calcium within the food web is limited because calcium is an essential nutrient for human health, in addition to the relatively widespread natural abundance and availability of calcium in sediments and surface waters. Calcium is an important component of aquatic plant cell walls and the shells and bones of many aquatic organisms. The relatively nontoxic properties of calcium within aquatic ecosystems are indicated in U.S. Department of Energy's (1999) Environmental Restoration Division sources. Calcium does not biomagnify in the food chain, and consumption of aquatic biota is not a significant exposure pathway for calcium.

## Chromium

Cr(III) is an essential nutrient for biological organisms and does not biomagnify in the food web. Flora and fauna have natural mechanisms to regulate uptake and elimination of Cr(III). Specifically, Cr(III) plays a role in sugar and protein metabolism (Eisler, 1986; Newman and Unger, 2003; NPS, 1997). As a result of bioregulation, the extent to which Cr(III) is accumulated is expected to be concentration-dependent. That is, the ratio of chromium in tissue to bioavailable chromium in environmental media is highest when bioavailable chromium is scarce and lowest when bioavailable chromium is relatively abundant.

Like many other metals, chromium exhibits biodiminution through the food web. Eisler (1986) indicated the following:

> …Although chromium is abundant in primary producers, there is little evidence of biomagnification through marine food chains consisting of herbivores and carnivores. [Previous researchers] followed the transfer of assimilated and unassimilated radiochromium through an experimental food chain that included phytoplankton, brine shrimp, postlarval fish, and adult fish. When chromium was successively transferred through each of the four trophic levels, concentrations declined after each transfer.

A study more directly related to DMT is of chromium bioaccumulation from sediment assessed for a wetland site along the Hackensack River surrounded by COPR (Hall and Pulliam, 1995). Researchers found that metals (including chromium) in sediment were detected at concentrations nine times greater in the COPR-impacted wetland study site than in a reference site. However they found no statistically significant differences between the study and reference sites for total chromium in blue crab (*Callinectes sapidus*) muscle tissue, whole-body killifish (*Fundulus sp*.), or giant reed tissue (*Phragmites*). Although there was a statistically significant difference seen in chromium in blue crab hepatopancreas tissues in this study between the study site and the reference site (Hall and Pulliam, 1995), researchers indicated that this difference was likely caused by foraging strategies of crabs and the role of their hepatopancreas. Crabs ingest sediments while gleaning food, and the hepatopancreas' function is to filter foreign materials from the blood. Researchers concluded that the lack of statistically significant differences in total chromium concentrations in these tissue samples provides evidence of tight binding of total chromium to the study site sediments and low bioavailability of chromium (Hall and Pulliam, 1995). These results are also consistent with the bioregulation of chromium as an essential nutrient.

In addition to these studies above, ENVIRON (2006) evaluated more than 300 fish tissue samples from among 24 species of fish compared with chromium concentrations in sediment, using data available from National Oceanic and Atmospheric Administration Regional Environmental Mapping Program. The results of this study showed no statistical correlation between chromium in sediment and chromium concentrations in fish tissues.

The maximum detected concentration of Cr(III) in surface water samples addressed in the HHRA is below the National Ambient Water Quality Criterion (NAWQC) (EPA, 2006d) for consumption of water and organisms.[1] A report was recently submitted to MDE summarizing studies conducted by MDE; EPA; Johns Hopkins University's Center for

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[1] The maximum concentration of Cr(III) was identified based on a combined dataset of measured concentrations and concentrations calculated from Cr(VI) and Cr(total). As indicated in the NAWQC document, the Cr(III) Maximum Contaminant Level was used as the Cr(III) surface water criterion.

Contaminant Transport, Fate, and Remediation; the University of Maryland; and others (ENVIRON, 2008). The report concluded that Cr(III) concentrations present in the environment are far below levels that are toxic to estuarine organisms. Further, none of the toxicity studies evaluated in the report exhibited a concentration-response relationship with chromium in sediments. These studies and general information from scientific literature indicate that biomagnification in the food chain (to edible fish tissue) does not occur. Therefore, consumption of aquatic biota is not a significant exposure pathway for either Cr(III) or Cr(VI).

### Iron

Iron is an essential trace element required by both aquatic plants and animals. It is a vital oxygen transport mechanism in the blood of all vertebrate animals.

The ferrous (bivalent) and the ferric (trivalent) irons are the primary forms of concern in the aquatic environment. For practical purposes the ferric form is insoluble (EPA, 1986b). There are no EPA-established national acute or chronic water quality criteria for iron.

Furthermore, toxicity and bioaccumulation studies of iron on aquatic life are rare. Iron is usually an objectionable constituent in water supplies only when the supplies are used for either domestic or industrial use (because iron can affect the taste of beverages and can stain laundered clothes and plumbing fixtures). As a result, iron is not typically a concern in risk assessment because aesthetic considerations often outweigh actual toxicological effects (Iowa Department of Natural Resources, 2005). There is no information indicating that iron biomagnifies in the food chain (to edible fish tissue). Therefore, consumption of aquatic biota is not a significant exposure pathway for iron.

### Magnesium

Magnesium is similar to calcium in its low solubility and its being a critical essential nutrient within aquatic ecosystems; limited information on adverse bioaccumulative effects is available for magnesium. Studies have shown that the concentration of magnesium within fish tissue is generally equal to the available dissolved magnesium in the water body from which the specimen was collected (Vincoli, 1997). Additional studies also provide evidence that as with manganese, the potential for biomagnification of magnesium from lower trophic levels to higher ones is low (Newman and Unger, 2003). Therefore, consumption of aquatic biota is not a significant exposure pathway for magnesium.

### Manganese

It has been established that while lower organisms (e.g., plankton, aquatic plants, and some fish) can significantly bioconcentrate manganese, higher organisms (including humans) tend to maintain manganese homeostasis. This indicates that the potential for biomagnification of manganese from lower trophic levels to higher ones is low. ATSDR (2000b) indicates that additional research in this area does not appear to be essential at this time. Therefore, consumption of aquatic biota is not a significant exposure pathway for manganese.

### Vanadium

Bioaccumulation of vanadium is low for fish (Irwin et al., 1997). There is no evidence of vanadium accumulation or biomagnification in food chains in marine organisms, the most studied group (World Health Organization, 2001). Based on human studies, biomagnification of vanadium in food chains is unlikely because any vanadium absorbed is rapidly excreted (Fox, 1987, as cited in ATSDR, 1992). In a study by Miramand et al. (1992), the whole-body concentration factor for the benthic fish *Gobius minutus* was low (0.8) after three weeks of exposure to vanadium using a radiotracer ($^{48}V$) in seawater. Miramand et al. (1992) hypothesized that low vanadium toxicity in fish is likely related to the low degree of vanadium uptake from water and food. Although one study of rainbow trout indicated that this species bioaccumulated vanadium from a diet that was directly supplemented with sodium orthovanadate, BCFs were overall low, ranging from 0.75 to 33.5 (Hilton and Bettger, 1988). In summary, consumption of aquatic biota is not expected to be a significant exposure pathway because vanadium bioaccumulation is low, and that which is accumulated is rapidly excreted.

## 3.4 Quantification of Exposures

For the COPCs identified in media impacted by a potential site release, potential exposures were quantified for applicable receptors for the exposure medium. To further evaluate the potentially complete exposure pathways, the magnitude, frequency, and duration of potential exposures were quantified. The EPCs were estimated, and potential intakes were quantified. EPA (1989) guidance recommends selecting intake variable values for a given pathway so that the combination of all intake values results in an estimate of the Reasonable Maximum Exposure (RME) for that pathway. EPA recommends using upper-bound parameter values (as opposed to average values) for exposure frequency and duration.

### 3.4.1 Exposure Point Concentrations

EPCs are the concentrations in an environmental medium to which a receptor can be exposed at a specific location (the “exposure point”). If fewer than 10 samples are available for a COPC within a data grouping, the maximum detected concentration was used as the EPC at the direction of MDE. However, if 10 or more samples are available, the EPCs were identified using the most recent parametric (distributional) and nonparametric EPA recommendations provided in ProUCL (EPA, 2006a, 2009b). Version 4 of ProUCL provides approaches for calculating upper confidence limits (UCLs) of the mean, particularly when nondetects are present. These approaches consider a large variety of inputs, including the perceived distribution of the detected results (if no perceived distribution is acceptable, nonparametric alternatives are offered), sample size, variability, and skewness.

The recommended UCLs from the ProUCL output were used as the EPCs for all media. The UCL concentrations are presented in Tables 3.1 through 3.9 of Appendix A, and the ProUCL output is provided in Appendix B.

### 3.4.2 Exposure Estimates

#### Exposure Factors

Exposure factors often are assumed values, and their magnitude affects the estimates of potential exposure. The applicability of the selected exposure factor values contributes to uncertainty in the resulting exposure estimates. The equations and exposure factors used in the HHRA are presented in Tables 4.1 through 4.8 of Appendix A. The primary sources for the exposure factors are the following:

- Risk Assessment Guidance for Superfund (RAGS) Part E (Dermal Risk Assessment) (EPA, 2004)
- Supplemental Guidance to RAGS: Standard Default Exposure Factors (EPA, 1991)
- Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (EPA, 2002)
- RAGS Part A (EPA, 1989)
- Exposure Factors Handbook (EPA, 1997)
- Cleanup Standards for Soil and Groundwater (MDE, 2008)

The following exposure scenarios were quantified in the HHRA:

- **Groundwater:** hypothetical future dermal contact with shallow groundwater in excavations by construction workers
- **Surface soil (less than 0.5 foot bgs):** hypothetical future ingestion, dermal contact, and inhalation by DMT workers
- **Total soil (0 to 10 feet bgs):** hypothetical future ingestion, dermal contact, and inhalation by DMT workers and construction workers
- **Stormwater:** hypothetical future dermal contact by utility workers
- **Surface water:** current and future ingestion and dermal contact by offsite residents (adult, adolescent, and child)
- **Sediment (0 to 1 foot bgs):** current ingestion and dermal contact by offsite residents (adult, adolescent, and child)
- **Sediment (0 to 3 feet bgs):** future ingestion and dermal contact by offsite residents (adult, adolescent, and child)

### Sediment-to-Skin Adherence Factor

A sediment-to-skin adherence factor (AF) is needed to estimate sediment exposures. Few published studies are available that address sediment adherence. However, four documents (MDEP, 2002; EPA, 2004; Shoaf et al., 2005; Spalt et al., 2009)that form the basis for the proposed conservative sediment-to-skin AF of 1 mg/cm$^2$ were located.

Dermal absorption of chemicals from soil (or sediment) is potentially affected by various physical and chemical factors including layering, particle size distribution, sorption capacity, soil–chemical contact time, and contaminant soil–skin contact time (Spalt et al., 2009). Adherence of soil to skin varies considerably by body part and by activity. Weighted AFs are weighted according to the skin surface area assumed to be exposed to soil (MDEP, 2002).

Spalt et al. (2009) provide a literature review of 41 available studies addressing soil adherence. Inconsistent and flawed experimental designs and incomplete reporting make interpretation and use of much data extremely difficult. In most of the reviewed empirical investigations, absorption was reported as percentage of initial dose applied even though soil-loading results were super-monolayer.

Shoaf et al. (2005) provide sediment adherence data for nine children playing (wading, running, and sliding along the shoreline; throwing sediment and digging with bare hands) in a tide flat in Rhode Island. Sediments at the study site were characterized as predominately sand on the basis of size range; only 0.77 percent of the total sample mass (dry mass basis) was characterized as clay or silt. Sandy sediment is less adhesive and more subject to rapid attrition once active contact stops. The field protocol included washing participants (face, forearms, hands, lower legs, and feet) before and after unscripted activity. The total sediment mass recovered in wash water was converted to average skin loading for each body part based on the surface area of each body part exposed. The highest dermal loadings were observed on feet. The weighted sediment adherence factor was 4.67 mg/cm$^2$ but included super-monolayer loading.

MDEP (2002) identified on the basis of judgment and unpublished experimental observations a value of 1 mg/cm$^2$ as a best estimate of the loading that corresponds to a monolayer with most sediment types encountered at hazardous waste sites.

The soil adherence protocol in RAGS Part E (EPA, 2004) is based on only a few studies available at that time. On the basis of the "Children Playing (wet soil)" scenario, the geometric mean weighted AF is 0.2 mg/cm$^2$, whereas the 95th percentile weighted AF is 3.3 mg/cm$^2$. On the basis of the "Children-in-Mud (No. 1 & 2)" scenario, the geometric mean weighted AF is 21 mg/cm$^2$, whereas the 95th percentile weighted AF is 231 mg/cm$^2$. The children-in-mud AFs have the following footnote:

> Information on soil adherence values for the children-in-mud scenario is provided to illustrate the range of values for this type of activity. However, the application of these data to the dermal dose equations in this guidance may result in a significant overestimation of dermal risk. Therefore, it is recommended that the 95th percentile AF values not be used in a quantitative dermal risk assessment.

The document also indicates that sediments consistently covered by considerable amounts of water are likely to wash off before the individual reaches the shore.

Chemical-specific values for the dermal absorption fraction from soil are presented in Exhibit 3-4 of RAGS Part E (EPA, 2004). The document indicates that other chemicals will be added to the list as results of further research become available, and that as an interim method, dermal exposure to other compounds should be treated qualitatively in the uncertainty section or quantitatively using default values after presenting relevant studies to the regional risk assessor. The document also indicates that, for inorganics, the speciation of the compound is critical to dermal absorption and there are too little data to extrapolate a reasonable default value. Loren Lund (a member of the RAGS Part E workgroup while employed by the Texas Natural Resource Conservation Commission) indicated that it was the intention of the workgroup that dermal risk estimates for metals other than arsenic and cadmium not be quantified because of the lack of dermal absorption studies (Lund, 2009). Because none of the COPR-related constituents is included in Exhibit 3-4 (EPA, 2004), quantitative dermal exposure estimates to COPR constituents could be eliminated from the HHRA according to RAGS Part E.

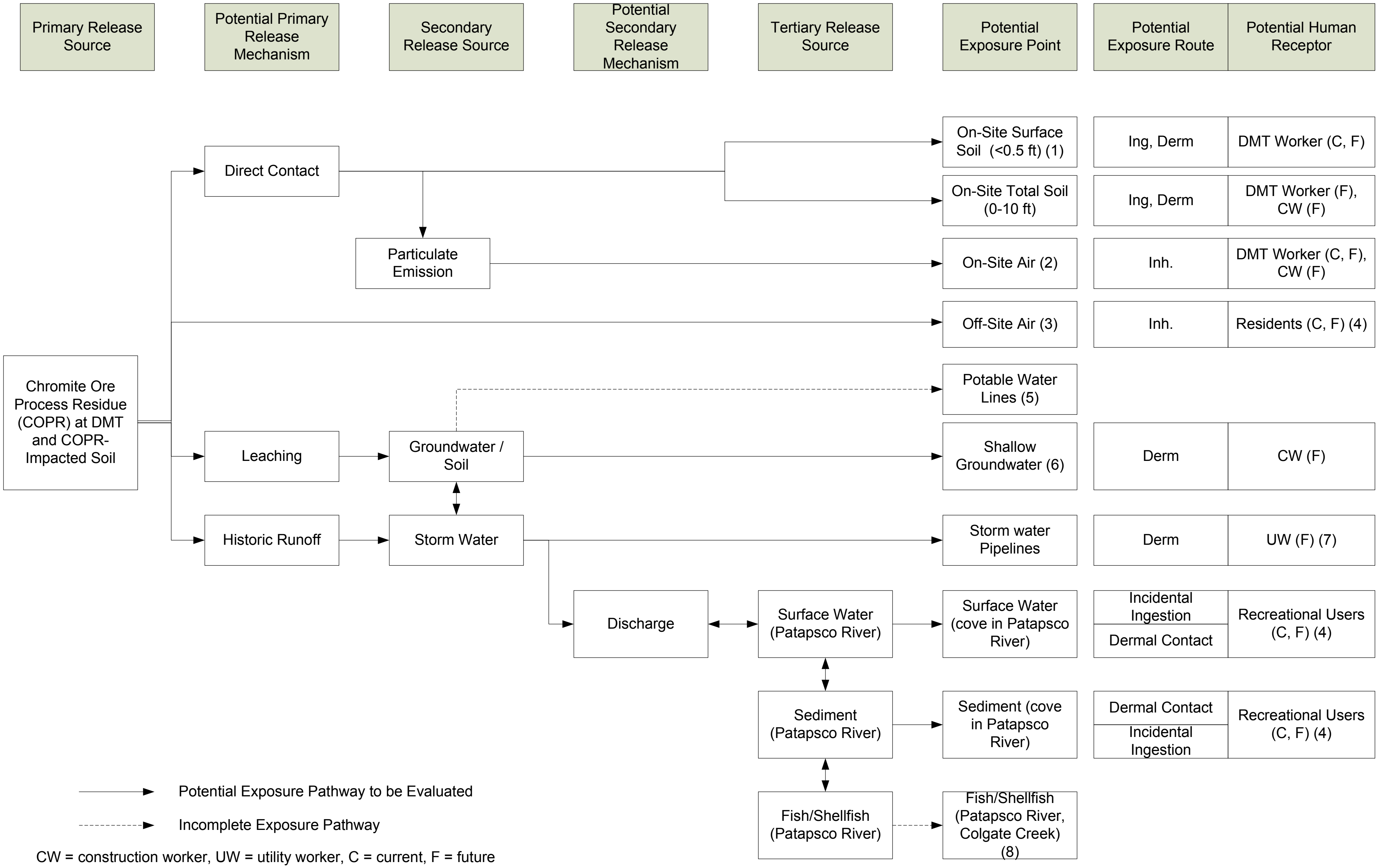
**TABLE 3-1**
Grain Size Distribution and Sediment Type
*Dundalk Marine Terminal, Baltimore, Maryland*

| Station | Sample Interval (ft) | Date Collected | Total Water Depth (ft) | % Gravel >2 mm | % Sand 0.062–2.0 mm | % Silt 0.004–0.062 mm | % Clay <0.004 mm | Sediment Type |
|---|---|---|---|---|---|---|---|---|
| A1 | 0.0–0.5 | 8/22/2007 | 5.7 | 0.1 | 46.2 | 48.7 | 5.0 | Sandy silt |
| | 0.0–0.5 | 5/12/2007 | 4.0 | 0.0 | 72.8 | 22.7 | 4.5 | Silty sand |
| | 0.9–1.4 | 8/13/2007 | 5.7 | 0.2 | 59.2 | 17.6 | 23.0 | Clayey sand |
| | 2.5–3.0 | 8/13/2007 | 5.7 | 0.0 | 97.8 | 0.2 | 2.0 | Sand |
| A2 | 0.0–0.5 | 8/22/2007 | 5.1 | 0.0 | 97.8 | 0.7 | 1.5 | Sand |
| | 0.0–0.5 | 5/17/2007 | 3.9 | 0.0 | 96.1 | 3.4 | 0.5 | Sand |
| A3 | 0.0–0.5 | 8/22/2007 | 4.8 | 0.0 | 97.3 | 0.7 | 2.0 | Sand |
| | 0.0–0.5 | 5/17/2007 | 3.2 | 0.0 | 97.9 | 1.1 | 1.0 | Sand |
| A4 | 0.0–0.5 | 8/22/2007 | 4.5 | 0.0 | 97.1 | 0.9 | 2.0 | Sand |
| | 0.0–0.5 | 5/17/2007 | 4.2 | 0.0 | 98.1 | 0.4 | 1.5 | Sand |
| J4 | 0.0–0.5 | 2/21/2008 | 1.4 | 0.0 | 93.2 | 5.8 | 1.0 | Sand |
| | 0.5–1.0 | 2/20/2008 | 1.4 | 0.0 | 92.9 | 4.1 | 3.0 | Sand |
| | 2.5–3.0 | 2/20/2008 | 1.4 | 0.0 | 97.5 | 0.5 | 2.0 | Sand |

**TABLE 3-2**
Bioaccumulation Factors for COPR Constituents in Freshwater
*Dundalk Marine Terminal, Baltimore, MD*

| Chemical | BAF (L/kg) |
|---|---|
| Aluminum | 500 |
| Calcium | n/a |
| Chromium | 200 |
| Iron | 200 |
| Magnesium | n/a |
| Manganese | 400 |
| Vanadium | n/a |

BAF, Bioaccumulation Factor; n/a, not available.
Source: Environmental Assessment Division, User's Manual for RESRAD Version 6, *ANL/EAD-4*, Argonne National Laboratory, 2001.




CW = construction worker, UW = utility worker, C = current, F = future
(1) – Asphalt & gravel 2 ft thick over COPR-impacted area; needed for site operations (heavy equipment & storage).
(2) – Exposure of DMT workers to on-site air will be quantified through the soil PEF analysis. Perimeter air monitoring data will not be used for this exposure pathway.
(3) – Evaluation of potential contribution of COPR to air concentrations using perimeter air monitoring data.
(4) – Aggregate child/adolescent/adult.
(5) – Positive pressure in the lines prevents groundwater from entering the lines if breaks occur.
(6) – No future use of shallow site groundwater.
(7) – Recreators cannot access stormwater outfalls since they are under the marine platform or under water.
(8) – Fish do not biomagnify the COPR constituents.

**Figure 3-1**
Human Health Conceptual Exposure Model
Human Health Risk Assessment
Dundalk Marine Terminal
Baltimore, MD

SECTION 4

# Toxicity Assessment

## 4.1 Approach

The purpose of the toxicity assessment is to provide an estimate of the relationship between the extent of exposure to a COPC and the likelihood of, or severity of, adverse health effects. EPA uses a weight-of-evidence approach to evaluate potential human carcinogens and categorizes them in the Integrated Risk Information System (IRIS) (EPA, 2009c). The cancer slope factors (CSF) and inhalation unit risks (IUR) express the potential carcinogenicity of a chemical. The CSF and IUR are toxicity values that define the quantitative relationship between dose and response. It is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The CSF and IUR are usually the 95 percent UCL of the slope of the dose–response curve. Noncarcinogen reference doses (RfD) and Reference Concentration (RfC) are the toxicity values used in evaluating the potential for noncarcinogenic effects resulting from exposures to chemicals. The RfD and RfC are defined as estimates of a daily exposure level for the human population, including sensitive subpopulations (such as the elderly and children), that is likely to be without an appreciable risk of adverse effects during a lifetime.

## 4.2 Toxicity Values

The toxicity values used in the HHRA are summarized in Table 4-1. Under the current guidelines (EPA, 1986c), Cr(VI) by the inhalation route of exposure is classified as a known human carcinogen (i.e., Group A). Current EPA toxicity value sources do not indicate that Cr(III) and Cr(VI) are carcinogenic through the oral route of exposure.

The quantitative toxicity values for COPR constituents were obtained from EPA's IRIS database (EPA, 2009c). However, in the RSL table, the Cr(VI) IUR is $8.4 \times 10^{-2}$ per (micrograms per cubic meter [$\mu g/m^3$) (assuming 100 percent Cr(VI)) as presented. This IUR is calculated by multiplying the IUR of $1.2 \times 10^{-2}$ per ($\mu g/m^3$) presented in IRIS (EPA, 2009c) by 7, because the IRIS supporting documentation states that the IUR in IRIS is based on an assumed 1:6 ratio of Cr(VI):Cr(III). The use of the higher IUR in the RSL table is consistent with the State of California's interpretation of the Mancuso study (1975), which forms the basis of the Cr(VI) toxicity value.

### Chromium Metabolism

Within the human body, Cr(VI) is reduced and eventually transformed into Cr(III). Once absorbed, Cr(VI) is reduced by many substances, including ascorbate, glutathione, and gastric juice, and in many organs such as the lungs, stomach, and liver (ATSDR, 2006). The Cr(III) RfD used in this HHRA was obtained from a feeding study of Cr(III) in rats; therefore, if any transformation of Cr(III) occurred, the intermediates and resulting Cr(VI) were formed within the gastrointestinal system after ingestion, and the derived RfD accounted for toxicity effects caused by the transformed chromium species.

Toxicity values for calcium and magnesium are not available in EPA sources. For these chemicals, the DRIs published by the National Academy of Sciences (2004), were used to calculate RfDs by dividing the DRIs by the body weight of an adult or child, as appropriate. Toxicity values for aluminum and iron were based on Provisional Peer-Reviewed Toxicity Values (PPRTVs) as presented in the RSL table (EPA, 2006b, c).

### Vanadium

The toxicity of vanadium is dependent on its physiochemical state (primarily valence state and solubility), with toxicity generally increasing with increased valence state. The only Tier 1 toxicity values (in EPA's (2003a) hierarchy of toxicity values for HHRAs) for vanadium are those for vanadium pentoxide; in addition, the RSL table contains a calculated oral toxicity value for "vanadium and compounds" based on the toxicity data in IRIS. Tier 2 PPRTVs are available for oral and inhalation exposures to vanadium pentoxide, and Tier 3 toxicity values ("other toxicity values" from peer-reviewed sources) are available for oral exposure to vanadium sulfate and metallic vanadium.

Vanadium toxicity following oral exposure by humans is generally low. Chronic oral RfDs (expressed in milligrams per kilogram per day) in EPA's RSL table range from 0.005 mg/kg-d (for "vanadium and compounds") to 0.02 mg/kg-d for vanadium sulfate (EPA, 2009a).

For cancer effects from oral exposures to vanadium, the data from animal studies are contradictory. Although one study on the carcinogenicity of vanadium indicated that tumors were induced in female mice (Schroeder and Mitchener, 1975), data from more than 20 other studies suggest that vanadium compounds could have a protective effect against cancer and are associated with a decreased incidence of tumors and with smaller tumors (National Toxicology Program, 2008).

The Institutes of Medicine (2001) have reviewed information to determine whether vanadium could be an essential element. It determined that there is evidence of vanadium playing a beneficial role in some physiological processes in some species, but that the data are not consistent enough to support the development of a recommended daily intake level. It did, however, identify a tolerable upper intake level for vanadium of 1.8 mg/day.

At the DMT site, data are available for total vanadium. The pH and environmental conditions (i.e., pH, reducing versus oxidizing conditions) were evaluated to determine the form of vanadium most likely to be present so that the appropriate toxicity values could be identified for each environmental matrix. The following were concluded:

- **Groundwater.** Because of the high pH of groundwater in the COPR area, vanadium is not likely to be present as vanadium pentoxide, vanadium sulfate, or metallic vanadium; therefore, "vanadium and compounds" toxicity values were used for risk estimates associated with groundwater.
- **Surface soil.** In dry soils, vanadium pentoxide associated with iron oxyhydroxides can be present; therefore, vanadium pentoxide toxicity values were used for risk estimates associated with surface soil.
- **Total soil.** In dry soils (i.e., those at the soil–air interface and at a depth of 1 to 2 inches into the soil, away from the soil–air interface), vanadium pentoxide can be present; in deeper soils, the form is more likely to be "vanadium and compounds." Because the

exposure scenario for total soil exposures involves excavated soils, vanadium pentoxide toxicity values were used for risk estimates associated with soil.

- **Stormwater.** The pH is high (up to 12) in some sewer lines (the "priority drains") as a result of groundwater infiltration, and therefore vanadium is not likely to be present as vanadium pentoxide, vanadium sulfate, or metallic vanadium; "vanadium and compounds" toxicity values were used for risk estimates associated with stormwater.
- **Surface water.** Because the pH of surface water is circumneutral, detected vanadium is modeled as vanadium pentoxide; therefore, vanadium pentoxide toxicity values were used for risk estimates associated with surface water.
- **Sediment.** Reducing conditions are present, and the most likely form present is vanadate; therefore, "vanadium and compounds" toxicity values were used for risk estimates associated with sediment.

No dermal toxicity values are available from the resources listed above. In accordance with RAGS Part E (EPA, 2004) and the EPA Region 3 (2003b) technical guidance manual, the dermal (absorbed-dose) toxicity values are derived by applying gastrointestinal absorption factors ($ABS_{GI}$) to oral (administered-dose) toxicity values. Because of the intrinsic variability in the analysis of absorption studies, the "twofold rule" was applied, where no adjustment of absorbed-dose toxicity values are made unless there will be at least a twofold difference in the toxicity values (i.e., if $ABS_{GI}$ is approximately 50 percent or less). The $ABS_{GI}$ values were used for calculating dermal toxicity values as follows:

$$RfD_{ABS(dermal)} = RfD_{oral} \times ABS_{GI}$$

The $ABS_{GI}$ values and dermal toxicity values for each COPC are presented in Table 4-1.

**TABLE 4-1**
Toxicity Values Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| | Chronic Oral or Dermal RfD (mg/kg/day) or Inhalation RfC ($mg/m^3$) (Target Organ) | | | IUR $(\mu g/m^3)^{-1}$ | | Cancer Slope Factor $(mg/kg/day)^{-1}$ | | | Absorption Factor | | Absorption Factor | | Permeability Coefficient | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Oral** | **Dermal** | **Inhalation** | **Inhalation** | **Reference** | **Oral** [g] | **Dermal** [g] | **Reference** | $ABS_{GI}$ | **Reference** | $ABS_{derm}$ | **Reference** | $K_p$ **(cm/hr)** | **Reference** |
| Cr(III) | 1.5 [a] | 0.02 [a] | NA | NA | IRIS (EPA, 2009) | — | — | IRIS (EPA, 2009) | 1.3% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.001 | EPA, 1994 |
| Cr(VI) | 0.003 [a] | 0.000075 [a] | 0.0001 [d] | 0.084 | IRIS (EPA, 2009) | — | — | IRIS (EPA, 2009) | 2.5% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.002 | EPA, 1994 |
| Aluminum | 1.0 [b] | 1.0 [b] | 0.005 [b] | NA | PPRTV | — | — | NA | 100% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.001 (default) | EPA, 1994 |
| Calcium | 36 (adult), 170 (child) [a] | 36 (adult), 170 (child) [a] | NA | NA | DRI (NAS, 2004) | — | — | NA | 100% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.001 (default) | EPA, 1994 |
| Iron | 0.7 [e] | 0.7 [e] | NA | NA | PPRTV | — | — | NA | 100% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.001 (default) | EPA, 1994 |
| Magnesium | 5.0 (adult), 4.3 (child) [a] | 5.0 (adult), 4.3 (child) [a] | NA | NA | DRI (NAS, 2004) | — | — | NA | 100% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.001 (default) | EPA, 1994 |
| Manganese | 0.14 [b] | 0.0056 [b] | 0.00005 [c] | NA | IRIS (EPA, 2009) | — | — | NA | 4% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.001 (default) | EPA, 1994 |
| Vanadium and compounds | 0.005 [f] | 0.00013 [f] | NA | NA | RSL Table (EPA, 2009) | — | — | NA | 2.6% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.001 (default) | EPA, 1994 |
| Vanadium pentoxide | 0.009 [f] | 0.000234 [f] | 0.000007 | 0.0083 | IRIS (EPA, 2009), PPRTV | — | — | IRIS (EPA, 2009) | 2.6% | RAGS E (EPA, 2004) | 1% (default) | EPA Region 3 (1995) | 0.001 (default) | EPA, 1994 |

NAS, National Academy of Sciences; RfC, reference concentration; RfD, reference dose; CSF, cancer slope factor; IUR, inhalation unit risk; $ABS_{GI}$, gastrointestinal absorption; $ABS_{derm}$, dermal absorption; PPRTV, Provisional Peer-Reviewed Toxicity Value published by the National Center for Environmental Assessment; RSL, Regional Screening Level (EPA, 2009).

Oral Reference Dose is based on the Dietary Reference Intake (DRI) Tolerable Upper Intake Level divided by body weight.

RfD-Dermal = RfD-Oral × ABS-GI

[a] No observed effects.
[b] Central nervous system.
[c] Impairment of neurobehavioral function.
[d] Respiratory.
[e] Gastrointestinal.
[f] Hair cystine.
[g] Not available; Group D chemicals (not classifiable as to human carcinogenicity) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.

SECTION 5

# Risk Characterization

Risk characterization involves estimating the magnitude of potential adverse health effects from exposure to COPCs associated with a potential release from the site. This step of the HHRA combines the estimated exposure levels and toxicity values to provide numerical estimates of potential carcinogenic health risks and semiquantitative estimates of noncarcinogenic health risks. Risk characterization also considers the nature and weight of evidence supporting these estimates and the magnitude of uncertainty surrounding the estimates.

The risk estimates are intended to provide the basis for management decisions and do not predict actual health outcomes. The estimates are based on conservative (health-protective) assumptions and a hypothetical future scenario whereby the institutional/engineering controls currently in place (e.g., the SSHSP and SCMP) are no longer required, and uncontrolled contact with COPR-impacted media occurs by DMT workers, construction workers, and utility workers. Thus, actual risks are likely to be less than these estimates.

## 5.1 Approach for Potential Excess Lifetime Cancer Risks

To characterize potential carcinogenic effects, statistical probabilities are estimated from calculated exposures and toxicity values that a hypothetical receptor group will develop cancer over a lifetime as a result of the assumed exposures.

Using the IUR, estimated air concentrations were converted to incremental risks of a hypothetical receptor developing cancer (EPA, 2009d). The following formula was used to estimate potential carcinogenic risk ("excess lifetime cancer risk," or ELCR) from inhalation exposures to Cr(VI) and vanadium pentoxide:

$$ELCR = Exposure\ Concentration \times IUR$$

EPA's target range for carcinogenic risk associated with Comprehensive Environmental Response Compensation, and Liability Act (CERCLA) sites is 1 in 10,000 ($1 \times 10^{-4}$) to 1 in 1 million ($1 \times 10^{-6}$). That is, the risk associated with a CERCLA site should not exceed this target range. Although the DMT site is not a CERCLA site, this target range is relevant. The MDE target cumulative site ELCR is $1 \times 10^{-5}$.

## 5.2 Approach for Potential Noncarcinogenic Effects

Potential noncarcinogenic health risks were estimated by calculating a hazard quotient (HQ) for each COPC through each exposure route. The HQ was calculated as the ratio of the estimated intake to the RfD (and air concentration to RfC) as follows:

$$HQ = \frac{Intake}{RfD} \quad \text{or} \quad HQ = \frac{Exposure\ \ Concentration}{RfC}$$

If the estimated daily intake for a COPC exceeds its RfD (or air concentration exceeds its RfC), the HQ will exceed 1.0. An HQ that exceeds 1.0 indicates that there is a potential for adverse health effects associated with exposure to the COPC, but it does not indicate the actual level of risk.

A hazard index (HI) approach was used to evaluate potential noncarcinogenic health risks posed by more than one COPC and exposure route. The HI approach assumes that simultaneous subthreshold exposures to several chemicals and exposure routes are additive. The HI is equal to the sum of the HQs and is calculated as follows:

$$HI = \frac{I_1}{RfD_1} + \frac{I_2}{RfD_2} \cdots \frac{I_i}{RfD_i}$$

where:

$I$ = intake level (mg/kg-day)
$RfD$ = chronic reference dose (mg/kg-day)
$I_i$ = intake level (intake) for the *i*th constituent
$RfD_i$ = reference dose for the *i*th constituent

and

$$HI = \frac{Exp.Conc_1}{RfC_1} + \frac{Exp.Conc_2}{RfC_2} \cdots \frac{Exp.Conc_i}{RfC_i}$$

where:

*Exp. Conc.* = exposure concentration (mg/m$^3$)
*RfC* = reference concentration (mg/m$^3$)
$Exp.\ Conc_i$ = air concentration for the *i*th constituent
$RfC_i$ = reference concentration for the *i*th constituent

According to EPA (1989) guidance for noncarcinogens, it is appropriate to calculate HI values for each applicable target organ. Therefore, target-organ-specific HIs were used to evaluate potential noncarcinogenic effects.

Calculation of a cumulative target-organ-specific HI in excess of 1.0 indicates the potential for adverse health effects. The cumulative HI is defined as the sum of the HQs associated with all media, COPCs, and pathways of exposure that are applicable for a particular receptor group.

## 5.3 Results of Risk Estimates

Potential risks associated with exposures to the COPCs were estimated for the potential current and hypothetical future exposure scenarios identified in Section 3.4.2. The calculated ELCRs and HIs for each receptor group are summarized below.

### 5.3.1 Current Exposure Scenarios

#### Outdoor Air

The Cr(VI) concentrations measured in outdoor air as part of the perimeter air-monitoring program were evaluated to determine whether the Cr(VI) concentrations detected in outdoor air are indicative of a site release or attributed to local background levels. An evaluation was also made between the measured Cr(VI) concentrations and PM concentrations to determine whether the measured Cr(VI) concentrations are associated with potential fugitive dust either from the site or from offsite sources. Findings are summarized below:

- There is no statistically significant variation in the monitored Cr(VI) concentrations attributed to any particular wind direction.
- There is no statistically significant correlation between the monitored particulate concentrations and concurrent Cr(VI) concentrations, indicating that measured Cr(VI) concentrations cannot be attributed to fugitive dust emanating from the site.

One hundred nineteen background air samples were identified based on the prevailing wind direction measured during the perimeter air-monitoring events. The background samples are indicated in Table 1.4 of Appendix A. The background Cr(VI) EPC was calculated as described in Section 3.4.1, and the ProUCL output is provided in Appendix B. Because no current site releases to outdoor air were identified, current site-related air impacts on DMT workers and offsite residents are insignificant.

#### Offsite Recreational Users

Offsite recreational users in the cove were assumed to contact surface water and sediment (0 to 1 foot deep) through incidental ingestion and dermal contact.

- **Adult.** All target organ-specific HIs less than 1.0 (Table 5.1 of Appendix A; summarized in Table 6.1 of Appendix A).
- **Adolescent.** All target organ-specific HIs less than 1.0 (Table 5.2 of Appendix A; summarized in Table 6.2 of Appendix A).
- **Child.** All target organ-specific HIs less than 1.0 (Table 5.3 of Appendix A; summarized in Table 6.3 of Appendix A).

### 5.3.2 Future Exposure Scenarios

#### DMT Workers

As a hypothetical scenario, it was assumed that the institutional/engineering controls currently in place (e.g., the SSHSP and SCMP) are no longer required, and COPR blooms occur at the site surface (at a depth less than 0.5 foot bgs) and are contacted by DMT workers through incidental ingestion, dermal contact, and inhalation. In addition, it was assumed that deeper soils (currently 0 to 10 feet bgs) could be brought to the surface during construction activities and contacted by future DMT workers through incidental ingestion, dermal contact, and inhalation.

- **Surface soil.** $2 \times 10^{-4}$ ELCR (driven by Cr(VI) inhalation exposures from COPR dust that is hypothetically assumed to be continuously exposed at the site surface and contacted on a daily basis) and all target-organ-specific HIs less than 1.0 (Table 5.4, summarized in Table 6.4 RME of Appendix A).

- **Total soil.** $3 \times 10^{-4}$ ELCR (driven by Cr(VI) inhalation exposures from COPR dust that is hypothetically assumed to be continuously exposed and contacted on a daily basis) and all target organ-specific HIs less than 1.0 (Table 5.5, summarized in Table 6.5 RME of Appendix A).

### Construction Workers

As a hypothetical scenario, it was assumed that the current institutional/engineering controls (e.g., the SSHSP and SCMP) do not remain in place, and soil (0 to 10 feet bgs) is contacted by construction workers during excavation activities through incidental ingestion, dermal contact, and inhalation. In addition, it was assumed that construction workers may have uncontrolled dermal exposures to shallow groundwater in excavations.

- **Exposure frequency of 60 days/year.** $3 \times 10^{-6}$ ELCR and a target-organ-specific HI of 3 (driven by Cr(VI) in soil and groundwater) (Table 5.6 of Appendix A; summarized in Table 6.6 of Appendix A).

- **Exposure frequency of 250 days/year.** $1 \times 10^{-5}$ ELCR and a target-organ-specific HI of 14 (driven by Cr(VI) in soil and groundwater) (Table 5.7 of Appendix A; summarized in Table 6.7 of Appendix A).

### Utility Workers

As a hypothetical scenario, it was assumed that the current institutional controls (e.g., the SSHSP) do not remain in place, and utility workers have uncontrolled dermal exposures to stormwater.

- **Nonpriority drains.** HI less than 1.0 (Table 5.8, summarized in Table 6.8 of Appendix A).

- **Priority drains.** A target-organ-specific HI of 30 (driven by Cr(VI)) (Table 5.9 of Appendix A; summarized in Table 6.9 of Appendix A).

### Offsite Recreational Users

Offsite recreational users in the cove were assumed to contact surface water and sediment (0 to 3 feet deep) through incidental ingestion and dermal contact.

- **Adult.** All target-organ-specific HIs less than 1.0 (Table 5.10 of Appendix A; summarized in Table 6.10 of Appendix A).

- **Adolescent.** All target-organ-specific HIs less than 1.0 (Table 5.11 of Appendix A; summarized in Table 6.11 of Appendix A).

- **Child.** All target-organ-specific HIs less than 1.0 (Table 5.12 of Appendix A; summarized in Table 6.12 of Appendix A).

### 5.3.3 Summary of Risk Estimates

A summary of risk estimates and risk drivers is presented in Table 5-1.

Current and future potential exposures by recreational users in the cove adjacent to DMT are within acceptable levels.

Measured outdoor air concentrations of Cr(VI) exceed risk-based screening levels. However, the evaluation of the air transport pathway found no significant difference between upwind and downwind concentrations of Cr(VI) in air (see Appendix C). This finding is expected, given that COPR is contained beneath the surface cover present at DMT. The SCMP includes a rigorous inspection and repair program for the surface cover that ensures COPR remains contained, thereby limiting the potential for chromium transport via air.

As a hypothetical future scenario, it was assumed that the institutional/engineering controls currently in place (e.g., the SSHSP and SCMP) are no longer required, and uncontrolled contact with COPR-impacted media occurs by DMT workers, construction workers, and utility workers. COPR materials were assumed to be continuously exposed and contacted by DMT workers and construction workers every workday while onsite. The following risk estimates were calculated for these receptor groups:

#### DMT Workers

- **Surface soil.** $2 \times 10^{-4}$ ELCR and HI less than 1
- **Total soil.** $3 \times 10^{-4}$ ELCR and HI less than 1

Both estimates were driven by Cr(VI) inhalation exposures. The estimates exceed EPA's target risk range and MDE's target cumulative ELCR of $1 \times 10^{-5}$.

#### Construction Workers

- **Low-exposure frequency.** $3 \times 10^{-6}$ ELCR and HI of 3
- **High-exposure frequency.** $1 \times 10^{-5}$ ELCR and HI of 14

Both estimates are driven by Cr(VI) in soil and groundwater. These estimates exceed EPA's and MDE's target HI of 1.0.

As an additional hypothetical future scenario, utility workers were assumed to access stormwater in storm drains without adhering to an SSHSP. The following risk estimates were calculated for utility workers in nonpriority drains and priority drains.

#### Utility Workers

- **Nonpriority drains.** HI less than 1.0
- **Priority drains.** HI of 30 (driven by Cr(VI))

Risk estimates for priority drains exceed EPA's and MDE's target HI of 1.0.

## 5.4 Uncertainty Analyses

All HHRAs involve assumptions, professional judgments, and imperfect data to varying degrees; these in turn result in uncertainty in the final risk estimates. This subsection of the HHRA describes the likelihood that the approaches incorporated in the HHRA result in an overestimate or underestimate of actual risks associated with exposure to site-related COPC concentrations. There are several categories of uncertainty (e.g., data evaluation) associated with risk assessment. The major uncertainties associated with each category are briefly discussed below.

### 5.4.1 Uncertainty Associated with Data Evaluation

A comparison of maximum detected concentrations to adjusted RSLs (noncarcinogenic-based RSLs were reduced by a factor of 10 to account for the cumulative effects from multiple chemicals) was conducted for each medium. Constituents whose maximum detected concentrations were below their RSLs were not carried through the HHRA. It is unlikely that this risk-based screening would have excluded constituents that would be of concern, based on the conservative exposure assumptions and conservatively derived toxicity criteria on which the RSLs are based. Although following this methodology does not provide a quantitative risk estimate for every COPR constituent, it focuses the HHRA on the constituents accounting for the greatest relative risks (i.e., constituents whose maximum concentrations exceed their respective adjusted RSLs), and the overall cumulative risk estimates are not expected to be significantly underestimated.

Measured outdoor air data are available for Cr(VI) but not for the other COPR constituents. Inhalation toxicity data are available for three other COPR constituents listed in Table 4-1: aluminum, manganese, and vanadium pentoxide. A comparison of the surface soil EPCs (based on COPR blooms) for these constituents with the inhalation component of the industrial and residential soil RSLs is provided below (in milligrams per kilograms):

- **Aluminum.** EPC (maximum detected concentration since aluminum was not identified as a COPC in surface soil) = 51,900; industrial RSL = 30,000,000; residential RSL = 7,100,000.
- **Manganese.** EPC = 750; industrial RSL = 300,000; residential RSL = 71,000.
- **Vanadium pentoxide.** EPC = 390; industrial RSL = 2,000; residential RSL -= 400.

Based on the comparison of surface soil EPCs (or the maximum detected concentration for aluminum) with the RSL for protection of residential and industrial air, the lack of measured outdoor air data for constituents other than Cr(VI) is not expected to significantly affect the conclusions of the HHRA.

### 5.4.2 Uncertainty Associated with the Exposure Assessment

The primary areas of uncertainty regarding chemical intakes are assumptions regarding potentially complete exposure pathways, estimating EPCs, and selecting exposure factors to estimate chemical intakes. The uncertainties associated with these sources are discussed below.

#### Exposure Pathways

The potential exposure pathways that were quantified were assumed to be complete currently or under a hypothetical future scenario where the existing engineering and institutional controls in place at the site (e.g., the SCMP and SSHSP) are no longer implemented. The hypothetical scenario assumes that DMT workers and construction workers inhale fugitive dusts from COPR materials (currently situated at 0 to 10 feet bgs) and contact COPR materials every day while onsite. The inhalation exposure pathway was evaluated using a calculated PEF and soil data. The hypothetical scenario also assumes that utility workers have uncontrolled exposures to stormwater.

Onsite outdoor air may occasionally be a complete exposure pathway for DMT workers when small COPR blooms are present. Due to the likely low exposure frequency and short exposure duration, this exposure scenario was not quantified in the HHRA for current conditions but rather was quantified as part of the hypothetical future scenario addressing constant exposures to COPR materials.

### Exposure Point Concentrations

With respect to calculating EPCs, it was assumed that contact with COPR-impacted soil, groundwater, and stormwater occurs in the future without the use of personal protective equipment. The soil EPCs for DMT workers and construction workers were based on a data set composed mostly of COPR material samples rather than traditional soil samples. In addition, it was assumed that the EPCs remain constant over time. This approach will likely lead to an overestimate of actual exposure because receptors are assumed to be exposed to the UCL of the mean concentration for their entire exposure duration. As the data indicate, some chemicals were detected in specific media at a relatively low frequency (less than 50 percent). Thus, the assumption that all potential exposures are to the UCL or maximum concentrations probably will result in an overestimation of actual exposures and estimates of potential risk.

### Exposure Factors

Most of the exposure factors used to estimate chemical intakes are conservative and reflect worst-case or upper-bound exposure assumptions in accordance with EPA guidance regarding evaluation of potential exposures at Superfund sites. For example, future DMT workers were assumed to have uncontrolled exposures to COPR materials on a daily basis for a period of 25 years. In addition, construction workers were assumed to have uncontrolled exposures to soil and groundwater, and utility workers were assumed to have uncontrolled exposures to stormwater every day when onsite. An underlying assumption in the HHRA is that individuals at the site will regularly engage in activities that will result in chemical exposures. This assumption is conservative in that it is more likely that the future activities assumed to occur onsite (e.g., uncontrolled soil, groundwater, and stormwater exposures) will not occur, but rather that the current institutional and engineering controls will remain in place.

The entire exposed skin surface of a utility worker is assumed to contact stormwater in storm drains for the entire workday (i.e., 8 hours) for 25 days per year. It is highly unlikely that an individual utility worker would engage in inspection activities at the site for this extended time period (8 hours) and that his or her entire exposed skin area would be in contact with stormwater in the storm drain. Therefore, the actual risks for future utility workers are likely to be less than the estimated risks presented in this HHRA.

### 5.4.3 Uncertainty Associated with Toxicity Assessment

Uncertainty factors are applied to extrapolate doses from animal studies to humans. For instance, the uncertainty factor applied to the Cr(VI) RfD is 300. Therefore, uncertainty is inherent in the toxicity values used to estimate risks.

Inhalation unit risks developed by EPA represent upper-bound estimates. The ELCRs generated in this HHRA should be regarded as upper-bound estimates on the potential ELCR rather than an accurate representation of ELCR. The true ELCR is likely to be less than the predicted value.

EPA-derived toxicity values were not available for two essential nutrients (calcium and magnesium). Noncarcinogenic toxicity values were calculated based on the DRIs provided by the National Academy of Sciences. Therefore, there is some uncertainty in the screening levels and toxicity values used for calcium and magnesium, but risks are not expected to significantly overestimate potential exposures.

For dermal exposures, the absence of dermal toxicity values necessitated the use of oral toxicity data. To calculate risk estimates for the dermal pathway, dermal absorption doses were combined with oral toxicity values. Oral toxicity values, which are typically expressed in terms of potential (or administered) doses, are adjusted when assessing dermal absorption doses, which are expressed as internal (or absorbed) doses. In this HHRA, absolute oral absorption factors that reflect the toxicity study conditions were used to modify the oral toxicity values.

#### Cr(VI) Contact Dermatitis

There is uncertainty associated with the RSLs for Cr(VI) in addressing contact dermatitis. Dermal exposure to Cr(VI) may produce irritant and allergic contact dermatitis (Bruynzeel et al., 1988; Polak, 1983; Cronin, 1980; Hunter, 1974). The Cr(VI) RSLs that are protective of carcinogenic and noncarcinogenic effects are likely lower than the concentrations inducing allergic contact dermatitis. However, these RSLs might not be lower than concentrations eliciting an allergic response in individuals who have been previously induced (EPA, 2009c).

New Jersey Department of Environmental Protection (NJDEP) and Massachusetts Department of Environmental Protection (MDEP) are two leading state environmental agencies regarding this subject and have proposed health-based soil concentrations of Cr(VI) for protection of allergic contact dermatitis based on intensive literature review. The Cr(VI) soil concentrations recommended by these two agencies and key information used to derive these concentrations are presented in Table 6-1. As seen in Table 6-1, Cr(VI) soil cleanup levels of 170 and 400 mg/kg were established by MDEP and NJDEP, respectively, based on a patch testing study of 54 subjects with a known Cr(VI) sensitivity (Nethercott et al., 1994). The difference between the two cleanup levels is primarily a result of the different soil AFs applied in the calculation. Because the soil AF used by NJDEP is consistent with the current EPA dermal guidance document (EPA, 2004), the Cr(VI) concentration derived by NJDEP (400 mg/kg) is considered the more appropriate level. The industrial soil RSL of 200 mg/kg for Cr(VI) (particulates) was used to screen soil in the HHRA. Because the soil RSL value is lower than the Cr(VI) cleanup level currently recommended by NJDEP (400 mg/kg), the soil RSL used in the HHRA is protective of inducing contact dermatitis.

However, these agencies indicate uncertainties associated with the derived Cr(VI) soil cleanup level (NJDEP, 2005; MDEP, 1998), potentially warranting additional evaluations of soil concentrations addressing this health effect in the future. A summary of the major areas of uncertainty associated with the derived Cr(VI) soil cleanup level identified by NJDEP and MDEP include the following:

- Relevance of data derived from patch testing to environmental exposures
- Bioavailability factor for Cr(VI) in soil.
- pH level in soil (Historical patch testing studies have demonstrated increasing allergic contact dermatitis sensitivity to Cr(VI) at higher pH levels.)
- Route of exposure (Available data strongly suggest that Cr(VI) could be a more potent dermal sensitizer when exposures are through ingestion or inhalation exposure routes.)

### 5.4.3 Uncertainty in Risk Characterization

The uncertainties identified in each component of the HHRA ultimately contribute to uncertainty in the risk estimates. The addition of risks and HQs across potential pathways and constituents contributes to uncertainty based on the interaction of COPCs (i.e., additivity, synergism, and potentiation) and susceptibility of exposed receptors. The uncertainties associated with potential interactions of COPR constituents are provided below.

The COPCs in soil are aluminum, calcium, chromium (III and VI), iron, magnesium, manganese, and vanadium. These chemicals occur naturally in food and environmental media. Some of these chemicals are essential nutrients for normal physiological functioning of organisms. These chemicals are reported to have either competition or synergism in absorption and physiological functioning. For example, calcium, chromium, magnesium, and manganese are required for normal functioning of the body and organ systems. However, deficiency of some of the nutrients and acidic conditions can promote absorption of iron and manganese.

Aluminum is absorbed more in the presence of citrate, whereas silicic acid will decrease the bioavailability of aluminum by providing a strong competitive binding site for it within the gut contents, thus making aluminum less available for absorption (ATSDR, 2008).

The absorption of iron increases in the presence of manganese. High levels of iron lead to decreased manganese absorption and toxicity, and low levels of iron lead to increased manganese absorption and toxicity. High levels of calcium in systems reduce the uptake of manganese.

Calcium, chromium, and magnesium belong to a group of “parasympathetic” elements that exhibit anti-inflammatory properties, in contrast to elements such as iron, which are pro-inflammatory at high concentrations.

The combination of manganese and vanadium administered to pregnant mice caused some alterations in behavioral development of the pups as compared with either element administered alone (ATSDR, 1992).

The overall presence of multiple inorganic chemicals in various combinations in site media could result in different effects than those assumed in the risk assessment, thus contributing to uncertainty in the risk estimates. As noted in the above-listed studies, some inorganic chemicals can prevent the absorption of others.

**TABLE 5-1**
Summary of Risk Estimates and Risk Drivers
*Honeywell Dundalk Marine Terminal, Baltimore, MD*

| Receptor | Age | Cancer | Noncancer |
|---|---|---|---|
| ***Current Exposure Scenario*** | | | |
| Offsite recreational user (sediment, 0–1 foot) | Adult | — | HI < 1.0 |
| | Youth | — | HI < 1.0 |
| | Child | — | HI < 1.0 |
| ***Future Exposure Scenario*** | | | |
| DMT worker (Surface Soil) | Adult | $2 \times 10^{-4}$; chemical: Cr(VI) (surface soil) | HI < 1.0 |
| DMT worker (Total Soil) | Adult | $3 \times 10^{-4}$ chemical: Cr (VI) (subsurface soil) | HI ≤ 1.0 |
| Construction worker (low frequency; EF=60 d/yr) | Adult | $< 1 \times 10^{-5}$ | Total HI = 4; Maximum Target Organ-Specific HI = 3; chemical: Cr(VI) (total soil) |
| Construction worker (high frequency; EF=250 d/yr) | Adult | $\leq 1 \times 10^{-5}$ | Total HI = 16; Maximum Target Organ Specific HI = 14; chemical: Cr(VI) (total soil, groundwater) |
| Utility worker (nonpriority drain) | Adult | — | HI < 1.0 |
| Utility worker (priority drain) | Adult | — | Total HI = 29; Maximum Target Organ Specific HI = 29 chemical: Cr(VI) (stormwater) |
| Offsite recreational user (sediment, 0–3 feet) | Adult | — | HI < 1.0 |
| | Youth | — | HI < 1.0 |
| | Child | — | HI < 1.0 |

SECTION 6

# Summary and Conclusion

The HHRA was conducted in accordance with EPA (1989) risk assessment guidance 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 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 (1989) guidance. The COPCs in each exposure medium were identified by comparing maximum detected concentrations to EPA RSLs (EPA, 2009a). 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 HHRA results indicate acceptable risks for onsite receptors (DMT workers, construction workers, and utility workers) and for recreational users exposed to surface water and sediment in the cove adjacent to the site.

The air transport pathway evaluation found no significant difference between upwind and downwind concentrations of Cr(VI) in air. This finding is expected, given that COPR is contained beneath the surface cover present at DMT, and the SCMP includes a rigorous inspection and repair program for surface cover which ensures that COPR remains contained, thereby limiting the potential for chromium transport via air.

**TABLE 6-1**
Recommended Cr(VI) Soil Levels for Allergic Contact Dermatitis
*Honeywell Dundalk Marine Terminal, Baltimore, MD*

| Agency | Cr(VI) Skin Loading Inducing ACD (µg/cm$^2$) | Source | Soil Adherence Factor (mg/cm$^2$) | Source [a] | Bioavailability | Recommended Cr(VI) Soil Level for ACD (mg/kg) |
|---|---|---|---|---|---|---|
| MDEP (1998) | 0.089 | 10% MET [b] | 0.51 | EPA (1996) | 100% | 170 |
| NJDEP (2005) | 0.08 | $BMDL_{10}$ [c] | 0.2 | EPA (2004) | 100% | 400 |

ACD, allergic contact dermatitis.

[a] EPA. 1996. Soil Screening Guidance: Technical Background Document, *EPA/540/R-95/128*. Office of Solid Waste and Emergency Response, Washington, DC. EPA. 2004. Risk Assessment Guidance for Superfund (RAGS), Volume 1—Human Health Evaluation Manual (HHEM) (Part E) Supplemental Guidance for Dermal Risk Assessment. July.

[b] MET (minimum elicitation threshold) is the concentration that would elicit allergic reaction in 10% of the Cr(VI) sensitized population. (Source: Nethercott et al. (1994). A study of chromium induced allergic contact dermatitis with 54 volunteers: Implications for environmental risk assessment. Occup. Environ. Med.51(6):371-380.)

[c] $BMDL_{10}$ is the lower 95% confidence limit on the dose corresponding to a 10% response among sensitized individuals. (Modeled on the basis of Nethercott et al. (1994). A study of chromium induced allergic contact dermatitis with 54 volunteers: Implications for environmental risk assessment. Occup. Environ. Med.51(6):371-380.)

**SECTION 7**

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# Appendix A
# HHRA Calculation Tables

**TABLE 1.1**
Groundwater Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose |
|---|---|---|---|
| DMT-12S | 5/22/2006 | DMT12S-052206 | REG |
| DMT-14S | 5/22/2006 | DMT14S-052206 | REG |
| DMT-15S | 5/22/2006 | DMT15S-052206 | REG |
| DMT-16S | 5/22/2006 | DMT16S-052206 | REG |
| DMT-17S | 5/23/2006 | DMT17S-052306 | REG |
| DMT-18S | 5/23/2006 | DMT18S-052306 | REG |
| DMT-1S | 5/23/2006 | DMT01S-052306 | REG |
| DMT-1S | 5/23/2006 | DMT01S-052306-D | FD |
| DMT-22S | 5/23/2006 | DMT22S-052306 | REG |
| DMT-23S | 5/23/2006 | DMT23S-052306 | REG |
| DMT-2S | 5/23/2006 | DMT02S-052306 | REG |
| DMT-3S | 5/23/2006 | DMT03S-052306 | REG |
| DMT-4S | 5/23/2006 | DMT04S-052306 | REG |
| DMT-5S | 5/23/2006 | DMT05S-052306 | REG |
| DMT-6S | 5/23/2006 | DMT06S-052306 | REG |
| DMT-10S | 5/24/2006 | DMT10S-052406 | REG |
| DMT-11S | 5/24/2006 | DMT11S-052406 | REG |
| DMT-13S | 5/24/2006 | DMT13S-052406 | REG |
| DMT-19S | 5/24/2006 | DMT19S-052406 | REG |
| DMT-20S | 5/24/2006 | DMT20S-052406 | REG |
| DMT-21S | 5/24/2006 | DMT21S-052506 | REG |
| DMT-24S | 5/24/2006 | DMT24S-052406 | REG |
| DMT-25S | 5/24/2006 | DMT25S-052406 | REG |
| DMT-7S | 5/24/2006 | DMT07S-052406 | REG |
| DMT-8S | 5/24/2006 | DMT08S-052406 | REG |
| DMT-9S | 5/24/2006 | DMT09S-052406 | REG |
| DMT-9S | 5/24/2006 | DMT09S-052406-D | FD |
| DMT-21S | 10/4/2006 | DMT-21S-GRW-100406 | REG |
| DMT-23S | 10/4/2006 | DMT-23S-GRW-100406 | REG |
| DMT-23S | 10/4/2006 | DMT-23S-GRW-100406-D | FD |
| DMT-24S | 10/4/2006 | DMT-24S-GRW-100406 | REG |
| DMT-25S | 10/4/2006 | DMT-25S-GRW-100406 | REG |
| EAC-1S | 11/28/2006 | EAC-1S-GRW-112806 | REG |
| EA-6S | 11/29/2006 | EA-6S-GRW-112906 | REG |
| EA-15S | 11/30/2006 | EA-15S-GRW-113006 | REG |
| EAC-4S | 11/30/2006 | EAC-4S-GRW-113006 | REG |
| EAC-4S | 11/30/2006 | EAC-4S-GRW-113006-D | FD |
| EA-11S | 12/1/2006 | EA-11S-GRW-120106 | REG |
| DMT-25S | 12/4/2006 | DMT-25S-GRW-120406 | REG |
| DMT-29S | 12/15/2006 | DMT-29S-GRW-1011 | REG |
| DMT-29S | 12/15/2006 | DMT-29S-GRW-1415 | REG |
| DMT-29S | 12/15/2006 | DMT-29S-GRW-1920 | REG |
| DMT-12S | 2/26/2007 | DMT-12S-GRW-022607 | REG |
| DMT-14S | 2/26/2007 | DMT-14S-GRW-022607 | REG |
| TPZ-27A | 2/26/2007 | TPZ-27A-GRW-022607 | REG |
| TPZ-27B | 2/26/2007 | TPZ-27B-GRW-022607 | REG |
| TPZ-30A | 2/26/2007 | TPZ-30A-GRW-022607 | REG |
| TPZ-30B | 2/26/2007 | TPZ-30B-GRW-022607 | REG |
| DMT-17S | 2/27/2007 | DMT-17S-GRW-022707 | REG |
| DMT-27S | 2/27/2007 | DMT-27S-GRW-022707 | REG |
| DMT-29S | 2/27/2007 | DMT-29S-GRW-022707 | REG |
| DMT-33S | 2/27/2007 | DMT-33S-GRW-022707 | REG |
| DMT-33S | 2/27/2007 | DMT-33S-GRW-022707-D | FD |
| DMT-39S | 2/27/2007 | DMT-39S-GRW-022707 | REG |
| EAC-3S | 2/27/2007 | EAC-3S-GRW-022707 | REG |

**TABLE 1.1**
Groundwater Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose |
|---|---|---|---|
| TPZ-28 | 2/27/2007 | TPZ-28-GRW-022707 | REG |
| TPZ-29 | 2/27/2007 | TPZ-29-GRW-022707 | REG |
| DMT-15S | 2/28/2007 | DMT-15S-GRW-022807 | REG |
| DMT-18S | 2/28/2007 | DMT-18S-GRW-022807 | REG |
| DMT-18S | 2/28/2007 | DMT-18S-GRW-022807-D | FD |
| DMT-19S | 2/28/2007 | DMT-19S-GRW-022807 | REG |
| DMT-26S | 2/28/2007 | DMT-26S-GRW-022807 | REG |
| DMT-30S | 2/28/2007 | DMT-30S-GRW-022807 | REG |
| EA-8S | 2/28/2007 | EA-8S-GRW-022807 | REG |
| EA-8S | 2/28/2007 | EA-8S-GRW-022807-D | FD |
| DMT-16S | 3/1/2007 | DMT-16S-GRW-030107 | REG |
| DMT-31S | 3/1/2007 | DMT-31S-GRW-030107 | REG |
| DMT-32S | 3/1/2007 | DMT-32S-GRW-030107 | REG |
| EA-10S | 3/1/2007 | EA-10S-GRW-030107 | REG |
| DMT-20S | 3/2/2007 | DMT-20S-GRW-030207 | REG |
| DMT-28S | 3/2/2007 | DMT-28S-GRW-030207 | REG |
| EAC-2S | 3/2/2007 | EAC-2S-GRW-030207 | REG |
| DMT-40S | 9/25/2007 | DMT-40S-GRW-092507 | REG |
| DMT-40S | 9/25/2007 | DMT-40S-GRW-092507-F | REG |
| DMT-43S | 9/25/2007 | DMT-43S-GRW-092507 | REG |
| DMT-43S | 9/25/2007 | DMT-43S-GRW-092507-F | REG |
| DMT-44S | 9/25/2007 | DMT-44S-GRW-092507 | REG |
| DMT-44S | 9/25/2007 | DMT-44S-GRW-092507-F | REG |
| DMT-41S | 9/26/2007 | DMT-41S-GRW-092607 | REG |
| DMT-41S | 9/26/2007 | DMT-41S-GRW-092607-F | REG |
| DMT-42S | 9/26/2007 | DMT-42S-GRW-092607 | REG |
| DMT-42S | 9/26/2007 | DMT-42S-GRW-092607-F | REG |
| DMT-45S | 9/26/2007 | DMT-45S-GRW-092607 | REG |
| DMT-45S | 9/26/2007 | DMT-45S-GRW-092607-F | REG |
| TPZ-33 | 9/26/2007 | TPZ-33-GRW-092607 | REG |
| TPZ-33 | 9/26/2007 | TPZ-33-GRW-092607-F | REG |
| TPZ-36 | 9/26/2007 | TPZ-36-GRW-092607 | REG |
| TPZ-36 | 9/26/2007 | TPZ-36-GRW-092607-F | REG |
| TPZ-38 | 9/26/2007 | TPZ-38-GRW-092607 | REG |
| TPZ-38 | 9/26/2007 | TPZ-38-GRW-092607-F | REG |
| DMT-56S | 9/27/2007 | DMT-56S-GRW-092707 | REG |
| DMT-56S | 9/27/2007 | DMT-56S-GRW-092707-F | REG |
| DMT-57S | 9/27/2007 | DMT-57S-GRW-092707 | REG |
| DMT-57S | 9/27/2007 | DMT-57S-GRW-092707-F | REG |
| DMT-58S | 9/27/2007 | DMT-58S-GRW-092707 | REG |
| DMT-58S | 9/27/2007 | DMT-58S-GRW-092707-F | REG |
| EA-8S | 9/28/2007 | EA-8S-GRW-092807 | REG |
| EA-8S | 9/28/2007 | EA-8S-GRW-092807-F | REG |
| TPZ-44 | 9/28/2007 | TPZ-44-GRW-092807 | REG |
| TPZ-44 | 9/28/2007 | TPZ-44-GRW-092807-F | REG |
| TPZ-45 | 9/28/2007 | TPZ-45-GRW-092807 | REG |
| TPZ-45 | 9/28/2007 | TPZ-45-GRW-092807-D | FD |
| TPZ-45 | 9/28/2007 | TPZ-45-GRW-092807-F | REG |
| TPZ-45 | 9/28/2007 | TPZ-45-GRW-092807-FD | FD |
| TPZ-46 | 9/28/2007 | TPZ-46-GRW-092807 | REG |
| TPZ-46 | 9/28/2007 | TPZ-46-GRW-092807-F | REG |
| DMT-46S | 10/1/2007 | DMT-46S-GRW-100107 | REG |
| DMT-46S | 10/1/2007 | DMT-46S-GRW-100107-F | REG |
| DMT-47S | 10/2/2007 | DMT-47S-GRW-100207 | REG |
| DMT-47S | 10/2/2007 | DMT-47S-GRW-100207-F | REG |

**TABLE 1.1**
Groundwater Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose |
|---|---|---|---|
| DMT-30S | 10/8/2007 | DMT-30S-GRW-100807 | REG |
| DMT-30S | 10/8/2007 | DMT-30S-GRW-100807-F | REG |
| DMT-61S | 11/26/2007 | DMT-61S-GRW-112607 | REG |
| DMT-61S | 11/26/2007 | DMT-61S-GRW-112607-F | REG |
| DMT-62S | 11/26/2007 | DMT-62S-GRW-112607 | REG |
| DMT-62S | 11/26/2007 | DMT-62S-GRW-112607-F | REG |
| DMT-48S | 11/27/2007 | DMT-48S-GRW-112707 | REG |
| DMT-48S | 11/27/2007 | DMT-48S-GRW-112707-F | REG |
| DMT-55S | 11/27/2007 | DMT-55S-GRW-112707 | REG |
| DMT-55S | 11/27/2007 | DMT-55S-GRW-112707-F | REG |
| DMT-59S | 11/29/2007 | DMT-59S-GRW-112907 | REG |
| DMT-59S | 11/29/2007 | DMT-59S-GRW-112907-F | REG |
| DMT-63S | 11/20/2008 | DMT-63US-GRW-112008 | REG |
| DMT-63S | 11/20/2008 | DMT-63US-GRW-112008F | REG |
| DMT-17S | 6/4/2009 | DMT-17S-GRW-060409 | REG |
| DMT-17S | 6/4/2009 | DMT-17S-GRW-060409-D | FD |
| DMT-17S | 6/4/2009 | DMT-17S-GRW-060409-D-F | FD |
| DMT-27S | 6/4/2009 | DMT-27S-GRW-060409 | REG |
| DMT-27S | 6/4/2009 | DMT-27S-GRW-060409-F | REG |
| DMT-42S | 6/4/2009 | DMT-42S-GRW-060409 | REG |
| DMT-42S | 6/4/2009 | DMT-42S-GRW-060409-F | REG |
| EAC-1S | 6/4/2009 | EAC-01S-GRW-060409 | REG |
| EAC-1S | 6/4/2009 | EAC-01S-GRW-060409-F | REG |
| DMT-12S | 6/5/2009 | DMT-12S-GRW-060509 | REG |
| DMT-12S | 6/5/2009 | DMT-12S-GRW-060509-F | REG |
| DMT-41S | 6/5/2009 | DMT-41S-GRW-060509 | REG |
| DMT-41S | 6/5/2009 | DMT-41S-GRW-060509-F | REG |
| DMT-14S | 6/8/2009 | DMT-14S-GRW-060809 | REG |
| DMT-14S | 6/8/2009 | DMT-14S-GRW-060809-F | REG |
| DMT-15S | 6/8/2009 | DMT-15S-GRW-060809 | REG |
| DMT-15S | 6/8/2009 | DMT-15S-GRW-060809-F | REG |
| DMT-44S | 6/8/2009 | DMT-44S-GRW-060809 | REG |
| DMT-44S | 6/8/2009 | DMT-44S-GRW-060809-D | FD |
| DMT-44S | 6/8/2009 | DMT-44S-GRW-060809-F | REG |
| EA-11S | 6/8/2009 | EA-11S-GRW-060809 | REG |
| EA-11S | 6/8/2009 | EA-11S-GRW-060809-F | REG |
| DMT-57S | 6/9/2009 | DMT-57S-GRW-060909 | REG |
| DMT-57S | 6/9/2009 | DMT-57S-GRW-060909-F | REG |
| DMT-63S | 6/9/2009 | DMT-63S-GRW-060909 | REG |
| DMT-63S | 6/9/2009 | DMT-63S-GRW-060909-F | REG |
| DMT-39S | 6/10/2009 | DMT-39S-GRW-061009 | REG |
| DMT-39S | 6/10/2009 | DMT-39S-GRW-061009-D | FD |
| DMT-39S | 6/10/2009 | DMT-39S-GRW-061009-F | REG |
| DMT-59S | 6/10/2009 | DMT-59S-GRW-061009 | REG |
| DMT-59S | 6/10/2009 | DMT-59S-GRW-061009-F | REG |
| DMT-45S | 6/11/2009 | DMT-45S-GRW-061109 | REG |
| DMT-45S | 6/11/2009 | DMT-45S-GRW-061109-F | REG |
| DMT-58S | 6/11/2009 | DMT-58S-061109 | REG |
| DMT-58S | 6/11/2009 | DMT-58S-061109-F | REG |

Note:
Reg - Normal sample
FD - Field Duplicate

**TABLE 1.2**
Surface Soil (0<0.5 feet) Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| SB-159 | 12/17/2008 | 0 | 2 | SB-159-SOI-000020 | REG |
| SB-162 | 12/17/2008 | 0 | 2 | SB-162-SOI-000020 | REG |
| SB-164 | 12/17/2008 | 0 | 2 | SB-164-SOI-000020 | REG |
| SB-165 | 12/17/2008 | 0 | 2 | SB-165-SOI-000020 | REG |
| SB-166 | 12/17/2008 | 0 | 2 | SB-166-SOI-000020 | REG |
| SB-168 | 12/17/2008 | 0 | 2 | SB-168-SOI-000020 | REG |
| SB-170 | 12/17/2008 | 0 | 3 | SB-170-SOI-000030 | REG |
| SB-170 | 12/17/2008 | 0 | 3 | SB-170-SOI-000030-D | FD |
| SB-171 | 12/17/2008 | 0 | 1 | SB-171-SOI-000010 | REG |
| SB-173 | 12/17/2008 | 0 | 2 | SB-173-SOI-000020 | REG |
| SB-175 | 12/17/2008 | 0 | 2 | SB-175-SOI-000020 | REG |
| SB-144 | 12/18/2008 | 0 | 2 | SB-144-SOI-000020 | REG |
| SB-145 | 12/18/2008 | 0 | 3 | SB-145-SOI-000030 | REG |
| SB-145 | 12/18/2008 | 0 | 3 | SB-145-SOI-000030-D | FD |
| SB-146 | 12/18/2008 | 0 | 4 | SB-146-SOI-000040 | REG |
| SB-148 | 12/18/2008 | 0 | 3 | SB-148-SOI-000030 | REG |
| SB-161 | 12/18/2008 | 0 | 2 | SB-161-SOI-000020 | REG |
| SB-169 | 12/18/2008 | 0 | 2 | SB-169-SOI-000020 | REG |
| SB-176 | 12/18/2008 | 0 | 2 | SB-176-SOI-000020 | REG |
| SB-181 | 12/18/2008 | 0 | 2 | SB-181-SOI-000020 | REG |
| SB-183 | 12/18/2008 | 0 | 2 | SB-183-SOI-000020 | REG |
| SB-142 | 12/19/2008 | 0 | 2 | SB-142-SOI-000020 | REG |
| SB-147 | 12/19/2008 | 0 | 2 | SB-147-SOI-000020 | REG |
| SB-150 | 12/19/2008 | 0 | 4 | SB-150-SOI-000040 | REG |
| SB-150 | 12/19/2008 | 0 | 4 | SB-150-SOI-000040-D | FD |
| SB-151 | 12/19/2008 | 0 | 2.5 | SB-151-SOI-000025 | REG |
| SB-152 | 12/19/2008 | 0 | 3 | SB-152-SOI-000030 | REG |
| SB-153 | 12/19/2008 | 0 | 4 | SB-153-SOI-000040 | REG |
| SB-153 | 12/19/2008 | 0 | 4 | SB-153-SOI-000040-D | FD |
| SB-154 | 12/19/2008 | 0 | 4 | SB-154-SOI-000040 | REG |
| SB-155 | 12/19/2008 | 0 | 2 | SB-155-SOI-000020 | REG |
| SB-157 | 12/19/2008 | 0 | 2 | SB-157-SOI-000020 | REG |
| SB-158 | 12/19/2008 | 0 | 2 | SB-158-SOI-000020 | REG |
| SB-184 | 12/19/2008 | 0 | 2 | SB-184-SOI-000020 | REG |
| SB-185 | 12/19/2008 | 0 | 3 | SB-185-SOI-000030 | REG |
| SB-192 | 12/23/2008 | 0 | 2 | SB-192-SOI-000020 | REG |
| SB-193 | 12/23/2008 | 0 | 3 | SB-193-SOI-000030 | REG |
| SB-194 | 12/23/2008 | 0 | 3 | SB-194-SOI-000030 | REG |
| SB-195 | 12/23/2008 | 0 | 3 | SB-195-SOI-000030 | REG |
| SB-196 | 12/23/2008 | 0 | 2 | SB-196-SOI-000020 | REG |
| SB-197 | 12/23/2008 | 0 | 4 | SB-197-SOI-000040 | REG |
| SB-197 | 12/23/2008 | 0 | 4 | SB-197-SOI-000040-D | FD |
| SB-198 | 12/23/2008 | 0 | 4 | SB-198-SOI-000040 | REG |
| SB-199 | 12/23/2008 | 0 | 4 | SB-199-SOI-000040 | REG |
| SB-200 | 12/23/2008 | 0 | 3 | SB-200-SOI-000030 | REG |
| SB-201 | 12/29/2008 | 0 | 2 | SB-201-SOI-000020 | REG |
| SB-202 | 12/29/2008 | 0 | 2 | SB-202-SOI-000020 | REG |
| SB-203 | 12/29/2008 | 0 | 2 | SB-203-SOI-000020 | REG |
| SB-204 | 12/29/2008 | 0 | 2 | SB-204-SOI-000020 | REG |
| SB-205 | 12/29/2008 | 0 | 2 | SB-205-SOI-000020 | REG |
| SB-206 | 12/29/2008 | 0 | 2 | SB-206-SOI-000020 | REG |
| NS2-E1 | 1/5/2009 | 0 | 2.5 | DMT-NS2-SWC-E1-01 | REG |

**TABLE 1.2**

Surface Soil (0<0.5 feet) Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| NS2-E1 | 1/5/2009 | 0 | 2.5 | DMT-NS2-SWC-E1-01-D | FD |
| NS2-E2 | 1/5/2009 | 0 | 2 | DMT-NS2-SWC-E2-01 | REG |
| NS2-S1 | 1/5/2009 | 0 | 1 | DMT-NS2-SWC-S1-01 | REG |
| NS2-E3 | 1/6/2009 | 0 | 2 | DMT-NS2-SWC-E3-01 | REG |
| NS2-E4 | 1/6/2009 | 0 | 2 | DMT-NS2-SWC-E4-01 | REG |
| NS2-E5 | 1/7/2009 | 0 | 2.5 | DMT-NS2-SWC-E5-01 | REG |
| NS2-E6 | 1/7/2009 | 0 | 2.5 | DMT-NS2-SWC-E6-01 | REG |
| NS2-E7 | 1/8/2009 | 0 | 2 | DMT-NS2-SWC-E7-01 | REG |
| NS2-E7 | 1/8/2009 | 0 | 2 | DMT-NS2-SWC-E7-01-D | FD |
| NS2-E8 | 1/12/2009 | 0 | 1.5 | DMT-NS2-SWC-E8-01 | REG |
| NS2-E9 | 1/12/2009 | 0 | 3 | DMT-NS2-SWC-E9-01 | REG |
| NS2-E10 | 1/13/2009 | 0 | 2 | DMT-NS2-SWC-E10-01 | REG |
| NS2-E11 | 1/14/2009 | 0 | 1.5 | DMT-NS2-SWC-E11-01 | REG |
| NS2-E11 | 1/14/2009 | 0 | 1.5 | DMT-NS2-SWC-E11-01-D | FD |
| NS2-N1 | 1/14/2009 | 0 | 1.5 | DMT-NS2-SWC-N1-01 | REG |
| Area 1501/1602 JMDMT-1 | 5/19/2009 | 0 | 0.5 | JMDMT-1 | REG |
| Area 1501/1602 JMDMT-2 | 5/19/2009 | 0 | 0.5 | JMDMT-2 | REG |
| Area 1501/1602 JMDMT-3 | 5/19/2009 | 0 | 0.5 | JMDMT-3 | REG |
| Area 1501/1602 JMDMT-4 | 5/19/2009 | 0 | 0.5 | JMDMT-4 | REG |
| Area 1501/1602 JMDMT-5 | 5/19/2009 | 0 | 0.5 | JMDMT-5 | REG |
| Area 1501/1602 JMDMT-6 | 5/19/2009 | 0 | 0.5 | JMDMT-6 | REG |
| Area 1501/1602 JMDMT-6 | 5/19/2009 | 0 | 0.5 | JMDMT-6-D | FD |
| SB-213 | 6/17/2009 | 0 | 1 | SB-213-SOI-000010 | REG |
| SB-214 | 6/17/2009 | 0 | 3 | SB-214-SOI-000030 | REG |
| E1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-E1-01 | REG |
| N1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-N1-01 | REG |
| N1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-N1-01D | FD |
| S1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-S1-01 | REG |
| W1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-W1-01 | REG |
| SB-167 | 12/17/2008 | 0 | 2 | SB-167-SOI-000020 | REG |
| SB-172 | 12/17/2008 | 0 | 2 | SB-172-SOI-000020 | REG |
| SB-174 | 12/17/2008 | 0 | 2 | SB-174-SOI-000020 | REG |
| SB-174 | 12/17/2008 | 0 | 2 | SB-174-SOI-000020-D | FD |
| SB-177 | 12/18/2008 | 0 | 2 | SB-177-SOI-000020 | REG |
| SB-178 | 12/18/2008 | 0 | 2 | SB-178-SOI-000020 | REG |

Note:
Sample depth is presented in feet.
Reg - Normal sample
FD - Field Duplicate

**TABLE 1.3**
Total Soil (0-10 feet) Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| SB-159 | 12/17/2008 | 0 | 2 | SB-159-SOI-000020 | REG |
| SB-159 | 12/17/2008 | 2 | 4 | SB-159-SOI-020040 | REG |
| SB-160 | 12/17/2008 | 1 | 3 | SB-160-SOI-010030 | REG |
| SB-160 | 12/17/2008 | 4 | 6 | SB-160-SOI-040060 | REG |
| SB-162 | 12/17/2008 | 0 | 2 | SB-162-SOI-000020 | REG |
| SB-162 | 12/17/2008 | 2 | 4 | SB-162-SOI-020040 | REG |
| SB-164 | 12/17/2008 | 0 | 2 | SB-164-SOI-000020 | REG |
| SB-164 | 12/17/2008 | 2 | 4 | SB-164-SOI-020040 | REG |
| SB-164 | 12/17/2008 | 2 | 4 | SB-164-SOI-020040-D | FD |
| SB-165 | 12/17/2008 | 0 | 2 | SB-165-SOI-000020 | REG |
| SB-165 | 12/17/2008 | 2 | 4 | SB-165-SOI-020040 | REG |
| SB-166 | 12/17/2008 | 0 | 2 | SB-166-SOI-000020 | REG |
| SB-166 | 12/17/2008 | 2 | 4 | SB-166-SOI-020040 | REG |
| SB-168 | 12/17/2008 | 0 | 2 | SB-168-SOI-000020 | REG |
| SB-168 | 12/17/2008 | 2 | 4 | SB-168-SOI-020040 | REG |
| SB-168 | 12/17/2008 | 6 | 8 | SB-168-SOI-060080 | REG |
| SB-170 | 12/17/2008 | 0 | 3 | SB-170-SOI-000030 | REG |
| SB-170 | 12/17/2008 | 0 | 3 | SB-170-SOI-000030-D | FD |
| SB-170 | 12/17/2008 | 3 | 4 | SB-170-SOI-030040 | REG |
| SB-171 | 12/17/2008 | 0 | 1 | SB-171-SOI-000010 | REG |
| SB-171 | 12/17/2008 | 2 | 4 | SB-171-SOI-020040 | REG |
| SB-173 | 12/17/2008 | 0 | 2 | SB-173-SOI-000020 | REG |
| SB-173 | 12/17/2008 | 2 | 4 | SB-173-SOI-020040 | REG |
| SB-175 | 12/17/2008 | 0 | 2 | SB-175-SOI-000020 | REG |
| SB-175 | 12/17/2008 | 2 | 4 | SB-175-SOI-020040 | REG |
| SB-143 | 12/18/2008 | 1 | 3 | SB-143-SOI-010030 | REG |
| SB-143 | 12/18/2008 | 3 | 4 | SB-143-SOI-030040 | REG |
| SB-144 | 12/18/2008 | 0 | 2 | SB-144-SOI-000020 | REG |
| SB-144 | 12/18/2008 | 2 | 4 | SB-144-SOI-020040 | REG |
| SB-145 | 12/18/2008 | 0 | 3 | SB-145-SOI-000030 | REG |
| SB-145 | 12/18/2008 | 0 | 3 | SB-145-SOI-000030-D | FD |
| SB-145 | 12/18/2008 | 3 | 4 | SB-145-SOI-030040 | REG |
| SB-146 | 12/18/2008 | 0 | 4 | SB-146-SOI-000040 | REG |
| SB-146 | 12/18/2008 | 6 | 8 | SB-146-SOI-060080 | REG |
| SB-148 | 12/18/2008 | 0 | 3 | SB-148-SOI-000030 | REG |
| SB-148 | 12/18/2008 | 3 | 4 | SB-148-SOI-030040 | REG |
| SB-149 | 12/18/2008 | 1 | 3 | SB-149-SOI-010030 | REG |
| SB-149 | 12/18/2008 | 3 | 4 | SB-149-SOI-030040 | REG |
| SB-161 | 12/18/2008 | 0 | 2 | SB-161-SOI-000020 | REG |
| SB-161 | 12/18/2008 | 2 | 4 | SB-161-SOI-020040 | REG |
| SB-169 | 12/18/2008 | 0 | 2 | SB-169-SOI-000020 | REG |
| SB-169 | 12/18/2008 | 2 | 4 | SB-169-SOI-020040 | REG |
| SB-176 | 12/18/2008 | 0 | 2 | SB-176-SOI-000020 | REG |
| SB-176 | 12/18/2008 | 2 | 4 | SB-176-SOI-020040 | REG |
| SB-181 | 12/18/2008 | 0 | 2 | SB-181-SOI-000020 | REG |
| SB-181 | 12/18/2008 | 2 | 4 | SB-181-SOI-020040 | REG |
| SB-182 | 12/18/2008 | 2 | 4 | SB-182-SOI-020040 | REG |
| SB-182 | 12/18/2008 | 4 | 6 | SB-182-SOI-040060 | REG |
| SB-183 | 12/18/2008 | 0 | 2 | SB-183-SOI-000020 | REG |
| SB-183 | 12/18/2008 | 2 | 4 | SB-183-SOI-020040 | REG |
| SB-183 | 12/18/2008 | 2 | 4 | SB-183-SOI-020040-D | FD |
| SB-142 | 12/19/2008 | 0 | 2 | SB-142-SOI-000020 | REG |

**TABLE 1.3**
Total Soil (0-10 feet) Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| SB-142 | 12/19/2008 | 2 | 4 | SB-142-SOI-020040 | REG |
| SB-147 | 12/19/2008 | 0 | 2 | SB-147-SOI-000020 | REG |
| SB-147 | 12/19/2008 | 2 | 4 | SB-147-SOI-020040 | REG |
| SB-150 | 12/19/2008 | 0 | 4 | SB-150-SOI-000040 | REG |
| SB-150 | 12/19/2008 | 0 | 4 | SB-150-SOI-000040-D | FD |
| SB-151 | 12/19/2008 | 0 | 2.5 | SB-151-SOI-000025 | REG |
| SB-151 | 12/19/2008 | 2.5 | 4 | SB-151-SOI-025040 | REG |
| SB-152 | 12/19/2008 | 0 | 3 | SB-152-SOI-000030 | REG |
| SB-153 | 12/19/2008 | 0 | 4 | SB-153-SOI-000040 | REG |
| SB-153 | 12/19/2008 | 0 | 4 | SB-153-SOI-000040-D | FD |
| SB-153 | 12/19/2008 | 6 | 8 | SB-153-SOI-060080 | REG |
| SB-154 | 12/19/2008 | 0 | 4 | SB-154-SOI-000040 | REG |
| SB-154 | 12/19/2008 | 6 | 8 | SB-154-SOI-060080 | REG |
| SB-155 | 12/19/2008 | 0 | 2 | SB-155-SOI-000020 | REG |
| SB-155 | 12/19/2008 | 2 | 4 | SB-155-SOI-020040 | REG |
| SB-156 | 12/19/2008 | 1 | 4 | SB-156-SOI-010040 | REG |
| SB-156 | 12/19/2008 | 5 | 6 | SB-156-SOI-050060 | REG |
| SB-157 | 12/19/2008 | 0 | 2 | SB-157-SOI-000020 | REG |
| SB-157 | 12/19/2008 | 2 | 4 | SB-157-SOI-020040 | REG |
| SB-157 | 12/19/2008 | 2 | 4 | SB-157-SOI-020040-D | FD |
| SB-158 | 12/19/2008 | 0 | 2 | SB-158-SOI-000020 | REG |
| SB-158 | 12/19/2008 | 2 | 4 | SB-158-SOI-020040 | REG |
| SB-184 | 12/19/2008 | 0 | 2 | SB-184-SOI-000020 | REG |
| SB-184 | 12/19/2008 | 2 | 4 | SB-184-SOI-020040 | REG |
| SB-185 | 12/19/2008 | 0 | 3 | SB-185-SOI-000030 | REG |
| SB-185 | 12/19/2008 | 3 | 4 | SB-185-SOI-030040 | REG |
| SB-192 | 12/23/2008 | 0 | 2 | SB-192-SOI-000020 | REG |
| SB-192 | 12/23/2008 | 2 | 4 | SB-192-SOI-020040 | REG |
| SB-193 | 12/23/2008 | 0 | 3 | SB-193-SOI-000030 | REG |
| SB-193 | 12/23/2008 | 3 | 4 | SB-193-SOI-030040 | REG |
| SB-194 | 12/23/2008 | 0 | 3 | SB-194-SOI-000030 | REG |
| SB-194 | 12/23/2008 | 3 | 4 | SB-194-SOI-030040 | REG |
| SB-195 | 12/23/2008 | 0 | 3 | SB-195-SOI-000030 | REG |
| SB-196 | 12/23/2008 | 0 | 2 | SB-196-SOI-000020 | REG |
| SB-196 | 12/23/2008 | 2 | 4 | SB-196-SOI-020040 | REG |
| SB-197 | 12/23/2008 | 0 | 4 | SB-197-SOI-000040 | REG |
| SB-197 | 12/23/2008 | 0 | 4 | SB-197-SOI-000040-D | FD |
| SB-197 | 12/23/2008 | 6 | 8 | SB-197-SOI-060080 | REG |
| SB-198 | 12/23/2008 | 0 | 4 | SB-198-SOI-000040 | REG |
| SB-198 | 12/23/2008 | 4 | 6 | SB-198-SOI-040060 | REG |
| SB-199 | 12/23/2008 | 0 | 4 | SB-199-SOI-000040 | REG |
| SB-199 | 12/23/2008 | 6 | 8 | SB-199-SOI-060080 | REG |
| SB-200 | 12/23/2008 | 0 | 3 | SB-200-SOI-000030 | REG |
| SB-200 | 12/23/2008 | 3 | 4 | SB-200-SOI-030040 | REG |
| SB-201 | 12/29/2008 | 0 | 2 | SB-201-SOI-000020 | REG |
| SB-201 | 12/29/2008 | 2 | 4 | SB-201-SOI-020040 | REG |
| SB-202 | 12/29/2008 | 0 | 2 | SB-202-SOI-000020 | REG |
| SB-202 | 12/29/2008 | 2 | 4 | SB-202-SOI-020040 | REG |
| SB-202 | 12/29/2008 | 2 | 4 | SB-202-SOI-020040-D | FD |
| SB-203 | 12/29/2008 | 0 | 2 | SB-203-SOI-000020 | REG |
| SB-203 | 12/29/2008 | 2 | 4 | SB-203-SOI-020040 | REG |
| SB-204 | 12/29/2008 | 0 | 2 | SB-204-SOI-000020 | REG |

**TABLE 1.3**
Total Soil (0-10 feet) Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| SB-204 | 12/29/2008 | 2 | 4 | SB-204-SOI-020040 | REG |
| SB-205 | 12/29/2008 | 0 | 2 | SB-205-SOI-000020 | REG |
| SB-205 | 12/29/2008 | 2 | 4 | SB-205-SOI-020040 | REG |
| SB-206 | 12/29/2008 | 0 | 2 | SB-206-SOI-000020 | REG |
| SB-206 | 12/29/2008 | 2 | 4 | SB-206-SOI-020040 | REG |
| SB-212 | 6/17/2009 | 2.5 | 4 | SB-212-SOI-025040 | REG |
| SB-215 | 6/17/2009 | 6 | 8 | SB-215-SOI-060080 | REG |
| SB-215 | 6/17/2009 | 6 | 8 | SB-215-SOI-060080-D | FD |
| SB-217 | 6/17/2009 | 2 | 4 | SB-217-SOI-020040 | REG |
| SB-217 | 6/17/2009 | 4 | 7 | SB-217-SOI-040070 | REG |
| SB-218 | 6/17/2009 | 2 | 4 | SB-218-SOI-020040 | REG |
| SB-218 | 6/17/2009 | 6 | 7 | SB-218-SOI-060070 | REG |
| SB-219 | 6/17/2009 | 3 | 4 | SB-219-SOI-030040 | REG |
| SB-219 | 6/17/2009 | 6 | 8 | SB-219-SOI-060080 | REG |
| SB-220 | 6/18/2009 | 2 | 4 | SB-220-SOI-020040 | REG |
| SB-221 | 6/18/2009 | 1.5 | 3 | SB-221-SOI-015030 | REG |
| SB-222 | 6/18/2009 | 1.5 | 3 | SB-222-SOI-015030 | REG |
| SB-223 | 6/18/2009 | 3 | 4 | SB-223-SOI-030040 | REG |
| SB-224 | 6/18/2009 | 5.5 | 7 | SB-224-SOI-050070 | REG |
| SB-224 | 6/18/2009 | 5.5 | 7 | SB-224-SOI-050070-D | FD |
| SB-225 | 6/18/2009 | 6 | 7 | SB-225-SOI-060070 | REG |
| SB-226 | 6/18/2009 | 1.5 | 3 | SB-226-SOI-015030 | REG |
| SB-227 | 6/18/2009 | 6.5 | 8 | SB-227-SOI-065080 | REG |
| SB-228 | 6/18/2009 | 3 | 4 | SB-228-SOI-030040 | REG |
| SB-229 | 6/18/2009 | 7 | 8 | SB-229-SOI-070080 | REG |
| SB-230 | 6/18/2009 | 7 | 8 | SB-230-SOI-070080 | REG |
| SB-231 | 6/18/2009 | 7 | 8 | SB-231-SOI-070080 | REG |
| SB-232 | 6/18/2009 | 5.5 | 7 | SB-232-SOI-055070 | REG |
| SB-235 | 6/19/2009 | 2 | 4 | SB-235-SOI-020040 | REG |
| SB-236 | 6/19/2009 | 2 | 4 | SB-236-SOI-020040 | REG |
| SB-237 | 6/19/2009 | 3.5 | 4 | SB-237-SOI-035040 | REG |
| SB-238 | 6/19/2009 | 7 | 8 | SB-238-SOI-070080 | REG |
| SB-239 | 6/19/2009 | 3 | 4 | SB-239-SOI-030040 | REG |
| SB-240 | 6/19/2009 | 3.5 | 4 | SB-240-SOI-035040 | REG |
| SB-241 | 6/19/2009 | 5 | 6 | SB-241-SOI-050060 | REG |
| SB-242 | 6/19/2009 | 7 | 8 | SB-242-SOI-070080 | REG |
| SB-243 | 6/19/2009 | 6 | 8 | SB-243-SOI-060070 | REG |
| SB-244 | 6/19/2009 | 6 | 7 | SB-244-SOI-060070 | REG |
| SB-245 | 6/19/2009 | 5 | 6 | SB-245-SOI-050060 | REG |
| SB-246 | 6/19/2009 | 3 | 4 | SB-246-SOI-030040 | REG |
| DMT-10S | 12/6/2005 | 8 | 10 | SODMT10S-0810 | REG |
| DMT-9S | 12/7/2005 | 6 | 8 | SODMT9S-0608 | REG |
| DMT-6S | 12/9/2005 | 8 | 10 | SODMT6S-0810 | REG |
| DMT-1S | 12/11/2005 | 6 | 8 | SODMT1S-0608 | REG |
| DMT-38M | 11/28/2006 | 8 | 10 | DMT-38M-SOI-0810 | REG |
| DMT-35M | 12/4/2006 | 8 | 9 | DMT-35M-SOI-0809 | REG |
| DMT-32S | 12/6/2006 | 4 | 6 | DMT-32S-SOI-0406 | REG |
| B-127 | 2/8/2007 | 4 | 5.5 | B-127-SOI-0406 | REG |
| B-127 | 2/8/2007 | 6 | 10 | B-127-SOI-0610 | REG |
| B-128 | 2/12/2007 | 2 | 4 | B-128-SOI-0204 | REG |
| B-128 | 2/12/2007 | 4 | 5.5 | B-128-SOI-0406 | REG |
| TPZ-25 | 2/13/2007 | 5 | 5.5 | TPZ-25-SOI-0405 | REG |

**TABLE 1.3**
Total Soil (0-10 feet) Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| TPZ-25 | 2/13/2007 | 5.5 | 6 | TPZ-25-SOI-0506 | REG |
| TPZ-26 | 2/13/2007 | 3.5 | 5 | TPZ-26-SOI-0405 | REG |
| TPZ-27 | 2/14/2007 | 4.5 | 9.5 | TPZ-27-SOI-0510 | REG |
| TPZ-28 | 2/14/2007 | 3 | 3.5 | TPZ-28-SOI-0304 | REG |
| TPZ-29 | 2/15/2007 | 3.5 | 5 | TPZ-29-SOI-0305-D | FD |
| TPZ-29 | 2/15/2007 | 5 | 6.5 | TPZ-29-SOI-0507 | REG |
| TPZ-30 | 2/15/2007 | 3.5 | 6 | TPZ-30-SOI-0406 | REG |
| TPZ-30 | 2/15/2007 | 3.5 | 6 | TPZ-30-SOI-0406-D | FD |
| DMT-39S | 2/16/2007 | 4 | 7.5 | DMT-39S-SOI-0407 | REG |
| TPZ-31 | 2/16/2007 | 5 | 6 | TPZ-31-SOI-0506 | REG |
| TPZ-31 | 2/16/2007 | 6 | 10 | TPZ-31-SOI-0610 | REG |
| TPZ-32 | 2/17/2007 | 4 | 5 | TPZ-32-SOI-0405 | REG |
| TPZ-32 | 2/17/2007 | 5 | 7 | TPZ-32-SOI-0507 | REG |
| SBA-F-1 | 6/28/2007 | 5 | 6 | SBA-F-1-SOI-050060-A | REG |
| SBA-F-1 | 6/28/2007 | 6.5 | 7.5 | SBA-F-1-SOI-065075-A | REG |
| SBA-H-1 | 6/30/2007 | 2 | 3 | SBA-H-1-SOI-020030-A | REG |
| SBA-H-1 | 6/30/2007 | 4 | 5 | SBA-H-1-SOI-040050-A | REG |
| SBA-H-1 | 6/30/2007 | 5.5 | 6 | SBA-H-1-SOI-055060-A | REG |
| SBA-H-1 | 6/30/2007 | 6 | 8 | SBA-H-1-SOI-060080-A | REG |
| SBA-F-3 | 7/2/2007 | 4 | 5 | SBA-F-3-SOI-040050-A | REG |
| SBA-F-3 | 7/2/2007 | 9 | 10 | SBA-F-3-SOI-090100-A | REG |
| SBA-D-1 | 7/10/2007 | 6 | 7 | SBA-D-1-SOI-060070-A | REG |
| SBA-D-1 | 7/10/2007 | 8 | 9 | SBA-D-1-SOI-080090-A | REG |
| SBA-D-4 | 7/12/2007 | 6 | 7 | SBA-D-4-SOI-060070-A | REG |
| SBA-D-4 | 7/12/2007 | 8 | 9 | SBA-D-4-SOI-080090-A | REG |
| SBA-D-5 | 7/12/2007 | 6 | 7 | SBA-D-5-SOI-060070-A | REG |
| SBA-D-5 | 7/12/2007 | 7 | 8 | SBA-D-5-SOI-070080-A | REG |
| TT1 | 7/12/2007 | 5.5 | 5.7 | TT1-SOI-S22-055057-A | REG |
| TT1 | 7/12/2007 | 5.5 | 6.2 | TT1-SOI-S30-055062-A | REG |
| SBA-F-5 | 7/13/2007 | 4 | 8 | SBA-F-5-SOI-040080-A | REG |
| SBA-F-5 | 7/13/2007 | 9 | 10 | SBA-F-5-SOI-090100-A | REG |
| SBA-H-4 | 7/13/2007 | 6 | 7 | SBA-H-4-SOI-060070-A | REG |
| SBA-H-4 | 7/13/2007 | 8 | 9 | SBA-H-4-SOI-080090-A | REG |
| SBA-H-4 | 7/13/2007 | 8 | 9 | SBA-H-4-SOI-080090-AD | FD |
| SBA-H-6 | 7/13/2007 | 6 | 7 | SBA-H-6-SOI-060070-A | REG |
| SBA-H-6 | 7/13/2007 | 8 | 9 | SBA-H-6-SOI-080090-A | REG |
| TT1 | 7/16/2007 | 0.8 | 1.6 | TT1-SOI-S09N-008016-A | REG |
| TT1 | 7/16/2007 | 1.6 | 2.4 | TT1-SOI-S09N-016024-AD | FD |
| TT1 | 7/16/2007 | 1.6 | 2.8 | TT1-SOI-S25N-016028-A | REG |
| TT1 | 7/16/2007 | 2.4 | 3.9 | TT1-SOI-S09N-024039-A | REG |
| TT1 | 7/16/2007 | 2.8 | 3.6 | TT1-SOI-S25N-028036-A | REG |
| TT1 | 7/16/2007 | 3.6 | 4.1 | TT1-SOI-S25N-036041-A | REG |
| TT1 | 7/16/2007 | 4.1 | 4.7 | TT1-SOI-S25N-041047-A | REG |
| TT1 | 7/16/2007 | 4.5 | 5 | TT1-SOI-S09N-045050-A | REG |
| TT1 | 7/16/2007 | 4.7 | 4.8 | TT1-SOI-S25N-047048-A | REG |
| TT1 | 7/16/2007 | 4.8 | 5 | TT1-SOI-S25N-048050-A | REG |
| TT1 | 7/16/2007 | 5 | 5.1 | TT1-SOI-S09N-050051-A | REG |
| TT1 | 7/16/2007 | 5.1 | 5.5 | TT1-SOI-S09N-051055-A | REG |
| TT1 | 7/16/2007 | 5.5 | 6 | TT1-SOI-S25N-055060-A | REG |
| TT1 | 7/16/2007 | 5.7 | 6 | TT1-SOI-S09N-057060-A | REG |
| TT1 | 7/16/2007 | 6 | 6.5 | TT1-SOI-S25N-060065-A | REG |
| TT1 | 7/16/2007 | 6.2 | 7 | TT1-SOI-S09N-062070-A | REG |

**TABLE 1.3**
Total Soil (0-10 feet) Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| TT1 | 7/16/2007 | 7.5 | 7.5 | TT1-SOI-S09N-075075-A | REG |
| TT1 | 7/16/2007 | 7.5 | 7.8 | TT1-SOI-S09N-075078-A | REG |
| TT1 | 7/16/2007 | 8 | 9 | TT1-SOI-S09N-080090-A | REG |
| TT1 | 7/16/2007 | 8 | 9 | TT1-SOI-S45N-080090-A | REG |
| TT1 | 7/16/2007 | 8 | 9 | TT1-SOI-S09N-080090-AD | FD |
| TT1 | 7/16/2007 | 8.1 | 8.5 | TT1-SOI-S25N-081085-A | REG |
| TT1 | 7/16/2007 | 8.6 | 8.7 | TT1-SOI-S25N-086087-A | REG |
| TT1 | 7/16/2007 | 8.7 | 9.2 | TT1-SOI-S25N-087092-A | REG |
| DMT-53US | 7/26/2007 | 8 | 9 | DMT-53US-SOI-080090-A | REG |
| SBA-I-1 | 8/6/2007 | 9 | 9.5 | SBA-I-1-SOI-090095-A | REG |
| SBA-I-1 | 8/6/2007 | 9.5 | 10 | SBA-I-1-SOI-095100-A | REG |
| SBA-I-2 | 8/6/2007 | 8 | 9 | SBA-I-2-SOI-080090-A | REG |
| CSG-2 | 8/9/2007 | 2 | 3.5 | CSG-2-SOI-020035-A | REG |
| CSG-2 | 8/9/2007 | 3.5 | 4 | CSG-2-SOI-035040-A | REG |
| CSG-2 | 8/9/2007 | 5 | 6 | CSG-2-SOI-050060-A | REG |
| CSG-1 | 8/10/2007 | 2 | 3 | CSG-1-SOI-020030-A | REG |
| CSG-1 | 8/10/2007 | 3 | 4 | CSG-1-SOI-030040-A | REG |
| CSG-1 | 8/10/2007 | 4 | 4.5 | CSG-1-SOI-040045-A | REG |
| CSG-1 | 8/10/2007 | 4.5 | 5 | CSG-1-SOI-045050-A | REG |
| CSG-1 | 8/10/2007 | 5.5 | 6.5 | CSG-1-SOI-055065-A | REG |
| CSG-1 | 8/10/2007 | 8 | 10 | CSG-1-SOI-080100-A | REG |
| SBA-F-6 | 9/8/2007 | 2 | 6 | SBA-F-6-SOI-020060-A | REG |
| SBA-F-6 | 9/8/2007 | 8.5 | 10 | SBA-F-6-SOI-085100-A | REG |
| SBA-H-7 | 9/8/2007 | 2 | 8 | SBA-H-7-SOI-020080-A | REG |
| DMT-71US | 10/12/2008 | 1 | 4 | DMT-71US-SOI-0104 | REG |
| DMT-65US | 10/14/2008 | 6 | 10 | DMT-65US-SOI-0610 | REG |
| DMT-64US | 10/23/2008 | 6 | 10 | DMT-64US-SOI-0610 | REG |
| DMT-70US | 10/25/2008 | 6 | 10 | DMT-70US-SOI-0610 | REG |
| DMT-66US | 10/26/2008 | 6 | 10 | DMT-66US-SOI-0610 | REG |
| DMT-69US | 11/5/2008 | 2 | 6 | DMT-69US-SOI-0206 | REG |
| DMT-67US | 11/7/2008 | 2 | 6 | DMT-67US-SOI-0206 | REG |
| DMT-68US | 11/8/2008 | 2 | 6 | DMT-68US-SOI-0206 | REG |
| NS2-C1 | 1/5/2009 | 2.5 | 2.5 | DMT-NS2-CF-C1-01 | REG |
| NS2-C2 | 1/5/2009 | 3 | 3 | DMT-NS2-CF-C2-01 | REG |
| NS2-E1 | 1/5/2009 | 0 | 2.5 | DMT-NS2-SWC-E1-01 | REG |
| NS2-E1 | 1/5/2009 | 0 | 2.5 | DMT-NS2-SWC-E1-01-D | FD |
| NS2-E2 | 1/5/2009 | 0 | 2 | DMT-NS2-SWC-E2-01 | REG |
| NS2-S1 | 1/5/2009 | 0 | 1 | DMT-NS2-SWC-S1-01 | REG |
| NS2-C3 | 1/6/2009 | 4 | 4 | DMT-NS2-CF-C3-01 | REG |
| NS2-C4 | 1/6/2009 | 2.5 | 2.5 | DMT-NS2-CF-C4-01 | REG |
| NS2-E3 | 1/6/2009 | 0 | 2 | DMT-NS2-SWC-E3-01 | REG |
| NS2-E4 | 1/6/2009 | 0 | 2 | DMT-NS2-SWC-E4-01 | REG |
| NS2-C5 | 1/7/2009 | 3 | 3 | DMT-NS2-CF-C5-01 | REG |
| NS2-C6 | 1/7/2009 | 3 | 3 | DMT-NS2-CF-C6-01 | REG |
| NS2-E5 | 1/7/2009 | 0 | 2.5 | DMT-NS2-SWC-E5-01 | REG |
| NS2-E6 | 1/7/2009 | 0 | 2.5 | DMT-NS2-SWC-E6-01 | REG |
| NS2-C7 | 1/8/2009 | 2.5 | 2.5 | DMT-NS2-CF-C7-01 | REG |
| NS2-E7 | 1/8/2009 | 0 | 2 | DMT-NS2-SWC-E7-01 | REG |
| NS2-E7 | 1/8/2009 | 0 | 2 | DMT-NS2-SWC-E7-01-D | FD |
| NS2-C8 | 1/12/2009 | 2 | 2 | DMT-NS2-CF-C8-01 | REG |
| NS2-C9 | 1/12/2009 | 4 | 4 | DMT-NS2-CF-C9-01 | REG |
| NS2-E8 | 1/12/2009 | 0 | 1.5 | DMT-NS2-SWC-E8-01 | REG |

**TABLE 1.3**
Total Soil (0-10 feet) Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| NS2-E9 | 1/12/2009 | 0 | 3 | DMT-NS2-SWC-E9-01 | REG |
| NS2-C10 | 1/13/2009 | 3 | 3 | DMT-NS2-CF-C10-01 | REG |
| NS2-E10 | 1/13/2009 | 0 | 2 | DMT-NS2-SWC-E10-01 | REG |
| NS2-C11 | 1/14/2009 | 2 | 2 | DMT-NS2-CF-C11-01 | REG |
| NS2-E11 | 1/14/2009 | 0 | 1.5 | DMT-NS2-SWC-E11-01 | REG |
| NS2-E11 | 1/14/2009 | 0 | 1.5 | DMT-NS2-SWC-E11-01-D | FD |
| NS2-N1 | 1/14/2009 | 0 | 1.5 | DMT-NS2-SWC-N1-01 | REG |
| NS2-C12 | 1/20/2009 | 4 | 4 | DMT-NS2-CF-C12-01 | REG |
| NS2-C13 | 1/20/2009 | 2.5 | 2.5 | DMT-NS2-CF-C13-01 | REG |
| Area 1501/1602 JMDMT-1 | 5/19/2009 | 0 | 0.5 | JMDMT-1 | REG |
| Area 1501/1602 JMDMT-2 | 5/19/2009 | 0 | 0.5 | JMDMT-2 | REG |
| Area 1501/1602 JMDMT-3 | 5/19/2009 | 0 | 0.5 | JMDMT-3 | REG |
| Area 1501/1602 JMDMT-4 | 5/19/2009 | 0 | 0.5 | JMDMT-4 | REG |
| Area 1501/1602 JMDMT-5 | 5/19/2009 | 0 | 0.5 | JMDMT-5 | REG |
| Area 1501/1602 JMDMT-6 | 5/19/2009 | 0 | 0.5 | JMDMT-6 | REG |
| Area 1501/1602 JMDMT-6 | 5/19/2009 | 0 | 0.5 | JMDMT-6-D | FD |
| SB-12+95 | 6/9/2009 | 4 | 5 | NS-SOI-12+95-01 | REG |
| SB-13+30 | 6/9/2009 | 4 | 5 | NS-SOI-13+30-01 | REG |
| SB-13+70 | 6/9/2009 | 4 | 5 | NS-SOI-13+70-01 | REG |
| SB-213 | 6/17/2009 | 0 | 1 | SB-213-SOI-000010 | REG |
| SB-213 | 6/17/2009 | 1 | 4 | SB-213-SOI-010040 | REG |
| SB-214 | 6/17/2009 | 0 | 3 | SB-214-SOI-000030 | REG |
| SB-214 | 6/17/2009 | 5 | 8 | SB-214-SOI-050080 | REG |
| Station 27 SB-207 | 6/17/2009 | 2.5 | 4 | SB-207-SOI-025040 | REG |
| Station 27 SB-208 | 6/17/2009 | 1 | 3 | SB-208-SOI-010030 | REG |
| Station 27 SB-209 | 6/17/2009 | 2 | 4 | SB-209-SOI-020040 | REG |
| Station 27 SB-210 | 6/17/2009 | 1 | 3 | SB-210-SOI-010030 | REG |
| Station 27 SB-211 | 6/17/2009 | 2 | 4 | SB-211-SOI-020040 | REG |
| Station 27 SB-233 | 6/18/2009 | 3.5 | 4 | SB-233-SOI-035040 | REG |
| Station 27 SB-234 | 6/18/2009 | 3.5 | 4 | SB-234-SOI-035040 | REG |
| INC-11 | 10/22/2006 | 8 | 10 | INC-11-SOI-0810 | REG |
| INC-13 | 10/22/2006 | 7 | 9 | INC-13-SOI-0709 | REG |
| INC-16 | 10/22/2006 | 8.2 | 8.4 | INC-16-SOI-0808 | REG |
| INC-21 | 10/22/2006 | 5.7 | 6.1 | INC-21-SOI-0506 | REG |
| INC-22 | 10/22/2006 | 1.5 | 2.5 | INC-22-SOI-0102 | REG |
| INC-17 | 10/25/2006 | 4 | 6 | INC-17-SOI-0406 | REG |
| INC-18 | 10/25/2006 | 5 | 8 | INC-18-SOI-0508 | REG |
| INC-18 | 10/25/2006 | 8 | 10 | INC-18-SOI-0810 | REG |
| INC-18 | 10/25/2006 | 8 | 10 | INC-18-SOI-0810-D | FD |
| INC-23 | 11/3/2006 | 6 | 8 | INC-23-SOI-0608 | REG |
| INC-14 | 11/7/2006 | 6 | 8 | INC-14-SOI-0608 | REG |
| INC-20 | 11/7/2006 | 5 | 6 | INC-20-SOI-0506 | REG |
| INC-5 | 11/7/2006 | 5 | 7 | INC-5-SOI-0507 | REG |
| INC-5 | 11/7/2006 | 8 | 10 | INC-5-SOI-0810 | REG |
| INC-4 | 12/4/2006 | 8.5 | 9 | INC-4-SOI-0809 | REG |
| INC-18 | 12/15/2006 | 8.7 | 8.8 | INC-18-SOI-0808 | REG |
| INC-18 | 12/15/2006 | 9.8 | 9.9 | INC-18-SOI-0909 | REG |
| INC-8 | 12/16/2006 | 7 | 8 | INC-8-SOI-0708 | REG |
| INC-9 | 1/8/2007 | 5 | 5.4 | INC-9-SOI-0505-3 | REG |
| INC-9 | 1/8/2007 | 5.4 | 5.4 | INC-9-SOI-0505-2 | REG |
| INC-9 | 1/8/2007 | 5.5 | 5.9 | INC-9-SOI-0606 | REG |
| INC-I-1 | 8/6/2007 | 9 | 10 | INC-I-1-SOI-090100-A | REG |

**TABLE 1.3**

Total Soil (0-10 feet) Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| C1 | 12/11/2008 | 2.5 | 2.5 | DMT-NS-CF-C1-01 | REG |
| E1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-E1-01 | REG |
| N1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-N1-01 | REG |
| N1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-N1-01D | FD |
| S1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-S1-01 | REG |
| W1 | 12/11/2008 | 0 | 2.5 | DMT-NS-SWC-W1-01 | REG |
| SB-167 | 12/17/2008 | 0 | 2 | SB-167-SOI-000020 | REG |
| SB-167 | 12/17/2008 | 2 | 4 | SB-167-SOI-020040 | REG |
| SB-172 | 12/17/2008 | 0 | 2 | SB-172-SOI-000020 | REG |
| SB-172 | 12/17/2008 | 2 | 4 | SB-172-SOI-020040 | REG |
| SB-174 | 12/17/2008 | 0 | 2 | SB-174-SOI-000020 | REG |
| SB-174 | 12/17/2008 | 0 | 2 | SB-174-SOI-000020-D | FD |
| SB-174 | 12/17/2008 | 2 | 4 | SB-174-SOI-020040 | REG |
| SB-177 | 12/18/2008 | 0 | 2 | SB-177-SOI-000020 | REG |
| SB-177 | 12/18/2008 | 2 | 4 | SB-177-SOI-020040 | REG |
| SB-178 | 12/18/2008 | 0 | 2 | SB-178-SOI-000020 | REG |
| SB-178 | 12/18/2008 | 2 | 4 | SB-178-SOI-020040 | REG |

Note:
Sample depth is presented in feet.
Reg - Normal sample
FD - Field Duplicate

**TABLE 1.4**

Air Monitoring Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air2 | 9/5/2007 | Air2-090507T | REG | |
| Air2C | 9/5/2007 | AirC-090507T | FD | |
| Air3 | 9/5/2007 | Air3-090507T | REG | |
| Air4 | 9/5/2007 | Air4-090507T | REG | |
| Air5 | 9/5/2007 | Air5-090507T | REG | X |
| Air6 | 9/5/2007 | Air6-090507T | REG | X |
| Air7 | 9/5/2007 | Air7-090507T | REG | |
| Air8 | 9/5/2007 | Air8-090507T | REG | X |
| Air9 | 9/5/2007 | Air9-090507T | REG | |
| Air1 | 9/13/2007 | Air1-091307T | REG | |
| Air2 | 9/13/2007 | Air2-091307T | REG | |
| Air2C | 9/13/2007 | AirC-091307T | FD | |
| Air3 | 9/13/2007 | Air3-091307T | REG | |
| Air4 | 9/13/2007 | Air4-091307T | REG | |
| Air5 | 9/13/2007 | Air5-091307T | REG | X |
| Air6 | 9/13/2007 | Air6-091307T | REG | X |
| Air7 | 9/13/2007 | Air7-091307T | REG | |
| Air8 | 9/13/2007 | Air8-091307T | REG | X |
| Air9 | 9/13/2007 | Air9-091307T | REG | |
| Air1 | 9/21/2007 | Air1-092107T | REG | X |
| Air2 | 9/21/2007 | Air2-092107T | REG | |
| Air3 | 9/21/2007 | Air3-092107T | REG | |
| Air4 | 9/21/2007 | Air4-092107T | REG | |
| Air5 | 9/21/2007 | Air5-092107T | REG | |
| Air6 | 9/21/2007 | Air6-092107T | REG | |
| Air7 | 9/21/2007 | Air7-092107T | REG | |
| Air8 | 9/21/2007 | Air8-092107T | REG | X |
| Air8C | 9/21/2007 | AirC-092107T | FD | X |
| Air9 | 9/21/2007 | Air9-092107T | REG | X |
| Air1 | 9/25/2007 | Air1-092507T | REG | X |
| Air2 | 9/25/2007 | Air2-092507T | REG | |
| Air3 | 9/25/2007 | Air3-092507T | REG | |
| Air4 | 9/25/2007 | Air4-092507T | REG | |
| Air5 | 9/25/2007 | Air5-092507T | REG | |
| Air6 | 9/25/2007 | Air6-092507T | REG | X |
| Air6C | 9/25/2007 | AirC-092507T | FD | X |
| Air7 | 9/25/2007 | Air7-092507T | REG | |
| Air8 | 9/25/2007 | Air8-092507T | REG | X |
| Air9 | 9/25/2007 | Air9-092507T | REG | X |
| Air1 | 10/3/2007 | Air1-100307T | REG | X |
| Air2 | 10/3/2007 | Air2-100307T | REG | X |
| Air3 | 10/3/2007 | Air3-100307T | REG | |
| Air4 | 10/3/2007 | Air4-100307T | REG | |
| Air5 | 10/3/2007 | Air5-100307T | REG | |
| Air5C | 10/3/2007 | AirC-100307T | FD | |
| Air6 | 10/3/2007 | Air6-100307T | REG | |
| Air7 | 10/3/2007 | Air7-100307T | REG | |
| Air8 | 10/3/2007 | Air8-100307T | REG | X |
| Air9 | 10/3/2007 | Air9-100307T | REG | X |
| Air1 | 10/11/2007 | Air1-101107T | REG | |
| Air2 | 10/11/2007 | Air2-101107T | REG | |
| Air3 | 10/11/2007 | Air3-101107T | REG | |

**TABLE 1.4**
Air Monitoring Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air4 | 10/11/2007 | Air4-101107T | REG | |
| Air5 | 10/11/2007 | Air5-101107T | REG | X |
| Air6 | 10/11/2007 | Air6-101107T | REG | X |
| Air7 | 10/11/2007 | Air7-101107T | REG | |
| Air8 | 10/11/2007 | Air8-101107T | REG | |
| Air1 | 10/19/2007 | Air1-101907T | REG | |
| Air5 | 10/19/2007 | Air5-101907T | REG | X |
| Air1 | 10/23/2007 | Air1-102307T | REG | X |
| Air2 | 10/23/2007 | Air2-102307T | REG | |
| Air2C | 10/23/2007 | AirC-102307T | FD | |
| Air3 | 10/23/2007 | Air3-102307T | REG | |
| Air4 | 10/23/2007 | Air4-102307T | REG | |
| Air5 | 10/23/2007 | Air5-102307T | REG | |
| Air6 | 10/23/2007 | Air6-102307T | REG | X |
| Air7 | 10/23/2007 | Air7-102307T | REG | |
| Air8 | 10/23/2007 | Air8-102307T | REG | X |
| Air1 | 10/31/2007 | Air1-103107T | REG | X |
| Air2 | 10/31/2007 | Air2-103107T | REG | |
| Air3 | 10/31/2007 | Air3-103107T | REG | |
| Air4 | 10/31/2007 | Air4-103107T | REG | |
| Air5 | 10/31/2007 | Air5-103107T | REG | |
| Air6 | 10/31/2007 | Air6-103107T | REG | X |
| Air7 | 10/31/2007 | Air7-103107T | REG | |
| Air8 | 10/31/2007 | Air8-103107T | REG | X |
| Air8C | 10/31/2007 | AirC-103107T | FD | X |
| Air9 | 10/31/2007 | Air9-103107T | REG | X |
| Air1 | 11/8/2007 | Air1-110807T | REG | |
| Air2 | 11/8/2007 | Air2-110807T | REG | |
| Air3 | 11/8/2007 | Air3-110807T | REG | |
| Air4 | 11/8/2007 | Air4-110807T | REG | |
| Air5 | 11/8/2007 | Air5-110807T | REG | X |
| Air6 | 11/8/2007 | Air6-110807T | REG | X |
| Air6C | 11/8/2007 | AirC-110807T | FD | X |
| Air7 | 11/8/2007 | Air7-110807T | REG | |
| Air8 | 11/8/2007 | Air8-110807T | REG | |
| Air9 | 11/8/2007 | Air9-110807T | REG | |
| Air1 | 11/20/2007 | Air1-112007T | REG | X |
| Air2 | 11/20/2007 | Air2-112007T | REG | X |
| Air3 | 11/20/2007 | Air3-112007T | REG | X |
| Air4 | 11/20/2007 | Air4-112007T | REG | X |
| Air5 | 11/20/2007 | Air5-112007T | REG | |
| Air6 | 11/20/2007 | Air6-112007T | REG | |
| Air7 | 11/20/2007 | Air7-112007T | REG | |
| Air8 | 11/20/2007 | Air8-112007T | REG | |
| Air8C | 11/20/2007 | AirC-112007T | FD | |
| Air9 | 11/20/2007 | Air9-112007T | REG | |
| Air1 | 11/28/2007 | Air1-112807T | REG | |
| Air2 | 11/28/2007 | Air2-112807T | REG | |
| Air3 | 11/28/2007 | Air3-112807T | REG | |
| Air4 | 11/28/2007 | Air4-112807T | REG | |
| Air5 | 11/28/2007 | Air5-112807T | REG | X |
| Air6 | 11/28/2007 | Air6-112807T | REG | |

**TABLE 1.4**
Air Monitoring Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air7 | 11/28/2007 | Air7-112807T | REG | |
| Air7C | 11/28/2007 | AirC-112807T | FD | |
| Air8 | 11/28/2007 | Air8-112807T | REG | |
| Air9 | 11/28/2007 | Air9-112807T | REG | |
| Air1 | 12/7/2007 | Air1-120707T | REG | |
| Air2 | 12/7/2007 | Air2-120707T | REG | |
| Air3 | 12/7/2007 | Air3-120707T | REG | X |
| Air4 | 12/7/2007 | Air4-120707T | REG | |
| Air5 | 12/7/2007 | Air5-120707T | REG | X |
| Air5C | 12/7/2007 | AirC-120707T | FD | X |
| Air6 | 12/7/2007 | Air6-120707T | REG | |
| Air7 | 12/7/2007 | Air7-120707T | REG | |
| Air8 | 12/7/2007 | Air8-120707T | REG | |
| Air1 | 12/19/2007 | Air1-121907T | REG | |
| Air2 | 12/19/2007 | Air2-121907T | REG | |
| Air3 | 12/19/2007 | Air3-121907T | REG | |
| Air4 | 12/19/2007 | Air4-121907T | REG | |
| Air4C | 12/19/2007 | AirC-121907T | FD | |
| Air5 | 12/19/2007 | Air5-121907T | REG | X |
| Air6 | 12/19/2007 | Air6-121907T | REG | |
| Air7 | 12/19/2007 | Air7-121907T | REG | |
| Air8 | 12/19/2007 | Air8-121907T | REG | |
| Air1 | 12/28/2007 | Air1-122807T | REG | X |
| Air2 | 12/28/2007 | Air2-122807T | REG | |
| Air3 | 12/28/2007 | Air3-122807T | REG | |
| Air3C | 12/28/2007 | AirC-122807T | FD | |
| Air4 | 12/28/2007 | Air4-122807T | REG | |
| Air5 | 12/28/2007 | Air5-122807T | REG | |
| Air6 | 12/28/2007 | Air6-122807T | REG | |
| Air7 | 12/28/2007 | Air7-122807T | REG | |
| Air8 | 12/28/2007 | Air8-122807T | REG | X |
| Air9 | 12/28/2007 | Air9-122807T | REG | |
| Air1 | 1/3/2008 | Air1-010308T | REG | |
| Air2 | 1/3/2008 | Air2-010308T | REG | |
| Air2C | 1/3/2008 | AirC-010308T | FD | |
| Air3 | 1/3/2008 | Air3-010308T | REG | |
| Air4 | 1/3/2008 | Air4-010308T | REG | |
| Air5 | 1/3/2008 | Air5-010308T | REG | X |
| Air6 | 1/3/2008 | Air6-010308T | REG | |
| Air7 | 1/3/2008 | Air7-010308T | REG | |
| Air8 | 1/3/2008 | Air8-010308T | REG | |
| Air9 | 1/3/2008 | Air9-010308T | REG | |
| Air1 | 1/8/2008 | Air1-010808T | REG | X |
| Air2 | 1/8/2008 | Air2-010808T | REG | X |
| Air3 | 1/8/2008 | Air3-010808T | REG | X |
| Air4 | 1/8/2008 | Air4-010808T | REG | X |
| Air5 | 1/8/2008 | Air5-010808T | REG | |
| Air6 | 1/8/2008 | Air6-010808T | REG | |
| Air7 | 1/8/2008 | Air7-010808T | REG | |
| Air8 | 1/8/2008 | Air8-010808T | REG | X |
| Air8C | 1/8/2008 | AirC-010808T | FD | X |
| Air9 | 1/8/2008 | Air9-010808T | REG | |

**TABLE 1.4**
Air Monitoring Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air1 | 1/16/2008 | Air1-011608T | REG | |
| Air2 | 1/16/2008 | Air2-011608T | REG | |
| Air3 | 1/16/2008 | Air3-011608T | REG | |
| Air4 | 1/16/2008 | Air4-011608T | REG | |
| Air5 | 1/16/2008 | Air5-011608T | REG | |
| Air7 | 1/16/2008 | Air7-011608T | REG | |
| Air8 | 1/16/2008 | Air8-011608T | REG | |
| Air8C | 1/16/2008 | AirC-011608T | FD | |
| Air9 | 1/16/2008 | Air9-011608T | REG | |
| Air1 | 1/24/2008 | Air1-012408T | REG | |
| Air2 | 1/24/2008 | Air2-012408T | REG | |
| Air3 | 1/24/2008 | Air3-012408T | REG | |
| Air4 | 1/24/2008 | Air4-012408T | REG | |
| Air5 | 1/24/2008 | Air5-012408T | REG | X |
| Air6 | 1/24/2008 | Air6-012408T | REG | X |
| Air6C | 1/24/2008 | AirC-012408T | FD | X |
| Air7 | 1/24/2008 | Air7-012408T | REG | |
| Air8 | 1/24/2008 | Air8-012408T | REG | |
| Air9 | 1/24/2008 | Air9-012408T | REG | |
| Air1 | 1/31/2008 | Air1-013108T | REG | |
| Air2 | 1/31/2008 | Air2-013108T | REG | |
| Air3 | 1/31/2008 | Air3-013108T | REG | |
| Air4 | 1/31/2008 | Air4-013108T | REG | |
| Air5 | 1/31/2008 | Air5-013108T | REG | |
| Air6 | 1/31/2008 | Air6-013108T | REG | |
| Air7 | 1/31/2008 | Air7-013108T | REG | |
| Air7C | 1/31/2008 | AirC-013108T | FD | |
| Air8 | 1/31/2008 | Air8-013108T | REG | |
| Air9 | 1/31/2008 | Air9-013108T | REG | |
| Air1 | 2/8/2008 | Air1-020808T | REG | |
| Air2 | 2/8/2008 | Air2-020808T | REG | |
| Air3 | 2/8/2008 | Air3-020808T | REG | |
| Air4 | 2/8/2008 | Air4-020808T | REG | |
| Air5 | 2/8/2008 | Air5-020808T | REG | X |
| Air5C | 2/8/2008 | AirC-020808T | FD | X |
| Air6 | 2/8/2008 | Air6-020808T | REG | X |
| Air7 | 2/8/2008 | Air7-020808T | REG | |
| Air8 | 2/8/2008 | Air8-020808T | REG | X |
| Air9 | 2/8/2008 | Air9-020808T | REG | |
| Air1 | 2/12/2008 | Air1-021208T | REG | |
| Air2 | 2/12/2008 | Air2-021208T | REG | |
| Air3 | 2/12/2008 | Air3-021208T | REG | |
| Air4 | 2/12/2008 | Air4-021208T | REG | |
| Air4C | 2/12/2008 | AirC-021208T | FD | |
| Air5 | 2/12/2008 | Air5-021208T | REG | X |
| Air6 | 2/12/2008 | Air6-021208T | REG | X |
| Air7 | 2/12/2008 | Air7-021208T | REG | |
| Air8 | 2/12/2008 | Air8-021208T | REG | X |
| Air9 | 2/12/2008 | Air9-021208T | REG | |
| Air1 | 2/20/2008 | Air1-022008T | REG | X |
| Air2 | 2/20/2008 | Air2-022008T | REG | |
| Air3 | 2/20/2008 | Air3-022008T | REG | |

**TABLE 1.4**
Air Monitoring Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air3C | 2/20/2008 | AirC-022008T | FD | |
| Air4 | 2/20/2008 | Air4-022008T | REG | |
| Air5 | 2/20/2008 | Air5-022008T | REG | X |
| Air6 | 2/20/2008 | Air6-022008T | REG | X |
| Air7 | 2/20/2008 | Air7-022008T | REG | |
| Air8 | 2/20/2008 | Air8-022008T | REG | X |
| Air9 | 2/20/2008 | Air9-022008T | REG | X |
| Air1 | 2/28/2008 | Air1-022808T | REG | |
| Air2 | 2/28/2008 | Air2-022808T | REG | |
| Air2C | 2/28/2008 | AirC-022808T | FD | |
| Air3 | 2/28/2008 | Air3-022808T | REG | |
| Air4 | 2/28/2008 | Air4-022808T | REG | |
| Air5 | 2/28/2008 | Air5-022808T | REG | X |
| Air6 | 2/28/2008 | Air6-022808T | REG | X |
| Air7 | 2/28/2008 | Air7-022808T | REG | |
| Air8 | 2/28/2008 | Air8-022808T | REG | X |
| Air1 | 3/7/2008 | Air1-030708T | REG | |
| Air2 | 3/7/2008 | Air2-030708T | REG | X |
| Air3 | 3/7/2008 | Air3-030708T | REG | X |
| Air4 | 3/7/2008 | Air4-030708T | REG | X |
| Air5 | 3/7/2008 | Air5-030708T | REG | |
| Air6 | 3/7/2008 | Air6-030708T | REG | |
| Air6C | 3/7/2008 | AirC-030708T | FD | |
| Air7 | 3/7/2008 | Air7-030708T | REG | |
| Air1 | 3/11/2008 | Air1-031108T | REG | |
| Air3 | 3/11/2008 | Air3-031108T | REG | |
| Air4 | 3/11/2008 | Air4-031108T | REG | |
| Air5 | 3/11/2008 | Air5-031108T | REG | |
| Air6 | 3/11/2008 | Air6-031108T | REG | |
| Air6C | 3/11/2008 | AirC-031108T | FD | |
| Air7 | 3/11/2008 | Air7-031108T | REG | |
| Air9 | 3/11/2008 | Air9-031108T | REG | |
| Air1 | 3/21/2008 | Air1-032108T | REG | |
| Air2 | 3/21/2008 | Air2-032108T | REG | |
| Air3 | 3/21/2008 | Air3-032108T | REG | |
| Air4 | 3/21/2008 | Air4-032108T | REG | |
| Air5 | 3/21/2008 | Air5-032108T | REG | X |
| Air6 | 3/21/2008 | Air6-032108T | REG | X |
| Air7 | 3/21/2008 | Air7-032108T | REG | |
| Air7C | 3/21/2008 | AirC-032108T | FD | |
| Air8 | 3/21/2008 | Air8-032108T | REG | |
| Air9 | 3/21/2008 | Air9-032108T | REG | |
| Air1 | 3/25/2008 | Air1-032508T | REG | |
| Air2 | 3/25/2008 | Air2-032508T | REG | |
| Air3 | 3/25/2008 | Air3-032508T | REG | |
| Air4 | 3/25/2008 | Air4-032508T | REG | |
| Air5 | 3/25/2008 | Air5-032508T | REG | |
| Air5C | 3/25/2008 | AirC-032508T | FD | |
| Air6 | 3/25/2008 | Air6-032508T | REG | |
| Air7 | 3/25/2008 | Air7-032508T | REG | |
| Air8 | 3/25/2008 | Air8-032508T | REG | |
| Air9 | 3/25/2008 | Air9-032508T | REG | |

**TABLE 1.4**
Air Monitoring Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air1 | 4/3/2008 | Air1-040308T | REG | |
| Air2 | 4/3/2008 | Air2-040308T | REG | |
| Air3 | 4/3/2008 | Air3-040308T | REG | |
| Air4 | 4/3/2008 | Air4-040308T | REG | |
| Air4C | 4/3/2008 | AirC-040308T | FD | |
| Air5 | 4/3/2008 | Air5-040308T | REG | X |
| Air6 | 4/3/2008 | Air6-040308T | REG | |
| Air7 | 4/3/2008 | Air7-040308T | REG | |
| Air8 | 4/3/2008 | Air8-040308T | REG | |
| Air9 | 4/3/2008 | Air9-040308T | REG | |
| Air1 | 4/11/2008 | Air1-041108T | REG | X |
| Air2 | 4/11/2008 | Air2-041108T | REG | |
| Air3 | 4/11/2008 | Air3-041108T | REG | |
| Air3C | 4/11/2008 | AirC-041108T | FD | |
| Air4 | 4/11/2008 | Air4-041108T | REG | |
| Air5 | 4/11/2008 | Air5-041108T | REG | |
| Air6 | 4/11/2008 | Air6-041108T | REG | |
| Air7 | 4/11/2008 | Air7-041108T | REG | |
| Air8 | 4/11/2008 | Air8-041108T | REG | X |
| Air1 | 4/15/2008 | Air1-041508T | REG | |
| Air2 | 4/15/2008 | Air2-041508T | REG | |
| Air2C | 4/15/2008 | AirC-041508T | FD | |
| Air3 | 4/15/2008 | Air3-041508T | REG | |
| Air4 | 4/15/2008 | Air4-041508T | REG | X |
| Air5 | 4/15/2008 | Air5-041508T | REG | X |
| Air6 | 4/15/2008 | Air6-041508T | REG | |
| Air7 | 4/15/2008 | Air7-041508T | REG | |
| Air8 | 4/15/2008 | Air8-041508T | REG | |
| Air1 | 4/23/2008 | Air1-042308T | REG | X |
| Air2 | 4/23/2008 | Air2-042308T | REG | X |
| Air3 | 4/23/2008 | Air3-042308T | REG | X |
| Air4 | 4/23/2008 | Air4-042308T | REG | X |
| Air5 | 4/23/2008 | Air5-042308T | REG | |
| Air6 | 4/23/2008 | Air6-042308T | REG | |
| Air7 | 4/23/2008 | Air7-042308T | REG | |
| Air8 | 4/23/2008 | Air8-042308T | REG | |
| Air8C | 4/23/2008 | AirC-042308T | FD | |
| Air9 | 4/23/2008 | Air9-042308T | REG | |
| Air1 | 5/1/2008 | Air1-050108T | REG | |
| Air2 | 5/1/2008 | Air2-050108T | REG | |
| Air3 | 5/1/2008 | Air3-050108T | REG | |
| Air4 | 5/1/2008 | Air4-050108T | REG | |
| Air5 | 5/1/2008 | Air5-050108T | REG | |
| Air6 | 5/1/2008 | Air6-050108T | REG | X |
| Air6C | 5/1/2008 | AirC-050108T | FD | X |
| Air7 | 5/1/2008 | Air7-050108T | REG | |
| Air8 | 5/1/2008 | Air8-050108T | REG | X |
| Air9 | 5/1/2008 | Air9-050108T | REG | |
| Air1 | 5/14/2008 | Air1-051408T | REG | |
| Air2 | 5/14/2008 | Air2-051408T | REG | X |
| Air3 | 5/14/2008 | Air3-051408T | REG | X |
| Air4 | 5/14/2008 | Air4-051408T | REG | X |

**TABLE 1.4**
Air Monitoring Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air5 | 5/14/2008 | Air5-051408T | REG | X |
| Air6 | 5/14/2008 | Air6-051408T | REG | |
| Air7 | 5/14/2008 | Air7-051408T | REG | |
| Air8 | 5/14/2008 | Air8-051408T | REG | |
| Air8C | 5/14/2008 | AirC-051408T | FD | |
| Air9 | 5/14/2008 | Air9-051408T | REG | |
| Air1 | 5/22/2008 | Air1-052208T | REG | |
| Air2 | 5/22/2008 | Air2-052208T | REG | |
| Air3 | 5/22/2008 | Air3-052208T | REG | |
| Air4 | 5/22/2008 | Air4-052208T | REG | |
| Air5 | 5/22/2008 | Air5-052208T | REG | |
| Air6 | 5/22/2008 | Air6-052208T | REG | X |
| Air7 | 5/22/2008 | Air7-052208T | REG | |
| Air7C | 5/22/2008 | AirC-052208T | FD | |
| Air8 | 5/22/2008 | Air8-052208T | REG | X |
| Air9 | 5/22/2008 | Air9-052208T | REG | |
| Air1 | 5/30/2008 | Air1-053008T | REG | X |
| Air2 | 5/30/2008 | Air2-053008T | REG | |
| Air3 | 5/30/2008 | Air3-053008T | REG | |
| Air4 | 5/30/2008 | Air4-053008T | REG | |
| Air5 | 5/30/2008 | Air5-053008T | REG | |
| Air5C | 5/30/2008 | AirC-053008T | FD | |
| Air6 | 5/30/2008 | Air6-053008T | REG | |
| Air7 | 5/30/2008 | Air7-053008T | REG | |
| Air8 | 5/30/2008 | Air8-053008T | REG | X |
| Air9 | 5/30/2008 | Air9-053008T | REG | X |
| Air1 | 6/26/2008 | Air1-062608T | REG | X |
| Air2 | 6/26/2008 | Air2-062608T | REG | |
| Air3 | 6/26/2008 | Air3-062608T | REG | |
| Air4 | 6/26/2008 | Air4-062608T | REG | |
| Air4C | 6/26/2008 | AirC-062608T | FD | |
| Air5 | 6/26/2008 | Air5-062608T | REG | X |
| Air6 | 6/26/2008 | Air6-062608T | REG | X |
| Air7 | 6/26/2008 | Air7-062608T | REG | |
| Air8 | 6/26/2008 | Air8-062608T | REG | X |
| Air9 | 6/26/2008 | Air9-062608T | REG | X |
| Air1 | 7/22/2008 | Air1-072208T | REG | |
| Air2 | 7/22/2008 | Air2-072208T | REG | |
| Air3 | 7/22/2008 | Air3-072208T | REG | |
| Air3C | 7/22/2008 | AirC-072208T | FD | |
| Air4 | 7/22/2008 | Air4-072208T | REG | |
| Air5 | 7/22/2008 | Air5-072208T | REG | |
| Air6 | 7/22/2008 | Air6-072208T | REG | X |
| Air7 | 7/22/2008 | Air7-072208T | REG | |
| Air8 | 7/22/2008 | Air8-072208T | REG | X |
| Air9 | 7/22/2008 | Air9-072208T | REG | |
| Air1 | 8/13/2008 | Air1-081308T | REG | |
| Air2 | 8/13/2008 | Air2-081308T | REG | |
| Air2C | 8/13/2008 | AirC-081308T | FD | |
| Air3 | 8/13/2008 | Air3-081308T | REG | |
| Air4 | 8/13/2008 | Air4-081308T | REG | |
| Air5 | 8/13/2008 | Air5-081308T | REG | X |

**TABLE 1.4**
Air Monitoring Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air7 | 8/13/2008 | Air7-081308T | REG | |
| Air8 | 8/13/2008 | Air8-081308T | REG | |
| Air9 | 8/13/2008 | Air9-081308T | REG | |
| Air2 | 1/30/2009 | Air2-013009T | REG | |
| Air2C | 1/30/2009 | AirC-013009T | FD | |
| Air3 | 1/30/2009 | Air3-013009T | REG | |
| Air4 | 1/30/2009 | Air4-013009T | REG | |
| Air5 | 1/30/2009 | Air5-013009T | REG | X |
| Air6 | 1/30/2009 | Air6-013009T | REG | X |
| Air7 | 1/30/2009 | Air7-013009T | REG | |
| Air8 | 1/30/2009 | Air8-013009T | REG | X |
| Air9 | 1/30/2009 | Air9-013009T | REG | |
| Air1 | 2/17/2009 | Air1-021709T | REG | |
| Air2 | 2/17/2009 | Air2-021709T | REG | |
| Air3 | 2/17/2009 | Air3-021709T | REG | |
| Air5 | 2/17/2009 | Air5-021709T | REG | X |
| Air6 | 2/17/2009 | Air6-021709T | REG | X |
| Air7 | 2/17/2009 | Air7-021709T | REG | |
| Air8 | 2/17/2009 | Air8-021709T | REG | |
| Air8C | 2/17/2009 | AirC-021709T | FD | |
| Air1 | 3/18/2009 | Air1-031809T | REG | |
| Air2 | 3/18/2009 | Air2-031809T | REG | |
| Air3 | 3/18/2009 | Air3-031809T | REG | |
| Air4 | 3/18/2009 | Air4-031809T | REG | |
| Air5 | 3/18/2009 | Air5-031809T | REG | |
| Air6 | 3/18/2009 | Air6-031809T | REG | |
| Air6C | 3/18/2009 | AirC-031809T | FD | |
| Air7 | 3/18/2009 | Air7-031809T | REG | |
| Air8 | 3/18/2009 | Air8-031809T | REG | |
| Air1 | 4/17/2009 | Air1-041709T | REG | |
| Air2 | 4/17/2009 | Air2-041709T | REG | |
| Air3 | 4/17/2009 | Air3-041709T | REG | |
| Air4 | 4/17/2009 | Air4-041709T | REG | |
| Air5 | 4/17/2009 | Air5-041709T | REG | X |
| Air6 | 4/17/2009 | Air6-041709T | REG | X |
| Air7 | 4/17/2009 | Air7-041709T | REG | |
| Air7C | 4/17/2009 | AirC-041709T | FD | |
| Air8 | 4/17/2009 | Air8-041709T | REG | X |
| Air1 | 5/19/2009 | Air1-051909T | REG | X |
| Air2 | 5/19/2009 | Air2-051909T | REG | X |
| Air3 | 5/19/2009 | Air3-051909T | REG | X |
| Air4 | 5/19/2009 | Air4-051909T | REG | X |
| Air5C | 5/19/2009 | AirC-051909T | FD | X |
| Air6 | 5/19/2009 | Air6-051909T | REG | |
| Air7 | 5/19/2009 | Air7-051909T | REG | |
| Air8 | 5/19/2009 | Air8-051909T | REG | |
| Air9 | 5/19/2009 | Air9-051909T | REG | |
| Air2 | 6/26/2009 | Air2-062609T | REG | |
| Air3 | 6/26/2009 | Air3-062609T | REG | |
| Air4 | 6/26/2009 | Air4-062609T | REG | |
| Air5 | 6/26/2009 | Air5-062609T | REG | X |
| Air6 | 6/26/2009 | Air6-062609T | REG | X |

**TABLE 1.4**
Air Monitoring Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose | Used for Background |
|---|---|---|---|---|
| Air7 | 6/26/2009 | Air7-062609T | REG | |
| Air8 | 6/26/2009 | Air8-062609T | REG | X |
| Air1 | 7/16/2009 | Air1-071609T | REG | |
| Air2 | 7/16/2009 | Air2-071609T | REG | |
| Air3 | 7/16/2009 | Air3-071609T | REG | |
| Air3C | 7/16/2009 | AirC-071609T | FD | |
| Air4 | 7/16/2009 | Air4-071609T | REG | |
| Air5 | 7/16/2009 | Air5-071609T | REG | |
| Air6 | 7/16/2009 | Air6-071609T | REG | |
| Air7 | 7/16/2009 | Air7-071609T | REG | |
| Air8 | 7/16/2009 | Air8-071609T | REG | |

Note:
Reg - Normal sample
FD - Field Duplicate

**TABLE 1.5**

Non-Priority Drain Stormwater Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose |
|---|---|---|---|
| 10TH STREET OUTFALL | 7/1/2005 | 10ST_3Q05_DRY_070105-C | REG |
| 10.5TH STREET OUTFALL | 9/1/2005 | 10.5ST_3Q05_DRY_090105-C | REG |
| 11.5TH STREET OUTFALL | 9/1/2005 | 11.5ST_3Q05_DRY_090105-C | REG |
| 11TH STREET OUTFALL | 9/1/2005 | 11ST_3Q05_DRY_090105-C | REG |
| 10.5TH STREET OUTFALL | 9/15/2005 | 10.5ST_3Q05_WET_091505-C | REG |
| 9.5TH STREET OUTFALL | 9/15/2005 | 9.5ST_3Q05_Wet_091505-C | REG |
| 9TH STREET OUTFALL | 9/15/2005 | 9ST_3Q05_Wet_091505-C | REG |
| 11TH STREET OUTFALL | 4/30/2007 | 11.0-MH117-043007 | REG |
| 11TH STREET OUTFALL | 4/30/2007 | 11.0-MH118-043007 | REG |
| 11.5TH STREET OUTFALL | 5/9/2007 | 11.5-IN136-050907 | REG |
| 10.5TH STREET OUTFALL | 5/12/2007 | 10.5-IN116-051207 | REG |
| 10.5TH STREET OUTFALL | 5/12/2007 | 10.5-IN123-051207 | REG |
| 11TH STREET OUTFALL | 10/12/2007 | 11.0-MH115-101207 | REG |
| 11TH STREET OUTFALL | 10/12/2007 | 11.0-MH116-101207 | REG |
| 11TH STREET OUTFALL | 10/12/2007 | 11.0-MH117-101207 | REG |
| 11TH STREET OUTFALL | 10/12/2007 | 11.0-MH118-101207 | REG |
| 10TH STREET OUTFALL | 11/30/2007 | 10.0-MHM1-113007 | REG |
| 10TH STREET OUTFALL | 11/30/2007 | 10.0-MHM2-113007 | REG |
| 10TH STREET OUTFALL | 11/30/2007 | 10.0-MHM5-113007 | REG |
| 10TH STREET OUTFALL | 11/30/2007 | 10.0-MHS1-113007 | REG |
| 9TH STREET OUTFALL | 12/21/2007 | 9.0-MHI2-122107 | REG |
| 9TH STREET OUTFALL | 12/21/2007 | 9.0-MHM1-122107 | REG |
| 9TH STREET OUTFALL | 12/21/2007 | 9.0-MHM2-122107 | REG |
| 9TH STREET OUTFALL | 12/21/2007 | 9.0-MHM3-122107 | REG |
| 9TH STREET OUTFALL | 12/21/2007 | 9.0-MHM4-122107 | REG |
| 9TH STREET OUTFALL | 12/21/2007 | 9.0-MHM6-122107 | REG |
| 9TH STREET OUTFALL | 12/21/2007 | 9.0-MHO53-122107 | REG |

Note:
Reg - Normal sample
FD - Field Duplicate

**TABLE 1.6**

Priority Drain Stormwater Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose |
|---|---|---|---|
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B1 | REG |
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B2 | REG |
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B3 | REG |
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B4 | REG |
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B5 | REG |
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B6 | REG |
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B7 | REG |
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B8 | REG |
| 14TH STREET OUTFALL | 2/26/2004 | 14ST_1Q04_DRY_022604B8D | FD |
| 14TH STREET OUTFALL | 3/5/2004 | 14ST_1Q04_WET_030504-C | REG |
| 14TH STREET OUTFALL | 8/24/2004 | DMT14th08242004-F10 | REG |
| 14TH STREET OUTFALL | 8/24/2004 | DMT14th08242004-F45 | REG |
| 14TH STREET OUTFALL | 1/7/2005 | 14_ST_1Q05_WET_010705-C | REG |
| 15N STREET OUTFALL | 1/7/2005 | 15N_ST_1Q05_WET_010705-C | REG |
| 15S STREET OUTFALL | 1/7/2005 | 15S_ST_1Q05_WET_010705-C | REG |
| 12.5TH STREET OUTFALL | 2/15/2005 | 12_5ST_1Q05_WET_021505-D | FD |
| 13.5TH STREET OUTFALL | 3/9/2005 | 13_5ST_1Q05_Wet_030905-C | REG |
| 14TH STREET OUTFALL | 3/16/2005 | 14_ST_1Q05_DRY_031605B1 | REG |
| 14TH STREET OUTFALL | 3/16/2005 | 14_ST_1Q05_DRY_031605B2 | REG |
| 14TH STREET OUTFALL | 3/16/2005 | 14_ST_1Q05_DRY_031605B3 | REG |
| 14TH STREET OUTFALL | 3/16/2005 | 14_ST_1Q05_DRY_031605B4 | REG |
| 14TH STREET OUTFALL | 3/16/2005 | 14_ST_1Q05_DRY_031605B5 | REG |
| 14TH STREET OUTFALL | 3/16/2005 | 14_ST_1Q05_DRY_031605B6 | REG |
| 14TH STREET OUTFALL | 3/16/2005 | 14_ST_1Q05_DRY_031605B7 | REG |
| 14TH STREET OUTFALL | 3/16/2005 | 14_ST_1Q05_DRY_031605B8 | REG |
| 15S STREET OUTFALL | 3/16/2005 | 15S_ST_1Q05_DRY_031605B1 | REG |
| 15S STREET OUTFALL | 3/16/2005 | 15S_ST_1Q05_DRY_031605B2 | REG |
| 15S STREET OUTFALL | 3/16/2005 | 15S_ST_1Q05_DRY_031605B3 | REG |
| 15S STREET OUTFALL | 3/16/2005 | 15S_ST_1Q05_DRY_031605B4 | REG |
| 15S STREET OUTFALL | 3/16/2005 | 15S_ST_1Q05_DRY_031605B5 | REG |
| 15S STREET OUTFALL | 3/16/2005 | 15S_ST_1Q05_DRY_031605B6 | REG |
| 15S STREET OUTFALL | 3/16/2005 | 15S_ST_1Q05_DRY_031605B7 | REG |
| 15S STREET OUTFALL | 3/16/2005 | 15S_ST_1Q05_DRY_031605B8 | REG |
| 15N STREET OUTFALL | 3/17/2005 | 15N_ST_1Q05_DRY_031705B1 | REG |
| 15N STREET OUTFALL | 3/17/2005 | 15N_ST_1Q05_DRY_031705B2 | REG |
| 15N STREET OUTFALL | 3/17/2005 | 15N_ST_1Q05_DRY_031705B3 | REG |
| 15N STREET OUTFALL | 3/17/2005 | 15N_ST_1Q05_DRY_031705B4 | REG |
| 15N STREET OUTFALL | 3/17/2005 | 15N_ST_1Q05_DRY_031705B5 | REG |
| 15N STREET OUTFALL | 3/17/2005 | 15N_ST_1Q05_DRY_031705B6 | REG |
| 15N STREET OUTFALL | 3/17/2005 | 15N_ST_1Q05_DRY_031705B7 | REG |
| 15N STREET OUTFALL | 3/17/2005 | 15N_ST_1Q05_DRY_031705B8 | REG |
| 12.5TH STREET OUTFALL | 5/9/2005 | 12_5ST_2Q05_DRY_050905_B1 | REG |
| 12.5TH STREET OUTFALL | 5/9/2005 | 12_5ST_2Q05_DRY_050905_B2 | REG |
| 12.5TH STREET OUTFALL | 5/9/2005 | 12_5ST_2Q05_DRY_050905_B3 | REG |
| 12.5TH STREET OUTFALL | 5/9/2005 | 12_5ST_2Q05_DRY_050905_B4 | REG |
| 12.5TH STREET OUTFALL | 5/9/2005 | 12_5ST_2Q05_DRY_050905_B5 | REG |
| 12.5TH STREET OUTFALL | 5/9/2005 | 12_5ST_2Q05_DRY_050905_B6 | REG |
| 12.5TH STREET OUTFALL | 5/9/2005 | 12_5ST_2Q05_DRY_050905_B7 | REG |
| 12.5TH STREET OUTFALL | 5/9/2005 | 12_5ST_2Q05_DRY_050905_B8 | REG |
| 15S STREET OUTFALL | 5/9/2005 | 15S_ST_2Q05_DRY_050905B1 | REG |
| 15S STREET OUTFALL | 5/9/2005 | 15S_ST_2Q05_DRY_050905B2 | REG |
| 15S STREET OUTFALL | 5/9/2005 | 15S_ST_2Q05_DRY_050905B3 | REG |

**TABLE 1.6**

Priority Drain Stormwater Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose |
|---|---|---|---|
| 15S STREET OUTFALL | 5/9/2005 | 15S_ST_2Q05_DRY_050905B4 | REG |
| 15S STREET OUTFALL | 5/9/2005 | 15S_ST_2Q05_DRY_050905B5 | REG |
| 15S STREET OUTFALL | 5/9/2005 | 15S_ST_2Q05_DRY_050905B6 | REG |
| 15S STREET OUTFALL | 5/9/2005 | 15S_ST_2Q05_DRY_050905B7 | REG |
| 15S STREET OUTFALL | 5/9/2005 | 15S_ST_2Q05_DRY_050905B8D | FD |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B1 | REG |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B2 | REG |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B3 | REG |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B4 | REG |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B5 | REG |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B6 | REG |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B7 | REG |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B8 | REG |
| 15N STREET OUTFALL | 5/11/2005 | 15N_ST_2Q05_DRY_051105B8D | FD |
| 12.5TH STREET OUTFALL | 5/25/2005 | 12_5ST_2Q05_WET_052505-C | REG |
| 13.5TH STREET OUTFALL | 5/25/2005 | 13_5ST_2Q05_WET_052505-C | REG |
| 14TH STREET OUTFALL | 5/25/2005 | 14_ST_2Q05_WET_052505-C | REG |
| 15N STREET OUTFALL | 5/25/2005 | 15N_ST_2Q05_WET_052505-C | REG |
| 15S STREET OUTFALL | 5/25/2005 | 15S_ST_2Q05_WET_052505-C | REG |
| 12.5TH STREET OUTFALL | 8/19/2005 | 12_5ST_3Q05_WET_081905-C | REG |
| 12TH STREET OUTFALL | 8/19/2005 | 12ST_3Q05_WET_081905-C | REG |
| 14TH STREET OUTFALL | 9/15/2005 | 14_ST_3Q05_WET_091505-C | REG |
| 15N STREET OUTFALL | 9/15/2005 | 15N_ST_3Q05_WET_091505-C | REG |
| 15S STREET OUTFALL | 9/15/2005 | 15S_ST_3Q05_WET_091505-C | REG |
| 12.5TH STREET OUTFALL | 9/23/2005 | 12_5ST_3Q05_DRY_092305-C | REG |
| 12TH STREET OUTFALL | 9/23/2005 | 12ST_3Q05_DRY_092305-C | REG |
| 14TH STREET OUTFALL | 9/30/2005 | 14_ST_3Q05_DRY_09305-C | REG |
| 14TH STREET OUTFALL | 9/30/2005 | 14_ST_3Q05_DRY_09305-D | FD |
| 15N STREET OUTFALL | 9/30/2005 | 15N_ST_3Q05_DRY_093005-C | REG |
| 15S STREET OUTFALL | 9/30/2005 | 15S_ST_3Q05_DRY_093005-C | REG |
| 12.5TH STREET OUTFALL | 3/28/2007 | MESDMTMH-124 | REG |
| 12.5TH STREET OUTFALL | 3/28/2007 | MESDMTMH-124B | REG |
| 13.5TH STREET OUTFALL | 4/11/2007 | DMTI169 | REG |
| 13.5TH STREET OUTFALL | 4/11/2007 | DMTI172 | REG |
| 12TH STREET OUTFALL | 4/26/2007 | 12.0-MH122-042607 | REG |
| 12TH STREET OUTFALL | 4/26/2007 | 12.0-MH124-042607 | REG |
| 13TH STREET OUTFALL | 4/26/2007 | 13.0-MH127-042607 | REG |
| 13TH STREET OUTFALL | 4/26/2007 | 13.0-MH128-042607 | REG |
| 12.5TH STREET OUTFALL | 4/30/2007 | 12.5-MH124-043007 | REG |
| 13.5TH STREET OUTFALL | 5/16/2007 | 13.5-IN169-051607 | REG |
| 13TH STREET OUTFALL | 5/16/2007 | 13.0-MH125A-051607 | REG |
| 13TH STREET OUTFALL | 5/16/2007 | 13.0-MH126-051607 | REG |
| 13TH STREET OUTFALL | 5/16/2007 | 13.0-MH128-051607 | REG |
| 13TH STREET OUTFALL | 5/24/2007 | 13.0-MH128-052407 | REG |
| 13TH STREET OUTFALL | 6/6/2007 | 13.0-MH128-060607 | REG |
| 12TH STREET OUTFALL | 10/4/2007 | 12.0-MH120-100407-D | FD |
| 12TH STREET OUTFALL | 10/5/2007 | 12.0-MH120-100507 | REG |
| 13TH STREET OUTFALL | 10/5/2007 | 13.0-MH125-100507 | REG |
| 13TH STREET OUTFALL | 10/5/2007 | 13.0-MH126-100507 | REG |
| 13TH STREET OUTFALL | 10/5/2007 | 13.0-MH128-100507 | REG |
| 12TH STREET OUTFALL | 10/8/2007 | 12.0-MH120-100807 | REG |
| 12TH STREET OUTFALL | 10/8/2007 | 12.0-MH121-100807 | REG |

**TABLE 1.6**

Priority Drain Stormwater Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose |
|---|---|---|---|
| 12TH STREET OUTFALL | 10/8/2007 | 12.0-MH122-100807 | REG |
| 12TH STREET OUTFALL | 10/8/2007 | 12.0-MH123-100807 | REG |
| 12TH STREET OUTFALL | 10/8/2007 | 12.0-MH124-100807 | REG |
| 13TH STREET OUTFALL | 10/8/2007 | 13.0-MH125-100807 | REG |
| 13TH STREET OUTFALL | 10/8/2007 | 13.0-MH125A-100807 | REG |
| 13TH STREET OUTFALL | 10/8/2007 | 13.0-MH126-100807 | REG |
| 13TH STREET OUTFALL | 10/8/2007 | 13.0-MH127-100807 | REG |
| 13TH STREET OUTFALL | 10/8/2007 | 13.0-MH128-100807 | REG |
| 13TH STREET OUTFALL | 10/8/2007 | 13.0-MH129-100807 | REG |
| 13TH-ST-IRM | 9/25/2008 | 13THSTOUTFALL_092508_DRY | REG |
| 13TH-ST-IRM | 4/1/2009 | 13.0-13IRM-040109-02 | REG |
| 13TH-ST-IRM | 4/1/2009 | 13.0-13IRM-040109-02F | REG |
| 13TH-ST-IRM | 6/25/2009 | 13.0-13IRM-062509-01 | REG |
| 13TH-ST-IRM | 6/25/2009 | 13.0-13IRM-062509-01F | REG |

Note:
Reg - Normal sample
FD - Field Duplicate

**TABLE 1.7**
Surface Water Samples Used in the HHRA
*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Purpose |
|---|---|---|---|
| A1 | 5/17/2007 | 051707-A1-SW-02.00 | REG |
| A1 | 8/22/2007 | 082207-A1-SW-02.00 | REG |
| A1 | 8/22/2007 | 082207-A1-SW-04.00 | REG |
| A1 | 12/5/2007 | 120507-A1-SW-01.50 | REG |
| A1 | 2/24/2008 | 022408-A1-SW-01.50 | REG |
| A1 | 2/24/2008 | 022408-A1-SW-04.00 | REG |
| A2 | 5/17/2007 | 051707-A2-SW-02.00-D | FD |
| A2 | 5/17/2007 | 051707-A2-SW-02.00 | REG |
| A2 | 8/22/2007 | 082207-A2-SW-01.50 | REG |
| A2 | 8/22/2007 | 082207-A2-SW-03.50 | REG |
| A2 | 12/11/2007 | 121107-A2-SW-02.00 | REG |
| A2 | 2/24/2008 | 022408-A2-SW-02.40 | REG |
| A3 | 5/17/2007 | 051707-A3-SW-02.00 | REG |
| A3 | 8/22/2007 | 082207-A3-SW-02.50 | REG |
| A3 | 12/11/2007 | 121107-A3-SW-02.00 | REG |
| A3 | 2/24/2008 | 022408-A3-SW-02.30-D | FD |
| A3 | 2/24/2008 | 022408-A3-SW-02.30 | REG |
| A4 | 5/17/2007 | 051707-A4-SW-02.00 | REG |
| A4 | 8/22/2007 | 082207-A4-SW-02.20-D | FD |
| A4 | 8/22/2007 | 082207-A4-SW-02.20 | REG |
| A4 | 12/11/2007 | 121107-A4-SW-02.00 | REG |
| A4 | 2/24/2008 | 022408-A4-SW-02.50 | REG |
| J4 | 2/21/2008 | 022108-J4-SW-01.00 | REG |

Note:
Reg - Normal sample
FD - Field Duplicate

**TABLE 1.8**

Sediment (0-1 foot) Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Start Depth | End Depth | Field Sample ID | Purpose |
|---|---|---|---|---|---|
| A1 | 5/17/2007 | 0 | 0.5 | 051707-A1-SD-00.50 | REG |
| A1 | 8/22/2007 | 0 | 0.5 | 082207-A1-SD-00.50 | REG |
| A2 | 5/17/2007 | 0 | 0.5 | 051707-A2-SD-00.50 | REG |
| A2 | 8/22/2007 | 0 | 0.5 | 082207-A2-SD-00.50 | REG |
| A3 | 5/17/2007 | 0 | 0.5 | 051707-A3-SD-00.50 | REG |
| A3 | 8/22/2007 | 0 | 0.5 | 082207-A3-SD-00.50 | REG |
| A4 | 5/17/2007 | 0 | 0.5 | 051707-A4-SD-00.50 | REG |
| A4 | 8/22/2007 | 0 | 0.5 | 082207-A4-SD-00.50 | REG |
| J4 | 2/20/2008 | 0.5 | 1 | 022008-J4-SD-01.00 | REG |
| J4 | 2/21/2008 | 0 | 0.5 | 022108-J4-SD-00.50 | REG |

Note:

Sample depth is presented in feet.

Reg - Normal sample

**TABLE 1.9**

Sediment (0-3 feet) Samples Used in the HHRA

*Dundalk Marine Terminal, Baltimore, MD*

| Location ID | Collection Date | Field Sample ID | Start Depth | End Depth | Purpose |
|---|---|---|---|---|---|
| A1 | 5/17/2007 | 051707-A1-SD-00.50 | 0 | 0.5 | REG |
| A1 | 8/13/2007 | 081307-A1-SD-01.40 | 0.9 | 1.4 | REG |
| A1 | 8/13/2007 | 081307-A1-SD-03.00 | 2.5 | 3 | REG |
| A1 | 8/22/2007 | 082207-A1-SD-00.50 | 0 | 0.5 | REG |
| A2 | 5/17/2007 | 051707-A2-SD-00.50 | 0 | 0.5 | REG |
| A2 | 8/13/2007 | 081307-A2-SD-01.40 | 0.9 | 1.4 | REG |
| A2 | 8/13/2007 | 081307-A2-SD-03.00 | 2.5 | 3 | REG |
| A2 | 8/22/2007 | 082207-A2-SD-00.50 | 0 | 0.5 | REG |
| A3 | 5/17/2007 | 051707-A3-SD-00.50 | 0 | 0.5 | REG |
| A3 | 8/13/2007 | 081307-A3-SD-01.50 | 1 | 1.5 | REG |
| A3 | 8/13/2007 | 081307-A3-SD-03.00 | 2.5 | 3 | REG |
| A3 | 8/22/2007 | 082207-A3-SD-00.50 | 0 | 0.5 | REG |
| A4 | 5/17/2007 | 051707-A4-SD-00.50 | 0 | 0.5 | REG |
| A4 | 8/13/2007 | 081307-A4-SD-01.50 | 1 | 1.5 | REG |
| A4 | 8/13/2007 | 081307-A4-SD-03.00 | 2.5 | 3 | REG |
| A4 | 8/22/2007 | 082207-A4-SD-00.50 | 0 | 0.5 | REG |
| J4 | 2/20/2008 | 022008-J4-SD-01.00 | 0.5 | 1 | REG |
| J4 | 2/20/2008 | 022008-J4-SD-03.00 | 2.5 | 3 | REG |
| J4 | 2/21/2008 | 022108-J4-SD-00.50 | 0 | 0.5 | REG |

Note:
Sample depth is presented in feet.
Reg - Normal sample

Table 2.1

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Groundwater (Shallow)
Exposure Medium: Groundwater (Shallow)

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Qualifier | Maximum Concentration | Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater in Excavations (Shallow) | 7429-90-5 | Aluminum | 98.1 | | 190000 | | ug/L | DMT-29S | 84 / 90 | 0.84 - 401 | 190000 | -- | 3700 | n | -- | -- | Yes | ASL |
| | 7429-90-5 | Aluminum, Dissolved | 83.9 | | 32900 | | ug/L | DMT-45S | 52 / 90 | 23 - 401 | 32900 | -- | 3700 | n | -- | -- | Yes | ASL |
| | 7440-70-2 | Calcium | 3600 | | 984000 | | ug/L | DMT-29S | 89 / 90 | 49 - 5000 | 984000 | -- | 130000 | n | -- | -- | Yes | ASL |
| | 7440-70-2 | Calcium, Dissolved | 409 | J | 808000 | | ug/L | TPZ-33 | 90 / 90 | 49 - 5000 | 808000 | -- | 130000 | n | -- | -- | Yes | ASL |
| | 16065-83-1 | Chromium (III) | 2.8 | B | 21600 | L | ug/L | DMT-30S | 81 / 101 | 5 - 500 | 21600 | -- | 5500 | n | -- | -- | Yes | ASL |
| | 16065-83-1 | Chromium (III), Dissolved | 1.7 | J | 24000 | | ug/L | DMT-29S | 29 / 57 | - | 24000 | -- | 5500 | n | -- | -- | Yes | ASL |
| | 18540-29-9 | Chromium (VI) | 5.2 | J | 220000 | | ug/L | DMT-29S | 37 / 101 | 1.2 - 2500 | 220000 | -- | 11 | n | -- | -- | Yes | ASL |
| | 18540-29-9 | Chromium (VI), Dissolved | 6.7 | J | 70000 | | ug/L | DMT-7S | 22 / 57 | 1.2 - 2500 | 70000 | -- | 11 | n | -- | -- | Yes | ASL |
| | 7439-89-6 | Iron | 73.8 | B | 1850000 | | ug/L | TPZ-33 | 87 / 90 | 25 - 522 | 1850000 | -- | 2600 | n | -- | -- | Yes | ASL |
| | 7439-89-6 | Iron, Dissolved | 45 | B | 1780000 | | ug/L | TPZ-33 | 63 / 90 | 25 - 522 | 1780000 | -- | 2600 | n | -- | -- | Yes | ASL |
| | 7439-95-4 | Magnesium | 36.9 | | 391000 | | ug/L | TPZ-33 | 84 / 90 | 13.5 - 5000 | 391000 | -- | 16000 | n | -- | -- | Yes | ASL |
| | 7439-95-4 | Magnesium, Dissolved | 21.1 | B | 416000 | | ug/L | TPZ-33 | 61 / 90 | 13.5 - 5000 | 416000 | -- | 16000 | n | -- | -- | Yes | ASL |
| | 7439-96-5 | Manganese | 0.58 | | 25800 | | ug/L | TPZ-33 | 89 / 90 | 0.36 - 15 | 25800 | -- | 88 | n | -- | -- | Yes | ASL |
| | 7439-96-5 | Manganese, Dissolved | 0.52 | | 27400 | | ug/L | TPZ-33 | 66 / 90 | 0.36 - 15 | 27400 | -- | 88 | n | -- | -- | Yes | ASL |
| | 7440-62-2 | Vanadium | 1.7 | | 4540 | | ug/L | DMT-29S | 75 / 90 | 1.5 - 50 | 4540 | -- | 18 | | -- | -- | Yes | ASL |
| | 7440-62-2 | Vanadium, Dissolved | 1.6 | | 2200 | | ug/L | DMT-18S | 51 / 90 | 1.5 - 50 | 2200 | -- | 18 | | -- | -- | Yes | ASL |

(1) Regional Screening Levels for Tapwater (EPA, 2009a). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

Chromium (III) (Insoluble Salts) SL was used as the SL for Trivalent Chromium.

Chromium VI (chromic acid mists) SL was used as the SL for Hexavalent Chromium.

Manganese (Water) SL was used as the SL for Manganese.

Vanadium and Compounds SL was used as the SL for Vanadium.

Screening levels for Calcium and Magnesium were calculated using Dietary Reference Intake (NAS, 2004).

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

c = Carcinogenic

n = Noncarcinogenic

NA = Not available

SL = Screening Level

J = Estimated Value

B = Value between the MDL/IDL and the RL

L = Analyte is present but low bias

Table 2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil (0-0.5 feet)

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Qualifier | Maximum Concentration | Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface Soil | 7429-90-5 | Aluminum | 3470 | | 51900 | | mg/kg | SB-168 | 57 / 57 | 3.4 - 4.23 | 51900 | -- | 99000 | n | -- | -- | No | BSL |
| | 7440-70-2 | Calcium | 534 | | 242000 | | mg/kg | SB-153 | 57 / 57 | 6.3 - 69.2 | 242000 | -- | 100000 | max | -- | -- | Yes | ASL |
| | 16065-83-1 | Chromium (III) | 8.2 | | 17600 | | mg/kg | SB-153 | 77 / 77 | 0.61 - 50.2 | 17600 | -- | 100000 | max | -- | -- | No | BSL |
| | 18540-29-9 | Chromium (VI) | 0.28 | B | 6710 | | mg/kg | SB-170 | 70 / 70 | 0.21 - 129 | 6710 | -- | 200 | c | -- | -- | Yes | ASL |
| | 7439-89-6 | Iron | 3570 | | 129000 | | mg/kg | SB-153 | 57 / 57 | 4.78 - 53.3 | 129000 | -- | 72000 | n | -- | -- | Yes | ASL |
| | 7439-95-4 | Magnesium | 768 | | 85300 | | mg/kg | SB-200 | 57 / 57 | 2.58 - 14.1 | 85300 | -- | 100000 | max | -- | -- | No | BSL |
| | 7439-96-5 | Manganese | 56.6 | | 4060 | | mg/kg | SB-161 | 57 / 57 | 0.0569 - 0.341 | 4060 | -- | 2300 | n | -- | -- | Yes | ASL |
| | 7440-09-7 | Potassium | 328 | | 6490 | | mg/kg | SB-174 | 18 / 18 | 3.36 - 4.15 | 6490 | -- | 100000 | max | -- | -- | No | BSL |
| | 7440-23-5 | Sodium | 40.4 | J | 3830 | | mg/kg | SB-197 | 18 / 18 | 37.9 - 46.8 | 3830 | -- | 100000 | max | -- | -- | No | BSL |
| | 7440-62-2 | Vanadium | 10.6 | | 1210 | | mg/kg | SB-153 | 57 / 57 | 0.173 - 0.994 | 1210 | -- | 750 | n | -- | -- | Yes | ASL |

(1) Regional Screening Levels for Industrial Soil (EPA, 2009a). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

Chromium (III) (Insoluble Salts) SL was used as the SL for Trivalent Chromium.

Chromium VI (particulates) SL was used as the SL for Hexavalent Chromium.

Manganese (Water) SL was used as the SL for Manganese.

Vanadium Pentoxide SL was used as the SL for Vanadium.

Screening levels for Calcium, Magnesium, Potassium, and Sodium were calculated using Dietary Reference Intake (NAS, 2004).

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

c = Carcinogenic

n = Noncarcinogenic

max = ceiling limit

NA = Not available

SL = Screening Level

J = Estimated Value

B = Value between the MDL/IDL and the RL

Table 2.3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil (0-10 feet)

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Qualifier | Maximum Concentration | Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Soil | 7429-90-5 | Aluminum | 79.9 | | 65400 | | mg/kg | INC-23 | 204 / 204 | 2.4 - 130 | 65400 | -- | 99000 | n | -- | -- | No | BSL |
| | 7440-70-2 | Calcium | 102 | | 272000 | | mg/kg | INC-20 | 203 / 203 | 6.3 - 3200 | 272000 | -- | 100000 | max | -- | -- | Yes | ASL |
| | 16065-83-1 | Chromium (III) | 2.461 | | 32070 | J | mg/kg | TT1 | 293 / 295 | 0.61 - 50.2 | 32070 | -- | 100000 | max | -- | -- | No | BSL |
| | 18540-29-9 | Chromium (VI) | 0.28 | B | 41800 | | mg/kg | TT1 | 293 / 301 | 0.21 - 2000 | 41800 | -- | 200 | c | -- | -- | Yes | ASL |
| | 7439-89-6 | Iron | 242 | | 164000 | | mg/kg | INC-8, TT1 | 204 / 204 | 4.4 - 64 | 164000 | -- | 72000 | n | -- | -- | Yes | ASL |
| | 7439-95-4 | Magnesium | 29.7 | | 85300 | | mg/kg | SB-200 | 204 / 204 | 0.6 - 3200 | 85300 | -- | 100000 | max | -- | -- | No | BSL |
| | 7439-96-5 | Manganese | 3.4 | | 4060 | | mg/kg | SB-161 | 204 / 204 | 0.032 - 9.6 | 4060 | -- | 2300 | n | -- | -- | Yes | ASL |
| | 7440-09-7 | Potassium | 109 | B | 6490 | | mg/kg | SB-174 | 27 / 44 | 3.36 - 3200 | 6490 | -- | 100000 | max | -- | -- | No | BSL |
| | 7440-23-5 | Sodium | 40.4 | J | 6710 | | mg/kg | INC-23 | 34 / 44 | 37.9 - 6400 | 6710 | -- | 100000 | max | -- | -- | No | BSL |
| | 7440-62-2 | Vanadium | 1.47 | | 1630 | | mg/kg | INC-9 | 204 / 204 | 0.14 - 32 | 1630 | -- | 750 | n | -- | -- | Yes | ASL |

(1) Regional Screening Levels for Industrial Soil (EPA, 2009a). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

Chromium (III) (Insoluble Salts) SL was used as the SL for Trivalent Chromium.

Chromium VI (particulates) SL was used as the SL for Hexavalent Chromium.

Manganese (Water) SL was used as the SL for Manganese.

Vanadium Pentoxide SL was used as the SL for Vanadium.

Screening levels for Calcium, Magnesium, Potassium, and Sodium were calculated using Dietary Reference Intake (NAS, 2004).

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/
To Be Considered

c = Carcinogenic

n = Noncarcinogenic

max = ceiling limit

NA = Not available

SL = Screening Level

J = Estimated Value

B = Value between the MDL/IDL and the RL

Table 2.4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current/Future
Medium: Outdoor Air
Exposure Medium: Outdoor Air (Perimeter)

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Qualifier | Maximum Concentration | Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value (3) | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outdoor Air (Perimeter) | 18540-29-9 | Chromium (VI) | 6.36E-07 | | 3.67E-06 | | $mg/m^3$ | Air6 | 228 / 427 | 2.12E-07 - 2.85E-07 | 3.67E-06 | 1.15E-06 | 2.90E-08 | c | -- | -- | Yes | ASL |

(1) Regional Screening Levels for Residential Air (EPA, 2009a).

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

(3) Upper confidence limit concentration based on 119 upwind samples (see Appendix E).

Chromium VI (particulates) SL was used as the SL for Hexavalent Chromium.

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

c = Carcinogenic

NA = Not available

SL = Screening Level

Table 2.5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Stormwater
Exposure Medium: Stormwater (Non-Priority Drains)

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Qualifier | Maximum Concentration | Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subsurface Stormwater Lines | 16065-83-1 | Chromium (III) | 3.1 | J | 650 | | ug/L | 9TH STREET OUTFALL | 18 / 27 | - | 650 | -- | 5500 | n | -- | -- | No | BSL |
| | 18540-29-9 | Chromium (VI) | 10 | | 1000 | J | ug/L | 11TH STREET OUTFALL | 9 / 27 | 0 - 50 | 1000 | -- | 11 | n | -- | -- | Yes | ASL |

(1) Regional Screening Levels for Tapwater (EPA, 2009a). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

Chromium (III) (Insoluble Salts) SL was used as the SL for Trivalent Chromium.

Chromium VI (chromic acid mists) SL was used as the SL for Hexavalent Chromium.

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

c = Carcinogenic

n = Noncarcinogenic

NA = Not available

SL = Screening Level

J = Estimated Value

Table 2.6

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Stormwater
Exposure Medium: Stormwater (Priority Drains)

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Qualifier | Maximum Concentration | Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subsurface Stormwater Lines | 7429-90-5 | Aluminum, Dissolved | 110 | | 921 | | ug/L | 14TH STREET OUTFALL | 2 / 2 | 39.8 - 39.8 | 921 | -- | 3700 | n | -- | -- | No | BSL |
| | 7440-70-2 | Calcium, Dissolved | 422000 | | 422000 | | ug/L | 14TH STREET OUTFALL | 1 / 1 | 47.9 - 47.9 | 422000 | -- | 130000 | n | -- | -- | Yes | ASL |
| | 16065-83-1 | Chromium (III) | 20 | | 10000 | | ug/L | 12.5TH STREET OUTFALL | 53 / 110 | - | 10000 | -- | 5500 | n | -- | -- | Yes | ASL |
| | 18540-29-9 | Chromium (VI) | 20 | | 57000 | | ug/L | 12.5TH STREET OUTFALL | 106 / 111 | 0 - 2500 | 57000 | -- | 11 | n | -- | -- | Yes | ASL |
| | 18540-29-9 | Chromium (VI), Dissolved | 31000 | | 31000 | | ug/L | 14TH STREET OUTFALL | 1 / 1 | 600 - 600 | 31000 | -- | 11 | n | -- | -- | Yes | ASL |
| | 7439-96-5 | Manganese, Dissolved | 0.9 | J | 0.9 | J | ug/L | 14TH STREET OUTFALL | 1 / 2 | 0.84 - 0.84 | 0.9 | -- | 88 | n | -- | -- | No | BSL |
| | 7440-62-2 | Vanadium, Dissolved | 42 | | 42 | | ug/L | 14TH STREET OUTFALL | 1 / 1 | 1.6 - 1.6 | 42 | -- | 18 | n | -- | -- | Yes | ASL |

(1) Regional Screening Levels for Tapwater (EPA, 2009a). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

Chromium (III) (Insoluble Salts) SL was used as the SL for Trivalent Chromium.

Chromium VI (chromic acid mists) SL was used as the SL for Hexavalent Chromium.

Manganese (Water) SL was used as the SL for Manganese.

Vanadium and Compounds SL was used as the SL for Vanadium.

A screening level was calculated for calcium using Dietary Reference Intake (NAS, 2004).

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

c = Carcinogenic

n = Noncarcinogenic

NA = Not available

SL = Screening Level

J = Estimated Value

Table 2.7
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Minimum Qualifier | Maximum Concentration | Maximum Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Patapsco River | 7429-90-5 | Aluminum | 82.4 | | 347 | | ug/L | A1 | 16 / 20 | 80.2 - 80.2 | 347 | -- | 3700 | n | -- | -- | No | BSL |
| | 7440-70-2 | Calcium | 71100 | | 165000 | | ug/L | A1 | 20 / 20 | 63.2 - 104 | 165000 | -- | 130000 | n | -- | -- | Yes | ASL |
| | 7440-70-2 | Calcium, Dissolved | 71300 | | 165000 | | ug/L | A1 | 20 / 20 | 63.2 - 104 | 165000 | -- | 130000 | n | -- | -- | Yes | ASL |
| | 16065-83-1 | Chromium (III) | 2.8 | J | 16.9 | | ug/L | A1 | 4 / 20 | - | 16.9 | -- | 5500 | n | -- | -- | No | BSL |
| | 7439-89-6 | Iron | 174 | | 556 | | ug/L | A1 | 12 / 20 | 52.2 - 52.2 | 556 | -- | 2600 | n | -- | -- | No | BSL |
| | 7439-89-6 | Iron, Dissolved | 55.7 | | 62.4 | J | ug/L | A1 | 2 / 20 | 52.2 - 52.2 | 62.4 | -- | 2600 | n | -- | -- | No | BSL |
| | 7439-95-4 | Magnesium | 191000 | | 506000 | | ug/L | A2 | 20 / 20 | 13.5 - 32.2 | 506000 | -- | 16000 | n | -- | -- | Yes | ASL |
| | 7439-95-4 | Magnesium, Dissolved | 185000 | | 473000 | | ug/L | A2 | 20 / 20 | 13.5 - 32.2 | 473000 | -- | 16000 | n | -- | -- | Yes | ASL |
| | 7439-96-5 | Manganese | 11.9 | | 106 | | ug/L | A1 | 20 / 20 | 0.36 - 0.84 | 106 | -- | 88 | n | -- | -- | Yes | ASL |
| | 7439-96-5 | Manganese, Dissolved | 3.8 | | 56.4 | | ug/L | A1 | 20 / 20 | 0.36 - 0.84 | 56.4 | -- | 88 | n | -- | -- | No | BSL |
| | 7440-62-2 | Vanadium | 1.5 | J | 4.5 | | ug/L | A1 | 12 / 20 | 1.5 - 1.5 | 4.5 | -- | 33 | n | -- | -- | No | BSL |
| | 7440-62-2 | Vanadium, Dissolved | 2.2 | | 3 | | ug/L | A1 | 6 / 20 | 1.5 - 1.5 | 3 | -- | 33 | n | -- | -- | No | BSL |

(1) Regional Screening Levels for Tapwater (EPA, 2009a). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

Chromium (III) (Insoluble Salts) SL was used as the SL for Trivalent Chromium.

Manganese (Water) SL was used as the SL for Manganese.

Vanadium Pentoxide SL was used as the SL for Vanadium.

Screening levels for calcium and magnesium were calculated using Dietary Reference Intake (NAS, 2004).

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

c = Carcinogenic

n = Noncarcinogenic

NA = Not available

SL = Screening Level

J = Estimated Value

Table 2.8
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current
Medium: Sediment
Exposure Medium: Sediment (0-1 foot)

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Minimum Qualifier | Maximum Concentration | Maximum Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Patapsco River | 7429-90-5 | Aluminum | 1140 | | 12000 | | mg/kg | J4 | 10 / 10 | 4.24 - 5.34 | 12000 | -- | 7700 | n | -- | -- | Yes | ASL |
| | 7440-70-2 | Calcium | 198 | | 13300 | | mg/kg | J4 | 10 / 10 | 7.75 - 19.2 | 13300 | -- | 100000 | max | -- | -- | No | BSL |
| | 7440-47-3 | Chromium | 89.6 | | 8140 | J | mg/kg | J4 | 10 / 10 | 0.737 - 7.53 | 8140 | -- | 12000 | n | -- | -- | No | BSL |
| | 7439-89-6 | Iron | 6180 | | 37600 | | mg/kg | A4 | 10 / 10 | 5.95 - 7.51 | 37600 | -- | 5500 | n | -- | -- | Yes | ASL |
| | 7439-95-4 | Magnesium | 269 | | 30200 | | mg/kg | J4 | 10 / 10 | 3.21 - 4.05 | 30200 | -- | 34000 | n | -- | -- | No | BSL |
| | 7439-96-5 | Manganese | 70.9 | | 2070 | | mg/kg | J4 | 10 / 10 | 0.0708 - 0.42 | 2070 | -- | 180 | n | -- | -- | Yes | ASL |
| | 7440-62-2 | Vanadium | 9.4 | | 146 | | mg/kg | J4 | 10 / 10 | 0.202 - 0.255 | 146 | -- | 39 | n | -- | -- | Yes | ASL |

(1) Regional Screening Levels for Residential Soil (EPA, 2009a). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

Chromium (III) (Insoluble Salts) SL was used as the SL for Chromium.

Vanadium and Compounds SL was used as the SL for Vanadium.

Screening levels were calculated for calcium and magnesium using Dietary Reference Intake (NAS, 2004).

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

c = Carcinogenic

n = Noncarcinogenic

max = ceiling limit

NA = Not available

SL = Screening Level

J = Estimated Value

Table 2.9

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment (0-3 feet)

| Exposure Point | CAS Number | Chemical | Minimum Concentration | Minimum Qualifier | Maximum Concentration | Maximum Qualifier | Units | Location of Maximum Concentration | Detection Frequency | Range of Detection Limits | Concentration Used for Screening | Background Value | Screening Toxicity Value (1) | | Potential ARAR/TBC Value | Potential ARAR/TBC Source | COPC Flag | Rationale for Selection or Deletion (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Patapsco River | 7429-90-5 | Aluminum | 227 | | 12700 | | mg/kg | A4 | 19 / 19 | 3.86 - 5.34 | 12700 | -- | 7700 | n | -- | -- | Yes | ASL |
| | 7440-70-2 | Calcium | 10.3 | | 13300 | | mg/kg | J4 | 19 / 19 | 7.07 - 19.2 | 13300 | -- | 100000 | max | -- | -- | No | BSL |
| | 7440-47-3 | Chromium | 2.91 | K | 8140 | J | mg/kg | J4 | 19 / 19 | 0.672 - 7.53 | 8140 | -- | 12000 | n | -- | -- | No | BSL |
| | 7439-89-6 | Iron | 316 | | 37600 | | mg/kg | A4 | 19 / 19 | 5.43 - 7.51 | 37600 | -- | 5500 | n | -- | -- | Yes | ASL |
| | 7439-95-4 | Magnesium | 16.2 | | 30200 | | mg/kg | J4 | 19 / 19 | 2.93 - 4.05 | 30200 | -- | 34000 | n | -- | -- | No | BSL |
| | 7439-96-5 | Manganese | 1.69 | | 2070 | | mg/kg | J4 | 19 / 19 | 0.0646 - 0.42 | 2070 | -- | 180 | n | -- | -- | Yes | ASL |
| | 7440-62-2 | Vanadium | 1.42 | | 146 | | mg/kg | J4 | 19 / 19 | 0.185 - 0.255 | 146 | -- | 39 | n | -- | -- | Yes | ASL |

(1) Regional Screening Levels for Residential Soil (EPA, 2009a). Concentrations based on non-carcinogenic health effects are adjusted using HQ=0.1.

(2) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)

Chromium (III) (Insoluble Salts) SL was used as the SL for Chromium.

Vanadium and Compounds SL was used as the SL for Vanadium.

Screening levels were calculated for calcium and magnesium using Dietary Reference Intake (NAS, 2004).

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

c = Carcinogenic

n = Noncarcinogenic

max = ceiling limit

NA = Not available

SL = Screening Level

J = Estimated Value

K = The analyte is present but biased high.

Table 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Groundwater (Shallow)
Exposure Medium: Groundwater (Shallow)

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T/G) | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Value | Units | Statistic | Rationale |
| Groundwater | Aluminum | ug/L | 1.1E+04 | 2.9E+04 | 1.9E+05 | 2.9E+04 | ug/L | 97.5% KM (Chebyshev) | (4) |
| | Calcium | ug/L | 1.4E+05 | 2.2E+05 | 9.8E+05 | 2.2E+05 | ug/L | 95% Cheb-m | (4) |
| | Chromium (III) | ug/L | 2.3E+03 | 6.5E+03 | 2.4E+04 | 6.5E+03 | ug/L | 99% KM (Chebyshev) | (4) |
| | Chromium (VI) | ug/L | 1.8E+04 | 1.1E+04 | 2.2E+05 | 1.1E+04 | ug/L | 95% KM (t) | (4) |
| | Iron | ug/L | 4.5E+04 | 1.7E+05 | 1.9E+06 | 1.7E+05 | ug/L | 97.5% KM (Chebyshev) | (4) |
| | Magnesium | ug/L | 5.3E+04 | 1.1E+05 | 3.9E+05 | 1.1E+05 | ug/L | 97.5% KM (Chebyshev) | (4) |
| | Manganese | ug/L | 1.1E+03 | 2.8E+03 | 2.7E+04 | 2.8E+03 | ug/L | 97.5% KM (Chebyshev) | (4) |
| | Vanadium | ug/L | 2.5E+02 | 5.9E+02 | 4.5E+03 | 5.9E+02 | ug/L | 97.5% KM (Chebyshev) | (4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL; 99% Chebyshev (MVUE) UCL
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Chebyshev (MVUE) UCL;
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

Rationale:
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
ug/L= micrograms/liter

Table 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil (0-0.5 feet)

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T/G) | | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Value | Units | Statistic | Rationale |
| Surface Soil | Calcium | mg/kg | 1.2E+05 | 1.4E+05 | N | 2.4E+05 | 1.4E+05 | mg/kg | 95% Stud-t | (2) |
| | Chromium (VI) | mg/kg | 6.2E+02 | 2.4E+03 | | 6.7E+03 | 2.4E+03 | mg/kg | 99% Chebyshev (Mean, Sd) | (4) |
| | Iron | mg/kg | 3.0E+04 | 3.9E+04 | T | 1.3E+05 | 3.9E+04 | mg/kg | 95% H-UCL | (1) |
| | Manganese | mg/kg | 6.0E+02 | 7.5E+02 | G | 4.1E+03 | 7.5E+02 | mg/kg | App. Gamma | (3) |
| | Vanadium | mg/kg | 1.8E+02 | 3.9E+02 | | 1.2E+03 | 3.9E+02 | mg/kg | 97.5% Chebyshev (Mean, Sd) | (4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL; 99% Chebyshev (MVUE) UCL
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Chebyshev (MVUE) UCL;
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

Rationale:
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
mg/kg= milligrams/kilograms

Table 3.3.RME

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil (0-10 feet)

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T/G) | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Value | Units | Statistic | Rationale |
| Total Soil | Calcium | mg/kg | 1.0E+05 | 1.7E+05 | 2.7E+05 | 1.7E+05 | mg/kg | 99% Chebyshev (Mean, Sd) | (4) |
| | Chromium (VI) | mg/kg | 1.7E+03 | 3.1E+03 | 4.2E+04 | 3.1E+03 | mg/kg | 97.5% KM (Chebyshev) | (4) |
| | Iron | mg/kg | 4.7E+04 | 6.9E+04 | 1.6E+05 | 6.9E+04 | mg/kg | 97.5% Chebyshev (Mean, Sd) | (4) |
| | Manganese | mg/kg | 5.5E+02 | 8.1E+02 | 4.1E+03 | 8.1E+02 | mg/kg | 97.5% Chebyshev (Mean, Sd) | (4) |
| | Vanadium | mg/kg | 3.8E+02 | 6.1E+02 | 1.6E+03 | 6.1E+02 | mg/kg | 97.5% Chebyshev (Mean, Sd) | (4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL; 99% Chebyshev (MVUE) UCL
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Chebyshev (MVUE) UCL;
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
mg/kg= milligrams/kilograms

Table 3.4.RME

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current/Future
Medium: Outdoor Air
Exposure Medium: Outdoor Air

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T/G) | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Value | Units | Statistic | Rationale |
| Outdoor Air (Perimeter) | Chromium (VI) | $mg/m^3$ | 1.5E-06 | 1.1E-06 | 3.7E-06 | 1.1E-06 | $mg/m^3$ | 95% KM (t) | (4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL; 99% Chebyshev (MVUE) UCL
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Chebyshev (MVUE) UCL;
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

Rationale:
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
$mg/m^3$= milligrams/(meter)$^3$

Table 3.5.RME

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Stormwater
Exposure Medium: Stormwater (Non-Priority Drains)

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T/G) | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Value | Units | Statistic | Rationale |
| Subsurface Stormwater Lines | Chromium (VI) | ug/L | 3.5E+02 | 2.1E+02 | 1.0E+03 J | 2.1E+02 | ug/L | 99% KM (Chebyshev) | (4) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL; 99% Chebyshev (MVUE) UCL
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Chebyshev (MVUE) UCL; 99% Chebyshev (Mean, Sd) (99% Cheb-m) UCL
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

Rationale:

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
ug/L= micrograms/liter

Table 3.6.RME

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Stormwater
Exposure Medium: Stormwater (Priority Drains)

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T/G) | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Value | Units | Statistic | Rationale |
| Subsurface Stormwater Lines | Calcium | ug/L | NA | NA | 4.2E+05 | 4.2E+05 | ug/L | Max | (6) |
| | Chromium (III) | ug/L | 2.0E+03 | 1.3E+03 | 1.0E+04 | 1.3E+03 | ug/L | 95% KM (t) | (4) |
| | Chromium (VI) (7) | ug/L | 1.7E+04 | 2.5E+04 | 5.7E+04 | 2.5E+04 | ug/L | 97.5% KM (Chebyshev) | (4) |
| | Vanadium | ug/L | NA | NA | 4.2E+01 | 4.2E+01 | ug/L | Max | (6) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL; 99% Chebyshev (MVUE) UCL
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Chebyshev (MVUE) UCL; 99% Chebyshev (Mean, Sd) (99% Cheb-m) UCL
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

Rationale:

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(5) The maximum detected concentration was used as the UCL because the value recommended by ProUCL was higher than the Max.
(6) The maximum detected concentration was used as the UCL because there were less than 10 samples.
(7) The UCL for Chromium (VI) (total) data was used rather than the UCL of Chromium (VI) (Dissolved) due to the higher detection frequency of Chromium (VI) (total) compared to Chromium (VI) (Dissolved) (106/110 vs 1/1).

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
ug/L= micrograms/liter

Table 3.7.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T//G) | | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Value | Units | Statistic | Rationale |
| Patapsco River | Calcium | ug/L | 1.2E+05 | 1.4E+05 | N | 1.7E+05 | 1.4E+05 | ug/L | 95% Stud-t | (2) |
| | Magnesium | ug/L | 3.4E+05 | 3.9E+05 | N | 5.1E+05 | 3.9E+05 | ug/L | 95% Stud-t | (2) |
| | Manganese | ug/L | 6.1E+01 | 7.2E+01 | N | 1.1E+02 | 7.2E+01 | ug/L | 95% Stud-t | (2) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL;
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Modified-t UCL;
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

Rationale:
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
ug/L= micrograms/liter

Table 3.8.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current
Medium: Sediment
Exposure Medium: Sediment (0-1 foot)

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T/G) | | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Value | Units | Statistic | Rationale |
| Patapsco River | Aluminum | mg/kg | 4.2E+03 | 9.7E+03 | | 1.2E+04 | 9.7E+03 | mg/Kg | 95% Cheb-m | (4) |
| | Iron | mg/kg | 2.2E+04 | 3.6E+04 | G | 3.8E+04 | 3.6E+04 | mg/Kg | App. Gamma | (3) |
| | Manganese | mg/kg | 4.6E+02 | 9.5E+02 | G | 2.1E+03 | 9.5E+02 | mg/Kg | App. Gamma | (3) |
| | Vanadium | mg/kg | 4.0E+01 | 1.1E+02 | T | 1.5E+02 | 1.1E+02 | mg/Kg | 95% H-UCL | (1) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL; 99% Chebyshev (MVUE) UCL
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Chebyshev (MVUE) UCL;
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

Rationale:
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
mg/kg= milligrams/kilograms

Table 3.9.RME

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment (0-3 feet)

| Exposure Point | Chemical of Potential Concern | Units | Arithmetic Mean | UCL (N/T/G) | | Maximum Concentration (Qualifier) | Exposure Point Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Value | Units | Statistic | Rationale |
| Patapsco River | Aluminum | mg/kg | 4.2E+03 | 1.1E+04 | | 1.3E+04 | 1.1E+04 | mg/Kg | 95% Chebyshev (MVUE) | (4) |
| | Iron | mg/kg | 1.8E+04 | 2.8E+04 | G | 3.8E+04 | 2.8E+04 | mg/Kg | App. Gamma | (3) |
| | Manganese | mg/kg | 2.6E+02 | 5.7E+02 | G | 2.1E+03 | 5.7E+02 | mg/Kg | Adj. Gamma | (3) |
| | Vanadium | mg/kg | 3.0E+01 | 5.0E+01 | G | 1.5E+02 | 5.0E+01 | mg/Kg | App. Gamma | (3) |

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate RME EPC, following recommendations based on distribution and standard deviation in users guide (EPA. May 2009. ProUCL, Version 4.00.04. Prepared by Lockheed Martin Environmental Services).

Statistics: Maximum Detected Value (Max); 95% KM (t) UCL; 95% KM (z) UCL; 95% KM (jackknife) UCL;
99% KM (Chebyshev) UCL; 97.5% KM (Chebyshev) UCL; 95% KM (Chebyshev) UCL; 99% Chebyshev (MVUE) UCL
95% KM (bootstrap t) UCL; 95% Student's-T test UCL (95% Stud-t); 95% KM (BCA) UCL; 95% H-UCL; 95% Chebyshev (MVUE) UCL;
95% KM (Percentile Bootstrap) UCL; 95% Approximate Gamma (App. Gamma); 95% Adjusted Gamma (Adj. Gamma); 95% Chebyshev (Mean, Sd) UCL (95% Cheb-m)

Rationale:

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).

G = Gamma distribution.
N = Normal distribution.
T = Log-normal distribution.
mg/kg= milligrams/kilograms

TABLE 4.1

Exposure Factors for Groundwater

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future

Medium: Groundwater (Shallow)

Exposure Medium: Groundwater (Excavation)

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Construction Worker | Adult | Groundwater in Exacavations (Shallow) | CW | Chemical Concentration in Water | UCL | µg/l | UCL | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | mg/cm$^2$-event | calculated | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | $t_{event}$ | Event Time | 0.58 | hr/event | MDE, 2008 (2) | Inorganics: DAevent (mg/cm$^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 5,670 | cm$^2$ | MDE, 2008 (2, 3) | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | | EV | Event Frequency | 1 | events/day | MDE, 2008 (2, 3) | |
| | | | | EF | Exposure Frequency | 60, 250 | days/year | (1) | |
| | | | | ED | Exposure Duration | 1 | years | MDE, 2008 (2, 3); EPA, 2002 | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991; MDE, 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 365 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | l/cm$^3$ | - - | |

**Notes:**

(1) Professional judgment for short-term and longer-term construction activities.

(2) Commercial site

(3) Industrial site

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

MDE, 2008: Cleanup Standards for Soil and Groundwater

TABLE 4.2

Exposure Factors for Surface Soil (<0.5 feet)

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

| |
|---|
| Scenario Timeframe: Future |
| Medium: Surface Soil |
| Exposure Medium: Surface Soil (0-0.5 feet) |

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | DMT Worker | Adult | Surface Soil | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-S | Ingestion Rate of Soil | 50 | mg/day | MDE, 2008 (1) | CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 250 | days/year | EPA, 1991; MDE, 2008 (1) | |
| | | | | ED | Exposure Duration | 25 | years | EPA, 1991; MDE, 2008 (1) | |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991; MDE, 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | EPA, 1989 | |
| Dermal | DMT Worker | Adult | Surface Soil | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | CDI (mg/kg-day) = |
| | | | | SA | Skin Surface Area Available for Contact | 3,300 | $cm^2$ | EPA, 2004 (2); MDE, 2008 (1) | CS x SA x SSAF x DABS x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | SSAF | Soil to Skin Adherence Factor | 0.07 | $mg/cm^2$-day | MDE, 2008 (1) | |
| | | | | DABS | Dermal Absorption Factor Solids | chem-specific | -- | EPA, 2004 | |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | EF | Exposure Frequency | 250 | days/year | EPA, 1991; MDE, 2008 (1) | |
| | | | | ED | Exposure Duration | 25 | years | EPA, 1991; MDE, 2008 (1) | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | EPA, 1989 | |

**Notes:**

(1) Default for commercial/industrial worker

(2) Head, hands, forearms, and lower legs.

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. USEPA/540/R/99/005.

MDE, 2008: Cleanup Standards for Soil and Groundwater

TABLE 4.3

Exposure Factors for Outdoor Air Impacts from Surface Soil (<0.5 feet)

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Surface Soil (0-0.5 feet)
Exposure Medium: Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Inhalation | DMT Worker | Adult | Air | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | Average Exposure Concentration ($mg/m^3$) = |
| | | | | CA | Chemical Concentration in Air | calculated | $mg/m^3$ | calculated | CA x ET x EF x ED x CF x 1/AT |
| | | | | PEF | Particulate Emission Factor | 7.80E+07 | $m^3/kg$ | MDE, 2008 (1) | |
| | | | | ET | Exposure Time | 8 | hours/day | EPA, 2009 | |
| | | | | EF | Exposure Frequency | 250 | days/year | EPA, 1991, MDE, 2008 (1) | CA ($mg/m^3$) = CS / PEF |
| | | | | ED | Exposure Duration | 25 | years | EPA, 1991; MDE, 2008 (1) | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | EPA, 1989 | |
| | | | | CF | Conversion Factor | 1/24 | days/hour | -- | |

**Notes:**

(1) Default for commercial/industrial scenario

**Sources:**

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

MDE, 2008: Cleanup Standards for Soil and Groundwater

EPA, 2009: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part F. Supplemental Guidance for Inhalation Risk Assessment.

TABLE 4.4

Exposure Factors for Total Soil (0-10 feet)

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

| |
|---|
| Scenario Timeframe: Future |
| Medium: Total Soil |
| Exposure Medium: Total Soil (0-10 feet) |

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | DMT Worker | Adult | Surface Soil | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-S | Ingestion Rate of Soil | 50 | mg/day | MDE, 2008 (1) | CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 250 | days/year | EPA, 1991; MDE, 2008 (1) | |
| | | | | ED | Exposure Duration | 25 | years | EPA, 1991; MDE, 2008 (1) | |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991; MDE, 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | EPA, 1989 | |
| | Construction Worker | Adult | Total Soil | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | CDI (mg/kg-day) = |
| | | | | IR-S | Ingestion Rate of Soil | 480 | mg/day | MDE, 2008 (2,3) | CS x IR-S x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 60, 250 | days/year | (4) | |
| | | | | ED | Exposure Duration | 1 | years | EPA, 2002; MDE, 2008 (2,3) | |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991; MDE, 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 365 | days | EPA, 1989 | |
| Dermal | DMT Worker | Adult | Surface Soil | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | CDI (mg/kg-day) = |
| | | | | SA | Skin Surface Area Available for Contact | 3,300 | $cm^2$ | EPA, 2004 (5); MDE, 2008 (1) | CS x SA x SSAF x DABS x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | SSAF | Soil to Skin Adherence Factor | 0.07 | $mg/cm^2$-day | MDE, 2008 (1) | |
| | | | | DABS | Dermal Absorption Factor Solids | chem-specific | -- | EPA, 2004 | |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | EF | Exposure Frequency | 250 | days/year | EPA, 1991; MDE, 2008 (1) | |
| | | | | ED | Exposure Duration | 25 | years | EPA, 1991; MDE, 2008 (1) | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | EPA, 1989 | |
| | Construction Worker | Adult | Total Soil | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | CDI (mg/kg-day) = |
| | | | | SA | Skin Surface Area Available for Contact | 3,280 | $cm^2$ | MDE, 2008 (2,3) | CS x SA x SSAF x DABS x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | SSAF | Soil to Skin Adherence Factor | 0.2 | $mg/cm^2$-day | MDE, 2008 (2) | |
| | | | | DABS | Dermal Absorption Factor Solids | chem-specific | -- | EPA, 2004 | |
| | | | | CF1 | Conversion Factor 1 | 0.000001 | kg/mg | - - | |
| | | | | EF | Exposure Frequency | 60, 250 | days/year | (4) | |
| | | | | ED | Exposure Duration | 1 | years | EPA, 2002; MDE, 2008 (2,3) | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991; MDE, 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 365 | days | EPA, 1989 | |

**Notes:**

(1) Default for commercial/industrial worker

(2) Commercial setting

(3) Industrial setting

(4) Professional judgment for short-term and longer-term construction activities.

TABLE 4.4

Exposure Factors for Total Soil (0-10 feet)

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil (0-10 feet)

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|

(5) Head, hands, forearms, and lower legs.

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. USEPA/540/R/99/005.

MDE, 2008: Cleanup Standards for Soil and Groundwater

TABLE 4.5

Exposure Factors for Total Soil (0-10 Feet)/Outdoor Air

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Medium: Total Soil (0-10 feet)
Exposure Medium: Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Inhalation | DMT Worker | Adult | Air | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | Average Exposure Concentration (AEC) ($mg/m^3$) = |
| | | | | CA | Chemical Concentration in Air | calculated | $mg/m^3$ | calculated | CA x ET x EF x ED x CF x 1/AT |
| | | | | PEF | Particulate Emission Factor | 7.80E+07 | $m^3/kg$ | MDE, 2008 (1) | |
| | | | | ET | Exposure Time | 8 | hours/day | EPA, 2009 | |
| | | | | EF | Exposure Frequency | 250 | days/year | EPA, 1991, MDE, 2008 (1) | CA ($mg/m^3$) = CS / PEF |
| | | | | ED | Exposure Duration | 25 | years | EPA, 1991; MDE, 2008 (1) | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 9,125 | days | EPA, 1989 | |
| | | | | CF | Conversion Factor | 1/24 | days/hour | -- | |
| | Construction Worker | Adult | Air | CS | Chemical Concentration in Soil | UCL | mg/kg | UCL | AEC ($mg/m^3$) = |
| | | | | CA | Chemical Concentration in Air | calculated | $mg/m^3$ | calculated | CA x ET x EF x ED x CF x 1/AT |
| | | | | PEF | Particulate Emission Factor | 7.80E+07 | $m^3/kg$ | MDE, 2008 (2, 3) | |
| | | | | ET | Exposure Time | 8 | hours/day | EPA, 2009 | |
| | | | | EF | Exposure Frequency | 60, 250 | days/year | (4) | CA ($mg/m^3$) = CS / PEF |
| | | | | ED | Exposure Duration | 1 | years | MDE, 2008; EPA, 2002 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 365 | days | EPA, 1989 | |
| | | | | CF | Conversion Factor | 1/24 | days/hour | -- | |

**Notes:**

(1) Default for commercial/industrial scenario

(2) Default for CW commercial scenarios.

(3) Default for industrial scenario.

(4) Professional judgment for short-term and longer-term construction activities.

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. USEPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

MDE, 2008: Cleanup Standards for Soil and Groundwater

EPA, 2009: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part F. Supplemental Guidance for Inhalation Risk Assessment.

TABLE 4.6

Exposure Factors for Stormwater

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

| |
|---|
| Scenario Timeframe: Future |
| Medium: Stormwater |
| Exposure Medium: Stormwater |

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/Reference | Intake Equation/Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Utility Worker | Adult | Subsurface Stormwater Pipelines | CW | Chemical Concentration in Storm Water | UCL | μg/l | -- | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | $mg/cm^2$-event | -- | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | Kp | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | |
| | | | | $t_{event}$ | Event Time | 8 | hr/event | (1) | Inorganics: DAevent ($mg/cm^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 5,670 | $cm^3$ | MDE, 2008 (2) | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 2004 | |
| | | | | EF | Exposure Frequency | 25 | days/year | (3) | |
| | | | | ED | Exposure Duration | 1 | years | EPA, 2002 (4) | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 365 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/μg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | $l/cm^3$ | - - | |

**Notes:**

(1) Professional judgment.

(2) Industrial site or commercial site.

(3) Professional judgment; yearly inspection of 14th & 15th Street drain lines requires a maximum of 8 days total. 9th Street to 13th Street drain lines are cleaned on an irregular basis (conservatively assumed at 17 days/year).

(4) Inspections currently performed by CH2M HILL, drain cleaning currently performed by MES or subcontractors.

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

MDE, 2008: Cleanup Standards for Soil and Groundwater

TABLE 4.7

Exposure Factors for Surface Water

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/References | Intake Equation/Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Recreational User | Adult | Patapsco River | CW | Chemical Concentration in Water | UCL | µg/l | - - | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 0.050 | liters/hour | EPA, 1989 | CW x IR-W x ET x EV x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | ET | Exposure Time | 3 | hours/event | EPA, 1997 (1) | |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 1997 | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 30 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 10,950 | days | EPA, 1989 | |
| | | Adolescent (4) | Patapsco River | CW | Chemical Concentration in Water | UCL | µg/l | - - | CDI (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 0.050 | liters/hour | EPA, 1989 | CW x IR-W x ET x EV x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | ET | Exposure Time | 3 | hours/event | EPA, 1997 (1) | |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 1997 | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 12 | years | MDE, 2008 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 40 | kg | MDE, 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 4,380 | days | MDE, 2008 | |
| | | Child | Patapsco River | CW | Chemical Concentration in Water | UCL | µg/l | - - | CDI (mg/kg-day) = |
| | | | | IR-W | Ingestion Rate of Water | 0.050 | liters/hour | EPA, 1989 | CW x IR-W x ET x EV x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | ET | Exposure Time | 3 | hours/event | EPA, 1997 (1) | |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 1997 | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | Child/Adolescent/Adult | Patapsco River | CW | Chemical Concentration in Water | UCL | µg/l | - - | CDI (mg/kg-day) = |
| | | Aggregate | | IR-W-Adj | Ingestion Rate of Water, Age-adjusted | 0.111 | liters-year/event-kg | calculated | CW x IR-W-adj x EV x EF x CF1 x 1/AT |
| | | | | IR-W | Ingestion Rate of Water | 0.050 | liters/hour | EPA, 1989 | |
| | | | | ET | Exposure Time | 3 | hours/event | EPA, 1997 (1) | IR-W-Adj (liters-year/event-kg) = |
| | | | | $ED_{adult}$ | Exposure Duration (adult) | 24 | years | EPA, 1991 | ∑(IR-W x ET x ED x 1/BW) [from adult and child age groups (5)] |
| | | | | $ED_{child}$ | Exposure Duration (child) | 6 | years | EPA, 1991 | |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 1997 | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | $BW_{adult}$ | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | $BW_{child}$ | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |

TABLE 4.7

Exposure Factors for Surface Water

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/References | Intake Equation/Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Recreational User | Adult | Patapsco River | CW | Chemical Concentration in Water | UCL | µg/l | -- | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | mg/cm$^2$-event | -- | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | Kp | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | |
| | | | | $t_{event}$ | Event Time | 3 | hr/event | EPA, 1997 (1) | Inorganics: DAevent (mg/cm$^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 18,000 | cm$^2$ | EPA, 2004 (3) | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 1997 | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 30 | years | EPA, 1991 | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 10,950 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | l/cm$^3$ | - - | |
| | | Adolescent (4) | Patapsco River | CW | Chemical Concentration in Water | UCL | µg/l | -- | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | mg/cm$^2$-event | -- | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | Kp | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | |
| | | | | $t_{event}$ | Event Time | 3 | hr/event | EPA, 1997 (1) | Inorganics: DAevent (mg/cm$^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 13,100 | cm$^2$ | MDE, 2008 (3) | Kp x CW x tevent x CF1 x CF2 |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 1997 | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 12 | years | MDE, 2008 | |
| | | | | BW | Body Weight | 40 | kg | MDE 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 4,380 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | l/cm$^3$ | - - | |
| | | Child | Patapsco River | CW | Chemical Concentration in Water | UCL | µg/l | -- | CDI (mg/kg-day) = |
| | | | | DAevent | Dermally Absorbed Dose per Event | calculated | mg/cm$^2$-event | -- | DAevent x SA x EV x EF x ED x 1/BW x 1/AT |
| | | | | Kp | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | |
| | | | | $t_{event}$ | Event Time | 3 | hr/event | EPA, 1997 (1) | Inorganics: DAevent (mg/cm$^2$-event) = |
| | | | | SA | Skin Surface Area Available for Contact | 6,600 | cm$^2$ | EPA, 2004 (3) | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 1997 | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | l/cm$^3$ | - - | |

TABLE 4.7

Exposure Factors for Surface Water

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

| |
|---|
| Scenario Timeframe: Current/Future |
| Medium: Surface Water |
| Exposure Medium: Surface Water |

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/References | Intake Equation/Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Recreational User | Child/Adolescent/Adult | Patapsco River | CW | Chemical Concentration in Water | UCL | µg/l | -- | CDI (mg/kg-day) = |
| (cont.) | (cont.) | Aggregate | | DAevent | Dermally Absorbed Dose per Event | calculated | mg/cm$^2$-event | -- | DAevent-Adj x EV x EF x 1/AT |
| | | | | DAevent-Adj | Dermally Absorbed Dose per Event, Age-adjusted | calculated | mg-year/event-kg | calculated | Inorganics: DAevent (mg/cm2-event) = |
| | | | | Kp | Permeability Coefficient | chemical-specific | cm/hr | EPA, 2004 | Kp x CW x $t_{event}$ x CF1 x CF2 |
| | | | | $t_{event}$ | Event Time | 3 | hr/event | EPA, 1997 (1) | |
| | | | | $SA_{adult}$ | Skin Surface Area Available for Contact | 18,000 | cm$^2$ | EPA, 2004 (3) | DAevent-Adj (mg-year/event-kg)= |
| | | | | $SA_{child}$ | Skin Surface Area Available for Contact | 6,600 | cm$^2$ | EPA, 2004 (3) | ∑(DA-event x ED x SA/BW)[from adult and child age groups (5)] |
| | | | | EV | Event Frequency | 1 | events/day | EPA, 1997 | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | $ED_{adult}$ | Exposure Duration | 24 | years | EPA, 1991 | |
| | | | | $ED_{child}$ | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | $BW_{adult}$ | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | $BW_{child}$ | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 0.001 | mg/µg | - - | |
| | | | | CF2 | Conversion Factor 2 | 0.001 | l/cm3 | - - | |

**Notes:**

(1) Recommended swimming exposure duration (90th percentile).

(2) EF based on Level 3 Recreational Scenario (Open Space Public Rec Area - Low Frequency Use)

(3) Total body surface area.

(4) Adolescent age group spans 6-18 years of age.

(5) Consistent with MDE's age aggregate approach, adult and child age groups are used.

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

MDE, 2008: Cleanup Standards for Soil and Groundwater

TABLE 4.8

Exposure Factors for Sediment

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Time Frame: Current/Future
Medium: Sediment
Exposure Medium: Sediment

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/Reference | Intake Equation/Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Recreational User | Adult | Patapsco River | CSed | Chemical Concentration in Sediment | UCL | mg/kg | - - | Chronic Daily Intake (CDI) (mg/kg-day) = |
| | | | | IR-Sed | Ingestion Rate of Sediment | 100 | mg/day | EPA, 1991 (1) | CSed x IR-Sed x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 30 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 1.00E-06 | kg/mg | - - | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 10,950 | days | EPA, 1989 | |
| | | Adolescent (3) | Patapsco River | CSed | Chemical Concentration in Sediment | UCL | mg/kg | -- | CDI (mg/kg-day) = |
| | | | | IR-Sed | Ingestion Rate of Sediment | 100 | mg/day | MDE, 2008 (1) | CSed x IR-Sed x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 12 | years | MDE, 2008 | |
| | | | | CF1 | Conversion Factor 1 | 1.00E-06 | kg/mg | - - | |
| | | | | BW | Body Weight | 40 | kg | MDE, 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 4,380 | days | EPA, 1989 | |
| | | Child | Patapsco River | CSed | Chemical Concentration in Sediment | UCL | mg/kg | - - | CDI (mg/kg-day) = |
| | | | | IR-Sed | Ingestion Rate of Sediment | 200 | mg/day | EPA, 1991 (1) | CSed x IR-Sed x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 1.00E-06 | kg/mg | - - | |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | Child/Adolescent/Adult Aggregate | Patapsco River | CSed | Chemical Concentration in Sediment | UCL | mg/kg | - - | CDI (mg/kg-day) = |
| | | | | IR-S-Adj | Ingestion Rate of Sediment, Age-Adjusted | 114 | mg-year/kg-day | Calculated | Csed x IR-S-Adj x EF x CF1 x 1/AT |
| | | | | $IR\text{-}Sed_{adult}$ | Ingestion Rate of Sediment | 100 | mg/day | EPA, 1991 (1) | |
| | | | | $IR\text{-}Sed_{child}$ | Ingestion Rate of Sediment | 200 | mg/day | EPA, 1991 (1) | IR-S-Adj (mg-year/kg-day) |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (3) | ∑(ED x IR-S x 1/BW) [from adult and child age groups (8)] |
| | | | | $ED_{adult}$ | Exposure Duration | 24 | years | EPA, 1991 | |
| | | | | $ED_{child}$ | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | CF1 | Conversion Factor 1 | 1.00E-06 | kg/mg | - - | |
| | | | | $BW_{adult}$ | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | $BW_{child}$ | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |

TABLE 4.8

Exposure Factors for Sediment

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

| |
|---|
| Scenario Time Frame: Current/Future |
| Medium: Sediment |
| Exposure Medium: Sediment |

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/Reference | Intake Equation/Model Name |
|---|---|---|---|---|---|---|---|---|---|
| Dermal Contact | Recreational User | Adult | Patapsco River | CSed | Chemical Concentration in Sediment | UCL | mg/kg | -- | CDI (mg/kg-day) = |
| | | | | SSAF | Sediment to Skin Adherence Factor | 1 | mg/cm$^2$-day | MDEP, 2002 (7) | CSed x SA x SSAF x DABS x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | unitless | EPA, 2004 | |
| | | | | SA | Skin Surface Area Available for Contact | 5,700 | cm$^2$ | EPA, 2004 (4) | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 30 | years | EPA, 1991 | |
| | | | | BW | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 10,950 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 1.00E-06 | kg/mg | - - | |
| | | Adolescent (3) | Patapsco River | CSed | Chemical Concentration in Sediment | UCL | mg/kg | -- | CDI (mg/kg-day) = |
| | | | | SSAF | Sediment to Skin Adherence Factor | 1 | mg/cm$^2$-day | MDEP, 2002 (7) | CSed x SA x SSAF x DABS x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | unitless | EPA, 2004 | |
| | | | | SA | Skin Surface Area Available for Contact | 4,000 | cm$^2$ | EPA, 2004 (5) | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 12 | years | MDE 2008 | |
| | | | | BW | Body Weight | 40 | kg | MDE 2008 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 4,380 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 1.00E-06 | kg/mg | - - | |
| | | Child | Patapsco River | CSed | Chemical Concentration in Sediment | UCL | mg/kg | -- | CDI (mg/kg-day) = |
| | | | | SSAF | Sediment to Skin Adherence Factor | 1 | mg/cm$^2$-day | MDEP, 2002 (7) | CSed x SA x SSAF x DABS x EF x ED x CF1 x 1/BW x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | unitless | EPA, 2004 | |
| | | | | SA | Skin Surface Area Available for Contact | 1,900 | cm$^2$ | EPA, 2004 (6) | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (2) | |
| | | | | ED | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | BW | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | 2,190 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 1.00E-06 | kg/mg | - - | |
| | | Child/Adolescent/Adult Aggregate | Patapsco River | Csed | Chemical Concentration in Sediment | UCL | mg/kg | -- | CDI (mg/kg-day) = |
| | | | | SSAF | Sediment to Skin Adherence Factor | 1 | mg/cm$^2$-day | MDEP, 2002 (7) | Csed x DA-Adj x DABS x CF1 x EF x 1/AT |
| | | | | DABS | Dermal Absorption Factor Solids | chemical-specific | unitless | EPA, 2004 | |
| | | | | DA-Adj | Dermal Absorption, Age-adjusted | 2,714 | mg-year/kg-day | calculated | DA-Adj (mg-year/kg-day) |
| | | | | $SA_{adult}$ | Skin Surface Area Available for Contact | 5,700 | cm$^2$ | EPA, 2004 (4) | ∑(ED x SA x SSAF x 1/BW) [from adult and child age groups (8)] |
| | | | | $SA_{child}$ | Skin Surface Area Available for Contact | 1,900 | cm$^2$ | EPA, 2004 (6) | |
| | | | | EF | Exposure Frequency | 52 | days/year | MDE, 2008 (3) | |
| | | | | $ED_{adult}$ | Exposure Duration | 24 | years | EPA, 1991 | |
| | | | | $ED_{child}$ | Exposure Duration | 6 | years | EPA, 1991 | |
| | | | | $BW_{adult}$ | Body Weight | 70 | kg | EPA, 1991 | |
| | | | | $BW_{child}$ | Body Weight | 15 | kg | EPA, 1991 | |
| | | | | AT-C | Averaging Time (Cancer) | 25,550 | days | EPA, 1989 | |
| | | | | CF1 | Conversion Factor 1 | 1.00E-06 | kg/mg | - - | |

TABLE 4.8

Exposure Factors for Sediment

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

| |
|---|
| Scenario Time Frame: Current/Future |
| Medium: Sediment |
| Exposure Medium: Sediment |

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/Reference | Intake Equation/Model Name |
|---|---|---|---|---|---|---|---|---|---|

**Notes:**

(1) Equal to the soil ingestion rate

(2) EF based on Level 3 Recreational Scenario (Open Space Public Rec Area - Low Frequency Use)

(3) Adolescent age group spans 6-18 years of age.

(4) Average adult surface area for hands, forearms, lower legs, and feet.

(5) Surface area for children age "<7 to <18" for hands, forearms, lower legs and feet

(6) Surface area for children age "<1 to <6" for hands, forearms, lower legs and feet

(7) MDEP's recommended value as a best estimate of the loading that corresponds to a monolayer with most sediment types

(8) Consistent with MDE's age aggregate approach, adult and child age groups are used.

**Sources:**


EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

MDE, 2008: Cleanup Standards for Soil and Groundwater

MDEP, 2002: Technical Update. Weighted Skin-Soil Adherence Factors

TABLE 5.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current
Receptor Population: Recreator
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Ingestion | Aluminum | 9.7E+03 | mg/kg | 8.5E-04 | mg/kg-day | NA | NA | NA | 2.0E-03 | mg/kg-day | 1.0E+00 | mg/kg-day | 2.0E-03 |
| | | | | Iron | 3.6E+04 | mg/kg | 3.1E-03 | mg/kg-day | NA | NA | NA | 7.3E-03 | mg/kg-day | 7.0E-01 | mg/kg-day | 1.0E-02 |
| | | | | Manganese | 9.5E+02 | mg/kg | 8.3E-05 | mg/kg-day | NA | NA | NA | 1.9E-04 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.4E-03 |
| | | | | Vanadium | 1.1E+02 | mg/kg | 9.9E-06 | mg/kg-day | NA | NA | NA | 2.3E-05 | mg/kg-day | 5.0E-03 | mg/kg-day | 4.6E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.8E-02 |
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Dermal | Aluminum | 9.7E+03 | mg/kg | 4.8E-05 | mg/kg-day | NA | NA | NA | 1.1E-04 | mg/kg-day | 1.0E+00 | mg/kg-day | 1.1E-04 |
| | | | | Iron | 3.6E+04 | mg/kg | 1.8E-04 | mg/kg-day | NA | NA | NA | 4.2E-04 | mg/kg-day | 7.0E-01 | mg/kg-day | 6.0E-04 |
| | | | | Manganese | 9.5E+02 | mg/kg | 4.7E-06 | mg/kg-day | NA | NA | NA | 1.1E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 2.0E-03 |
| | | | | Vanadium | 1.1E+02 | mg/kg | 5.6E-07 | mg/kg-day | NA | NA | NA | 1.3E-06 | mg/kg-day | 1.3E-04 | mg/kg-day | 1.0E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.3E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 3.1E-02 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 3.1E-02 |
| Sediment Total | | | | | | | | | | | 0.0E+00 | | | | | 3.1E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Ingestion | Calcium | 1.4E+05 | ug/L | 1.8E-02 | mg/kg-day | NA | NA | NA | 4.1E-02 | mg/kg-day | 3.6E+01 | mg/kg-day | 1.2E-03 |
| | | | | Magnesium | 3.9E+05 | ug/L | 5.1E-02 | mg/kg-day | NA | NA | NA | 1.2E-01 | mg/kg-day | 5.0E+00 | mg/kg-day | 2.4E-02 |
| | | | | Manganese | 7.2E+01 | ug/L | 9.5E-06 | mg/kg-day | NA | NA | NA | 2.2E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.6E-04 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 2.5E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Dermal | Calcium | 1.4E+05 | ug/L | 6.4E-03 | mg/kg-day | NA | NA | NA | 1.5E-02 | mg/kg-day | 3.6E+01 | mg/kg-day | 4.2E-04 |
| | | | | Magnesium | 3.9E+05 | ug/L | 1.8E-02 | mg/kg-day | NA | NA | NA | 4.3E-02 | mg/kg-day | 5.0E+00 | mg/kg-day | 8.5E-03 |
| | | | | Manganese | 7.2E+01 | ug/L | 3.4E-06 | mg/kg-day | NA | NA | NA | 8.0E-06 | mg/kg-day | 5.6E-03 | mg/kg-day | 1.4E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.0E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 3.5E-02 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 3.5E-02 |
| Surface Water Total | | | | | | | | | | | 0.0E+00 | | | | | 3.5E-02 |
| Receptor Total | | | | | | | | | | | 0.0E+00 | | | | | 6.7E-02 |

NA = Not applicable.

TABLE 5.1.RME SUPPLEMENT A
CALCULATION OF DAEVENT
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Surface Water Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/$cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Calcium | 1.35E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 4.1E-04 | 1 |
| Magnesium | 3.89E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 1.2E-03 | 1 |
| Manganese | 7.24E+01 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 2.2E-07 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$DA_{event}$ = Kp x CW x tevent x 0.001 mg/ug x 0.001 l/$cm^3$ (Eq 1)

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t* - Time to reach steady-state

TABLE 5.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current
Receptor Population: Recreator
Receptor Age: Adolescent

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Ingestion | Aluminum | 9.7E+03 | mg/kg | 5.9E-04 | mg/kg-day | NA | NA | NA | 3.5E-03 | mg/kg-day | 1.0E+00 | mg/kg-day | 3.5E-03 |
| | | | | Iron | 3.6E+04 | mg/kg | 2.2E-03 | mg/kg-day | NA | NA | NA | 1.3E-02 | mg/kg-day | 7.0E-01 | mg/kg-day | 1.8E-02 |
| | | | | Manganese | 9.5E+02 | mg/kg | 5.8E-05 | mg/kg-day | NA | NA | NA | 3.4E-04 | mg/kg-day | 1.4E-01 | mg/kg-day | 2.4E-03 |
| | | | | Vanadium | 1.1E+02 | mg/kg | 6.9E-06 | mg/kg-day | NA | NA | NA | 4.0E-05 | mg/kg-day | 5.0E-03 | mg/kg-day | 8.0E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 3.2E-02 |
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Dermal | Aluminum | 9.7E+03 | mg/kg | 2.4E-05 | mg/kg-day | NA | NA | NA | 1.4E-04 | mg/kg-day | 1.0E+00 | mg/kg-day | 1.4E-04 |
| | | | | Iron | 3.6E+04 | mg/kg | 8.8E-05 | mg/kg-day | NA | NA | NA | 5.1E-04 | mg/kg-day | 7.0E-01 | mg/kg-day | 7.3E-04 |
| | | | | Manganese | 9.5E+02 | mg/kg | 2.3E-06 | mg/kg-day | NA | NA | NA | 1.3E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 2.4E-03 |
| | | | | Vanadium | 1.1E+02 | mg/kg | 2.8E-07 | mg/kg-day | NA | NA | NA | 1.6E-06 | mg/kg-day | 1.3E-04 | mg/kg-day | 1.2E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.6E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 4.8E-02 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 4.8E-02 |
| Sediment Total | | | | | | | | | | | 0.0E+00 | | | | | 4.8E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Ingestion | Calcium | 1.4E+05 | ug/L | 1.2E-02 | mg/kg-day | NA | NA | NA | 7.2E-02 | mg/kg-day | 3.6E+01 | mg/kg-day | 2.0E-03 |
| | | | | Magnesium | 3.9E+05 | ug/L | 3.6E-02 | mg/kg-day | NA | NA | NA | 2.1E-01 | mg/kg-day | 5.0E+00 | mg/kg-day | 4.2E-02 |
| | | | | Manganese | 7.2E+01 | ug/L | 6.6E-06 | mg/kg-day | NA | NA | NA | 3.9E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 2.8E-04 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 4.4E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Dermal | Calcium | 1.4E+05 | ug/L | 3.3E-03 | mg/kg-day | NA | NA | NA | 1.9E-02 | mg/kg-day | 3.6E+01 | mg/kg-day | 5.3E-04 |
| | | | | Magnesium | 3.9E+05 | ug/L | 9.3E-03 | mg/kg-day | NA | NA | NA | 5.4E-02 | mg/kg-day | 5.0E+00 | mg/kg-day | 1.1E-02 |
| | | | | Manganese | 7.2E+01 | ug/L | 1.7E-06 | mg/kg-day | NA | NA | NA | 1.0E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 1.8E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.3E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 5.7E-02 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 5.7E-02 |
| Surface Water Total | | | | | | | | | | | 0.0E+00 | | | | | 5.7E-02 |
| Receptor Total | | | | | | | | | | | 0.0E+00 | | | | | 1.0E-01 |

NA = Not applicable.

TABLE 5.2.RME SUPPLEMENT A
CALCULATION OF DAEVENT
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Surface Water Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Calcium | 1.35E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 4.1E-04 | 1 |
| Magnesium | 3.89E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 1.2E-03 | 1 |
| Manganese | 7.24E+01 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 2.2E-07 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$DA_{event}$ = Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm$^3$ (Eq 1)

Notes:
NA - Not applicable
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).
t* - Time to reach steady-state

TABLE 5.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current
Receptor Population: Recreator
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC Value | EPC Units | Cancer Intake/Exposure Concentration Value | Cancer Intake/Exposure Concentration Units | CSF/Unit Risk Value | CSF/Unit Risk Units | Cancer Risk | Non-Cancer Intake/Exposure Concentration Value | Non-Cancer Intake/Exposure Concentration Units | RfD/RfC Value | RfD/RfC Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Ingestion | Aluminum | 9.7E+03 | mg/kg | 1.6E-03 | mg/kg-day | NA | NA | NA | 1.9E-02 | mg/kg-day | 1.0E+00 | mg/kg-day | 1.9E-02 |
| | | | | Iron | 3.6E+04 | mg/kg | 5.9E-03 | mg/kg-day | NA | NA | NA | 6.9E-02 | mg/kg-day | 7.0E-01 | mg/kg-day | 9.8E-02 |
| | | | | Manganese | 9.5E+02 | mg/kg | 1.5E-04 | mg/kg-day | NA | NA | NA | 1.8E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.3E-02 |
| | | | | Vanadium | 1.1E+02 | mg/kg | 1.8E-05 | mg/kg-day | NA | NA | NA | 2.1E-04 | mg/kg-day | 5.0E-03 | mg/kg-day | 4.3E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.7E-01 |
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Dermal | Aluminum | 9.7E+03 | mg/kg | 1.5E-05 | mg/kg-day | NA | NA | NA | 1.8E-04 | mg/kg-day | 1.0E+00 | mg/kg-day | 1.8E-04 |
| | | | | Iron | 3.6E+04 | mg/kg | 5.6E-05 | mg/kg-day | NA | NA | NA | 6.5E-04 | mg/kg-day | 7.0E-01 | mg/kg-day | 9.3E-04 |
| | | | | Manganese | 9.5E+02 | mg/kg | 1.5E-06 | mg/kg-day | NA | NA | NA | 1.7E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 3.1E-03 |
| | | | | Vanadium | 1.1E+02 | mg/kg | 1.7E-07 | mg/kg-day | NA | NA | NA | 2.0E-06 | mg/kg-day | 1.3E-04 | mg/kg-day | 1.6E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 2.0E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 1.9E-01 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 1.9E-01 |
| Sediment Total | | | | | | | | | | | 0.0E+00 | | | | | 1.9E-01 |
| Surface Water | Surface Water | Patapsco River Surface Water | Ingestion | Calcium | 1.4E+05 | ug/L | 1.7E-02 | mg/kg-day | NA | NA | NA | 1.9E-01 | mg/kg-day | 1.7E+02 | mg/kg-day | 1.2E-03 |
| | | | | Magnesium | 3.9E+05 | ug/L | 4.7E-02 | mg/kg-day | NA | NA | NA | 5.5E-01 | mg/kg-day | 4.3E+00 | mg/kg-day | 1.3E-01 |
| | | | | Manganese | 7.2E+01 | ug/L | 8.8E-06 | mg/kg-day | NA | NA | NA | 1.0E-04 | mg/kg-day | 1.4E-01 | mg/kg-day | 7.4E-04 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.3E-01 |
| Surface Water | Surface Water | Patapsco River Surface Water | Dermal | Calcium | 1.4E+05 | ug/L | 2.2E-03 | mg/kg-day | NA | NA | NA | 2.5E-02 | mg/kg-day | 1.7E+02 | mg/kg-day | 1.5E-04 |
| | | | | Magnesium | 3.9E+05 | ug/L | 6.3E-03 | mg/kg-day | NA | NA | NA | 7.3E-02 | mg/kg-day | 4.3E+00 | mg/kg-day | 1.7E-02 |
| | | | | Manganese | 7.2E+01 | ug/L | 1.2E-06 | mg/kg-day | NA | NA | NA | 1.4E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 2.4E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.9E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 1.5E-01 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 1.5E-01 |
| Surface Water Total | | | | | | | | | | | 0.0E+00 | | | | | 1.5E-01 |
| Receptor Total | | | | | | | | | | | 0.0E+00 | | | | | 3.4E-01 |

NA = Not applicable.

TABLE 5.3.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Surface Water Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Calcium | 1.35E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 4.1E-04 | 1 |
| Magnesium | 3.89E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 1.2E-03 | 1 |
| Manganese | 7.24E+01 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 2.2E-07 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$$DA_{event} = \text{Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm}^3 \quad \text{(Eq 1)}$$

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t* - Time to reach steady-state

TABLE 5.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: DMT Workers
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Surface Soil | Surface Soil (0-0.5 feet) | Surface Soil | Ingestion | Calcium | 1.4E+05 | mg/kg | 2.4E-02 | mg/kg-day | NA | NA | NA | 6.7E-02 | mg/kg/day | 3.6E+01 | mg/kg-day | 1.9E-03 |
| | | | | Chromium (VI) | 2.4E+03 | mg/kg | 4.2E-04 | mg/kg-day | NA | NA | NA | 1.2E-03 | mg/kg/day | 3.0E-03 | mg/kg-day | 3.9E-01 |
| | | | | Iron | 3.9E+04 | mg/kg | 6.8E-03 | mg/kg-day | NA | NA | NA | 1.9E-02 | mg/kg/day | 7.0E-01 | mg/kg-day | 2.7E-02 |
| | | | | Manganese | 7.5E+02 | mg/kg | 1.3E-04 | mg/kg-day | NA | NA | NA | 3.7E-04 | mg/kg/day | 1.4E-01 | mg/kg-day | 2.6E-03 |
| | | | | Vanadium | 3.9E+02 | mg/kg | 6.8E-05 | mg/kg-day | NA | NA | NA | 1.9E-04 | mg/kg/day | 9.0E-03 | mg/kg-day | 2.1E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 4.5E-01 |
| Surface Soil | Surface Soil (0-0.5 feet) | Surface Soil | Dermal | Calcium | 1.4E+05 | mg/kg | 1.1E-04 | mg/kg-day | NA | NA | NA | 3.1E-04 | mg/kg/day | 3.6E+01 | mg/kg-day | 8.7E-06 |
| | | | | Chromium (VI) | 2.4E+03 | mg/kg | 1.9E-06 | mg/kg-day | NA | NA | NA | 5.4E-06 | mg/kg/day | 7.5E-05 | mg/kg-day | 7.3E-02 |
| | | | | Iron | 3.9E+04 | mg/kg | 3.2E-05 | mg/kg-day | NA | NA | NA | 8.8E-05 | mg/kg/day | 7.0E-01 | mg/kg-day | 1.3E-04 |
| | | | | Manganese | 7.5E+02 | mg/kg | 6.0E-07 | mg/kg-day | NA | NA | NA | 1.7E-06 | mg/kg/day | 5.6E-03 | mg/kg-day | 3.0E-04 |
| | | | | Vanadium | 3.9E+02 | mg/kg | 3.1E-07 | mg/kg-day | NA | NA | NA | 8.8E-07 | mg/kg/day | 2.3E-04 | mg/kg-day | 3.8E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 7.7E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 5.2E-01 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 5.2E-01 |
| Surface Soil | Outdoor Air | Emissions from Surface Soil | Inhalation | Calcium | 1.8E-03 | $mg/m^3$ | 1.4E-04 | $mg/m^3$ | NA | NA | NA | 4.0E-04 | $mg/m^3$ | NA | NA | NA |
| | | | | Chromium (VI) | 3.1E-05 | $mg/m^3$ | 2.5E-06 | $mg/m^3$ | 8.4E-02 | 1/(ug/m3) | 2.1E-04 | 7.1E-06 | $mg/m^3$ | 1.0E-04 | mg/m3 | 7.1E-02 |
| | | | | Iron | 5.0E-04 | $mg/m^3$ | 4.1E-05 | $mg/m^3$ | NA | NA | NA | 1.1E-04 | $mg/m^3$ | NA | NA | NA |
| | | | | Manganese | 9.6E-06 | $mg/m^3$ | 7.8E-07 | $mg/m^3$ | NA | NA | NA | 2.2E-06 | $mg/m^3$ | 5.0E-05 | mg/m3 | 4.4E-02 |
| | | | | Vanadium | 5.0E-06 | $mg/m^3$ | 4.1E-07 | $mg/m^3$ | 8.3E-03 | 1/(ug/m3) | 3.4E-06 | 1.1E-06 | $mg/m^3$ | 7.0E-06 | mg/m3 | 1.6E-01 |
| | | | Exp. Route Total | | | | | | | | 2.1E-04 | | | | | 2.8E-01 |
| | | Exposure Point Total | | | | | | | | | 2.1E-04 | | | | | 2.8E-01 |
| | Exposure Medium Total | | | | | | | | | | 2.1E-04 | | | | | 2.8E-01 |
| Soil Total | | | | | | | | | | | 2.1E-04 | | | | | 8.0E-01 |
| Receptor Total | | | | | | | | | | | 2.1E-04 | | | | | 8.0E-01 |

NA = Not applicable.

TABLE 5.5.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: DMT Workers
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC Value | EPC Units | Cancer Risk Calculations: Intake/Exposure Concentration Value | Intake/Exposure Concentration Units | CSF/Unit Risk Value | CSF/Unit Risk Units | Cancer Risk | Non-Cancer Hazard Calculations: Intake/Exposure Concentration Value | Intake/Exposure Concentration Units | RfD/RfC Value | RfD/RfC Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Soil | Total Soil (0-10 feet) | Total Soil | Ingestion | Calcium | 1.7E+05 | mg/kg | 2.9E-02 | mg/kg-day | NA | NA | NA | 8.1E-02 | mg/kg/day | 3.6E+01 | mg/kg-day | 2.3E-03 |
| | | | | Chromium (VI) | 3.1E+03 | mg/kg | 5.4E-04 | mg/kg-day | NA | NA | NA | 1.5E-03 | mg/kg/day | 3.0E-03 | mg/kg-day | 5.0E-01 |
| | | | | Iron | 6.9E+04 | mg/kg | 1.2E-02 | mg/kg-day | NA | NA | NA | 3.4E-02 | mg/kg/day | 7.0E-01 | mg/kg-day | 4.9E-02 |
| | | | | Manganese | 8.1E+02 | mg/kg | 1.4E-04 | mg/kg-day | NA | NA | NA | 3.9E-04 | mg/kg/day | 1.4E-01 | mg/kg-day | 2.8E-03 |
| | | | | Vanadium | 6.1E+02 | mg/kg | 1.1E-04 | mg/kg-day | NA | NA | NA | 3.0E-04 | mg/kg/day | 9.0E-03 | mg/kg-day | 3.3E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 5.9E-01 |
| Total Soil | Total Soil (0-10 feet) | Total Soil | Dermal | Calcium | 1.7E+05 | mg/kg | 1.3E-04 | mg/kg-day | NA | NA | NA | 3.7E-04 | mg/kg/day | 3.6E+01 | mg/kg-day | 1.0E-05 |
| | | | | Chromium (VI) | 3.1E+03 | mg/kg | 2.5E-06 | mg/kg-day | NA | NA | NA | 6.9E-06 | mg/kg/day | 7.5E-05 | mg/kg-day | 9.2E-02 |
| | | | | Iron | 6.9E+04 | mg/kg | 5.6E-05 | mg/kg-day | NA | NA | NA | 1.6E-04 | mg/kg/day | 7.0E-01 | mg/kg-day | 2.2E-04 |
| | | | | Manganese | 8.1E+02 | mg/kg | 6.5E-07 | mg/kg-day | NA | NA | NA | 1.8E-06 | mg/kg/day | 5.6E-03 | mg/kg-day | 3.3E-04 |
| | | | | Vanadium | 6.1E+02 | mg/kg | 4.9E-07 | mg/kg-day | NA | NA | NA | 1.4E-06 | mg/kg/day | 2.3E-04 | mg/kg-day | 5.9E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 9.9E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 6.9E-01 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 6.9E-01 |
| Total Soil | Outdoor Air | Emissions from Total Soil | Inhalation | Calcium | 2.1E-03 | mg/m$^3$ | 1.7E-04 | mg/m$^3$ | NA | NA | NA | 4.9E-04 | mg/m$^3$ | NA | NA | NA |
| | | | | Chromium (VI) | 3.9E-05 | mg/m$^3$ | 3.2E-06 | mg/m$^3$ | 8.4E-02 | 1/(ug/m3) | 2.7E-04 | 9.0E-06 | mg/m$^3$ | 1.0E-04 | mg/m3 | 9.0E-02 |
| | | | | Iron | 8.9E-04 | mg/m$^3$ | 7.3E-05 | mg/m$^3$ | NA | NA | NA | 2.0E-04 | mg/m$^3$ | NA | NA | NA |
| | | | | Manganese | 1.0E-05 | mg/m$^3$ | 8.4E-07 | mg/m$^3$ | NA | NA | NA | 2.4E-06 | mg/m$^3$ | 5.0E-05 | mg/m3 | 4.7E-02 |
| | | | | Vanadium | 7.8E-06 | mg/m$^3$ | 6.3E-07 | mg/m$^3$ | 8.3E-03 | 1/(ug/m3) | 5.3E-06 | 1.8E-06 | mg/m$^3$ | 7.0E-06 | mg/m3 | 2.5E-01 |
| | | | Exp. Route Total | | | | | | | | 2.7E-04 | | | | | 3.9E-01 |
| | | Exposure Point Total | | | | | | | | | 2.7E-04 | | | | | 3.9E-01 |
| | Exposure Medium Total | | | | | | | | | | 2.7E-04 | | | | | 3.9E-01 |
| Soil Total | | | | | | | | | | | 2.7E-04 | | | | | 1.1E+00 |
| Receptor Total | | | | | | | | | | | 2.7E-04 | | | | | 1.1E+00 |

NA = Not applicable.

TABLE 5.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Construction Worker (Low Exposure Frequency)
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Total Soil | Total Soil (0-10 feet) | Total Soil | Ingestion | Calcium | 1.7E+05 | mg/kg | 2.7E-03 | mg/kg-day | NA | NA | NA | 1.9E-01 | mg/kg-day | 3.6E+01 | mg/kg-day | 5.2E-03 |
| | | | | Chromium (VI) | 3.1E+03 | mg/kg | 4.9E-05 | mg/kg-day | NA | NA | NA | 3.5E-03 | mg/kg-day | 3.0E-03 | mg/kg-day | 1.2E+00 |
| | | | | Iron | 6.9E+04 | mg/kg | 1.1E-03 | mg/kg-day | NA | NA | NA | 7.8E-02 | mg/kg-day | 7.0E-01 | mg/kg-day | 1.1E-01 |
| | | | | Manganese | 8.1E+02 | mg/kg | 1.3E-05 | mg/kg-day | NA | NA | NA | 9.1E-04 | mg/kg-day | 1.4E-01 | mg/kg-day | 6.5E-03 |
| | | | | Vanadium | 6.1E+02 | mg/kg | 9.8E-06 | mg/kg-day | NA | NA | NA | 6.8E-04 | mg/kg-day | 9.0E-03 | mg/kg-day | 7.6E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.4E+00 |
| Total Soil | Total Soil (0-10 feet) | Total Soil | Dermal | Calcium | 1.7E+05 | mg/kg | 3.7E-06 | mg/kg-day | NA | NA | NA | 2.6E-04 | mg/kg-day | 3.6E+01 | mg/kg-day | 7.2E-06 |
| | | | | Chromium (VI) | 3.1E+03 | mg/kg | 6.8E-08 | mg/kg-day | NA | NA | NA | 4.7E-06 | mg/kg-day | 7.5E-05 | mg/kg-day | 6.3E-02 |
| | | | | Iron | 6.9E+04 | mg/kg | 1.5E-06 | mg/kg-day | NA | NA | NA | 1.1E-04 | mg/kg-day | 7.0E-01 | mg/kg-day | 1.5E-04 |
| | | | | Manganese | 8.1E+02 | mg/kg | 1.8E-08 | mg/kg-day | NA | NA | NA | 1.2E-06 | mg/kg-day | 5.6E-03 | mg/kg-day | 2.2E-04 |
| | | | | Vanadium | 6.1E+02 | mg/kg | 1.3E-08 | mg/kg-day | NA | NA | NA | 9.3E-07 | mg/kg-day | 2.3E-04 | mg/kg-day | 4.0E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 6.7E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 1.4E+00 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 1.4E+00 |
| Total Soil | Outdoor Air | Emissions from Total Soil | Inhalation | Calcium | 2.1E-03 | $mg/m^3$ | 1.7E-06 | $mg/m^3$ | NA | NA | NA | 1.2E-04 | mg/m3 | NA | NA | NA |
| | | | | Chromium (VI) | 3.9E-05 | $mg/m^3$ | 3.1E-08 | $mg/m^3$ | 8.4E-02 | 1/(ug/m3) | 2.6E-06 | 2.2E-06 | mg/m3 | 1.0E-04 | mg/m3 | 2.2E-02 |
| | | | | Iron | 8.9E-04 | $mg/m^3$ | 7.0E-07 | $mg/m^3$ | NA | NA | NA | 4.9E-05 | mg/m3 | NA | NA | NA |
| | | | | Manganese | 1.0E-05 | $mg/m^3$ | 8.1E-09 | $mg/m^3$ | NA | NA | NA | 5.7E-07 | mg/m3 | 5.0E-05 | mg/m3 | 1.1E-02 |
| | | | | Vanadium | 7.8E-06 | $mg/m^3$ | 6.1E-09 | $mg/m^3$ | 8.3E-03 | 1/(ug/m3) | 5.1E-08 | 4.3E-07 | mg/m3 | 7.0E-06 | mg/m3 | 6.1E-02 |
| | | | Exp. Route Total | | | | | | | | 2.6E-06 | | | | | 9.4E-02 |
| | | Exposure Point Total | | | | | | | | | 2.6E-06 | | | | | 9.4E-02 |
| | Exposure Medium Total | | | | | | | | | | 2.6E-06 | | | | | 9.4E-02 |
| Soil Total | | | | | | | | | | | 2.6E-06 | | | | | 1.5E+00 |
| Groundwater | Groundwater (Excavation) | Groundwater (Excavation) | Dermal | Aluminum | 2.9E+04 | ug/L | 3.2E-06 | mg/kg-day | NA | NA | NA | 2.2E-04 | mg/kg-day | 1.0E+00 | mg/kg-day | 2.2E-04 |
| | | | | Calcium | 2.2E+05 | ug/L | 2.4E-05 | mg/kg-day | NA | NA | NA | 1.7E-03 | mg/kg-day | 3.6E+01 | mg/kg-day | 4.7E-05 |
| | | | | Chromium (III) | 6.5E+03 | ug/L | 7.1E-07 | mg/kg-day | NA | NA | NA | 5.0E-05 | mg/kg-day | 2.0E-02 | mg/kg-day | 2.6E-03 |
| | | | | Chromium (VI) | 1.1E+04 | ug/L | 2.3E-06 | mg/kg-day | NA | NA | NA | 1.6E-04 | mg/kg-day | 7.5E-05 | mg/kg-day | 2.2E+00 |
| | | | | Iron | 1.7E+05 | ug/L | 1.9E-05 | mg/kg-day | NA | NA | NA | 1.4E-03 | mg/kg-day | 7.0E-01 | mg/kg-day | 1.9E-03 |
| | | | | Magnesium | 1.1E+05 | ug/L | 1.2E-05 | mg/kg-day | NA | NA | NA | 8.3E-04 | mg/kg-day | 5.0E+00 | mg/kg-day | 1.7E-04 |
| | | | | Manganese | 2.8E+03 | ug/L | 3.1E-07 | mg/kg-day | NA | NA | NA | 2.2E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 3.9E-03 |
| | | | | Vanadium | 5.9E+02 | ug/L | 6.5E-08 | mg/kg-day | NA | NA | NA | 4.5E-06 | mg/kg-day | 1.3E-04 | mg/kg-day | 3.5E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 2.2E+00 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 2.2E+00 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 2.2E+00 |
| Groundwater Total | | | | | | | | | | | 0.0E+00 | | | | | 2.2E+00 |
| Receptor Total | | | | | | | | | | | 2.6E-06 | | | | | 3.7E+00 |

NA = Not applicable.

TABLE 5.6.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Groundwater Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 2.86E+04 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.7E-05 | 1 |
| Calcium | 2.17E+05 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.3E-04 | 1 |
| Chromium (III) | 6.47E+03 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 3.8E-06 | 1 |
| Chromium (VI) | 1.06E+04 | 2.0E-03 | NA | NA | NA | NA | 0.58 | 1.2E-05 | 1 |
| Iron | 1.75E+05 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.0E-04 | 1 |
| Magnesium | 1.07E+05 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 6.2E-05 | 1 |
| Manganese | 2.80E+03 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.6E-06 | 1 |
| Vanadium | 5.88E+02 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 3.4E-07 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$$DA_{event} = \quad Kp \times CW \times tevent \times 0.001\ mg/ug \times 0.001\ l/cm^3 \qquad \text{(Eq 1)}$$

Notes:
NA - Not applicable
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).
t* - Time to reach steady-state

TABLE 5.7.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Construction Worker (High Exposure Frequency)
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC Value | EPC Units | Cancer Risk Calculations: Intake/Exposure Concentration Value | Intake/Exposure Concentration Units | CSF/Unit Risk Value | CSF/Unit Risk Units | Cancer Risk | Non-Cancer Hazard Calculations: Intake/Exposure Concentration Value | Intake/Exposure Concentration Units | RfD/RfC Value | RfD/RfC Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Soil | Subsurface Soil (0-10 feet) | Total Soil | Ingestion | Calcium | 1.7E+05 | mg/kg | 1.1E-02 | mg/kg-day | NA | NA | NA | 7.8E-01 | mg/kg-day | 3.6E+01 | mg/kg-day | 2.2E-02 |
| | | | | Chromium (VI) | 3.1E+03 | mg/kg | 2.1E-04 | mg/kg-day | NA | NA | NA | 1.4E-02 | mg/kg-day | 3.0E-03 | mg/kg-day | 4.8E+00 |
| | | | | Iron | 6.9E+04 | mg/kg | 4.7E-03 | mg/kg-day | NA | NA | NA | 3.3E-01 | mg/kg-day | 7.0E-01 | mg/kg-day | 4.7E-01 |
| | | | | Manganese | 8.1E+02 | mg/kg | 5.4E-05 | mg/kg-day | NA | NA | NA | 3.8E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 2.7E-02 |
| | | | | Vanadium | 6.1E+02 | mg/kg | 4.1E-05 | mg/kg-day | NA | NA | NA | 2.8E-03 | mg/kg-day | 9.0E-03 | mg/kg-day | 3.2E-01 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 5.6E+00 |
| Total Soil | Subsurface Soil (0-10 feet) | Total Soil | Dermal | Calcium | 1.7E+05 | mg/kg | 1.5E-05 | mg/kg-day | NA | NA | NA | 1.1E-03 | mg/kg-day | 3.6E+01 | mg/kg-day | 3.0E-05 |
| | | | | Chromium (VI) | 3.1E+03 | mg/kg | 2.8E-07 | mg/kg-day | NA | NA | NA | 2.0E-05 | mg/kg-day | 7.5E-05 | mg/kg-day | 2.6E-01 |
| | | | | Iron | 6.9E+04 | mg/kg | 6.4E-06 | mg/kg-day | NA | NA | NA | 4.5E-04 | mg/kg-day | 7.0E-01 | mg/kg-day | 6.4E-04 |
| | | | | Manganese | 8.1E+02 | mg/kg | 7.4E-08 | mg/kg-day | NA | NA | NA | 5.2E-06 | mg/kg-day | 5.6E-03 | mg/kg-day | 9.2E-04 |
| | | | | Vanadium | 6.1E+02 | mg/kg | 5.6E-08 | mg/kg-day | NA | NA | NA | 3.9E-06 | mg/kg-day | 2.3E-04 | mg/kg-day | 1.7E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 2.8E-01 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 5.9E+00 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 5.9E+00 |
| Total Soil | Outdoor Air | Emissions from Total Soil | Inhalation | Calcium | 2.1E-03 | $mg/m^3$ | 6.9E-06 | $mg/m^3$ | NA | NA | NA | 4.9E-04 | mg/m3 | NA | NA | NA |
| | | | | Chromium (VI) | 3.9E-05 | $mg/m^3$ | 1.3E-07 | $mg/m^3$ | 8.4E-02 | 1/(ug/m3) | 1.1E-05 | 9.0E-06 | mg/m3 | 1.0E-04 | mg/m3 | 9.0E-02 |
| | | | | Iron | 8.9E-04 | $mg/m^3$ | 2.9E-06 | $mg/m^3$ | NA | NA | NA | 2.0E-04 | mg/m3 | NA | NA | NA |
| | | | | Manganese | 1.0E-05 | $mg/m^3$ | 3.4E-08 | $mg/m^3$ | NA | NA | NA | 2.4E-06 | mg/m3 | 5.0E-05 | mg/m3 | 4.7E-02 |
| | | | | Vanadium | 7.8E-06 | $mg/m^3$ | 2.5E-08 | $mg/m^3$ | 8.3E-03 | 1/(ug/m3) | 2.1E-07 | 1.8E-06 | mg/m3 | 7.0E-06 | mg/m3 | 2.5E-01 |
| | | | Exp. Route Total | | | | | | | | 1.1E-05 | | | | | 3.9E-01 |
| | | Exposure Point Total | | | | | | | | | 1.1E-05 | | | | | 3.9E-01 |
| | Exposure Medium Total | | | | | | | | | | 1.1E-05 | | | | | 3.9E-01 |
| Soil Total | | | | | | | | | | | 1.1E-05 | | | | | 6.3E+00 |
| Groundwater | Groundwater (Excavation) | Groundwater (Excavation) | Dermal | Aluminum | 2.9E+04 | ug/L | 1.3E-05 | mg/kg-day | NA | NA | NA | 9.2E-04 | mg/kg-day | 1.0E+00 | mg/kg-day | 9.2E-04 |
| | | | | Calcium | 2.2E+05 | ug/L | 1.0E-04 | mg/kg-day | NA | NA | NA | 7.0E-03 | mg/kg-day | 3.6E+01 | mg/kg-day | 2.0E-04 |
| | | | | Chromium (III) | 6.5E+03 | ug/L | 3.0E-06 | mg/kg-day | NA | NA | NA | 2.1E-04 | mg/kg-day | 2.0E-02 | mg/kg-day | 1.1E-02 |
| | | | | Chromium (VI) | 1.1E+04 | ug/L | 9.7E-06 | mg/kg-day | NA | NA | NA | 6.8E-04 | mg/kg-day | 7.5E-05 | mg/kg-day | 9.1E+00 |
| | | | | Iron | 1.7E+05 | ug/L | 8.0E-05 | mg/kg-day | NA | NA | NA | 5.6E-03 | mg/kg-day | 7.0E-01 | mg/kg-day | 8.0E-03 |
| | | | | Magnesium | 1.1E+05 | ug/L | 4.9E-05 | mg/kg-day | NA | NA | NA | 3.4E-03 | mg/kg-day | 5.0E+00 | mg/kg-day | 6.9E-04 |
| | | | | Manganese | 2.8E+03 | ug/L | 1.3E-06 | mg/kg-day | NA | NA | NA | 9.0E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 1.6E-02 |
| | | | | Vanadium | 5.9E+02 | ug/L | 2.7E-07 | mg/kg-day | NA | NA | NA | 1.9E-05 | mg/kg-day | 1.3E-04 | mg/kg-day | 1.4E-01 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 9.3E+00 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 9.3E+00 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 9.3E+00 |
| Groundwater Total | | | | | | | | | | | 0.0E+00 | | | | | 9.3E+00 |
| Receptor Total | | | | | | | | | | | 1.1E-05 | | | | | 1.6E+01 |

NA = Not applicable.

TABLE 5.7.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Groundwater Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 2.86E+04 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.7E-05 | 1 |
| Calcium | 2.17E+05 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.3E-04 | 2 |
| Chromium (III) | 6.47E+03 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 3.8E-06 | 3 |
| Chromium (VI) | 1.06E+04 | 2.0E-03 | NA | NA | NA | NA | 0.58 | 1.2E-05 | 4 |
| Iron | 1.75E+05 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.0E-04 | 5 |
| Magnesium | 1.07E+05 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 6.2E-05 | 6 |
| Manganese | 2.80E+03 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 1.6E-06 | 7 |
| Vanadium | 5.88E+02 | 1.0E-03 | NA | NA | NA | NA | 0.58 | 3.4E-07 | 8 |

**Inorganics: DAevent (mg/cm2-event) =**

$$DA_{event} = \quad Kp \times CW \times tevent \times 0.001\ mg/ug \times 0.001\ l/cm^3 \qquad \text{(Eq 1)}$$

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t* - Time to reach steady-state

TABLE 5.8.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Utility Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Storm Water | Storm Water (Non Priority Subsurface Stormwater Lines) | Storm Water (Subsurface Stormwater Lines) | Dermal | Chromium (VI) | 2.1E+02 | ug/L | 2.7E-07 | mg/kg-day | NA | NA | NA | 1.9E-05 | mg/kg-day | 7.5E-05 | mg/kg-day | 2.5E-01 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 2.5E-01 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 2.5E-01 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 2.5E-01 |
| Storm Water Total | | | | | | | | | | | 0.0E+00 | | | | | 2.5E-01 |
| Receptor Total | | | | | | | | | | | 0.0E+00 | | | | | 2.5E-01 |

NA = Not applicable.

TABLE 5.8.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Groundwater Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Chromium (VI) | 2.11E+02 | 2.0E-03 | NA | NA | NA | NA | 8.0 | 3.4E-06 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$DA_{event}$ = Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm$^3$ (Eq 1)

Notes:
NA - Not applicable
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).
t* - Time to reach steady-state

TABLE 5.9 RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

| |
|---|
| Scenario Timeframe: Future |
| Receptor Population: Utility Worker |
| Receptor Age: Adult |

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Storm Water | Storm Water (Priority Subsurface Stormwater Lines) | Storm Water (Subsurface Stormwater Lines) | Dermal | Chromium (III) | 1.3E+03 | ug/L | 8.3E-07 | mg/kg-day | NA | NA | NA | 5.8E-05 | mg/kg-day | 2.0E-02 | mg/kg-day | 3.0E-03 |
| | | | | Chromium (VI) | 2.5E+04 | ug/L | 3.1E-05 | mg/kg-day | NA | NA | NA | 2.2E-03 | mg/kg-day | 7.5E-05 | mg/kg-day | 2.9E+01 |
| | | | | Vanadium | 4.2E+01 | ug/L | 2.7E-08 | mg/kg-day | NA | NA | NA | 1.9E-06 | mg/kg-day | 1.3E-04 | mg/kg-day | 1.4E-02 |
| | | | | Calcium | 4.2E+05 | ug/L | 2.7E-04 | mg/kg-day | NA | NA | NA | 1.9E-02 | mg/kg-day | 3.6E+01 | mg/kg-day | 5.2E-04 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 2.9E+01 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 2.9E+01 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 2.9E+01 |
| Storm Water Total | | | | | | | | | | | 0.0E+00 | | | | | 2.9E+01 |
| Receptor Total | | | | | | | | | | | 0.0E+00 | | | | | 2.9E+01 |

NA = Not applicable.

TABLE 5.9.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Groundwater Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Chromium (III) | 1.31E+03 | 1.0E-03 | NA | NA | NA | NA | 8.0 | 1.1E-05 | 1 |
| Chromium (VI) | 2.46E+04 | 2.0E-03 | NA | NA | NA | NA | 8.0 | 3.9E-04 | 1 |
| Vanadium | 4.20E+01 | 1.0E-03 | NA | NA | NA | NA | 8.0 | 3.4E-07 | 1 |
| Calcium | 4.22E+05 | 1.0E-03 | NA | NA | NA | NA | 8.0 | 3.4E-03 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$$DA_{event} = Kp \times CW \times tevent \times 0.001\ mg/ug \times 0.001\ l/cm^3 \quad \text{(Eq 1)}$$

Notes:
NA - Not applicable
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).
t* - Time to reach steady-state

TABLE 5.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Recreator
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC Value | EPC Units | Cancer Risk Calculations: Intake/Exposure Concentration Value | Intake/Exposure Concentration Units | CSF/Unit Risk Value | CSF/Unit Risk Units | Cancer Risk | Non-Cancer Hazard Calculations: Intake/Exposure Concentration Value | Intake/Exposure Concentration Units | RfD/RfC Value | RfD/RfC Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Ingestion | Aluminum | 1.1E+04 | mg/kg | 9.4E-04 | mg/kg-day | NA | NA | NA | 2.2E-03 | mg/kg-day | 1.0E+00 | mg/kg-day | 2.2E-03 |
| | | | | Iron | 2.8E+04 | mg/kg | 2.4E-03 | mg/kg-day | NA | NA | NA | 5.7E-03 | mg/kg-day | 7.0E-01 | mg/kg-day | 8.1E-03 |
| | | | | Manganese | 5.7E+02 | mg/kg | 5.0E-05 | mg/kg-day | NA | NA | NA | 1.2E-04 | mg/kg-day | 1.4E-01 | mg/kg-day | 8.3E-04 |
| | | | | Vanadium | 5.0E+01 | mg/kg | 4.4E-06 | mg/kg-day | NA | NA | NA | 1.0E-05 | mg/kg-day | 5.0E-03 | mg/kg-day | 2.0E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.3E-02 |
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Dermal | Aluminum | 1.1E+04 | mg/kg | 5.4E-05 | mg/kg-day | NA | NA | NA | 1.3E-04 | mg/kg/day | 1.0E+00 | mg/kg-day | 1.3E-04 |
| | | | | Iron | 2.8E+04 | mg/kg | 1.4E-04 | mg/kg-day | NA | NA | NA | 3.2E-04 | mg/kg/day | 7.0E-01 | mg/kg-day | 4.6E-04 |
| | | | | Manganese | 5.7E+02 | mg/kg | 2.8E-06 | mg/kg-day | NA | NA | NA | 6.6E-06 | mg/kg/day | 5.6E-03 | mg/kg-day | 1.2E-03 |
| | | | | Vanadium | 5.0E+01 | mg/kg | 2.5E-07 | mg/kg-day | NA | NA | NA | 5.8E-07 | mg/kg/day | 1.3E-04 | mg/kg-day | 4.4E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 6.2E-03 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 1.9E-02 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 1.9E-02 |
| Sediment Total | | | | | | | | | | | 0.0E+00 | | | | | 1.9E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Ingestion | Calcium | 1.4E+05 | ug/L | 1.8E-02 | mg/kg-day | NA | NA | NA | 4.1E-02 | mg/kg/day | 3.6E+01 | mg/kg-day | 1.2E-03 |
| | | | | Magnesium | 3.9E+05 | ug/L | 5.1E-02 | mg/kg-day | NA | NA | NA | 1.2E-01 | mg/kg/day | 5.0E+00 | mg/kg-day | 2.4E-02 |
| | | | | Manganese | 7.2E+01 | ug/L | 9.5E-06 | mg/kg-day | NA | NA | NA | 2.2E-05 | mg/kg/day | 1.4E-01 | mg/kg-day | 1.6E-04 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 2.5E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Dermal | Calcium | 1.4E+05 | ug/L | 6.4E-03 | mg/kg-day | NA | NA | NA | 1.5E-02 | mg/kg/day | 3.6E+01 | mg/kg-day | 4.2E-04 |
| | | | | Magnesium | 3.9E+05 | ug/L | 1.8E-02 | mg/kg-day | NA | NA | NA | 4.3E-02 | mg/kg/day | 5.0E+00 | mg/kg-day | 8.5E-03 |
| | | | | Manganese | 7.2E+01 | ug/L | 3.4E-06 | mg/kg-day | NA | NA | NA | 8.0E-06 | mg/kg/day | 5.6E-03 | mg/kg-day | 1.4E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.0E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 3.5E-02 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 3.5E-02 |
| Surface Water Total | | | | | | | | | | | 0.0E+00 | | | | | 3.5E-02 |
| Receptor Total | | | | | | | | | | | 0.0E+00 | | | | | 5.5E-02 |

NA = Not applicable.

TABLE 5.10.RME SUPPLEMENT A
CALCULATION OF DAEVENT
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Surface Water Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent ($mg/cm^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Calcium | 1.35E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 4.1E-04 | 1 |
| Magnesium | 3.89E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 1.2E-03 | 1 |
| Manganese | 7.24E+01 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 2.2E-07 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$DA_{event}$ = Kp x CW x tevent x 0.001 mg/ug x 0.001 $l/cm^3$ (Eq 1)

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t* - Time to reach steady-state

TABLE 5.11.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

Dundalk Marine Terminal, Baltimore, MD

| |
|---|
| Scenario Timeframe: Future |
| Receptor Population: Recreator |
| Receptor Age: Adolescent |

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Units | Intake/Exposure Concentration | | CSF/Unit Risk | | Cancer Risk | Intake/Exposure Concentration | | RfD/RfC | | Hazard Quotient |
| | | | | | | | Value | Units | Value | Units | | Value | Units | Value | Units | |
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Ingestion | Aluminum | 1.1E+04 | mg/kg | 6.6E-04 | mg/kg-day | NA | NA | NA | 3.8E-03 | mg/kg-day | 1.0E+00 | mg/kg-day | 3.8E-03 |
| | | | | Iron | 2.8E+04 | mg/kg | 1.7E-03 | mg/kg-day | NA | NA | NA | 9.9E-03 | mg/kg-day | 7.0E-01 | mg/kg-day | 1.4E-02 |
| | | | | Manganese | 5.7E+02 | mg/kg | 3.5E-05 | mg/kg-day | NA | NA | NA | 2.0E-04 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.4E-03 |
| | | | | Vanadium | 5.0E+01 | mg/kg | 3.1E-06 | mg/kg-day | NA | NA | NA | 1.8E-05 | mg/kg-day | 5.0E-03 | mg/kg-day | 3.5E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 2.3E-02 |
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Dermal | Aluminum | 1.1E+04 | mg/kg | 2.6E-05 | mg/kg-day | NA | NA | NA | 1.5E-04 | mg/kg-day | 1.0E+00 | mg/kg-day | 1.5E-04 |
| | | | | Iron | 2.8E+04 | mg/kg | 6.8E-05 | mg/kg-day | NA | NA | NA | 4.0E-04 | mg/kg-day | 7.0E-01 | mg/kg-day | 5.7E-04 |
| | | | | Manganese | 5.7E+02 | mg/kg | 1.4E-06 | mg/kg-day | NA | NA | NA | 8.1E-06 | mg/kg-day | 5.6E-03 | mg/kg-day | 1.4E-03 |
| | | | | Vanadium | 5.0E+01 | mg/kg | 1.2E-07 | mg/kg-day | NA | NA | NA | 7.1E-07 | mg/kg-day | 1.3E-04 | mg/kg-day | 5.4E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 7.6E-03 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 3.1E-02 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 3.1E-02 |
| Sediment Total | | | | | | | | | | | 0.0E+00 | | | | | 3.1E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Ingestion | Calcium | 1.4E+05 | ug/L | 1.2E-02 | mg/kg-day | NA | NA | NA | 7.2E-02 | mg/kg-day | 3.6E+01 | mg/kg-day | 2.0E-03 |
| | | | | Magnesium | 3.9E+05 | ug/L | 3.6E-02 | mg/kg-day | NA | NA | NA | 2.1E-01 | mg/kg-day | 5.0E+00 | mg/kg-day | 4.2E-02 |
| | | | | Manganese | 7.2E+01 | ug/L | 6.6E-06 | mg/kg-day | NA | NA | NA | 3.9E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 2.8E-04 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 4.4E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Dermal | Calcium | 1.4E+05 | ug/L | 3.3E-03 | mg/kg-day | NA | NA | NA | 1.9E-02 | mg/kg-day | 3.6E+01 | mg/kg-day | 5.3E-04 |
| | | | | Magnesium | 3.9E+05 | ug/L | 9.3E-03 | mg/kg-day | NA | NA | NA | 5.4E-02 | mg/kg-day | 5.0E+00 | mg/kg-day | 1.1E-02 |
| | | | | Manganese | 7.2E+01 | ug/L | 1.7E-06 | mg/kg-day | NA | NA | NA | 1.0E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 1.8E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.3E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 5.7E-02 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 5.7E-02 |
| Surface Water Total | | | | | | | | | | | 0.0E+00 | | | | | 5.7E-02 |
| Receptor Total | | | | | | | | | | | 0.0E+00 | | | | | 8.8E-02 |

NA = Not applicable.

TABLE 5.11.RME SUPPLEMENT A
CALCULATION OF DAEVENT
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Surface Water Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Calcium | 1.35E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 4.1E-04 | 1 |
| Magnesium | 3.89E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 1.2E-03 | 1 |
| Manganese | 7.24E+01 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 2.2E-07 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$DA_{event}$ = Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm$^3$ (Eq 1)

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t* - Time to reach steady-state

TABLE 5.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Recreator
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC Value | EPC Units | Cancer Intake/Exposure Concentration Value | Cancer Intake/Exposure Concentration Units | CSF/Unit Risk Value | CSF/Unit Risk Units | Cancer Risk | Non-Cancer Intake/Exposure Concentration Value | Non-Cancer Intake/Exposure Concentration Units | RfD/RfC Value | RfD/RfC Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Ingestion | Aluminum | 1.1E+04 | mg/kg | 1.8E-03 | mg/kg-day | NA | NA | NA | 2.1E-02 | mg/kg-day | 1.0E+00 | mg/kg-day | 2.1E-02 |
| | | | | Iron | 2.8E+04 | mg/kg | 4.5E-03 | mg/kg-day | NA | NA | NA | 5.3E-02 | mg/kg-day | 7.0E-01 | mg/kg/day | 7.6E-02 |
| | | | | Manganese | 5.7E+02 | mg/kg | 9.3E-05 | mg/kg-day | NA | NA | NA | 1.1E-03 | mg/kg-day | 1.4E-01 | mg/kg/day | 7.7E-03 |
| | | | | Vanadium | 5.0E+01 | mg/kg | 8.2E-06 | mg/kg-day | NA | NA | NA | 9.5E-05 | mg/kg-day | 5.0E-03 | mg/kg/day | 1.9E-02 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.2E-01 |
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Dermal | Aluminum | 1.1E+04 | mg/kg | 1.7E-05 | mg/kg-day | NA | NA | NA | 1.9E-04 | mg/kg-day | 1.0E+00 | mg/kg-day | 1.9E-04 |
| | | | | Iron | 2.8E+04 | mg/kg | 4.3E-05 | mg/kg-day | NA | NA | NA | 5.0E-04 | mg/kg-day | 7.0E-01 | mg/kg/day | 7.2E-04 |
| | | | | Manganese | 5.7E+02 | mg/kg | 8.8E-07 | mg/kg-day | NA | NA | NA | 1.0E-05 | mg/kg-day | 5.6E-03 | mg/kg/day | 1.8E-03 |
| | | | | Vanadium | 5.0E+01 | mg/kg | 7.7E-08 | mg/kg-day | NA | NA | NA | 9.0E-07 | mg/kg-day | 1.3E-04 | mg/kg/day | 6.9E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 9.6E-03 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 1.3E-01 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 1.3E-01 |
| Sediment Total | | | | | | | | | | | 0.0E+00 | | | | | 1.3E-01 |
| Surface Water | Surface Water | Patapsco River Surface Water | Ingestion | Calcium | 1.4E+05 | ug/L | 1.7E-02 | mg/kg-day | NA | NA | NA | 1.9E-01 | mg/kg-day | 1.7E+02 | mg/kg-day | 1.2E-03 |
| | | | | Magnesium | 3.9E+05 | ug/L | 4.7E-02 | mg/kg-day | NA | NA | NA | 5.5E-01 | mg/kg-day | 4.3E+00 | mg/kg-day | 1.3E-01 |
| | | | | Manganese | 7.2E+01 | ug/L | 8.8E-06 | mg/kg-day | NA | NA | NA | 1.0E-04 | mg/kg-day | 1.4E-01 | mg/kg-day | 7.4E-04 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.3E-01 |
| Surface Water | Surface Water | Patapsco River Surface Water | Dermal | Calcium | 1.4E+05 | ug/L | 2.2E-03 | mg/kg-day | NA | NA | NA | 2.5E-02 | mg/kg-day | 1.7E+02 | mg/kg-day | 1.5E-04 |
| | | | | Magnesium | 3.9E+05 | ug/L | 6.3E-03 | mg/kg-day | NA | NA | NA | 7.3E-02 | mg/kg-day | 4.3E+00 | mg/kg-day | 1.7E-02 |
| | | | | Manganese | 7.2E+01 | ug/L | 1.2E-06 | mg/kg-day | NA | NA | NA | 1.4E-05 | mg/kg-day | 5.6E-03 | mg/kg-day | 2.4E-03 |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.9E-02 |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 1.5E-01 |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 1.5E-01 |
| Surface Water Total | | | | | | | | | | | 0.0E+00 | | | | | 1.5E-01 |
| Receptor Total | | | | | | | | | | | 0.0E+00 | | | | | 2.8E-01 |

NA = Not applicable.

TABLE 5.12.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Dundalk Marine Terminal, Baltimore, MD

| Chemical of Potential Concern | Surface Water Concentration (CW) (ug/L) | Permeability Coefficient (Kp) (cm/hr) | B (dimensionless) | Lag Time ($\tau_{event}$) (hr) | t* (hr) | Fraction Absorbed Water (FA) (dimensionless) | Duration of Event (tevent) (hr) | DAevent (mg/cm$^2$-event) | Eq |
|---|---|---|---|---|---|---|---|---|---|
| Calcium | 1.35E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 4.1E-04 | 1 |
| Magnesium | 3.89E+05 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 1.2E-03 | 1 |
| Manganese | 7.24E+01 | 1.0E-03 | NA | NA | NA | NA | 3.0 | 2.2E-07 | 1 |

**Inorganics: DAevent (mg/cm2-event) =**

$$DA_{event} = Kp \times CW \times tevent \times 0.001\ mg/ug \times 0.001\ l/cm^3 \quad \text{(Eq 1)}$$

Notes:
NA - Not applicable
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).
t* - Time to reach steady-state

TABLE 6.1.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current
Receptor Population: Recreator
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Aluminum | NA | NA | NA | NA | CNS | 2E-03 | NA | 1E-04 | 2E-03 |
| | | | Iron | NA | NA | NA | NA | GI | 1E-02 | NA | 6E-04 | 1E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 1E-03 | NA | 2E-03 | 3E-03 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 5E-03 | NA | 1E-02 | 1E-02 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-02 | NA | 1E-02 | 3E-02 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-02 | NA | 1E-02 | 3E-02 |
| Sediment Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-02 | NA | 1E-02 | 3E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Calcium | NA | NA | NA | NA | NOE | 1E-03 | NA | 4E-04 | 2E-03 |
| | | | Magnesium | NA | NA | NA | NA | NOE | 2E-02 | NA | 9E-03 | 3E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 2E-04 | NA | 1E-03 | 2E-03 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 1E-02 | 4E-02 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 1E-02 | 4E-02 |
| Surface Water Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 1E-02 | 4E-02 |
| Receptor Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-02 | NA | 2E-02 | 7E-02 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 7E-03 |
| Total GI HI Across Media = | 1E-02 |
| Total Hair HI Across Media = | 1E-02 |
| Total NOE HI Across Media = | 3E-02 |

TABLE 6.2.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current
Receptor Population: Recreator
Receptor Age: Adolescent

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Aluminum | NA | NA | NA | NA | CNS | 3E-03 | NA | 1E-04 | 4E-03 |
| | | | Iron | NA | NA | NA | NA | GI | 2E-02 | NA | 7E-04 | 2E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 2E-03 | NA | 2E-03 | 5E-03 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 8E-03 | NA | 1E-02 | 2E-02 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 2E-02 | 5E-02 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 2E-02 | 5E-02 |
| Sediment Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 2E-02 | 5E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Calcium | NA | NA | NA | NA | NOE | 2E-03 | NA | 5E-04 | 3E-03 |
| | | | Magnesium | NA | NA | NA | NA | NOE | 4E-02 | NA | 1E-02 | 5E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 3E-04 | NA | 2E-03 | 2E-03 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-02 | NA | 1E-02 | 6E-02 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-02 | NA | 1E-02 | 6E-02 |
| Surface Water Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-02 | NA | 1E-02 | 6E-02 |
| Receptor Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 8E-02 | NA | 3E-02 | 1E-01 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 1E-02 |
| Total GI HI Across Media = | 2E-02 |
| Total Hair HI Across Media = | 2E-02 |
| Total NOE HI Across Media = | 5E-02 |

TABLE 6.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Current
Receptor Population: Recreator
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Sediment | Sediment (0 -1 foot) | Patapsco River Sediment | Aluminum | NA | NA | NA | NA | CNS | 2E-02 | NA | 2E-04 | 2E-02 |
| | | | Iron | NA | NA | NA | NA | GI | 1E-01 | NA | 9E-04 | 1E-01 |
| | | | Manganese | NA | NA | NA | NA | CNS | 1E-02 | NA | 3E-03 | 2E-02 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 4E-02 | NA | 2E-02 | 6E-02 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-01 | NA | 2E-02 | 2E-01 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-01 | NA | 2E-02 | 2E-01 |
| Sediment Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-01 | NA | 2E-02 | 2E-01 |
| Surface Water | Surface Water | Patapsco River Surface Water | Calcium | NA | NA | NA | NA | NOE | 1E-03 | NA | 2E-04 | 1E-03 |
| | | | Magnesium | NA | NA | NA | NA | NOE | 1E-01 | NA | 2E-02 | 1E-01 |
| | | | Manganese | NA | NA | NA | NA | CNS | 7E-04 | NA | 2E-03 | 3E-03 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 2E-02 | 1E-01 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 2E-02 | 1E-01 |
| Surface Water Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 2E-02 | 1E-01 |
| Receptor Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-01 | NA | 4E-02 | 3E-01 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 4E-02 |
| Total GI HI Across Media = | 1E-01 |
| Total Hair HI Across Media = | 6E-02 |
| Total NOE HI Across Media = | 1E-01 |

TABLE 6.4.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: DMT Workers
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Surface Soil | Surface Soil | Surface Soil | Calcium | NA | NA | NA | NA | NOE | 2E-03 | NA | 9E-06 | 2E-03 |
| | | | Chromium (VI) | NA | NA | NA | NA | NOE | 4E-01 | NA | 7E-02 | 5E-01 |
| | | | Iron | NA | NA | NA | NA | GI | 3E-02 | NA | 1E-04 | 3E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 3E-03 | NA | 3E-04 | 3E-03 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 2E-02 | NA | 4E-03 | 2E-02 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-01 | NA | 8E-02 | 5E-01 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-01 | NA | 8E-02 | 5E-01 |
| | Outdoor Air | Emissions from Surface Soil | Calcium | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | Chromium (VI) | NA | 2E-04 | NA | 2E-04 | Respiratory | NA | 7E-02 | NA | 7E-02 |
| | | | Iron | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | Manganese | NA | NA | NA | NA | CNS | NA | 4E-02 | NA | 4E-02 |
| | | | Vanadium | NA | 3E-06 | NA | 3E-06 | NA | NA | 2E-01 | NA | 2E-01 |
| | | Exposure Point Total | | NA | 2E-04 | NA | 2E-04 | | NA | 3E-01 | NA | 3E-01 |
| | Exposure Medium Total | | | NA | 2E-04 | NA | 2E-04 | | NA | 3E-01 | NA | 3E-01 |
| Medium Total | | | | NA | 2E-04 | NA | 2E-04 | | 4E-01 | 3E-01 | 8E-02 | 8E-01 |
| Receptor Total | | | | NA | 2E-04 | NA | 2E-04 | | 4E-01 | 3E-01 | 8E-02 | 8E-01 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 5E-02 |
| Total GI HI Across Media = | 3E-02 |
| Total Hair HI Across Media = | 2E-02 |
| Total Respiratory HI Across Media = | 7E-02 |
| Total NOE HI Across Media = | 5E-01 |

TABLE 6.5.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: DMT Workers
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Total Soil | Total Soil | Total Soil | Calcium | NA | NA | NA | NA | NOE | 2E-03 | NA | 1E-05 | 2E-03 |
| | | | Chromium (VI) | NA | NA | NA | NA | NOE | 5E-01 | NA | 9E-02 | 6E-01 |
| | | | Iron | NA | NA | NA | NA | GI | 5E-02 | NA | 2E-04 | 5E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 3E-03 | NA | 3E-04 | 3E-03 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 3E-02 | NA | 6E-03 | 4E-02 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 6E-01 | NA | 1E-01 | 7E-01 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 6E-01 | NA | 1E-01 | 7E-01 |
| | Outdoor Air | Emissions from Total Soil | Calcium | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | Chromium (VI) | NA | 3E-04 | NA | 3E-04 | Respiratory | NA | 9E-02 | NA | 9E-02 |
| | | | Iron | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | Manganese | NA | NA | NA | NA | CNS | NA | 5E-02 | NA | 5E-02 |
| | | | Vanadium | NA | 5E-06 | NA | 5E-06 | NA | NA | 3E-01 | NA | 3E-01 |
| | | Exposure Point Total | | NA | 3E-04 | NA | 3E-04 | | NA | 4E-01 | NA | 4E-01 |
| | Exposure Medium Total | | | NA | 3E-04 | NA | 3E-04 | | NA | 4E-01 | NA | 4E-01 |
| Medium Total | | | | NA | 3E-04 | NA | 3E-04 | | 6E-01 | 4E-01 | 1E-01 | 1E+00 |
| Receptor Total | | | | NA | 3E-04 | NA | 3E-04 | | 6E-01 | 4E-01 | 1E-01 | 1E+00 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 5E-02 |
| Total GI HI Across Media = | 5E-02 |
| Total Hair HI Across Media = | 4E-02 |
| Total Respiratory HI Across Media = | 9E-02 |
| Total NOE HI Across Media = | 6E-01 |

TABLE 6.6.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Construction Worker (Low Exposure Frequency)
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Total Soil | Total Soil | Total Soil | Calcium | NA | NA | NA | NA | NOE | 5E-03 | NA | 7E-06 | 5E-03 |
| | | | Chromium (VI) | NA | NA | NA | NA | NOE | 1E+00 | NA | 6E-02 | 1E+00 |
| | | | Iron | NA | NA | NA | NA | GI | 1E-01 | NA | 2E-04 | 1E-01 |
| | | | Manganese | NA | NA | NA | NA | CNS | 6E-03 | NA | 2E-04 | 7E-03 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 8E-02 | NA | 4E-03 | 8E-02 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E+00 | NA | 7E-02 | 1E+00 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E+00 | NA | 7E-02 | 1E+00 |
| | Outdoor Air | Emissions from Total Soil | Calcium | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | Chromium (VI) | NA | 3E-06 | NA | 3E-06 | Respiratory | NA | 2E-02 | NA | 2E-02 |
| | | | Iron | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | Manganese | NA | NA | NA | NA | CNS | NA | 1E-02 | NA | 1E-02 |
| | | | Vanadium | NA | 5E-08 | NA | 5E-08 | NA | NA | 6E-02 | NA | 6E-02 |
| | | Exposure Point Total | | NA | 3E-06 | NA | 3E-06 | | NA | 9E-02 | NA | 9E-02 |
| | Exposure Medium Total | | | NA | 3E-06 | NA | 3E-06 | | NA | 9E-02 | NA | 9E-02 |
| Medium Total | | | | 0E+00 | 3E-06 | 0E+00 | 3E-06 | | 1E+00 | 9E-02 | 7E-02 | 2E+00 |
| Groundwater | Groundwater (Excavation) | Groundwater (Excavation) | Aluminum | NA | NA | NA | NA | CNS | NA | NA | 2E-04 | 2E-04 |
| | | | Calcium | NA | NA | NA | NA | NOE | NA | NA | 5E-05 | 5E-05 |
| | | | Chromium (III) | NA | NA | NA | NA | NOE | NA | NA | 3E-03 | 3E-03 |
| | | | Chromium (VI) | NA | NA | NA | NA | NOE | NA | NA | 2E+00 | 2E+00 |
| | | | Iron | NA | NA | NA | NA | GI | NA | NA | 2E-03 | 2E-03 |
| | | | Magnesium | NA | NA | NA | NA | NOE | NA | NA | 2E-04 | 2E-04 |
| | | | Manganese | NA | NA | NA | NA | CNS | NA | NA | 4E-03 | 4E-03 |
| | | | Vanadium | NA | NA | NA | NA | Hair | NA | NA | 3E-02 | 3E-02 |
| | | Exposure Point Total | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 2E+00 | 2E+00 |
| | Exposure Medium Total | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 2E+00 | 2E+00 |
| Medium Total | | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 2E+00 | 2E+00 |
| Receptor Total | | | | 0E+00 | 3E-06 | 0E+00 | 3E-06 | | 1E+00 | 9E-02 | 2E+00 | 4E+00 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 2E-02 |
| Total GI HI Across Media = | 1E-01 |
| Total Hair HI Across Media = | 1E-01 |
| Total Respiratory HI Across Media = | 2E-02 |
| Total NOE HI Across Media = | **3E+00** |

TABLE 6.7.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Construction Worker (High Exposure Frequency)
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Total Soil | Subsurface Soil | Total Soil | Calcium | NA | NA | NA | NA | NOE | 2E-02 | NA | 3E-05 | 2E-02 |
| | | | Chromium (VI) | NA | NA | NA | NA | NOE | 5E+00 | NA | 3E-01 | 5E+00 |
| | | | Iron | NA | NA | NA | NA | GI | 5E-01 | NA | 6E-04 | 5E-01 |
| | | | Manganese | NA | NA | NA | NA | CNS | 3E-02 | NA | 9E-04 | 3E-02 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 3E-01 | NA | 2E-02 | 3E-01 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 6E+00 | NA | 3E-01 | 6E+00 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 6E+00 | NA | 3E-01 | 6E+00 |
| | Outdoor Air | Emissions from Total Soil | Calcium | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | Chromium (VI) | NA | 1E-05 | NA | 1E-05 | Respiratory | NA | 9E-02 | NA | 9E-02 |
| | | | Iron | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | | | Manganese | NA | NA | NA | NA | CNS | NA | 5E-02 | NA | 5E-02 |
| | | | Vanadium | NA | 2E-07 | NA | 2E-07 | NA | NA | 3E-01 | NA | 3E-01 |
| | | Exposure Point Total | | NA | 1E-05 | NA | 1E-05 | | NA | 4E-01 | NA | 4E-01 |
| | Exposure Medium Total | | | NA | 1E-05 | NA | 1E-05 | | NA | 4E-01 | NA | 4E-01 |
| Medium Total | | | | 0E+00 | 1E-05 | 0E+00 | 1E-05 | | 6E+00 | 4E-01 | 3E-01 | 6E+00 |
| Groundwater | Groundwater (Excavation) | Groundwater (Excavation) | Aluminum | NA | NA | NA | NA | CNS | NA | NA | 9E-04 | 9E-04 |
| | | | Calcium | NA | NA | NA | NA | NOE | NA | NA | 2E-04 | 2E-04 |
| | | | Chromium (III) | NA | NA | NA | NA | NOE | NA | NA | 1E-02 | 1E-02 |
| | | | Chromium (VI) | NA | NA | NA | NA | NOE | NA | NA | 9E+00 | 9E+00 |
| | | | Iron | NA | NA | NA | NA | GI | NA | NA | 8E-03 | 8E-03 |
| | | | Magnesium | NA | NA | NA | NA | NOE | NA | NA | 7E-04 | 7E-04 |
| | | | Manganese | NA | NA | NA | NA | CNS | NA | NA | 2E-02 | 2E-02 |
| | | | Vanadium | NA | NA | NA | NA | Hair | NA | NA | 1E-01 | 1E-01 |
| | | Exposure Point Total | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 9E+00 | 9E+00 |
| | Exposure Medium Total | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 9E+00 | 9E+00 |
| Medium Total | | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 9E+00 | 9E+00 |
| Receptor Total | | | | 0E+00 | 1E-05 | 0E+00 | 1E-05 | | 6E+00 | 4E-01 | 1E+01 | 2E+01 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 9E-02 |
| Total GI HI Across Media = | 5E-01 |
| Total Hair HI Across Media = | 5E-01 |
| Total Respiratory HI Across Media = | 9E-02 |
| Total NOE HI Across Media = | **1E+01** |

TABLE 6.8.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Utility Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Stormwater | Stormwater (Non Priority Subsurface Stormwater Lines) | Stormwater (Subsurface Stormwater Lines) | Chromium (VI) | NA | NA | NA | NA | NOE | NA | NA | 3E-01 | 3E-01 |
| | | Exposure Point Total | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 3E-01 | 3E-01 |
| | Exposure Medium Total | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 3E-01 | 3E-01 |
| Medium Total | | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 3E-01 | 3E-01 |
| Receptor Total | | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 3E-01 | 3E-01 |

NA = Not applicable or not available

Total NOE HI Across Media = 3E-01

TABLE 6.9.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Utility Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Stormwater | Stormwater (Priority Subsurface Stormwater Lines) | Stormwater (Subsurface Stormwater Lines) | Chromium (III) | NA | NA | NA | NA | NOE | NA | NA | 3E-03 | 3E-03 |
| | | | Chromium (VI) | NA | NA | NA | NA | NOE | NA | NA | 3E+01 | 3E+01 |
| | | | Vanadium | NA | NA | NA | NA | Hair | NA | NA | 1E-02 | 1E-02 |
| | | | Calcium | NA | NA | NA | NA | NOE | NA | NA | 5E-04 | 5E-04 |
| | | Exposure Point Total | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 3E+01 | 3E+01 |
| | Exposure Medium Total | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 3E+01 | 3E+01 |
| Medium Total | | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 3E+01 | 3E+01 |
| Receptor Total | | | | NA | NA | 0E+00 | 0E+00 | | NA | NA | 3E+01 | 3E+01 |

NA = Not applicable or not available

| | |
|---|---|
| Total Hair HI Across Media = | 1E-02 |
| Total NOE HI Across Media = | **3E+01** |

TABLE 6.10.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Recreator
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Aluminum | NA | NA | NA | NA | CNS | 2E-03 | NA | 1E-04 | 2E-03 |
| | | | Iron | NA | NA | NA | NA | GI | 8E-03 | NA | 5E-04 | 9E-03 |
| | | | Manganese | NA | NA | NA | NA | CNS | 8E-04 | NA | 1E-03 | 2E-03 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 2E-03 | NA | 4E-03 | 6E-03 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-02 | NA | 6E-03 | 2E-02 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-02 | NA | 6E-03 | 2E-02 |
| Sediment Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-02 | NA | 6E-03 | 2E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Calcium | NA | NA | NA | NA | NOE | 1E-03 | NA | 4E-04 | 2E-03 |
| | | | Magnesium | NA | NA | NA | NA | NOE | 2E-02 | NA | 9E-03 | 3E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 2E-04 | NA | 1E-03 | 2E-03 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 1E-02 | 4E-02 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 1E-02 | 4E-02 |
| Surface Water Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-02 | NA | 1E-02 | 4E-02 |
| Receptor Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-02 | NA | 2E-02 | 5E-02 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 6E-03 |
| Total GI HI Across Media = | 9E-03 |
| Total Hair HI Across Media = | 6E-03 |
| Total NOE HI Across Media = | 3E-02 |

TABLE 6.11.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Recreator
Receptor Age: Adolescent

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Aluminum | NA | NA | NA | NA | CNS | 4E-03 | NA | 2E-04 | 4E-03 |
| | | | Iron | NA | NA | NA | NA | GI | 1E-02 | NA | 6E-04 | 1E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 1E-03 | NA | 1E-03 | 3E-03 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 4E-03 | NA | 5E-03 | 9E-03 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-02 | NA | 8E-03 | 3E-02 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-02 | NA | 8E-03 | 3E-02 |
| Sediment Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 2E-02 | NA | 8E-03 | 3E-02 |
| Surface Water | Surface Water | Patapsco River Surface Water | Calcium | NA | NA | NA | NA | NOE | 2E-03 | NA | 5E-04 | 3E-03 |
| | | | Magnesium | NA | NA | NA | NA | NOE | 4E-02 | NA | 1E-02 | 5E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 3E-04 | NA | 2E-03 | 2E-03 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-02 | NA | 1E-02 | 6E-02 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-02 | NA | 1E-02 | 6E-02 |
| Surface Water Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 4E-02 | NA | 1E-02 | 6E-02 |
| Receptor Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 7E-02 | NA | 2E-02 | 9E-02 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 9E-03 |
| Total GI HI Across Media = | 1E-02 |
| Total Hair HI Across Media = | 9E-03 |
| Total NOE HI Across Media = | 5E-02 |

TABLE 6.12.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

Dundalk Marine Terminal, Baltimore, MD

Scenario Timeframe: Future
Receptor Population: Recreator
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Carcinogenic Risk | | | | Non-Carcinogenic Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | Inhalation | Dermal | Exposure Routes Total | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Sediment | Sediment (0 -3 feet) | Patapsco River Sediment | Aluminum | NA | NA | NA | NA | CNS | 2E-02 | NA | 2E-04 | 2E-02 |
| | | | Iron | NA | NA | NA | NA | GI | 8E-02 | NA | 7E-04 | 8E-02 |
| | | | Manganese | NA | NA | NA | NA | CNS | 8E-03 | NA | 2E-03 | 1E-02 |
| | | | Vanadium | NA | NA | NA | NA | Hair | 2E-02 | NA | 7E-03 | 3E-02 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 1E-02 | 1E-01 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 1E-02 | 1E-01 |
| Sediment Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 1E-02 | 1E-01 |
| Surface Water | Surface Water | Patapsco River Surface Water | Calcium | NA | NA | NA | NA | NOE | 1E-03 | NA | 2E-04 | 1E-03 |
| | | | Magnesium | NA | NA | NA | NA | NOE | 1E-01 | NA | 2E-02 | 1E-01 |
| | | | Manganese | NA | NA | NA | NA | CNS | 7E-04 | NA | 2E-03 | 3E-03 |
| | | Exposure Point Total | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 2E-02 | 1E-01 |
| | Exposure Medium Total | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 2E-02 | 1E-01 |
| Surface Water Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 1E-01 | NA | 2E-02 | 1E-01 |
| Receptor Total | | | | 0E+00 | NA | 0E+00 | 0E+00 | | 3E-01 | NA | 3E-02 | 3E-01 |

NA = Not applicable or not available

| | |
|---|---|
| Total CNS HI Across Media = | 3E-02 |
| Total GI HI Across Media = | 8E-02 |
| Total Hair HI Across Media = | 3E-02 |
| Total NOE HI Across Media = | 1E-01 |

# Appendix B
# ProUCL Output

## General UCL Statistics for Data Sets with Non-Detects

**User Selected Options**

| | |
|---|---|
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL2.xls.wst |
| Full Precision | ON |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**Hexavalent Chromium(mg/m3)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Data | 427 | Number of Detected Data | 228 |
| Number of Distinct Detected Data | 224 | Number of Non-Detect Data | 199 |
| | | Percent Non-Detects | 46.60% |

| | | | |
|---|---|---|---|
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 6.355E-07 | Minimum Detected | -14.26885 |
| Maximum Detected | 3.666E-06 | Maximum Detected | -12.51641 |
| Mean of Detected | 1.495E-06 | Mean of Detected | -13.50201 |
| SD of Detected | 6.553E-07 | SD of Detected | 0.4188793 |
| Minimum Non-Detect | 5.902E-07 | Minimum Non-Detect | -14.3428 |
| Maximum Non-Detect | 7.781E-07 | Maximum Non-Detect | -14.06641 |

| | | | |
|---|---|---|---|
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 223 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 204 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 52.22% |

**UCL Statistics**

| | | | |
|---|---|---|---|
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.1057514 | Lilliefors Test Statistic | 0.0575825 |
| 5% Lilliefors Critical Value | 0.0586768 | 5% Lilliefors Critical Value | 0.0586768 |
| **Data not Normal at 5% Significance Level** | | **Data appear Lognormal at 5% Significance Level** | |

| | | | |
|---|---|---|---|
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 9.599E-07 | Mean | -14.14267 |
| SD | 7.471E-07 | SD | 0.7522295 |
| 95% DL/2 (t) UCL | 1.02E-06 | 95% H-Stat (DL/2) UCL | 7.702E-07 |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | |
| Mean | 7.13E-07 | Mean in Log Scale | -13.96529 |
| SD | 1.051E-06 | SD in Log Scale | 0.5853169 |
| 95% MLE (t) UCL | 7.969E-07 | Mean in Original Scale | 1.035E-06 |
| 95% MLE (Tiku) UCL | 8.19E-07 | SD in Original Scale | 6.876E-07 |
| | | 95% Percentile Bootstrap UCL | 1.088E-06 |
| | | 95% BCA Bootstrap UCL | 1.091E-06 |

| | | | |
|---|---|---|---|
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 5.7174389 | **Data appear Lognormal at 5% Significance Level** | |
| Theta Star | 2.615E-07 | | |

| | | | |
|---|---|---|---|
| nu star | 2607.1521 | | |
| | | | |
| A-D Test Statistic | 1.8723692 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.7556359 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.7556359 | Mean | 1.096E-06 |
| 5% K-S Critical Value | 0.0605229 | SD | 6.415E-07 |
| Data not Gamma Distributed at 5% Significance Level | | SE of Mean | 3.112E-08 |
| | | 95% KM (t) UCL | 1.147E-06 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 1.147E-06 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 1.137E-06 |
| Minimum | 3.75E-07 | 95% KM (bootstrap t) UCL | 1.145E-06 |
| Maximum | 3.666E-06 | 95% KM (BCA) UCL | 1.172E-06 |
| Mean | 1.435E-06 | 95% KM (Percentile Bootstrap) UCL | 1.157E-06 |
| Median | 1.383E-06 | 95% KM (Chebyshev) UCL | 1.231E-06 |
| SD | 4.979E-07 | 97.5% KM (Chebyshev) UCL | 1.29E-06 |
| k star | 9.4327401 | 99% KM (Chebyshev) UCL | 1.405E-06 |
| Theta star | 1.521E-07 | | |
| Nu star | 8055.56 | **Potential UCLs to Use** | |
| AppChi2 | 7847.9226 | 95% KM (t) UCL | 1.147E-06 |
| 95% Gamma Approximate UCL | 1.473E-06 | 95% KM (% Bootstrap) UCL | 1.157E-06 |
| 95% Adjusted Gamma UCL | 1.473E-06 | | |
| **Note: DL/2 is not a recommended method.** | | | |

## General UCL Statistics for Data Sets with Non-Detects

| | | | |
|---|---|---|---|
| **User Selected Options** | | | |
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL_v2_SH.wst | | |
| Full Precision | OFF | | |
| Confidence Coefficient | 95% | | |
| Number of Bootstrap Operations | | | 2000 |

### Aluminum(ug/L)

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 90 | Number of Detected Data | 84 |
| Number of Distinct Detected Data | 80 | Number of Non-Detect Data | 6 |
| | | Percent Non-Detects | 6.67% |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 98.1 | Minimum Detected | 4.586 |
| Maximum Detected | 190000 | Maximum Detected | 12.15 |
| Mean of Detected | 10661 | Mean of Detected | 7.666 |
| SD of Detected | 29235 | SD of Detected | 1.693 |
| Minimum Non-Detect | 80.2 | Minimum Non-Detect | 4.385 |
| Maximum Non-Detect | 80.2 | Maximum Non-Detect | 4.385 |

| | | | |
|---|---|---|---|
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.359 | Lilliefors Test Statistic | 0.114 |
| 5% Lilliefors Critical Value | 0.0967 | 5% Lilliefors Critical Value | 0.0967 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 9953 | Mean | 7.401 |
| SD | 28358 | SD | 1.915 |
| 95% DL/2 (t) UCL | 14921 | 95% H-Stat (DL/2) UCL | 13046 |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | |
| Mean | 8579 | Mean in Log Scale | 7.4 |
| SD | 29437 | SD in Log Scale | 1.921 |
| 95% MLE (t) UCL | 13736 | Mean in Original Scale | 9953 |
| 95% MLE (Tiku) UCL | 13253 | SD in Original Scale | 28357 |
| | | 95% Percentile Bootstrap UCL | 15567 |
| | | 95% BCA Bootstrap UCL | 17092 |
| | | | |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.401 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 26576 | | |
| nu star | 67.39 | | |
| | | | |
| A-D Test Statistic | 5.591 | **Nonparametric Statistics** | |

| | | | |
|---|---|---|---|
| 5% A-D Critical Value | 0.841 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.841 | Mean | 9957 |
| 5% K-S Critical Value | 0.104 | SD | 28198 |
| Data not Gamma Distributed at 5% Significance Level | | SE of Mean | 2990 |
| | | 95% KM (t) UCL | 14927 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 14875 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 14925 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 20499 |
| Maximum | 190000 | 95% KM (BCA) UCL | 15384 |
| Mean | 9950 | 95% KM (Percentile Bootstrap) UCL | 14984 |
| Median | 1580 | 95% KM (Chebyshev) UCL | 22991 |
| SD | 28358 | 97.5% KM (Chebyshev) UCL | 28631 |
| k star | 0.213 | 99% KM (Chebyshev) UCL | 39709 |
| Theta star | 46775 | | |
| Nu star | 38.29 | **Potential UCLs to Use** | |
| AppChi2 | 25.12 | 97.5% KM (Chebyshev) UCL | 28631 |
| 95% Gamma Approximate UCL | 15168 | | |
| 95% Adjusted Gamma UCL | 15273 | | |
| Note: DL/2 is not a recommended method. | | | |

**Aluminum, Dissolved(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 90 | Number of Detected Data | 52 |
| Number of Distinct Detected Data | 52 | Number of Non-Detect Data | 38 |
| | | Percent Non-Detects | 42.22% |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 83.9 | Minimum Detected | 4.43 |
| Maximum Detected | 32900 | Maximum Detected | 10.4 |
| Mean of Detected | 4985 | Mean of Detected | 7.319 |
| SD of Detected | 8028 | SD of Detected | 1.672 |
| Minimum Non-Detect | 80.2 | Minimum Non-Detect | 4.385 |
| Maximum Non-Detect | 401 | Maximum Non-Detect | 5.994 |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 52 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 38 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 57.78% |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.322 | Lilliefors Test Statistic | 0.0817 |
| 5% Lilliefors Critical Value | 0.123 | 5% Lilliefors Critical Value | 0.123 |
| Data not Normal at 5% Significance Level | | Data appear Lognormal at 5% Significance Level | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 2904 | Mean | 5.864 |
| SD | 6552 | SD | 2.148 |

| | | | |
|---|---|---|---|
| 95% DL/2 (t) UCL | 4051 | 95% H-Stat (DL/2) UCL | 2159 |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 5.579 |
| | | SD in Log Scale | 2.557 |
| | | Mean in Original Scale | 2899 |
| | | SD in Original Scale | 6554 |
| | | 95% Percentile Bootstrap UCL | 4088 |
| | | 95% BCA Bootstrap UCL | 4320 |
| | | | |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.51 | **Data appear Lognormal at 5% Significance Level** | |
| Theta Star | 9785 | | |
| nu star | 52.99 | | |
| | | | |
| A-D Test Statistic | 1.573 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.812 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.812 | Mean | 2917 |
| 5% K-S Critical Value | 0.13 | SD | 6510 |
| **Data not Gamma Distributed at 5% Significance Level** | | SE of Mean | 692.9 |
| | | 95% KM (t) UCL | 4069 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 4057 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 4055 |
| Minimum | 83.9 | 95% KM (bootstrap t) UCL | 4459 |
| Maximum | 32900 | 95% KM (BCA) UCL | 4106 |
| Mean | 4120 | 95% KM (Percentile Bootstrap) UCL | 4171 |
| Median | 1904 | 95% KM (Chebyshev) UCL | 5937 |
| SD | 6313 | 97.5% KM (Chebyshev) UCL | 7244 |
| k star | 0.69 | 99% KM (Chebyshev) UCL | 9811 |
| Theta star | 5972 | | |
| Nu star | 124.2 | **Potential UCLs to Use** | |
| AppChi2 | 99.44 | 97.5% KM (Chebyshev) UCL | 7244 |
| 95% Gamma Approximate UCL | 5144 | | |
| 95% Adjusted Gamma UCL | 5163 | | |
| **Note: DL/2 is not a recommended method.** | | | |

**Calcium(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 90 | Number of Detected Data | 89 |
| Number of Distinct Detected Data | 85 | Number of Non-Detect Data | 1 |
| | | Percent Non-Detects | 1.11% |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 3600 | Minimum Detected | 8.189 |
| Maximum Detected | 984000 | Maximum Detected | 13.8 |
| Mean of Detected | 136130 | Mean of Detected | 11.13 |
| SD of Detected | 179786 | SD of Detected | 1.238 |
| Minimum Non-Detect | 351 | Minimum Non-Detect | 5.861 |

| | | | |
|---|---|---|---|
| Maximum Non-Detect | 351 | Maximum Non-Detect | 5.861 |
| | | | |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.25 | Lilliefors Test Statistic | 0.0467 |
| 5% Lilliefors Critical Value | 0.0939 | 5% Lilliefors Critical Value | 0.0939 |
| Data not Normal at 5% Significance Level | | Data appear Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 134619 | Mean | 11.06 |
| SD | 179346 | SD | 1.382 |
| 95% DL/2 (t) UCL | 166042 | 95% H-Stat (DL/2) UCL | 223840 |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | |
| Mean | 133461 | Mean in Log Scale | 11.09 |
| SD | 179784 | SD in Log Scale | 1.281 |
| 95% MLE (t) UCL | 164960 | Mean in Original Scale | 134643 |
| 95% MLE (Tiku) UCL | 162361 | SD in Original Scale | 179328 |
| | | 95% Percentile Bootstrap UCL | 167371 |
| | | 95% BCA Bootstrap UCL | 173350 |
| | | | |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.825 | Data appear Lognormal at 5% Significance Level | |
| Theta Star | 164959 | | |
| nu star | 146.9 | | |
| | | | |
| A-D Test Statistic | 1.219 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.789 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.789 | Mean | 134657 |
| 5% K-S Critical Value | 0.0981 | SD | 178319 |
| Data not Gamma Distributed at 5% Significance Level | | SE of Mean | 18903 |
| | | 95% KM (t) UCL | 166077 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 165750 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 166042 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 172751 |
| Maximum | 984000 | 95% KM (BCA) UCL | 164606 |
| Mean | 134617 | 95% KM (Percentile Bootstrap) UCL | 167041 |
| Median | 70150 | 95% KM (Chebyshev) UCL | 217053 |
| SD | 179348 | 97.5% KM (Chebyshev) UCL | 252706 |
| k star | 0.583 | 99% KM (Chebyshev) UCL | 322739 |
| Theta star | 230913 | | |
| Nu star | 104.9 | **Potential UCLs to Use** | |
| AppChi2 | 82.3 | 95% KM (Chebyshev) UCL | 217053 |
| 95% Gamma Approximate UCL | 171649 | | |
| 95% Adjusted Gamma UCL | 172329 | | |
| Note: DL/2 is not a recommended method. | | | |

**Calcium, Dissolved(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 90 | Number of Distinct Observations | 88 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 409 | Minimum of Log Data | 6.014 |
| Maximum | 808000 | Maximum of Log Data | 13.6 |
| Mean | 119879 | Mean of log Data | 10.94 |
| Median | 67650 | SD of log Data | 1.366 |
| SD | 161291 | | |
| Coefficient of Variation | 1.345 | | |
| Skewness | 2.527 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.252 | Lilliefors Test Statistic | 0.0682 |
| Lilliefors Critical Value | 0.0934 | Lilliefors Critical Value | 0.0934 |
| Data not Normal at 5% Significance Level | | Data appear Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 148138 | 95% H-UCL | 208883 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 256881 |
| 95% Adjusted-CLT UCL | 152683 | 97.5% Chebyshev (MVUE) UCL | 307423 |
| 95% Modified-t UCL | 148893 | 99% Chebyshev (MVUE) UCL | 406701 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.767 | Data appear Lognormal at 5% Significance Level | |
| Theta Star | 156380 | | |
| MLE of Mean | 119879 | | |
| MLE of Standard Deviation | 136918 | | |
| nu star | 138 | | |
| Approximate Chi Square Value (.05) | 111.8 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0473 | 95% CLT UCL | 147844 |
| Adjusted Chi Square Value | 111.5 | 95% Jackknife UCL | 148138 |
| | | 95% Standard Bootstrap UCL | 147915 |
| Anderson-Darling Test Statistic | 0.999 | 95% Bootstrap-t UCL | 153238 |
| Anderson-Darling 5% Critical Value | 0.792 | 95% Hall's Bootstrap UCL | 153445 |
| Kolmogorov-Smirnov Test Statistic | 0.117 | 95% Percentile Bootstrap UCL | 148869 |
| Kolmogorov-Smirnov 5% Critical Value | 0.0978 | 95% BCA Bootstrap UCL | 154277 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 193987 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 226053 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 289042 |
| 95% Approximate Gamma UCL | 147898 | | |
| 95% Adjusted Gamma UCL | 148404 | | |
| | | | |
| Potential UCL to Use | | Use 95% H-UCL | 208883 |

**Hexavalent Chromium(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 101 | Number of Detected Data | 37 |
| Number of Distinct Detected Data | 37 | Number of Non-Detect Data | 64 |
| | | Percent Non-Detects | 63.37% |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 5.2 | Minimum Detected | 1.649 |
| Maximum Detected | 220000 | Maximum Detected | 12.3 |
| Mean of Detected | 17938 | Mean of Detected | 7.831 |
| SD of Detected | 37394 | SD of Detected | 2.816 |
| Minimum Non-Detect | 5 | Minimum Non-Detect | 1.609 |
| Maximum Non-Detect | 2500 | Maximum Non-Detect | 7.824 |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 78 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 23 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 77.23% |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Shapiro Wilk Test Statistic | 0.476 | Shapiro Wilk Test Statistic | 0.901 |
| 5% Shapiro Wilk Critical Value | 0.936 | 5% Shapiro Wilk Critical Value | 0.936 |
| **Data not Normal at 5% Significance Level** | | **Data not Lognormal at 5% Significance Level** | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 6590 | Mean | 3.73 |
| SD | 24054 | SD | 3.683 |
| 95% DL/2 (t) UCL | 10564 | 95% H-Stat (DL/2) UCL | 35736 |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 3.004 |
| | | SD in Log Scale | 4.644 |
| | | Mean in Original Scale | 6578 |
| | | SD in Original Scale | 24057 |
| | | 95% Percentile Bootstrap UCL | 10755 |
| | | 95% BCA Bootstrap UCL | 13101 |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.334 | **Data appear Gamma Distributed at 5% Significance Level** | |
| Theta Star | 53760 | | |
| nu star | 24.69 | | |
| A-D Test Statistic | 0.471 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.847 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.847 | Mean | 6576 |
| 5% K-S Critical Value | 0.156 | SD | 23938 |
| **Data appear Gamma Distributed at 5% Significance Level** | | SE of Mean | 2415 |
| | | 95% KM (t) UCL | 10585 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 10548 |

| | | | |
|---|---|---|---|
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 10547 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 15707 |
| Maximum | 263964 | 95% KM (BCA) UCL | 11382 |
| Mean | 46877 | 95% KM (Percentile Bootstrap) UCL | 11019 |
| Median | 17000 | 95% KM (Chebyshev) UCL | 17101 |
| SD | 66992 | 97.5% KM (Chebyshev) UCL | 21656 |
| k star | 0.133 | 99% KM (Chebyshev) UCL | 30603 |
| Theta star | 353667 | | |
| Nu star | 26.77 | **Potential UCLs to Use** | |
| AppChi2 | 15.98 | 95% KM (t) UCL | 10585 |
| 95% Gamma Approximate UCL | 78558 | | |
| 95% Adjusted Gamma UCL | 79156 | | |

**Note: DL/2 is not a recommended method.**

**Hexavalent Chromium, Dissolved(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 57 | Number of Detected Data | 22 |
| Number of Distinct Detected Data | 22 | Number of Non-Detect Data | 35 |
| | | Percent Non-Detects | 61.40% |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 6.7 | Minimum Detected | 1.902 |
| Maximum Detected | 70000 | Maximum Detected | 11.16 |
| Mean of Detected | 13558 | Mean of Detected | 8.148 |
| SD of Detected | 15703 | SD of Detected | 2.587 |
| Minimum Non-Detect | 5 | Minimum Non-Detect | 1.609 |
| Maximum Non-Detect | 2500 | Maximum Non-Detect | 7.824 |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 41 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 16 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 71.93% |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Shapiro Wilk Test Statistic | 0.763 | Shapiro Wilk Test Statistic | 0.822 |
| 5% Shapiro Wilk Critical Value | 0.911 | 5% Shapiro Wilk Critical Value | 0.911 |
| **Data not Normal at 5% Significance Level** | | **Data not Lognormal at 5% Significance Level** | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 5265 | Mean | 4.289 |
| SD | 11683 | SD | 3.674 |
| 95% DL/2 (t) UCL | 7854 | 95% H-Stat (DL/2) UCL | 125845 |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 4.196 |
| | | SD in Log Scale | 3.923 |
| | | Mean in Original Scale | 5246 |

| | | | |
|---|---|---|---|
| | | SD in Original Scale | 11690 |
| | | 95% Percentile Bootstrap UCL | 7897 |
| | | 95% BCA Bootstrap UCL | 8724 |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.436 | Data Follow Appr. Gamma Distribution at 5% Significance Level | |
| Theta Star | 31113 | | |
| nu star | 19.17 | | |
| A-D Test Statistic | 0.929 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.811 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.811 | Mean | 5238 |
| 5% K-S Critical Value | 0.197 | SD | 11591 |
| Data follow Appr. Gamma Distribution at 5% Significance Level | | SE of Mean | 1571 |
| | | 95% KM (t) UCL | 7866 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 7823 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 7819 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 9112 |
| Maximum | 70000 | 95% KM (BCA) UCL | 8162 |
| Mean | 13763 | 95% KM (Percentile Bootstrap) UCL | 8004 |
| Median | 12329 | 95% KM (Chebyshev) UCL | 12087 |
| SD | 13933 | 97.5% KM (Chebyshev) UCL | 15051 |
| k star | 0.218 | 99% KM (Chebyshev) UCL | 20873 |
| Theta star | 63018 | | |
| Nu star | 24.9 | **Potential UCLs to Use** | |
| AppChi2 | 14.53 | 95% KM (t) UCL | 7866 |
| 95% Gamma Approximate UCL | 23578 | | |
| 95% Adjusted Gamma UCL | 23917 | | |
| Note: DL/2 is not a recommended method. | | | |

**Iron(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 90 | Number of Detected Data | 87 |
| Number of Distinct Detected Data | 85 | Number of Non-Detect Data | 3 |
| | | Percent Non-Detects | 3.33% |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 73.8 | Minimum Detected | 4.301 |
| Maximum Detected | 1850000 | Maximum Detected | 14.43 |
| Mean of Detected | 45495 | Mean of Detected | 8.568 |
| SD of Detected | 202180 | SD of Detected | 2.068 |
| Minimum Non-Detect | 52.2 | Minimum Non-Detect | 3.955 |
| Maximum Non-Detect | 100 | Maximum Non-Detect | 4.605 |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 4 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 86 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 4.44% |

**UCL Statistics**

| | | | |
|---|---|---|---|
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.411 | Lilliefors Test Statistic | 0.04 |
| 5% Lilliefors Critical Value | 0.095 | 5% Lilliefors Critical Value | 0.095 |
| Data not Normal at 5% Significance Level | | Data appear Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 43979 | Mean | 8.399 |
| SD | 198913 | SD | 2.232 |
| 95% DL/2 (t) UCL | 78830 | 95% H-Stat (DL/2) UCL | 97496 |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | |
| Mean | 37349 | Mean in Log Scale | 8.4 |
| SD | 203103 | SD in Log Scale | 2.229 |
| 95% MLE (t) UCL | 72934 | Mean in Original Scale | 43979 |
| 95% MLE (Tiku) UCL | 69063 | SD in Original Scale | 198913 |
| | | 95% Percentile Bootstrap UCL | 83895 |
| | | 95% BCA Bootstrap UCL | 108651 |
| | | | |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.314 | Data appear Lognormal at 5% Significance Level | |
| Theta Star | 145079 | | |
| nu star | 54.56 | | |
| | | | |
| A-D Test Statistic | 4.689 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.863 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.863 | Mean | 43981 |
| 5% K-S Critical Value | 0.104 | SD | 197804 |
| Data not Gamma Distributed at 5% Significance Level | | SE of Mean | 20971 |
| | | 95% KM (t) UCL | 78838 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 78475 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 78830 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 194619 |
| Maximum | 1850000 | 95% KM (BCA) UCL | 88247 |
| Mean | 43978 | 95% KM (Percentile Bootstrap) UCL | 85709 |
| Median | 4580 | 95% KM (Chebyshev) UCL | 135392 |
| SD | 198913 | 97.5% KM (Chebyshev) UCL | 174946 |
| k star | 0.232 | 99% KM (Chebyshev) UCL | 252642 |
| Theta star | 189876 | | |
| Nu star | 41.69 | **Potential UCLs to Use** | |
| AppChi2 | 27.89 | 97.5% KM (Chebyshev) UCL | 174946 |
| 95% Gamma Approximate UCL | 65738 | | |
| 95% Adjusted Gamma UCL | 66174 | | |
| Note: DL/2 is not a recommended method. | | | |

**Iron, Dissolved(ug/L)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Data | 90 | Number of Detected Data | 63 |
| Number of Distinct Detected Data | 60 | Number of Non-Detect Data | 27 |
| | | Percent Non-Detects | 30.00% |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 45 | Minimum Detected | 3.807 |
| Maximum Detected | 1780000 | Maximum Detected | 14.39 |
| Mean of Detected | 43152 | Mean of Detected | 7.921 |
| SD of Detected | 223944 | SD of Detected | 2.408 |
| Minimum Non-Detect | 52.2 | Minimum Non-Detect | 3.955 |
| Maximum Non-Detect | 261 | Maximum Non-Detect | 5.565 |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 40 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 50 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 44.44% |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.424 | Lilliefors Test Statistic | 0.0731 |
| 5% Lilliefors Critical Value | 0.112 | 5% Lilliefors Critical Value | 0.112 |
| **Data not Normal at 5% Significance Level** | | **Data appear Lognormal at 5% Significance Level** | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 30219 | Mean | 6.613 |
| SD | 187966 | SD | 2.856 |
| 95% DL/2 (t) UCL | 63152 | 95% H-Stat (DL/2) UCL | 38603 |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 6.344 |
| | | SD in Log Scale | 3.247 |
| | | Mean in Original Scale | 30216 |
| | | SD in Original Scale | 187967 |
| | | 95% Percentile Bootstrap UCL | 69446 |
| | | 95% BCA Bootstrap UCL | 91282 |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.255 | **Data appear Lognormal at 5% Significance Level** | |
| Theta Star | 169013 | | |
| nu star | 32.17 | | |
| A-D Test Statistic | 3.842 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.884 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.884 | Mean | 30221 |
| 5% K-S Critical Value | 0.123 | SD | 186919 |
| **Data not Gamma Distributed at 5% Significance Level** | | SE of Mean | 19861 |
| | | 95% KM (t) UCL | 63234 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 62890 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 63150 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 263973 |

| | | | |
|---|---|---|---|
| Maximum | 1780000 | 95% KM (BCA) UCL | 70165 |
| Mean | 30207 | 95% KM (Percentile Bootstrap) UCL | 68233 |
| Median | 654.5 | 95% KM (Chebyshev) UCL | 116794 |
| SD | 187968 | 97.5% KM (Chebyshev) UCL | 154254 |
| k star | 0.0812 | 99% KM (Chebyshev) UCL | 227838 |
| Theta star | 372082 | | |
| Nu star | 14.61 | **Potential UCLs to Use** | |
| AppChi2 | 6.993 | 97.5% KM (Chebyshev) UCL | 154254 |
| 95% Gamma Approximate UCL | 63120 | | |
| 95% Adjusted Gamma UCL | 63906 | | |

**Note: DL/2 is not a recommended method.**

**Magnesium(ug/L)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Data | 90 | Number of Detected Data | 84 |
| Number of Distinct Detected Data | 81 | Number of Non-Detect Data | 6 |
| | | Percent Non-Detects | 6.67% |

| **Raw Statistics** | | **Log-transformed Statistics** | |
|---|---|---|---|
| Minimum Detected | 36.9 | Minimum Detected | 3.608 |
| Maximum Detected | 391000 | Maximum Detected | 12.88 |
| Mean of Detected | 52724 | Mean of Detected | 8.793 |
| SD of Detected | 89892 | SD of Detected | 2.519 |
| Minimum Non-Detect | 32.2 | Minimum Non-Detect | 3.472 |
| Maximum Non-Detect | 5000 | Maximum Non-Detect | 8.517 |

| | | |
|---|---|---|
| Note: Data have multiple DLs - Use of KM Method is recommended | Number treated as Non-Detect | 42 |
| For all methods (except KM, DL/2, and ROS Methods), | Number treated as Detected | 48 |
| Observations < Largest ND are treated as NDs | Single DL Non-Detect Percentage | 46.67% |

**UCL Statistics**

| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
|---|---|---|---|
| Lilliefors Test Statistic | 0.318 | Lilliefors Test Statistic | 0.0926 |
| 5% Lilliefors Critical Value | 0.0967 | 5% Lilliefors Critical Value | 0.0967 |
| **Data not Normal at 5% Significance Level** | | **Data appear Lognormal at 5% Significance Level** | |

| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
|---|---|---|---|
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 49266 | Mean | 8.513 |
| SD | 87779 | SD | 2.718 |
| 95% DL/2 (t) UCL | 64645 | 95% H-Stat (DL/2) UCL | 477151 |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 8.479 |
| | | SD in Log Scale | 2.743 |
| | | Mean in Original Scale | 49227 |
| | | SD in Original Scale | 87800 |
| | | 95% Percentile Bootstrap UCL | 66102 |

| | | | |
|---|---|---|---|
| | | 95% BCA Bootstrap UCL | 66310 |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.323 | **Data appear Lognormal at 5% Significance Level** | |
| Theta Star | 163111 | | |
| nu star | 54.3 | | |
| A-D Test Statistic | 2.132 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.86 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.86 | Mean | 49231 |
| 5% K-S Critical Value | 0.106 | SD | 87309 |
| **Data not Gamma Distributed at 5% Significance Level** | | SE of Mean | 9258 |
| | | 95% KM (t) UCL | 64620 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 64460 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 64614 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 68176 |
| Maximum | 391000 | 95% KM (BCA) UCL | 66501 |
| Mean | 49209 | 95% KM (Percentile Bootstrap) UCL | 64555 |
| Median | 6730 | 95% KM (Chebyshev) UCL | 89588 |
| SD | 87810 | 97.5% KM (Chebyshev) UCL | 107050 |
| k star | 0.188 | 99% KM (Chebyshev) UCL | 141352 |
| Theta star | 261599 | | |
| Nu star | 33.86 | **Potential UCLs to Use** | |
| AppChi2 | 21.55 | 97.5% KM (Chebyshev) UCL | 107050 |
| 95% Gamma Approximate UCL | 77310 | | |
| 95% Adjusted Gamma UCL | 77888 | | |
| **Note: DL/2 is not a recommended method.** | | | |

**Magnesium, Dissolved(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 90 | Number of Detected Data | 61 |
| Number of Distinct Detected Data | 60 | Number of Non-Detect Data | 29 |
| | | Percent Non-Detects | 32.22% |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 21.1 | Minimum Detected | 3.049 |
| Maximum Detected | 416000 | Maximum Detected | 12.94 |
| Mean of Detected | 68186 | Mean of Detected | 8.987 |
| SD of Detected | 100580 | SD of Detected | 2.957 |
| Minimum Non-Detect | 13.5 | Minimum Non-Detect | 2.603 |
| Maximum Non-Detect | 5000 | Maximum Non-Detect | 8.517 |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 48 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 42 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 53.33% |

**UCL Statistics**

| | |
|---|---|
| **Normal Distribution Test with Detected Values Only** | **Lognormal Distribution Test with Detected Values Only** |

| | | | |
|---|---|---|---|
| Lilliefors Test Statistic | 0.301 | Lilliefors Test Statistic | 0.155 |
| 5% Lilliefors Critical Value | 0.113 | 5% Lilliefors Critical Value | 0.113 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 46387 | Mean | 7.35 |
| SD | 88493 | SD | 3.605 |
| 95% DL/2 (t) UCL | 61892 | 95% H-Stat (DL/2) UCL | 1393932 |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 7.115 |
| | | SD in Log Scale | 3.783 |
| | | Mean in Original Scale | 46241 |
| | | SD in Original Scale | 88569 |
| | | 95% Percentile Bootstrap UCL | 61937 |
| | | 95% BCA Bootstrap UCL | 64132 |
| | | | |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.314 | Data Follow Appr. Gamma Distribution at 5% Significance Level | |
| Theta Star | 217191 | | |
| nu star | 38.3 | | |
| | | | |
| A-D Test Statistic | 0.903 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.859 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.859 | Mean | 46232 |
| 5% K-S Critical Value | 0.123 | SD | 88080 |
| Data follow Appr. Gamma Distribution at 5% Significance Level | | SE of Mean | 9361 |
| | | 95% KM (t) UCL | 61792 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 61630 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 61751 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 64186 |
| Maximum | 416000 | 95% KM (BCA) UCL | 63816 |
| Mean | 48531 | 95% KM (Percentile Bootstrap) UCL | 62891 |
| Median | 7924 | 95% KM (Chebyshev) UCL | 87038 |
| SD | 87950 | 97.5% KM (Chebyshev) UCL | 104695 |
| k star | 0.112 | 99% KM (Chebyshev) UCL | 139378 |
| Theta star | 432517 | | |
| Nu star | 20.2 | **Potential UCLs to Use** | |
| AppChi2 | 11 | 95% KM (BCA) UCL | 63816 |
| 95% Gamma Approximate UCL | 89136 | | |
| 95% Adjusted Gamma UCL | 90042 | | |
| Note: DL/2 is not a recommended method. | | | |

**Manganese(ug/L)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Data | 90 | Number of Detected Data | 89 |
| Number of Distinct Detected Data | 88 | Number of Non-Detect Data | 1 |

| | | | |
|---|---|---|---|
| | | Percent Non-Detects | 1.11% |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 0.58 | Minimum Detected | -0.545 |
| Maximum Detected | 25800 | Maximum Detected | 10.16 |
| Mean of Detected | 927.8 | Mean of Detected | 4.858 |
| SD of Detected | 2825 | SD of Detected | 2.321 |
| Minimum Non-Detect | 0.36 | Minimum Non-Detect | -1.022 |
| Maximum Non-Detect | 0.36 | Maximum Non-Detect | -1.022 |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.371 | Lilliefors Test Statistic | 0.117 |
| 5% Lilliefors Critical Value | 0.0939 | 5% Lilliefors Critical Value | 0.0939 |
| **Data not Normal at 5% Significance Level** | | **Data not Lognormal at 5% Significance Level** | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 917.5 | Mean | 4.785 |
| SD | 2810 | SD | 2.41 |
| 95% DL/2 (t) UCL | 1410 | 95% H-Stat (DL/2) UCL | 5302 |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | |
| Mean | 895.8 | Mean in Log Scale | 4.788 |
| SD | 2814 | SD in Log Scale | 2.401 |
| 95% MLE (t) UCL | 1389 | Mean in Original Scale | 917.5 |
| 95% MLE (Tiku) UCL | 1331 | SD in Original Scale | 2810 |
| | | 95% Percentile Bootstrap UCL | 1446 |
| | | 95% BCA Bootstrap UCL | 1934 |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.338 | **Data do not follow a Discernable Distribution (0.05)** | |
| Theta Star | 2747 | | |
| nu star | 60.12 | | |
| A-D Test Statistic | 2.288 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.857 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.857 | Mean | 917.5 |
| 5% K-S Critical Value | 0.102 | SD | 2795 |
| **Data not Gamma Distributed at 5% Significance Level** | | SE of Mean | 296.3 |
| | | 95% KM (t) UCL | 1410 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 1405 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 1410 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 2228 |
| Maximum | 25800 | 95% KM (BCA) UCL | 1553 |
| Mean | 917.5 | 95% KM (Percentile Bootstrap) UCL | 1457 |
| Median | 109.1 | 95% KM (Chebyshev) UCL | 2209 |
| SD | 2810 | 97.5% KM (Chebyshev) UCL | 2768 |
| k star | 0.303 | 99% KM (Chebyshev) UCL | 3865 |

| | | | |
|---|---|---|---|
| Theta star | 3028 | | |
| Nu star | 54.54 | **Potential UCLs to Use** | |
| AppChi2 | 38.57 | 97.5% KM (Chebyshev) UCL | 2768 |
| 95% Gamma Approximate UCL | 1297 | | |
| 95% Adjusted Gamma UCL | 1305 | | |

**Note: DL/2 is not a recommended method.**

**Manganese, Dissolved(ug/L)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Data | 90 | Number of Detected Data | 66 |
| Number of Distinct Detected Data | 63 | Number of Non-Detect Data | 24 |
| | | Percent Non-Detects | 26.67% |

| **Raw Statistics** | | **Log-transformed Statistics** | |
|---|---|---|---|
| Minimum Detected | 0.52 | Minimum Detected | -0.654 |
| Maximum Detected | 27400 | Maximum Detected | 10.22 |
| Mean of Detected | 1149 | Mean of Detected | 4.534 |
| SD of Detected | 3426 | SD of Detected | 3.007 |
| Minimum Non-Detect | 0.36 | Minimum Non-Detect | -1.022 |
| Maximum Non-Detect | 15 | Maximum Non-Detect | 2.708 |

| | |
|---|---|
| Note: Data have multiple DLs - Use of KM Method is recommended | Number treated as Non-Detect: 46 |
| For all methods (except KM, DL/2, and ROS Methods), | Number treated as Detected: 44 |
| Observations < Largest ND are treated as NDs | Single DL Non-Detect Percentage: 51.11% |

**UCL Statistics**

| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
|---|---|---|---|
| Lilliefors Test Statistic | 0.369 | Lilliefors Test Statistic | 0.188 |
| 5% Lilliefors Critical Value | 0.109 | 5% Lilliefors Critical Value | 0.109 |
| **Data not Normal at 5% Significance Level** | | **Data not Lognormal at 5% Significance Level** | |

| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
|---|---|---|---|
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 843.4 | Mean | 3.25 |
| SD | 2972 | SD | 3.449 |
| 95% DL/2 (t) UCL | 1364 | 95% H-Stat (DL/2) UCL | 16418 |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 2.958 |
| | | SD in Log Scale | 3.797 |
| | | Mean in Original Scale | 843 |
| | | SD in Original Scale | 2972 |
| | | 95% Percentile Bootstrap UCL | 1447 |
| | | 95% BCA Bootstrap UCL | 1804 |

| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** |
|---|---|---|
| k star (bias corrected) | 0.275 | **Data do not follow a Discernable Distribution (0.05)** |
| Theta Star | 4173 | |

| | | | |
|---|---|---|---|
| nu star | 36.35 | | |
| | | | |
| A-D Test Statistic | 1.71 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.875 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.875 | Mean | 843 |
| 5% K-S Critical Value | 0.12 | SD | 2956 |
| **Data not Gamma Distributed at 5% Significance Level** | | SE of Mean | 313.9 |
| | | 95% KM (t) UCL | 1365 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 1359 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 1364 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 2247 |
| Maximum | 27400 | 95% KM (BCA) UCL | 1502 |
| Mean | 854.4 | 95% KM (Percentile Bootstrap) UCL | 1414 |
| Median | 17.75 | 95% KM (Chebyshev) UCL | 2211 |
| SD | 2970 | 97.5% KM (Chebyshev) UCL | 2804 |
| k star | 0.102 | 99% KM (Chebyshev) UCL | 3967 |
| Theta star | 8403 | | |
| Nu star | 18.3 | **Potential UCLs to Use** | |
| AppChi2 | 9.608 | 97.5% KM (Chebyshev) UCL | 2804 |
| 95% Gamma Approximate UCL | 1627 | | |
| 95% Adjusted Gamma UCL | 1645 | | |
| **Note: DL/2 is not a recommended method.** | | | |

**Trivalent Chromium(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 101 | Number of Detected Data | 81 |
| Number of Distinct Detected Data | 74 | Number of Non-Detect Data | 20 |
| | | Percent Non-Detects | 19.80% |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 2.8 | Log Statistics Not Avaliable | |
| Maximum Detected | 21600 | | |
| Mean of Detected | 1341 | | |
| Mean of Detected | 1341 | | |
| Mean of Detected | 1341 | | |
| Maximum Non-Detect | 500 | | |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 75 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 26 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 74.26% |
| | | | |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.353 | Not Available | |
| 5% Lilliefors Critical Value | 0.0984 | | |
| **Data not Normal at 5% Significance Level** | | | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | N/A |

| | | | |
|---|---|---|---|
| Mean | 1078 | | |
| SD | 3226 | | |
| 95% DL/2 (t) UCL | 1611 | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | N/A |
| Mean | -5046 | | |
| SD | 7770 | | |
| 95% MLE (t) UCL | -3763 | | |
| 95% MLE (Tiku) UCL | -2469 | | |

| | |
|---|---|
| **Gamma Distribution Test with Detected Values Only** | **Data Distribution Test with Detected Values Only** |
| Gamma Statistics Not Available | Data do not follow a Discernable Distribution (0.05) |

| | | | |
|---|---|---|---|
| **Potential UCLs to Use** | | **Nonparametric Statistics** | |
| 97.5% KM (Chebyshev) UCL | 3084 | Kaplan-Meier (KM) Method | |
| | | Mean | 1076 |
| | | SD | 3210 |
| | | SE of Mean | 321.4 |
| | | 95% KM (t) UCL | 1610 |
| | | 95% KM (z) UCL | 1605 |
| | | 95% KM (jackknife) UCL | 1609 |
| | | 95% KM (bootstrap t) UCL | 1907 |
| | | 95% KM (BCA) UCL | 1695 |
| | | 95% KM (Percentile Bootstrap) UCL | 1645 |
| | | 95% KM (Chebyshev) UCL | 2477 |
| | | 97.5% KM (Chebyshev) UCL | 3084 |
| | | 99% KM (Chebyshev) UCL | 4274 |

**Note: DL/2 is not a recommended method.**

**Trivalent Chromium, Dissolved (Calc)(ug/L)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Data | 57 | Number of Detected Data | 29 |
| Number of Distinct Detected Data | 27 | Number of Non-Detect Data | 28 |
| | | Percent Non-Detects | 49.12% |

| | | | |
|---|---|---|---|
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 1.7 | Log Statistics Not Avaliable | |
| Maximum Detected | 24000 | | |
| Mean of Detected | 2305 | | |
| Mean of Detected | 2305 | | |
| Mean of Detected | 2305 | | |
| Maximum Non-Detect | 2.7 | | |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 29 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 28 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 50.88% |

**UCL Statistics**

| | | | |
|---|---|---|---|
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Shapiro Wilk Test Statistic | 0.495 | Not Available | |
| 5% Shapiro Wilk Critical Value | 0.926 | | |
| Data not Normal at 5% Significance Level | | | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | N/A |
| Mean | 1173 | | |
| SD | 3982 | | |
| 95% DL/2 (t) UCL | 2055 | | |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | N/A |
| Mean | -1684 | | |
| SD | 6207 | | |
| 95% MLE (t) UCL | -308.7 | | |
| 95% MLE (Tiku) UCL | 72.39 | | |
| | | | |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| Gamma Statistics Not Available | | Data appear Lognormal at 5% Significance Level | |
| | | | |
| Potential UCLs to Use | | **Nonparametric Statistics** | |
| 99% KM (Chebyshev) UCL | 6467 | Kaplan-Meier (KM) Method | |
| | | Mean | 1174 |
| | | SD | 3947 |
| | | SE of Mean | 532 |
| | | 95% KM (t) UCL | 2064 |
| | | 95% KM (z) UCL | 2049 |
| | | 95% KM (jackknife) UCL | 2055 |
| | | 95% KM (bootstrap t) UCL | 2942 |
| | | 95% KM (BCA) UCL | 2217 |
| | | 95% KM (Percentile Bootstrap) UCL | 2141 |
| | | 95% KM (Chebyshev) UCL | 3493 |
| | | 97.5% KM (Chebyshev) UCL | 4496 |
| | | 99% KM (Chebyshev) UCL | 6467 |

Note: DL/2 is not a recommended method.

**Vanadium(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 90 | Number of Detected Data | 75 |
| Number of Distinct Detected Data | 72 | Number of Non-Detect Data | 15 |
| | | Percent Non-Detects | 16.67% |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 1.7 | Minimum Detected | 0.531 |
| Maximum Detected | 4540 | Maximum Detected | 8.421 |
| Mean of Detected | 252.2 | Mean of Detected | 3.555 |
| SD of Detected | 619.8 | SD of Detected | 2.143 |

| | | | |
|---|---|---|---|
| Minimum Non-Detect | 1.5 | Minimum Non-Detect | 0.405 |
| Maximum Non-Detect | 50 | Maximum Non-Detect | 3.912 |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 57 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 33 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 63.33% |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.343 | Lilliefors Test Statistic | 0.129 |
| 5% Lilliefors Critical Value | 0.102 | 5% Lilliefors Critical Value | 0.102 |
| **Data not Normal at 5% Significance Level** | | **Data not Lognormal at 5% Significance Level** | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 211.6 | Mean | 3.109 |
| SD | 572.5 | SD | 2.298 |
| 95% DL/2 (t) UCL | 311.9 | 95% H-Stat (DL/2) UCL | 440.8 |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 2.893 |
| | | SD in Log Scale | 2.549 |
| | | Mean in Original Scale | 210.7 |
| | | SD in Original Scale | 572.8 |
| | | 95% Percentile Bootstrap UCL | 319.6 |
| | | 95% BCA Bootstrap UCL | 373.8 |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.337 | **Data do not follow a Discernable Distribution (0.05)** | |
| Theta Star | 748.6 | | |
| nu star | 50.54 | | |
| A-D Test Statistic | 3.316 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.855 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.855 | Mean | 210.9 |
| 5% K-S Critical Value | 0.111 | SD | 569.5 |
| **Data not Gamma Distributed at 5% Significance Level** | | SE of Mean | 60.44 |
| | | 95% KM (t) UCL | 311.3 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 310.3 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 311.2 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 384.6 |
| Maximum | 4540 | 95% KM (BCA) UCL | 331.4 |
| Mean | 213.8 | 95% KM (Percentile Bootstrap) UCL | 322.5 |
| Median | 12.55 | 95% KM (Chebyshev) UCL | 474.3 |
| SD | 572.3 | 97.5% KM (Chebyshev) UCL | 588.3 |
| k star | 0.148 | 99% KM (Chebyshev) UCL | 812.2 |
| Theta star | 1440 | | |
| Nu star | 26.72 | **Potential UCLs to Use** | |
| AppChi2 | 15.94 | 97.5% KM (Chebyshev) UCL | 588.3 |
| 95% Gamma Approximate UCL | 358.5 | | |

| | | | |
|---|---|---|---|
| 95% Adjusted Gamma UCL | 361.6 | | |
| Note: DL/2 is not a recommended method. | | | |

**Vanadium, Dissolved(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 90 | Number of Detected Data | 51 |
| Number of Distinct Detected Data | 49 | Number of Non-Detect Data | 39 |
| | | Percent Non-Detects | 43.33% |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 1.6 | Minimum Detected | 0.47 |
| Maximum Detected | 2200 | Maximum Detected | 7.696 |
| Mean of Detected | 215.8 | Mean of Detected | 3.538 |
| SD of Detected | 458.7 | SD of Detected | 2.053 |
| Minimum Non-Detect | 1.5 | Minimum Non-Detect | 0.405 |
| Maximum Non-Detect | 50 | Maximum Non-Detect | 3.912 |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 68 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 22 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 75.56% |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.32 | Lilliefors Test Statistic | 0.114 |
| 5% Lilliefors Critical Value | 0.124 | 5% Lilliefors Critical Value | 0.124 |
| Data not Normal at 5% Significance Level | | Data appear Lognormal at 5% Significance Level | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 125 | Mean | 2.231 |
| SD | 359.3 | SD | 2.363 |
| 95% DL/2 (t) UCL | 188 | 95% H-Stat (DL/2) UCL | 131.2 |
| Maximum Likelihood Estimate(MLE) Method | N/A | Log ROS Method | |
| **MLE yields a negative mean** | | Mean in Log Scale | 1.499 |
| | | SD in Log Scale | 3.055 |
| | | Mean in Original Scale | 122.9 |
| | | SD in Original Scale | 360 |
| | | 95% Percentile Bootstrap UCL | 189.9 |
| | | 95% BCA Bootstrap UCL | 205.6 |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.356 | Data appear Lognormal at 5% Significance Level | |
| Theta Star | 606.9 | | |
| nu star | 36.27 | | |
| A-D Test Statistic | 2.239 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.847 | Kaplan-Meier (KM) Method | |

| | | | |
|---|---|---|---|
| K-S Test Statistic | 0.847 | Mean | 123.5 |
| 5% K-S Critical Value | 0.134 | SD | 357.8 |
| Data not Gamma Distributed at 5% Significance Level | | SE of Mean | 38.09 |
| | | 95% KM (t) UCL | 186.9 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 186.2 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 186.6 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 226.7 |
| Maximum | 2200 | 95% KM (BCA) UCL | 185.5 |
| Mean | 165.6 | 95% KM (Percentile Bootstrap) UCL | 192.1 |
| Median | 12 | 95% KM (Chebyshev) UCL | 289.6 |
| SD | 391.2 | 97.5% KM (Chebyshev) UCL | 361.4 |
| k star | 0.101 | 99% KM (Chebyshev) UCL | 502.6 |
| Theta star | 1635 | | |
| Nu star | 18.24 | **Potential UCLs to Use** | |
| AppChi2 | 9.561 | 97.5% KM (Chebyshev) UCL | 361.4 |
| 95% Gamma Approximate UCL | 315.8 | | |
| 95% Adjusted Gamma UCL | 319.2 | | |
| Note: DL/2 is not a recommended method. | | | |

General UCL Statistics for Data Sets with Non-Detects

| | | | |
|---|---|---|---|
| **User Selected Options** | | | |
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL2.xls.wst | | |
| Full Precision | ON | | |
| Confidence Coefficient | 95% | | |
| Number of Bootstrap Operations | | | 2000 |

**Aluminum(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 10 | Number of Distinct Observations | 10 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 1140 | Minimum of Log Data | 7.0387835 |
| Maximum | 12000 | Maximum of Log Data | 9.3926619 |
| Mean | 4186 | Mean of log Data | 7.9339072 |
| Median | 1645 | SD of log Data | 0.9282608 |
| SD | 4032.1767 | | |
| Coefficient of Variation | 0.9632529 | | |
| Skewness | 1.133392 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.7718041 | Shapiro Wilk Test Statistic | 0.8233616 |
| Shapiro Wilk Critical Value | 0.842 | Shapiro Wilk Critical Value | 0.842 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 6523.3771 | 95% H-UCL | 10721.141 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 9488.6793 |
| 95% Adjusted-CLT UCL | 6771.6453 | 97.5% Chebyshev (MVUE) UCL | 11837.603 |
| 95% Modified-t UCL | 6599.5444 | 99% Chebyshev (MVUE) UCL | 16451.608 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 1.0295832 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 4065.7227 | | |
| MLE of Mean | 4186 | | |
| MLE of Standard Deviation | 4125.423 | | |
| nu star | 20.591665 | | |
| Approximate Chi Square Value (.05) | 11.288468 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0267 | 95% CLT UCL | 6283.3302 |
| Adjusted Chi Square Value | 10.111139 | 95% Jackknife UCL | 6523.3771 |
| | | 95% Standard Bootstrap UCL | 6178.2028 |
| Anderson-Darling Test Statistic | 0.9452577 | 95% Bootstrap-t UCL | 7918.4963 |
| Anderson-Darling 5% Critical Value | 0.7414792 | 95% Hall's Bootstrap UCL | 6223.8888 |
| Kolmogorov-Smirnov Test Statistic | 0.3194309 | 95% Percentile Bootstrap UCL | 6259 |
| Kolmogorov-Smirnov 5% Critical Value | 0.2717744 | 95% BCA Bootstrap UCL | 6589 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 9743.972 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 12148.911 |

| | | | |
|---|---|---|---|
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 16872.948 |
| 95% Approximate Gamma UCL | 7635.8202 | | |
| 95% Adjusted Gamma UCL | 8524.9256 | | |
| | | | |
| **Potential UCL to Use** | | Use 95% Chebyshev (Mean, Sd) UCL | 9743.972 |

**Iron(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 10 | Number of Distinct Observations | 10 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 6180 | Minimum of Log Data | 8.7290736 |
| Maximum | 37600 | Maximum of Log Data | 10.534759 |
| Mean | 22318 | Mean of log Data | 9.753673 |
| Median | 27000 | SD of log Data | 0.8259879 |
| SD | 13991.304 | | |
| Coefficient of Variation | 0.6269067 | | |
| Skewness | -0.229673 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.801868 | Shapiro Wilk Test Statistic | 0.7592764 |
| Shapiro Wilk Critical Value | 0.842 | Shapiro Wilk Critical Value | 0.842 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 30428.496 | 95% H-UCL | 51756.785 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 50681.34 |
| 95% Adjusted-CLT UCL | 29252.196 | 97.5% Chebyshev (MVUE) UCL | 62565.388 |
| 95% Modified-t UCL | 30374.939 | 99% Chebyshev (MVUE) UCL | 85909.3 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 1.5214368 | Data Follow Appr. Gamma Distribution at 5% Significance Level | |
| Theta Star | 14669.028 | | |
| MLE of Mean | 22318 | | |
| MLE of Standard Deviation | 18093.739 | | |
| nu star | 30.428737 | | |
| Approximate Chi Square Value (.05) | 18.830169 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0267 | 95% CLT UCL | 29595.554 |
| Adjusted Chi Square Value | 17.26086 | 95% Jackknife UCL | 30428.496 |
| | | 95% Standard Bootstrap UCL | 29358.347 |
| Anderson-Darling Test Statistic | 1.097641 | 95% Bootstrap-t UCL | 29946.318 |
| Anderson-Darling 5% Critical Value | 0.735314 | 95% Hall's Bootstrap UCL | 28267.16 |
| Kolmogorov-Smirnov Test Statistic | 0.2675374 | 95% Percentile Bootstrap UCL | 29248 |
| Kolmogorov-Smirnov 5% Critical Value | 0.2697036 | 95% BCA Bootstrap UCL | 28765 |
| Data follow Appr. Gamma Distribution at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 41603.682 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 49948.612 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 66340.611 |

| | | | |
|---|---|---|---|
| 95% Approximate Gamma UCL | 36064.92 | | |
| 95% Adjusted Gamma UCL | 39343.842 | | |
| **Potential UCL to Use** | | Use 95% Approximate Gamma UCL | 36064.92 |

**Manganese(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 10 | Number of Distinct Observations | 10 |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 70.9 | Minimum of Log Data | 4.2612704 |
| Maximum | 2070 | Maximum of Log Data | 7.6353039 |
| Mean | 463.59 | Mean of log Data | 5.564386 |
| Median | 181 | SD of log Data | 1.0545904 |
| SD | 619.44213 | | |
| Coefficient of Variation | 1.3361853 | | |
| Skewness | 2.34647 | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.6630945 | Shapiro Wilk Test Statistic | 0.9185204 |
| Shapiro Wilk Critical Value | 0.842 | Shapiro Wilk Critical Value | 0.842 |
| **Data not Normal at 5% Significance Level** | | **Data appear Lognormal at 5% Significance Level** | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 822.66896 | 95% H-UCL | 1409.475 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 1065.808 |
| 95% Adjusted-CLT UCL | 941.10066 | 97.5% Chebyshev (MVUE) UCL | 1344.5384 |
| 95% Modified-t UCL | 846.894 | 99% Chebyshev (MVUE) UCL | 1892.0504 |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.7695023 | **Data appear Gamma Distributed at 5% Significance Level** | |
| Theta Star | 602.45433 | | |
| MLE of Mean | 463.59 | | |
| MLE of Standard Deviation | 528.48066 | | |
| nu star | 15.390046 | | |
| Approximate Chi Square Value (.05) | 7.533647 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0267 | 95% CLT UCL | 785.79182 |
| Adjusted Chi Square Value | 6.6008585 | 95% Jackknife UCL | 822.66896 |
| | | 95% Standard Bootstrap UCL | 772.52616 |
| Anderson-Darling Test Statistic | 0.7116974 | 95% Bootstrap-t UCL | 1734.0007 |
| Anderson-Darling 5% Critical Value | 0.7481968 | 95% Hall's Bootstrap UCL | 2159.4767 |
| Kolmogorov-Smirnov Test Statistic | 0.2717881 | 95% Percentile Bootstrap UCL | 822.48 |
| Kolmogorov-Smirnov 5% Critical Value | 0.2737287 | 95% BCA Bootstrap UCL | 977.5 |
| **Data appear Gamma Distributed at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 1317.432 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 1686.8902 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 2412.6191 |
| 95% Approximate Gamma UCL | 947.04086 | | |

| | | | |
|---|---|---|---|
| 95% Adjusted Gamma UCL | 1080.8702 | | |
| **Potential UCL to Use** | | Use 95% Approximate Gamma UCL | 947.04086 |

**Vanadium(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 10 | Number of Distinct Observations | 10 |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 9.4 | Minimum of Log Data | 2.2407097 |
| Maximum | 146 | Maximum of Log Data | 4.9836066 |
| Mean | 40.301 | Mean of log Data | 3.2251898 |
| Median | 14.9 | SD of log Data | 0.9883097 |
| SD | 44.238254 | | |
| Coefficient of Variation | 1.0976962 | | |
| Skewness | 1.764974 | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.7394072 | Shapiro Wilk Test Statistic | 0.8527832 |
| Shapiro Wilk Critical Value | 0.842 | Shapiro Wilk Critical Value | 0.842 |
| **Data not Normal at 5% Significance Level** | | **Data appear Lognormal at 5% Significance Level** | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 65.945085 | 95% H-UCL | 113.05964 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 93.272939 |
| 95% Adjusted-CLT UCL | 71.65435 | 97.5% Chebyshev (MVUE) UCL | 117.00765 |
| 95% Modified-t UCL | 67.246407 | 99% Chebyshev (MVUE) UCL | 163.6299 |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.906949 | **Data appear Lognormal at 5% Significance Level** | |
| Theta Star | 44.435794 | | |
| MLE of Mean | 40.301 | | |
| MLE of Standard Deviation | 42.317927 | | |
| nu star | 18.13898 | | |
| Approximate Chi Square Value (.05) | 9.4913817 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0267 | 95% CLT UCL | 63.311457 |
| Adjusted Chi Square Value | 8.4251887 | 95% Jackknife UCL | 65.945085 |
| | | 95% Standard Bootstrap UCL | 62.099905 |
| Anderson-Darling Test Statistic | 0.8424531 | 95% Bootstrap-t UCL | 84.118445 |
| Anderson-Darling 5% Critical Value | 0.7446467 | 95% Hall's Bootstrap UCL | 79.850158 |
| Kolmogorov-Smirnov Test Statistic | 0.3275401 | 95% Percentile Bootstrap UCL | 64.031 |
| Kolmogorov-Smirnov 5% Critical Value | 0.2726959 | 95% BCA Bootstrap UCL | 69.451 |
| **Data not Gamma Distributed at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 101.27923 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 127.66455 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 179.49342 |
| 95% Approximate Gamma UCL | 77.019245 | | |
| 95% Adjusted Gamma UCL | 86.765896 | | |
| **Potential UCL to Use** | | Use 95% H-UCL | 113.05964 |

## General UCL Statistics for Data Sets with Non-Detects

| | | | |
|---|---|---|---|
| **User Selected Options** | | | |
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL2.xls.wst | | |
| Full Precision | ON | | |
| Confidence Coefficient | 95% | | |
| Number of Bootstrap Operations | | | 2000 |
| | | | |
| **Aluminum(mg/Kg)** | | | |
| | | | |
| **General Statistics** | | | |
| Number of Valid Observations | 19 | Number of Distinct Observations | 18 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 227 | Minimum of Log Data | 5.42495 |
| Maximum | 12700 | Maximum of Log Data | 9.4493573 |
| Mean | 4196.5789 | Mean of log Data | 7.7464429 |
| Median | 1530 | SD of log Data | 1.2088204 |
| SD | 4313.8981 | | |
| Coefficient of Variation | 1.0279559 | | |
| Skewness | 1.0233194 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.7931248 | Shapiro Wilk Test Statistic | 0.9252593 |
| Shapiro Wilk Critical Value | 0.901 | Shapiro Wilk Critical Value | 0.901 |
| Data not Normal at 5% Significance Level | | Data appear Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 5912.7403 | 95% H-UCL | 11037.49 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 10793.773 |
| 95% Adjusted-CLT UCL | 6072.7119 | 97.5% Chebyshev (MVUE) UCL | 13508.043 |
| 95% Modified-t UCL | 5951.464 | 99% Chebyshev (MVUE) UCL | 18839.7 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.8539322 | Data appear Lognormal at 5% Significance Level | |
| Theta Star | 4914.4171 | | |
| MLE of Mean | 4196.5789 | | |
| MLE of Standard Deviation | 4541.3367 | | |
| nu star | 32.449423 | | |
| Approximate Chi Square Value (.05) | 20.428756 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.03687 | 95% CLT UCL | 5824.4513 |
| Adjusted Chi Square Value | 19.596157 | 95% Jackknife UCL | 5912.7403 |
| | | 95% Standard Bootstrap UCL | 5820.1347 |
| Anderson-Darling Test Statistic | 0.7811041 | 95% Bootstrap-t UCL | 6109.4836 |
| Anderson-Darling 5% Critical Value | 0.7702852 | 95% Hall's Bootstrap UCL | 5739.6617 |
| Kolmogorov-Smirnov Test Statistic | 0.2291441 | 95% Percentile Bootstrap UCL | 5817.4737 |
| Kolmogorov-Smirnov 5% Critical Value | 0.2045156 | 95% BCA Bootstrap UCL | 6040.6316 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 8510.4771 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 10377.104 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 14043.732 |

| | | | |
|---|---|---|---|
| 95% Approximate Gamma UCL | 6665.9255 | | |
| 95% Adjusted Gamma UCL | 6949.1467 | | |
| **Potential UCL to Use** | | Use 95% Chebyshev (MVUE) UCL | 10793.773 |

**Iron(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 19 | Number of Distinct Observations | 19 |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 316 | Minimum of Log Data | 5.7557422 |
| Maximum | 37600 | Maximum of Log Data | 10.534759 |
| Mean | 17648.737 | Mean of log Data | 9.2006981 |
| Median | 8240 | SD of log Data | 1.3613856 |
| SD | 14488.689 | | |
| Coefficient of Variation | 0.8209477 | | |
| Skewness | 0.2638835 | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.8341643 | Shapiro Wilk Test Statistic | 0.8608304 |
| Shapiro Wilk Critical Value | 0.901 | Shapiro Wilk Critical Value | 0.901 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 23412.649 | 95% H-UCL | 68969.813 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 59643.053 |
| 95% Adjusted-CLT UCL | 23331.135 | 97.5% Chebyshev (MVUE) UCL | 75494.255 |
| 95% Modified-t UCL | 23446.187 | 99% Chebyshev (MVUE) UCL | 106630.87 |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.8765332 | **Data Follow Appr. Gamma Distribution at 5% Significance Level** | |
| Theta Star | 20134.705 | | |
| MLE of Mean | 17648.737 | | |
| MLE of Standard Deviation | 18850.786 | | |
| nu star | 33.30826 | | |
| Approximate Chi Square Value (.05) | 21.112232 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.03687 | 95% CLT UCL | 23116.121 |
| Adjusted Chi Square Value | 20.264552 | 95% Jackknife UCL | 23412.649 |
| | | 95% Standard Bootstrap UCL | 23109.765 |
| Anderson-Darling Test Statistic | 0.8620601 | 95% Bootstrap-t UCL | 23831.206 |
| Anderson-Darling 5% Critical Value | 0.7692599 | 95% Hall's Bootstrap UCL | 22851.476 |
| Kolmogorov-Smirnov Test Statistic | 0.1865986 | 95% Percentile Bootstrap UCL | 23361.368 |
| Kolmogorov-Smirnov 5% Critical Value | 0.2043255 | 95% BCA Bootstrap UCL | 22948.421 |
| **Data follow Appr. Gamma Distribution at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 32137.426 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 38406.693 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 50721.455 |
| 95% Approximate Gamma UCL | 27843.987 | | |

| | | | |
|---|---|---|---|
| 95% Adjusted Gamma UCL | 29008.719 | | |
| **Potential UCL to Use** | | Use 95% Approximate Gamma UCL | 27843.987 |

**Manganese(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 19 | Number of Distinct Observations | 19 |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 1.69 | Minimum of Log Data | 0.5247285 |
| Maximum | 2070 | Maximum of Log Data | 7.6353039 |
| Mean | 259.19947 | Mean of log Data | 4.0565629 |
| Median | 116 | SD of log Data | 2.0867701 |
| SD | 491.87528 | | |
| Coefficient of Variation | 1.8976708 | | |
| Skewness | 3.18331 | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.5519712 | Shapiro Wilk Test Statistic | 0.9465009 |
| Shapiro Wilk Critical Value | 0.901 | Shapiro Wilk Critical Value | 0.901 |
| **Data not Normal at 5% Significance Level** | | **Data appear Lognormal at 5% Significance Level** | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 454.87803 | 95% H-UCL | 4449.7913 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 1356.7489 |
| 95% Adjusted-CLT UCL | 532.86758 | 97.5% Chebyshev (MVUE) UCL | 1778.2759 |
| 95% Modified-t UCL | 468.61304 | 99% Chebyshev (MVUE) UCL | 2606.284 |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.3996129 | **Data appear Gamma Distributed at 5% Significance Level** | |
| Theta Star | 648.62647 | | |
| MLE of Mean | 259.19947 | | |
| MLE of Standard Deviation | 410.02883 | | |
| nu star | 15.185288 | | |
| Approximate Chi Square Value (.05) | 7.3906153 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.03687 | 95% CLT UCL | 444.81122 |
| Adjusted Chi Square Value | 6.9185741 | 95% Jackknife UCL | 454.87803 |
| | | 95% Standard Bootstrap UCL | 440.83761 |
| Anderson-Darling Test Statistic | 0.442334 | 95% Bootstrap-t UCL | 862.0692 |
| Anderson-Darling 5% Critical Value | 0.8162286 | 95% Hall's Bootstrap UCL | 1172.7037 |
| Kolmogorov-Smirnov Test Statistic | 0.168614 | 95% Percentile Bootstrap UCL | 466.79211 |
| Kolmogorov-Smirnov 5% Critical Value | 0.2117151 | 95% BCA Bootstrap UCL | 559.72158 |
| **Data appear Gamma Distributed at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 751.07476 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 963.90959 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 1381.9824 |
| 95% Approximate Gamma UCL | 532.56984 | | |
| 95% Adjusted Gamma UCL | 568.90607 | | |

| | | | |
|---|---|---|---|
| **Potential UCL to Use** | | Use 95% Adjusted Gamma UCL | 568.90607 |

**Vanadium(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 19 | Number of Distinct Observations | 19 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 1.42 | Minimum of Log Data | 0.3506569 |
| Maximum | 146 | Maximum of Log Data | 4.9836066 |
| Mean | 29.835263 | Mean of log Data | 2.6435843 |
| Median | 13.4 | SD of log Data | 1.3559003 |
| SD | 37.134922 | | |
| Coefficient of Variation | 1.2446655 | | |
| Skewness | 1.9985742 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.7435366 | Shapiro Wilk Test Statistic | 0.9542004 |
| Shapiro Wilk Critical Value | 0.901 | Shapiro Wilk Critical Value | 0.901 |
| **Data not Normal at 5% Significance Level** | | **Data appear Lognormal at 5% Significance Level** | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 44.608333 | 95% H-UCL | 96.539603 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 83.900808 |
| 95% Adjusted-CLT UCL | 48.022103 | 97.5% Chebyshev (MVUE) UCL | 106.15885 |
| 95% Modified-t UCL | 45.259358 | 99% Chebyshev (MVUE) UCL | 149.88048 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.700662 | **Data appear Gamma Distributed at 5% Significance Level** | |
| Theta Star | 42.581536 | | |
| MLE of Mean | 29.835263 | | |
| MLE of Standard Deviation | 35.64311 | | |
| nu star | 26.625155 | | |
| Approximate Chi Square Value (.05) | 15.861595 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.03687 | 95% CLT UCL | 43.848323 |
| Adjusted Chi Square Value | 15.136899 | 95% Jackknife UCL | 44.608333 |
| | | 95% Standard Bootstrap UCL | 43.483999 |
| Anderson-Darling Test Statistic | 0.4694656 | 95% Bootstrap-t UCL | 52.601346 |
| Anderson-Darling 5% Critical Value | 0.7772379 | 95% Hall's Bootstrap UCL | 52.309714 |
| Kolmogorov-Smirnov Test Statistic | 0.1929688 | 95% Percentile Bootstrap UCL | 44.864737 |
| Kolmogorov-Smirnov 5% Critical Value | 0.2058042 | 95% BCA Bootstrap UCL | 47.821053 |
| **Data appear Gamma Distributed at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 66.970185 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 83.038495 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 114.60158 |
| 95% Approximate Gamma UCL | 50.08125 | | |
| 95% Adjusted Gamma UCL | 52.478945 | | |
| | | | |
| **Potential UCL to Use** | | Use 95% Approximate Gamma UCL | 50.08125 |

General UCL Statistics for Data Sets with Non-Detects

**User Selected Options**

| | |
|---|---|
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL2.wst |
| Full Precision | ON |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**Calcium(ug/L)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Observations | 20 | Number of Distinct Observations | 20 |

| | | | |
|---|---|---|---|
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 71100 | Minimum of Log Data | 11.171843 |
| Maximum | 165000 | Maximum of Log Data | 12.013701 |
| Mean | 122505 | Mean of log Data | 11.67668 |
| Median | 118000 | SD of log Data | 0.2954533 |
| SD | 33487.727 | | |
| Coefficient of Variation | 0.273358 | | |
| Skewness | -0.15952 | | |

**Relevant UCL Statistics**

| | | | |
|---|---|---|---|
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.8731752 | Shapiro Wilk Test Statistic | 0.8585459 |
| Shapiro Wilk Critical Value | 0.905 | Shapiro Wilk Critical Value | 0.905 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 135452.89 | 95% H-UCL | 139465.58 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 158599.19 |
| 95% Adjusted-CLT UCL | 134536.4 | 97.5% Chebyshev (MVUE) UCL | 174102.78 |
| 95% Modified-t UCL | 135408.37 | 99% Chebyshev (MVUE) UCL | 204556.59 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 11.007502 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 11129.228 | | |
| MLE of Mean | 122505 | | |
| MLE of Standard Deviation | 36924.059 | | |
| nu star | 440.30007 | | |
| Approximate Chi Square Value (.05) | 392.65238 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.038 | 95% CLT UCL | 134821.8 |
| Adjusted Chi Square Value | 389.10291 | 95% Jackknife UCL | 135452.89 |
| | | 95% Standard Bootstrap UCL | 134122.63 |
| Anderson-Darling Test Statistic | 1.0113046 | 95% Bootstrap-t UCL | 135077.2 |
| Anderson-Darling 5% Critical Value | 0.7415169 | 95% Hall's Bootstrap UCL | 134546.61 |
| Kolmogorov-Smirnov Test Statistic | 0.1963303 | 95% Percentile Bootstrap UCL | 134560 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1937423 | 95% BCA Bootstrap UCL | 133155 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 155144.8 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 169268.07 |

| | | | |
|---|---|---|---|
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 197010.49 |
| 95% Approximate Gamma UCL | 137370.77 | | |
| 95% Adjusted Gamma UCL | 138623.89 | | |
| | | | |
| **Potential UCL to Use** | | Use 95% Student's-t UCL | 135452.89 |
| | | or 95% Modified-t UCL | 135408.37 |

**Calcium, Dissolved(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 20 | Number of Distinct Observations | 16 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 71300 | Minimum of Log Data | 11.174652 |
| Maximum | 165000 | Maximum of Log Data | 12.013701 |
| Mean | 119040 | Mean of log Data | 11.65114 |
| Median | 113000 | SD of log Data | 0.2815198 |
| SD | 31587.796 | | |
| Coefficient of Variation | 0.2653545 | | |
| Skewness | -0.05944 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.8844055 | Shapiro Wilk Test Statistic | 0.8756174 |
| Shapiro Wilk Critical Value | 0.905 | Shapiro Wilk Critical Value | 0.905 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 131253.29 | 95% H-UCL | 134521.85 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 152332.37 |
| 95% Adjusted-CLT UCL | 130557.69 | 97.5% Chebyshev (MVUE) UCL | 166660.52 |
| 95% Modified-t UCL | 131237.64 | 99% Chebyshev (MVUE) UCL | 194805.39 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 11.954313 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 9957.9122 | | |
| MLE of Mean | 119040 | | |
| MLE of Standard Deviation | 34429.491 | | |
| nu star | 478.17253 | | |
| Approximate Chi Square Value (.05) | 428.46785 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.038 | 95% CLT UCL | 130658.01 |
| Adjusted Chi Square Value | 424.75653 | 95% Jackknife UCL | 131253.29 |
| | | 95% Standard Bootstrap UCL | 130524.35 |
| Anderson-Darling Test Statistic | 0.9419834 | 95% Bootstrap-t UCL | 131612.57 |
| Anderson-Darling 5% Critical Value | 0.7413933 | 95% Hall's Bootstrap UCL | 130648.45 |
| Kolmogorov-Smirnov Test Statistic | 0.2072714 | 95% Percentile Bootstrap UCL | 130215 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1937011 | 95% BCA Bootstrap UCL | 130425 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 149827.97 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 163149.96 |

| | | | |
|---|---|---|---|
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 189318.41 |
| 95% Approximate Gamma UCL | 132849.31 | | |
| 95% Adjusted Gamma UCL | 134010.08 | | |
| **Potential UCL to Use** | | Use 95% Student's-t UCL | 131253.29 |
| | | or 95% Modified-t UCL | 131237.64 |

**Magnesium(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 20 | Number of Distinct Observations | 19 |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 191000 | Minimum of Log Data | 12.160029 |
| Maximum | 506000 | Maximum of Log Data | 13.134292 |
| Mean | 343200 | Mean of log Data | 12.688501 |
| Median | 304000 | SD of log Data | 0.3519328 |
| SD | 117377.75 | | |
| Coefficient of Variation | 0.3420098 | | |
| Skewness | 0.2717173 | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.8419076 | Shapiro Wilk Test Statistic | 0.8639976 |
| Shapiro Wilk Critical Value | 0.905 | Shapiro Wilk Critical Value | 0.905 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 388583.62 | 95% H-UCL | 401521.53 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 463657.35 |
| 95% Adjusted-CLT UCL | 388075.53 | 97.5% Chebyshev (MVUE) UCL | 515615.83 |
| 95% Modified-t UCL | 388849.4 | 99% Chebyshev (MVUE) UCL | 617678.22 |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 7.554807 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 45428.03 | | |
| MLE of Mean | 343200 | | |
| MLE of Standard Deviation | 124863.53 | | |
| nu star | 302.19228 | | |
| Approximate Chi Square Value (.05) | 262.92335 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.038 | 95% CLT UCL | 386371.59 |
| Adjusted Chi Square Value | 260.03303 | 95% Jackknife UCL | 388583.62 |
| | | 95% Standard Bootstrap UCL | 384802.54 |
| Anderson-Darling Test Statistic | 1.1559713 | 95% Bootstrap-t UCL | 392469.64 |
| Anderson-Darling 5% Critical Value | 0.7426205 | 95% Hall's Bootstrap UCL | 387078.52 |
| Kolmogorov-Smirnov Test Statistic | 0.2150482 | 95% Percentile Bootstrap UCL | 385100 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1939927 | 95% BCA Bootstrap UCL | 387950 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 457605.68 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 507109.11 |

| | | | |
|---|---|---|---|
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 604349.01 |
| 95% Approximate Gamma UCL | 394458.66 | | |
| 95% Adjusted Gamma UCL | 398843.14 | | |
| **Potential UCL to Use** | | Use 95% Student's-t UCL | 388583.62 |
| | | or 95% Modified-t UCL | 388849.4 |

**Magnesium, Dissolved(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 20 | Number of Distinct Observations | 20 |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 185000 | Minimum of Log Data | 12.128111 |
| Maximum | 473000 | Maximum of Log Data | 13.066851 |
| Mean | 337300 | Mean of log Data | 12.678131 |
| Median | 306500 | SD of log Data | 0.3324804 |
| SD | 106649.01 | | |
| Coefficient of Variation | 0.3161844 | | |
| Skewness | 0.1172158 | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.8504862 | Shapiro Wilk Test Statistic | 0.865661 |
| Shapiro Wilk Critical Value | 0.905 | Shapiro Wilk Critical Value | 0.905 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 378535.4 | 95% H-UCL | 390980.76 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 449254.36 |
| 95% Adjusted-CLT UCL | 377193.43 | 97.5% Chebyshev (MVUE) UCL | 497437.01 |
| 95% Modified-t UCL | 378639.57 | 99% Chebyshev (MVUE) UCL | 592082.48 |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 8.5722611 | **Data do not follow a Discernable Distribution (0.05)** | |
| Theta Star | 39347.845 | | |
| MLE of Mean | 337300 | | |
| MLE of Standard Deviation | 115204.29 | | |
| nu star | 342.89045 | | |
| Approximate Chi Square Value (.05) | 300.9826 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.038 | 95% CLT UCL | 376525.55 |
| Adjusted Chi Square Value | 297.88471 | 95% Jackknife UCL | 378535.4 |
| | | 95% Standard Bootstrap UCL | 375384.26 |
| Anderson-Darling Test Statistic | 1.0794513 | 95% Bootstrap-t UCL | 379770.87 |
| Anderson-Darling 5% Critical Value | 0.7418349 | 95% Hall's Bootstrap UCL | 376286.6 |
| Kolmogorov-Smirnov Test Statistic | 0.2259058 | 95% Percentile Bootstrap UCL | 374700 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1938483 | 95% BCA Bootstrap UCL | 377450 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 441248.59 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 486227.23 |

| | | | |
|---|---|---|---|
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 574579.06 |
| 95% Approximate Gamma UCL | 384264.56 | | |
| 95% Adjusted Gamma UCL | 388260.77 | | |
| | | | |
| **Potential UCL to Use** | | Use 95% Student's-t UCL | 378535.4 |
| | | or 95% Modified-t UCL | 378639.57 |

**Manganese(ug/L)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 20 | Number of Distinct Observations | 19 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 11.9 | Minimum of Log Data | 2.4765384 |
| Maximum | 106 | Maximum of Log Data | 4.6634391 |
| Mean | 61.24 | Mean of log Data | 3.9494573 |
| Median | 57.4 | SD of log Data | 0.674914 |
| SD | 28.975587 | | |
| Coefficient of Variation | 0.4731481 | | |
| Skewness | -0.245184 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Shapiro Wilk Test Statistic | 0.9474459 | Shapiro Wilk Test Statistic | 0.8212544 |
| Shapiro Wilk Critical Value | 0.905 | Shapiro Wilk Critical Value | 0.905 |
| **Data appear Normal at 5% Significance Level** | | **Data not Lognormal at 5% Significance Level** | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 72.44329 | 95% H-UCL | 91.731949 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 109.2707 |
| 95% Adjusted-CLT UCL | 71.517679 | 97.5% Chebyshev (MVUE) UCL | 128.72707 |
| 95% Modified-t UCL | 72.384088 | 99% Chebyshev (MVUE) UCL | 166.94534 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 2.737147 | **Data appear Normal at 5% Significance Level** | |
| Theta Star | 22.373661 | | |
| MLE of Mean | 61.24 | | |
| MLE of Standard Deviation | 37.015713 | | |
| nu star | 109.48588 | | |
| Approximate Chi Square Value (.05) | 86.334718 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.038 | 95% CLT UCL | 71.897234 |
| Adjusted Chi Square Value | 84.711005 | 95% Jackknife UCL | 72.44329 |
| | | 95% Standard Bootstrap UCL | 71.732758 |
| Anderson-Darling Test Statistic | 0.8819278 | 95% Bootstrap-t UCL | 72.139692 |
| Anderson-Darling 5% Critical Value | 0.7471681 | 95% Hall's Bootstrap UCL | 71.718363 |
| Kolmogorov-Smirnov Test Statistic | 0.1985884 | 95% Percentile Bootstrap UCL | 71.41 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1949594 | 95% BCA Bootstrap UCL | 70.815 |
| **Data not Gamma Distributed at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 89.481909 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 101.7022 |

| | | | |
|---|---|---|---|
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 125.70661 |
| 95% Approximate Gamma UCL | 77.661867 | | |
| 95% Adjusted Gamma UCL | 79.150464 | | |
| | | | |
| **Potential UCL to Use** | | Use 95% Student's-t UCL | 72.44329 |

## General UCL Statistics for Data Sets with Non-Detects

| | |
|---|---|
| **User Selected Options** | |
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL_v3.2.wst |
| Full Precision | ON |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

### Calcium(mg/Kg)

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 57 | Number of Distinct Observations | 51 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 534 | Minimum of Log Data | 6.2803958 |
| Maximum | 242000 | Maximum of Log Data | 12.396693 |
| Mean | 122600.42 | Mean of log Data | 11.383358 |
| Median | 138000 | SD of log Data | 1.1845131 |
| SD | 63701.866 | | |
| Coefficient of Variation | 0.5195893 | | |
| Skewness | -0.32346 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.1157331 | Lilliefors Test Statistic | 0.2213858 |
| Lilliefors Critical Value | 0.1173536 | Lilliefors Critical Value | 0.1173536 |
| Data appear Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 136712.36 | 95% H-UCL | 268786.27 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 320810.81 |
| 95% Adjusted-CLT UCL | 136092.64 | 97.5% Chebyshev (MVUE) UCL | 384499.49 |
| 95% Modified-t UCL | 136652.11 | 99% Chebyshev (MVUE) UCL | 509603.57 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 1.5719774 | Data appear Normal at 5% Significance Level | |
| Theta Star | 77991.21 | | |
| MLE of Mean | 122600.42 | | |
| MLE of Standard Deviation | 97784.228 | | |
| nu star | 179.20542 | | |
| Approximate Chi Square Value (.05) | 149.24325 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0457895 | 95% CLT UCL | 136478.9 |
| Adjusted Chi Square Value | 148.53642 | 95% Jackknife UCL | 136712.36 |
| | | 95% Standard Bootstrap UCL | 136266.43 |
| Anderson-Darling Test Statistic | 3.3202424 | 95% Bootstrap-t UCL | 136579.95 |
| Anderson-Darling 5% Critical Value | 0.7667786 | 95% Hall's Bootstrap UCL | 136155.57 |
| Kolmogorov-Smirnov Test Statistic | 0.1955594 | 95% Percentile Bootstrap UCL | 136360.25 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1198241 | 95% BCA Bootstrap UCL | 136194.39 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 159378.71 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 175292.71 |

| | | | |
|---|---|---|---|
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 206552.67 |
| 95% Approximate Gamma UCL | 147213.77 | | |
| 95% Adjusted Gamma UCL | 147914.3 | | |
| | | | |
| Potential UCL to Use | | Use 95% Student's-t UCL | 136712.36 |

**Chromium (VI)(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 70 | Number of Distinct Observations | 66 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 0.28 | Minimum of Log Data | -1.272966 |
| Maximum | 6710 | Maximum of Log Data | 8.8113542 |
| Mean | 617.64329 | Mean of log Data | 3.1154966 |
| Median | 18.65 | SD of log Data | 2.7767736 |
| SD | 1506.2481 | | |
| Coefficient of Variation | 2.4387024 | | |
| Skewness | 2.7035049 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.4370217 | Lilliefors Test Statistic | 0.1059966 |
| Lilliefors Critical Value | 0.1058973 | Lilliefors Critical Value | 0.1058973 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 917.79804 | 95% H-UCL | 3110.2433 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 2910.8803 |
| 95% Adjusted-CLT UCL | 975.92737 | 97.5% Chebyshev (MVUE) UCL | 3805.9795 |
| 95% Modified-t UCL | 927.49363 | 99% Chebyshev (MVUE) UCL | 5564.2287 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.2192657 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 2816.8714 | | |
| MLE of Mean | 617.64329 | | |
| MLE of Standard Deviation | 1319.023 | | |
| nu star | 30.697199 | | |
| Approximate Chi Square Value (.05) | 19.041751 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0465714 | 95% CLT UCL | 913.76807 |
| Adjusted Chi Square Value | 18.848486 | 95% Jackknife UCL | 917.79804 |
| | | 95% Standard Bootstrap UCL | 905.67541 |
| Anderson-Darling Test Statistic | 6.2753538 | 95% Bootstrap-t UCL | 1024.2726 |
| Anderson-Darling 5% Critical Value | 0.9012328 | 95% Hall's Bootstrap UCL | 958.49715 |
| Kolmogorov-Smirnov Test Statistic | 0.2855268 | 95% Percentile Bootstrap UCL | 941.187 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1174957 | 95% BCA Bootstrap UCL | 998.26186 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 1402.3806 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 1741.9371 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 2408.93 |

| | | | |
|---|---|---|---|
| 95% Approximate Gamma UCL | 995.70247 | | |
| 95% Adjusted Gamma UCL | 1005.912 | | |
| Potential UCL to Use | | Use 99% Chebyshev (Mean, Sd) UCL | 2408.93 |

**Iron(mg/Kg)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Observations | 57 | Number of Distinct Observations | 56 |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 3570 | Minimum of Log Data | 8.1803209 |
| Maximum | 129000 | Maximum of Log Data | 11.767568 |
| Mean | 29842.632 | Mean of log Data | 9.8996521 |
| Median | 17800 | SD of log Data | 0.9005964 |
| SD | 29449.279 | | |
| Coefficient of Variation | 0.9868191 | | |
| Skewness | 1.8103713 | | |

**Relevant UCL Statistics**

| | | | |
|---|---|---|---|
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.2261038 | Lilliefors Test Statistic | 0.0953269 |
| Lilliefors Critical Value | 0.1173536 | Lilliefors Critical Value | 0.1173536 |
| Data not Normal at 5% Significance Level | | Data appear Lognormal at 5% Significance Level | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 36366.559 | 95% H-UCL | 39056.826 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 47321.118 |
| 95% Adjusted-CLT UCL | 37258.053 | 97.5% Chebyshev (MVUE) UCL | 54990.917 |
| 95% Modified-t UCL | 36522.448 | 99% Chebyshev (MVUE) UCL | 70056.75 |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 1.3194609 | Data appear Lognormal at 5% Significance Level | |
| Theta Star | 22617.291 | | |
| MLE of Mean | 29842.632 | | |
| MLE of Standard Deviation | 25979.982 | | |
| nu star | 150.41855 | | |
| Approximate Chi Square Value (.05) | 123.07055 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0457895 | 95% CLT UCL | 36258.634 |
| Adjusted Chi Square Value | 122.43076 | 95% Jackknife UCL | 36366.559 |
| | | 95% Standard Bootstrap UCL | 36197.283 |
| Anderson-Darling Test Statistic | 1.289789 | 95% Bootstrap-t UCL | 37765.849 |
| Anderson-Darling 5% Critical Value | 0.7710267 | 95% Hall's Bootstrap UCL | 37267.297 |
| Kolmogorov-Smirnov Test Statistic | 0.1532759 | 95% Percentile Bootstrap UCL | 36267.719 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1203235 | 95% BCA Bootstrap UCL | 37211.228 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 46845.181 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 54202.197 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 68653.632 |
| 95% Approximate Gamma UCL | 36474.083 | | |
| 95% Adjusted Gamma UCL | 36664.686 | | |

| | | | |
|---|---|---|---|
| **Potential UCL to Use** | | Use 95% H-UCL | 39056.826 |

**Manganese(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 57 | Number of Distinct Observations | 57 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 56.6 | Minimum of Log Data | 4.036009 |
| Maximum | 4060 | Maximum of Log Data | 8.3089383 |
| Mean | 600.04386 | Mean of log Data | 5.9148328 |
| Median | 429 | SD of log Data | 0.9774909 |
| SD | 713.285 | | |
| Coefficient of Variation | 1.1887214 | | |
| Skewness | 2.8720788 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.2356498 | Lilliefors Test Statistic | 0.0683898 |
| Lilliefors Critical Value | 0.1173536 | Lilliefors Critical Value | 0.1173536 |
| **Data not Normal at 5% Significance Level** | | **Data appear Lognormal at 5% Significance Level** | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 758.05858 | 95% H-UCL | 807.87517 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 981.51492 |
| 95% Adjusted-CLT UCL | 793.84753 | 97.5% Chebyshev (MVUE) UCL | 1150.8339 |
| 95% Modified-t UCL | 764.04867 | 99% Chebyshev (MVUE) UCL | 1483.4283 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 1.1254653 | **Data Follow Appr. Gamma Distribution at 5% Significance Level** | |
| Theta Star | 533.15183 | | |
| MLE of Mean | 600.04386 | | |
| MLE of Standard Deviation | 565.60983 | | |
| nu star | 128.30304 | | |
| Approximate Chi Square Value (.05) | 103.13926 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0457895 | 95% CLT UCL | 755.44454 |
| Adjusted Chi Square Value | 102.55546 | 95% Jackknife UCL | 758.05858 |
| | | 95% Standard Bootstrap UCL | 759.91475 |
| Anderson-Darling Test Statistic | 1.0479699 | 95% Bootstrap-t UCL | 809.24153 |
| Anderson-Darling 5% Critical Value | 0.7755264 | 95% Hall's Bootstrap UCL | 850.77387 |
| Kolmogorov-Smirnov Test Statistic | 0.1084045 | 95% Percentile Bootstrap UCL | 757.97018 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1208416 | 95% BCA Bootstrap UCL | 795.32105 |
| **Data follow Appr. Gamma Distribution at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 1011.8591 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 1190.0519 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 1540.0772 |
| 95% Approximate Gamma UCL | 746.44177 | | |
| 95% Adjusted Gamma UCL | 750.69088 | | |

| | | | |
|---|---|---|---|
| **Potential UCL to Use** | | Use 95% Approximate Gamma UCL | 746.44177 |

**Vanadium(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 57 | Number of Distinct Observations | 53 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 10.6 | Minimum of Log Data | 2.360854 |
| Maximum | 1210 | Maximum of Log Data | 7.0983756 |
| Mean | 179.1807 | Mean of log Data | 4.3274679 |
| Median | 49.7 | SD of log Data | 1.2807023 |
| SD | 253.66112 | | |
| Coefficient of Variation | 1.4156721 | | |
| Skewness | 1.960248 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.3252513 | Lilliefors Test Statistic | 0.1752169 |
| Lilliefors Critical Value | 0.1173536 | Lilliefors Critical Value | 0.1173536 |
| **Data not Normal at 5% Significance Level** | | **Data not Lognormal at 5% Significance Level** | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 235.3745 | 95% H-UCL | 278.15112 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 325.31114 |
| 95% Adjusted-CLT UCL | 243.76605 | 97.5% Chebyshev (MVUE) UCL | 393.49564 |
| 95% Modified-t UCL | 236.82841 | 99% Chebyshev (MVUE) UCL | 527.4309 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.6764906 | **Data do not follow a Discernable Distribution (0.05)** | |
| Theta Star | 264.868 | | |
| MLE of Mean | 179.1807 | | |
| MLE of Standard Deviation | 217.8514 | | |
| nu star | 77.119924 | | |
| Approximate Chi Square Value (.05) | 57.890455 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0457895 | 95% CLT UCL | 234.44488 |
| Adjusted Chi Square Value | 57.458617 | 95% Jackknife UCL | 235.3745 |
| | | 95% Standard Bootstrap UCL | 234.57794 |
| Anderson-Darling Test Statistic | 4.3751854 | 95% Bootstrap-t UCL | 248.8576 |
| Anderson-Darling 5% Critical Value | 0.7968919 | 95% Hall's Bootstrap UCL | 249.12261 |
| Kolmogorov-Smirnov Test Statistic | 0.2284698 | 95% Percentile Bootstrap UCL | 236.21053 |
| Kolmogorov-Smirnov 5% Critical Value | 0.1229912 | 95% BCA Bootstrap UCL | 239.97368 |
| **Data not Gamma Distributed at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 325.63202 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 389.00162 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 513.47893 |
| 95% Approximate Gamma UCL | 238.69915 | | |
| 95% Adjusted Gamma UCL | 240.49312 | | |
| | | | |
| **Potential UCL to Use** | | Use 97.5% Chebyshev (Mean, Sd) UCL | 389.00162 |

Honeywell Dundalk Marine Terminal, Non-Priority Stormwater UCL Output

General UCL Statistics for Data Sets with Non-Detects

**User Selected Options**

| | | | |
|---|---|---|---|
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL2.wst | | |
| Full Precision | ON | | |
| Confidence Coefficient | 95% | | |
| Number of Bootstrap Operations | | | 2000 |

**Hexavalent Chromium(ug/L)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Data | 27 | Number of Detected Data | 9 |
| Number of Distinct Detected Data | 9 | Number of Non-Detect Data | 18 |
| | | Percent Non-Detects | 66.67% |

| | | | |
|---|---|---|---|
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 10 | Log Statistics Not Avaliable | |
| Maximum Detected | 1000 | | |
| Mean of Detected | 354.33333 | | |
| Mean of Detected | 354.33333 | | |
| Mean of Detected | 354.33333 | | |
| Maximum Non-Detect | 5 | | |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 18 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 9 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 66.67% |

**Warning: There are only 9 Detected Values in this data**
**Note: It should be noted that even though bootstrap may be performed on this data set**
**the resulting calculations may not be reliable enough to draw conclusions**

**It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.**

**UCL Statistics**

| | | | |
|---|---|---|---|
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Shapiro Wilk Test Statistic | 0.8898535 | Not Available | |
| 5% Shapiro Wilk Critical Value | 0.829 | | |
| **Data appear Normal at 5% Significance Level** | | | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | N/A |
| Mean | 119.31481 | | |
| SD | 256.02956 | | |
| 95% DL/2 (t) UCL | 203.35558 | | |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | N/A |
| Mean | -248.3855 | | |
| SD | 563.08674 | | |
| 95% MLE (t) UCL | -63.55435 | | |
| 95% MLE (Tiku) UCL | 49.778544 | | |

| Gamma Distribution Test with Detected Values Only | | Data Distribution Test with Detected Values Only | |
|---|---|---|---|
| Gamma Statistics Not Available | | Data appear Normal at 5% Significance Level | |
| | | | |
| **Potential UCLs to Use** | | **Nonparametric Statistics** | |
| 95% KM (t) UCL | 211.3659 | Kaplan-Meier (KM) Method | |
| 95% KM (Percentile Bootstrap) UCL | 240.74074 | Mean | 124.77778 |
| | | SD | 248.70365 |
| | | SE of Mean | 50.76642 |
| | | 95% KM (t) UCL | 211.3659 |
| | | 95% KM (z) UCL | 208.28111 |
| | | 95% KM (jackknife) UCL | 197.66546 |
| | | 95% KM (bootstrap t) UCL | 249.69568 |
| | | 95% KM (BCA) UCL | 281.85185 |
| | | 95% KM (Percentile Bootstrap) UCL | 240.74074 |
| | | 95% KM (Chebyshev) UCL | 346.06347 |
| | | 97.5% KM (Chebyshev) UCL | 441.81397 |
| | | 99% KM (Chebyshev) UCL | 629.89728 |

**Note: DL/2 is not a recommended method.**

## General UCL Statistics for Data Sets with Non-Detects

**User Selected Options**

| | |
|---|---|
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL_v3.1_STW_PRI_update.wst |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**HexavalentChromium(ug/L)**

**General Statistics**

| | | | |
|---|---|---|---|
| Number of Valid Data | 111 | Number of Detected Data | 106 |
| Number of Distinct Detected Data | 55 | Number of Non-Detect Data | 5 |
| Number of Missing Values | 7 | Percent Non-Detects | 4.50% |

| | | | |
|---|---|---|---|
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 20 | Log Statistics Not Avaliable | |
| Maximum Detected | 57000 | | |
| Mean of Detected | 16889 | | |
| Mean of Detected | 16889 | | |
| Mean of Detected | 16889 | | |
| Maximum Non-Detect | 5 | | |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 5 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 106 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 4.50% |

**UCL Statistics**

| | | | |
|---|---|---|---|
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.161 | Not Available | |
| 5% Lilliefors Critical Value | 0.0861 | | |
| **Data not Normal at 5% Significance Level** | | | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | N/A |
| Mean | 16129 | | |
| SD | 14296 | | |
| 95% DL/2 (t) UCL | 18380 | | |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | N/A |
| Mean | 15789 | | |
| SD | 14759 | | |
| 95% MLE (t) UCL | 18113 | | |
| 95% MLE (Tiku) UCL | 18029 | | |
| | | | |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| Gamma Statistics Not Available | | Data do not follow a Discernable Distribution (0.05) | |
| | | | |
| **Potential UCLs to Use** | | **Nonparametric Statistics** | |
| 97.5% KM (Chebyshev) UCL | 24605 | Kaplan-Meier (KM) Method | |

| | | | |
|---|---|---|---|
| | | Mean | 16130 |
| | | SD | 14231 |
| | | SE of Mean | 1357 |
| | | 95% KM (t) UCL | 18381 |
| | | 95% KM (z) UCL | 18362 |
| | | 95% KM (jackknife) UCL | 18380 |
| | | 95% KM (bootstrap t) UCL | 18593 |
| | | 95% KM (BCA) UCL | 18204 |
| | | 95% KM (Percentile Bootstrap) UCL | 18370 |
| | | 95% KM (Chebyshev) UCL | 22045 |
| | | 97.5% KM (Chebyshev) UCL | 24605 |
| | | 99% KM (Chebyshev) UCL | 29633 |

Note: DL/2 is not a recommended method.

**TrivalentChromium(ug/L)**

| **General Statistics** | | | |
|---|---|---|---|
| Number of Valid Data | 110 | Number of Detected Data | 53 |
| Number of Distinct Detected Data | 38 | Number of Non-Detect Data | 57 |
| Number of Missing Values | 8 | Percent Non-Detects | 51.82% |

| **Raw Statistics** | | **Log-transformed Statistics** | |
|---|---|---|---|
| Minimum Detected | 20 | Log Statistics Not Avaliable | |
| Maximum Detected | 10000 | | |
| Mean of Detected | 2039 | | |
| Mean of Detected | 2039 | | |
| Mean of Detected | 2039 | | |
| Maximum Non-Detect | 0 | | |

**UCL Statistics**

| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
|---|---|---|---|
| Lilliefors Test Statistic | 0.215 | Not Available | |
| 5% Lilliefors Critical Value | 0.122 | | |
| Data not Normal at 5% Significance Level | | | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | N/A |
| Mean | 982.6 | | |
| SD | 2018 | | |
| 95% DL/2 (t) UCL | 1302 | | |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | N/A |
| Mean | -517.3 | | |
| SD | 3381 | | |
| 95% MLE (t) UCL | 17.51 | | |
| 95% MLE (Tiku) UCL | 161 | | |

| **Gamma Distribution Test with Detected Values Only** | **Data Distribution Test with Detected Values Only** |
|---|---|
| Gamma Statistics Not Available | Data appear Gamma Distributed at 5% Significance Level |

| Potential UCLs to Use | | Nonparametric Statistics | |
|---|---|---|---|
| 95% KM (t) UCL | 1313 | Kaplan-Meier (KM) Method | |
| | | Mean | 992.9 |
| | | SD | 2003 |
| | | SE of Mean | 192.8 |
| | | 95% KM (t) UCL | 1313 |
| | | 95% KM (z) UCL | 1310 |
| | | 95% KM (jackknife) UCL | 1307 |
| | | 95% KM (bootstrap t) UCL | 1376 |
| | | 95% KM (BCA) UCL | 1362 |
| | | 95% KM (Percentile Bootstrap) UCL | 1324 |
| | | 95% KM (Chebyshev) UCL | 1834 |
| | | 97.5% KM (Chebyshev) UCL | 2197 |
| | | 99% KM (Chebyshev) UCL | 2912 |

**Note: DL/2 is not a recommended method.**

## General UCL Statistics for Data Sets with Non-Detects

| | | | |
|---|---|---|---|
| **User Selected Options** | | | |
| From File | C:\Documents and Settings\sharper\Desktop\prel-proUCL_v3.2.wst | | |
| Full Precision | ON | | |
| Confidence Coefficient | 95% | | |
| Number of Bootstrap Operations | | | 2000 |

### Calcium(mg/Kg)

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 203 | Number of Distinct Observations | 181 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 102 | Minimum of Log Data | 4.6249728 |
| Maximum | 272000 | Maximum of Log Data | 12.513557 |
| Mean | 101776.86 | Mean of log Data | 10.191854 |
| Median | 89100 | SD of log Data | 2.3958482 |
| SD | 91827.211 | | |
| Coefficient of Variation | 0.9022405 | | |
| Skewness | 0.2721011 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.1681497 | Lilliefors Test Statistic | 0.2062347 |
| Lilliefors Critical Value | 0.062185 | Lilliefors Critical Value | 0.062185 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 112426.8 | 95% H-UCL | 864456.16 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 1043697.1 |
| 95% Adjusted-CLT UCL | 112509.47 | 97.5% Chebyshev (MVUE) UCL | 1302106.6 |
| 95% Modified-t UCL | 112447.31 | 99% Chebyshev (MVUE) UCL | 1809702.1 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.4740681 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 214688.29 | | |
| MLE of Mean | 101776.86 | | |
| MLE of Standard Deviation | 147818.47 | | |
| nu star | 192.47164 | | |
| Approximate Chi Square Value (.05) | 161.37602 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0488177 | 95% CLT UCL | 112377.95 |
| Adjusted Chi Square Value | 161.17433 | 95% Jackknife UCL | 112426.8 |
| | | 95% Standard Bootstrap UCL | 112207.55 |
| Anderson-Darling Test Statistic | 10.940015 | 95% Bootstrap-t UCL | 113011.33 |
| Anderson-Darling 5% Critical Value | 0.82629 | 95% Hall's Bootstrap UCL | 112741.8 |
| Kolmogorov-Smirnov Test Statistic | 0.1803568 | 95% Percentile Bootstrap UCL | 111820.28 |
| Kolmogorov-Smirnov 5% Critical Value | 0.0671525 | 95% BCA Bootstrap UCL | 112714.51 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 129870 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 142025.92 |

| | | | |
|---|---|---|---|
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 165903.87 |
| 95% Approximate Gamma UCL | 121388.29 | | |
| 95% Adjusted Gamma UCL | 121540.19 | | |
| | | | |
| **Potential UCL to Use** | | Use 99% Chebyshev (Mean, Sd) UCL | 165903.87 |

**Chromium (VI)(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Data | 301 | Number of Detected Data | 293 |
| Number of Distinct Detected Data | 235 | Number of Non-Detect Data | 8 |
| | | Percent Non-Detects | 2.66% |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum Detected | 0.28 | Minimum Detected | -1.272966 |
| Maximum Detected | 41800 | Maximum Detected | 10.640652 |
| Mean of Detected | 1683.7178 | Mean of Detected | 3.6172107 |
| SD of Detected | 4015.4041 | SD of Detected | 3.3810303 |
| Minimum Non-Detect | 0.22 | Minimum Non-Detect | -1.514128 |
| Maximum Non-Detect | 0.94 | Maximum Non-Detect | -0.061875 |
| | | | |
| Note: Data have multiple DLs - Use of KM Method is recommended | | Number treated as Non-Detect | 46 |
| For all methods (except KM, DL/2, and ROS Methods), | | Number treated as Detected | 255 |
| Observations < Largest ND are treated as NDs | | Single DL Non-Detect Percentage | 15.28% |
| | | | |
| **UCL Statistics** | | | |
| **Normal Distribution Test with Detected Values Only** | | **Lognormal Distribution Test with Detected Values Only** | |
| Lilliefors Test Statistic | 0.3435052 | Lilliefors Test Statistic | 0.1302854 |
| 5% Lilliefors Critical Value | 0.0517607 | 5% Lilliefors Critical Value | 0.0517607 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| DL/2 Substitution Method | | DL/2 Substitution Method | |
| Mean | 1638.9757 | Mean | 3.483609 |
| SD | 3970.7774 | SD | 3.4341544 |
| 95% DL/2 (t) UCL | 2016.6024 | 95% H-Stat (DL/2) UCL | 24656.217 |
| | | | |
| Maximum Likelihood Estimate(MLE) Method | | Log ROS Method | |
| Mean | 1160.4813 | Mean in Log Scale | 3.4329836 |
| SD | 4413.0035 | SD in Log Scale | 3.5277802 |
| 95% MLE (t) UCL | 1580.1644 | Mean in Original Scale | 1638.9705 |
| 95% MLE (Tiku) UCL | 1559.1264 | SD in Original Scale | 3970.7796 |
| | | 95% Percentile Bootstrap UCL | 2040.001 |
| | | 95% BCA Bootstrap UCL | 2113.1038 |
| | | | |
| **Gamma Distribution Test with Detected Values Only** | | **Data Distribution Test with Detected Values Only** | |
| k star (bias corrected) | 0.194283 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 8666.3144 | | |
| nu star | 113.84986 | | |

| | | | |
|---|---|---|---|
| A-D Test Statistic | 20.992653 | **Nonparametric Statistics** | |
| 5% A-D Critical Value | 0.9319165 | Kaplan-Meier (KM) Method | |
| K-S Test Statistic | 0.9319165 | Mean | 1638.9788 |
| 5% K-S Critical Value | 0.0589359 | SD | 3964.1747 |
| Data not Gamma Distributed at 5% Significance Level | | SE of Mean | 228.88215 |
| | | 95% KM (t) UCL | 2016.6226 |
| **Assuming Gamma Distribution** | | 95% KM (z) UCL | 2015.4564 |
| Gamma ROS Statistics using Extrapolated Data | | 95% KM (jackknife) UCL | 2016.6051 |
| Minimum | 1E-09 | 95% KM (bootstrap t) UCL | 2121.4761 |
| Maximum | 41800 | 95% KM (BCA) UCL | 2033.0597 |
| Mean | 1638.9679 | 95% KM (Percentile Bootstrap) UCL | 2040.7462 |
| Median | 13.1 | 95% KM (Chebyshev) UCL | 2636.653 |
| SD | 3970.7807 | 97.5% KM (Chebyshev) UCL | 3068.3474 |
| k star | 0.1707385 | 99% KM (Chebyshev) UCL | 3916.3274 |
| Theta star | 9599.2894 | | |
| Nu star | 102.78455 | **Potential UCLs to Use** | |
| AppChi2 | 80.391664 | 97.5% KM (Chebyshev) UCL | 3068.3474 |
| 95% Gamma Approximate UCL | 2095.4981 | | |
| 95% Adjusted Gamma UCL | 2097.9656 | | |
| **Note: DL/2 is not a recommended method.** | | | |

**Iron(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 204 | Number of Distinct Observations | 172 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 242 | Minimum of Log Data | 5.4889377 |
| Maximum | 164000 | Maximum of Log Data | 12.007622 |
| Mean | 47258.539 | Mean of log Data | 9.9812114 |
| Median | 18950 | SD of log Data | 1.4524129 |
| SD | 50771.856 | | |
| Coefficient of Variation | 1.0743425 | | |
| Skewness | 0.9350381 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.2567177 | Lilliefors Test Statistic | 0.1069092 |
| Lilliefors Critical Value | 0.0620324 | Lilliefors Critical Value | 0.0620324 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 53132.373 | 95% H-UCL | 80589.809 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 99526.549 |
| 95% Adjusted-CLT UCL | 53354.226 | 97.5% Chebyshev (MVUE) UCL | 116015.3 |
| 95% Modified-t UCL | 53171.158 | 99% Chebyshev (MVUE) UCL | 148404.25 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |

| | | | |
|---|---|---|---|
| k star (bias corrected) | 0.7555412 | **Data do not follow a Discernable Distribution (0.05)** | |
| Theta Star | 62549.255 | | |
| MLE of Mean | 47258.539 | | |
| MLE of Standard Deviation | 54368.984 | | |
| nu star | 308.26081 | | |
| Approximate Chi Square Value (.05) | 268.58756 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0488235 | 95% CLT UCL | 53105.568 |
| Adjusted Chi Square Value | 268.3269 | 95% Jackknife UCL | 53132.373 |
| | | 95% Standard Bootstrap UCL | 52971.942 |
| Anderson-Darling Test Statistic | 5.2746223 | 95% Bootstrap-t UCL | 53208.768 |
| Anderson-Darling 5% Critical Value | 0.7955732 | 95% Hall's Bootstrap UCL | 53356.937 |
| Kolmogorov-Smirnov Test Statistic | 0.1283776 | 95% Percentile Bootstrap UCL | 53391.466 |
| Kolmogorov-Smirnov 5% Critical Value | 0.0656906 | 95% BCA Bootstrap UCL | 53709.392 |
| **Data not Gamma Distributed at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 62753.296 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 69457.889 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 82627.765 |
| 95% Approximate Gamma UCL | 54239.13 | | |
| 95% Adjusted Gamma UCL | 54291.82 | | |
| | | | |
| **Potential UCL to Use** | | Use 97.5% Chebyshev (Mean, Sd) UCL | 69457.889 |

**Manganese(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 204 | Number of Distinct Observations | 178 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 3.4 | Minimum of Log Data | 1.2237754 |
| Maximum | 4060 | Maximum of Log Data | 8.3089383 |
| Mean | 552.45897 | Mean of log Data | 5.4804984 |
| Median | 300.5 | SD of log Data | 1.5894427 |
| SD | 580.60895 | | |
| Coefficient of Variation | 1.050954 | | |
| Skewness | 1.7598103 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.1754522 | Lilliefors Test Statistic | 0.1156336 |
| Lilliefors Critical Value | 0.0620324 | Lilliefors Critical Value | 0.0620324 |
| **Data not Normal at 5% Significance Level** | | **Data not Lognormal at 5% Significance Level** | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 619.63005 | 95% H-UCL | 1147.2925 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 1430.3526 |
| 95% Adjusted-CLT UCL | 624.67532 | 97.5% Chebyshev (MVUE) UCL | 1687.0745 |
| 95% Modified-t UCL | 620.46482 | 99% Chebyshev (MVUE) UCL | 2191.3551 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.7143326 | **Data do not follow a Discernable Distribution (0.05)** | |

| | | | |
|---|---|---|---|
| Theta Star | 773.39179 | | |
| MLE of Mean | 552.45897 | | |
| MLE of Standard Deviation | 653.65681 | | |
| nu star | 291.4477 | | |
| Approximate Chi Square Value (.05) | 252.90473 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0488235 | 95% CLT UCL | 619.32352 |
| Adjusted Chi Square Value | 252.65197 | 95% Jackknife UCL | 619.63005 |
| | | 95% Standard Bootstrap UCL | 617.52 |
| Anderson-Darling Test Statistic | 2.536305 | 95% Bootstrap-t UCL | 624.01561 |
| Anderson-Darling 5% Critical Value | 0.799037 | 95% Hall's Bootstrap UCL | 627.94724 |
| Kolmogorov-Smirnov Test Statistic | 0.101409 | 95% Percentile Bootstrap UCL | 622.07074 |
| Kolmogorov-Smirnov 5% Critical Value | 0.0658544 | 95% BCA Bootstrap UCL | 630.20525 |
| Data not Gamma Distributed at 5% Significance Level | | 95% Chebyshev(Mean, Sd) UCL | 729.65151 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 806.32287 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 956.9289 |
| 95% Approximate Gamma UCL | 636.65436 | | |
| 95% Adjusted Gamma UCL | 637.29128 | | |
| | | | |
| **Potential UCL to Use** | | Use 97.5% Chebyshev (Mean, Sd) UCL | 806.32287 |

**Vanadium(mg/Kg)**

| | | | |
|---|---|---|---|
| **General Statistics** | | | |
| Number of Valid Observations | 204 | Number of Distinct Observations | 181 |
| | | | |
| **Raw Statistics** | | **Log-transformed Statistics** | |
| Minimum | 1.47 | Minimum of Log Data | 0.3852624 |
| Maximum | 1630 | Maximum of Log Data | 7.3963353 |
| Mean | 382.89858 | Mean of log Data | 4.5926693 |
| Median | 51.65 | SD of log Data | 1.8362252 |
| SD | 510.92868 | | |
| Coefficient of Variation | 1.3343708 | | |
| Skewness | 1.077866 | | |
| | | | |
| **Relevant UCL Statistics** | | | |
| **Normal Distribution Test** | | **Lognormal Distribution Test** | |
| Lilliefors Test Statistic | 0.3098593 | Lilliefors Test Statistic | 0.1525916 |
| Lilliefors Critical Value | 0.0620324 | Lilliefors Critical Value | 0.0620324 |
| Data not Normal at 5% Significance Level | | Data not Lognormal at 5% Significance Level | |
| | | | |
| **Assuming Normal Distribution** | | **Assuming Lognormal Distribution** | |
| 95% Student's-t UCL | 442.0083 | 95% H-UCL | 781.32561 |
| **95% UCLs (Adjusted for Skewness)** | | 95% Chebyshev (MVUE) UCL | 981.62475 |
| 95% Adjusted-CLT UCL | 444.62308 | 97.5% Chebyshev (MVUE) UCL | 1180.6947 |
| 95% Modified-t UCL | 442.45822 | 99% Chebyshev (MVUE) UCL | 1571.729 |
| | | | |
| **Gamma Distribution Test** | | **Data Distribution** | |
| k star (bias corrected) | 0.4691518 | Data do not follow a Discernable Distribution (0.05) | |
| Theta Star | 816.15079 | | |

| | | | |
|---|---|---|---|
| MLE of Mean | 382.89858 | | |
| MLE of Standard Deviation | 559.01966 | | |
| nu star | 191.41392 | | |
| Approximate Chi Square Value (.05) | 160.4072 | **Nonparametric Statistics** | |
| Adjusted Level of Significance | 0.0488235 | 95% CLT UCL | 441.73855 |
| Adjusted Chi Square Value | 160.20713 | 95% Jackknife UCL | 442.0083 |
| | | 95% Standard Bootstrap UCL | 440.97186 |
| Anderson-Darling Test Statistic | 12.275884 | 95% Bootstrap-t UCL | 442.16284 |
| Anderson-Darling 5% Critical Value | 0.8275075 | 95% Hall's Bootstrap UCL | 445.34531 |
| Kolmogorov-Smirnov Test Statistic | 0.2183488 | 95% Percentile Bootstrap UCL | 443.18647 |
| Kolmogorov-Smirnov 5% Critical Value | 0.0670749 | 95% BCA Bootstrap UCL | 444.37289 |
| **Data not Gamma Distributed at 5% Significance Level** | | 95% Chebyshev(Mean, Sd) UCL | 538.82582 |
| | | 97.5% Chebyshev(Mean, Sd) UCL | 606.29566 |
| **Assuming Gamma Distribution** | | 99% Chebyshev(Mean, Sd) UCL | 738.8271 |
| 95% Approximate Gamma UCL | 456.91288 | | |
| 95% Adjusted Gamma UCL | 457.48348 | | |
| | | | |
| **Potential UCL to Use** | | Use 97.5% Chebyshev (Mean, Sd) UCL | 606.29566 |