FINAL RCRA FACILITY INVESTIGATION REPORT

Former Bethlehem Steel Corporation Facility
Lackawanna, New York

PART IV - HUMAN HEALTH RISK ASSESSMENT REPORT

October 2004

Submitted by:
TECUMSEH REDEVELOPMENT, INC.
4020 Kinross Lakes Parkway
Richfield, Ohio 44286-9000

BETHLEHEM STEEL

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DRAFT

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HUMAN HEALTH RISK ASSESSMENT RCRA FACILITY INVESTIGATION REPORT BETHLEHEM STEEL CORPORATION LACKAWANNA, NEW YORK

October, 2004

URS
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LIST OF ACRONYMS:

AOC	Administrative Order on Consent
ASTM	American Society for Testing and Materials
BCF	Bioconcentration Factor
bgs	Below ground surface
BSC	Bethlehem Steel Company
CLT	Central limit theorem
COPC	Chemical of potential concern
COPI	Constituent of potential interest
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
ID	Interim Deliverable
IEUBK	Integrated exposure uptake biokinetic
IRIS	Integrated Risk Information System
ISCST	Industrial Source Complex Short-Term
LMS	Linearized multistage
mgd	Million gallons per day
NAPL	Nonaqueous phase liquid
NCEA	National Center for Environmental Assessment
NYSDEC	New York State Department of Environmental Conservation
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbon
PEL	Permissible Exposure Limit
RAIS	Risk Assessment Information System
RBC	Risk-based concentration
RBSL	Risk-based screening level
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfC	Reference concentration
RfD	Reference dose
RFI	RCRA Facility Investigation
SF	Slope factor
SLCR	Screening-level cancer risk

SLHI	Screening-level hazard index
SLHQ	Screening-level hazard quotient
SFA	Slag fill area
SSL	Soil screening level
SVOC	Semivolatile organic compound
SWMU	Solid waste management unit
UCL	Upper confidence limit
USEPA	U.S. Environmental Protection Agency
VF	Volatilization factor
VOC	Volatile organic compound

1.0

1.0 INTRODUCTION

This Part IV section of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report presents the conceptual approach and methodology for evaluating potential human health risks due to releases from solid waste management units (SWMUs) to soil, air, groundwater, sediment, and surface water at or near the Lackawanna facility. A RCRA Facility Assessment (RFA) conducted in 1988 identified 104 SWMUs that could have received or released hazardous constituents and/or wastes, including six watercourses (USEPA 1988).

In 1990, Bethlehem Steel Company (BSC) and the U.S. Environmental Protection Agency (USEPA) Region 2 negotiated and entered into an Administrative Order on Consent (AOC). The AOC directed the performance of a phased, site-wide RFI to determine the nature, extent, and potential health impacts of the releases. The evaluation of health impacts to human populations is accomplished by the risk assessment process (i.e., a Human Health Risk Assessment, or HHRA). This process combines information on potential exposures to site-related hazardous constituents with toxicological information to generate a quantitative estimate of risk. The approach and methodologies presented in this section of the RFI report follow the standard steps prescribed in USEPA's guidance: 1) data evaluation/selection of chemicals of potential concern, 2) exposure assessment, 3) toxicity assessment, 4) risk characterization and uncertainty analysis (USEPA 1989a). The overall approach is also based on the American Society for Testing and Materials (ASTM's) Risk-Based Corrective Action paradigm as documented in ASTM (1995). The primary ASTM element adopted for this HHRA includes the utilization of a tiered approach that emphasizes increasing levels of detail for focusing resources on areas of probable risk and the calculation of appropriate risk-based target concentrations for affected media.

As part of the negotiations between BSC and the USEPA, a work plan to conduct the HHRA was developed and approved by the USEPA (BSC 1997). This work plan provided an overall conceptual approach for each risk assessment step and provided a schedule for the submission of three Interim Deliverables (IDs) that would address the critical early and middle stages of the risk assessment process. These IDs were as follows:

- ID No. 1: The selection of site-related hazardous chemicals of potential concern (COPCs) and presentation of toxicological information,

- ID No. 2: The exposure pathway analysis and presentation of Tier 1 risk-based screening level (RBSL) equations, with selected exposure parameter values, and
- ID No. 3: The calculation of representative concentrations and presentation of Tier I RBSLs.

During the 1997 through 2003 timeframe, Interim Deliverables No. 1 and No. 2 were submitted to USEPA and revised based on USEPA comments. Revised Interim Deliverable No. 1 was approved by the USEPA Region 2 in 1998; Interim Deliverable No. 2 was revised in 1999, and a final set of review comments was received from USEPA Region 2 in April, 2003. In their review comment letter dated April 3, 2003, USEPA stated that there was no need or benefit for review and approval of ID No. 3 prior to completion of the RFI Report (USEPA 2003). Rather, the USEPA requested that the proposed content of ID No. 3 be included as part of the HHRA submitted within the Draft Final RFI Report. This section of the RFI (Part IV), therefore, presents a summary of the content of ID No. 1 and ID No. 2 and the information that would have been included in ID No. 3 (i.e., representative concentrations and RBSLs). For reference purposes, Appendices A and B include both ID reports in their entirety (BSC 1998; 1999). In addition, clarifying information relative to the most recent USEPA Region 2 comments on ID No. 2 is included as Appendix C.

Based on the approach and methodologies contained in the IDs and this RFI Part IV, individual or group risk assessments were completed for each SWMU, SWMU group, or watercourse. These risk assessments are documented in Parts V, VI, and VII of the RFI report.

There are several receptor scenarios that were slated for quantitative evaluation, but are not directly related to a given SWMU report. These include: Lake Erie exposures, site-wide groundwater exposures, and exposures to groundwater in Zones 1 and 5. These assessments are included within this section of the RFI report (Appendices D and E and Section 5).

The remainder of Part IV addresses each of the four risk assessment steps described above and includes a general conclusions section that provides an overall summary of the risk assessments in Parts V, VI, and VII of the RFI report as well as risk characterization summaries for receptor populations not included in the Part V, VI, and VII reports.

2.0

2.0 DATA EVALUATION AND THE SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Interim Deliverable No. 1 provided the following methods and assumptions for use in the HHRA for the Lackawanna Facility:

- Identification of the SWMUs to be considered in the risk assessment,
- The grouping of SWMUs based on proximity and content, and
- The selection of COPCs in each potential exposure medium to be included in the risk assessment.

This information is summarized in the following sections. A complete copy of ID No. 1 is included as Appendix A of this section of the RFI.

2.1 Identification of SWMUs to be Quantified in the HHRA

The RFA identified 104 SWMUs that could have received hazardous constituents and/or wastes and six watercourses that could have been impacted by SWMU releases (USEPA 1988). For some of these, no further assessment (NFA) determinations were made, leaving 45 SWMUs and five watercourses for evaluation in the RFI. Three SWMUs have been subsequently eliminated from the quantitative risk assessment for the following reasons:

SWMU S-12 (Asbestos Landfill L): This landfill has not experienced a release of hazardous constituents and does not represent available exposure pathways for human receptors.

SWMU S-13 (Coal Tar Sludge Landfill): This area was closed in place as a landfill in 1988. The closure included a cover over the unit and deed restrictions. The unit is currently monitored under a New York State Department of Environmental Conservation (NYSDEC) approved post-closure plan. The exposure potential of this unit was qualitatively evaluated in the SWMU report (Part V of the RFI).

SWMU S-29 (Drum Landfill): The presence of drums or other evidence of waste disposal activities other than miscellaneous debris have not been identified, and the area does not represent available exposure pathways for human receptors.

The remaining SWMUs and watercourses quantitatively evaluated in the HHRA are listed in Table 2-1. Based on proximity and similarity of operations and constituents, several

SWMUs were grouped together as one SWMU group. These are listed in Table 2-2. Individual quantitative HHRAs were developed for the remaining SWMUs and SWMU groups listed in Tables 2-1 and 2-2. Most SWMUs are located within a particular groundwater zone (as determined in ID No. 1). The groundwater zone assigned to each SWMU is also indicated in Table 2-1. Four SWMUs are not located within a groundwater zone of concern; they are classified as "other" on Table 2-1. Groundwater was not evaluated in the risk assessments for these four SWMUs.

2.2 Screening Process for Selecting Chemicals of Potential Concern

The selection of COPCs is an initial step in the risk assessment process designed to reduce the number of detected chemicals for quantitative risk evaluation to those that dominate or provide the major contribution to overall risk estimates. This is accomplished by first developing a dataset of appropriate analytical information for use in both screening and, ultimately, in estimating representative concentrations in site media. Elimination of some chemicals is then accomplished during the screening step by applying several criteria.

A list of 96 hazardous constituents of potential interest (COPIs) was generated for the site based on USEPA and industry information related to hazardous constituents potentially present in waste streams generated by integrated iron and steel operations (i.e., cokemaking, sintering, ironmaking, steelmaking, hot forming, cold forming, and steel finishing). This list, shown in Table 2-3, includes a variety of organic compounds (both volatile and semivolatile), metals, and cyanide. This list represents a consensus of potentially SWMU-related chemicals at the Lackawanna site. In most cases, all samples of all media collected during the RFI were analyzed for the full suite of COPIs. These are the data that provide the basis for the risk assessment.

The specific datasets were developed from the analytical data using appropriately qualified data (excluding any R-qualified data), determining the most recent data for certain media, evaluating the effects of averaging field duplicates, and the determination of surrogate values for analyses reported as nondetect. The details of this process are included in Section 3.2 of ID No. 1 (BSC 1998). In some cases, when additional sampling data were collected after ID No. 1 was completed, the datasets were updated and re-evaluated. Individual SWMU reports indicate where additional data were included in the risk assessment.

The decision process for COPC selection is depicted on Figure 2-1. The sequential application of the selection criteria included:

- The chemical was detected in at least 5% of the samples in the dataset,
- The chemical was detected at a level above the medium-specific maximum background value in at least one sample, and
- The chemical was detected in at least one sample in the dataset above the applicable screening level.

The maximum detected concentrations of organic and inorganic chemicals present in surficial SWMU material, sediment, and surface water were compared to maximum concentrations measured in background samples described in Section 3.9 of ID No. 1. No background data were available for subsurface material or groundwater.

The selected screening criteria were as follows:

- USEPA Region III risk-based concentrations (RBCs) for surficial SWMU material, subsurface SWMU material (nonvolatile chemicals), and sediment (USEPA 2000a),
- USEPA Soil Screening Levels (SSLs) based on inhalation for volatile chemicals in subsurface SWMU material (USEPA 1996a), and
- For water (groundwater, surface water, pit water), the lower of the New York State Ambient Water Quality Standard or Guidance Value (NYSDEC 1998) and the USEPA Region III residential tap water RBC (USEPA 2000a).

Because there is no RBC for lead in soil, a screening level of 400 mg/kg was used for SWMU material and sediment. This value represents a soil concentration that the integrated exposure uptake biokinetic (IEUBK) model predicts would result in an acceptable blood lead level in children assuming default residential exposures (USEPA 1994). Since there is no residential tap water RBC for lead, the drinking water action level of 15 µg/L was used (USEPA 1991c).

Screening criteria are not available for all chemicals detected. In most cases, this is because toxicity values are not available. Surrogate criteria were selected for these chemicals based on similarity in chemical structure. The use of surrogate criteria is noted, where it occurred, in each SWMU or watercourse report.

An initial determination of COPCs for each SWMU, SWMU group, or watercourse was completed in Section 4.0 of ID No. 1. The screening was revised in each SWMU report to reflect

revisions in screening values, using the RBC values from USEPA (2000a). The remaining tables in this section summarize the COPCs selected and their representative concentrations. The tables are organized as follows:

- Table 2-4: Surficial SWMU Material
- Table 2-5: Subsurface SWMU Material
- Table 2-6: Groundwater
- Table 2-7: Groundwater to Surface Water
- Table 2-8: Surface Water
- Table 2-9: Sediment
- Table 2-10: Pit Water

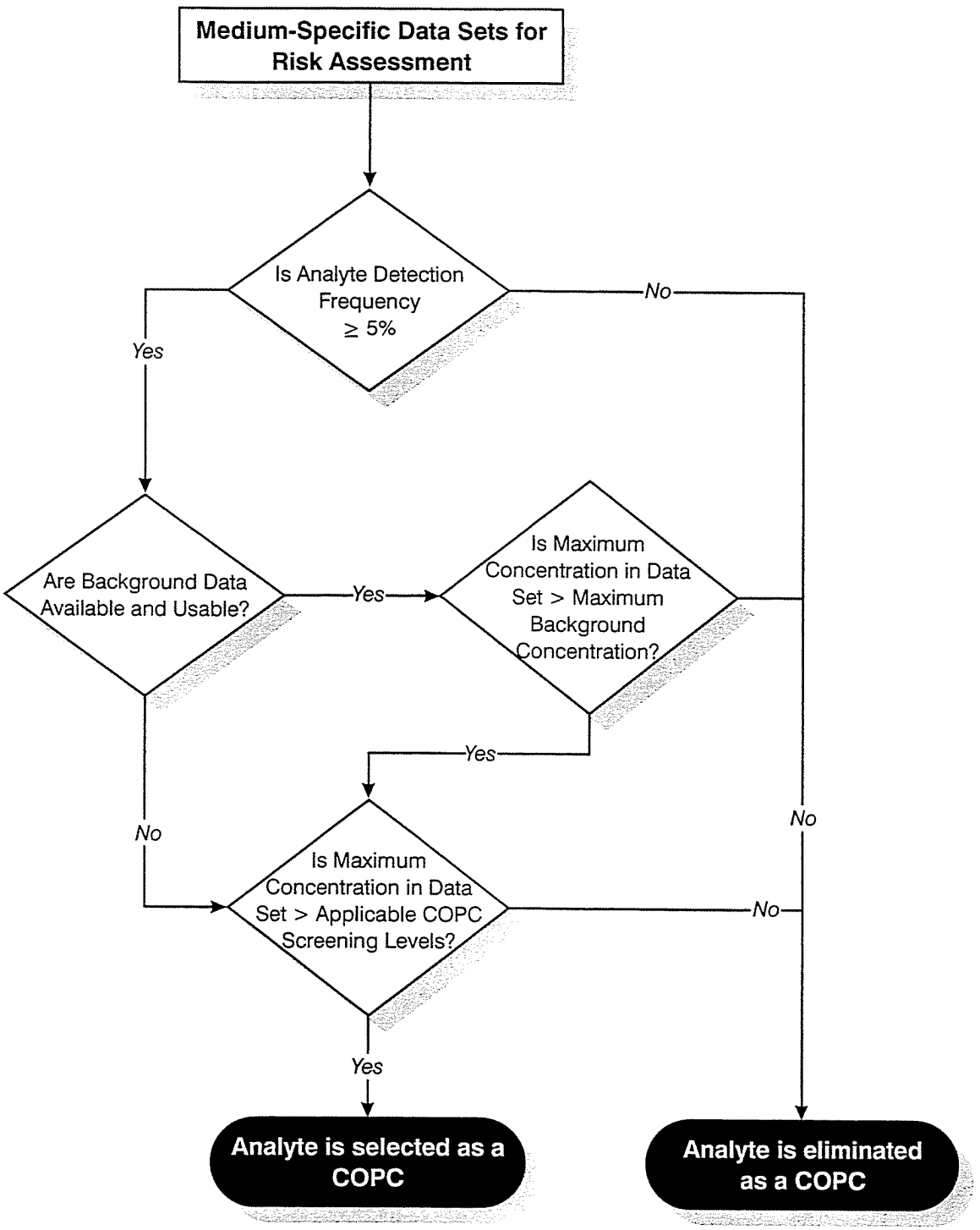

Figure 2-1
Decision Process for COPC Selection
Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Table 2-1
SWMUs and Watercourses Quantitatively Evaluated in the HHRA

Groundwater Zone	SWMU Number	Unit Description
Coke Oven Area	P-1	Quench Water Pit, North Station
	P-2	Quench Water Pit, Arctic Station
	P-3	Quench Water Pit, Central Station
	P-4	Quench Water Pit, A Station
	P-5	Quench Water Pit, B Station
	P-6	Lime Sludge Settling Basin
	P-7	Abandonded Lime Sludge Settling Basin
	P-9	Abandonded Tar Decanter Sludge Pits
	P-10	Contaminated Soil Near Ball Mill
	P-11	Benzol Plant Tank Storage Area
	P-12	Spill Cleanup Storage Area
	P-18	Blast Furnace Cooling Tower and Hot and Cold Wells
	S-26	Fill Area Near Coke Battery 8
Tank Farm Area	P-8	Waste Oil Storage Tanks in Tank Farm
	P-74	Solid Fuel Mix Storage Piles in Tank Farm
	P-75	Tank Storage Area, Tank Farm
Slag Fill Area Zone 2	S-1	Surface Impoundment A
	S-2	Surface Impoundment B
	S-3	Surface Impoundment C
	S-4	Surface Impoundment D
	S-5	Surface Impoundment E
	S-6	Surface Impoundment F
	S-7	Surface Impoundment G
	S-8	Surface Impoundment H
	S-11	Landfill K, Acid Tar Pit, South
	S-20	Drying Area for Sludge from Impoundment F
	S-21	Sludge Storage Area
	S-22	Vacuum Carbonate Blowdown Impoundment (Acid Tar Pit North)
	S-24	Tar Pit North of Lime Plant
	S-27	Sludge Disposal Area (Adjacent to SWMU S-1)
Slag Fill Area Zone 3	S-10	Slag Quench Area J
Slag Fill Area Zone 4	S-14	General Rubble Landfill N
	S-15	General Rubble Landfill O
	S-16	Lime Stabilized SPL Sludge/Slag Landfill
	S-17	Vacuum Carbonate Blowdown - Landfill Q
	S-18	Lime/Kish Landfill
	S-23	Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill
	S-28	Drum Landfill
Other Areas	S-19	Murphy's Mountain Landfill
	S-25	Landfill/Impoundment Under North End of of Coal Pile
	P-63	Former Mill Scale Storage Area No. 2
	P-73	Former Drum Storage Area
Watercourses	Blasdell Creek	
	Lackawanna Ship Canal (re-named Gateway Metroport Ship Canal)	
	Smokes Creek	
	North Return Water Trench	
	South Return Water Trench	

Table 2-2
SWMU Groupings

Location	Group Designation	SWMUs Included
Slag Fill Area (SFA)	SFA-1	S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27
	SFA-2	S-11, S-22
Process Area (PA)	PA-1	P-1, P-2, P-3, P-4, P-5
	PA-2	P-6, P-7
	PA-3	P-9, P-10
	PA-4	P-11, P-12
Tank Farm Area	Tank Farm	P-8, P-74, P-75

Table 2-3
List of Chemicals of Potential Interest (COPIs)

VOCs	SVOCs	Inorganics
Acrylonitrile	**PAHs**	**Metals** [a]
Benzene*	Acenaphthene*	Antimony*
bis(2-Chloroethyl)ether	Acenaphthylene*	Arsenic *
Bromodichloromethane*	Anthracene*	Barium*
Bromoform	Benzo(a)anthracene*	Cadmium*
Bromomethane	Benzo(a)pyrene*	Chromium*
Carbon disulfide*	Benzo(b)fluoranthene*	Lead*
Carbon tetrachloride*	Benzo(k)fluoranthene*	Mercury*
Chlorobenzene*	Benzo(g,h,i)perylene*	Nickel*
Chloroethane	Chrysene*	Selenium*
2-Chloroethylvinyl ether	Dibenz[a,h]anthracene*	Silver*
Chloroform*	Fluoranthene*	Thallium*
Chloromethane	Fluorene*	
Dibromochloromethane *	Indeno(1,2,3-cd)pyrene*	
1,2-Dichlorobenzene	Naphthalene*	**Miscellaneous**
1,3-Dichlorobenzene	Phenanthrene*	Cyanide*
1,4-Dichlorobenzene	Pyrene*	
1,1-Dichloroethane		
1,2-Dichloroethane*	**Other SVOCs**	
1,1-Dichloroethene *	Butyl benzyl phthalate	
trans-1,2-Dichloroethene	bis(2-Ethylhexyl)phthalate*	
Dichlorodifluoromethane	2-Chloronaphthalene	
1,2-Dichloropropane	4-Chloro-3-methylphenol	
cis-1,3-Dichloropropene	m-Cresol (3-methylphenol)*	
trans-1,3-Dichloropropene	o-Cresol (2-methylphenol)*	
Ethylbenzene*	p-Cresol (4-methylphenol)*	
Hexachlorobenzene	2,4-Dichlorophenol	
Hexachlorobutadiene	Diethyl phthalate	
Hexachlorocyclopentadiene	Dimethyl phthalate	
Hexachloroethane	2,4-Dimethylphenol*	
Methyl ethyl ketone	Di-n-butyl phthalate	
Methylene chloride *	Di-n-octyl phthalate	
Pyridine*	2-Methyl-4,6-dinitrophenol	
1,1,1,2-Tetrachloroethane	2,4-Dinitrotoluene	
1,1,2,2-Tetrachloroethane	2,6-Dinitrotoluene	
Tetrachloroethene	Isophorone	
Toluene*	Pentachlorophenol	
1,2,4-Trichlorobenzene	Phenol*	
1,1,1-Trichloroethane*	2,3,4,6-Tetrachlorophenol	
1,1,2-Trichloroethane	2,4,5-Trichlorophenol	
Trichloroethene*	2,4,6-Trichlorophenol	
Trichlorofluoromethane		
Vinyl chloride*		
m-Xylene*		
o-Xylene*		
p-Xylene*		

* Indicates chemical was selected as a chemical of potential concern in at least one medium.

a Manganese and zinc also selected as chemicals of potential concern in groundwater.

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Coke Oven Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU Group PA-1 (SWMUs (P-1, P-2, P-3, P-4 and P-5)					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	3	3	100%	15	15
SWMU Group PA-2 (SWMU P-6 and P-7)					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	2	2	100%	35	35
Benzo(a)pyrene	2	2	100%	20	20
Benzo(b)fluoranthene	2	2	100%	24	24
Benzo(k)fluoranthene	2	2	100%	13	13
Dibenz(a,h)anthracene	2	2	100%	2.7	2.7
Indeno(1,2,3-c,d)pyrene	2	2	100%	13	13
Inorganic Compounds					
Chromium	2	2	100%	343	343
SWMU Group PA-4 (SWMUs P-11 and P-12)					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	3	3	100%	30.5	30.5
Chromium	3	3	100%	254	254

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Coke Oven Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU P-18 [a]					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	7	6	86%	20	20
Benzo(a)pyrene	7	6	86%	4.2	4.2
Benzo(b)fluoranthene	7	7	100%	11	11
Dibenz(a,h)anthracene	7	3	43%	1.2	1.2
Indeno(1,2,3-c,d)pyrene	7	5	71%	5.3	5.3
Inorganic Compounds					
Arsenic	7	7	100%	91	91
Lead	7	7	100%	14,000	14,000
Thallium	7	6	86%	27	27
SWMU S-26 [a]					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	2	2	100%	3.6	3.6
Benzo(a)pyrene	2	2	100%	2.8	2.8
Benzo(b)fluoranthene	2	2	100%	3.6	3.6
Dibenz(a,h)anthracene	2	2	100%	0.29	0.29
Indeno(1,2,3-c,d)pyrene	2	2	100%	1.4	1.4
Inorganic Compounds					
Arsenic	2	2	100%	14.9	14.9
Chromium	2	2	100%	1,400	1,400

a Subsurface sample data used as surrogate at uncovered SWMUs lacking surface data.

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Tank Farm Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU Group Tank Farm (SWMUs P-8, P-74 and P-75)					
Volatile Compounds					
None					
Semivolatile Compounds					
Acenaphthylene	15	10	67%	130	130
Benzo(a)anthracene	15	14	93%	310	310
Benzo(a)pyrene	15	15	100%	400	400
Benzo(b)fluoranthene	11	11	100%	640	640
Benzo(k)fluoranthene	11	11	100%	320	320
Chrysene	15	15	100%	330	330
Dibenz(a,h)anthracene	11	11	100%	89	89
Indeno(1,2,3-c,d)pyrene	11	11	100%	400	400
Inorganic Compounds					
Antimony	15	13	87%	81	81
Arsenic	15	15	100%	90.3	71
Chromium	15	15	100%	797	202
Lead	15	15	100%	960	226
Thallium	15	4	27%	6.9	2.0

a Data did not fit normal or lognormal distribution; lognormal distribution assumed.

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Slag Fill Area Zone 2

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU Group SFA-1 (SWMUs S-1, S-2, S-4, S-5, S-6, S-20 and S-27)					
Volatile Compounds					
None					
Semivolatile Compounds					
Acenaphthylene	11	1	9%	200	200
Benzo(a)anthracene	17	9	53%	630	556
Benzo(a)pyrene	17	9	53%	330	330
Benzo(b)fluoranthene	11	7	64%	490	490
Benzo(k)fluoranthene	11	3	27%	150	150
Chrysene	17	12	71%	540	540
Dibenz(a,h)anthracene	11	1	9%	38	38
Indeno(1,2,3-c,d)pyrene	11	6	55%	210	210
Inorganic Compounds					
Antimony	17	5	29%	375	247
Arsenic	17	17	100%	23	15
Chromium	9	9	100%	299	299
Lead	17	16	94%	3,670	2,439
Thallium	17	2	12%	7.2	2.9
SWMU Group SFA-2 (SWMUs S-11 and S-12) [a]					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	4	4	100%	8.9	8.9
Benzo(a)pyrene	4	2	50%	10	10
Inorganic Compounds					
Arsenic	4	4	100%	47	47
Thallium	4	4	100%	7.1	7.1
SWMU S-3 [a]					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	2	2	100%	41	41
Lead	2	2	100%	3,960	3,960
Thallium	2	1	50%	5.6	5.6

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Slag Fill Area Zone 2

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-8					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	2	2	100%	74	74
Chromium	2	2	100%	436	436
Lead	2	2	100%	2,160	2,160
Thallium	2	2	100%	23	23
SWMU S-21					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Antimony	2	1	50%	78	78
Arsenic	2	2	100%	61	61
Chromium	2	2	100%	292	292
Lead	2	2	100%	1,650	1,650

a Subsurface sample data used as surrogate at uncovered SWMUs lacking surface data.

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Slag Fill Area Zone 3

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-10 [a]					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	2	2	100%	15.9	15.9
Chromium	2	2	100%	850	850
Thallium	2	2	100%	34.7	34.7

a Subsurface sample data used as surrogate at uncovered SWMUs lacking surface data.

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Slag Fill Area Zone 4

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-14					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Antimony	4	4	100%	45	45
Lead	4	4	100%	910	910
SWMU S-15					
Semivolatile Compounds					
None					
Inorganic Compounds					
Antimony	2	2	100%	42.7	42.7
SWMU S-17 [a]					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	4	4	100%	2.4	2.4
Benzo(a)pyrene	4	4	100%	3.4	3.4
Benzo(b)fluoranthene	2	2	100%	3.6	3.6
Indeno(1,2,3-c,d)pyrene	2	2	100%	2.5	2.5
Inorganic Compounds					
Arsenic	4	4	100%	8.4	8.4
Chromium	4	4	100%	1,740	1,740
Mercury	4	2	50%	45	45
Thallium	4	3	75%	7.7	7.7

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Slag Fill Area Zone 4

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-18					
Semivolatile Compounds					
None					
Inorganic Compounds					
Antimony	10	8	80%	150	150
Arsenic	10	10	100%	84.9	56
Chromium	10	9	90%	253	253
Lead	9	9	100%	18,800	11,635
Thallium	10	5	50%	34.4	34
SWMU S-28 [a]					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	2	2	100%	1.4	1.4
Benzo(a)pyrene	2	2	100%	1.7	1.7
Inorganic Compounds					
Arsenic	2	2	100%	27	27
Chromium	2	2	100%	641	641

a Subsurface sample data used as surrogate at uncovered SWMUs lacking surface data.

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Other Areas

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-19					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	4	3	75%	55	55
SWMU S-25 [a]					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)pyrene	2	1	50%	0.18	0.18
Inorganic Compounds					
Chromium	2	2	100%	1,580	1,580
SWMU P-63					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	3	3	100%	51.5	51.5
Chromium	3	3	100%	296	296
Lead	3	3	100%	458	458

Table 2-4
Summary of COPCs and Representative Concentrations in Surficial SWMU Material
Other Areas

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Representative Concentration (mg/kg)
SWMU P-73					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	6	6	100%	51	51
Chromium	6	6	100%	409	409
Thallium	6	2	33%	8.1	8.1

a Subsurface sample data used as surrogate at uncovered SWMUs lacking surface data.

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Coke Oven Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU Group PA-1 (SWMUs P-1, P-2, P-3, P-4 and P-5)					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	2	2	100%	5.1	5.1
Benzo(a)pyrene	2	2	100%	4.6	4.6
Indeno(1,2,3-c,d)pyrene	2	2	100%	2.5	2.5
Benzo(b)fluoranthene	2	2	100%	4.1	4.1
Dibenz(a,h)anthracene	2	1	50%	0.63	0.63
Inorganic Compounds					
Arsenic	2	2	100%	15.4	15
Thallium	2	2	100%	6.2	6.2
SWMU Group PA-3 (SWMUs P-9 and P-10)					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
Anthracene	1	1	100%	56	56
Semivolatile Compounds					
Benzo(a)anthracene	1	1	100%	45	45
Benzo(a)pyrene	1	1	100%	26	26
Benzo(b)fluoranthene	1	1	100%	35	35
Benzo(k)fluoranthene	1	1	100%	26	26
Indeno(1,2,3-c,d)pyrene	1	1	100%	15	15
Inorganic Compounds					
Arsenic	1	1	100%	5.3	5.3
Thallium	1	1	100%	6.0	6.0

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Coke Oven Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU Group PA-4 (SWMUs P-11 and P-12)					
Volatile Compounds					
Benzene	11	11	100%	2,800	2,800
Toluene	11	10	91%	1,700	1,700
Xylenes, Total	11	10	91%	1,100	1,100
Volatile Semivolatile Compounds					
Naphthalene	11	11	100%	1,100	1,100
SWMU P-18					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	7	6	86%	20	20
Benzo(a)pyrene	7	6	86%	4.2	4.2
Benzo(b)fluoranthene	7	7	100%	11	11
Dibenz(a,h)anthracene	7	3	43%	1.2	1.2
Indeno(1,2,3-c,d)pyrene	7	5	71%	5.3	5.3
Inorganic Compounds					
Arsenic	7	7	100%	91	91
Lead	7	7	100%	14,000	14,000
Thallium	7	6	86%	27	27

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Coke Oven Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-26					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	2	2	100%	3.6	3.6
Benzo(a)pyrene	2	2	100%	2.8	2.8
Benzo(b)fluoranthene	2	2	100%	3.6	3.6
Dibenz(a,h)anthracene	2	2	100%	0.29	0.29
Indeno(1,2,3-c,d)pyrene	2	2	100%	1.4	1.4
Inorganic Compounds					
Arsenic	2	2	100%	14.9	14.9
Chromium	2	2	100%	1,400	1,400

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Tank Farm Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU Group TF (SWMUs P-8, P-74 and P-75)					
Volatile Compounds					
Benzene	6	1	17%	17	17
Volatile Semivolatile Compounds					
Acenaphthylene	6	5	83%	1,600	1,600
Anthracene	6	6	100%	1,400	1,400
Fluorene	6	6	100%	1,300	1,300
Naphthalene	6	6	100%	6,500	6,500
Phenanthrene	6	6	100%	4,100	4,100
Semivolatile Compounds					
Benzo(a)anthracene	6	5	83%	1,000	1,000
Benzo(a)pyrene	6	5	83%	850	850
Chrysene	6	5	83%	1,000	1,000
Inorganic Compounds					
Arsenic	6	6	100%	28	28
Thallium	6	3	50%	16	16

Table 2-5
Summary of COPCs and Representative Concentrations In Subsurface SWMU Material
Slag Fill Area Zone 2

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU Group SFA-1 (SWMUs S-1, S-2, S-4, S-5, S-6, S-7, S-20 and S-27)					
Volatile Compounds					
Benzene	16	9	56%	9.5	9.5
Volatile Semivolatile Compounds					
Acenaphthylene	16	4	25%	46	46
Naphthalene	16	12	75%	1,600	1,091
Phenanthrene	16	8	50%	130	87
Semivolatile Compounds					
Benzo(a)anthracene	16	6	38%	3.2	3.2
Benzo(a)pyrene	16	1	6%	0.49	0.49
Benzo(b)fluoranthene	16	7	44%	2.0	2.0
Inorganic Compounds					
Arsenic	16	16	100%	31	24
Lead	16	16	100%	1,630	893
Thallium	16	6	38%	5.9	4.2
SWMU Group SFA-2 (SWMU S-11 and S-22)					
Volatile Compounds					
Benzene	7	7	100%	29,000	29,000
1,1,2,2-Tetrachloroethane	7	1	14%	2.9	2.9
Toluene	7	7	100%	3,400	3,400
Trichloroethene	7	1	14%	17	17
Xylenes, total	7	7	100%	3,270	3,270
Volatile Semivolatile Compounds					
Acenaphthylene	7	5	71%	5.4	5.4
Fluorene	7	5	71%	340	340
Naphthalene	7	7	100%	850	850
Phenanthrene	7	6	86%	180	180
Semivolatile Compounds					
Benzo(a)anthracene	7	5	71%	49	49
Benzo(a)pyrene	7	4	57%	22	22
Benzo(b)fluoranthene	2	2	100%	2.5	2.5
Dibenz(a,h)anthracene	2	2	100%	0.63	0.63
Indeno(1,2,3-c,d)pyrene	2	2	100%	2.1	2.1
Inorganic Compounds					
Antimony	7	3	43%	39.9	40
Arsenic	7	7	100%	39.1	39
Lead	7	7	100%	878	878

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Slag Fill Area Zone 2

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-3					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)pyrene	20	6	30%	0.69	0.69
Inorganic Compounds					
Arsenic	20	12	60%	16.2	16
Lead	20	20	100%	7,520	3,000
Thallium	8	5	63%	43	43
SWMU S-21					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Antimony	2	1	50%	78.1	78
Arsenic	2	2	100%	60.5	61
Chromium	2	2	100%	292	292
Lead	2	2	100%	1,650	1,650

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Slag Fill Area Zone 2

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-24					
Volatile Compounds					
Benzene	6	5	83%	40,000	40,000
Toluene	6	6	100%	14,000	14,000
Xylenes, total	6	5	83%	4,800	4,800
Volatile Semivolatile Compounds					
Anthracene	6	6	100%	210	210
Fluorene	6	6	100%	330	330
Naphthalene	6	6	100%	1,800	1,800
Semivolatile Compounds					
Benzo(a)anthracene	6	6	100%	220	220
Benzo(a)pyrene	6	5	83%	140	140
Benzo(b)fluoranthene	6	6	100%	160	160
Benzo(k)fluoranthene	6	3	50%	91	91
Chrysene	6	6	100%	180	180
Dibenz(a,h)anthracene	6	2	33%	29	29
Indeno(1,2,3-c,d)pyrene	6	4	67%	68	68
Inorganic Compounds					
Arsenic	6	6	100%	20.1	20.1

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Slag Fill Area Zone 3

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-10					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	2	2	100%	3.2	3.2
Benzo(a)pyrene	2	2	100%	1.4	1.4
Benzo(b)fluoranthene	2	2	100%	2.4	2.4
Indeno(1,2,3-c,d)pyre	2	2	100%	1.0	1.0
Inorganic Compounds					
Arsenic	2	1	50%	11.3	11.3
Chromium	2	2	100%	871	871
Thallium	2	2	100%	28.4	28.4

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Slag Fill Area Zone 4

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-14					
Volatile Compounds					
Benzene	2	2	100%	0.825	0.83
Volatile Semivolatile Compounds					
Acenaphthylene	2	2	100%	32	32
Anthracene	2	2	100%	26	26
Naphthalene	2	2	100%	1,400	1,400
Phenanthrene	2	2	100%	130	130
Semivolatile Compounds					
Benzo(a)anthracene	2	2	100%	30	30
Benzo(a)pyrene	2	2	100%	27	27
Benzo(b)fluoranthene	2	2	100%	27	27
Benzo(k)fluoranthene	2	2	100%	20	20
Dibenz(a,h)anthracen	2	2	100%	3.5	3.5
Indeno(1,2,3-c,d)pyre	2	2	100%	17	17
Inorganic Compounds					
Arsenic	2	2	100%	12.8	13
SWMU S-17					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	4	4	100%	2.4	2.4
Benzo(a)pyrene	4	4	100%	3.4	3.4
Benzo(b)fluoranthene	2	2	100%	3.6	3.6
Indeno(1,2,3-c,d)pyre	2	2	100%	2.5	2.5
Inorganic Compounds					
Arsenic	4	4	100%	8.4	8.4
Chromium	4	4	100%	1,740	1,740
Mercury	4	2	50%	45	45
Thallium	4	3	75%	7.7	7.7

Table 2-5
Summary of COPCs and Representative Concentrations in Subsurface SWMU Material
Slag Fill Area Zone 4

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-18					
Semivolatile Compounds					
Anthracene	3	2	67%	7.3	7.3
Benzo(a)anthracene	3	2	67%	18	18
Benzo(a)pyrene	3	2	67%	17	17
Inorganic Compounds					
Arsenic	3	3	100%	49.3	49
Chromium	3	3	100%	316	316
Lead	3	3	100%	1,650	1,650
Thallium	3	2	67%	9.4	9.4
SWMU S-23					
Volatile Compounds					
Benzene	2	2	100%	48	48
Volatile Semivolatile Compounds					
Acenaphthylene	2	2	100%	1,400	1,400
Anthracene	2	2	100%	1,300	1,300
Fluorene	2	2	100%	1,600	1,600
Naphthalene	2	2	100%	11,000	11,000
Phenanthrene	2	2	100%	5,500	5,500
Semivolatile Compounds					
Benzo(a)anthracene	2	2	100%	1,100	1,100
Benzo(a)pyrene	2	2	100%	780	780
Benzo(b)fluoranthene	2	2	100%	950	950
Benzo(k)fluoranthene	2	2	100%	490	490
Chrysene	2	1	50%	610	610
Fluoranthene	2	2	100%	3,500	3,500
Indeno(1,2,3-c,d)pyre	2	1	50%	280	280
Inorganic Compounds					
Arsenic	2	2	100%	9.2	9.2
Thallium	2	2	100%	5.7	5.7

Table 2-5
Summary of COPCs and Representative Concentrations In Subsurface SWMU Material
Other Areas

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
SWMU S-25					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)pyrene	2	1	50%	0.18	0.18
Inorganic Compounds					
Chromium	2	2	100%	1,580	1,580
SWMU P-63					
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	6	6	100%	58	58
SWMU P-73					
Volatile Compounds					
None					
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	6	2	33%	5.0	5.0
Benzo(a)pyrene	6	2	33%	4.7	4.7
Benzo(b)fluoranthene	6	2	33%	8.9	8.9
Dibenz(a,h)anthracene	6	1	17%	0.84	0.84
Indeno(1,2,3-c,d)pyren	6	1	17%	4.4	4.4
Inorganic Compounds					
Arsenic	6	6	100%	26.4	26

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Coke Oven Area (original)

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	120	99	83%	570,000	570,000
Ethylbenzene	109	34	31%	25,000	2,300
Toluene	109	58	53%	77,000	20,000
Xylenes, Total	95	58	61%	390,000	60,000
Volatile SemIvolatiles					
Acenaphthene	9	3	33%	360	360
Acenaphthylene	90	25	28%	90	30
Anthracene	90	8	9%	270	30
Fluorene	90	37	41%	1,700	57
Naphthalene	117	80	68%	280,000	21,000
Phenanthrene	90	35	39%	940	45
SemIvolatiles					
2,4-Dimethylphenol	90	22	24%	340	46
2-Methylphenol	90	18	20%	140	40
3-Methylphenol and 4-Methylphenol	74	10	14%	220	67
4-Methylphenol	16	5	31%	110	37
Benzo(a)anthracene	90	8	9%	280	42
Benzo(a)pyrene	90	7	8%	230	39
Benzo(b)fluoranthene	9	2	22%	69	69
Benzo(k)fluoranthene	9	2	22%	71	71
bis(2-Ethylhexyl)phthalate	90	16	18%	110	34
Chrysene	90	9	10%	260	41
Dibenz(a,h)anthracene	10	2	20%	22	15
Fluoranthene	90	20	22%	760	74
Indeno(1,2,3-cd)pyrene	10	2	20%	40	40
Phenol	90	46	51%	560	81
Pyrene	90	17	19%	410	51
Pyridine	81	6	7%	200	60

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Coke Oven Area (original)

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Inorganic Constituents					
Antimony	63	10	16%	4.0	4.0
Arsenic	63	38	60%	740	110
Barium	63	60	95%	1,790	450
Chromium	63	50	79%	322	37
Cyanide	71	58	82%	800	160
Lead	63	29	46%	142	18
Manganese	16	16	100%	89,900	21,000
Mercury	63	11	17%	3.0	0.28

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Coke Oven Area (new)

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	120	99	83%	570,000	50,000
Ethylbenzene	109	34	31%	25,000	1,700
Toluene	109	58	53%	77,000	6,400
Xylenes, Total	95	58	61%	390,000	17,000
Volatile Semivolatiles					
Acenaphthene	9	3	33%	360	360
Acenaphthylene	90	25	28%	90	2.6
Anthracene	90	8	9%	270	40
Fluorene	90	37	41%	1,700	110
Naphthalene	117	80	68%	280,000	13,000
Phenanthrene	90	35	39%	940	7.3
Semivolatiles					
2,4-Dimethylphenol	90	22	24%	340	46
2-Methylphenol	90	18	20%	140	40
3-Methylphenol and 4-Methylphenol	74	10	14%	220	67
4-Methylphenol	16	5	31%	110	37
Benzo(a)anthracene	90	8	9%	280	42
Benzo(a)pyrene	90	7	8%	230	39
Benzo(b)fluoranthene	9	2	22%	69	69
Benzo(k)fluoranthene	9	2	22%	71	71
bis(2-Ethylhexyl)phthalate	90	16	18%	110	34
Chrysene	90	9	10%	260	41
Dibenz(a,h)anthracene	10	2	20%	22	15
Fluoranthene	90	20	22%	760	74
Indeno(1,2,3-cd)pyrene	10	2	20%	40	40
Phenol	90	46	51%	560	81
Pyrene	90	17	19%	410	51
Pyridine	81	6	7%	200	60

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Coke Oven Area (new)

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Inorganic Constituents					
Antimony	63	10	16%	4.0	4.0
Arsenic	63	38	60%	740	110
Barium	63	60	95%	1,790	450
Chromium	63	50	79%	322	37
Cyanide	71	58	82%	800	160
Lead	63	29	46%	142	18
Manganese	16	16	100%	89,900	21,000
Mercury	63	11	17%	3.0	0.28

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Tank Farm Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	25	12	48%	200	55
Chloroform	22	2	9%	12	4.2
Toluene	22	5	23%	8.7	4.4
Xylenes, Total	18	3	17%	7.8	4.3
Volatile Semivolatiles					
Naphthalene	25	14	56%	130	160
Semivolatiles					
2,4-Dimethylphenc	22	11	50%	420	110
2-Methylphenol	22	15	68%	2,600	630
and 4-Methylphenol	20	16	80%	11,000	3,000
Phenol	22	17	77%	28,000	6,800
Inorganic Constituents					
Arsenic	13	8	62%	36	15
Cyanide	19	16	84%	28,000	7,500
Selenium	13	11	85%	15	10

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Slag Fill Area Zone 1

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	31	8	26%	2.6	13
Carbon tetrachloride	16	1	6.3%	3.4	3.0
Methylene chloride	16	1	6.3%	5.8	4.7
1,1,1-Trichloroethane	16	1	6.3%	11	3.5
Xylenes, Total	16	2	13%	6.4	3.5
Volatile Semivolatiles					
Naphthalene	37	6	16%	800	71
Semivolatiles					
Phenol	22	3	14%	15	7.6
Other					
Cyanide	20	9	45%	330	107

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Slag Fill Area Zone 2

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	248	210	85%	110,000	170
1,1-Dichloroethane	191	103	54%	210	8.4
1,2-Dichloroethane	191	19	10%	300	6.5
1,2-Dichloroethene, Total	10	3	30%	7.6	5.3
Ethylbenzene	195	97	50%	53	10
Methylene chloride	187	14	7%	130	6.5
Pyrene	262	29	11%	120	44
Toluene	191	137	72%	700	34
Trichloroethene	187	43	23%	31	6.8
Xylenes, Total	190	129	68%	1,000	130
Volatile Semivolatiles					
Acenaphthylene	194	111	57%	91	29
Fluorene	194	109	56%	100	25
Naphthalene	240	181	75%	3,500	910
Phenanthrene	194	118	61%	110	30
Semivolatiles					
2,4-Dimethylphenol	262	92	35%	140	44
bis(2-Ethylhexyl)phthalate	258	57	22%	120	47
Cresols, Total	4	1	25%	27	27
Fluoranthene	262	42	16%	160	44
2-Methylphenol	227	87	38%	980	36
3-Methylphenol and 4-Methylphenol	166	67	40%	5,400	17
4-Methylphenol	61	22	36%	150	22
Phenol	262	71	27%	430	57
Phenols	36	36	100%	120	12

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Slag Fill Area Zone 2

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Inorganic Constituents					
Antimony	127	24	19%	165	30
Arsenic	197	94	48%	901	30
Barium	188	155	82%	22,200	690
Cadmium	230	22	10%	63	4.3
Chromium	189	105	56%	1,140	44
Cyanide	256	196	77%	18,000	420
Lead	189	78	41%	1,470	64
Manganese	41	33	80%	87,080	8,300
Mercury	189	32	17%	0.79	0.13
Nickel	139	54	39%	184	30
Selenium	189	92	49%	25	6.8
Silver	189	25	13%	68	6.1
Thallium	127	7	6%	12	8.3
Zinc	5	4	80%	6,630	6,600

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Slag Fill Area Zone 3

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	38	35	92%	890	97
Ethylbenzene	30	4	13%	14	3.7
Toluene	30	23	77%	190	30
Xylenes, Total	29	18	62%	430	60
Volatile Semivolatiles					
Acenaphthylene	30	17	57%	160	110
Fluorene	30	19	63%	140	70
Naphthalene	38	33	87%	1,400	1,200
Phenanthrene	30	22	73%	170	140
Semivolatiles					
2-Methylphenol	30	22	73%	130	51
3-Methylphenol and 4-Methylphenol	25	19	76%	1,000	280
4-Methylphenol	5	2	40%	24	24
bis(2-Ethylhexyl)phthalate	30	5	17%	5	5.0
Fluoranthene	30	14	47%	56	34
Phenol	30	20	67%	2,700	570

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Slag Fill Area Zone 4

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	311	254	82%	2,200	67
Chlorobenzene	255	15	6%	54	3.6
1,1-Dichloroethane	255	40	16%	160	6.1
Ethylbenzene	255	66	26%	35	3.7
Methylene chloride	250	26	10%	200	6.1
Pyridine	248	38	15%	50	15
Toluene	250	179	72%	170	14
Trichloroethene	250	48	19%	46	4.0
Xylenes, Total	249	199	80%	140	40
Volatile Semivolatiles					
Acenaphthylene	257	167	65%	130	16
Anthracene	259	44	17%	59	12
Fluorene	259	186	72%	72	14
Naphthalene	314	264	84%	1,900	200
Phenanthrene	259	171	66%	120	17

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Slag Fill Area Zone 5

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	7	5	71%	6.9	6.9
Xylenes, Total	4	4	100%	11	11
Volatile Semivolatiles					
Naphthalene	7	7	100%	49	49

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Smokes Creek Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	62	51	82%	230,000	230,000
Carbon disulfide	3	1	33%	1,300	1,300
1,1-Dichloroethane	40	6	15%	32	32
Ethylbenzene	50	3	6%	5,600	5,600
Methylene chloride	42	2	5%	7.0	7,000
Pyridine	36	17	47%	130,000	130,000
Toluene	51	24	47%	16,000	16,000
Vinyl chloride	41	2	5%	1,100	1,100
Xylenes, Total	50	18	36%	37,500	38,000
Volatile Semivolatiles					
Naphthalene	53	23	43%	1,200	620

Table 2-6
Summary of COPCs and Representative Concentrations: Groundwater Pathway
Sitewide Groundwater

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	821	697	85%	570,000	3,200
Carbon disulfide	66	15	23%	1,300	1,000
1,1-Dichloroethane	637	149	23%	3,100	21
Ethylbenzene	673	215	32%	25,000	44
Methylene chloride	628	45	7%	3,700	23
Toluene	664	445	67%	77,000	180
Trichloroethene	628	94	15%	52	17
Xylenes, Total	643	443	69%	390,000	420
Volatile Semivolatiles					
Acenaphthene	69	20	29%	360	34
Acenaphthylene	638	334	52%	150	25
Anthracene	639	91	14%	270	20
Fluorene	639	370	58%	1,700	24
Naphthalene	804	622	77%	280,000	620
Phenanthrene	639	370	58%	940	28
Semivolatiles					
Pyridine	602	82	14%	250,000	84

Table 2-7
Summary of COPCs and Representative Concentrations: Groundwater-to-Surface Water Pathway
Lake Erie Discharge Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	615	478	78%	570,000	200
1,1-Dichloroethane	494	128	26%	3,100	7.9
1,2-Dichloroethene, Total	19	2	11%	7.5	7.5
Ethylbenzene	499	162	32%	1,300	9.0
Methylene chloride	485	40	8%	3,700	7.8
Pyridine	454	48	11%	200	21
Toluene	490	330	67%	70,000	33
Trichloroethene	485	89	18%	77	5.9
Xylenes, Total	490	336	69%	8,600	94
Volatile Semivolatiles					
Acenaphthylene	495	285	58%	130	19
Anthracene	497	71	14%	59	14
Fluorene	497	305	61%	1,700	17
Naphthalene	612	481	79%	32,000	390
Phenanthrene	497	306	62%	330	20
Semivolatiles					
bis(2-Ethylhexyl)phthalate	497	111	22%	890	17
Cresols, Total	9	4	44%	39	39
2,4-Dimethylphenol	494	170	34%	140	15
Fluoranthene	497	138	28%	160	15
2-Methylphenol	467	180	39%	980	18
3-Methylphenol & 4-Methylphenol	377	183	49%	5,400	36
4-Methylphenol	91	34	37%	140	15
Phenol	521	250	48%	29,000	51
Pyrene	497	104	21%	120	14

Table 2-7
Summary of COPCs and Representative Concentrations: Groundwater-to-Surface Water Pathway
Lake Erie Discharge Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Inorganic Constituents					
Antimony	184	24	13%	11	11
Arsenic	300	128	43%	900	9.3
Barium	299	213	71%	33,000	180
Cadmium	300	26	9%	63	2.9
Chromium	300	171	57%	1,100	19
Cyanide	448	275	61%	18,000	110.00
Lead	301	104	35%	1,400	6.3
Mercury	301	50	17%	3.0	0.11
Nickel	183	39	21%	180	35
Selenium	283	179	63%	28	8.1
Thallium	183	15	8%	18	6.6

Table 2-7
Summary of COPCs and Representative Concentrations: Groundwater-to-Surface Water Pathway
Smokes Creek Discharge Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatiles					
Benzene	109	83	76%	230,000	230,000
Carbon disulfide	7	1	14%	1,300	1,300
1,1-Dichloroethane	77	14	18%	210	210
Ethylbenzene	85	10	12%	5,600	1,300
Toluene	86	43	50%	16,000	5,400
Vinyl chloride	77	2	3%	1,100	1,100
Xylenes, Total	86	40	47%	38,000	5,900
Volatile Semivolatiles					
Acenaphthylene	77	17	22%	160	180
Anthracene	77	10	13%	60	60
Fluorene	78	23	29%	440	200
Naphthalene	96	54	56%	2,800	1,100
Phenanthrene	77	27	35%	760	270
Pyrene	77	16	21%	220	180
Semivolatiles					
bis(2-Ethylhexyl)phthalate	78	9	12%	33	33
2,4-Dimethylphenol	77	34	44%	410	150
Fluoranthene	77	16	21%	310	170
2-Methylphenol	77	38	49%	2,400	240
3-Methylphenol & 4-Methylphenol	59	31	53%	10,000	1,300
4-Methylphenol	18	7	39%	1,000	280
Phenol	77	51	66%	26,000	3,900
Pyridine	70	20	29%	120,000	6,500

Table 2-7
Summary of COPCs and Representative Concentrations: Groundwater-to-Surface Water Pathway
Smokes Creek Discharge Area

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Inorganic Constituents					
Antimony	48	12	25%	190	64
Arsenic	47	31	66%	73	16
Barium	50	35	70%	2,000	160
Cadmium	50	10	20%	120	16
Chromium	48	38	79%	2,000	270
Cyanide	63	56	89%	27,000	3,200
Lead	50	27	54%	1,400	54
Mercury	50	9	18%	0.79	0.16
Nickel	50	19	38%	370	38
Silver	50	14	28%	100	12
Thallium	46	7	15%	89	58

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Tab: Smokes Creek Discharge Area

Table 2-8
Summary of COPCs and Representative Concentrations in Surface Water
Lake Erie

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatile Compounds					
None					
Semivolatile Compounds					
bis(2-Ethylhexyl)phthalate	10	1	10%	21	21
Inorganic Compounds					
None					

Table 2-8
Summary of Representative Concentrations in Surface Water
Smokes Creek

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatile Compounds					
Benzene	32	11	34%	4.0	1.3
Bromodichloromethane	20	1	5%	0.40	0.28
Chloroform	20	10	50%	8.8	3.1
Dibromochloromethane	20	8	40%	1.0	0.55
1,2-Dichloroethane	20	2	10%	3.0	1.0
Methylene chloride	20	3	15%	14	11
Vinyl chloride	20	1	5%	2.0	0.50
Volatile Semivolatile Compounds					
None					
Semivolatile Compounds					
bis(2-Ethylhexyl)phthalate	15	6	40%	24	10
Inorganic Compounds					
Arsenic	15	4	27%	7.0	7.0

Table 2-8
Summary of COPCs and Representative Concentrations in Surface Water
Blasdell Creek

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatile Compounds					
1,1-Dichloroethane	15	1	7%	6.2	6.2
Semivolatile Compounds					
None					
Inorganic Compounds					
Arsenic	15	6	40%	6.9	4.7
Lead	15	7	47%	19.6	13.9

Table 2-8
Summary of COPCs and Representative Concentrations in Surface Water
Ship Canal - Current Conditions

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatile Compounds					
Benzene	26	2	8%	1.0	0.33
Semivolatile Compounds					
bis(2-Ethylhexyl)phthalate	13	6	46%	20	6.5
Inorganic Compounds					
Arsenic	17	5	29%	6.3	5.0

Table 2-8
Summary of COPCs and Representative Concentrations in Surface Water
Ship Canal - Future Conditions

Chemical of Potential Concern	Representative Concentration[a] (µg/l)
Volatile Compounds	
Benzene	132
Trichloroethene	0.036
Xylenes, Total	7.5
Volatile Semivolatile Compounds	
Naphthalene	9.5
Semivolatile Compounds	
Phenol	2.7
Inorganic Compounds	
Arsenic	0.38

a Maximum concentrations of ship canal discharge area groundwater COPCs that may reach ship canal surface water in the absence of pumping. Estimated using average concentrations of COPCs in groundwater (under current conditions) entering the canal and a mass balance model.

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Tab: Ship Canal - Future Conditions

Table 2-9
Summary of COPCs and Representative Concentrations in Sediment
Lake Erie

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
Volatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)pyrene	10	3	30%	0.40	0.30
Dibenz(a,h)anthracene	10	1	10%	0.18	0.18
Inorganic Compounds					
Arsenic	10	10	100%	6.7	6.4

Table 2-9
Summary of COPCs and Representative Concentrations in Sediment
Smokes Creek

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
Volatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	13	13	100%	85	19
Benzo(a)pyrene	13	13	100%	61	13
Benzo(b)fluoranthene	13	13	100%	62	16
Benzo(k)fluoranthene	13	10	77%	48	12
Dibenz(a,h)anthracene	13	10	77%	19	7.0
Indeno(1,2,3-cd)pyrene	13	13	100%	38	10
Inorganic Compounds					
Arsenic	13	13	100%	35	13
Lead	13	13	100%	470	150

Table 2-9
Summary of COPCs and Representative Concentrations in Sediment
Blasdell Creek

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
Volatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	19	19	100%	19	19
Benzo(a)pyrene	19	18	95%	13	13
Benzo(b)fluoranthene	10	10	100%	29	29
Benzo(k)fluoranthene	10	7	70%	12	12
Dibenz(a,h)anthracene	10	8	80%	4.0	4.0
Indeno(1,2,3-cd)pyrene	10	10	100%	8.2	8.2
Inorganic Compounds					
Arsenic	22	21	95%	328	328
Cadmium	22	13	59%	168	4.8
Chromium	22	22	100%	526	455

NA Not applicable; no distribution testing conducted as sample size is less than 10.

Table 2-9
Summary of COPCs and Representative Concentrations in Sediment
Ship Canal

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
Volatile Compounds					
None					
Semivolatile Compounds					
Benzo(a)anthracene	17	17	100%	9	8.1
Benzo(a)pyrene	17	16	94%	10	7.3
Benzo(b)fluoranthene	17	17	100%	14	13
Dibenz(a,h)anthracene	17	14	82%	2.0	1.7
Indeno(1,2,3-cd)pyrene	17	16	94%	7	5.5
Inorganic Compounds					
Arsenic	17	17	100%	16	12
Lead	17	17	100%	580	245

Table 2-9
Summary of COPCs and Representative Concentrations in Sediment
North Return Water Trench

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
Volatile Compounds					
None					
Semivolatile Compounds					
Acenaphthylene	2	1	50%	57	57
Benzo(a)anthracene	2	2	100%	160	160
Benzo(a)pyrene	2	2	100%	120	120
Benzo(b)fluoranthene	2	2	100%	140	140
Benzo(k)fluoranthene	2	2	100%	60	60
Chrysene	2	2	100%	140	140
Dibenz(a,h)anthracene	2	2	100%	19	19
Indeno(1,2,3-cd)pyrene	2	2	100%	68	68
Inorganic Compounds					
Arsenic	2	2	100%	13.7	14

Table 2-9
Summary of COPCs and Representative Concentrations in Sediment
South Return Water Trench

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Value (mg/kg)	Representative Concentration (mg/kg)
Volatile Compounds					
None					
Semivolatile Compounds					
None					
Inorganic Compounds					
Antimony	4	3	75%	53.3	53.3
Arsenic	4	4	100%	102	102
Lead	4	4	100%	1,010	1,010

P:\I\ISG\13809741\DOCs\Risk\HHRA\Part_IV\Tables\Table Series 2-4\Table 2-9
Tab: South Return Water Trench

Table 2-10
Summary of COPCs and Representative Concentrations in Quench Pit Water
SWMU Group PA-1 Pits

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatile Compounds					
Benzene	4	3	75%	6.3	6.3
Volatile Semivolatile Compounds					
Naphthalene	4	2	50%	62	62
Semivolatile Compounds					
2,4-Dimethylphenol	4	2	50%	60	60
2-Methylphenol	4	3	75%	3,800	3,800
3-Methylphenol & 4-Methylphenol	4	3	75%	17,000	17,000
Chrysene	4	2	50%	14	14
Phenol	4	2	50%	42,000	42,000
Inorganic Compounds					
Arsenic	4	2	50%	44	44
Cyanide	4	3	75%	270	270
Lead	4	3	75%	16	16
Selenium	4	2	50%	17	17

Table 2-10
Summary of COPCs and Representative Concentrations in Quench Pit Water
Pit #17 in P-11

Chemical of Potential Concern	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/l)	Representative Concentration (µg/l)
Volatile Compounds					
Benzene	3	3	100%	34,000	34,000
Ethylbenzene	3	2	67%	600	600
Pyridine	1	1	100%	180	180
Toluene	3	3	100%	3,100	3,100
Xylenes, Total	3	1	33%	360	360
Volatile Semivolatile Compounds					
Napthalene	1	1	100%	660	660
Phenanthrene	1	1	100%	80	80
Semivolatile Compounds					
2-Methylphenol	1	1	100%	100	100
3-Methylphenol & 4-Methylphenol	1	1	100%	130	130
Phenol	1	1	100%	390	390
Inorganic Compounds					
Arsenic	1	1	100%	3.9	3.90
Mercury	1	1	100%	27.1	27

3.0

3.0 EXPOSURE ASSESSMENT

The exposure assessment estimates the type and magnitude of exposures to the COPCs selected for the site. The types of relevant exposures are identified by determining what complete exposure pathways are or could foreseeably become complete for either the entire site or portions of it. Determining the magnitude of exposures is accomplished by quantifying the intensity, duration, and frequency of exposure events for those complete exposure pathways.

3.1 Complete Exposure Pathway Analysis

The human health risk assessment for the Lackawanna Facility is a conservative, baseline risk assessment of potential health effects caused by releases, in the absence of any actions to control or mitigate those releases. Potential exposure pathways were evaluated with both current and future time frames in mind along with the four components that define an exposure pathway. They are:

- A source and mechanism of constituent release to the environment,
- A mechanism to transport that constituent to an exposure medium,
- A point of potential human contact with the affected medium, and
- A route of entry into humans.

If any of these elements are missing, the pathway is considered incomplete and does not require quantification, or inclusion in the HHRA. A detailed exposure pathway conceptual model was originally presented in ID No. 2 (BSC 1999). It was amended based on USEPA (2003) and is reproduced as Figure 3-1. The model represents current understanding of the sources of the COPCs, the mechanisms by which they are released, and the pathways and routes human populations could be exposed to them. The major elements are summarized in the following sections.

3.1.1 Land Use and Potential Human Receptors

The receptor scenarios evaluated in this HHRA are associated with current use patterns and unrestricted future commercial/industrial development of all areas of the site, as well as recreational development in the area of slag fill area (SFA) Zone 1. These populations and a description of their activity patterns that could result in exposure are:

- **Current Non-BSC Commercial/Industrial Workers:** These workers in general are not located in areas where SWMUs are located. Limited exposures to releases to ambient air from nearby sources (i.e., uncovered SWMUs, subsurface SWMU material or from groundwater/pit water) are assumed.

- **Future Commercial/Industrial Workers:** These workers are a future population that could come in direct contact with SWMU material, if those areas are redeveloped for some industrial or commercial land use. Inhalation of either ambient or indoor air affected by SWMU releases are also considered relevant exposures.

- **Future Construction Workers:** This population is possible under future development of the site. Because of excavation-type activities, this population could come in direct contact with both surface and subsurface SWMU material, as well as vapors or particulates released to ambient air from these SWMUs. In some areas of the site, groundwater is sufficiently shallow, resulting in potential direct contact exposures by this population. Similar exposures could occur in site areas where pits are located.

- **Future Utility/Maintenance Workers:** Once the Lackawanna site is redeveloped there may be potential for contact with SWMU material for this type of population, either directly or through inhalation of releases from the SWMUs, groundwater or pitwater.

- **Future Ship Canal Maintenance Worker:** Although the historical activity patterns for workers at this site location represent minimal exposures, this population is included. This population could be exposed to both surface water and sediment in the Ship Canal.

- **Current and Future Trespassers:** This adolescent-aged population could bypass site security and freely wander the site. This population could come in limited contact with surficial SWMU material, as well as vapors and particulates emanating from either the SWMU material, or groundwater and pitwater affected by SWMU releases.

- **Future Marina Workers:** This population could be relevant depending on recreational development within SFA Zone 1. Although direct contact with SWMU material is not relevant for this population, inhalation of releases from other SWMUs (including groundwater and standing water in pits) are potential exposures.

- **Future Greenway Users:** Greenway users are assumed to be adults and children residing in the area who would regularly use a proposed greenway area for recreational purposes. As with the marina workers, direct contact with SWMU material is not relevant, but inhalation of releases is a potential exposure.

- **Current and Future Recreational Bathers:** Recreational bathers are adults and children who reside in the area and regularly wade or swim in Blasdell Creek, Smokes Creek, and along nearshore Lake Erie in the vicinity of the Lackawanna site. Exposures could occur to surface water and sediment in these waterbodies affected by site releases.

- **Current and Future Fish Consumers:** This population consists of adults and children residing in the area who regularly catch and eat fish from Smokes Creek and nearshore Lake Erie.

- **Current and Future Off-Site Residents:** These populations consist of adults and children living on the fenceline of the Lackawanna boundary who could be exposed to particulate or vapor releases from SWMU material, including groundwater and pit water affected by releases.

- **Present and Future Off-Site Water Consumer:** The off-site water consumer population includes adults and children whose drinking water supply is surface water from intakes downstream of the mouth of the Niagara River.

3.1.2 Potential Sources, Exposure Media, and Transport Mechanisms

The SWMUs and watercourses described in Section 2.1 are the sources of COPCs that include metals, cyanide, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and other semivolatile organic compounds (SVOCs). The exposure media relevant for the human receptor populations described earlier include:

- Surficial and subsurface materials within the SWMUs,
- Groundwater,
- Standing water in Coke Oven Area pits,
- Airborne particles and vapors released from SWMU material, groundwater or pit water,
- Surface water in Lake Erie, Smokes Creek, Blasdell Creek, the Return Water Trenches (North and South) and the Ship Canal,
- Sediment in Lake Erie, Smokes Creek, Blasdell Creek, the Return Water Trenches (North and South) and the Ship Canal, and
- Fish from Lake Erie, Smokes Creek, and Blasdell Creek.

The concentrations and distributions of COPCs can be affected by the following fate and transport mechanisms:

- Leaching from SWMU material to underlying groundwater,
- Migration of dissolved COPCs in groundwater to surface water bodies,
- Volatilization from SWMU material, groundwater, and pit water to ambient or indoor air,
- Suspension and transport of COPCs in particulate form to ambient air,
- Transport of COPCs adsorbed to soil particles via surface water runoff,
- Biological or chemical transformation, and
- Trophic transfer of COPCs in aquatic or terrestrial systems.

3.1.3 Summary of Complete Exposure Pathways

The following information was considered in developing the complete exposure pathway determination for the Lackawanna site summarized in Table 3-1. On-site groundwater consumption was not considered a complete pathway as public water is supplied to the site.

However, the potential for transport of the COPCs in Lake Erie and Smokes Creek groundwater to nearby potable surface water intakes in Lake Erie and at the southern end of the Niagara River was evaluated. On-site residential development is not expected to occur and was not considered a foreseeable future land use. It was assumed that commercial/industrial workers (and buildings to house them) could be present anywhere on the site regardless of the feasibility of this actually happening. Each Part V,VI, and VII SWMU and watercourse report includes more specific information regarding complete exposures evaluated in each specific risk assessment and provides information as to why certain pathways are considered incomplete and, therefore, not evaluated quantitatively.

3.2 Quantification of Exposure

In order to develop RBSLs and compare them to site concentrations in a risk characterization, two steps must be taken to quantify exposure: 1) the development of population-specific exposure factors and 2) the calculation of representative exposure concentrations for use in the RBSL comparisons.

Several assumptions were made in developing the exposure scenarios that affect the RBSL calculations:

- The conditions at each SWMU were assumed to remain unchanged (except for the scenarios that include intrusive activities). Therefore, no contact with surface material is assumed at covered SWMUs.
- Where surface data are lacking at uncovered SWMUs, subsurface results were considered representative of surface material.
- For inhalation of airborne particles released from uncovered SWMUs, the receptor was assumed to be actually present on the SWMU.
- For on-site receptors, "direct contact" was defined as total exposure via ingestion, dermal contact, and inhalation of either volatiles or particulates.
- On-site receptors are assumed to spend their entire exposure duration on or in a building at each SWMU.

3.2.1 Population-Specific Exposure Factor Assumptions

The human physiological or activity attributes that result in exposure are collectively referred to as exposure factors or parameters. These factors are used to define general population behavior, and are conservative estimates derived from scientific studies, observations, or professional judgment. Many are USEPA-recommended default values (USEPA 1989a, 1991a, 1991b, 1996a). The selections of the exposure factors for all the assumed populations at the Lackawanna Facility are detailed in ID No. 2 (BSC 1999). Subsequent to the submission of ID No. 2, additional potentially complete exposure pathways were identified by USEPA (2003). Tables 3-2 through 3-6 summarize the assumed exposure factors for these additional pathways.

3.2.2 Calculation of Representative Exposure Concentrations

In order to determine if RBSLs are exceeded, it is necessary to develop a representative concentration for each chemical at each SWMU or watercourse undergoing evaluation. These representative concentrations (sometimes referred to as exposure point concentrations) are based on site-specific sampling results described in Part II of this RFI report. Representative concentrations were determined for each COPC in each potential exposure or source medium (i.e., surface and subsurface SWMU material, pit water, groundwater, surface water and sediments).

In general, the available useable analytical data were combined into a dataset and representative concentrations were derived based on guidance in USEPA (1992). The risk assessment process for the Lackawanna site has been on-going since the January 1999 submission of ID No. 2. At that time USEPA (1992) was the recognized guidance for calculating representative concentrations, thus it was the guidance used in the majority of the SWMU-specific HHRAs. If a dataset contained 10 or more samples the 95% upper confidence limit (95UCL) of arithmetic mean, based on the distribution of the data, was used as the representative concentration. For a dataset with normal distribution, the 95UCL was calculated based on the t-statistic. If the data set was non-normal or log normal, the 95UCL was calculated based on the H-statistic. If the 95UCL was greater than the maximum detected concentration, the maximum concentration was conservatively considered the representative concentration. If the dataset contained less than 10 samples, the maximum detected concentration was used as the representative concentration.

In April 2003, USEPA Region 2 issued final comments to ID No. 2 that required the addition of a dermal contact with groundwater pathway. This pathway was considered for construction workers and utility/maintenance workers in areas where groundwater at a SWMU or SWMU group is shallow (i.e., less than 15 feet below ground surface (bgs)). Since the addition of this pathway required the calculation of representative concentrations for additional chemicals (i.e., nonvolatile COPCs), more recent USEPA guidance was used (USEPA 2002). This guidance acknowledges that use of a lognormal 95UCL can produce extremely high values. The guidance provides other methods that can be used to calculate a 95UCL concentration. The new representative concentrations in groundwater were therefore calculated using the central limit theorem (CLT) (adjusted) method (USEPA 2002).

The USEPA (2002) guidance was also used to determine the representative concentrations of COPCs in groundwater at SWMU S-26. This SWMU was selected as a representative location for evaluating the new guidance. This SWMU was selected because it is located the Coke Oven groundwater zone, which contains more COPCs than other zones. For benzene in this zone, use of the lognormal 95UCL generated a value higher than the maximum detected concentration (USEPA 1992). However, the USEPA's recent guidance discusses how the maximum concentration is not always an appropriate measure of a representative concentration in environmental media (USEPA 2002). Thus, it was of interest to evaluate alternate means of statistically deriving more defensibly representative concentrations for the Coke Oven groundwater zone. In addition, SWMU S-26 is the only location within the zone where a building is located. Therefore, representative groundwater concentrations were re-calculated based on USEPA (2002) for SWMU S-26 and used for the evaluation of current and future indoor workers. These representative concentrations in groundwater were also calculated using the central limit theorem (adjusted) method (USEPA 2002).

Representative concentrations calculated for each medium and SWMU evaluated are also included in Tables 2-4 through 2-10.

3.2.3 Modeling of Intermedia Transfers

Most of the environmental media in the individual risk assessments were assessed based on direct sampling measurements, using calculated representative concentrations (as previously discussed). In some cases, however, representative chemical concentrations in a medium that was not directly sampled were required to evaluate certain exposure scenarios. This was

accomplished by fate and transport modeling from the sampled medium to the exposure medium. These situations are discussed below.

Calculation of Air Concentrations Based on Vapor and Particulate Emissions:

Inhalation of vapors released from subsurface SWMU material to ambient air were modeled by calculating Volatilization Factors (VFs) in accordance with the methodology presented in ASTM (1995). Similarly, VFs were calculated for releases from subsurface SWMU material to indoor air and groundwater (ASTM 1995). Wind erosion of nonvolatile COPCs from surficial SWMU material was modeled using an ASTM (1995) equation to derive a particulate emission factor. Modeling of releases from pit water used the stagnant film model from USEPA (1989b). Model equations are included in ID No. 2.

Dispersion Modeling for Air Concentrations:

Vapor dispersion modeling was performed to enable estimation of potential exposure to airborne COPCs emanating from subsurface SWMU material, site-wide groundwater, and the Coke Oven Area quench pits. The particulate inhalation pathways simplistically and conservatively assume that the receptor is actually present on the SWMU, and thus, no particle dispersion modeling was performed for nonvolatile COPCs. In accordance with ID No. 2, the vapor modeling was performed with the USEPA Industrial Source Complex Short-Term model (ISCST3, version 99155), utilizing meteorological data collected at a monitoring station at the Lackawanna site in 1991. Each of the sources was represented in the model by a polygon (area source) that closely matched the shape and area of the source as it appears on an electronic map of the site. The areas of the polygons were used to arrive at area source emissions (in $g/s/m^2$) that represent 1.0 g/s emissions from each area source. For modeling of emissions from subsurface SWMU material in SWMU Group PA-4, the area of Pit #17 in SWMU P-11 was subtracted from the total area for P-11. The area source polygons for site-wide groundwater were determined from a map of the 1.0 mg/L benzene plume within the site.

For on-site scenarios, a receptor grid with 100-meter spacing was placed within the site area, and impacts were predicted for the north, south, and middle portions of the site and Zone 1. For the fenceline resident scenario, receptors were located at 100-meter intervals along the eastern and southern boundaries of the facility. For current non-BSC workers, maximum estimated impacts in the northern, middle, and southern regions of the site were utilized. Marina

workers and greenway users were assumed to be in Zone 1. Results of the ISCST3 modeling are summarized in Table 3-7.

Future Ship Canal Surface Water:

The Ship Canal conceptual exposure model includes a future ship canal maintenance worker who is exposed to ship canal surface water under potential future conditions. Under assumed current conditions, the pumps are continuously (24 hours per day) emptying water from the Ship Canal, resulting in a net flow of water into the Ship Canal from the Buffalo Outer Harbor. The future ship canal maintenance worker scenario evaluates a situation where the pumps cease operating. Under this assumption, the influence of groundwater from the Coke Oven groundwater discharge area on Ship Canal surface water was estimated as follows.

In accordance with ID No. 2 (BSC 1999; USEPA 2003), the representative concentrations for the future Ship Canal surface water were determined using information presented in Part II of the RFI. Potential future concentrations for each chemical in the Ship Canal (assuming all Coke Oven pumps are shut off) were determined by dividing the total mass flux of each chemical in Ship Canal discharge area groundwater by the total groundwater and rainfall flow into the Ship Canal (and applying the appropriate conversion factors). This determination was made for each chemical detected in the most recent round of groundwater sampling. The total mass flux for each chemical from the Ship Canal discharge area groundwater was obtained from Table 3-29 of the RFI (Part II). With pumps shut off, the total water flow into the Ship Canal was determined to be 0.19 million gallons per day (mgd), which incorporates flow from the following sources of water into the Ship Canal: groundwater flow from the east and west sides of the canal (Table J-1, Part II of the RFI), water from precipitation (Appendix E, Section 7, ID No. 1), and water from sheet flow (Appendix E, Section 7, ID No. 1). Potential future surface water concentrations in the Ship Canal are summarized in Table 2-8.

Current Indoor Air at SWMU S-26:

In accordance with USEPA's most recent comments to ID No. 2 (USEPA 2003), for SWMUs where buildings exist, the current indoor commercial/industrial worker scenario was to be evaluated by determining representative concentrations of COPCs in indoor air that could volatilize from Coke Oven groundwater. The only SWMU within the Coke Oven groundwater zone where a building is located is SWMU S-26. Thus, indoor air concentrations were determined by using the VF for groundwater to enclosed space vapors in equation IW-10b from

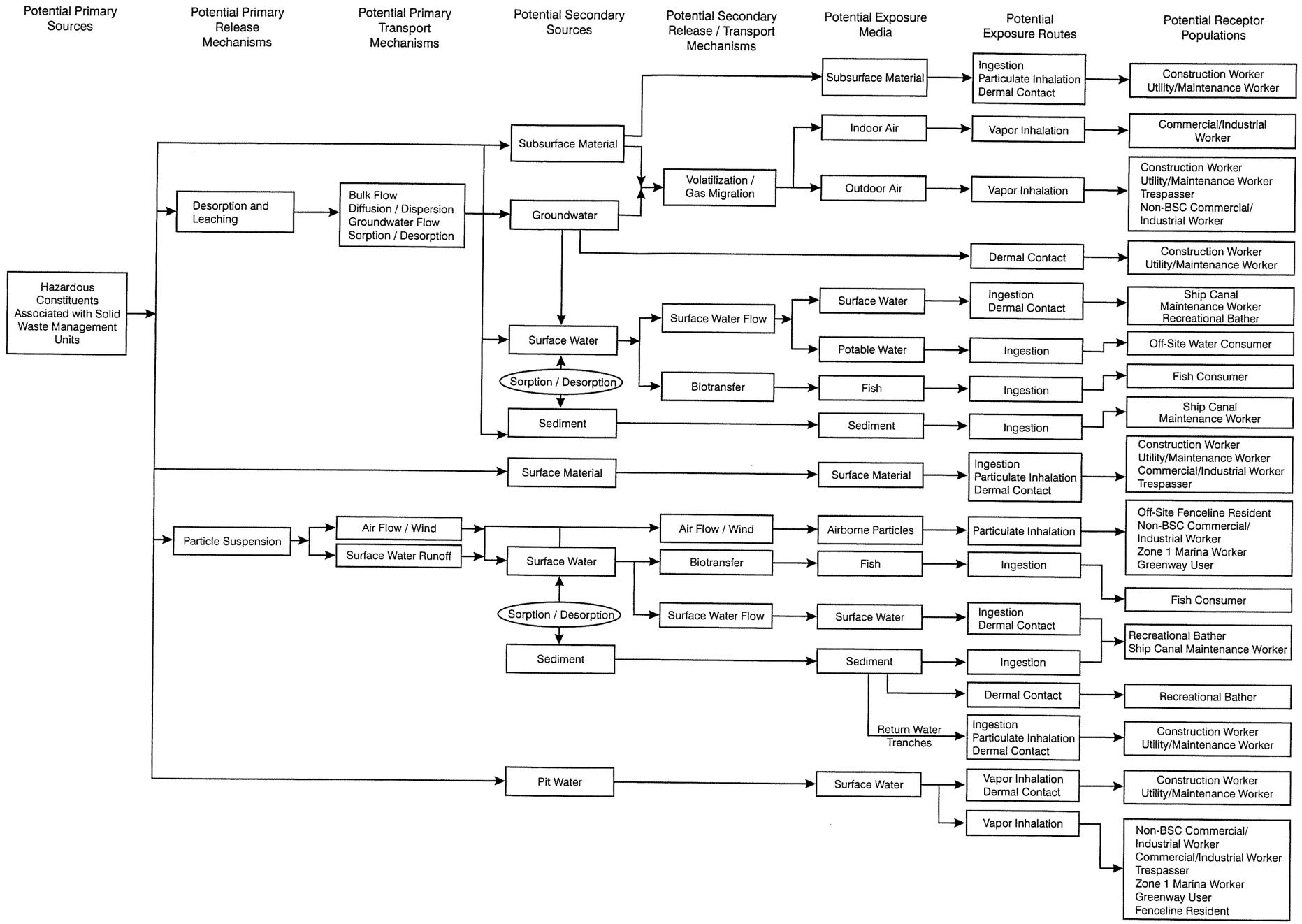
ID No. 2 to determine the indoor air concentration (instead of the RBSL, as is illustrated in ID No. 2). The equation was used as follows:

$$C_{INDOOR} = VF_{wesp} \times C_{GW}$$

Where:

C_{INDOOR}	=	the steady state indoor air concentration
C_{GW}	=	the representative concentration in groundwater
VF_{wesp}	=	for volatilization from groundwater to enclosed space vapors

The estimated indoor air concentrations for SWMU S-26, resulting from volatilization from Coke Oven groundwater, are presented in Table 2-6.



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LACKAWANNA, NEW YORK

CONCEPTUAL SITE MODEL
POTENTIAL EXPOSURE PATHWAYS

URS

FIGURE 3-1

AG18719-13809741-101204-GCM

Table 3-1
Potential Exposure Scenarios Evaluated[a]

Potential Receptor Scenario	Exposure Media	Potential Pathway of Exposure
Future Commercial/Industrial Worker	Surface SWMU Material	particulate inhalation
		ingestion
		dermal contact
	Groundwater	ambient and indoor vapor inhalation
	Pit Water	ambient vapor inhalation
Current Non-BSC Commercial/Industrial Worker	Surface SWMU Material	particulate inhalation
	Groundwater	ambient vapor inhalation
	Pit Water	ambient vapor inhalation
Future Utility/Maintenance Worker	Surface SWMU Material	particulate inhalation
		ingestion
		dermal contact
	Subsurface SWMU Material	particulate inhalation
		ingestion
		dermal contact
	Groundwater	ambient vapor inhalation
		dermal contact
	Pit Water	ambient vapor inhalation
		dermal contact
	Sediment (Return Water Trenches)	particulate inhalation
		ingestion
		dermal contact
Trespasser	Surface SWMU Material	particulate inhalation
		ingestion
		dermal contact
	Groundwater	ambient vapor inhalation
	Pit Water	ambient vapor inhalation
Future Construction Worker	Surface SWMU Material	particulate inhalation
		ingestion
		dermal contact
	Subsurface SWMU Material	particulate inhalation
		ingestion
		dermal contact
	Groundwater	ambient vapor inhalation
		dermal contact
	Pit Water	ambient vapor inhalation
		dermal contact
	Sediment (Return Water Trenches)	particulate inhalation
		ingestion
		dermal contact
Future Marina Worker	Surface SWMU Material	particulate inhalation
	Pit Water	ambient vapor inhalation
Future Greenway User	Surface SWMU Material	particulate inhalation
	Pit Water	ambient vapor inhalation
Present/Future Fenceline Resident	Surface SWMU Material	particulate inhalation
	Pit Water	ambient vapor inhalation
Current Ship Canal Maintenance Worker	Surface Water	ingestion
		dermal contact
	Sediment	ingestion
Future Ship Canal Maintenance Worker	Groundwater Discharge Area to Surface Water	ingestion
		dermal contact
	Sediment	ingestion
Present/Future Recreational Bather	Surface Water	ingestion
		dermal contact
	Groundwater Discharge Area to Surface Water	ingestion
		dermal contact
	Sediment	ingestion
		dermal contact
Present/Future Fish Consumer	Surface Water to Fish	ingestion
	Groundwater Discharge Area to Surface Water to Fish	ingestion
Present/Future Off-Site Water Consumer	Groundwater Discharge Area to Surface Water to Off-Site Surface Water	ingestion

a Potential exposure scenarios are based on those determined in ID No. 2 (BSC 1999), the chemicals of potential concern determined in ID No. 1 (BSC 1998), and comments from USEPA Region 2 (USEPA 2003).

Table 3-2
Exposure Parameters
Recreational Bather – Ingestion of and Dermal Contact with Sediment

Parameter Definition		Value	Units	Source	Comment
ABS_o	Dermal absorption factor	1	unitless	Default	
ABS_d	Oral absorption factor	1	unitless	Default	
AF	Adherence factor	0.04	mg/cm^2		
AT_c	Averaging time for carcinogenic effects	27,375	days	USEPA 1997	Recommended value
AT_n	Averaging time for noncarcinogenic effects	10,950	days		Total ED (30 years) x 365 days/year
CF	Conversion factor	1.0×10^{-6}	kg/mg		
ED	Exposure duration	30	years	Professional judgment	
EF_{rec}	Exposure frequency	6	days/year	Professional judgment	Assumes contact twice a month during three months of summer
IFS_{rec}	Age-adjusted sediment ingestion factor	13.2	mg-yr/kg-d	Calculated by analogy to RAGS Vol. I Part B (USEPA 1991a): $IFS_{rec} = \frac{IR_{sed/c} \cdot ED_c}{BW_c} + \frac{IR_{sed/a} \cdot ED_a}{BW_a}$ (Presented in Interim Deliverable No. 2)	
RfD_o	Chronic oral reference dose, also used for dermal	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
SAF_{rec}	Age-adjusted sediment dermal contact factor	4,644	cm^2-year/kg	Assumed appropriate surface area for dermal contact with sediment is one-half of that for recreational bather surface area in contact with water in swimming scenario (presented in Interim Deliverable No. 1)	
SF_o	Oral slope factor, also used for dermal	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	See Interim Deliverable No. 1	
THQ	Target hazard quotient	1	unitless	USEPA 1989b	Default
TR	Target cancer risk level	1.0×10^{-6}	unitless	USEPA 1989b	Default

Table 3-3
Exposure Parameters
Utility Worker – Dermal Contact with and Inhalation of Vapors from Pit Water

Parameter Definition		Value	Units	Source	Comment
AT_c	Averaging time for carcinogenic effects	27,375	days	USEPA 1997b	Recommended value
AT_n	Averaging time for noncarcinogenic effects	365	days	USEPA 1989b	ED x 365 days/year
BW	Body weight	71.8	kg	USEPA 1997b	Recommended value
CF	Conversion factor	1.0×10^{-3}	L/cm^3		
ED	Exposure duration	1	years	Professional judgment	
EF	Exposure frequency	20	days/year	Professional judgment	
ET	Exposure time	4	hours/day	Professional judgment	
IR	Inhalation rate	13	m^3/day	USEPA 1997b	Hourly average for outdoor workers (1.3 m^3/hour x 10 hours work/day)
PC	Permeability coefficient	Chemical-specific	cm/hour	Risk Assessment Information System (RAIS 2004) http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf	
RAF_d	Dermal relative absorption factor	1.0	unitless	Default	
RAF_i	Inhalation relative absorption factor	1.0	unitless	Default	
RfD_d	Chronic dermal reference dose	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	Presented in Interim Deliverable No. 1	
SF_d	Dermal slope factor	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	Presented in Interim Deliverable No. 1	
SSA	Skin surface area	4,123	cm^2	USEPA 1997b	Sum of head, arm, and hand averages of mean total surface area in adults
THQ	Target hazard quotient	1	unitless	USEPA 1989b	Default
TR	Target cancer risk level	1.0×10^{-6}	unitless	USEPA 1989b	Default
VF	Volatilization factor	Chemical-specific	L/m^2	Calculated per Interim Deliverable No. 2	

Table 3-4
Exposure Parameters
Utility Worker – Dermal Contact with and Inhalation of Vapors from Groundwater

Parameter Definition		Value	Units	Source	Comment
AT_c	Averaging time for carcinogenic effects	27,375	days	USEPA 1997b	Recommended value
AT_n	Averaging time for noncarcinogenic effects	365	days	USEPA 1989b	ED x 365 days/year
BW	Body weight	71.8	kg	USEPA 1997b	Recommended value
CF	Conversion factor	1.0×10^{-3}	L/cm^3		
ED	Exposure duration	1	years	Professional judgment	
EF	Exposure frequency	20	days/year	Professional judgment	
ET	Exposure time	4	hours/day	Professional judgment	
IR	Inhalation rate	13	m^3/day	USEPA 1997b	Hourly average for outdoor workers (1.3 m^3/hour x 10 hours work/day)
PC	Permeability coefficient	Chemical-specific	cm/hour	Risk Assessment Information System (RAIS 2004) http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf	
RAF_d	Dermal relative absorption factor	1.0	unitless	Default	
RAF_i	Inhalation relative absorption factor	1.0	unitless	Default	
RfD_d	Chronic dermal reference dose	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	Presented in Interim Deliverable No. 1	
SF_d	Dermal slope factor	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	Presented in Interim Deliverable No. 1	
SSA	Skin surface area	4,123	cm^2	USEPA 1997b	Sum of head, arm, and hand averages of mean total surface area in adults
THQ	Target hazard quotient	1	unitless	USEPA 1989b	Default
TR	Target cancer risk level	1.0×10^{-6}	unitless	USEPA 1989b	Default
VF	Volatilization factor	Chemical-specific	L/m^2	Calculated per Interim Deliverable No. 2	

Table 3-5
Exposure Parameters
Construction Worker – Dermal Contact with and Inhalation of Vapors from Pit Water

Parameter Definition		Value	Units	Source	Comment
AT_c	Averaging time for carcinogenic effects	27,375	days	USEPA 1997b	Recommended value
AT_n	Averaging time for noncarcinogenic effects	365	days	USEPA 1989b	ED x 365 days/year
BW	Body weight	71.8	kg	USEPA 1997	Recommended value
CF	Conversion factor	1.0×10^{-3}	L/cm^3		
ED	Exposure duration	1	years	Professional judgment	
EF	Exposure frequency	100	days/year	Professional judgment	
ET	Exposure time	4	hours/day	Professional judgment	
IR	Inhalation rate	13	m^3/day	USEPA 1997b	Hourly average for outdoor workers (1.3 m^3/hour x 10 hours work/day)
PC	Permeability coefficient	Chemical-specific	cm/hour	Risk Assessment Information System (RAIS 2004) http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf	
RAF_d	Dermal relative absorption factor	1.0	unitless	Default	
RAF_i	Inhalation relative absorption factor	1.0	unitless	Default	
RfD_d	Chronic dermal reference dose	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	Presented in Interim Deliverable No. 1	
SF_d	Dermal slope factor	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	Presented in Interim Deliverable No. 1	
SSA	Skin surface area	9.088	cm^2	USEPA 1997b	Sum of head, arm, hand, and leg averages of mean total surface area in adults
THQ	Target hazard quotient	1	unitless	USEPA 1989b	Default
TR	Target cancer risk level	1.0×10^{-6}	unitless	USEPA 1989b	Default
VF	Volatilization factor	Chemical-specific	L/m^2	Calculated per Interim Deliverable No. 2	

Table 3-6
Exposure Parameters
Construction Worker – Dermal Contact with and Inhalation of Vapors from Groundwater

Parameter Definition		Value	Units	Source	Comment
AT_c	Averaging time for carcinogenic effects	27,375	days	USEPA 1997b	Recommended value
AT_n	Averaging time for noncarcinogenic effects	365	days	USEPA 1989b	ED x 365 days/year
BW	Body weight	71.8	kg	USEPA 1997	Recommended value
CF	Conversion factor	1.0×10^{-3}	L/cm^3		
ED	Exposure duration	1	years	Professional judgment	
EF	Exposure frequency	100	days/year	Professional judgment	
ET	Exposure time	4	hours/day	Professional judgment	
IR	Inhalation rate	13	m^3/day	USEPA 1997b	Hourly average for outdoor workers (1.3 m^3/hour x 10 hours work/day)
PC	Permeability coefficient	Chemical-specific	cm/hour	Risk Assessment Information System (RAIS 2004) http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf	
RAF_d	Dermal relative absorption factor	1.0	unitless	Default	
RAF_i	Inhalation relative absorption factor	1.0	unitless	Default	
RfD_d	Chronic dermal reference dose	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-d	Presented in Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	Presented in Interim Deliverable No. 1	
SF_d	Dermal slope factor	Chemical-specific	$(mg/kg\text{-}d)^{-1}$	Presented in Interim Deliverable No. 1	
SSA	Skin surface area	9.088	cm^2	USEPA 1997	Sum of head, arm, hand, and leg averages of mean total surface area in adults
THQ	Target hazard quotient	1	unitless	USEPA 1989b	Default
TR	Target cancer risk level	1.0×10^{-6}	unitless	USEPA 1989b	Default
VF	Volatilization factor	Chemical-specific	L/m^2	Calculated per Interim Deliverable No. 2	

Table 3-7
Predicted Maximum Annual Unit Emission Rates (ug/m^3) for Relevant Units and Receptor Groups

Potential Sources	Fenceline Residents	On-Site Indirect Exposure Scenarios			
		Zone 1	North Site	South Site	Mid-Site
COKE OVEN AREA					
PA-3 (P-9 and P-10)	8.68	0.00044	338.76	0.18	0.02
PA-4 (P-11 and P-12)	4.16	0.00036	119.53	0.18	6.98
PA-1 Pits	12.67	0.0046	202.52	0.33	0.01
Pit #17 at SWMU P-11	4.0	0.00037	129.10	0.17	6.48
SLAG FILL AREA ZONE 2					
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	9.38	110.92	21.08	5.63	22.79
SFA-2 (S-11 and S-22)	4.17	48.72	12.59	1.12	6.33
S-24	3.17	2.69	8.94	0.47	4.08
SLAG FILL AREA ZONE 4					
S-14	10.6	0.24	2.89	0.17	1.05
S-23	1.12	0.24	3.04	0.18	1.11
Site-Wide Groundwater	4.55	13.18	285.71	0.70	11.56

4.0

4.0 TOXICITY ASSESSMENT

The toxicity assessment step in the risk assessment process characterizes the relationship between the magnitude of exposure and the nature and magnitude of the resulting adverse health effect. In general, chemical toxicity is divided into two broad categories for risk assessment purposes: noncancer and cancer. The USEPA has developed toxicity criteria derived from available toxicological and epidemiological information for one or both categories for most chemicals detected at the Lackawanna Site. These two categories and the criteria that quantify the toxic response are discussed below.

Table 4-1 summarizes the toxicity criteria for all selected COPCs and the sources of the information. The toxicity criteria were selected from a hierarchy including:

- The Integrated Risk Information System (IRIS) (USEPA 2000b)
- Health Effects Assessment Summary Tables (HEAST) (USEPA 1997a)
- National Center for Environmental Assessment (NCEA) Provisional Values, as noted in Region III RBC tables (USEPA 2000a)

4.1 Toxicity Criteria for Noncarcinogenic Effects

A noncarcinogenic effect is defined as any adverse response to a chemical that is not cancer. Noncancer effects are evaluated using USEPA-derived reference doses (RfDs) and airborne reference concentrations (RfCs). These values represent the daily lifetime exposure levels to humans, including sensitive subgroups, that are likely to be without appreciable risk of deleterious effects (USEPA 1989a). These criteria are based on the assumption that thresholds (exposure levels below which no adverse effects are expected) exist for noncarcinogenic effects. These values are derived by USEPA using empirical effects levels from oral and inhalation studies (typically using the most sensitive species, strain, and sex of an experimental animal population) and a series of uncertainty factors to account for inter- and intraspecies variabilility and the quality and completeness of the database.

The oral RfD is expressed in units of mg of chemical/kg of body weight/day; the units of the RfC are mg chemical/m^3 air. In order to use the RfC in subsequent risk calculations, RfCs are converted from a concentration in air to a dose (mg chemical/kg body weight/day) by multiplying the RfC by a daily inhalation rate of 20 m^3/day and dividing it by an assumed body weight of 70 kg (USEPA 1989a). The result is an inhalation RfD (in units of mg/kg/day).

The RfDs and RfCs are calculated for both subchronic and chronic exposures. A subchronic RfD is generally a higher value than the chronic since its development takes into account the human body's protective mechanisms to overcome toxicity when exposures are short. Subchronic RfDs and RfCs have been developed, however, for a limited number of chemicals. For most chemicals, the chronic RfD is conservatively assumed for subchronic exposures (i.e., one-year exposure duration of the future construction worker and the future utility/maintenance worker). The Part V, VI, and VII reports indicate limited circumstances where a subchronic reference dose was used in developing RBSL values at a particular SWMU.

4.2 Toxicity Criteria for Cancer

Cancers are broadly defined as diseases of mutation that affect cell growth and differentiation. The USEPA generally assumes there is no threshold for carcinogenic responses, that is, any dose of a potential carcinogen poses some risk. The numeric descriptor of cancer is the slope factor (SF), expressed in terms of risk per unit dose ($(mg/kg/day)^{-1}$). Slope factors are route specific (oral and inhalation) and are derived by extrapolating from observed toxicological data at high dose levels, using a model that assumes the dose response curve becomes linear at low doses and has no threshold. The linearized multi-stage model for low-dose extrapolation is one of the most conservative available, and it leads to an upper-bound estimate of risk (the upper 95% confidence limit on the modeled animal dose-response slope). Thus, the probability that the true risk is higher is only 5%.

Each carcinogenic chemical is also assigned a weight-of-evidence classification that expresses its potential for human carcinogenicity. These classifications range from "A" (human carcinogen) to "E" (evidence of noncarcinogenicity for humans).

4.3 Toxicological Evaluation of Lead

Lead's toxicological properties are somewhat unique. Lead produces noncarcinogenic effects, but does not appear to have a threshold. Some of lead's characteristic effects appear to occur at blood lead levels so low as to be essentially without a threshold. The USEPA generally evaluates lead by estimating blood lead levels through pharmacokinetic modeling and comparing them to target blood lead levels. When evaluating a child's residential exposures to lead, the USEPA recommends its IEUBK model that predicts a soil level of 400 mg/kg as a suitable screening criteria (USEPA 1994). For adult populations, USEPA has developed an Adult Lead

Model that predicts an acceptable level of lead in the soil that would be protective of a developing fetus (USEPA 1996b). This model was used to develop RBSLs for soil and sediment for applicable occupational and trespasser receptors. The inputs to the model are described in ID No. 2 (BSC 1999).

4.4 Chemicals Lacking Toxicity Criteria

Toxicity values are not available for all chemicals for all routes of exposure. Where appropriate, surrogate chemicals were used both in the screening process and in the risk characterization. The surrogate selections are footnoted in each SWMU, SWMU group, or watercourse report. The most frequently used surrogate was pyrene; its oral reference dose was used for other multi-ring, noncarcinogenic PAHs (i.e., phenanthrene, benzo(g,h,i)pyrene).

For other chemicals, oral toxicity values, but not inhalation, are available; dermal toxicity values are not available for any chemical. Route-to-route extrapolations were utilized in these cases. For each extrapolation, the toxicity value was assumed to be the same for each route. This assumption, therefore, conservatively assumes that the chemical is equitoxic by both routes (i.e., oral to inhalation or oral to dermal).

4.5 Other Chemical-Specific Criteria

There are other chemical-specific, toxicity related factors needed to evaluate certain exposures. For dermal exposures to water, permeability coefficients are needed to quantify the ability of a chemical in water to be absorbed by the skin. These values can either be measured or predicted by certain chemical properties. Permeability coefficients in water for the COPCs were obtained from the Risk Assessment Information System (RAIS 2004). In Process Area groundwater and groundwater discharge to Smokes Creek, however, representative concentrations for some PAHs were higher than the chemicals' solubilities, thus indicating the presence of nonaqueous phase liquid (NAPL). In these cases, USEPA (1992) guidance indicates that the appropriate permeability coefficient is equal to the permeability coefficient for water divided by the octanol-water partition coefficient (K_{ow}). Permeability coefficients for the SWMU groups in the Process Area were calculated according to this guidance.

In order to evaluate a fish ingestion pathway, bioconcentration factors (BCFs) are needed to estimate the ratio of a chemical in edible animal tissue to the water concentration. These values can either be measured (as reported in available technical literature) or calculated based on

chemical structure and/or physiochemical properties. The BCFs used in calculating RBSLs are summarized in Table 4-2.

Table 4-1
Toxicity Criteria for Chemicals of Potential Concern

Chemical	CAS	Noncarcinogenic Toxicity Criteria				Carcinogenic Toxicity Criteria				
		Oral RfD (mg/kg-d)	Source	Inhalation RfD (mg/kg-d)	Source	Weight of Evidence[a]	Oral SF $(mg/kg\text{-}d)^{-1}$	Source	Inhalation SF $(mg/kg\text{-}d)^{-1}$	Source
Inorganics										
Antimony	7440-36-0	4.00E-04	H	4.00E-04	R	--	--	--	--	--
Arsenic	7440-38-2	3.00E-04	I	--	--	A	1.50E+00	I	1.51E+01	I
Barium	7440-39-3	7.00E-02		1.40E-04	--	--	--	--	--	--
Cadmium	7440-43-9	5.00E-04	I	5.70E-05	E	B1	--	--	6.30E+00	I
Chromium[b]	18540-29-9	3.0E-03(chronic) 2.0E-02 (subchronic)	I	3.00E-05	I	A	--	--	4.10E+01	H
Cyanide	57-12-5	2.00E-02	I	--	--	--	--	--	--	--
Lead[c]	71-43-2	--	--	--	--	--	--	--	--	--
Manganese	7439-96-5	2.00E-02	I	1.43E-05	I	--	--	--	--	--
Mercury[d]	7487-94-7	3.00E-04	I	3.00E-04	R	--	--	--	--	--
Nickel	7440-02-0	2.00E-02	I	--	--	--	--	--	--	--
Selenium	7782-49-2	5.00E-03	I	5.00E-03	R	--	--	--	--	--
Silver	7440-22-4	5.00E-03	I	--	--	--	--	--	--	--
Thallium[e]	108-90-7	8.0E-05 (chronic) 8.0E-04 (subchronic)	I	8.00E-05	R	--	--	--	--	--
Zinc	7440-66-6	3.00E-04	I	--	--	--	--	--	--	--
Organics										
1,1,1-Trichloroethane	71-55-6	2.80E-01	E	6.30E-01	E	--	--	--	--	--
1,1-Dichloroethane	75-34-3	1.00E-01	H	1.40E-01	H	--	--	--	--	--
1,2-Dichloroethane	107-06-2	3.00E-02	H	1.40E-03	E	B2	9.10E-02	I	9.10E-02	I
2,4-Dimethylphenol	105-67-9	2.00E-02	I	2.00E-02	R	--	--	--	--	--
2-Methylphenol	95-48-7	5.00E-02	I	--	--	--	--	--	--	--
3-Methylphenol and 4-Methylphenol[f]	108-39-4/ 106-44-5	6.00E-02	H	6.00E-02	R	--	--	--	--	--
4-Methylphenol	106-44-5	5.00E-03	I	--	--	--	--	--	--	--
Acenaphthene	83-32-9	6.00E-02	I	6.00E-02	R	--	--	--	--	--
Acenaphthylene[g]	208-96-8	6.00E-02	I	6.00E-02	R	--	--	--	--	--
Anthracene	120-12-7	3.00E-01	I	3.00E-01	R	--	--	--	--	--
Benzo(a)anthracene	56-55-3	--	--	--	--	B2	7.30E-01	E	3.10E-01	E
Benzene	71-43-2	3.00E-03	E	1.70E-03	E	A	5.50E-02	I	2.90E-02	I
Benzo(a)pyrene	50-32-8	--	--	--	--	B2	7.30E+00	I	3.10E+00	E
Benzo(b)fluoranthene	205-99-2	--	--	--	--	B2	7.30E-01	E	6.10E-01	E
Benzo(g,h,i)perylene[h]	191-24-2	3.00E-02	I	3.00E-02	R	--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	--	--	--	--	B2	7.30E-02	E	6.10E-02	E
Bis(2-ethylhexyl)phthalate	117-81-7	2.00E-02	I	--	--	B2	1.40E-02	I	1.40E-02	E
Bromodichloromethane	75-27-4	2.00E-02	I	--	--	B2	6.20E-02	I	--	--
Carbon disulfide	75-15-0	1.00E-01	I	2.00E-01	I	--	--	--	--	--
Carbon tetrachloride	56-23-5	7.00E-04	I	5.71E-04	E	B2	1.30E-01	I	5.30E-02	I
Chlorobenzene	75-09-2	2.00E-02	I	1.70E-02	E	--	--	--	--	--
Chloroform	67-66-3	1.00E-02	I	8.60E-05	E	B2	6.10E-03	I	8.10E-02	I
Chrysene	218-09-9	--	--	--	--	B2	7.30E-03	E	3.10E-03	E
Cresols, Total[f]	1319-77-3	5.00E-03	I	5.00E-03	R	--	--	--	--	--
Dibenz(a,h)anthracene	53-70-3	--	--	--	--	B2	7.30E+00	E	3.10E+00	E
Dibromochloromethane	124-48-1	2.00E-02	I	--	--	C	8.40E-02	I	--	--
Ethylbenzene	100-41-4	1.00E-01	I	2.90E-01	I	--	--	--	--	--
Fluoranthene	206-44-0	4.00E-02	I	--	--	--	--	--	--	--
Fluorene	86-73-7	4.00E-02	I	4.00E-02	R	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	193-39-5	--	--	--	--	B2	7.30E-01	E	3.10E-01	E
Methylene chloride	75-09-2	6.00E-02	I	8.60E-01	H	B2	7.50E-03	I	1.65E-03	I
Naphthalene	91-20-3	2.00E-02	I	9.00E-04	I	--	--	--	--	--
Phenanthrene[h]	85-01-8	3.00E-02	I	3.00E-02	R	--	--	--	--	--
Phenol	108-95-2	6.00E-01	I	--	--	--	--	--	--	--
Pyrene	129-00-0	3.00E-02	I	--	R	--	--	--	--	--
Pyridine	110-86-1	1.00E-03	I	1.00E-03	R	--	--	--	--	--
Toluene	108-88-3	2.00E-01	I	1.14E-01	I	--	--	--	--	--
Trichloroethene	79-01-6	6.00E-03	E	--	--	NC	1.10E-02	E	6.00E-03	E
Vinyl chloride	75-01-4	--	--	--	--	A	1.90E+00	H	3.00E-01	H
Xylenes, Total	1130-20-7	2.00E+00	I	2.00E+00	R	--	--	--	--	--

-- There is no toxicity criteria for this pathway.
I Obtained from IRIS (USEPA 2000b).
H Obtained from Health Effects Assessment Summary Tables (HEAST) (USEPA 1997).
E Obtained from USEPA NCEA, as noted in Region III RBC Tables (USEPA 2000a).
R Route-to-route extrapolation.

a Weight of Evidence: A - known human carcinogen, B1 -probable human carcinogen, B2 - probable human carcinogen (sufficient animal/inadequate human evidence), NC - no clas:
b The toxicity criteria for hexavalent chromium is conservatively used for chromium.
c Lead lacks standard toxicity criteria and was evaluated alternatively.
d The toxicity criteria for mercuric chloride is used for mercury.
e The toxicity criteria for thallium chloride is used for thallium.
f The toxicity criteria for 4-methylphenol is conservatively used for 3-methylphenol and 4-methylphenol, and cresols.
g The toxicity criteria for acenaphthene is used for acenaphthylene.
h The toxicity criteria for pyrene is used for benzo(g,h,i)perylene and phenanthrene.

Table 4-2
Bioconcentration Factors

Volatile Organic Chemicals			*Semivolatile Organic Chemicals*			*Inorganic Chemicals*		
Chemical of Potential Concern	**BCF**	**Ref.**	**Chemical of Potential Concern**	**BCF**	**Ref.**	**Chemical of Potential Concern**	**BCF**	**Ref.**
1,1-Dichloroethane	13	a	Acenaphthylene	575	a	Antimony	0.90	f
1,2-Dichloroethane	2.0	a	Anthracene	1,349	a	Arsenic	4.0	f
1,2-Dichloroethene, Total	19	b	Benzo(a)anthracene	350	a	Barium	93	g
Benzene	4.3	a	Benzo(a)pyrene	920	a	Cadmium	3,800	f
Bromodichloromethane	23	a	Benzo(b)fluoranthene	23,988	a	Chromium	1.00	f, i
Bromoform	3.2	a	Benzo(g,h,i)perylene	58,884	a	Lead	45.00	f
Carbon disulfide	11	a	Benzo(k)fluoranthene	33,884	a	Mercury	85,700	f
Chlorobenzene	447	a	bis(2-Ethylhexyl)phthalate	851	a	Nickel	0.80	f
Chloroform	8.3	a	Chrysene	11,749	a	Selenium	5,700	f
Dibromochloromethane	29	a	Dibenz(a,h)anthracene	10	a	Silver	28	f
Ethylbenzene	15	a	2,4-Dimethylphenol	151	a	Thallium	130	f
Methylene chloride	5.2	a	Fluoranthene	3,981	a	Cyanide	0.90	h
Pyridine	1.8	a	Fluorene	1,288	a			
Toluene	37	a	Indeno(1,2,3-c,d)pyrene	32,359	a			
Trichloroethene	17	a	2-Methylphenol	18	a			
Vinyl chloride	6.1	c	3-Methylphenol	20	a			
Xylenes, Total	19	d	4-Methylphenol	17	a			
			Cresols, Total	18	e			
			Naphthalene	427	a			
			Phenanthrene	1,778	a			
			Phenol	20	a			
			Pyrene	2,692	a			
			3-Methylphenol & 4-Methylphenol	19	e			

a Syracuse Research Corporation CHEMFATE database.
b Average of values for *cis* and *trans*-isomers in Syracuse Research Corporation CHEMFATE database.
c Calculated per USEPA (1988b): Log BCF = 0.79*Log Kow - 0.4. Log Kow value from USEPA (1996a).
d Average of values for m-, o-, and p-isomers in Syracuse Research Corporation CHEMFATE database.
e Average of values for component isomers in Syracuse Research Corporation CHEMFATE database.
f Superfund Chemical Data Matrix foodchain freshwater BCF.
g Average of two similar values in Syracuse Research Corporation DATALOG database.
h Screening level ecological risk protocol for hazardous waste combustion facilities (USEPA 1989b).
i All chromium is conservatively considered to be hexavalent chromium.

5.0 RISK CHARACTERIZATION

Risk characterization involves estimating the magnitude of the potential adverse health effects of the COPCs and summarizing the nature of the health impact to the assumed receptor populations. In this RFI risk assessment, risk characterization was accomplished in two steps. In the first step, RBSLs were calculated for each exposure medium – receptor population combination, and a comparison was done with the representative concentrations calculated for that medium. In the second step, RBSLs exceedances were further evaluated with regard to Tier 1 cancer and noncancer benchmarks.

5.1 Calculation of Medium- and Receptor-Specific RBSLs

Risk-based screening levels are chemical concentrations that are not expected to produce adverse health effects under the assumed exposure conditions. Inputs to the screening level calculations are the previously-described exposure factors, toxicity values, and any intermedia modeling factors (e.g., the volatilization factors for releases from groundwater or subsurface SWMU material). In addition, the equations require a target hazard index (THI, assumed to be 1.0) and a target cancer risk level (TR, assumed to be 1×10^{-6}).

The equations used to develop these RBSLs were originally presented in ID No. 2; additional exposure pathways were requested by USEPA in their comments to the revised ID No. 2 (USEPA 2003). The additional complete exposure pathways were discussed in the Exposure Assessment, and the associated exposure parameters provided in Tables 3-2 through 3-6. The additional RBSL equations necessitated by USEPA (2003) are summarized on Figure 5-1.

Although most of the RBSL equations are straightforward, additional information is warranted to describe some RBSL calculations. The current non-BSC commercial/industrial worker was evaluated in a different manner than other receptor scenarios. For this scenario, potential indoor inhalation exposures to volatile chemicals in groundwater were evaluated by estimating the indoor air concentrations of COPCs that volatilize from groundwater into the on-site building and then comparing these levels to the applicable Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) (OSHA 2004). Thus, RBSLs were not calculated for this exposure scenario.

The calculated RBSLs for each receptor are presented in Tables 5-1 through 5-45. Instances where RBSLs exceed the applicable representative chemical concentration are bolded.

There were no SWMUs quantified within groundwater Zones 1 and 5. The assessment for receptors within these areas is not included in any of the Part V through VII reports. However, as indicated within the tables in this section, none of the representative groundwater concentrations exceed the calculated RBSLs.

5.2 Tier 1 Risk Characterization

The comparison of the representative COPC concentration to the RBSL for each receptor population provides a preliminary screening of potential risk. If there are no exceedances of RBSLs, then the conclusion is that no further evaluation with regard to risk is warranted. If there are exceedances of RBSLs, a further evaluation is done that evaluates multiple chemicals and multiple pathways for each receptor population, and calculates total risk estimates.

This further characterization, or a Tier 1 HHRA, is accomplished by calculating either (or both) a screening-level hazard index (SLHI) or a total screening-level cancer risk ($SLCR_{total}$). These values are then compared with the Tier 1 noncancer benchmark (1) or the Tier 1 cancer benchmark of 1×10^{-4}.

5.2.1 Noncancer Hazards

For those chemicals that exceed RBSLs based on noncancer hazards, a screening-level hazard quotient (SLHQ) was calculated based on the following equation:

$$SLHQ = \frac{\text{Representative concentration}_{\text{COPC/medium}}}{\text{RBSL}_{\text{COPC/medium/receptor/pathway}}}$$

The SLHQs for each medium, receptor, and COPC combination were added to derive a noncarcinogenic SLHI.

A further evaluation of the SLHI was done by developing target organ-specific SLHIs. This segregation of effects acknowledges that not all chemicals have the same toxicological endpoints or mechanisms of toxicity. It is, therefore, appropriate to add only those chemicals that have similar effects. Any endpoint-specific SLHQ greater than 1 indicates that noncancer health hazards are unacceptable.

5.2.2 Carcinogenic Risk

Carcinogenic risks are defined in terms of the probability of an individual developing cancer over a lifetime as the result of exposure to a chemical at a given concentration (USEPA 1989). The incremental probability of developing cancer over a lifetime is referred to as an excess cancer risk, i.e., it is the additional risk above and beyond the risk in the absence of the assumed exposures. The SLCR is calculated by the following equation:

$$SLCR = \frac{\text{Representative concentration}_{COPC/medium}}{RBSL_{COPC/medium/receptor/pathway}} x \text{ Target Risk Level}$$

An SLCR is calculated for each RBSL exceedance. Cancer risks (i.e., individual, chemical-specific SLCRs) are then summed regardless of target organ differences, weight of evidence categories, or any potential antagonistic or synergistic effects. Based on USEPA guidance (USEPA 1989a, 1991d) total cancer risks for a given population equal to or less than 1 x 10^{-4} are considered negligible and further actions to reduce this risk are not warranted.

This second risk characterization step is documented in each SWMU or watercourse report in Parts V, VI, VII of this RFI report, Appendix D (the Lake Erie Risk Assessment) and Appendix E (site-wide groundwater) of this Part IV section.

5.3 Uncertainty Analysis

There are multiple sources of uncertainty in any exposure and risk estimate. Each time a single assumption is used to describe a dynamic parameter, some uncertainty is introduced. While certain assumptions have some or significant scientific basis, others do not. The selection of multiple, conservative assumptions, especially in the exposure assessment, generally results in an overestimation of potential health risks posed by the site. The key factors and assumptions that are primary contributors to uncertainty in the risk assessments for the SWMUs and watercourses are discussed qualitatively in the following sections. The individual risk assessments provide additional uncertainties specific to or applicable to the area.

5.3.1 Uncertainties in Data Collection and Selection of Chemicals of Potential Concern

For the most part, sampling locations within the SWMUs were selected with the objective of identifying the highest concentrations of chemicals. In reality, an average chemical concentration across the area where exposure is expected to occur is more representative of exposures to a given media (USEPA 1989a, 1991a, 2002). The SWMU risk assessments, therefore, are generally based on conservative estimates of chemical levels from biased samples. This results in an overestimate of risk in cases where the maximum concentrations were considered as representative concentrations. Underestimates of chemical concentrations are possible if the biased sampling did not characterize the highest concentrations. It is more likely, however, that chemical concentrations that form this critical element of the risk characterization are overestimates.

Chemicals of potential concern were selected based on a conservative screening methodology that used residential screening criteria. The conservative nature of the screening criteria means that it is unlikely that any significant risk driver was eliminated from consideration in the SWMU and watercourse risk assessments.

5.3.2 Uncertainties in Quantifying Exposure

The exposure factors selected to describe the physiological characteristics and human activities of the assumed receptors can be quite uncertain. In addition, most of these parameters are not single points, but represent a distribution of values within a given population. When faced with selecting a single value for risk characterization purposes, an attempt was made to include a reasonable, upper-bound value for most exposure factors. Some exposure factors are well-studied (e.g., body weight). Attempts to quantify others (e.g., soil ingestion rates, inhalation rates) are documented in the scientific literature, but remain uncertain for specific human activities. For many exposure factors (e.g., exposure events for utility or construction workers, bathers, etc.), estimates of a conservative value were based on professional judgment since no other information is available. Selection of multiple, conservative exposure factors leads to compounded conservatism when these factors are subsequently used to develop risk estimates.

In addition, a number of unrealistic exposure scenarios were included in the SWMU risk assessments. For example, an indoor future commercial/industrial worker was assumed at almost every SWMU regardless of whether a building could actually be constructed at that location. In addition, this worker was assumed to be at that location for the entire work day. Given the

foreseeable future development of the Lackawanna Facility, many hypothetical future receptor scenarios are not relevant, although they were included, in the SWMU/Watercourse risk assessments.

Considerable uncertainty exists wherever fate and transport models were used to develop acceptable concentrations for inhalation pathways. Modeling is inherently uncertain since it is not known whether all significant variables have been accounted for and whether all the relationships among them are accurate. Risks could be under or overestimated based on the output of this modeling.

5.3.3 Uncertainties in Evaluating Toxicity

The accuracy of human health risk predictions is dependent upon the accuracy of the toxicological values for each chemical. For most COPCs, these values are derived from a limited database, resulting in substantial uncertainty. In addition, toxicological data based on human exposures are quite limited. In an effort to account for these uncertainties, the USEPA derives toxicity values in a very conservative way. For noncarcinogens, uncertainty factors (usually a value of 10) are applied to a no-observed-effect level in animals to account for extrapolation to humans, length of the study, lack of supporting data, sensitivity in humans, etc. These procedures tend to be conservative so that potential effects on humans are likely overestimated rather than underestimated. It is widely accepted in the scientific community that low doses of toxicants can be detoxified by several processes in human organ systems (Ames et al. 1987). Thus, humans may not react to a chemical to the same degree as a population of genetically homogeneous laboratory animal population.

Cancer slope factors are derived by USEPA in a similarly conservative manner. The Linearized Multistage (LMS) Model, used by USEPA, is highly conservative since it assumes linearity between dose and effect to zero dose (i.e., there is no threshold). The human body, however, does have mechanisms to detoxify most chemicals, particularly at low doses. There is significant uncertainty associated with this low-dose extrapolation. In addition, the slope factor is taken to be the upper 95% confidence limit of the dose-response slope predicted by the LMS. There is some disagreement within the scientific community as to whether all carcinogens cause cancer at any dose level, or whether there is some threshold dose. Slope factors are also based on a lifetime of exposure and there is considerable debate on an acceptable procedure for handling the less-than-lifetime exposures that are assumed in this HHRA.

Toxicity values are not available for every chemical by every route of exposure. In some cases, surrogate chemicals were used assuming that similarities in chemical structure can predict similar toxicological properties. In some cases, oral toxicity values were assumed for the inhalation route. This assumption implies that the chemical is equitoxic by both routes of exposure. This is likely to overestimate hazards and risks by the inhalation route.

The USEPA does not derive dermal toxicity routes, but recommends extrapolation from the oral toxicity values. This represents a source of uncertainty especially if the route-specific chemical absorption differs. In this risk assessment, oral absorption and dermal absorption were considered equal. It is unknown whether this results in an underestimate or overestimate of risks from dermal exposures.

Because of its unique toxicological properties, toxicity values for lead are not appropriate. Although exposures to lead result in noncarcinogenic effects, lead does not appear to have a threshold. The USEPA recommends evaluating lead by predicting blood lead levels and comparing them to acceptable blood lead levels. In the SWMU risk assessments, USEPA's recommended approach for assessing nonresidential adult risks, relating soil lead intake to blood lead levels in women of child-bearing age was used. The acceptable blood lead level (10 µg/dl) is applied to the developing fetus of a pregnant woman. This methodology represents some uncertainty. These uncertainties relate to whether the model is capable of fully accounting for all significant variables that affect blood lead level and whether selected input values are accurate for the populations being evaluated. In addition, RBSLs were not calculated for lead exposures to other media (e.g., surface water, pit water, fish ingestion). This represents some uncertainty in risk estimates.

5.3.4 Uncertainties in Risk Characterization

Uncertainties in risk characterization are a combination of the uncertainties associated with both the toxicity assessment and the exposure assessment. For cancer, risks are summed without regard to differences in target organ, weight-of-evidence or potential interactions (i.e., antagonism, synergism). This is more likely to produce overestimates of risks rather than underestimates.

The hazard index approach used in the SWMU/Watercourse risk assessments does account for differences in endpoints. However, uncertainty remains as to whether those

endpoints have been sufficiently characterized in the supporting toxicity studies and whether antagonistic or synergistic effects are fully accounted for.

5.3.5 Uncertainty Summary

The SWMU/Watercourse risk assessments completed for the Lackawanna Facility effectively combine to overestimate potential exposures. The major sources of uncertainty are:

- Biased sampling toward areas of highest chemical concentrations
- Evaluation of exposure scenarios based on unrealistic future development
- Compounding effect of multiple, conservative exposure factors
- Fate and transport modeling to predict inhalation exposures
- Confidence in toxicity criteria

The net effect of the uncertainties in these risk assessments is the generation of excess cancer risks and hazards that probably far exceed any likely exposure conditions either now or in the future at the Lackawanna site.

Figure 5-1
Summary of RBSL Equations for Pathways Added by USEPA(2003)

I. Recreational Bather – Ingestion of and Dermal Contact with Sediment

$$RBSL_c = \frac{TR \cdot AT_c}{ED \cdot CF \cdot SF_o\left[\left(IFS_{rec} \cdot ABS_o\right) + \left(SAF_{rec} \cdot AF \cdot ABS_d\right)\right]}$$

$$RBSL_n = \frac{THQ \cdot AT_n}{EF_{rec} \cdot CF \cdot \frac{1}{RfD_o}\left[\left(IFS_{rec} \cdot ABS_o\right) + \left(SAF_{rec} \cdot ABS_d\right)\right]}$$

II. Utility Worker – Dermal Contact with and Inhalation of (Vapors from) Pit Water

$$RBSL_c = \frac{TR \cdot AT_c \cdot BW}{ED \cdot EF\left[\left(IR \cdot SF_i \cdot VF \cdot ABS\right) + \left(SF_d \cdot ET \cdot SSA \cdot PC \cdot CF_d \cdot ABS\right)\right]}$$

$$RBSL_n = \frac{THQ \cdot AT_n \cdot BW}{ED \cdot EF\left[\left(IR \cdot VF \cdot \frac{1}{RfD_i} \cdot ABS\right) + \left(ET \cdot SSA \cdot PC \cdot CF_d \cdot \frac{1}{RfD_d} \cdot ABS\right)\right]}$$

III. Utility Worker – Dermal Contact with and Inhalation of (Vapors from) Groundwater

$$RBSL_c = \frac{TR \cdot AT_c \cdot BW}{ED \cdot EF\left[\left(IR \cdot SF_i \cdot VF \cdot ABS\right) + \left(SF_d \cdot ET \cdot SSA \cdot PC \cdot CF_d \cdot ABS\right)\right]}$$

$$RBSL_n = \frac{THQ \cdot AT_n \cdot BW}{ED \cdot EF\left[\left(IR \cdot VF \cdot \frac{1}{RfD_i} \cdot ABS\right) + \left(ET \cdot SSA \cdot PC \cdot CF_d \cdot \frac{1}{RfD_d} \cdot ABS\right)\right]}$$

Figure 5-1
Summary of RBSL Equations for Pathways Added by USEPA(2003)

IV. Construction Worker – Dermal Contact with and Inhalation of Vapors from Pit Water

$$RBSL_c = \frac{TR \cdot AT_c \cdot BW}{ED \cdot EF\left[\left(IR \cdot SF_i \cdot VF \cdot ABS\right) + \left(SF_d \cdot ET \cdot SSA \cdot PC \cdot CF_d \cdot ABS\right)\right]}$$

$$RBSL_n = \frac{THQ \cdot AT_n \cdot BW}{ED \cdot EF\left[\left(IR \cdot VF \cdot \frac{1}{RfD_i} \cdot ABS\right) + \left(ET \cdot SSA \cdot PC \cdot CF_d \cdot \frac{1}{RfD_d} \cdot ABS\right)\right]}$$

V. Construction Worker – Dermal Contact with and Inhalation of (Vapors from) Groundwater

$$RBSL_c = \frac{TR \cdot AT_c \cdot BW}{ED \cdot EF\left[\left(IR \cdot SF_i \cdot VF \cdot ABS\right) + \left(SF_d \cdot ET \cdot SSA \cdot PC \cdot CF_d \cdot ABS\right)\right]}$$

$$RBSL_n = \frac{THQ \cdot AT_n \cdot BW}{ED \cdot EF\left[\left(IR \cdot VF \cdot \frac{1}{RfD_i} \cdot ABS\right) + \left(ET \cdot SSA \cdot PC \cdot CF_d \cdot \frac{1}{RfD_d} \cdot ABS\right)\right]}$$

Table 5-1
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area								Tank Farm Area		Slag Fill Area Zone 2	
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-4		SWMU S-26		SWMU Group TF		SWMU Group SFA-1	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	5,800	--	6,050
Antimony	--	--	--	--	--	--	--	--	--	**50**	--	**50**
Arsenic[a]	**12**	37.3	--	--	**12**	37.3	**12**	37.3	**12**	**37**	**12**	37
Benzo(a)anthracene	--	--	**1.9**	--	--	--	**1.9**	--	**1.9**	--	**1.9**	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	**0.19**	--	--	--	**0.19**	--	**0.19**	--	**0.19**	--
Benzo(b)fluoranthene	--	--	**1.9**	--	--	--	**1.9**	--	**1.9**	--	**1.9**	--
Benzo(g,h,i)perylene	--	--	--	3,729	--	--	--	--	--	3,700	--	3,730
Benzo(k)fluoranthene	--	--	19	--	--	--	--	--	**19**	--	**19**	--
Chromium[b]	--	--	>1,000,000	373	723,000	373	>1,000,000	**373**	85,700	373	>1,000,000	373
Chrysene	--	--	--	--	--	--	--	--	**194**	--	**194**	--
Dibenz(a,h)anthracene	--	--	**0.19**	--	--	--	**0.19**	--	**0.19**	--	**0.19**	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	**1.9**	--	--	--	1.94	--	**1.9**	--	**1.9**	--
Lead	--	--	--	--	--	--	--	--	--	1,545	--	1,545
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	3,140	--	3,240
Thallium	--	--	--	--	--	--	--	--	--	9.9	--	10
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-1
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	50	--	--	--	49.7
Arsenic[a]	12	37	0.94	37	12	37	12	37	12	37.3	--	--
Benzo(a)anthracene	1.9	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	0.19	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium[b]	--	--	--	--	234,000	373	922,000	373	>1,000,000	373	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	1,545	--	1,545	--	1,545	--	--	--	1,545
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	10	--	9.9	--	9.9	--	--	--	9.9	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-1
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4						Other Areas					
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-19		SWMU P-63		SWMU P-73	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	50	--	--	--	**50**			--	--	--	--
Arsenic[a]	--	--	12	37.3	**12**	**37**	**12**	**37**	**12**	**37.3**	**12**	**37**
Benzo(a)anthracene	--	--	**1.9**	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	**0.19**	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	**1.9**	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	3,730	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium[b]	--	--	945,000	**373**	863,000	373	--	--	>1,000,000	373	610,000	**373**
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	**1.9**	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	**1,545**	--	--	--	1,545	--	--
Mercury	--	--	--	**37**	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	3,670	--	--	--	--	--	--	--	--
Thallium	--	--	--	9.9	--	**10**	--	--	--	--	--	9.9
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a The cancer RBSL for arsenic is less than the background, therefore, the background was used as the RBSL.
b All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-2
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area				Tank Farm Area		Slag Fill Area Zone 2					
	SWMU Group PA-3		SWMU Group PA-4		SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-24	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	3.5	--	--	--
Acenaphthylene	--	--	--	--	--	>sat (1,115)	--	676,000	--	>sat (1,115)	--	--
Anthracene	--	>1,000,000	--	--	--	>sat (10.2)	--	--	--	--	--	>1,000,000
Benzene	--	--	**411**	>sat (1,260)	**3.4**	**15**	**1.3**	**5**	**4.1**	**18**	**15**	**64**
Fluorene	--	--	--	--	--	>sat (153)	--	--	--	>sat (153)	--	>1,000,000
Naphthalene	--	--	--	>sat (371)	--	**252**	--	**313**	--	654	--	>sat (371)
Phenanthrene	--	--	--	--	--	>sat (163)	--	>sat (163)	--	>sat (163)	--	--
Toluene	--	--	--	>sat (795)	--	--	--	--	--	>sat (795)	--	>sat (795)
Trichloroethene	--	--	--	--	--	--	--	--	20	--	--	--
Xylenes, Total	--	--	--	>sat (694)	--	--	--	--	--	>sat (694)	--	>sat (694)

Table 5-2
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)					
	Slag Fill Area Zone 4					
	SWMU S-14		SWMU S-18		SWMU S-23	
	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Acenaphthylene	--	>1,000,000	--	--	--	>1,000,000
Anthracene	--	>1,000,000	--	>1,000,000	--	>1,000,000
Benzene	3.0	12	--	--	**5.0**	**22**
Fluorene	--	--	--	--	--	>1,000,000
Naphthalene	--	>sat (371)	--	--	--	>sat (371)
Phenanthrene	--	>1,000,000	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
> sat The RBSL exceeds the saturation limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-3
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Indoor Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area				Tank Farm Area		Slag Fill Area Zone 2					
	SWMU Group PA-3		SWMU Group PA-4		SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-24	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	**0.55**	--	--	--
Acenaphthylene	--	--	--	--	--	>sat (1,115)	--	223,000	--	>sat (1,115)	--	--
Anthracene	--	>1,000,000	--	--	--	>sat (10.2)	--	--	--	--	--	>1,000,000
Benzene	--	--	**1.3**	**5.4**	**0.16**	**0.69**	**0.16**	**0.69**	**0.16**	**0.69**	**0.16**	**0.69**
Fluorene	--	--	--	--	--	>sat (153)	--	--	--	>sat (153)	--	>sat (153)
Naphthalene	--	--	--	**103**	--	**103**	--	**103**	--	**103**	--	**103**
Phenanthrene	--	--	--	--	--	>sat (163)	--	>sat (163)	--	>sat (163)	--	--
Toluene	--	--	--	**363**	--	--	--	--	--	**82**	--	**82**
Trichloroethene	--	--	--	--	--	--	--	--	**0.69**	--	--	--
Xylenes, Total	--	--	--	>sat (694)	--	--	--	--	--	>sat (694)	--	>sat (694)

Table 5-3
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Indoor Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)					
	Slag Fill Area Zone 4					
	SWMU S-14		SWMU S-18		SWMU S-23	
	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Acenaphthylene	--	>sat (1,110)	--	--	--	>sat (1,110)
Anthracene	--	>1,000,000	--	>1,000,000	--	>1,000,000
Benzene	**0.16**	**0.69**	--	--	**0.16**	**0.69**
Fluorene	--	--	--	--	--	>sat (153)
Naphthalene	--	**103**	--	--	--	**103**
Phenanthrene	--	>sat (163)	--	--	--	>sat (163)
Toluene	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
> sat The RBSL exceeds the saturation limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-4
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Coke Oven Area											
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-3		SWMU Group PA-4		SWMU P-18		SWMU S-26	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)
Benzene	**120**	**510**	**192**	831	**208**	901	**84**	**363**	**26**	**112**	62	268
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Methylene chloride	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Phenanthrene	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)
Pyridine	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-4
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Tank Farm Area		Slag Fill Area Zone 2									
	SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)
1,2-Dichloroethane	--	--	18	202	30	333	34	384	19	211	121	1,359
1,2-Dichloroethene (total)	--	--	--	417	--	753	--	795	--	604	--	3,090
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	11	50	19	82	34	149	36	156	28	122	141	612
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	5.0	2.9	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	--	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Methylene chloride	--	--	--	>sol (13,000)	--	>sol (13,000)	--	>sol (13,000)	--	>sol (13,000)	--	>sol (13,000)
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Phenanthrene	--	--	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)
Pyridine	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)
Trichloroethene	--	--	63	--	116	--	119	--	99	--	477	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-4
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Slag Fill Area Zone 2		Slag Fill Area Zone 3		Slag Fill Area Zone 4							
	SWMU S-24		SWMU S-10		SWMU S-14		SWMU S-15		SWMU S-16		SWMU S-17	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	>sol (5,060)	--	--	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)
1,2-Dichloroethane	37	418	--	--	--	--	--	--	--	--		
1,2-Dichloroethene (total)	--	1,069	--	--	--	--	--	--	--	--		
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--		
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	--	--	--	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)
Benzene	49	214	30	130	133	577	123	533	117	510	167	726
Carbon disulfide	--	--	--	--	--	--	--	--	--	--		
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	>sol (472)	--	>sol (472)	--	>sol (472)	--	>sol (472)
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Methylene chloride	1,274	>sol (13,000)	--	--	4,265	>sol (13,000)	3,290	>sol (13,000)	3,249	>sol (13,000)	4,870	>sol (13,000)
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Phenanthrene	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)
Pyridine	--	--	--	--	--	280	--	276	--	261	--	>sol (300)
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)
Trichloroethene	170	--	--	--	425	--	420	--	397	--	555	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-4
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)									
	Slag Fill Area Zone 4				Other Areas					
	SWMU S-18		SWMU S-23		Smokes Creek		Zone 1		Zone 5	
	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	>sol (5,060)	--	>sol (5,060)	--	4,300	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	>sol (1,330)	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	--	--	--	--	--
Anthracene	--	>sol (0.043)	--	>sol (0.043)	--	--	--	--	--	--
Benzene	171	741	74	323	**11**	**48**	4.2	18	10	42
Carbon disulfide	--	--	--	--	--	>sol (1,190)	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	0.69	1.8	--	--
Chlorobenzene	--	>sol (472)	--	>sol (472)	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	--	--	--
Fluorene	--	>sol (2.0)	--	>sol (2.0)	--	--	--	--	--	--
Methylene chloride	5,143	>sol (13,000)	2,165	>sol (13,000)	302	>sol (13,000)	104	12,978	--	--
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Phenanthrene	--	>sol (1.2)	--	>sol (1.2)	--	--	--	--	--	--
Pyridine	--	>sol (300)	--	162	--	**25**	--	--	--	--
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	--	--	--
Trichloroethene	559	--	247	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	**0.28**	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-5
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Indoor Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Coke Oven Area											
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-3		SWMU Group PA-4		SWMU P-18		SWMU S-26	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)
Benzene	**0.46**	**2.0**	**0.5**	**2.1**	**0.47**	**2.0**	**0.46**	**2.0**	**0.48**	**2.1**	**0.46**	**2.0**
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Methylene chloride	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	**10**	--	**11**	--	**11**	--	**10**	--	**11**	--	**10**
Phenanthrene	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)
Pyridine	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	120	--	125	--	120	--	120	--	127	--	122
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-5
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Indoor Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Tank Farm Area		Slag Fill Area Zone 2									
	SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	240	--	218	--	240	--	186	--	217
1,2-Dichloroethane	--	--	0.68	8.0	0.61	6.8	0.68	7.7	0.50	5.5	0.60	6.8
1,2-Dichloroethene (total)	--	--	--	13	--	12	--	13	--	10	--	12
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	0.50	2.2	0.59	2.6	0.54	2.4	0.59	3.0	0.47	2.0	0.54	2.3
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	0.22	0.13	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	--	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Methylene chloride	--	--	19	2,412	17	2,170	19	2,410	14	1,795	17	2,151
Naphthalene	--	12	--	16	--	14	--	16	--	11	--	13.5
Phenanthrene	--	--	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)
Pyridine	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	130	--	154	--	141	--	154	--	122	--	140
Trichloroethene	--	--	2	--	1.7	--	1.9	--	1.5	--	1.7	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-5
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Indoor Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Slag Fill Area Zone 2		Slag Fill Area Zone 3		Slag Fill Area Zone 4							
	SWMU S-24		SWMU S-10		SWMU S-14		SWMU S-15		SWMU S-16		SWMU S-17	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	199	--	--	--	311	--	207	--	218	--	239
1,2-Dichloroethane	0.50	6.0	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	11	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	--	--	--	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)
Benzene	0.50	2.2	0.47	2.0	0.76	3.3	0.52	2.2	0.54	2.4	0.59	2.6
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	56	--	37	--	39	--	43
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	>sol (1.98)	--	>sol (1.98)	--	>sol (1.98)	--	>sol (1.98)	--	>sol (1.98)	--	>sol (1.98)
Methylene chloride	16	1,939	--	--	26	3,233	16	2,030	17	2,163	19	2,406
Naphthalene	--	12	--	11	--	22	--	13	--	13.6	--	16
Phenanthrene	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)
Pyridine	--	--	--	--	--	1.6	--	1.1	--	1.1	--	1.2
Toluene	--	130	--	123	--	195	--	135	--	141	--	153
Trichloroethene	1.6	--	--	--	2.4	--	1.7	--	1.7	--	1.9	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-5
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Indoor Vapors from Groundwater*

Chemical	RBSL (mg/L)									
	Slag Fill Area Zone 4				Other Areas					
	SWMU S-18		SWMU S-23		Smokes Creek		Zone 1		Zone 5	
	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	258	--	239	--	210	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	>sol (1,330)	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	--	--	--	--	--
Anthracene	--	>sol (0.043)	--	>sol (0.043)	--	--	--	--	--	--
Benzene	0.64	2.8	0.59	2.6	**0.53**	**2.3**	0.48	18	0.54	2.3
Carbon disulfide	--	--	--	--	--	53	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	0.068	2	--	--
Chlorobenzene	--	46	--	43	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	--	--	--
Fluorene	--	>sol (1.98)	--	>sol (1.98)	--	--	--	--	--	--
Methylene chloride	21	2,625	19	2,406	17	2,098	15	12,978	--	--
Naphthalene	--	17.3	--	15.5	--	13	--	>sol (31)	--	13
Phenanthrene	--	>sol (1.15)	--	>sol (1.15)	--	--	--	--	--	--
Pyridine	--	1.3	--	1.2	--	**1.1**	--	--	--	--
Toluene	--	165	--	153	--	140	--	--	--	--
Trichloroethene	2.0	--	1.9	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	**0.012**	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-6
Tier I Risk Based Screening Levels (RBSLs)
Future Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Standing Water in Pits*

Chemical	RBSL (mg/L)			
	Coke Oven Area			
	SWMU Group PA-1		SWMU P-11	
	C	NC	C	NC
Benzene	0.31	1.3	**0.68**	**2.9**
Ethylbenzene	--	--	--	>sol (169)
Naphthalene	--	0.82	--	1.8
Phenanthrene	--	--	--	>sol (1.2)
Toluene	--	--	--	207
Xylenes, Total	--	--	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-7
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area								Tank Farm Area		Slag Fill Area Zone 2	
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-4		SWMU S-26		SWMU Group TF		SWMU Group SFA-1	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	11,000	--	--
Antimony	--	--	--	--	--	--	--	--	--	128.5	--	--
Arsenic	16	96	--	--	**16.1**	96.4	16.1	96.4	**16**	96	--	--
Benzo(a)anthracene	--	--	**33**	--	--	--	33	--	**33**	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	**3.3**	--	--	--	3.3	--	**3.3**	--	--	--
Benzo(b)fluoranthene	--	--	33	--	--	--	33	--	**33**	--	--	--
Benzo(g,h,i)perylene	--	--	--	9,640	--	--	--	--	--	9,637	--	--
Benzo(k)fluoranthene	--	--	330	--	--	--	--	--	330	--	--	--
Chromium[a]	--	--	>1,000,000	964	>1,000,000	964	>1,000,000	**963**	>1,000,000	963	--	--
Chrysene	--	--	--	--	--	--	--	--	3,300	--	3,300	--
Dibenz(a,h)anthracene	--	--	3.3	--	--	--	3.3	--	**3.3**	--	**3.3**	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	33	--	--	--	33	--	**33**	--	**33**	--
Lead	--	--	--	--	--	--	--	--	--	1,545	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	6,470	--	6,910
Thallium	--	--	--	--	--	--	--	--	--	26	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-7
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	128	--	--	--	128
Arsenic	**16**	96	**16**	96	**16**	96	**16**	96	**16**	96.4	--	--
Benzo(a)anthracene	33	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	**3.3**	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium[a]	--	--	--	--	>1,000,000	963	>1,000,000	963	>1,000,000	6,424	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	**1,545**	--	**1,545**	--	**1,545**	--	--	--	1,545
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	26	--	257	--	26	--	--	--	257	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-7
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4						Other Areas					
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-19		SWMU P-63		SWMU P-73	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	129	--	--	--	128	--	--	--	--	--	--
Arsenic	--	--	16.1	96.4	**16.1**	96	**16**	96	**16.1**	96.4	**16**	96
Benzo(a)anthracene	--	--	33	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	**3.3**	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	33	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	9,637	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium[a]	--	--	>1,000,000	6,425	>1,000,000	963	--	--	>1,000,000	964	>1,000,000	964
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	33	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	**1,545**	--	--	--	1,545	--	--
Mercury	--	--	--	96	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	9,230	--	--	--	--	--	--	--	--
Thallium	--	--	--	257	--	26	--	--	--	--	--	26
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-8
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Direct Contact With Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area										Tank Farm Area	
	SWMU Group PA-1		SWMU Group PA-3		SWMU Group PA-4		SWMU P-18		SWMU S-26		SWMU Group TF	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	16,100
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	11,000
Anthracene	--	--	--	95,114	--	--	--	--	--	--	--	76,300
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	16	96	16	96	--	--	**16**	96	16.1	96.4	**16**	96
Benzo(a)anthracene	33	--	**33**	--	--	--	33	--	33	--	**33**	--
Benzene	--	--	--	--	**146**	**126**	--	--	--	--	25	17
Benzo(a)pyrene	**3.3**	--	**3.3**	--	--	--	**3.3**	--	3.3	--	**3.3**	--
Benzo(b)fluoranthene	33	--	**33**	--	--	--	33	--	33	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	330	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	--	--	--	--	--	--	>1,000,000	**963**	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	3,300	--
Dibenz(a,h)anthracene	3.3	--	--	--	--	--	3.3	--	3.3	--	--	--
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	8,680
Indeno(1,2,3-c,d)pyrene	33	--	33	--	--	--	33	--	33	--	--	--
Lead	--	--	--	--	--	--	--	**1,545**	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	**524**	--	--	--	--	--	**67**
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	6,470
Thallium	--	26	--	26	--	--	--	257	--	--	--	26
Toluene	--	--	--	--	--	8,420	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	134,600	--	--	--	--	--	--

Table 5-8
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Direct Contact With Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-3		SWMU S-24		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	18	19,300	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	12,000	--	14,951	--	--	--	--	--	--	--	17,161
Anthracene	--	--	--	--	--	--	--	90,831	--	--	--	92,383
Antimony	--	--	--	129	--	--	--	--	--	--	--	--
Arsenic	**16**	96	**16**	96	16	96	**16**	96	16.1	96.4	16	96
Benzo(a)anthracene	33	--	**33**	--	--	--	**33**	--	33	--	33	--
Benzene	30	21	**59**	**43**	--	--	**90**	**42**	--	--	117	94
Benzo(a)pyrene	3.3	--	**3.3**	--	3.3	--	**3.3**	--	3.3	--	**3.3**	--
Benzo(b)fluoranthene	33	--	33	--	--	--	**33**	--	33	--	33	--
Benzo(g,h,i)perylene	--	9,637	--	9,637	--	--	--	--	--	--	--	9,637
Benzo(k)fluoranthene	--	--	--	--	--	--	330	--	--	--	330	--
Chromium [a]	--	--	--	--	--	--	--	--	>1,000,000	6,424	--	--
Chrysene	--	--	--	--	--	--	3,300	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	3.3	--	--	--	**3.3**	--	--	--	**3.3**	--
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	10,840	--	--	--	11,562	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	33	--	--	--	**33**	--	33	--	33	--
Lead	--	1,545	--	1,545	--	**1,545**	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	**83**	--	**171**	--	--	--	**279**	--	--	--	**387**
Phenanthrene	--	6,910	--	8,110	--	--	--	--	--	--	--	8,922
Thallium	--	26	--	--	--	257	--	--	--	257	--	--
Toluene	--	--	--	2,850	--	--	--	**4,607**	--	--	--	--
Trichloroethene	--	--	285	1,930	--	--	--	--	--	--	--	--
Xylenes, Total	--	--	--	48,500	--	--	--	76,722	--	--	--	--

Table 5-8
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Direct Contact With Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4								Other Areas			
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-23		SWMU S-19		SWMU S-25	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	16,700	--	--	--	--
Anthracene	--	--	--	--	--	93,921	--	91,000	--	--	--	--
Antimony	--	129	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	16.1	96.4	16	96	16	96	16	96	--	--
Benzo(a)anthracene	--	--	33	--	33	--	33	--	33	--	--	--
Benzene	--	--	--	--	--	--	99	77	--	--	--	--
Benzo(a)pyrene	--	--	3.3	--	3.3	--	3.3	--	3.3	--	3.3	--
Benzo(b)fluoranthene	--	--	33	--	--	--	33	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	9,637	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	330	--	--	--	--	--
Chromium [a]	--	--	>1,000,000	964	>1,000,000	963	--	--	>1,000,000	964	>1,000,000	6,400
Chrysene	--	--	--	--	--	--	3,300	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	--	--	--	--	--	--	--	11,700	--	--	--	--
Fluorene	--	--	--	--	--	--	--	11,700	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	33	--	--	--	33	--	--	--	--	--
Lead	--	--	--	--	--	1,545	--	--	--	--	--	--
Mercury	--	--	--	28	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	315	--	--	--	--
Phenanthrene	--	--	--	9,230	--	--	--	8,760	--	--	--	--
Thallium	--	--	--	26	--	26	--	26	--	--	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-8
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Direct Contact With Subsurface SWMU Material*

Chemical	RBSL (mg/kg)			
	Other Areas			
	SWMU P-63		SWMU P-73	
	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--
2-Methylphenol	--	--	--	--
Acenaphthylene	--	--	--	--
Anthracene	--	--	--	--
Antimony	--	--	--	--
Arsenic	**16.1**	96.4	**16**	96
Benzo(a)anthracene	--	--	33	--
Benzene	--	--	--	--
Benzo(a)pyrene	--	--	**3.3**	--
Benzo(b)fluoranthene	--	--	33	--
Benzo(g,h,I)perylene	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--
Chromium [a]	--	--	--	--
Chrysene	--	--	--	--
Dibenz(a,h)anthracene	--	--	3.3	--
Fluoranthene	--	--	--	--
Fluorene	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	33	--
Lead	--	--	--	--
Mercury	--	--	--	--
Naphthalene	--	--	--	--
Phenanthrene	--	--	--	--
Thallium	--	--	--	--
Toluene	--	--	--	--
Trichloroethene	--	--	--	--
Xylenes, Total	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-9
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Groundwater†

Chemical	RBSL (mg/L)											
	Coke Oven Area											
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-3		SWMU Group PA-4		SWMU P-18		SWMU S-26	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
2,4- Dimethylphenol	--	9.8	--	9.8	--	9.8	--	9.8	--	9.8	--	9.8
2-Methylphenol	--	36	--	36	--	36	--	36	--	36	--	36
3-Methylphenol and 4-Methylphenol	--	3.6	--	3.6	--	3.6	--	3.6	--	3.6	--	3.6
4-Methylphenol	--	3.6	--	3.6	--	3.6	--	3.6	--	3.6	--	3.6
Acenaphthene	--	1.7	--	1.7	--	1.7	--	1.7	--	1.7	--	1.7
Acenaphthylene	--	5.0	--	4.6	--	4.6	--	4.6	--	4.6	--	5.0
Anthracene	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)
Antimony	--	2.6	--	2.6	--	2.6	--	2.6	--	2.6	--	2.6
Arsenic	0.19	1.1	0.19	1.1	0.19	1.1	0.19	1.1	0.19	1.1	0.19	1.1
Barium	--	1,252	--	1,252	--	1,252	--	1,252	--	1,252	--	1,252
Benzo(a)anthracene	259	--	259	--	259	--	259	--	259	--	259	--
Benzene	45	1.0	46.1	1.0	46	1.0	45	1.0	42	1.0	45	1.0
Benzo(a)pyrene	77	--	77	--	77	--	77	--	77	--	77	--
Benzo(b)fluoranthene	638	--	638	--	638	--	638	--	638	--	638	--
Benzo(k)fluoranthene	7,951	--	7,951	--	7,951	--	7,951	--	7,951	--	7,951	--
bis(2-Ethylhexyl)phthalate	0.020	0.073	0.020	0.073	0.020	0.073	0.020	0.073	0.020	0.073	0.020	0.073
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	22	--	22	--	22	--	22	--	22	--	22
Chrysene	46,429	--	46,429	--	46,429	--	46,429	--	46,429	--	46,429	--
Cresols, Total	--	--	--	--	--	--	--	--	--	--	--	--
Cyanide	--	167	--	167	--	167	--	167	--	167	--	167
Dibenz(a,h)anthracene	221	--	221	--	221	--	221	--	221	--	221	--
Ethylbenzene	--	9.7	--	10	--	9.7	--	9.7	--	9.7	--	10
Fluoranthene	--	>sol (0.26)	--	>sol (0.26)	--	>sol (0.26)	--	>sol (0.26)	--	>sol (0.26)	--	>sol (0.26)
Fluorene	--	1.2	--	1.2	--	1.2	--	1.2	--	1.2	--	1.0
Indeno(1,2,3-c,d)pyrene	1,665	--	1,665	--	1,665	--	1,665	--	1,665	--	1,665	--
Lead	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Manganese	--	113	--	113	--	113	--	113	--	113	--	113
Mercury	--	74	--	74	--	74	--	74	--	74	--	74
Methylene Chloride	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	2.1	--	2.1	--	2.1	--	2.1	--	2.1	--	2.1
Nickel	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	0.80	--	0.80	--	0.80	--	0.80	--	0.80	--	1.0
Phenol	--	782	--	782	--	782	--	782	--	782	--	782
Phenols	--	--	--	--	--	--	--	--	--	--	--	--
Pyrene	--	>sol (0.14)	--	>sol (0.14)	--	>sol (0.14)	--	>sol (0.14)	--	>sol (0.14)	--	>sol (0.14)
Pyridine	--	4.0	--	4.0	--	4.0	--	4.0	--	4.0	--	4.0
Selenium	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	32	--	32	--	32	--	32	--	32	--	32
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	152	--	152	--	152	--	152	--	152	--	152
Zinc	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-9
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Groundwater†

Chemical	RBSL (mg/L)											
	Tank Farm Area		Slag Fill Area Zone 2									
	SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	81	--	>sol (5,060)
1,2-Dichloroethane	--	--	302	514	500	849	576	978	83	38	2,038	3,462
1,2-Dichloroethene (total)	--	--	--	1,060	--	1,920	--	2,025	--	0.88	--	>sol (4,900)
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
2,4- Dimethylphenol	--	9.8	--	--	--	--	--	--	--	9.80	--	--
2-Methylphenol	--	36	--	--	--	--	--	--	--	36	--	--
3-Methylphenol and 4-Methylphenol	--	3.6	--	--	--	--	--	--	--	3.6	--	--
4-Methylphenol	--	--	--	--	--	--	--	--	--	3.6	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	4.6	--	>sol (16.1)
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	0.19	1.1	--	--
Arsenic	0.19	1.1	--	--	--	--	--	--	0.19	1.1	--	--
Barium	--	--	--	--	--	--	--	--	--	1,252	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	38	1.0	318	209	578	380	606	398	43	1.0	>sol (1,750)	1,560
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	--	--	--	--	--	--	--	0.020	0.073	--	--
Cadmium	--	--	--	--	--	--	--	--	--	10	--	--
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	74	3.9	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	22	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Cresols, Total	--	--	--	--	--	--	--	--	--	0.024	--	--
Cyanide	--	167	--	--	--	--	--	--	--	167	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	9.7	--	>sol (169)
Fluoranthene	--	--	--	--	--	--	--	--	--	>sol (0.26)	--	--
Fluorene	--	--	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	1.2	--	>sol (2.0)
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	NE	NE	--	--
Manganese	--	--	--	--	--	--	--	--	--	113	--	--
Mercury	--	--	--	--	--	--	--	--	--	74	--	--
Methylene Chloride	--	--	9,260	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	1,406	96	--	>sol (13,000)
Naphthalene	--	2.1	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	2.1	--	>sol (31)
Nickel	--	--	--	--	--	--	--	--	--	438	--	--
Phenanthrene	--	--	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)	--	0.80	--	>sol (1.15)
Phenol	--	782	--	--	--	--	--	--	--	782	--	--
Phenols	--	--	--	--	--	--	--	--	--	782	--	--
Pyrene	--	--	--	--	--	--	--	--	--	>sol (0.14)	--	--
Pyridine	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	40	--	--	--	--	--	--	--	40	--	--
Silver	--	--	--	--	--	--	--	--	--	59	--	--
Thallium	--	--	--	--	--	--	--	--	--	3.7	--	--
Toluene	--	32	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	32	--	>sol (526)
Trichloroethene	--	--	1,050	--	>sol (1,100)	--	>sol (1,100)	--	259	2.7	>sol (1,100)	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	152	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	152	--	>sol (175)
Zinc	--	--	--	--	--	--	--	--	--	6.3	--	--

Table 5-9
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Groundwater†

Chemical	RBSL (mg/L)											
	Slag Fill Area Zone 2		Slag Fill Area Zone 3		Slag Fill Area Zone 4							
	SWMU S-24		SWMU S-10		SWMU S-14		SWMU S-15		SWMU S-16		SWMU S-17	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	81	--	--	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)
1,2-Dichloroethane	95	39	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	0.88	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
2,4- Dimethylphenol	--	9.8	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	36	--	36	--	--	--	--	--	--	--	--
3-Methylphenol and 4-Methylphenol	--	3.6	--	3.6	--	--	--	--	--	--	--	--
4-Methylphenol	--	3.6	--	3.6	--	--	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	4.6	--	4.6	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	--	--	--	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)
Antimony	--	2.6	--	--	--	--	--	--	--	--	--	--
Arsenic	0.19	1.1	--	--	--	--	--	--	--	--	--	--
Barium	--	1,252	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	44	1.0	43	1.0	>sol (1,750)	1,469	>sol (1,750)	1,360	>sol (1,750)	1,298	>sol (1,750)	>sol (1,750)
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	0.020	0.073	0.020	0.073	--	--	--	--	--	--	--	--
Cadmium	--	10	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	>sol (472)	--	>sol (472)	--	>sol (472)	--	>sol (472)
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	22	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Cresols, Total	--	0.024	--	--	--	--	--	--	--	--	--	--
Cyanide	--	167	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	9.7	--	9.7	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluoranthene	--	>sol (0.26)	--	>sol (0.26)	--	--	--	--	--	--	--	--
Fluorene	--	1.2	--	1.2	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	NE	NE	--	--	--	--	--	--	--	--	--	--
Manganese	--	113	--	--	--	--	--	--	--	--	--	--
Mercury	--	74	--	--	--	--	--	--	--	--	--	--
Methylene Chloride	1,491	96	--	--	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)
Naphthalene	--	2.1	--	2.1	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Nickel	--	438	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	0.80	--	0.80	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)	--	>sol (1.15)
Phenol	--	782	--	782	--	--	--	--	--	--	--	--
Phenols	--	782	--	--	--	--	--	--	--	--	--	--
Pyrene	--	>sol (0.24)	--	--	--	--	--	--	--	--	--	--
Pyridine			--	--	--	>sol (300)	--	>sol (300)	--	>sol (300)	--	>sol (300)
Selenium	--	40	--	--	--	--	--	--	--	--	--	--
Silver	--	59	--	--	--	--	--	--	--	--	--	--
Thallium	--	3.7	--	--	--	--	--	--	--	--	--	--
Toluene	--	320	--	32	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)
Trichloroethene	277	2.7	--	--	>sol (1,100)	--	>sol (1,100)	--	>sol (1,100)	--	>sol (1,100)	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	152	--	152	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)
Zinc	--	6.3	--	--	--	--	--	--	--	--	--	--

Table 5-9
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Groundwater†

Chemical	RBSL (mg/L)									
	Slag Fill Area Zone 4				Other Areas					
	SWMU S-18		SWMU S-23		Smokes Creek		Zone 1		Zone 5	
	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	116	--	--
2,4- Dimethylphenol	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--
3-Methylphenol and 4-Methylphenol	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	--	--	--	--	--
Anthracene	--	>sol (0.043)	--	>sol (0.043)	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--
Benzene	>sol (1,750)	>sol (1,750)	1,251	822	190	120	28	79	163	536
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	--	--	--	--	--	>sol (1,190)	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	0.21	--	--
Chlorobenzene	--	>sol (472)	--	>sol (472)	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--
Cresols, Total	--	--	--	--	--	--	--	--	--	--
Cyanide	--	--	--	--	--	--	--	166	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	--	--	--
Fluoranthene	--	--	--	--	--	--	--	--	--	--
Fluorene	--	>sol (2.0)	--	>sol (2.0)	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--
Methylene Chloride	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	5,079	>sol (13,000)	836	95.8	--	--
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	2	--	>sol (31)
Nickel	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	>sol (1.15)	--	>sol (1.15)	--	--	--	--	--	--
Phenol	--	--	--	--	--	--	--	782	--	--
Phenols	--	--	--	--	--	--	--	--	--	--
Pyrene	--	--	--	--	--	--	--	--	--	--
Pyridine	--	>sol (300)	--	>sol (300)	--	63	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	--	--	--
Trichloroethene	>sol (1,100)	--	>sol (1,100)	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	5.0	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	151	--	>sol (175)
Zinc	--	--	--	--	--	--	--	--	--	--

† Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses. See Section 3.0.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-10
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Standing Water in Pits*

Chemical	RBSL (mg/L)			
	Coke Oven Area			
	SWMU Group PA-1		SWMU P-11	
	C	NC	C	NC
2-Methylphenol	--	--	--	36
3-Methylphenol and 4-Methylphenol	--	--	--	3.6
Arsenic	--	--	0.19	1.1
Benzene	4.7	0.79	**9.0**	**0.90**
Chrysene	46,429	--	--	--
Ethylbenzene	--	--	--	9.7
Mercury	--	--	--	74
Naphthalene	--	1.0	--	**1.4**
Phenanthrene	--	--	--	0.80
Phenol	--	--	--	782.0
Pyridine	--	--	--	4.0
Toluene	--	--	--	77
Xylenes, Total	--	--	--	149

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses. See Section 3.0.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-11
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area								Tank Farm Area		Slag Fill Area Zone 2	
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-4		SWMU S-26		SWMU Group TF		SWMU Group SFA-1	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	50,500	--	--
Antimony	--	--	--	--	--	--	--	--	--	554	--	--
Arsenic	69	416	--	--	69	416	69	416	69	416	--	--
Benzo(a)anthracene	--	--	142	--	--	--	142	--	142	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	14	--	--	--	14.2	--	14	--	--	--
Benzo(b)fluoranthene	--	--	142	--	--	--	142	--	142	--	--	--
Benzo(g,h,i)perylene	--	--	--	41,600	--	--	--	--	--	41,581	--	--
Benzo(k)fluoranthene	--	--	1,420	--	--	--	--	--	1,420	--	--	--
Chromium[a]	--	--	>1,000,000	4,160	>1,000,000	4,160	>1,000,000	4,160	>1,000,000	4,160	--	--
Chrysene	--	--	--	--	--	--	--	--	14,240	--	--	--
Dibenz(a,h)anthracene	--	--	14	--	--	--	14.2	--	14	--	14	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	142	--	--	--	142	--	142	--	142	--
Lead	--	--	--	--	--	--	--	--	--	1,545	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	29,300	--	31,000
Thallium	--	--	--	--	--	--	--	--	--	111	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-11
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	554	--	--	--	1,108
Arsenic	69	416	69	416	69	416	69	416	69.3	416	--	--
Benoz(a)anthracene	142	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	14	--	14	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium[a]	--	--	--	--	>1,000,000	4,158	>1,000,000	4,158	>1,000,000	27,718	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	1,545	--	1,545	--	1,545	--	--	--	1,545
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	111	--	1,109	--	111	--	--	--	1,109	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-11
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4						Other Areas					
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-19		SWMU P-63		SWMU P-73	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	554	--	--	--	554	--	--	--	--	--	--
Arsenic	--	--	69	416	69	416	69	416	69	416	69	416
Benzo(a)anthracene	--	--	142	--	--	--	142	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	14	--	--	--	14	--	--	--	--	--
Benzo(b)fluoranthene	--	--	142	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	41,581	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium[a]	--	--	>1,000,000	27,720	>1,000,000	4,160	>1,000,000	4,160	>1,000,000	4,160	>1,000,000	4,160
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	142	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	**1,545**	--	--	--	1,545	--	--
Mercury	--	--	--	416	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	40,000	--	--	--	--	--	--	--	--
Thallium	--	--	--	1,109	--	111	--	--	--	--	--	111
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-12
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Direct Contact With Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area										Tank Farm Area	
	SWMU Group PA-1		SWMU Group PA-3		SWMU Group PA-4		SWMU P-18		SWMU S-26		SWMU Group TF	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	69,300
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	50,500
Anthracene	--	--	--	411,113	--	--	--	--	--	--	--	339,000
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	69	420	69	420	--	--	69	420	69	416	69	416
Benzo(a)anthracene	140	--	140	--	--	--	140	--	142	--	142	--
Benzene	--	--	--	--	695	616	--	--	--	--	122	84
Benzo(a)pyrene	14	--	14	--	--	--	14	--	14.2	--	14	--
Benzo(b)fluoranthene	140	--	140	--	--	--	140	--	142	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	1,400	--	--	--	--	--	--	--	--	--
Chromium[a]	--	--	--	--	--	--	--	--	>1,000,000	4,160	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	14,240	--
Dibenz(a,h)anthracene	14	--	--	--	--	--	14	--	14.2	--	--	--
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	39,200
Indeno(1,2,3-c,d)pyrene	140	--	140	--	--	--	142	--	142	--	--	--
Lead	--	--	--	--	--	--	--	1,545	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	2,590	--	--	--	--	--	334
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	29,300
Thallium	--	110	--	110	--	--	--	1,109	--	--	--	111
Toluene	--	--	--	--	--	41,300	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	652,000	--	--	--	--	--	--

Table 5-12
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Direct Contact With Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-3		SWMU S-24		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	88	83,162	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	54,600	--	66,600	--	--	--	--	--	--	--	75,200
Anthracene	--	--	--	--	--	--	--	395,011	--	--	--	401,000
Antimony	--	--	--	554	--	--	--	--	--	--	--	--
Arsenic	69	416	69	416	69	416	69	416	69	416	69	416
Benzo(a)anthracene	142	--	142	--	--	--	142	--	142	--	142	--
Benzene	149	104	287	211	--	--	434	196	--	--	559	464
Benzo(a)pyrene	14	--	14	--	14	--	14.2	--	14.2	--	14.2	--
Benzo(b)fluoranthene	142	--	142	--	--	--	142	--	142	--	142	--
Benzo(g,h,i)perylene	--	41,581	--	41,581	--	--	--	--	--	--	--	41,581
Benzo(k)fluoranthene	--	--	--	--	--	--	1,424	--	--	--	1,420	--
Chromium[a]	--	--	--	--	--	--	--	--	>1,000,000	27,718	--	--
Chrysene	--	--	--	--	--	--	14,240	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	14	--	--	--	14.2	--	--	--	14.2	--
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	47,800	--	--	--	50,578	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	142	--	--	--	142	--	142	--	142	--
Lead	--	1,545	--	1,545	--	1,545	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	414	--	851	--	--	--	1,387	--	--	--	1,920
Phenanthrene	--	31,000	--	35,800	--	--	--	--	--	--	--	38,900
Thallium	--	111	--	--	--	1,109	--	--	--	1,109	--	--
Toluene	--	--	--	14,200	--	--	--	22,773	--	--	--	--
Trichloroethene	--	--	1,394	8,320	--	--	--	--	--	--	--	--
Xylenes, Total	--	--	--	239,000	--	--	--	376,468	--	--	--	--

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Tab: Utility_DC subsurface

Table 5-12
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Direct Contact With Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4								Other Areas			
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-23		SWMU S-19		SWMU S-25	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	73,500	--	--	--	--
Anthracene	--	--	--	--	--	406,647	--	400,000	--	--	--	--
Antimony	--	554	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	69	416	69	416	69	416	69	416	--	--
Benzo(a)anthracene	--	--	142	--	142	--	142	--	142	--	--	--
Benzene	--	--	--	--	--	--	478	381	--	--	--	--
Benzo(a)pyrene	--	--	14	--	14	--	14.2	--	14	--	14	--
Benzo(b)fluoranthene	--	--	142	--	--	--	142	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	41,581	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	1,420	--	--	--	--	--
Chromium[a]	--	--	>1,000,000	4,160	>1,000,000	4,160	--	--	>1,000,000	4,160	>1,000,000	27,700
Chrysene	--	--	--	--	--	--	14,200	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	--	--	--	--	--	--	--	51,000	--	--	--	--
Fluorene	--	--	--	--	--	--	--	51,000	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	142	--	--	--	142	--	--	--	--	--
Lead	--	--	--	--	--	1,545	--	--	--	--	--	--
Mercury	--	--	--	119	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	1,565	--	--	--	--
Phenanthrene	--	--	--	40,000	--	--	--	38,300	--	--	--	--
Thallium	--	--	--	111	--	111	--	111	--	--	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-12
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Direct Contact With Subsurface SWMU Material*

Chemical	RBSL (mg/kg)			
	Other Areas			
	SWMU P-63		SWMU P-73	
	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--
2-Methylphenol	--	--	--	--
Acenaphthylene	--	--	--	--
Anthracene	--	--	--	--
Antimony	--	--	--	--
Arsenic	139	832	69	416
Benzo(a)anthracene	--	--	140	--
Benzene	--	--	--	--
Benzo(a)pyrene	--	--	14	--
Benzo(b)fluoranthene	--	--	140	--
Benzo(g,h,i)perylene	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--
Chromium[a]	--	--	--	--
Chrysene	--	--	--	--
Dibenz(a,h)anthracene	--	--	14	--
Fluoranthene	--	--	--	--
Fluorene	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	140	--
Lead	--	--	--	--
Mercury	--	--	--	--
Naphthalene	--	--	--	--
Phenanthrene	--	--	--	--
Thallium	--	--	--	--
Toluene	--	--	--	--
Trichloroethene	--	--	--	--
Xylenes, Total	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-13
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Groundwater†

Chemical	RBSL (mg/L)											
	Coke Oven Area											
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-3		SWMU Group PA-4		SWMU P-18		SWMU S-26	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	–	–	–	–	–	–	–	–	–	–	–	–
1,2-Dichloroethane	–	–	–	–	–	–	–	–	–	–	–	–
1,2-Dichloroethene (total)	–	–	–	–	–	–	–	–	–	–	–	–
1,1,1-Trichloroethane	–	–	–	–	–	–	–	–	–	–	–	–
2,4-Dimethylphenol	–	108	–	108	–	108	–	108	–	108	–	108
2-Methylphenol	–	393	–	393	–	393	–	393	–	393	–	393
3-Methylphenol and 4-Methylphenol	–	40	–	40	–	40	–	40	–	40	–	40
4-Methylphenol	–	40	–	40	–	40	–	40	–	40	–	40
Acenaphthene	–	>sol (4.2)	–	>sol (4.2)	–	>sol (4.2)	–	>sol (4.2)	–	>sol (4.2)	–	>sol (4.2)
Acenaphthylene	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)
Anthracene	–	>sol (0.043)	–	>sol (0.043)	–	>sol (0.043)	–	>sol (0.043)	–	>sol (0.043)	–	>sol (0.043)
Antimony	–	29	–	29	–	29	–	29	–	29	–	29
Arsenic	2.1	12	2.1	12	2.1	12	2.1	12	2.1	12	2.1	12
Barium	–	13,801	–	13,801	–	13,801	–	13,801	–	13,801	–	13,801
Benzo(a)anthracene	2,851	–	2,851	–	2,851	–	2,851	–	2,851	–	2,851	–
Benzene	102	11	103	11	103	11	102	11	99	11	101	11
Benzo(a)pyrene	848	–	848	–	848	–	848	–	848	–	848	–
Benzo(b)fluoranthene	7,037	–	7,037	–	7,037	–	7,037	–	7,037	–	7,037	–
Benzo(g,h,i)perylene	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(k)fluoranthene	87,634	–	87,634	–	87,634	–	87,634	–	87,634	–	87,634	–
bis(2-Ethylhexyl)phthalate	0.22	>sol (0.27)	0.22	>sol (0.27)	0.22	>sol (0.27)	0.22	>sol (0.27)	0.22	>sol (0.27)	0.22	>sol (0.27)
Cadmium	–	–	–	–	–	–	–	–	–	–	–	–
Carbon disulfide	–	–	–	–	–	–	–	–	–	–	–	–
Carbon tetrachloride	–	–	–	–	–	–	–	–	–	–	–	–
Chlorobenzene	–	–	–	–	–	–	–	–	–	–	–	–
Chloroform	–	–	–	–	–	–	–	–	–	–	–	–
Chromium	–	238	–	238	–	238	–	238	–	238	–	238
Chrysene	511,700	–	511,700	–	511,700	–	511,700	–	511,700	–	511,700	–
Cresols, Total	–	–	–	–	–	–	–	–	–	–	–	–
Cyanide	–	1,835	–	1,835	–	1,835	–	1,835	–	1,835	–	1,835
Dibenz(a,h)anthracene	2,435	–	2,435	–	2,435	–	2,435	–	2,435	–	2,435	–
Ethylbenzene	–	107	–	107	–	107	–	107	–	107	–	107
Fluoranthene	–	>sol (0.26)	–	>sol (0.26)	–	>sol (0.26)	–	>sol (0.26)	–	>sol (0.26)	–	>sol (0.26)
Fluorene	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)
Indeno(1,2,3-c,d)pyrene	18,346	–	18,346	–	18,346	–	18,346	–	18,346	–	18,346	–
Lead	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Manganese	–	1,241	–	1,241	–	1,241	–	1,241	–	1,241	–	1,241
Mercury	–	811	–	811	–	811	–	811	–	811	–	811
Methylene chloride	–	–	–	–	–	–	–	–	–	–	–	–
Naphthalene	–	23	–	23	–	23	–	23	–	23	–	23
Nickel	–	–	–	–	–	–	–	–	–	–	–	–
Phenanthrene	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)
Phenol	–	8,621	–	8,621	–	8,621	–	8,621	–	8,621	–	8,621
Phenols	–	–	–	–	–	–						
Pyrene	–	>sol (0.14)	–	>sol (0.14)	–	>sol (0.14)	–	>sol (0.14)	–	>sol (0.14)	–	>sol (0.14)
Pyridine	–	44	–	44	–	44	–	44	–	44	–	44
Selenium	–	–	–	–	–	–	–	–	–	–	–	–
Silver	–	–	–	–	–	–	–	–	–	–	–	–
Thallium	–	–	–	–	–	–	–	–	–	–	–	–
Toluene	–	353	–	353	–	353	–	353	–	352	–	353
Trichloroethene	–	–	–	–	–	–	–	–	–	–	–	–
Vinyl chloride	–	–	–	–	–	–	–	–	–	–	–	–
Xylenes, Total	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)
Zinc	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)

Table 5-13
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Groundwater†

Chemical	RBSL (mg/L)											
	Tank Farm Area		Slag Fill Area Zone 2									
	SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	–	–	–	>sol (5,060)	–	>sol (5,060)	–	>sol (5,060)	–	887	–	>sol (5,060)
1,2-Dichloroethane	–	–	1,510	2,570	2,500	4,250	2,880	4,892	214	385	>sol (8,520)	>sol (8,520)
1,2-Dichloroethene (total)	–	–	–	>sol (4,900)	–	>sol (4,900)	–	>sol (4,900)	–	10	–	>sol (4,900)
1,1,1-Trichloroethane	–	–	–	–	–	–	–	–	–	–	–	–
2,4-Dimethylphenol	–	108	–	–	–	–	–	108	–	108	–	–
2-Methylphenol	–	393	–	–	–	–	–	–	–	393	–	–
3-Methylphenol and 4-Methylphenol	–	40	–	–	–	–	–	–	–	40	–	–
4-Methylphenol	–	–	–	–	–	–	–	–	–	40	–	–
Acenaphthene	–	–	–	–	–	–	–	–	–	–	–	–
Acenaphthylene	–	–	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)
Anthracene	–	–	–	–	–	–	–	–	–	–	–	–
Antimony	–	–	–	–	–	–	–	–	–	29	–	–
Arsenic	2.1	12	–	–	–	–	–	–	2.1	12	–	–
Barium	–	–	–	–	–	–	–	–	–	13,801	–	–
Benzo(a)anthracene	–	–	–	–	–	–	–	–	–	–	–	–
Benzene	93	11	1,590	1,040	1,590	>sol (1,750)	>sol (1,750)	>sol (1,750)	99	11	>sol (1,750)	>sol (1,750)
Benzo(a)pyrene	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(b)fluoranthene	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(g,h,i)perylene	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(k)fluoranthene	–	–	–	–	–	–	–	–	–	–	–	–
bis(2-Ethylhexyl)phthalate	–	–	–	–	–	–	–	–	0.22	>sol (0.27)	–	–
Cadmium	–	–	–	–	–	–	–	–	–	114	–	–
Carbon disulfide	–	–	–	–	–	–	–	–	–	–	–	–
Carbon tetrachloride	–	–	–	–	–	–	–	–	–	–	–	–
Chlorobenzene	–	–	–	–	–	–	–	–	–	–	–	–
Chloroform	338	26	–	–	–	–	–	–	–	–	–	–
Chromium	–	–	–	–	–	–	–	–	–	238	–	–
Chrysene	–	–	–	–	–	–	–	–	–	–	–	–
Cresols, Total	–	–	–	–	–	–	–	–	–	>sol (0.087)	–	–
Cyanide	–	1,835	–	–	–	–	–	–	–	1,835	–	–
Dibenz(a,h)anthracene	–	–	–	–	–	–	–	–	–	–	–	–
Ethylbenzene	–	–	–	>sol (169)	–	>sol (169)	–	>sol (169)	–	107	–	>sol (169)
Fluoranthene	–	–	–	–	–	–	–	–	–	>sol (0.26)	–	–
Fluorene	–	–	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)
Indeno(1,2,3-c,d)pyrene	–	–	–	–	–	–	–	–	–	–	–	–
Lead	–	–	–	–	–	–	–	–	NE	NE	–	–
Manganese	–	–	–	–	–	–	–	–	–	1,241	–	–
Mercury	–	–	–	–	–	–	–	–	–	811	–	–
Methylene chloride	–	–	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	3,327	1,058	>sol (13,000)	>sol (13,000)
Naphthalene	–	23	–	>sol (31)	–	>sol (31)	–	>sol (31)	–	23	–	>sol (31)
Nickel	–	–	–	–	–	–	–	–	–	4,830	–	–
Phenanthrene	–	–	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)
Phenol	–	8,621	–	–	–	–	–	–	–	8,621	–	–
Phenols	–	–	–	–	–	–	–	–	–	8,621	–	–
Pyrene	–	–	–	–	–	–	–	–	–	>sol (0.14)	–	–
Pyridine	–	–	–	–	–	–	–	–	–	–	–	–
Selenium	–	440	–	–	–	–	–	–	–	440	–	–
Silver	–	–	–	–	–	–	–	–	–	652	–	–
Thallium	–	–	–	–	–	–	–	–	–	40	–	–
Toluene	–	350	–	>sol (526)	–	>sol (526)	–	>sol (526)	–	352	–	>sol (526)
Trichloroethene	–	–	>sol (1,100)	–	>sol (1,100)	–	>sol (1,100)	–	626	30	>sol (1,100)	–
Vinyl chloride	–	–	–	–	–	–	–	–	–	–	–	–
Xylenes, Total	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	–
Zinc	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	70	–	>sol (175)

Table 5-13
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Groundwater†

Chemical	RBSL (mg/L)											
	Slag Fill Area Zone 2		Slag Fill Area Zone 3		Slag Fill Area Zone 4							
	SWMU S-24		SWMU S-10		SWMU S-14		SWMU S-15		SWMU S-16		SWMU S-17	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	–	>sol (5,060)	–	–	–	>sol (5,060)	–	>sol (5,060)	–	>sol (5,060)	–	>sol (5,060)
1,2-Dichloroethane	3,138	5,330	–	–	–	–	–	–	–	–	–	–
1,2-Dichloroethene (total)	–	>sol (4,900)	–	–	–	–	–	–	–	–	–	–
1,1,1-Trichloroethane	–	–	–	–	–	–	–	–	–	–	–	–
2,4-Dimethylphenol	–	–	–	–	–	–	–	–	–	–	–	–
2-Methylphenol	–	–	–	393	–	–	–	–	–	–	–	–
3-Methylphenol and 4-Methylphenol	–	–	–	40	–	–	–	–	–	–	–	–
4-Methylphenol	–	–	–	40	–	–	–	–	–	–	–	–
Acenaphthene	–	–	–	–	–	–	–	–	–	–	–	–
Acenaphthylene	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)	–	>sol (16.1)
Anthracene	–	–	–	–	–	>sol (0.043)	–	>sol (0.043)	–	>sol (0.043)	–	>sol (0.043)
Antimony	–	–	–	–	–	–	–	–	–	–	–	–
Arsenic	–	–	–	–	–	–	–	–	–	–	–	–
Barium	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(a)anthracene	–	–	–	–	–	–	–	–	–	–	–	–
Benzene	>sol (1,750)	>sol (1,750)	99	11	–	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)
Benzo(a)pyrene	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(b)fluoranthene	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(g,h,i)perylene	–	–	–	–	–	–	–	–	–	–	–	–
Benzo(k)fluoranthene	–	–	–	–	–	–	–	–	–	–	–	–
bis(2-Ethylhexyl)phthalate	–	–	0.22	>sol (0.27)	–	–	–	–	–	–	–	–
Cadmium	–	–	–	–	–	–	–	–	–	–	–	–
Carbon disulfide	–	–	–	–	–	–	–	–	–	–	–	–
Carbon tetrachloride	–	–	–	–	–	–	–	–	–	–	–	–
Chlorobenzene	–	–	–	–	–	>sol (472)	–	>sol (472)	–	>sol (472)	–	>sol (472)
Chloroform	–	–	–	–	–	–	–	–	–	–	–	–
Chromium	–	–	–	–	–	–	–	–	–	–	–	–
Chrysene	–	–	–	–	–	–	–	–	–	–	–	–
Cresols, Total	–	–	–	–	–	–	–	–	–	–	–	–
Cyanide	–	–	–	–	–	–	–	–	–	–	–	–
Dibenz(a,h)anthracene	–	–	–	–	–	–	–	–	–	–	–	–
Ethylbenzene	–	>sol (169)	–	107	–	>sol (169)	–	>sol (169)	–	>sol (169)	–	>sol (169)
Fluoranthene	–	–	–	>sol (0.26)	–	–	–	–	–	–	–	–
Fluorene	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)	–	>sol (2.0)
Indeno(1,2,3-c,d)pyrene	–	–	–	–	–	–	–	–	–	–	–	–
Lead	–	–	–	–	–	–	–	–	–	–	–	–
Manganese	–	–	–	–	–	–	–	–	–	–	–	–
Mercury	–	–	–	–	–	–	–	–	–	–	–	–
Methylene chloride	>sol (13,000)	>sol (13,000)	–	–	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)
Naphthalene	–	>sol (31)	–	23	–	>sol (31)	–	>sol (31)	–	>sol (31)	–	>sol (31)
Nickel	–	–	–	–	–	–	–	–	–	–	–	–
Phenanthrene	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)	–	>sol (1.2)
Phenol	–	–	–	8,621	–	–	–	–	–	–	–	–
Phenols	–	–	–	–	–	–	–	–	–	–	–	–
Pyrene	–	–	–	–	–	–	–	–	–	–	–	–
Pyridine	–	–	–	–	–	>sol (300)	–	>sol (300)	–	>sol (300)	–	>sol (300)
Selenium	–	–	–	–	–	–	–	–	–	–	–	–
Silver	–	–	–	–	–	–	–	–	–	–	–	–
Thallium	–	–	–	–	–	–	–	–	–	–	–	–
Toluene	–	>sol (526)	–	352	–	>sol (526)	–	>sol (526)	–	>sol (526)	–	>sol (526)
Trichloroethene	>sol (1,100)	–	–	–	>sol (1,100)	–	>sol (1,100)	–	>sol (1,100)	–	>sol (1,100)	–
Vinyl chloride	–	–	–	–	–	–	–	–	–	–	–	–
Xylenes, Total	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)
Zinc	–	–	–	–	–	–	–	–	–	–	–	–

Table 5-13
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact with Groundwater†

Chemical	RBSL (mg/L)									
	Slag Fill Area Zone 4				Other Areas					
	SWMU S-18		SWMU S-23		Smokes Creek		Zone 1		Zone 5	
	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	–	>sol (5,060)	–	>sol (5,060)	–	>sol (5,060)	–	–	–	–
1,2-Dichloroethane	–	–	–	–	–	–	–	–	–	–
1,2-Dichloroethene (total)	–	–	–	–	–	–	–	–	–	–
1,1,1-Trichloroethane	–	–	–	–	–	–	–	1,262	–	–
2,4-Dimethylphenol	–	–	–	–	–	–	–	–	–	–
2-Methylphenol	–	–	–	–	–	–	–	–	–	–
3-Methylphenol and 4-Methylphenol	–	–	–	–	–	–	–	–	–	–
4-Methylphenol	–	–	–	–	–	–	–	–	–	–
Acenaphthene	–	–	–	–	–	–	–	–	–	–
Acenaphthylene	–	>sol (16.1)	–	>sol (16.1)	–	–	–	–	–	–
Anthracene	–	>sol (0.043)	–	>sol (0.043)	–	–	–	–	–	–
Antimony	–	–	–	–	–	–	–	–	–	–
Arsenic	–	–	–	–	–	–	–	–	–	–
Barium	–	–	–	–	–	–	–	–	–	–
Benzo(a)anthracene	–	–	–	–	–	–	–	–	–	–
Benzene	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	930	610	80	11	>sol (1,750)	>sol (1,750)
Benzo(a)pyrene	–	–	–	–	–	–	–	–	–	–
Benzo(b)fluoranthene	–	–	–	–	–	–	–	–	–	–
Benzo(g,h,i)perylene	–	–	–	–	–	–	–	–	–	–
Benzo(k)fluoranthene	–	–	–	–	–	–	–	–	–	–
bis(2-Ethylhexyl)phthalate	–	–	–	–	–	–	–	–	–	–
Cadmium	–	–	–	–	–	–	–	–	–	–
Carbon disulfide	–	–	–	–	–	>sol (1,190)	–	–	–	–
Carbon tetrachloride	–	–	–	–	–	–	–	2.2	–	–
Chlorobenzene	–	>sol (472)	–	>sol (472)	–	–	–	–	–	–
Chloroform	–	–	–	–	–	–	–	–	–	–
Chromium	–	–	–	–	–	–	–	–	–	–
Chrysene	–	–	–	–	–	–	–	–	–	–
Cresols, Total	–	–	–	–	–	–	–	–	–	–
Cyanide	–	–	–	–	–	–	–	1,835	–	–
Dibenz(a,h)anthracene	–	–	–	–	–	–	–	–	–	–
Ethylbenzene	–	>sol (169)	–	>sol (169)	–	>sol (169)	–	–	–	–
Fluoranthene	–	–	–	–	–	–	–	–	–	–
Fluorene	–	>sol (2.0)	–	>sol (2.0)	–	–	–	–	–	–
Indeno(1,2,3-c,d)pyrene	–	–	–	–	–	–	–	–	–	–
Lead	–	–	–	–	–	–	–	–	–	–
Manganese	–	–	–	–	–	–	–	–	–	–
Mercury	–	–	–	–	–	–	–	–	–	–
Methylene chloride	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	2,515	1,053	–	–
Naphthalene	–	>sol (31)	–	>sol (31)	–	>sol (31)	–	22	–	>sol (31)
Nickel	–	–	–	–	–	–	–	–	–	–
Phenanthrene	–	>sol (1.2)	–	>sol (1.2)	–	–	–	–	–	–
Phenol	–	–	–	–	–	–	–	8,621	–	–
Phenols	–	–	–	–	–	–	–	–	–	–
Pyrene	–	–	–	–	–	–	–	–	–	–
Pyridine	–	>sol (300)	–	>sol (300)	–	>sol (300)	–	–	–	–
Selenium	–	–	–	–	–	–	–	–	–	–
Silver	–	–	–	–	–	–	–	–	–	–
Thallium	–	–	–	–	–	–	–	–	–	–
Toluene	–	>sol (526)	–	>sol (526)	–	>sol (526)	–	–	–	–
Trichloroethene	>sol (1,100)	–	>sol (1,100)	–	–	–	–	–	–	–
Vinyl chloride	–	–	–	–	23	–	–	–	–	–
Xylenes, Total	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)	–	>sol (175)
Zinc	–	–	–	–	–	–	–	–	–	–

† Bolded values indicate RBSLs that are exceeded by representative concentrations.
– The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.
NE Not examined

Table 5-14
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Inhalation of Ambient Vapors from and Dermal Contact With Standing Water in Pits*

Chemical	RBSL (mg/L)			
	Coke Oven Area			
	SWMU Group PA-1		SWMU P-11	
	C	NC	C	NC
2-Methylphenol	--	108.0	--	393
3-Methylphenol and 4-Methylphenol	--	40	--	40
Arsenic	2	12	2.1	12
Benzene	21	6.8	**37**	**9.0**
Chrysene	511,700	--	--	--
Cyanide	--	1,835	--	--
2,4-Dimethylphenol	--	108.0	--	--
Ethylbenzene	--	--	--	106
Mercury	--	--	--	811
Naphthalene	--	7.2	--	11
Phenanthrene	--	--	--	>sol (1.2)
Phenol	--	8,621	--	8,621
Pyridine	--	--	--	44
Selenium	--	440	--	--
Toluene	--	--	--	>sol (526)
Xylenes, Total	--	--	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-15
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area								Tank Farm Area		Slag Fill Area Zone 2	
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-4		SWMU S-26		SWMU Group TF		SWMU Group SFA-1	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	847,360	--	875,504
Antimony	--	--	--	--	--	--	--	--	--	6,770	--	6,780
Arsenic	212	5,080	--	--	212	5,080	212	5,080	212	5,080	212	5,080
Benzo(a)anthracene	--	--	435	--	--	--	435	--	435	--	**435**	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	44	--	--	--	43.5	--	**44**	--	**44**	--
Benzo(b)fluoranthene	--	--	435	--	--	--	435	--	**435**	--	**435**	--
Benzo(g,h,i)perylene	--	--	--	508,000	--	--	--	--	--	507,800	--	507,800
Benzo(k)fluoranthene	--	--	4,350	--	--	--	--	--	4,350	--	4,350	--
Chromium[a]	--	--	>1,000,000	50,800	>1,000,000	50,800	>1,000,000	50,800	>1,000,000	50,800	>1,000,000	50,779
Chrysene	--	--	--	--	--	--	--	--	43,476	--	43,476	--
Dibenz(a,h)anthracene	--	--	44	--	--	--	43.5	--	**44**	--	44	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	435	--	--	--	435	--	435	--	435	--
Lead	--	--	--	--	--	--	--	--	--	1,545	--	**1,545**
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	449,683	--	459,897
Thallium	--	--	--	--	--	--	--	--	--	1,350	--	1,354
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-15
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	6,771	--	--	--	6,771
Arsenic	212	5,080	212	5,080	212	5,080	212	5,080	212	5,078	--	--
Benzo(a)anthracene	435	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	44	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium[a]	--	--	--	--	>1,000,000	50,800	>1,000,000	50,800	>1,000,000	50,780	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	1,545	--	1,545	--	1,545	--	--	--	1,545
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	1,354	--	1,354	--	1,354	--	--	--	1,354	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-15
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Direct Contact With Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4						Other Areas					
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-19		SWMU P-63		SWMU P-73	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	6,770	--	--	--	6,770	--	--	--	--	--	--
Arsenic	--	--	212	5,080	212	5,080	212	5,100	212	5,080	212	5,100
Benzo(a)anthracene	--	--	435	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	44	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	435	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	507,800	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium[a]	--	--	>1,000,000	50,800	>1,000,000	50,800	--	--	>1,000,000	50,800	>1,000,000	50,800
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	435	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	1,545	--	--	--	1,545	--	--
Mercury	--	--	--	5,080	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	502,000	--	--	--	--	--	--	--	--
Thallium	--	--	--	1,350	--	1,360	--	--	--	--	--	1,350
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-16
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area				Tank Farm Area		Slag Fill Area Zone 2					
	SWMU Group PA-3		SWMU Group PA-4		SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-24	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	1,450	--	--	--
Acenaphthylene	--	--	--	--	--	>sat (1,115)	--	>1,000,000	--	>sat (1,115)	--	--
Anthracene	--	>1,000,000	--	--	--	>sat (10.2)	--	--	--	--	--	>1,000,000
Benzene	--	--	>sat (1,260)	>sat (1,260)	862	>sat (1,260)	319	839	**1,050**	>sat (1,260)	>sat (1,260)	>sat (1,260)
Fluorene	--	--	--	--	--	>sat (153)	--	--	--	>sat (153)	--	>1,000,000
Naphthalene	--	--	--	>sat (371)	--	>sat (371)	--	79,400	--	>sat (371)	--	>sat (371)
Phenanthrene	--	--	--	--	--	>sat (163)	--	>1,000,000	--	>sat (163)	--	--
Toluene	--	--	--	>1,000,000	--	--	--	--	--	>sat (795)	--	>sat (795)
Trichloroethene	--	--	--	--	--	--	--	--	5,060	--	--	--
Xylenes, Total	--	--	--	>1,000,000	--	--	--	--	--	>sat (694)	--	>1,000,000

Table 5-16
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)					
	Slag Fill Area Zone 4					
	SWMU S-14		SWMU S-18		SWMU S-23	
	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Acenaphthylene	--	>1,000,000	--	--	--	>1,000,000
Anthracene	--	>1,000,000	--	>sat (10)	--	>1,000,000
Benzene	984	>sat (1,260)	--	--	>sat (1,260)	>sat (1,260)
Fluorene	--	--	--	--	--	>1,000,000
Naphthalene	--	>sat (371)	--	--	--	>sat (371)
Phenanthrene	--	>1,000,000	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
> sat The RBSL exceeds the saturation limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-17
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Coke Oven Area											
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-3		SWMU Group PA-4		SWMU P-18		SWMU S-26	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	>sol (5,060)	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	>sol (8,520)	>sol (8,520)	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	>sol (4,900)	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	>sol (4.24)	--	--	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)	--	>sol (4.24)
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	>sol (0.043)	--	--	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)
Benzene	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Methylene chloride	--	--	>sol (13,000)	>sol (13,000)	--	--	--	--	--	--	--	--
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Phenanthrene	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)
Pyridine	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)
Trichloroethene	--	--	>sol (1,100)	--	--	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-17
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Tank Farm Area		Slag Fill Area Zone 2									
	SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)
1,2-Dichloroethane	--	--	>sol (8,520)	>sol (8,520)	7,530	>sol (8,520)	>sol (8,520)	>sol (8,520)	7,874	>sol (8,520)	>sol (8,520)	>sol (8,520)
1,2-Dichloroethene (total)	--	--	--	>sol (4,900)	--	>sol (4,900)	--	>sol (4,900)	--	>sol (4,900)	--	>sol (4,900)
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--.	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	1,990	740	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	--	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Methylene chloride	--	--	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Phenanthrene	--	--	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)
Pyridine	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)
Trichloroethene	--	--	>sol (1,100)	--	>sol (1,100)	--	>sol (1,100)	--	>sol (1,100)	--	>sol (1,100)	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-17
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)											
	Slag Fill Area Zone 2		Slag Fill Area Zone 3		Slag Fill Area Zone 4							
	SWMU S-24		SWMU S-10		SWMU S-14		SWMU S-15		SWMU S-16		SWMU S-17	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	>sol (5,060)	--	--	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)
1,2-Dichloroethane	37	418	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	1,069	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)	--	>sol (16.1)
Anthracene	--	--	--	--	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)	--	>sol (0.043)
Benzene	49	214	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	>sol (472)	--	>sol (472)	--	>sol (472)	--	>sol (472)
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	>sol (169)
Fluorene	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)	--	>sol (2.0)
Methylene chloride	1,274	>sol (13,000)	--	--	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Phenanthrene	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)	--	>sol (1.2)
Pyridine	--	--	--	--	--	>sol (300)	--	>sol (300)	--	>sol (300)	--	>sol (300)
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	>sol (526)
Trichloroethene	170	--	--	--	>sol (1,100)	--	>sol (1,100)	--	>sol (1,100)	--	>sol (1,100)	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

Table 5-17
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)									
	Slag Fill Area Zone 4				Other Areas					
	SWMU S-18		SWMU S-23		Smokes Creek		Zone 1		Zone 5	
	C	NC	C	NC	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	>sol (5,060)	--	>sol (5,060)	--	>sol (5,060)	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	>sol (472)	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	>sol (16.1)	--	>sol (16.1)	--	--	--	--	--	--
Anthracene	--	>sol (0.043)	--	>sol (0.043)	--	--	--	--	--	--
Benzene	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)	>sol (1,750)
Carbon disulfide	--	--	--	--	--	>sol (1,190)	--	--	--	--
Carbon tetrachloride	--	--	--	--	--	--	289	>sol (169)	--	--
Chlorobenzene	--	>sol (472)	--	>sol (472)	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	>sol (169)	--	>sol (169)	--	>sol (169)	--	--	--	--
Fluorene	--	>sol (2.0)	--	>sol (2.0)	--	--	--	--	--	--
Methylene chloride	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	>sol (13,000)	--	--	--	--
Naphthalene	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)	--	>sol (31)
Phenanthrene	--	>sol (1.2)	--	>sol (1.2)	--	--	--	--	--	--
Pyridine	--	>sol (300)	--	>sol (300)	--	>sol (300)	--	--	--	--
Toluene	--	>sol (526)	--	>sol (526)	--	>sol (526)	--	--	--	--
Trichloroethene	>sol (1,100)	--	>sol (1,100)	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	120	--	--	--	--	--
Xylenes, Total	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)	--	>sol (175)

* Bolded values
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-18
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Trespasser Scenario
Inhalation of Ambient Vapors from Standing Water in Pits*

Chemical	RBSL (mg/L)			
	Coke Oven Area			
	SWMU Group PA-1		SWMU P-11	
	C	NC	C	NC
Benzene	130	0.34	283	745
Ethylbenzene	--	--	--	>sol (169)
Naphthalene	--	>sol (31)	--	>sol (31)
Toluene	--	--	--	>sol (526)
Xylenes, Total	--	--	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-19
Tier I Risk Based Screening Levels (RBSLs)
Current Non-BSC Commercial/Industrial Worker Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area								Tank Farm Area		Slag Fill Area Zone 2	
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-4		SWMU S-26		SWMU Group TF		SWMU Group SFA-1	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Antimony	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Arsenic	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	233,000	--	289,000	--
Benzo(a)anthracene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzo(b)fluoranthene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzo(g,h,i)perylene	--	--	--	>1,000,000	--	--	--	--	--	>1,000,000	--	>1,000,000
Benzo(k)fluoranthene	--	--	>1,000,000	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Chromium [a]	--	--	>1,000,000	>1,000,000	722,679	>1,000,000	523,000	>1,000,000	85,700	>1,000,000	>1,000,000	>1,000,000
Chrysene	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Dibenz(a,h)anthracene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Lead	--	--	--	--	--	--	--	--	--	NE	NE	NE
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Thallium	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-19
Tier I Risk Based Screening Levels (RBSLs)
Current Non-BSC Commercial/Industrial Worker Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	>1,000,000	--	--	--	>1,000,000
Arsenic	604,000	--	553,000	--	636,000	--	>1,000,000	--	677,000	--	--	--
Benzo(a)anthracene	>1,000,000	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	>1,000,000	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	--	--	234,000	>1,000,000	919,000	>1,000,000	249,000	>1,000,000	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	NE	NE	NE	--	--	NE	NE
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	>1,000,000	--	>1,000,000	--	>1,000,000	--	--	--	>1,000,000	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-19
Tier I Risk Based Screening Levels (RBSLs)
Current Non-BSC Commercial/Industrial Worker Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4						Other Areas					
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-19		SWMU P-63		SWMU P-73	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	>1,000,000	--	--	--	>1,000,000	--	--	--	--	--	--
Arsenic	--	--	>1,000,000	--	>1,000,000	--	364,000	--	>1,000,000	--	>1,000,000	--
Benzo(a)anthracene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	945,000	>1,000,000	865,000	>1,000,000	--	--	477,000	>1,000,000	610,000	>1,000,000
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	NE	NE	--	--	NE	NE	--	--
Mercury	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Thallium	--	--	--	>1,000,000	--	>1,000,000	--	--	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.
NE Not evaluated for this scenario.

Table 5-20
Tier I Risk Based Screening Levels (RBSLs)
Current Non-BSC Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area						Slag Fill Area Zone 2					
	SWMU Group PA-3		SWMU Group PA-4		SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-24	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	621	--	--	--
Acenaphthylene	--	--	--	--	--	>sat (1,115)	--	>1,000,000	--	>sat (1,115)	--	--
Anthracene	--	>1,000,000	--	--	--	>sat (10.2)	--	--	--	--	--	>1,000,000
Benzene	--	--	**198**	**860**	**6.3**	27	11	343	**179**	**776**	**348**	>sat (1,260)
Fluorene	--	--	--	--	--	>sat (153)	--	--	--	>sat (153)	--	>1,000,000
Naphthalene	--	--	--	>sat (371)	--	>sat (371)	--	51,700	--	>sat (371)	--	>sat (371)
Phenanthrene	--	--	--	--	--	>sat (163)	--	>1,000,000	--	>sat (163)	--	--
Toluene	--	--	--	>sat (795)	--	--	--	--	--	>sat (795)	--	>sat (126)
Trichloroethene	--	--	--	--	--	--	--	--	776	--	--	--
Xylenes, Total	--	--	--	>sat (694)	--	--	--	--	--	>sat (694)	--	>sat (694,000)

Table 5-20
Tier I Risk Based Screening Levels (RBSLs)
Current Non-BSC Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)					
	Slag Fill Area Zone 4					
	SWMU S-14		SWMU S-18		SWMU S-23	
	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Acenaphthylene	--	>1,000,000	--	--	--	>1,000,000
Anthracene	--	>1,000,000	--	>1,000,000	--	>1,000,000
Benzene	>sat (1,260)	>sat (1,260)	--	--	>sat (1,260)	>sat (1,260)
Fluorene	--	--	--	--	--	>1,000,000
Naphthalene	--	>1,000,000	--	--	--	>sat (371)
Phenanthrene	--	>1,000,000	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
> sat The RBSL exceeds the saturation limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-21
Tier I Risk Based Screening Levels (RBSLs)
Current Non-BSC Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)	
	Sitewide Groundwater	
	C	NC
1,1-Dichloroethane	--	3,000
Acenaphthene	--	>sol (4.24)
Acenaphthylene	--	>sol (16.1)
Anthracene	--	>sol (0.043)
Benzene	7.2	31
Carbon disulfide	--	570
Ethylbenzene	--	>sol (169)
Fluorene	--	>sol (1.98)
Methylene chloride	278	>sol (13,000)
Naphthalene	--	>sol (31)
Phenanthrene	--	>sol (1.15)
Pyridine	--	14
Toluene	--	>sol (526)
Trichloroethene	21	--
Xylenes, Total	--	>sol (175)

*	Bolded values indicate RBSLs that are exceeded by representative concentrations.
--	The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol	The RBSL exceeds the solubility limit indicated in parentheses.
C	Cancer RBSL.
NC	Noncancer RBSL.

Table 5-22
Tier I Risk Based Screening Levels (RBSLs)
Current Non-BSC Commercial/Industrial Worker Scenario
Inhalation of Ambient Vapors from Standing Water in Pits*

Chemical	RBSL (mg/L)			
	Coke Oven Area			
	SWMU Group PA-1		SWMU P-11	
	C	NC	C	NC
Benzene	36	160	68	293
Ethylbenzene	--	--	--	>sol (169)
Naphthalene	--	>sol (31)	--	>sol (31)
Toluene	--	--	--	>sol (526)
Xylenes, Total	--	--	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/L).
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-23
Tier I Risk Based Screening Levels (RBSLs)
Future Marina Worker Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area								Tank Farm Area		Slag Fill Area Zone 2	
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-4		SWMU S-26		SWMU Group TF		SWMU Group SFA-1	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Antimony	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Arsenic	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	298,000	--	370,000	--
Benzo(a)anthracene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzo(b)fluoranthene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzo(g,h,i)perylene	--	--	--	>1,000,000	--	--	--	--	--	>1,000,000	--	>1,000,000
Benzo(k)fluoranthene	--	--	>1,000,000	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Chromium [a]	--	--	>1,000,000	>1,000,000	926,000	>1,000,000	670,000	>1,000,000	110,000	>1,000,000	136,000	>1,000,000
Chrysene	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Dibenz(a,h)anthracene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Lead	--	--	--	--	--	--	--	--	--	NE	NE	NE
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Thallium	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-23
Tier I Risk Based Screening Levels (RBSLs)
Future Marina Worker Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	>1,000,000	--	--	--	>1,000,000
Arsenic	774,000	--	709,000	--	815,000	--	>1,000,000	--	868,000	--	--	--
Benzo(a)anthracene	>1,000,000	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	>1,000,000	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	--	--	300,000	>1,000,000	>1,000,000	>1,000,000	320,000	>1,000,000	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	NE	--	NE	--	--	--	NE
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	>1,000,000	--	>1,000,000	--	>1,000,000	--	--	--	>1,000,000	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-23
Tier I Risk Based Screening Levels (RBSLs)
Future Marina Worker Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4						Other Areas					
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-19		SWMU P-63		SWMU P-73	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	>1,000,000	--	--	--	>1,000,000	--	--	--	--	--	--
Arsenic	--	--	>1,000,000	--	>1,000,000	--	466,000	--	>1,000,000	>1,000,000	>1,000,000	--
Benzo(a)anthracene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	>1,000,000	>1,000,000	>1,000,000	>1,000,000	--	--	611,000	>1,000,000	782,000	>1,000,000
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	NE	NE	--	--	NE	NE	--	--
Mercury	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Thallium	--	--	--	>1,000,000	--	>1,000,000	--	--	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.
NE Not evaluated for this scenario.

Table 5-24
Tier I Risk Based Screening Levels (RBSLs)
Future Marina Worker Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area						Slag Fill Area Zone 2					
	SWMU Group PA-3		SWMU Group PA-4		SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-24	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	206	--	--	--
Acenaphthylene	--	--	--	--	--	>sat (1,115)	--	>1,000,000	--	>sat (1,115)	--	>1,000,000
Anthracene	--	>1,000,000	--	--	--	>sat (10.2)	--	--	--	--	--	--
Benzene	--	--	>1,000,000	>1,000,000	>sat (1,260)	>sat (1,260)	21	90	**59**	**257**	>sat (1,260)	>sat (1,260)
Fluorene	--	--	--	--	--	>sat (153)	--	--	--	>sat (153)	--	>1,000,000
Naphthalene	--	--	--	>1,000,000	--	>sat (371)	--	13,600	--	>sat (371)	--	>sat (371)
Phenanthrene	--	--	--	--	--	>sat (163)	--	>1,000,000	--	>sat (163)	--	--
Toluene	--	--	--	>1,000,000	--	--	--	--	--	>sat (795)	--	>sat (795)
Trichloroethene	--	--	--	--	--	--	--	--	257	--	--	--
Xylenes, Total	--	--	--	>1,000,000	--	--	--	--	--	>sat (694)	--	>1,000,000

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Tab: marina SWMU Vap Amb

Table 5-24
Tier I Risk Based Screening Levels (RBSLs)
Future Marina Worker Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)					
	Slag Fill Area Zone 4					
	SWMU S-14		SWMU S-18		SWMU S-23	
	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Acenaphthylene	--	>1,000,000	--	--	--	>1,000,000
Anthracene	--	>1,000,000	--	>1,000,000	--	>1,000,000
Benzene	>sat (1,260)	>sat (1,260)	--	--	>sat (1,260)	>sat (1,260)
Fluorene	--	--	--	--	--	>1,000,000
Naphthalene	--	>1,000,000	--	--	--	>1,000,000
Phenanthrene	--	>1,000,000	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
> sat The RBSL exceeds the saturation limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-25
Tier I Risk Based Screening Levels (RBSLs)
Future Marina Worker Scenario
Inhalation of Ambient Vapors from Zone 1 Groundwater*

Chemical	Zone 1	
	C	NC
1,1,1-Trichloroethane	--	>sol (472)
Benzene	5.4	23
Carbon tetrachloride	0.88	2.3
Methylene chloride	133	>sol (13,000)
Naphthalene	--	>sol (31)
Xylenes, Total	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.

-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.

C Cancer RBSL.

NC Noncancer RBSL.

> sol The RBSL exceeds the solubility limit indicated in parentheses.

Table 5-26
Tier I Risk Based Screening Levels (RBSLs)
Future Marina Worker Scenario
Inhalation of Ambient Vapors from Standing Water in Pits*

Chemical	RBSL (mg/L)			
	Coke Oven Area			
	SWMU Group PA-1		SWMU P-11	
	C	NC	C	NC
Benzene	>sol (1,750)	>sol (1,750)	>1,000,000	>1,000,000
Ethylbenzene	--	--	--	>1,000,000
Naphthalene	--	>sol (31)	--	>1,000,000
Toluene	--	--	--	>1,000,000
Xylenes, Total	--	--	--	>1,000,000

*	Bolded values indicate RBSLs that are exceeded by representative concentrations.
--	The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000	Calculated RBSL is greater than 1,000,000 parts per million (mg/L).
> sol	The RBSL exceeds the solubility limit indicated in parentheses.
C	Cancer RBSL.
NC	Noncancer RBSL.

Table 5-27
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fenceline Resident Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area								Tank Farm Area		Slag Fill Area Zone 2	
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-4		SWMU S-26		SWMU Group TF		SWMU Group SFA-1	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Antimony	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Arsenic	327,000	--	--	--	224,619	--	162,000	--	26,600	--	33,100	--
Benzo(a)anthracene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	>1,000,000	--	--	--	>sat (16)	--	>1,000,000	--	161,000	--
Benzo(b)fluoranthene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	818,000	--
Benzo(g,h,i)perylene	--	--	--	>1,000,000	--	--	--	--	--	>1,000,000	--	>1,000,000
Benzo(k)fluoranthene	--	--	>1,000,000	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Chromium [a]	--	--	176,000	>1,000,000	82,725	>1,000,000	59,800	>1,000,000	9,810	>1,000,000	12,200	>1,000,000
Chrysene	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Dibenz(a,h)anthracene	--	--	>1,000,000	--	--	--	>sat (45)	--	>1,000,000	--	161,000	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Lead	--	--	--	--	--	--	--	--	--	NE	NE	NE
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Thallium	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-27
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fenceline Resident Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	>1,000,000	--	--	--	>1,000,000
Arsenic	69,100	--	63,300	--	72,800	--	286,477	--	77,500	--	--	--
Benzo(a)anthracene	>1,000,000	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	337,000	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	--	--	26,800	>1,000,000	106,000	>1,000,000	28,500	>1,000,000	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	NE	NE	NE	--	--	NE	NE
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	>1,000,000	--	--	--	>1,000,000	--	--	--	>1,000,000	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-27
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fenceline Resident Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4						Other Areas					
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-19		SWMU P-63		SWMU P-73	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	>1,000,000	--	--	--	>1,000,000	--	--	--	--	--	--
Arsenic	--	--	294,000	--	269,000	--	41,600	--	148,201	--	190,000	--
Benzo(a)anthracene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	108,000	>1,000,000	98,900	>1,000,000	--	--	54,581	>1,000,000	69,800	>1,000,000
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	NE	NE	--	--	NE	NE	--	--
Mercury	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Thallium	--	--	--	>1,000,000	--	>1,000,000	--	--	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.
NE Not evaluated for this scenario.

Table 5-28
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fenceline Resident Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area						Slag Fill Area Zone 2					
	SWMU Group PA-3		SWMU Group PA-4		SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-24	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	215	--	--	--
Acenaphthylene	--	--	--	--	--	>sat (1,115)	--	>1,000,000	--	>sat (1,115)	--	--
Anthracene	--	>1,000,000	--	--	--	>sat (10.2)	--	--	--	--	--	>1,000,000
Benzene	--	--	**654**	71,000,000	30	592	22	434	**62**	1,220	**112**	>sat (1,260)
Fluorene	--	--	--	--	--	>sat (153)	--	--	--	>sat (153)	--	>1,000,000
Naphthalene	--	--	--	>1,000,000	--	>sat (371)	--	65,400	--	>sat (371)	--	>1,000,000
Phenanthrene	--	--	--	--	--	>sat (163)	--	>1,000,000	--	>sat (163)	--	--
Toluene	--	--	--	>1,000,000	--	--	--	--	--	>sat (795)	--	>sat (795)
Trichloroethene	--	--	--	--	--	--	--	--	999	--	--	--
Xylenes, Total	--	--	--	>1,000,000	--	--	--	--	--	>sat (694)	--	>1,000,000

Table 5-28
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fenceline Resident Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)					
	Slag Fill Area Zone 4					
	SWMU S-14		SWMU S-18		SWMU S-23	
	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Acenaphthylene	--	>1,000,000	--	--	--	>1,000,000
Anthracene	--	>1,000,000	>1,000,000	--	--	>1,000,000
Benzene	670	>sat (1,260)	--	--	411	>sat (1,260)
Fluorene	--	--	--	--	--	>1,000,000
Naphthalene	--	>1,000,000	--	--	--	>1,000,000
Phenanthrene	--	>1,000,000	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
> sat The RBSL exceeds the saturation limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-29
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fenceline Resident Scenario
Inhalation of Ambient Vapors from Groundwater*

Chemical	RBSL (mg/L)	
	Other Areas	
	Sitewide Groundwater	
	C	NC
1,1-Dichloroethane	--	>sol (5,060)
Acenaphthene	--	>sol (4.24)
Acenaphthylene	--	>sol (16.1)
Anthracene	--	>sol (0.043)
Benzene	51	1,000
Carbon disulfide	--	>sol (1,190)
Ethylbenzene	--	>sol (169)
Fluorene	--	>sol (1.98)
Methylene chloride	2,000	>sol (13,000)
Naphthalene	--	>sol (31)
Phenanthrene	--	>sol (1.15)
Pyridine	--	>sol (300)
Toluene	--	>sol (526)
Trichloroethene	150	--
Xylenes, Total	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-30
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fenceline Resident Scenario
Inhalation of Ambient Vapors from Standing Water in Pits*

Chemical	RBSL (mg/L)			
	Coke Oven Area			
	SWMU Group PA-1		SWMU P-11	
	C	NC	C	NC
Benzene	67	1,300	67	1,310
Ethylbenzene	--	--	--	>sol (169)
Naphthalene	--	>sol (31)	--	>sol (31)
Phenanthrene	--	--	--	>sol (1.2)
Toluene	--	--	--	>sol (526)
Xylenes, Total	--	--	--	>1,000,000

*	Bolded values indicate RBSLs that are exceeded by representative concentrations.
--	The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000	Calculated RBSL is greater than 1,000,000 parts per million (mg/L).
> sol	The RBSL exceeds the solubility limit indicated in parentheses.
C	Cancer RBSL.
NC	Noncancer RBSL.

Table 5-31
Tier I Risk Based Screening Levels (RBSLs)
Future Greenway User Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area								Tank Farm Area		Slag Fill Area Zone 2	
	SWMU Group PA-1		SWMU Group PA-2		SWMU Group PA-4		SWMU S-26		SWMU Group TF		SWMU Group SFA-1	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Antimony	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Arsenic	>1,000,000	--	--	--	>1,000,000	--	162,000	--	26,600	--	872,000	--
Benzo(a)anthracene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	>1,000,000	--	--	--	>sat (16)	--	>1,000,000	--	>1,000,000	--
Benzo(b)fluoranthene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Benzo(g,h,i)perylene	--	--	--	>1,000,000	--	--	>sat (45)	--	--	>1,000,000	--	>1,000,000
Benzo(k)fluoranthene	--	--	>1,000,000	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Chromium [a]	--	--	>1,000,000	>1,000,000	>1,000,000	>1,000,000	59,800	>1,000,000	9,810	>1,000,000	321,000	>1,000,000
Chrysene	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Dibenz(a,h)anthracene	--	--	>1,000,000	--	--	--	--	--	>1,000,000	--	>1,000,000	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	>1,000,000	--	--	--	>1,000,000	--	>1,000,000	--	>1,000,000	--
Lead	--	--	--	--	--	--	--	--	--	NE	NE	NE
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Thallium	--	--	--	--	--	--	--	--	--	>1,000,000	--	>1,000,000
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-31
Tier I Risk Based Screening Levels (RBSLs)
Future Greenway User Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 2								Slag Fill Area Zone 3		Slag Fill Area Zone 4	
	SWMU Group SFA-2		SWMU S-3		SWMU S-8		SWMU S-21		SWMU S-10		SWMU S-14	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	>1,000,000	--	--	--	>1,000,000
Arsenic	>1,000,000	--	>1,000,000	--	>1,000,000	--	>1,000,000	--	> 1,000,000	--	--	--
Benzo(a)anthracene	>1,000,000	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	>1,000,000	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	--	--	707,000	>1,000,000	>1,000,000	>1,000,000	752,000	> 1,000,000	--	--
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	NE	NE	NE	--	--	NE	NE
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Thallium	--	>1,000,000	--	--	--	>1,000,000	--	--	--	> 1,000,000	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

Table 5-31
Tier I Risk Based Screening Levels (RBSLs)
Future Greenway User Scenario
Inhalation of Airborne Particulates from Surficial SWMU Material*

Chemical	RBSL (mg/kg)											
	Slag Fill Area Zone 4						Other Areas					
	SWMU S-15		SWMU S-17		SWMU S-18		SWMU S-19		SWMU P-63		SWMU P-73	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	>1,000,000	--	--	--	>1,000,000	--	--	--	--	--	--
Arsenic	--	--	>1,000,000	--	>1,000,000	--	> 1,000,000	--	>1,000,000	--	> 1,000,000	--
Benzo(a)anthracene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--
Chromium [a]	--	--	>1,000,000	>1,000,000	>1,000,000	>1,000,000	--	--	>1,000,000	>1,000,000	> 1,000,000	> 1,000,000
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	--	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	>1,000,000	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	NE	NE	--	--	NE	NE	--	--
Mercury	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Naphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	--	--	--	>1,000,000	--	--	--	--	--	--	--	--
Thallium	--	--	--	>1,000,000	--	>1,000,000	--	--	--	--	--	> 1,000,000
Toluene	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--
Xylenes, total	--	--	--	--	--	--	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.
NE Not evaluated for this scenario.

Table 5-32
Tier I Risk Based Screening Levels (RBSLs)
Future Greenway User Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)											
	Coke Oven Area						Slag Fill Area Zone 2					
	SWMU Group PA-3		SWMU Group PA-4		SWMU Group TF		SWMU Group SFA-1		SWMU Group SFA-2		SWMU S-24	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	484	--	--	--
Acenaphthylene	--	--	--	--	--	> sat (1,115)	--	>1,000,000	--	> sat (1,115)	--	--
Anthracene	--	> 1,000,000	--	--	--	> sat (10.2)	--	--	--	--	--	>1,000,000
Benzene	--	--	> 1,000,000	>1,000,000	> sat (1,260)	> sat (1,260)	49	967	**140**	> sat (1,264)	> sat (1,260)	> sat (1,260)
Fluorene	--	--	--	--	--	> sat (153)	--	--	--	> sat (153)	--	>1,000,000
Naphthalene	--	--	--	> 1,000,000	--	> sat (371)	--	146,000	--	> sat (371)	--	>1,000,000
Phenanthrene	--	--	--	--	--	> sat (163)	--	>1,000,000	--	> sat (163)	--	--
Toluene	--	--	--	> 1,000,000	--	--	--	--	--	> sat (795)	--	>1,000,000
Trichloroethene	--	--	--	--	--	--	--	--	606	--	--	--
Xylenes, Total	--	--	--	> 1,000,000	--	--	--	--	--	> sat (694)	--	>1,000,000

Table 5-32
Tier I Risk Based Screening Levels (RBSLs)
Future Greenway User Scenario
Inhalation of Ambient Vapors from Subsurface SWMU Material*

Chemical	RBSL (mg/kg)					
	Slag Fill Area Zone 4					
	SWMU S-14		SWMU S-18		SWMU S-23	
	C	NC	C	NC	C	NC
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Acenaphthylene	--	>1,000,000	--	--	--	>1,000,000
Anthracene	--	>1,000,000	--	>1,000,000	--	>1,000,000
Benzene	> sat (1,260)	>1,000,000	--	--	> sat (1,260)	> sat (1,260)
Fluorene	--	--	--	--	--	>1,000,000
Naphthalene	--	>1,000,000	--	--	--	>1,000,000
Phenanthrene	--	>1,000,000	--	--	--	>1,000,000
Toluene	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--
Xylenes, Total	--	--	--	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
> sat The RBSL exceeds the saturation limit indicated in parentheses.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-33
Tier I Risk Based Screening Levels (RBSLs)
Future Greenway User Scenario
Inhalation of Ambient Vapors from Zone 1 Groundwater*

Chemical	Zone 1	
	C	NC
1,1,1-Trichloroethane	--	> sol (472)
Benzene	13	249
Carbon tetrachloride	2.1	25
Methylene chloride	314	> sol (13,000)
Naphthalene	--	> sol (31)
Xylenes, Total	--	> sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.

-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.

C Cancer RBSL.

NC Noncancer RBSL.

> sol The RBSL exceeds the solubility limit indicated in parentheses.

Table 5-34
Tier I Risk Based Screening Levels (RBSLs)
Future Greenway User Scenario
Inhalation of Ambient Vapors from Standing Water in Pits*

Chemical	RBSL (mg/L)			
	Coke Oven Area			
	SWMU Group PA-1		SWMU P-11	
	C	NC	C	NC
Benzene	> sol (1,750)	> sol (1,750)	> 1,000,000	> 1,000,000
Ethylbenzene	--	--	--	> 1,000,000
Naphthalene	--	> sol (31)	--	> 1,000,000
Phenanthrene	--	--	--	> 1,000,000
Toluene	--	--	--	> 1,000,000
Xylenes, Total	--	--	--	> 1,000,000

*	Bolded values indicate RBSLs that are exceeded by representative concentrations.
--	The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000	Calculated RBSL is greater than 1,000,000 parts per million (mg/L).
> sol	The RBSL exceeds the solubility limit indicated in parentheses.
C	Cancer RBSL.
NC	Noncancer RBSL.

Table 5-35
Tier I Risk Based Screening Levels (RBSLs)
Current Ship Canal Maintenance Worker Scenario
Direct Contact with Surface Water in Ship Canal*

Chemical	RBSL (mg/L)	
	C	NC
Arsenic	0.14	5.6
Benzene	0.58	8.4
bis(2-Ethylhexyl)phthalate	>sol (0.34)	>sol (0.34)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.

C Cancer RBSL.

NC Noncancer RBSL.

Table 5-36
Tier I Risk Based Screening Levels (RBSLs)
Future Ship Canal Maintenance Worker Scenario
Ship Canal Groundwater Discharge Area - Transport to Surface Water*

Chemical	RBSL (mg/L)	
	C	NC
Arsenic	0.14	5.6
Benzene	0.58	8.4
Naphthalene	--	18
Phenol	--	4,914
Trichloroethene	3.7	21
Xylenes, Total	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-37
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Ship Canal Maintenance Worker Scenario
Ingestion of Sediment from Ship Canal*

Chemical	RBSL (mg/kg)	
	Ship Canal (Current and Future Conditions)	
	C	NC
Arsenic	1,590	62,900
Benzo(a)anthracene	3,260	--
Benzo(a)pyrene	326	--
Benzo(b)fluoranthene	3,260	--
Dibenz(a,h)anthracene	326	--
Indeno(1,2,3-c,d)pyrene	>sat (760)	--
Lead	--	400

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-38
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Recreational Bather Scenario
Direct Contact with Surface Water*

Chemical	RBSL (mg/L)					
	Lake Erie		Smokes Creek		Blasdell Creek	
	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	--	--	1,600
1,2-Dichloroethane	--	--	0.60	650	--	--
Arsenic	--	--	0.069	12	**0.069**	12.4
Benzene	--	--	0.36	24	--	--
bis(2-Ethylhexyl)phthalate	1.3	150	1.3	150	--	--
Bromodichloromethane	--	--	0.83	411	--	--
Chloroform	--	--	6.4	160	--	--
Dibromochloromethane	--	--	0.76	510	--	--
Lead	--	--	--	--	--	15
Methylene chloride	--	--	7.9	1,400	--	--
Vinyl chloride	--	--	0.023	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.

-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.

C Cancer RBSL.

NC Noncancer RBSL.

Table 5-39
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Recreational Bather Scenario
Direct Contact with Surface Water via Transport from Groundwater Discharge Area*

Chemical	RBSL (mg/L)			
	Lake Erie Groundwater Discharge Area		Smokes Creek Groundwater Discharge Area	
	C	NC	C	NC
1,1-Dichloroethane	--	> sol (5,060)	--	> sol (5,060)
1,2-Dichloroethene, Total	--	>sol (4,900)	--	--
2,4-Dimethylphenol	--	3,649	--	6,261
2-Methylphenol	--	>sol (26,000)	--	>sol (26,000)
3-Methylphenol & 4-Methylphenol	--	5,120	--	8,787
4-Methylphenol	--	105	--	8,181
Acenaphthylene	--	>sol (16)	--	>sol (16)
Anthracene	--	>sol (0.043)	--	> 1,000,000
Antimony	--	1,741	--	2,988
Arsenic	7.3	1,306	12	2,241
Barium	--	304,704	--	522,875
Benzene	38	>sol (1,750)	**65**	>sol (1,750)
bis(2-Ethylhexyl)phthalate	>sol (0.34)	>sol (0.34)	>sol (0.34)	>sol (0.34)
Cadmium	--	2,176	--	3,735
Carbon disulfide	--	--	--	>sol (1,190)
Chromium[a]	--	13,059	--	22,409
Cresols, Total	--	5,163	--	--
Cyanide	--	36,840	--	63,217
Ethylbenzene	--	>sol (169)	--	>sol (169)

Chemical	RBSL (mg/L)			
	Lake Erie Groundwater Discharge Area (continued)		Smokes Creek Groundwater Discharge Area (continued)	
	C	NC	C	NC
Fluoranthene	--	>sol (0.21)	--	>sol (0.21)
Fluorene	--	>sol (2.0)	--	>sol (2.0)
Lead	--	0.015	--	**0.015**
Mercury	--	1,306	--	2,241
Methylene chloride	837	>sol (13,000)	--	--
Naphthalene	--	>sol (31)	--	>sol (31)
Nickel	--	87,058	--	149,393
Phenanthrene	--	>sol (1.2)	--	>sol (1.2)
Phenol	--	>sol (82,800)	--	> 1,000,000
Pyrene	--	>sol (0.14)	--	*
Pyridine	--	>sol (300)	--	>sol (300)
Selenium	--	21,765	--	--
Silver	--	--	--	37,348
Thallium	--	348	--	598
Toluene	--	>sol (526)	--	>sol (526)
Trichloroethene	239	>sol (1,100)	--	--
Vinyl chloride	--	--	4.2	--
Xylenes, Total	--	>sol (175)	--	>sol (175)

Bolded values indicate RBSLs that are exceeded by representative concentrations.

* The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.

-- Calculated RBSL is greater than 1,000,000 parts per million (mg/L).

>1,000,000 The RBSL exceeds the solubility limit indicated in parentheses.

> sol All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.

a Cancer RBSL.

C Noncancer RBSL.

NC

Table 5-40
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Recreational Bather Scenario
Dermal Contact with and Ingestion of Sediment*

Chemical	RBSL (mg/kg)					
	Lake Erie		Smokes Creek		Blasdell Creek	
	C	NC	C	NC	C	NC
Acenaphthylene	--	--	--	--	--	--
Arsenic	15	2,752	15	2,752	**15**	2,752
Benzo(a)anthracene	--	--	31	--	31	--
Benzo(a)pyrene	3	--	3	--	**3**	--
Benzo(b)fluoranthene	--	--	31	--	31	--
Benzo(g,h,i)perylene	--	>sat (4,121)	--	--	--	>sat (4,121)
Benzo(k)fluoranthene	--	--	314	--	314	--
Cadmium	--	--	--	--	--	4,586
Chromium[a]	--	--	--	--	--	27,518
Dibenz(a,h)anthracene	3	--	3	--	**3**	--
Indeno(1,2,3-c,d)pyrene	--	--	31	--	31	--
Lead	--	--	--	400	--	--
Phenanthrene	--	275,181	--	--	--	275,181

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chro
>sat The RBSL exceeds the saturation limit indicated in parentheses.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/kg).
C Cancer RBSL.
NC Noncancer RBSL.

Table 5-41
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fish Consumer Scenario
Ingestion of COPCs in Fish via Biotransport from Surface Water*

Chemical	RBSL (mg/L)					
	Lake Erie		Smokes Creek		Blasdell Creek	
	C	NC	C	NC	C	NC
1,1-Dichloroethane	--	--	--	--	--	26
1,2-Dichloroethane	--	--	0.046	51	--	--
Arsenic	--	--	**0.0014**	0.25	**0.0014**	0.25
Benzene	--	--	0.036	2.4	--	--
bis(2-Ethylhexyl)phthalate	**0.00071**	0.079	**0.00071**	0.079	--	--
Bromodichloromethane	--	--	0.0059	2.9	--	--
Chloroform	--	--	0.17	4.1	--	--
Dibromochloromethane	--	--	0.0035	2.3	--	--
Lead	--	--	--	--	--	15
Methylene chloride	--	--	0.22	39	--	--
Vinyl chloride	--	--	0.00073	--	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.

-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.

C Cancer RBSL.

NC Noncancer RBSL.

Table 5-42
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Fish Consumer Scenario
Ingestion of COPCs in Fish - via Transport from Groundwater to Surface Water*

Chemical	RBSL (mg/L)			
	Lake Erie Groundwater Discharge Area		Smokes Creek Groundwater Discharge Area	
	C	NC	C	NC
1,1-Dichloroethane	--	2,743	--	4,684
1,2-Dichloroethene, Total	--	169	--	--
2,4-Dimethylphenol	--	47	--	81
2-Methylphenol	--	991	--	1,691
3-Methylphenol & 4-Methylphenol	--	94	--	160
4-Methylphenol	--	105	--	179
Acenaphthylene	--	>sol (16)	--	>sol (16)
Anthracene	--	>sol (0.043)	--	135
Antimony	--	158	--	271
Arsenic	0.15	27	0.25	46
Barium	--	268	--	458
Benzene	3.8	249	**6.4**	425
bis(2-Ethylhexyl)phthalate	0.070	>sol (0.34)	0.13	>sol (0.34)
Cadmium	--	0.050	--	0.80
Carbon disulfide	--	--	--	>sol (1,190)
Chromium[a]	--	1,070	--	1,827
Cresols, Total	--	99	--	--
Cyanide	--	7,924	--	13,531
Ethylbenzene	--	>sol (169)	--	>sol (169)

Chemical	RBSL (mg/L)			
	Lake Erie Groundwater Discharge Area (continued)		Smokes Creek Groundwater Discharge Area (continued)	
	C	NC	C	NC
Fluoranthene	--	>sol (0.21)	--	>sol (0.21)
Fluorene	--	>sol (2.0)	--	>sol (2.0)
Lead	--	0.015	--	**0.015**
Mercury	--	2.3	--	0.0021
Methylene chloride	23	4,115	--	--
Naphthalene	--	17	--	29
Nickel	--	8,915	--	15,222
Phenanthrene	--	>sol (1.2)	--	18
Phenol	--	10,698	--	18,267
Pyrene	--	>sol (0.14)	--	6.8
Pyridine	--	198	--	>sol (300)
Selenium	--	0.31	--	--
Silver	--	--	--	109
Thallium	--	0.22	--	0.37
Toluene	--	>sol (526)	--	>sol (526)
Trichloroethene	4.8	126	--	--
Vinyl chloride	--	--	**0.13**	--
Xylenes, Total	--	>sol (175)	--	>sol (175)

* Bolded values indicate RBSLs that are exceeded by representative concentrations.

-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.

a All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.

C Cancer RBSL.

NC Noncancer RBSL.

Table 5-43
Tier I Risk Based Screening Levels (RBSLs)
Current and Future Off-Site Water Consumer Scenario
Ingestion of COPCs in Drinking Water - via Transport from Groundwater to Surface Water*

Chemical	RBSL (mg/L)	
	Lake Erie Groundwater Discharge Area	Smokes Creek Groundwater Discharge Area
1,1-Dichloroethane	180,000	48,000
1,2-Dichloroethene, Total	14,000	--
2,4-Dimethylphenol	160,000	380,000
2-Methylphenol	400,000	950,000
3-Methylphenol & 4-Methylphenol	40,000	95,000
4-Methylphenol	40,000	95,000
Acenaphthylene	82,000	196,000
Anthracene	410,000	982,000
Antimony	1,200	2,900
Arsenic	10,000	24,000
Barium	400,000	960,000
Benzene	1,000	2,400
bis(2-Ethylhexyl)phthalate	1,200	2,880
Cadmium	1,000	2,400
Carbon disulfide	--	558,000
Chromium	20,000	48,000
Cresols, Total	40,000	--
Cyanide	40,000	96,000
Ethylbenzene	140,000	336,000

Chemical	RBSL (mg/L)	
	Lake Erie Groundwater Discharge Area (continued)	Smokes Creek Groundwater Discharge Area (continued)
Fluoranthene	320,000	760,000
Fluorene	55,000	131,000
Lead	3,000	7,200
Mercury	400	960
Methylene chloride	1,000	--
Naphthalene	1,500	3,520
Nickel	158,000	380,000
Phenanthrene	10,000	98,200
Phenol	40,000	> 1,000,000
Pyrene	240,000	570,000
Pyridine	1,400	3,270
Selenium	10,000	--
Silver	--	95,000
Thallium	400	960
Toluene	200,000	480,000
Trichloroethene	1,000	--
Vinyl chloride	--	960
Xylenes, Total	> 1,000,000	> 1,000,000

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
>1,000,000 Calculated RBSL is greater than 1,000,000 parts per million (mg/L).

Table 5-44
Tier I Risk Based Screening Levels (RBSLs)
Future Construction Worker Scenario
Direct Contact with Trench Sediment*

Chemical	RBSL (mg/kg)			
	North Water Return Trench		South Water Return Trench	
	C	NC	C	NC
Acenaphthylene	--	19,000	--	--
Antimony	--	--	--	129
Arsenic	16	96	**16**	**96**
Benzo(a)anthracene	**33**	--	--	--
Benzo(a)pyrene	**3**	--	--	--
Benzo(b)fluoranthene	**33**	--	--	--
Benzo(g,h,i)perylene	--	9,600	--	--
Benzo(k)fluoranthene	330	--	--	--
Chrysene	3,300	--	--	--
Dibenz(a,h)anthracene	**3**	--	--	--
Indeno(1,2,3-c,d)pyrene	**33**	--	--	--
Lead	--	--	--	1,545
Phenanthrene	--	9,600	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.

-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.

C Cancer RBSL.

NC Noncancer RBSL.

Table 5-45
Tier I Risk Based Screening Levels (RBSLs)
Future Utility/Maintenance Worker Scenario
Direct Contact with Trench Sediment*

Chemical	RBSL (mg/kg)			
	North Water Return Trench		South Water Return Trench	
	C	NC	C	NC
Acenaphthylene	--	83,000	--	--
Antimony	--	--	--	554
Arsenic	69	420	**69**	416
Benzo(a)anthracene	**142**	--	--	--
Benzo(a)pyrene	**14**	--	--	--
Benzo(b)fluoranthene	142	--	--	--
Benzo(g,h,i)perylene	--	42,000	--	--
Benzo(k)fluoranthene	1,420	--	--	--
Chrysene	14,200	--	--	--
Dibenz(a,h)anthracene	**14**	--	--	--
Indeno(1,2,3-c,d)pyrene	142	--	--	--
Lead	--	--	--	1,545
Phenanthrene	--	42,000	--	--

* Bolded values indicate RBSLs that are exceeded by representative concentrations.
-- The chemical is not a COPC for this SWMU or there is no toxicity criteria for this pathway.
C Cancer RBSL.
NC Noncancer RBSL.

6.0

6.0 SUMMARY AND CONCLUSIONS

The results of the Tier 1 HHRAs conducted for SWMUs, SWMU groups, watercourses and site-wide groundwater at the Lackawanna Facility indicate that levels of benzene, naphthalene, pyridine, carcinogenic PAHs, and some metals (notably lead, arsenic, chromium, and thallium) exceed either (or both) noncarcinogenic RBSLs and carcinogenic RBSLs resulting in risk and hazard levels above the Tier 1 benchmarks of 1.0 (for hazard) and 1 x 10^{-4} (for excess cancer risk).

Table 6-1 summarizes the Tier 1 HHRA results for SWMUs and SWMU groups. Risks and hazards are the highest for the future commercial/industrial receptor scenario, which is the population that represents the greatest potential for exposure, via multiple pathways, to the COPCs. Since this worker cannot be exposed to ambient air and indoor air simultaneously, risk and hazard estimates were developed separately for ambient air exposures and indoor air exposures as shown on Table 6-1. The $SLCR_{totals}$ above the Tier 1 cancer benchmark range from 2 x 10^{-4} to 8 x 10^{-3}. These exceedances are generally attributable to indoor air exposures; benzene is the primary chemical contributor with carcinogenic PAHs contributing at some SWMUs. The $SLHI_{totals}$ for the future commercial/industrial worker that exceed the Tier 1 noncancer benchmark, range from 1.1 to 1,859. Again, the indoor air pathway is the significant pathway contributor, with benzene and naphthalene the primary chemical contributors. At five SWMUs, the soil lead RBSL is exceeded, indicating an unacceptable hazard attributable to this chemical.

For the other occupational scenarios exceedances of the risk or hazard benchmarks were not as frequent nor as great. For the future construction workers, $SLCR_{totals}$ exceed the Tier 1 benchmark at five SWMUs; risk estimates range from 2 x 10^{-4} to 5 x 10^{-4}. The $SLHI_{totals}$ for this population range from 2.5 to 964; benzene is the primary contributor. The soil lead RBSL is exceeded at five SWMUs for this population as well as for the utility/maintenance worker and the trespasser population, thus indicating an unacceptable hazard attributable to this chemical.

For the future utility/maintenance worker, the risk benchmark is met at all SWMUs, but not the hazard benchmark. The $SLHI_{totals}$ for this population range from 2.6 to 119 (benzene). Exceedances of the hazard benchmark for the non-BSC commercial/industrial worker are limited to five SWMUs. The $SLHI_{totals}$ range from 1.1 to 5.1 (benzene). Risk benchmarks are not exceeded at any SWMU for this receptor scenario.

For the trespasser receptor scenario, all risk and hazard benchmarks are met, except for lead at five SWMUs. For the future marina worker, the only benchmark exceedance occurs at SFA-2, where the $SLHI_{total}$ is 4.9 (benzene).

There are no exceedances of either risk or hazard benchmarks at any SWMU location for either the future greenway user or present/future fenceline resident population.

Table 6-2 summarizes the SLHI and SLCR values for populations evaluated for the watercourses and site-wide groundwater exposures. Benchmark exceedances occur only at Smokes Creek and the South Return Water Trench. The only exceedance of the risk benchmark (5×10^{-4}) is associated with the indoor air pathway for a future commercial/industrial worker at the Smokes Creek groundwater area. This exceedance is attributable to benzene in the groundwater in this area. The $SLHI_{total}$ for this population at this location ranges from 10 (ambient air) to 218 (indoor air). Both benzene and pyridine contribute to these exceedances. Other hazard exceedances are noted for the utility/maintenance worker at the South Return Water Trench (1.1, attributable to arsenic). For the future construction worker at Smokes Creek, a SLHI of 4.0 was calculated. This exceedance is attributable to pyridine.

At several SWMU locations and at Smokes Creek, lead in water (pit or surface water) may represent a benchmark exceedance. An RBSL in surface water for lead was not calculated, and the drinking water action level 15 µg/L) was used to evaluate dermal water exposures.

For all other receptor scenarios at the other watercourses, and for site-wide groundwater, there are no exceedances of risk or hazard benchmarks. In some locations and for some populations, none of the RBSLs are exceeded, indicating that a Tier 1 HHRA (i.e., the calculation of SLCR and SLHI values) was not needed. Tables 6-1 and 6-2 show these receptor/location combinations.

Based on the above information, most SWMUs require some evaluation as part of the Corrective Measures Study. The risk assessment concludes, however, that three SWMUs (S-15, S-16, and S-25), as well as Blasdell Creek, the Ship Canal, the North Return Water Trench, and Lake Erie do not warrant evaluation of remedial activities for the protection of human health.

Table 6-1
Risk Assessment Results for SWMUs and SWMU Groups
Summary of Total SLCRs and SLHIs

SWMU or SWMU Group	SWMU Description	Future Commercial/Industrial Worker		Future Construction Worker		Future Utility/Maintenance Worker		Current Non-BSC Commercial/Industrial Worker		Trespasser		Future Marina Worker		Future Greenway User		Present/Future Fenceline Resident	
		Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI
Slag Fill Areas																	
SFA-1	Zone 2 SWMUs: S-1,S-2,S-4,S-5,S-6,S-7, S-20,S-27	3×10^{-3} - ambient 3×10^{-3} - indoor	7.9 - ambient 22 - indoor lead	2×10^{-4}	15.1, lead	✓	2.6, lead	∞	∞	✓	∞, lead	∞	∞	∞	∞	∞	∞
SFA-2	SWMU S-11 and S-22: Landfill K and Acid Tar Pit North	4×10^{-4} - ambient 8×10^{-3} - indoor	71 - ambient 1,841 - indoor	5×10^{-4}	679	✓	137	✓	1.6	✓	∞	✓	4.9	✓	∞	✓	∞
S-3	Surface Impoundment C	✓ - ambient/indoor	1.1-ambient/indoor lead	∞	✓, lead	∞	∞, lead	∞	∞	∞	∞, lead	∞	∞	∞	∞	∞	∞
S-8	Surface Impoundment H	✓-ambient/indoor	5.5 - ambient/indoor lead	✓	2.2, lead	✓	∞, lead	∞	∞	∞	∞, lead	∞	∞	∞	∞	∞	∞
S-10	Slag Quench Area J	✓-ambient ∞-indoor	5.8-ambient ∞-indoor	∞	2.8	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
S-14	General Rubble Landfill N	✓-ambient/indoor	14.8 -ambient/indoor	✓	3.6	✓	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
S-15	General Rubble Landfill O	∞ -ambient/indoor	∞, ✓-ambient/indoor	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
S-16	Lime Stabilized SPL Sludge/Slag Landfill	∞ -ambient/indoor	∞ - ambient/indoor	∞	∞	∞	∞	NE	NE	∞	∞	NE	NE	NE	NE	NE	NE
S-17	Vacuum Carbonate Blowdown - Landfill Q	✓-ambient/indoor	5.9 - ambient/indoor	✓	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
S-18	Lime/Kish Landfill	✓-ambient/indoor	8.0 -ambient/indoor lead	✓	2.5, lead	✓	∞, lead	∞	∞	∞	∞, lead	∞	∞	∞	∞	∞	∞
S-19	Murphy's Mountain Landfill	✓-ambient/indoor	1.5 - ambient/indoor	✓	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
S-21	Sludge Storage Area	✓-ambient/indoor	3.2 - ambient/indoor lead	✓	∞, lead	∞	∞, lead	∞	∞	∞	∞, lead	∞	∞	∞	∞	∞	∞
S-23	Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill	✓ - ambient 3×10^{-4} - indoor	2.2 - ambient 73 - indoor	3×10^{-4}	35	✓	7.0	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
S-24	Tar Pit North of Lime Plant	✓ - ambient 8×10^{-3} - indoor	20 - ambient 1,839 - indoor	5×10^{-4}	964	✓	204	✓	∞	∞	∞	∞	∞	∞	∞	✓	∞
S-25	Landfill/Impoundment Under North End of Coal Pile	NE	NE	∞	∞	∞	∞	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
S-26	Fill Area Near Coke Battery 8	✓-ambient/indoor	3.8 - ambient 30 - indoor	✓	56	∞	4.5	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
S-28	Drum Landfill	✓-ambient/indoor	1.7 - ambient/indoor	✓	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞

Table 6-1
Risk Assessment Results for SWMUs and SWMU Groups
Summary of Total SLCRs and SLHIs

SWMU or SWMU Group	SWMU Description	Future Commercial/Industrial Worker		Future Construction Worker		Future Utility/Maintenance Worker		Current Non-BSC Commercial/Industrial Worker		Trespasser		Future Marina Worker		Future Greenway User		Present/Future Fenceline Resident	
		Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI	Cancer - SLCR	Noncancer-SLHI
Process Area SWMUs																	
PA-1	SWMUs P-1, P-2, P-3, P-4, P-5	✓ - ambient 1 x10^{-3} - indoor	1.1 - ambient 286 - indoor	✓	585, lead[(1)]	✓	52, lead[(1)]	✓	1.1	∞	∞	∞	∞	∞	∞	∞	∞
PA-2	SWMUs P-6 and P-7	2 x 10^{-4} - ambient 1 x 10^{-3} - indoor	∞ - ambient 273 - indoor	✓	580	✓	52	✓	∞	∞	∞	∞	∞	∞	∞	∞	∞
PA-3	SWMUs P-9 and P-10	✓ - ambient 1 x 10^{-3} - indoor	∞ - ambient 285 - indoor	✓	580	✓	52	✓	∞	∞	∞	∞	∞	∞	∞	∞	∞
P-11	Benzol Plant Tank Storage Area	✓ - ambient 2 x 10^{-3} - indoor	13 - ambient 526 - indoor	✓	642	✓	56	✓	3.0	∞	∞	∞	∞	∞	∞	✓	∞
P-12	Spill Cleanup Storage Area	✓ - ambient 2 x 10^{-3} - indoor	1.6 - ambient 526 - indoor	✓	605	✓	60	✓	3.0	∞	∞	∞	∞	∞	∞	✓	∞
P-18	Blast Furnace Cooling Tower and Hot & Cold Wells	✓ - ambient 1 x 10^{-3} - indoor	5.1 - ambient 273 - indoor	✓	581, lead[(1)]	✓	52, lead[(1)]	✓	5.1	∞	∞	NE	NE	NE	NE	NE	NE
Tank Farm	SWMUs P-8, P-74, P-75	3 x 10^{-3} - ambient/indoor	30 - ambient 91 - indoor	5 x 10^{-4}	97	✓	19	✓	∞	✓	∞	∞	∞	∞	∞	∞	∞
P-63	Former Mill Scale Storage Area No. 2	✓-ambient/indoor	1.4 - ambient/indoor	✓	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
P-73	Drum Storage Area East of Cold Strip Mill	✓-ambient/indoor	2.5 - ambient/indoor	✓	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞

SLCR Screening-Level Cancer Risk
SLHI Screening-Level Hazard Index
Lead Lead is not evaluated in either the SCR or the SLHI. Exceedances of the lead RBSL for surface or subsurface SWMU material noted as "Lead" in the SLHI column.
✓ Benchmarks not exceeded. (Cancer risk: 1 x 10^{-4}; Hazard Index of 1.0)
∞ No RBSLs exceeded.
NE Receptor scenario not evaluated for this SWMU/SWMU group
(1) No RBSL for lead in pit water calculated. Lead concentrations at these locations exceed the drinking water action level.

Table 6-2
Risk Assessment Results - Summary of Total SLCRs and SLHIs
Watercourses and Groundwater

Watercourse or Groundwater Evaluation	Future Commercial/Industrial Worker		Future Utility/Maintenance Worker		Trespasser		Future Construction Worker		Current Ship Canal Maintenance Worker		Future Ship Canal Maintenance Worker		Present/Future Recreational Bather		Present/Future Fish Consumer		Present/Future Off-Site Water Consumer		Future Marina Worker		Future Greenway User		Curren Non-BSC Commercial/Industrial Worker		Present/Future Fenceline Resident	
	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI	Cancer-SLCR	Noncancer - SLHI
Blasdell Creek	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	✓	ns	✓	ns	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Ship Canal	NE	NE	NE	NE	NE	NE	NE	NE	ns	ns	ns	ns	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Smokes Creek	✓ - ambient 5×10^{-4} - indoor	10.0 - ambient 218 - indoor	ns	ns	ns	ns	✓	4.0	NE	NE	NE	NE	✓, lead	ns, lead	✓, lead	ns, lead	ns	ns	NE	NE	NE	NE	NE	NE	NE	NE
North Return Water Trench	NE	NE	✓	ns	NE	NE	✓	ns	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
South Return Water Trench	NE	NE	✓	1.1	NE	NE	✓	ns	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Lake Erie	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	ns	ns	✓	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Site-Wide Groundwater	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	ns	ns	ns	ns
Zone 1 Groundwater	ns - ambient/indoor	ns - ambient/indoor	ns	ns	ns	ns	ns	ns	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	ns	ns	ns	ns	NE	NE	NE	NE
Zone 5 Groundwater	ns - ambient/indoor	ns - ambient/indoor	ns	ns	ns	ns	ns	ns	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

SLCR	Screening-Level Cancer Risk
SLHI	Screening-Level Hazard Index
Lead	Lead is not evaluated in either via the SLCR or the SLHI. RBSLs were not calculated for lead in surface water. Exceedance of drinking water action level noted.
✓	Benchmarks not exceeded. (Cancer risk: 1×10^{-4}; Hazard Index of 1.0)
ns	No RBSLs exceeded.
NE	Receptor scenario not evaluated for this watercourse.

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Tab: Waterways

7.0

7.0 REFERENCES

American Society for Testing and Materials (ASTM). 1995. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Site*. Standard E 1739-95. West Conshohocken, PA.

Ames, B.N., Magaw, R. and Gold, L.S. 1987. *Ranking possible carcinogenic hazards*. Science. 236:271-273.

Bethlehem Steel Corporation (BSC) 1997. *Human Health Risk Assessment Work Plan.* Bethlehem Steel Corporation, Lackawanna, NY. April.

Bethlehem Steel Corporation (BSC) 1998. *Human Health Risk Assessment for Bethlehem Steel Corporation's Lackawanna, New York Site. Revised Final Interim Deliverable Number 1: Detailed Process for Selection of Chemicals of Potential Concern and Identification of Toxicological Criteria.* Bethlehem Steel Corporation, Lackawanna, NY. December.

Bethlehem Steel Corporation (BSC) 1999. *Human Health Risk Assessment for Bethlehem Steel Corporation's Lackawanna, New York Site. Interim Deliverable Number 2: Exposure Pathway Conceptual Site Model and Tier 1 Equations and Parameter Values.* Bethlehem Steel Corporation, Lackawanna, NY. January.

New York State Department of Environmental Conservation (NYSDEC). 1998. *Ambient Water Quality Standards and Guidance Values*.

Occupational Safety and Health Administration (OSHA). 2004. *Permissible Exposure Limits*. http://www.osha.gov/SLTC/pel.

Risk Assessment Information System (RAIS). 2004. *Chemical-Specific Permeability Coefficients.* http://risk/lsd.ornl.gov/cgi-bin/tox.

United States Environmental Protection Agency (USEPA). 1988a. *RCRA Facility Assessment, Bethlehem Steel Corporation, Lackawanna Plant*. EPA/330/2-88/054. Denver, CO: National Enforcement Investigations Center. September.

United States Environmental Protection Agency (USEPA). 1988b. *Recommendations for and Documentation of Biological Values for Use in Risk Assessment.* EPA600/6-87/008, NTIS PB 88-179874/a-c. February.

United States Environmental Protection Agency (USEPA). 1989a. *Risk Assessment Guidance for Superfund, Volume 1. Human Health Evaluation Manual (Part A)*, Interim Final. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.

United States Environmental Protection Agency (USEPA). 1989b. *Hazardous Waste Treatment, Storage, and Disposal Facilities. OAQPS, Air Emissions Models.* EPA/450/3-87/026.

United States Environmental Protection Agency (USEPA). 1991a. *Risk Assessment Guidance for Superfund, Volume 1. Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*, interim. Office of Emergency and Remedial Response, Washington, D.C. PB92-963333.

United States Environmental Protection Agency (USEPA). 1991b. *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors."* Directive 9285.6-03. Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch, Washington, D.C.

United States Environmental Protection Agency (USEPA). 1991c. *National Primary Drinking Water Standards. Lead and Copper Rule.* 56 FR 26460, June 7, 1991.

United States Environmental Protection Agency (USEPA). 1991d. *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions.* Office of Solid Waste and Emergency Response. OSWER Directive 9355.0-30. April.

United States Environmental Protection Agency (USEPA). 1992a. *Dermal Exposure Assessment: Principles and Applications.* Office of Health and Environmental Assessment. Washington DC. EPA/600/8-91/011B. January.

United States Environmental Protection Agency (USEPA). 1992b. *Supplemental Guidance to RAGS: Calculating the Concentration Term.* Office of Solid Waste and Emergency Response. Washington DC. Publication 9285.7-081. May.

United States Environmental Protection Agency (USEPA). 1994. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.* OSWER Directive No. 9355.4-12. Office of Emergency and Remedial Response, Washington, DC EPA/540F-94/043, PB94-983282. August.

United States Environmental Protection Agency (USEPA). 1996a. *Soil Screening Guidance: Technical Background Document.* Office of Solid Waste and Emergency Response. Office of Emergency and Remedial Response; Hazardous Site Control Division. May, EPA/540/R-96/018.

United States Environmental Protection Agency (USEPA). 1996b. *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.* Technical Review Workgroup for Lead. Office of Emergency and Remedial Response. December.

United States Environmental Protection Agency (USEPA). 1997a. *Health Effects Assessment Summary Tables (HEAST).* USEPA, Environmental Criteria and Assessment, Office of Research and Development. Cincinnati, Ohio. EPA 540/R-97-036. July.

United States Environmental Protection Agency (USEPA). 1997b. *Exposure Factors Handbook.* Office of Research and Development. Washington DC. EPA/600/P-95/002F. August.

United States Environmental Protection Agency (USEPA). 2000a. Risk-Based Concentration Table, Region III. October 2000.

United States Environmental Protection Agency (USEPA). 2000b. *Integrated Risk Information System* IRIS). Cincinnati, OH.

United States Environmental Protection Agency (USEPA). 2002. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites.* Office of Solid Waste and Emergency Response. Washington DC. OSWER 9285.6-10. December.

United States Environmental Protection Agency (USEPA). 2003. *Comments on Revised Interim Deliverable No. 2 of the Draft Human Health Risk Assessment.* Letter from Dale J. Carpenter, Project Manager, USEPA Region 2 to Leo Kaercher, Director Environmental Engineering, Bethlehem Steel Corporation. April 3, 2003.

APPENDIX A

HHRA ID No. 1
(BSC 1998)

Bethlehem Steel Corporation

ROBERT B. ALLEN
MANAGER
WASTE MANAGEMENT AND REMEDIATION
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BETHLEHEM, PA 18016

PHONE: (610) 694-1210

December 4, 1998

Mr. Dale J. Carpenter
Project Manager
United States Environmental Protection Agency - Region II
RCRA Programs Branch
Division of Environmental Planning and Protection
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Revised Final Interim Deliverable No. 1
Human Health Risk Assessment
Bethlehem Steel Corporation, Lackawanna Site RFI
Administrative Order on Consent (AOC)
Docket No. II RCRA-90-3008(h)-0201

Dear Mr. Carpenter:

Transmitted herewith is Revised Final Interim Deliverable No. 1 (ID No. 1), Human Health Risk Assessment, for the Bethlehem Steel Corporation (BSC) Lackawanna site. These revisions have been made in response to your letter dated July 1, 1998 and subsequent, related correspondence (see Attachment A).

In the remainder of this letter, we describe the major changes that have been made to the May 1998 version of this document and how these changes are noted and provided in this submittal. We also respond to certain Agency comments that either requested clarification or have not been addressed in the revision of ID No. 1.

Document Revisions

A tabulation of the revisions that have been made to the May 1998 Final ID No. 1 is provided in attached Table 1. As noted in the table, some of the revisions are made for reasons other than Agency comments. Chief among these are the following:

- Inclusion of data from subsurface material and groundwater samples collected in 1997 from the Benzol Yard (SWMU S-11) for BSC by R.E. Wright - the final

report containing these data was not available for use in the RFI and risk assessment until after the May 1998 Final ID No. 1 was prepared

- Inclusion of data for the #17 Pit in the Benzol Yard – These data, collected in 1998, were not available until after the May 1998 ID No. 1 was submitted to the Agencies.

- Revision of EPA Region III Risk-Based Criteria (RBCs) - revised RBCs recently published by EPA Region III have been incorporated into COPC selection in ID No. 1

- Use of 1998 revised New York State guidance values for groundwater

- Use of new versions of HEAST and updated IRIS files.

Revisions to the May 1998 Final ID No. 1 are provided in the form of pages to be inserted. These pages have a December 1998 date on the lower right corner of each page. On these pages, text that has been added is indicated by underlining; text that has been deleted is indicated by ~~strikethrough~~, except for the Table of Contents, which has been newly generated and does not contain marked changes. Instructions for inserting pages into ID No. 1 are provided in Attachment B.

Agency Comments

As noted above, some Agency comments needed to be addressed in this venue rather than in the document itself. These questions, and BSC's responses, are provided in the following paragraphs.

Interim Deliverable No. 1 Comments

I.a) BSC states on page 3-3 of the February version of ID 1 that TCLP data will not be included in the risk assessment data set. However, the COPCs selected for North and South Return Trench sediments appear to be based on TCLP data (page 4-42, Table 4-49 of Final ID 1). If the information presented in the Data Summary Document, Tabs 3 and 6, is correct, BSC needs to clarify this discrepancy.

BSC Response: The sediment data presented in the October 31, 1998 Data Summary Document Phases I, II-A, II-b, and III, Tabs 3 and 6, are correct;

however, these are not the data used to select sediment COPCs for these watercourses. The sediment data used for COPC selection for the North and South Return Water Trenches are found in the October 21, 1998 [Phase II-C] Data Summary Document, Tabs C and G.

I.a) **Also, the Final ID 1 includes other changes required as a result of, for example, "newly identified data used in the COPC selection..." and "...updated background levels." as stated on page 2 of BSC's transmittal letter for the May 1998 Final ID 1. BSC states that Appendix A has been revised to "...include newly identified data used in the COPC selection that were not previously included..." and to "...included the updated background levels." BSC needs to identify exactly the "newly identified data" and "updated background levels" referenced in the transmittal letter.**

BSC Response: The "updated background levels" were those resulting from the modified approach to background levels made in response to Agency comments. Because additional data changes have been made in this as well as the May 1998 submittal, we suggest that the Agency treat the data tables in ID No. 1 as the current version of the data set for the Lackawanna site. They were taken directly from the current electronic database.

3.0 Editorial Comments

Page 3-10 of the February 1998 version of the ID 1 lists four bullet items which do not appear in the May 1998 version of ID 1 . BSC needs to indicate that these items were deleted by strike outs.

BSC Response: In the May 1998 version of ID No. 1, the material previously provided (February 1998 version) on page 3-10 was completely re-written. As elsewhere in the May 1998 version, where this occurred, the replaced text was not shown. If the Agency needs to have a specific documentation of the deleted text, we will provide it in the form of an additional replacement page(s) for the May 1998 version. Attempting to show the material deleted from the February 1998 version in the December 1998 version would be very confusing.

****

If you have any questions regarding this submittal, please contact me at 610-694-1210.

Very truly yours,
BETHLEHEM STEEL CORPORATION

R. B. Allen

Robert B. Allen
Manager, Site Management and Remediation

Enclosure

cc: Permits Administration Branch (EPA-II)
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BSC(37)152

ATTACHMENT A

LIST OF CORRESPONDENCE REGARDING REVISION OF FINAL INTERIM DELIVERABLE NO. 1 AND INTERIM DELIVERABLE NO. 2, BETHLEHEM STEEL CORPORATION'S LACKAWANNA, NY SITE

Date	Type	Subject
July 1, 1998	Letter from Dale J. Carpenter (USEPA Region II) to Robert B. Allen (BSC)	Comments on BSC's April 17, 1998 Response Letter, Final Interim Deliverable No. 1 Submitted May 1, 1998, and Draft Interim Deliverable No. 2 Submitted May 8, 1998
July 20, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II)	Response to Agency Letter Dated July 1, 1998
August 27, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II)	Request for Meeting to Discuss EPA Comments in August 14, 1998 Letter
September 10, 1998	Letter from Amy R. Chester (USEPA Region II) to Morgan G. Graham (Phillips, Lytle, *et al*)	EPA and BSC Meeting on September 16, 1998
September 17, 1998	Letter from Amy R. Chester (USEPA Region II) to Morgan G. Graham (Phillips, Lytle, *et al*)	The request for BSC to submit a Meeting Summary to the EPA by September 25, 1998
September 22, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II), Amy Chester (USEPA Region II)	Summary of and Proposals for Additional Agreements Related to the EPA/BSC meeting on September 16, 1998
October 21, 1998	Letter from Dale J. Carpenter (USEPA Region II) to Robert B. Allen (BSC)	Comments on BSC's September 22, 1998 "Summary of and Proposals for Additional Agreements Related to the EPA/BSC Meeting on September 16, 1998"
November 4, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II)	Intention to modify Final Interim Deliverable No. 1 and Interim Deliverable No. 2 in response to EPA's July 1, 1998, September 25, 1998, and October 21, 1998 comments.

ATTACHMENT B

INSTRUCTIONS FOR INSERTING PAGES INTO INTERIM DELIVERABLE NO. 1, HUMAN HEALTH RISK ASSESSMENT, BETHLEHEM STEEL CORPORATION'S LACKAWANNA, NY SITE

Section	Remove	Insert
Slip sheets for front and spine of binder	Sheets dated May 1998	**Sheets dated December 1998**
Cover page	Page dated May 1998	**Page dated December 1998**
Transmittal Letter	Letter dated May 1, 1998	**Letter dated December 4, 1998**
Table of Contents	i through vii	**i through vii**
Executive Summary	Page ES-1 Page ES-3 ES-7 through ES-11	**Page ES-1** **Page ES-3** **Pages ES-7 through ES-13**
Section 2.0	Pages 2-1 and 2-2 Page 2-5 Page 2-7 through 2-9	**Pages 2-1 and 2-2** **Page 2-5** **Page 2-7 through 2-9**
Section 3.0	Entire Section 3.0	**Entire Section 3.0**
Section 4.0	Entire Section 4.0	**Entire Section 4.0**
Section 5.0	Entire Section 5.0	**Entire Section 5.0**
Appendix A	Entire appendix	**New appendix**
Appendix B	Entire appendix	**New appendix**
Appendix C	Entire appendix	**New appendix**
Appendix D	Entire appendix	**New appendix**
Appendix E	Entire appendix	**New appendix**
--	--	**Appendix E.1**
--	--	**Appendix E.2**
Appendix F	Entire appendix	**New appendix**
Appendix G	Entire appendix	**New appendix**
Appendix H	Entire appendix	**Appendix deleted**

TABLE 1

SUMMARY OF MAJOR REVISIONS TO INTERIM DELIVERABLE NO. 1
HUMAN HEALTH RISK ASSESSMENT, LACKAWANNA SITE

Page Number	Section or Item	Change	Reason for Change
2-2	2.1	Description of SWMU S-13 moved to this section	This is one of the SWMUs that will be considered qualitatively rather than quantitatively in the risk assessment
2-7	Table 2-2	SWMU S-13 deleted from table	
3-9	3.2.3, items 4 and 5	"EPA Region III Risk-Based Concentration" replaced with "COPC screening level"	Duplicates analysis was redone using medium-specific COPC screening levels used for COPC selection
3-12	3.2.3.4	Sentence deleted	Unnecessary
3-13	3.3	Change in definition of surface water bodies of interest	EPA Comment 1.c
	3.3.1	Addition of references to North and South Return Water Trenches	
		Addition of receptor scenarios potentially exposed to groundwater COPCs via surface water flow	
		Addition of recorded worker exposure to Ship Canal	
3-15		Addition of Ship Canal as source for recreational bathers, fish consumers, and off-site water consumers	
		Deletion of Ship Canal flow information	Placed in Appendix E.1
3-16 to 3-17	3.3.1	Discussion of return water trenches moved to Section 3.6	More appropriate location
3-18	Table 3-3	Addition of wells in the Ship Canal Discharge Area	EPA Comment 1.c
3-20	Table 3-4	Addition of wells BPP-1 to BPP-9, MWN-21C, and MWN-27C (Coke Oven Area), A4-10A and A4-10B (Smokes Creek Area), and A2-5A and A2-5B (Zone 2)	Addition of data from wells sampled by R.E. Wright in 1997
		Addition of well MWN-34A to Coke Oven Area group	Mistakenly omitted previously
		Deletion of "wells" MW-2D3A, MW-2D3B, MW-2D3C (Zone 2), MW-1D3A, MW-1D3B, MW-1D3C (Zone 4), and MW-1U1A, MW-1U1B, MW-1U1C (Zone 4).	The inclusion of these "wells" is a prior error in this table; these are not wells but rather specific samples from wells MW-2D3, MW-1D3, and MW-1U1.
3-21 to 3-25	Table 3-5	Addition of more samples to the risk assessment data base	Addition of data from samples collected by R.E. Wright in 1997
3-27 to 3-28	3.6	Addition of return water trench descriptions from Section 3.3.1	More appropriate location

TABLE 1

SUMMARY OF MAJOR REVISIONS TO INTERIM DELIVERABLE NO. 1
HUMAN HEALTH RISK ASSESSMENT, LACKAWANNA SITE

Page Number	Section or Item	Change	Reason for Change
3-28	3.6	Addition of return water trench surface water as potential exposure medium for future construction workers	EPA Comment 1.c
3-29	3.7	Addition of Ship Canal sediment as potential exposure medium for future maintenance workers	EPA Comment 1.c
3-29	3.8	New data collected in 1998 for Pit # 17 of SWMU P-11	
4-2 to 4-7	Table 4-1	Changes reflect (1) addition of Ship Canal Discharge Area groundwater to analysis, and (2) altered COPC selection results	EPA Comment 1.c and use of updated EPA Region III RBC table for COPC screening
4-12	Table 4-4, Section 4.2.1.2, Table B-2	Cadmium no longer a COPC in SWMU S-8 surface material	EPA Region III RBC for Cd increased from 39 to 78 mg/kg
4-14	Table 4-8, Section 4.2.2.3, and Table B-6	Chromium added as COPC in SWMU S-18 surface material	EPA Region III RBC for Cr^{+6} decreased from 390 to 230 mg/kg
4-15	Table 4-10, Section 4.2.3.2, and Table B-8	Chromium added as COPC in SWMU Group PA-2 surface material	EPA Region III RBC for Cr^{+6} decreased from 390 to 230 mg/kg
4-16	Table 4-11, Section 4.2.3.3, and Table B-9	Chromium added as COPC in SWMU Group PA-4 surface material	EPA Region III RBC for Cr^{+6} decreased from 390 to 230 mg/kg
4-18	Table 4-14, Section 4.2.5.2, and Table B-12	Chromium added as COPC in SWMU P-63 surface material	EPA Region III RBC for Cr^{+6} decreased from 390 to 230 mg/kg
4-20	Table 4-16, Section 4.3.1.1, and Table C-1	Thallium added as COPC in SWMU Group SFA-1 subsurface material	EPA Region III RBC for thallium decreased from 6.3 to 5.5 mg/kg
4-26	Table 4-24, Section 4.3.3.4, and Table C-9	Thallium added as COPC in SWMU S-23 subsurface material	EPA Region III RBC for thallium decreased from 6.3 to 5.5 mg/kg
4-26	Table 4-25, Section 4.3.4.1, and Table C-10	Thallium added as COPC in SWMU Group PA-1 subsurface material	EPA Region III RBC for thallium decreased from 6.3 to 5.5 mg/kg
4-27	Table 4-26, Section 4.3.4.2, and Table C-11	Thallium added as COPC in SWMU Group PA-3 subsurface material	EPA Region III RBC for thallium decreased from 6.3 to 5.5 mg/kg
4-28	Table 4-27 and Table C-12	New tables and section	New subsurface data collected in 1997 by R.E. Wright from SWMU P-11
4-32	Table 4-33, Section 4.4.1.1, and Table D-1	Removal of manganese as a COPC in Lake Erie Discharge Area groundwater	Mn is not a COPI
		Addition of organics as COPCs	From additional wells (see above re: page 3-20) added to data base

TABLE 1

SUMMARY OF MAJOR REVISIONS TO INTERIM DELIVERABLE NO. 1
HUMAN HEALTH RISK ASSESSMENT, LACKAWANNA SITE

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4-33	Table 4-34, Section 4.4.1.2, and Table D-2	Addition of organics as COPCs in Smokes Creek Discharge Area groundwater	From additional wells (see above re: page 3-20) added to data base
4-35	Table 4-35, Section 4.4.1.3 and Table D-3	New tables and section	EPA Comment 1.c (addition of Ship Canal as potential source area)
4-40	Table 4-44, Section 4.4.3, and Table D-12	Addition of organics as COPCs	From additional wells added to data base
4-43	Table 4-48, Section 4.5.4, and Table E-4	New tables and section	EPA Comment 1.c (addition of return water trench surface water as potential exposure medium)
4-44	Table 4-49, Section 4.5.5. and Table E-5	New tables and section	EPA Comment 1.c (addition of return water trench surface water as potential exposure medium)
4-44	Table 4-50, Section 4.5.6, and Table E-6	New tables and section	EPA Comment 1.c (addition of Ship Canal surface water as potential exposure medium)
4-45	Table 4-51, Section 4.5.7, and Table E-7	New tables and section	
4-49	Table 4-55, Section 4.6.4, and Table F-4	New tables and section	North and South return water trenches considered separately
4-50	Table 4-56, Section 4.6.5, and Table F-5	New tables and section	
4-51	Table 4-57, Section 4.6.6, and Table F-6	New tables and section	EPA Comment 1.c (addition of Ship Canal sediment as potential exposure medium)
4-52	Table 4-59, Section 4.7, and Table G-2 (was Table H-1 in previous draft)	Fluorene eliminated as a COPC	Based on new data collected in 1998 for Pit # 17 in SWMU P-11
	Section 5.0	Changes in toxicity criteria and RBCs	Used new versions of EPA Region III RBCs and HEAST, updated IRIS files
	Table C-11	Replacement of second "benzo(a)pyrene" entry with "benzo(k)fluoranthene"	Mistaken entry; corrected per EPA editorial comment #5
	Table D-12 (formerly D-11)	Removal of acetone from chemical list	Acetone is not a COPI

HUMAN HEALTH RISK ASSESSMENT FOR BETHLEHEM STEEL CORPORATION'S LACKAWANNA, NEW YORK SITE

REVISED FINAL INTERIM DELIVERABLE NUMBER 1:
DETAILED PROCESS FOR SELECTION OF CHEMICALS OF POTENTIAL CONCERN AND IDENTIFICATION OF TOXICOLOGICAL CRITERIA

BETHLEHEM STEEL CORPORATION
2600 HAMBURG TURNPIKE
LACKAWANNA, NEW YORK 14218

December 1998

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G SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN QUENCH PITS

H SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN BENZOL YARD #17 PIT

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Bethlehem Steel Corporation (BSC) Lackawanna site was used for integrated iron and steel production from the turn of the century until 1983, when iron- and steel-making activities ceased. The only remaining operating BSC divisions at the site today are (1) the Coke Oven Division and (2) the Galvanized Products Division. A Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) conducted in 1988 identified 104 Solid Waste Management Units (SWMUs) that may have released hazardous constituents, and six watercourses that may have been impacted by potential hazardous constituent releases from the SWMUs (Table ES-1).

In 1990, BSC and the U.S. Environmental Protection Agency (EPA) Region II negotiated and entered into an Administrative Order on Consent (AOC) to conduct a RCRA Facility Investigation (RFI). The AOC was issued pursuant to Section 3008(h) of RCRA. The AOC directed BSC to perform a phased, site-wide RFI to determine the nature, extent, and potential risks to human health and/or the environment of any hazardous constituents released from SWMUs into soils, air, groundwater, sediment, and surface water at or near the Lackawanna site.

Since August 1990, SWMU assessment reports prepared by BSC for 59 SWMUs and one watercourse (see Table ES-1) have been approved by EPA, leaving a total of ~~45~~ 44 SWMUs and one water course units to be addressed in the RFI report. In May 1997, the EPA approved BSC's Human Health Risk Assessment Work Plan for conducting a tiered human health risk assessment for the Lackawanna site.

This document is the first of three interim deliverables to be submitted in the course of the risk assessment process. It details the methods and assumptions used to (1) identify SWMUs for consideration in the risk assessment, (2) group certain SWMUs on the basis of proximity and content, and (3) select chemicals of potential concern (COPCs) in each potential exposure medium to be carried through the risk assessment.

~~A total of 41~~42 Of the 44 SWMUs (Table ES-2) and five watercourses (Table ES-3), 41 SWMUs and the water courses will be addressed quantitatively by the Human Health Risk Assessment for the Lackawanna site. Three SWMUs will not be addressed because thee have been no releases of hazardous constituents from them. One SWMU will be addressed qualitatively in the risk assessment. Potential exposure media include surface and subsurface SWMU material, groundwater, surface water, sediment, and water in the Coke Oven Area quench pits and the Benzol Yard # 17 pit. The COPCs for the Lackawanna site Human Health Risk Assessment were selected by comparing, on a medium by medium basis for each SWMU and watercourse, the maximum concentration of each Constituent of Potential Interest (COPI) identified for each SWMU and watercourse with the maximum background concentration and appropriate, medium-specific screening levels, if available, for that COPI. Finally, EPA-approved toxicity criteria and relevant, medium-specific risk-based and regulatory concentrations are provided for each COPC. The COPC selection process is illustrated in Figure ES-1. The list of COPCs for the Lackawanna site by SWMU media, groundwater pathway, and watercourse media is provided in Table ES-4.

TABLE ES-1

SOLID WASTE MANAGEMENT UNITS AND WATERCOURSES,
BETHLEHEM STEEL CORPORATION LACKAWANNA SITE[1]

SWMU Number	Unit Description
P -1	Quench Water Pit, North Station
P -2	Quench Water Pit, Arctic Station
P -3	Quench Water Pit, Central Station
P -4	Quench Water Pit, A Station
P -5	Quench Water Pit, B Station
P -6	Lime Sludge Settling Basin
P -7	Abandoned Lime Sludge Settling Basin
P -8	Waste Oil Storage Tanks [in Tank Farm]
P -9	Abandoned Tar Decanter Sludge Pits
P -10	Contaminated Soil in area Near Ball Mill
P -11	Benzol Plant Tank Storage Area
P -12	Spill Cleanup Soil Storage Area
P -13	[Blast Furnace] A-B Primary Thickener *
P -14	[Blast Furnace] C Primary Thickener *
P -15	[Blast Furnace] F-G Primary Thickener *
P -16	[Blast Furnace] H-J Primary Thickener *
P -17	[Blast Furnace] Final Thickener *
P -18	[Blast Furnace] Cooling Tower and Hot & Cold Wells
P -19	[Sinter Plant] Thickener *
P -20	[Sinter Plant] Scrubber Sump *
P -21	[BOF] North Scalping Tank *
P -22	[BOF] South Scalping Tank *
P -23	[BOF] Primary Thickener *
P -24	[BOF] North Clarifier *
P -25	[BOF] South Clarifier *
P -26	[BOF] Cooling Tower *
P -27	[BOF] Final Thickener *
P -28	[Slab Mill] Main Settling Tank *
P -29	[Slab Mill]Five Sand Filters *
P -30	[Slab Mill] North Scale Pit *
P -31	[Slab Mill] South Scale Pit *
P -32	[Slab Mill] Scarfer Pit *
P -33	10" & 12" [Bar] Mills Scale Pit *
P -34	13" [Bar] Mill Scale Pit *
P -35	[Bar Mill] Process Water Pit *
P -36	[Bar Mill] Sand Filter *
P -37	[Bar Mill] Treated Water Storage Tank *
P -38	54" Mill Scale Pit *
P -39	48" Mill Scale Pit *
P -40	14", 18", 28", & 35" Mills Scale Pit *
P -41	Main Settling Tank, [South Mills] *
P -42	Five Sand Filters, [South Mills] *
P -43	44" Mill Scale Pit *
P -44	40" Mill Scale Pit *
P -45	36" Mill Scale Pit *
P -46	32" Mill Scale Pit *

1 **Unit names are as shown in RFA (EPA 1988), unless changed as shown with brackets.**

TABLE ES-1 (Continued)

SWMU Number	Unit Description
P -47	30" Mill Scale Pit *
P -48	21" Mill Scale Pit *
P -49	44" Mill Scarfer Pit *
P -50	40" Mill Scarfer Pit *
P -51	30" & 21" Mills Scarfer Pit *
P -52	Main Settling Tank, [North Mills] *
P -53	Seven Sand Filters, [North Mills] *
P -54	[Hot Strip Mill] Runout Table **Spray** Water Pit *
P -55	[Hot Strip Mill] Scale Pit *
P -56	[Hot Strip Mill] Main Settling Basin *
P -57	[Hot Strip Mill] Twenty-Four Sand Filters *
P -58	Bar Mill East Acid Sump **[Coil Pickling Area]***
P -59	Bar Mill West Acid Sump **[Billet Prep. Area]***
P -60	Bar Mill Waste Solution Tank *
P -61	Hot Strip Mill Acid Pit *
P -62	Mill Scale Storage Area 1 *
P -63	**[Former]** Mill Scale Storage Area 2
P -64	Scale Pit at 8" Bar Mill *
P -65	Tandem Mill Sump *
P -66	Pickling Rinse Water Pit*
P -67	Spent Pickle Liquor Pit *
P -68	Galvanizing Mill Sump *
P -69	Main Treatment Tank and Associated Facilities [at Water Quality Control Station #7]*
P -70	Hot Strip Mill Waste Oil Storage Tank [at Water Quality Control Station #7] *
P -71	Galvanizing Mill Pump Station **Wet Well** for Old Acid Sewer **Line***
P -72	Galvanizing Mill Sump Sludge Storage Area *
P -73	**[Former]** Drum Storage Area **East of Cold Strip Mill**
P -74	[Solid Fuel Mix Storage Piles in Tank Farm][2]
P -75	Tank Storage Area **for No. 6 Fuel Oil and Petroleum Tar** [Tank Farm]
S -1	Surface Impoundment A
S -2	Surface Impoundment B
S -3	Surface Impoundment C **(Hazardous Waste Unit)**
S -4	Surface Impoundment D
S -5	Surface Impoundment E
S -6	Surface Impoundment F
S -7	Surface Impoundment G
S -8	Surface Impoundment H [not used]
S -9	Waste Pile I *
S -10	Slag Quench Area J
S -11	Landfill K, [Acid Tar Pit, South]
S -12	Asbestos Landfill L
S -13	Coal Tar Sludge **(Hazardous Waste Unit)**
S -14	General Rubble Landfill N
S -15	General Rubble Landfill O
S -16	[Lime Stabilized SPL Sludge/Slag Landfill][3]
S -17	Vacuum Carbonate Blowdown - Landfill Q

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[2] **Called "Waste Storage Piles (Tar and Tank Fuel Tank Bottoms Mixed with Coke Breeze" in RFA (EPA 1988).**

[3] **Called "Spent Pickle Liquor Sludge Landfill P (Hazardous Waste Unit)" in RFA (EPA 1988).**

TABLE ES-1 (Continued)

SWMU Number	Unit Description
S -18	Lime Dust and Kish Landfill R
S -19	Murphy's Mountain Landfill AA
S -20	Drying Area for Sludge from Impoundment F
S -21	Sludge Storage Area
S -22	Vacuum Carbonate Blowdown Impoundment South of Smoke Creek [Acid Tar Pit North]
S -23	Tar Pit Adjacent To [Lime Stabilized SPL Sludge Landfill]
S -24	Tar Pit North of Lime Plant
S -25	Landfill/Impoundment under North End of Coal Pile
S -26	Fill Area Near Coke No. Battery 8
S -27	Sludge Disposal Area [Adjacent to SWMU S-1]
S -28	Drum Landfill
S -29	Drum Landfill
	WATERCOURSES
45" x 90" Slabbing Mill Return Water Trench *	
Blasdell Creek	
South Return Water Trench	
North Return Water Trench	
Smokes Creek	
Lackawanna Ship Canal (now named the Gateway Metroport Ship Canal)	

* Units that have received a "No Further Assessment" determination from EPA.

TABLE ES-2

SWMUS ~~TO BE ADDRESSED IN RISK ASSESSMENT~~ AND ASSOCIATED MEDIA CONTAINING CHEMICALS OF POTENTIAL CONCERN

SWMU Number	Unit Description	Medium Containing Chemicals of Potential Concern		
		Surface Material	Subsurface Material	~~Quench~~ Pit Water
Coke Oven Area				
SWMU Group PA-1	**(P-1 through P-5)**	X	X	X
SWMU Group PA-2	**(P-6 and P-7)**	X		
SWMU Group PA-3	**(P-9 and P-10)**		X	
SWMU Group PA-4	**(P-11 and P-12)**	X		X
S-26 Fill Area Near Coke Battery No. 8			X	
Tank Farm Area				
SWMU Group TF	**(P-8, P-74, P-75)**	X		
Slag Fill Area Zone 2				
S-3	**Surface Impoundment C**		X	
S-8	Surface Impoundment H	X		
S-21	Sludge Storage Area	X		
S-24	Tar Pit North of Lime Plant		X	
SWMU Group SFA-1	**(S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)**	X	X	
SWMU Group SFA-2	**(S-11 and S-22)**		X	
Slag Fill Area Zone 3				
S-10	Slag Quench Area J		X	
Slag Fill Area Zone 4				
S-14	General Rubble Landfill N	X	X	
S-15	General Rubble Landfill O	X		
S-17	Vacuum Carbonate Blowdown - Landfill Q		X	
S-18	Lime/kish Landfill	X		
S-23	Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill		X	
Other Areas				
S-19	Murphy's Mountain Landfill	X		
S-25	Landfill/Impoundment under North End of Coal Pile		X	
P-63	Former Mill Scale Storage Area No. 2	X	X	
P-73	Former Drum Storage Area	X	X	

TABLE ES-3

WATERCOURSES TO BE ADDRESSED IN THE RISK ASSESSMENT AND MEDIA CONTAINING CHEMICALS OF POTENTIAL CONCERN

Watercourse	Medium Containing Chemicals of Potential Concern		
	Surface Water	Sediment	Groundwater to Surface Water
Blasdell Creek	X	X	
Lake Erie	X	X	X
Smokes Creek	X	X	X
North Return Water Trench		X	
South Return Water Trench		X	

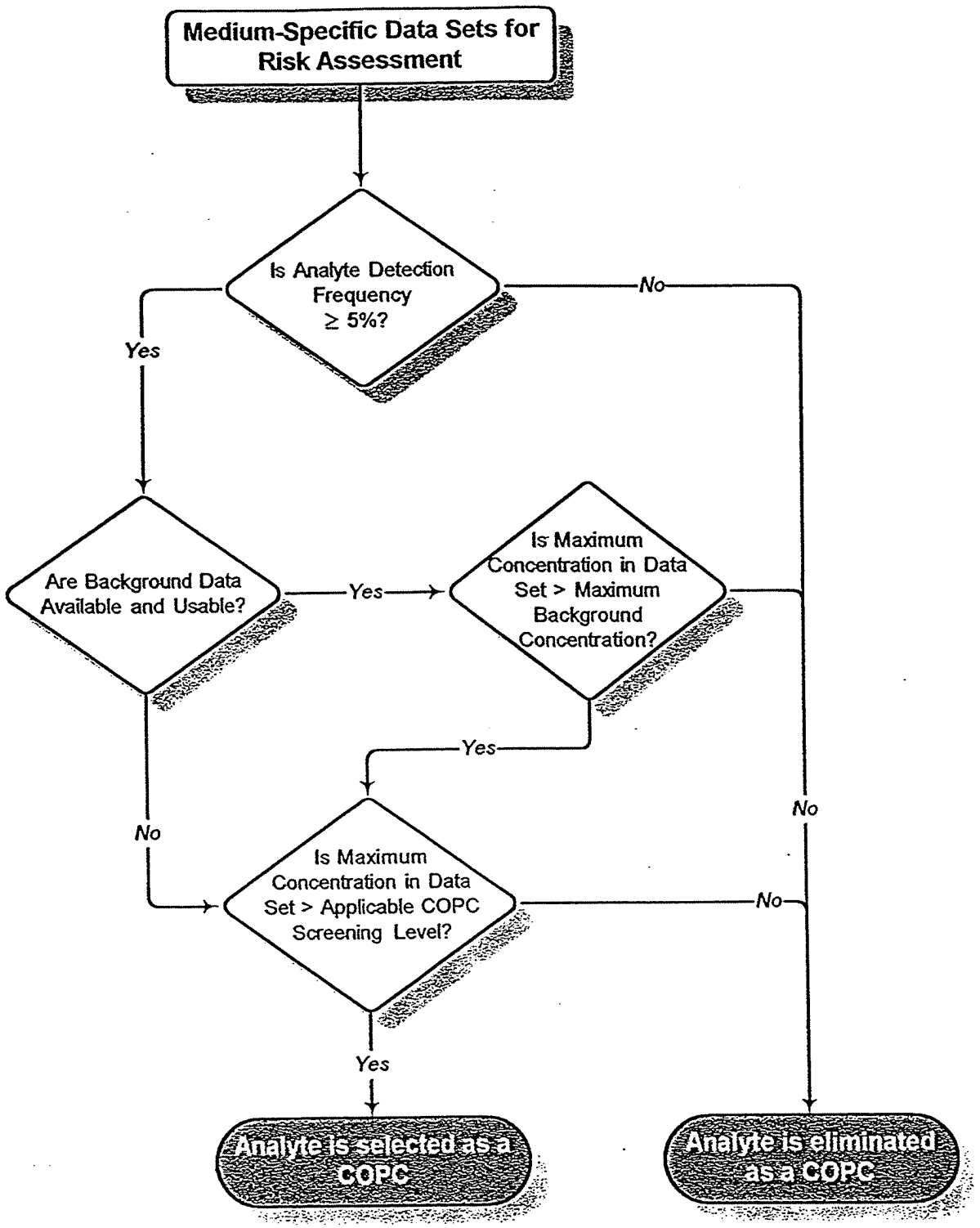

Figure ES-1
Decision Process for COPC Selection
Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

TABLE ES-4
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Volatile Organic Chemicals								
Benzene		SFA-1, SFA-2, S-14, S-23, S-24, PA-4	PA-1, P-11	Lake Erie, ~~and~~ Smokes Creek, and Ship Canal Discharge Areas	SFA Zone 1, SFA Zone 2, SFA Zone 3, SFA Zone 4, SFA Zone 5; Coke Oven, Tank Farm, and Smokes Creek Areas	Site-wide Groundwater	Smokes Creek, Ship Canal (current), and Shi pCanal (future)	
Bromodichloromethane							Smokes Creek	
Bromoform							Smokes Creek	
Carbon disulfide				Smokes Creek Discharge Area	Smokes Creek Area	Site-wide Groundwater		
Carbon tetrachloride					SFA Zone 1			
Chlorobenzene					SFA Zone 4			
Chlorodibromomethane							Smokes Creek	
Chloroform							Smokes Creek	
1,1-Dichloroethane				Lake Erie and Smokes Creek Discharge Area	SFA Zone 1, SFA Zone 2, SFA Zone 4, and Smokes Creek Areas	Site-wide Groundwater	Blasdell Creek	
1,2-Dichloroethane					SFA Zone 2		Smokes Creek	
1,2-Dichloroethene (total)				Lake Erie Discharge Area	SFA Zone 2			
Ethylbenzene			P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie Discharge Area, Smokes Creek Discharge Area~~	SFA Zone 2, SFA Zone 4, Coke Oven Area, Smokes Creek Area	Site-wide Groundwater		
Methylene chloride				Lake Erie and Ship Canal Discharge Areas	SFA Zone 1, SFA Zone 2, and SFA Zone 4	Site-wide Groundwater	Smokes Creek	

TABLE ES-4
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Pyridine				Lake Erie and Smokes Creek Discharge Areas	SFA Zone 4 and Smokes Creek Area	Site-wide Groundwater		
1,1,2,2-Tetrachlorothane		SFA-2						
Toluene		SFA-2, S-24, PA-4	P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 2, SFA Zone 3, SFA Zone 4, Tank Farm, Coke Oven and Smokes Creek Areas	Site-wide Groundwater	Ship Canal (future)	
1,1,1-Trichloroethane					SFA Zone 1			
Trichloroethene		SFA-2		Lake Erie Discharge Area	SFA Zone 2 and SFA Zone 4	Site-wide Groundwater		
Vinyl chloride				Smokes Creek Discharge Area	Smokes Creek Area		Smokes Creek	
m-Xylene and p-Xylene				Lake Erie Discharge Area	SFA Zone 2	Site-wide Groundwater		
o-Xylene				Lake Erie Discharge Area	SFA Zone 2	Site-wide Groundwater		
Xylenes (total)		SFA-2, S-24, PA-4	P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 1, SFA Zone 2, SFA Zone 3, SFA Zone 4, SFA Zone 5, Coke Oven, Tank Farm, and Smokes Creek Area	Site-wide Groundwater		
Semivolatile Organic Chemicals								
Acenaphthene				Ship Canal Discharge Area	Coke Oven Area	Site-wide Groundwater		

TABLE ES-4
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Acenaphthylene	PA-2, TF, SFA-1, ~~S-19~~	PA-3, SFA-1, SFA-2, S-10, S-14, S-23, S-24, S-26, P-73	PA-1	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 1, SFA Zone 2, SFA Zone 3, SFA Zone 4, SFA Zone 5; Coke Oven and Smokes Creek Areas	Site-Wide Groundwater	Ship Canal (future)	Smokes Creek, Blasdell Creek, and North and South Return Water Trenches, and Ship Canal
Anthracene		PA-3, S-24, S-14, and S-23		Lake Erie Discharge Area	SFA Zone 4	Site-wide Groundwater		
Benzo(a)anthracene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-10, S-14, S-17, S-23, S-24, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, ~~and~~ North Return Water Trench, and Ship Canal~~s~~
Benzo(a)pyrene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-3, S-10, S-14, S-17, S-23, S-24, S-25, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, Lake Erie, ~~and~~ North Return Water Trench, and Ship Canal~~s~~
Benzo(b)fluoranthene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-10, S-14, S-17, S-23, S-24, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, North Return Water Trench, and Ship Canal~~Smokes Creek, Blasdell Creek, and Return Water Trenches~~
Benzo(g,h,i)perylene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-14, S-17, S-24, S-25, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, Lake Erie, North Return Water Trench, and Ship Canal~~Smokes Creek, Blasdell Creek, Lake Erie, and Return Water Trenches~~

TABLE ES-4
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Benzo(k)fluoranthene	PA-2, TF, SFA-1	PA-3, S-14, S-23, S-24		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, and North Return Water Trenches
Bis(2-ethylhexyl)phthalate				Lake Erie, and Smokes Creek, and Ship Canal Discharge Areas			Smokes Creek and, Lake Erie, and Ship Canal (current)	
Chrysene	TF, SFA-1	S-23, S-24		Ship Canal Discharge Area			Ship Canal (future)	North Return Water Trenches
Dibenz(a,h)anthracene	PA-2, TF, SFA-1	PA-1, SFA-2, S-14, S-24, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, Lake Erie, andNorth and South Return Water Trenches, and Ship Canal
2,4-Dimethylphenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas				
Fluoranthene		S-23		Smokes Creek and Ship Canal Discharge Areas				
Fluorene		SFA-2, S-24, and S-23	P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge AreasLake Erie and Smokes Creek Discharge Areas	SFA Zone 2, SFA Zone 3, SFA Zone 4, and Coke Oven Area	Site-wide Groundwater		
Indeno(1,2,3-cd)pyrene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-2, S-10, S-14, S-17, S-23, S-24, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, North Return Water Trench, and Ship CanalSmokes Creek, Blasdell Creek, and Return Water Trenches

TABLE ES-4
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
2-Methylphenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas				
3-Methylphenol and 4-Methylphenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Area				
4-Methylphenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~				
Total Cresols				Lake Erie Discharge Area				
Naphthalene		SFA-1, SFA-2, S-24, S-14, S-23, and PA-4	PA-1, P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 1, SFA Zone 2, SFA Zone 3, SFA Zone 4, SFA Zone 5; Coke Oven, Tank Farm, and Smokes Creek Areas	Site-Wide Groundwater		
Phenanthrene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-3, S-10, S-14, S-17, S-23, S-24, S-25, S-26, P-18, P-73	PA-1	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 2, SFA Zone 3, SFA Zone 4, ~~SFA Zone 5;~~and Coke Oven~~, Tank Farm, and Smokes Creek~~ Areas	Site-Wide Groundwater		Smokes Creek, Blasdell Creek, Lake Erie, North Return Water Trench, and Ship Canal~~Smokes Creek, Blasdell Creek, Lake Erie, and Return Water Trenches~~
Phenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas				

TABLE ES-4
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Pyrene				Ship Canal Discharge Area				
Inorganic Chemicals								
Antimony	TF, SFA-1, S-21, S-14, S-15, S-18	~~TF,~~ SFA-2, ~~S-15, S-18~~		Lake Erie and Smokes Creek Discharge Areas				South Return Water Trenches
Arsenic	PA-1, PA-4, TF, SFA-1, S-8, S-18, S-19, S-21, P-63, P-73	PA-1, PA-3, SFA-1, SFA-2, S-8~~3~~, S-10, S-14, S-17, ~~S-19, S-21,~~ S-23, S-24, S-26, P-18, P-63, P-73		Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~			Smokes Creek, Ship Canal (current), and Ship Canal (future)	Smokes Creek, Blasdell Creek, Lake Erie, North and SouthReturn Water Trenches, and Ship Canal~~Smokes Creek, Blasdell Creek, Lake Erie, and Return Water Trenches~~
Barium				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas				
Cadmium	~~S-8~~			Smokes Creek Discharge Area				
Chromium	TF, S-8, S-18, PA-2, PA-4, P-63	S-10, S-25, S-26		Lake Erie and Smokes Creek Discharge Areas				
Cyanide				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~				

TABLE ES-4
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Lead	TF, SFA-1, S-8, S-14, S-18, S-21, P-63	SFA-1, SFA-2, S-3, ~~14, S-18, P-18, P-63~~		Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~				Smokes Creek~~and~~, South Return Water Trench, and Ship Canales
~~Manganese~~				~~Lake Erie Discharge Area~~				
Nickel				Lake Erie and Smokes Creek Discharge Areas				
Selenium				Lake Erie Discharge Area				
Silver				Smokes Creek Discharge Area				
Thallium	S-8, S-18	SFA-1, P-18, S-10, S-18, S-23, PA-1, PA-3		Lake Erie and Smokes Creek Discharge Areas				

1.0 INTRODUCTION

The Bethlehem Steel Corporation (BSC) Lackawanna site is located on the east end of Lake Erie in Lackawanna, New York. This site was used for integrated iron and steel production from the turn of the century until 1983, when iron- and steel-making activities ceased. The only remaining operating BSC divisions at the site today are (1) the Coke Oven Division, and (2) the Galvanized Products Division. A Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) conducted in 1988 identified 104 Solid Waste Management Units (SWMUs) that may have released hazardous constituents, and six watercourses that may have been impacted by potential hazardous constituent releases from the SWMUs (EPA, 1988). In 1990, BSC and the U.S. Environmental Protection Agency (EPA) Region II negotiated and entered into an Administrative Order on Consent (AOC) to conduct a RCRA Facility Investigation (RFI) (AOC, 1990). The AOC was issued pursuant to Section 3008(h) of RCRA.

The AOC directed BSC to perform a phased, site-wide RFI to determine the nature, extent, and potential health risks to human health and/or the environment of any hazardous constituents released from SWMUs into soils, air, groundwater, sediment, and surface water at or near the Lackawanna site (AOC, 1990). The potential for adverse impacts on human health or the environment due to releases of hazardous constituents from a site is evaluated by the process of risk assessment. This process combines information on potential exposure to site-related hazardous constituents with information on their toxic potency to generate a quantitative estimate of risk. As documented in the approved *Work Plan Module for the Human Health Risk Assessment* (Dames & Moore, 1997), a tiered human health risk assessment is to be performed for the Lackawanna site.

This document is the first of three interim deliverables to be submitted for EPA's ~~and New York State Department of Environmental Conservation's (NYSDEC)~~ review and approval in the course of the risk assessment process. It details the methods and assumptions used to (1) identify SWMUs for consideration in the risk assessment, (2) group certain SWMUs on the basis of proximity and content, and (3) select chemicals of potential concern (COPCs) in each potential exposure medium to be carried through the risk assessment. These media include surface and subsurface SWMU material[1] , groundwater, surface water, sediment, and water in the Coke Oven Area quench pits and the SWMU P-11 #17 Pit. Finally, EPA-approved toxicity criteria are provided for each COPC.

1.1 REFERENCES

Administrative Order on Consent (AOC), Docket No. II RCRA-90-3008(h)-0201. August 13, 1990.

Dames & Moore. 1997. *Work Plan Module for Human Health Risk Assessment.*

U.S. Environmental Protection Agency (EPA), National Enforcement Investigations Center (NEIC). 1988. RCRA Facility Assessment -- Bethlehem Steel Corporation, Lackawanna Plant. Lackawanna, New York. EPA-330/2/88-054.

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[1] **Surface and subsurface sample collected at the site during the RFI were primarily collected from, and were designed to characterize, SWMUs. A few were collected adjacent to SWMUs. Thus, most of the samples were of waste materials. However, some samples contained slag or other fill as well as waste materials. Thus, the term "SWMU material" is used throughout this document to refer to the type of solid samples collected from the surface and subsurface during the RFI.**

2.0 PROCESS FOR IDENTIFICATION AND GROUPING OF SOLID WASTE MANAGEMENT UNITS TO BE CONSIDERED IN THE RISK ASSESSMENT

2.1 IDENTIFICATION OF SOLID WASTE MANAGEMENT UNITS TO BE CONSIDERED IN THE RISK ASSESSMENT

As described~~mentioned~~ in Section 1.0, the RFA identified 104 SWMUs that may have received hazardous constituents and/or wastes and six watercourses that may have been impacted by hazardous constituent releases from the SWMUs (EPA, 1988). Figure 2-1 shows the location of these SWMUs and watercourses, and Table 2-1 lists their names. The EPA has subsequently issued No Further Assessment (NFA) determinations for ~~60 (~~59 SWMUs and one watercourse~~) of these units~~ (noted by an asterisk on Table 2-1), leaving ~~50 units~~ 45 SWMUs and five watercourses to be addressed in the RFI. Four~~Three~~ of these units have been eliminated from quantitative analysis in the risk assessment for the following reasons:

- **SWMU S-12 (Asbestos Landfill L):** S-12 is a pit approximately 100 feet long by 25 feet wide. It was excavated into blast furnace slag fill to a depth of approximately 16 feet below grade. The landfill was permitted by the NYSDEC (Permit No. 2278; Facility No. 15S12) exclusively for the purpose of containing asbestos. According to ~~plant~~ BSC records, no other materials were placed in this landfill. The asbestos contained in S-12 consists of insulation taken from various plant facilities from the fall of 1980 until plant shutdown in 1983 during repair or replacement activities. Prior to disposal in the landfill, the asbestos was wetted and placed in polyethylene bags, and the bags were tagged and sealed. The asbestos waste fills the excavation to a depth of approximately seven feet below grade. The waste is covered by a two- to three-foot thick layer of fine, granular slag; the top of this cover layer is approximately four to five feet below grade. A four-foot high berm surrounds the landfill on all but a small portion of the northwestern side of the landfill; however, as noted, this unbermed area is approximately four to five feet higher than the surface of the cover layer. Groundwater in this area is approximately 40 feet below the surface, or more than 20 feet below the bottom of the landfill.

  In July 1993, a soil gas survey was undertaken as part of the RFI to look for evidence that materials other than asbestos might be located in the landfill. Three soil gas probes were placed within the SWMU cover and one probe was located up-gradient (from a groundwater perspective) of the SWMU. Positive readings for oil, naphthalene, and aromatic compounds were measured in the samples from all four probes. According to the Northeast Research Institute, Inc. (NERI), the positive readings most likely reflect the presence of petroleum related hydrocarbons in the groundwater. Groundwater containing volatile organic compounds (VOCs) (benzene, toluene and xylenes) has been found in wells located both upgradient (MWN-29A) and downgradient (MWN-28A) of S-12. There is no indication in the data that contaminants are being added by a source between the wells up- and down-gradient of S-12. The contaminants are the same, and are present at similar levels, although benzene and toluene appear to be slightly higher in the upgradient well.

  This landfill has not experienced a release of hazardous constituents and is not likely to experience a release in the future; there is no available exposure pathway to direct human contact, nor to groundwater, surface water or air. Therefore, further evaluation of this SWMU in the risk assessment is not warranted.

- **SWMU S-28 and S-29 (Drum Landfills):** These two SWMUs were identified as RFA drum landfills based on 1982 BSC photographs. These units were created for the purpose of disposing of waste materials, but they were never used and were subsequently

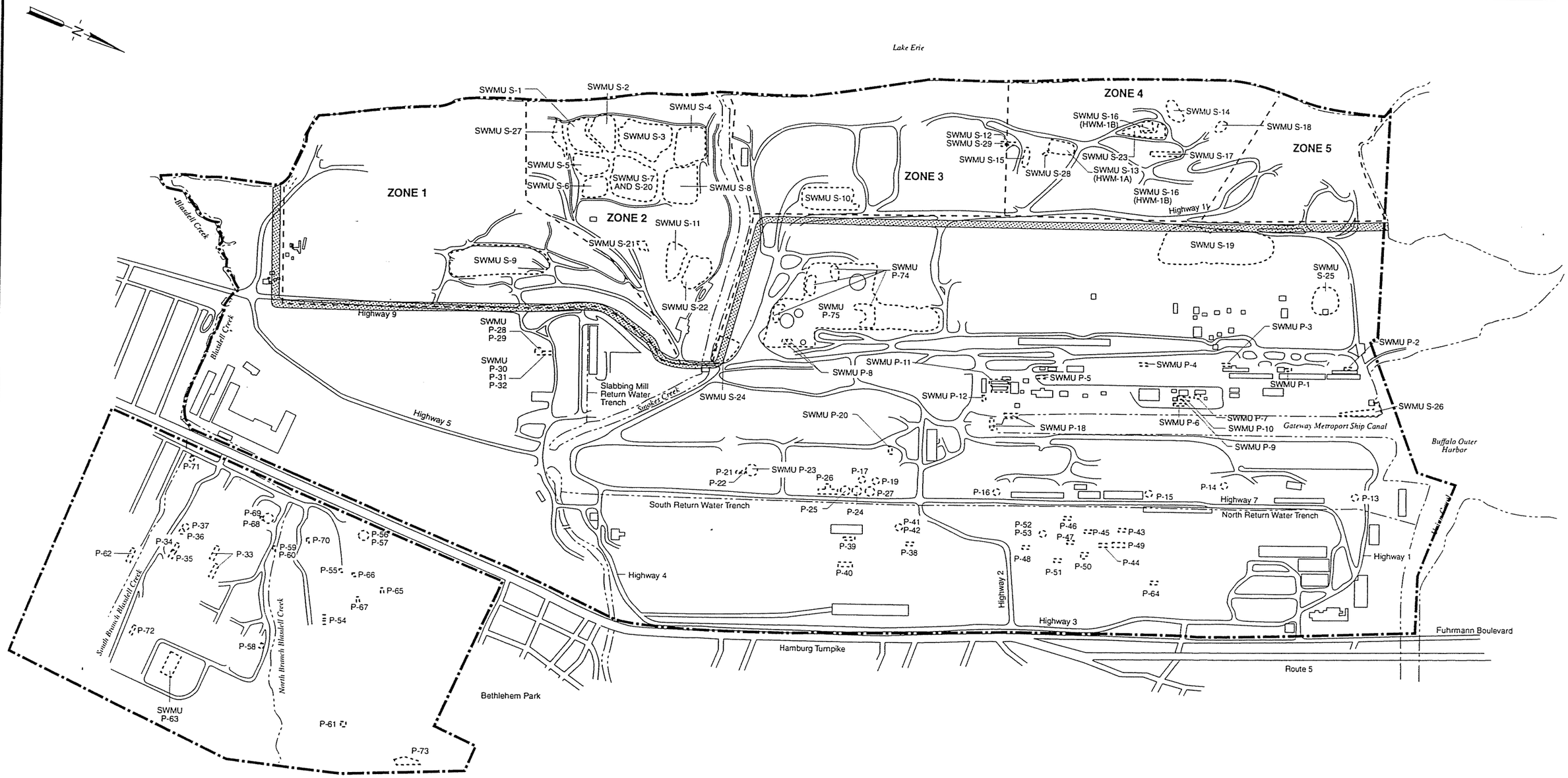
abandoned and filled with slag material. Test pits dug in these units found no evidence of drum or waste disposal other than some miscellaneous debris in SWMU S-29.

- **SWMU S-13:** SWMU S-13, also known as HWMU 1A, was closed in place as a landfill in 1988. Closure, including the placement of a final polyethylene cap over the unit and the recording of deed restrictions on future use of the area on and around the SWMU, was performed in accordance with a NYSDEC-approved closure plan. Closure of SWMU S-13 was approved by NYSDEC in 1989, and the unit currently is monitored under a NYSDEC-approved post-closure plan.

  Bethlehem Steel Corporation does not have data from the landfill that meet the criteria established for data to be used in the risk assessment (see Section 3.2 of this document). The available waste characterization data relevant to S-13 are for coal tar sludge, which comprises only approximately one percent of the waste material in S-13. Moreover, these data are primarily the result of conducting analyses using the Toxicity Characteristic Leaching procedure (TCLP) on a limited number of samples for a limited number of constituents. Groundwater monitoring specifically for SWMU S-13 has been conducted since the unit was closed. Contaminants found in the downgradient monitoring wells are also found in the upgradient monitoring well, and also in an RFI well upgradient of S-13. Because data are not available for the SWMU itself, COPC selection could not be performed for this unit, and the unit is not addressed further in this document. The potential for exposure to contaminants in this unit will be addressed qualitatively in the risk assessment. Groundwater data collected from the monitoring program for this unit are included in the groundwater data set used for COPC selection and in the risk assessment.

The remaining ~~46 units (~~41 SWMUs and five watercourses~~)~~ to be quantitatively evaluated in ~~this~~ the ~~document~~ risk assessment are listed in Table 2-2.

BETHLEHEM STEEL 00120-195-4060-152 — FINAL INT DEL 1



LEGEND:

- Site Boundary
- SWMU S-10 — Approximate Solid Waste Management Unit (SWMU) Boundary
- SFA Zone
- Boundary of Slag Fill Area (SFA)

Revised May 1998

BETHLEHEM STEEL CORPORATION
Lackawanna, New York

FIGURE 2-1
LOCATION OF SOLID WASTE MANAGEMENT UNITS (SWMUs)

Job No. 00120-195-152 Dames & Moore

TABLE 2-1

SOLID WASTE MANAGEMENT UNITS AND WATERCOURSES, BETHLEHEM STEEL CORPORATION LACKAWANNA SITE[1]

SWMU Number	Unit Description
P -1	Quench Water Pit, North Station
P -2	Quench Water Pit, Arctic Station
P -3	Quench Water Pit, Central Station
P -4	Quench Water Pit, A Station
P -5	Quench Water Pit, B Station
P -6	Lime Sludge Settling Basin
P -7	Abandoned Lime Sludge Settling Basin
P -8	Waste Oil Storage Tanks [in Tank Farm]
P -9	Abandoned Tar Decanter Sludge Pits
P -10	Contaminated Soil in area Near Ball Mill
P -11	Benzol Plant Tank Storage Area
P -12	Spill Cleanup Soil Storage Area
P -13	[Blast Furnace] A-B Primary Thickener *
P -14	[Blast Furnace] C Primary Thickener *
P -15	[Blast Furnace] F-G Primary Thickener *
P -16	[Blast Furnace] H-J Primary Thickener *
P -17	[Blast Furnace] Final Thickener *
P -18	[Blast Furnace] Cooling Tower and Hot & Cold Wells
P -19	[Sinter Plant] Thickener *
P -20	[Sinter Plant] Scrubber Sump *
P -21	[BOF] North Scalping Tank *
P -22	[BOF] South Scalping Tank *
P -23	[BOF] Primary Thickener *
P -24	[BOF] North Clarifier *
P -25	[BOF] South Clarifier *
P -26	[BOF] Cooling Tower *
P -27	[BOF] Final Thickener *
P -28	[Slab Mill] Main Settling Tank *
P -29	[Slab Mill]Five Sand Filters *
P -30	[Slab Mill] North Scale Pit *
P -31	[Slab Mill] South Scale Pit *
P -32	[Slab Mill] Scarfer Pit *
P -33	10" & 12" [Bar] Mills Scale Pit *
P -34	13" [Bar] Mill Scale Pit *
P -35	[Bar Mill] Process Water Pit *
P -36	[Bar Mill] Sand Filter *
P -37	[Bar Mill] Treated Water Storage Tank *
P -38	54" Mill Scale Pit *
P -39	48" Mill Scale Pit *
P -40	14", 18", 28", & 35" Mills Scale Pit *
P -41	Main Settling Tank, [South Mills] *
P -42	Five Sand Filters, [South Mills] *
P -43	44" Mill Scale Pit *
P -44	40" Mill Scale Pit *
P -45	36" Mill Scale Pit *
P -46	32" Mill Scale Pit *

1 Unit names are as shown in RFA (EPA 1988), unless changed as shown with brackets.

TABLE 2-1 (Continued)

SWMU Number	Unit Description
P -46	32" Mill Scale Pit *
P -47	30" Mill Scale Pit *
P -48	21" Mill Scale Pit *
P -49	44" Mill Scarfer Pit *
P -50	40" Mill Scarfer Pit *
P -51	30" & 21" Mills Scarfer Pit *
P -52	Main Settling Tank, [North Mills] *
P -53	Seven Sand Filters, [North Mills] *
P -54	[Hot Strip Mill] Runout Table Spray Water Pit *
P -55	[Hot Strip Mill] Scale Pit *
P -56	[Hot Strip Mill] Main Settling Basin *
P -57	[Hot Strip Mill] Twenty-Four Sand Filters *
P -58	Bar Mill East Acid Sump [Coil Pickling Area]*
P -59	Bar Mill West Acid Sump [Billet Prep. Area]*
P -60	Bar Mill Waste Solution Tank *
P -61	Hot Strip Mill Acid Pit *
P -62	Mill Scale Storage Area 1 *
P -63	[Former] Mill Scale Storage Area 2
P -64	Scale Pit at 8" Bar Mill *
P -65	Tandem Mill Sump *
P -66	Pickling Rinse Water Pit*
P -67	Spent Pickle Liquor Pit *
P -68	Galvanizing Mill Sump *
P -69	Main Treatment Tank and Associated Facilities [at Water Quality Control Station #7]*
P -70	Hot Strip Mill Waste Oil Storage Tank [at Water Quality Control Station #7] *
P -71	Galvanizing Mill Pump Station Wet Well for Old Acid Sewer Line*
P -72	Galvanizing Mill Sump Sludge Storage Area *
P -73	[Former] Drum Storage Area East of ~~Cord~~ Cold Strip Mill
P -74	[Solid Fuel Mix Storage Piles in Tank Farm][2]
P -75	Tank Storage Area for No. 6 Fuel ~~Oil~~ Oil and Petroleum Tar [Tank Farm]
S -1	Surface Impoundment A
S -2	Surface Impoundment B
S -3	Surface Impoundment C (Hazardous Waste Unit)
S -4	Surface Impoundment D
S -5	Surface Impoundment E
S -6	Surface Impoundment F
S -7	Surface Impoundment G
S -8	Surface Impoundment H [not used]
S -9	Waste Pile I *
S -10	Slag Quench Area J
S -11	Landfill K, [Acid Tar Pit, South]
S -12	Asbestos Landfill L
S -13	Coal Tar Sludge (Hazardous Waste Unit)
S -14	General Rubble Landfill N
S -15	General Rubble Landfill O

2 Called "Waste Storage Piles (Tar and Tank Fuel Tank Bottoms Mixed with Coke Breeze" in RFA (EPA 1988).

TABLE 2-1 (Continued)

SWMU Number	Unit Description
S -16	[Lime Stabilized SPL Sludge/Slag Landfill][3]
S -17	Vacuum Carbonate Blowdown - Landfill Q
S -18	Lime Dust and Kish Landfill R
S -19	Murphy's Mountain Landfill AA
S -20	Drying Area for Sludge from Impoundment F
S -21	Sludge Storage Area
S -22	Vacuum Carbonate Blowdown Impoundment South of Smoke Creek [Acid Tar Pit North]
S -23	Tar Pit Adjacent To [Lime Stabilized SPL Sludge Landfill]
S -24	Tar Pit North of Lime Plant
S -25	Landfill/Impoundment under North End of Coal Pile
S -26	Fill Area Near Coke No. Battery 8
S -27	Sludge Disposal Area [Adjacent to SWMU S-1]
S -28	Drum Landfill
S -29	Drum Landfill
WATERCOURSES	
45" x 90" Slabbing Mill Return Water Trench *	
Blasdell Creek	
South Return Water Trench	
North Return Water Trench	
Smokes Creek	
Lackawanna Ship Canal (now named the Gateway Metroport Ship Canal)	

* Units that have received a "No Further Assessment" determination from EPA.

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3 Called "Spent Pickle Liquor Sludge Landfill P (Hazardous Waste Unit)" in RFA (EPA 1988).

TABLE 2-2

SOLID WASTE MANAGEMENT UNITS TO BE CONSIDERED QUANTITATIVELY IN THE HUMAN HEALTH RISK ASSESSMENT

SWMU Number	Unit Description
Coke Oven Area	
P-1	Quench Water Pit, North Station
P-2	Quench Water Pit, Arctic Station
P-3	Quench Water Pit, Central Station
P-4	Quench Water Pit, A Station
P-5	Quench Water Pit, B Station
P-6	Lime Sludge Settling Basin
P-7	Abandoned Lime Sludge Settling Basin
P-9	Abandoned Tar Decanter Sludge Pits
P-10	Contaminated Soil Near Ball Mill
P-11	Benzol Plant Tank Storage Area
P-12	Spill Cleanup Soil Storage Area
P-18	Blast Furnace Cooling Tower and Hot & Cold Wells
S-26	Fill Area Near Coke Battery 8
Tank Farm Area	
P-8	Waste Oil Storage Tanks in Tank Farm
P-74	Solid Fuel Mix Storage Piles in Tank Farm
P-75	Tank Storage Area, Tank Farm
Slag Fill Area Zone 2	
S-1	Surface Impoundment A
S-2	Surface Impoundment B
S-3	Surface Impoundment C
S-4	Surface Impoundment D
S-5	Surface Impoundment E
S-6	Surface Impoundment F
S-7	Surface Impoundment G
S-20	Drying Area for Sludge from Impoundment F
S-8	Surface Impoundment H
S-11	Landfill K, Acid Tar Pit, South
S-21	Sludge Storage Area
S-22	Vacuum Carbonate Blowdown Impoundment (Acid Tar Pit North)
S-24	Tar Pit North of Lime Plant
S-27	Sludge Disposal Area (Adjacent to SWMU S-1)
Slag Fill Area Zone 3	
S-10	Slag Quench Area J
Slag Fill Area Zone 4	
~~S-13~~	~~Coal Tar Sludge Landfill~~
S-14	General Rubble Landfill N
S-15	General Rubble Landfill O
S-16	Lime Stabilized SPL Sludge/Slag Landfill
S-17	Vacuum Carbonate Blowdown - Landfill Q
S-18	Lime/kish Landfill
S-23	Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill
Other Areas	
S-19	Murphy's Mountain Landfill
S-25	Landfill/Impoundment under North End of Coal Pile
P-63	Former Mill Scale Storage Area No. 2
P-73	Former Drum Storage Area
Watercourses	
Blasdell Creek	
Lackawanna Ship Canal (now named the Gateway Metroport Ship canal)	
North Return Water Trench	
Smokes Creek	
South Return Water Trench	

2.2 GROUPING OF SOLID WASTE MANAGEMENT UNITS TO BE CONSIDERED IN THE RISK ASSESSMENT

In order to increase the size of analytical data sets available for estimating potential exposures, several of the ~~42~~ 41 SWMUs have been grouped on the basis of (1) the types and concentration ranges of constituents detected, (2) the proximity of the SWMU to neighboring units, and (3) the similarity of operations performed at each SWMU. Media-specific sample data collected at multiple depths have been pooled in order to determine COPCs per grouping. The SWMU groups defined on this basis are listed in Table 2-3.

TABLE 2-3.

PROPOSED SWMU GROUPINGS FOR THE BETHLEHEM STEEL CORPORATION LACKAWANNA SITE

Location	SWMUs Included	Group Designation
Slag Fill Area (SFA)	S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27	SFA-1
	S-11, S-22	SFA-2
Process Area (PA)	P-1, P-2, P-3, P-4, P-5	PA-1
	P-6, P-7	PA-2
	P-9, P-10	PA-3
	P-11, P-12	PA-4
Tank Farm Area	P-8, P-74, P-75	TF

The 1~~7~~5 remaining SWMUs (S-3, S-8, S-10, S-14, S-15, S-16, S-17, S-18, S-19, S-21, S-23, S-24, S-25, S-26, P-18, P-63, and P-73) will be evaluated individually.

~~SWMU S-13, also known as HWM-1A, was closed in place as a landfill in 1988. Closure, including the placement of a final polyethylene cap over the unit and the recording of deed restrictions on future use of the area on and around the SWMU, was performed in accordance with an NYSDEC approved closure plan. Closure of SWMU S-13 was approved by NYSDEC in 1989, and the unit currently operates under a post-closure plan.~~

~~Bethlehem Steel Corporation does not have data from the landfill that meet the criteria established for data to be used in the risk assessment (see Section 3.2 of this document). The available waste characterization data relevant to S-13 are for coal tar sludge, which comprises only approximately one percent of the waste material in S-13. Moreover, these are primarily the result of conducting analyses using the Toxicity Characteristic Leaching procedure (TCLP) on a limited number of samples for a limited number of constituents. Groundwater monitoring specifically for SWMU S-13 has been conducted since the unit was closed. Contaminants found in the downgradient monitoring wells are also found in the upgradient monitoring well, and also in an RFI well upgradient of S-13. Because data are not available for the SWMU itself, COPC selection could not be performed for this unit, and the unit is not addressed further in this document. The potential for exposure to contaminants in this unit will be addressed qualitatively in the risk assessment. Groundwater data collected from the monitoring program for this unit are included in the groundwater data set used for COPC selection and in the risk assessment.~~

2.3 REFERENCES

U.S. Environmental Protection Agency (EPA), National Enforcement Investigations Center (NEIC). 1988. RCRA Facility Assessment -- Bethlehem Steel Corporation, Lackawanna Plant. Lackawanna, New York. EPA-330/2/88-054.

3.0 DEVELOPMENT OF A DATA SET FOR USE IN THE RISK ASSESSMENT

One of the first steps of the risk assessment process is to evaluate all the data collected in the various field investigations as well as relevant historical information to develop a data set specifically designed to support the human health risk assessment. This data set is used for both selection of COPCs (Section 4.0) and estimation of representative concentrations in site media (to be presented in Interim Deliverable No. 3). This section describes the steps and methods used to define the risk assessment data set.

3.1 MASTER ANALYTE LIST FOR THE LACKAWANNA SITE

EPA guidance for the RCRA correction action program states that investigations should focus on those hazardous constituents that are "likely to have been released at a particular site, based on the available information" (EPA, 1990). Consistent with this guidance and approved under the RCRA §3008(h) AOC for the Lackawanna site, a list of 96 hazardous constituents of potential interest (COPIs) was developed based on EPA and industry studies concerning hazardous constituents potentially present in the waste streams generated by integrated iron and steel plant operations (cokemaking, sintering, ironmaking, steelmaking, hot forming, cold forming, and steel finishing). As shown in Table 3-1, the COPIs include ~~45~~ 46 VOCs, ~~39~~38 semi-volatile organic compound (SVOCs), 11 metals, and cyanide. Of the ~~39~~ 38 SVOCs, 17 are polycyclic aromatic hydrocarbons (PAHs). The COPIs represent a consensus list of potentially SWMU-related chemicals at the Lackawanna site.

Studies considered in this process include EPA's Development Document for Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category (1982), EPA studies under RCRA §3001 pertaining to the identification and listing of hazardous wastes in the steel industry (1979-1990), and United States Steel's The Making, Shaping, and Treating of Steel (1985). In addition to the hazardous constituents specific to steel operations, the COPI list contains numerous halogenated solvents that could have been used in plant degreasing/cleaning operations in the past. The list also includes all non-herbicide/non-pesticide toxicity characteristic (TC) hazardous constituents specified at 40 CFR 261.24, with the exception of nitrobenzene, as this compound was~~is~~ not associated with site operations.

Groundwater and surface water samples collected during the RFI were also routinely tested for a suite of general "indicator" parameters (pH, total organic carbon [TOC], total organic halogen (TOX), specific conductance, and total dissolved solids [TDS], as well as for major ions (chloride, sulfate, total alkalinity [as calcium carbonate], calcium, potassium, and sodium). As they lack toxicological criteria, the indicator parameters are not considered in quantitative risk analysis. However,~~These measurements will be addressed in~~ the risk assessment ~~and this~~ will include a qualitative assessment of the potential impacts of human exposure to low and high pH groundwater at the site.

TABLE 3-1

LIST OF HAZARDOUS CONSTITUENTS OF POTENTIAL INTEREST FOR THE BETHLEHEM STEEL CORPORATION LACKAWANNA SITE

VOCs	SVOCs	Inorganics
Acrylonitrile	**PAHs**	**Metals**
Benzene	Acenaphthene	Antimony
Bis(2-chloroethyl)ether	Acenaphthylene	Arsenic
Bromodichloromethane	Anthracene	Barium
Bromoform	Benzo(a)anthracene	Cadmium
Bromomethane	Benzo(a)pyrene	Chromium
Carbon disulfide	Benzo(b)fluoranthene	*Cyanide*
Carbon tetrachloride	Benzo(k)fluoranthene	Lead
Chlorobenzene	Benzo(g,h,i)perylene	Mercury
Chloroethane	2-Chloronaphthalene	Nickel
2-Chloroethylvinyl ether	Chrysene	Selenium
Chloroform	Dibenz[a,h]anthracene	Silver
Chloromethane	Fluoranthene	Thallium
Dibromochloromethane	Fluorene	~~Other Inorganics~~
1,2-Dichlorobenzene *	Indeno(1,2,3-cd)pyrene	~~Cyanide~~
1,3-Dichlorobenzene *	Naphthalene	
1,4-Dichlorobenzene *	Phenanthrene	
1,1-Dichloroethane	Pyrene	
1,2-Dichloroethane		
1,1-Dichloroethene	**Other SVOCs**	
trans-1,2-Dichloroethene	Butyl benzyl phthalate	
Dichlorodifluoromethane	Bis(2-ethylhexyl)phthalate	
1,2-Dichloropropane	4-Chloro-3-methylphenol	
cis-1,3-Dichloropropene	m-Cresol (3-methylphenol)	
trans-1,3-Dichloropropene	o-Cresol (2-methylphenol)	
Ethylbenzene	p-Cresol (4-methylphenol)	
Hexachlorobenzene	2,4-Dichlorophenol	
Hexachlorobutadiene	Diethyl phthalate	
Hexachlorocyclopentadiene	Dimethyl phthalate	
Hexachloroethane	2,4-Dimethylphenol	
Methyl ethyl ketone	Di-n-butyl phthalate	
Methylene chloride	Di-n-octyl phthalate	
Pyridine	2-Methyl-4,6-dinitrophenol	
1,1,1,2-Tetrachloroethane	2,4-Dinitrotoluene	
1,1,2,2-Tetrachloroethane	2,6-Dinitrotoluene	
Tetrachloroethene	Isophorone	
Toluene	Pentachlorophenol	
1,2,4-Trichlorobenzene *	Phenol	
1,1,1-Trichloroethane	~~Pyridine~~	
1,1,2-Trichloroethane	2,3,4,6-Tetrachlorophenol	
Trichloroethene	2,4,5-Trichlorophenol	
Trichlorofluoromethane	2,4,6-Trichlorophenol	
Vinyl chloride		
m-Xylene		
o-Xylene		
p-Xylene		

* Because these analytes can be quantified by SW-846 GC/MS method 8270 for SVOCs, they are sometimes listed as SVOCs. However, because the Henry's Law constants for all of these compounds are > 10^{-5} atm-m^3/mol **and their molecular weights are less than 200 daltons**, they are properly classified as volatile.

chromium), which are generally considered to be among the most prevalent in iron and steel industry waste streams. See Table 1 in AOC Attachment 1.

With limited exceptions[4], all samples of all media (surficial and subsurface materials in and immediately around SWMUs, sediment, groundwater, and surface water) collected for chemical analysis during the RFI (Phases I, II-A, II-B, II-C, and III) were assayed for the full suite of COPIs pursuant to analytical methods outlined in applicable EPA guidance and AOC-approved data collection quality assurance plans. These samples included surficial and subsurface materials collected from within (or, in several cases, immediately adjacent to or directly below) SWMUs, and samples of groundwater, surface water, and sediments potentially in receipt of releases from the SWMUs. In addition, many of the solid phase samples collected were subjected to Toxicity Characteristic Leaching Procedure (TCLP) and/or Synthetic Precipitation Leaching Procedure (SPLP) tests to evaluate the leachability of constituents from the sampled material. The resultant sample extracts were also analyzed for the full suite of COPIs. These analyses were performed for the purpose of evaluating materials handling alternatives and leaching potential. Because the results of these procedures were not intended to provide data suitable for human health or ecological risk assessment, they are not included in the risk assessment data set.

3.2 CRITERIA FOR DATA EVALUATION

Criteria specified in *Risk Assessment Guidance for Superfund (Part A)* (EPA, 1989) and the *Guidance for Data Useability in Risk Assessment* (EPA, 1992) were used in the data evaluation process. As mentioned above, indicator parameters (pH, specific conductivity, TOC, TDS, TSS, chloride, sulfate, TOX, etc.) and TCLP/SPLP results will be excluded from the quantitative risk assessment. Tentatively identified compounds (TICs), which are defined as compounds detected as peaks in chromatograms during laboratory analysis, will not be included. Because the specific identity of many of these compounds is highly uncertain, they were not included in the data evaluation process.

Samples that were qualified with a "U" for non-detects, "J" for estimated values below the quantitation limit, "B" for chemicals also detected in blanks (see below), and "E" for values that exceeded the linear range of the calibration were included in the risk assessment database. Data qualified with an "R," indicating that they were rejected in the validation process, were removed from the analysis.

The data set to be used in the risk assessment was identified according to the steps described in the following sections.

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4 Exceptions include a special Phase II-C survey that was focused on potential benzene releases to Smokes Creek, and three of the five Phase I ground-water sampling rounds in which analyses were only conducted for a targeted subset of the COPIs (benzene, naphthalene, phenolic compounds, lead, and chromium), which are generally considered to be among the most prevalent in iron and steel industry waste streams. See Table 1 in AOC Attachment 1.

3.2.1 Evaluation of Blanks

All associated field and laboratory blanks were evaluated in the data validation process. Sample results qualified with a "B" qualifier were re-evaluated during the validation process to determine data usability. If the measured concentration of common laboratory contaminants (including methylene chloride, methyl ethyl ketone, toluene, and phthalate esters) in a given sample was less than ten times the maximum amount detected in any associated method or field blank, then that sample was excluded from the risk assessment (EPA, 1989, 1992). Samples containing organic and inorganic compounds not considered common laboratory contaminants were excluded if the measured concentration was less than five times the maximum detected concentration in any associated method or field blank (EPA, 1989, 1992).

3.2.2 Evaluation of Non-Detect Results

One-half the sample quantitation limit was used as a surrogate value for non-detected results (EPA, 1989). Specific chemicals within a sample analysis were diluted by the laboratory when the peak concentrations exceeded the calibration range of the analytical method. The diluted results will be used in the risk assessment for only those compounds identified as exceeding the calibration limit; otherwise, the non-diluted results will be used. Method detection limits were adjusted accordingly based on the dilution factor used in the analysis by multiplying the dilution factor by the detection limit. It should be noted that because the COPC selection process involved comparison of maximum detected analyte concentrations with screening criteria (see Section 4.1), only detected results were used in the COPC selection process.

3.2.3 Evaluation of Sample Duplicate Analyses

A systematic analysis of duplicate results was performed in order to determine whether the common practice of duplicate averaging has any impact upon the COPC selection process. Possible impacts of duplicate averaging on determination of representative concentrations in site media will be examined in Interim Deliverable No. 3.

The following steps were performed:

1. Identify all duplicate data pairs for each medium. The number of duplicate pairs relative to the total data base for each medium is depicted in Figures 3-1 to 3-4.

2. Calculate the relative percent deviation (RPD) between duplicate pairs:

$$\text{Relative Percent Deviation} = \frac{(\text{Primary Value} - \text{Duplicate Value})}{(\text{Average of Primary and Duplicate Values})}$$

   The RPD is a standard measure of precision, or the repeatability of a single measurement (EPA, 1992).

FIGURE 3-1
OCCURRENCE OF DUPLICATES IN THE SURFACE WATER DATA SET
BETHLEHEM STEEL CORPORATION
LACKAWANNA SITE
LACKAWANNA, NEW YORK

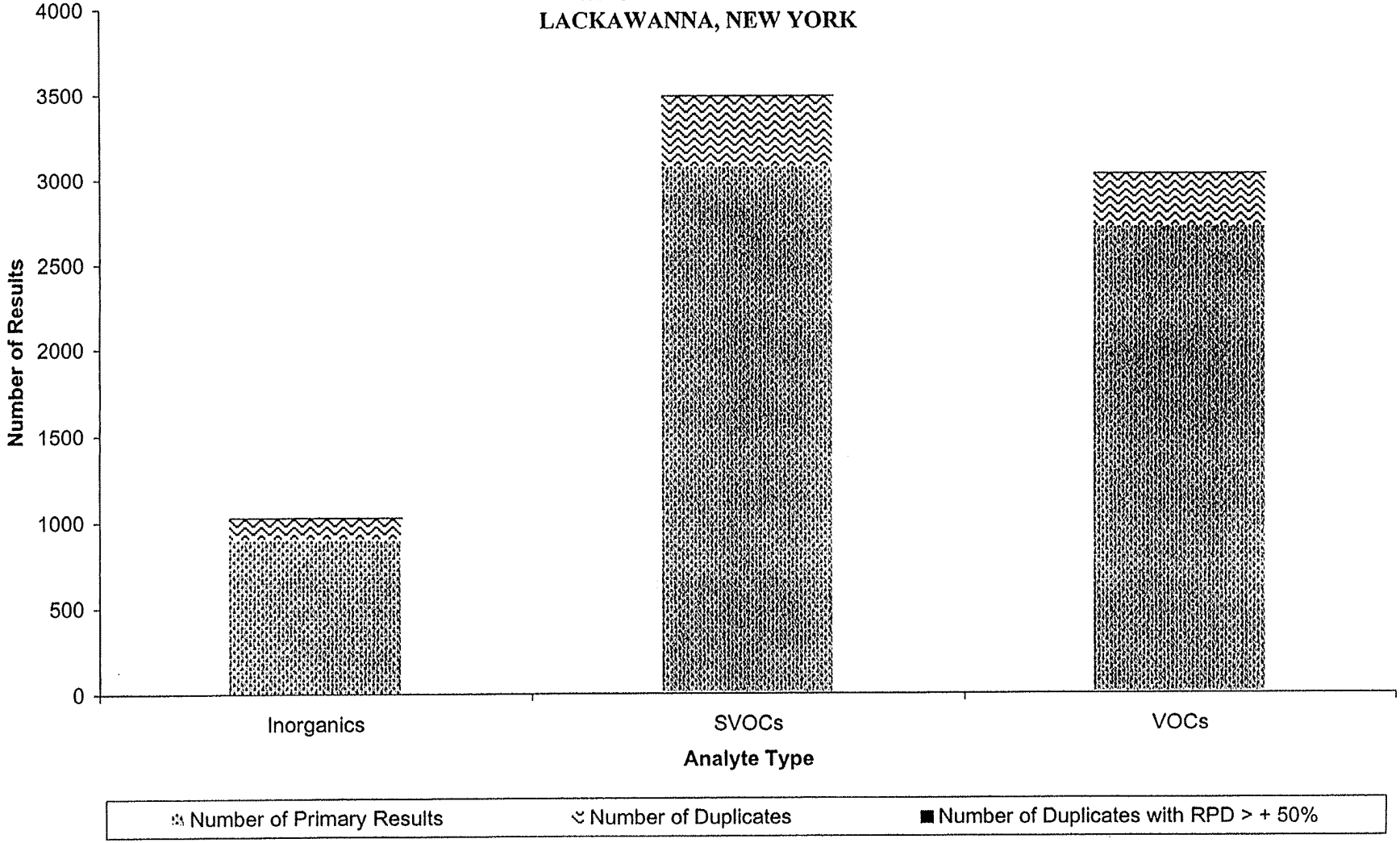


FIGURE 3-2
OCCURRENCE OF DUPLICATES IN THE SEDIMENT DATA SET
BETHLEHEM STEEL CORPORATION
LACKAWANNA SITE
LACKAWANNA, NEW YORK

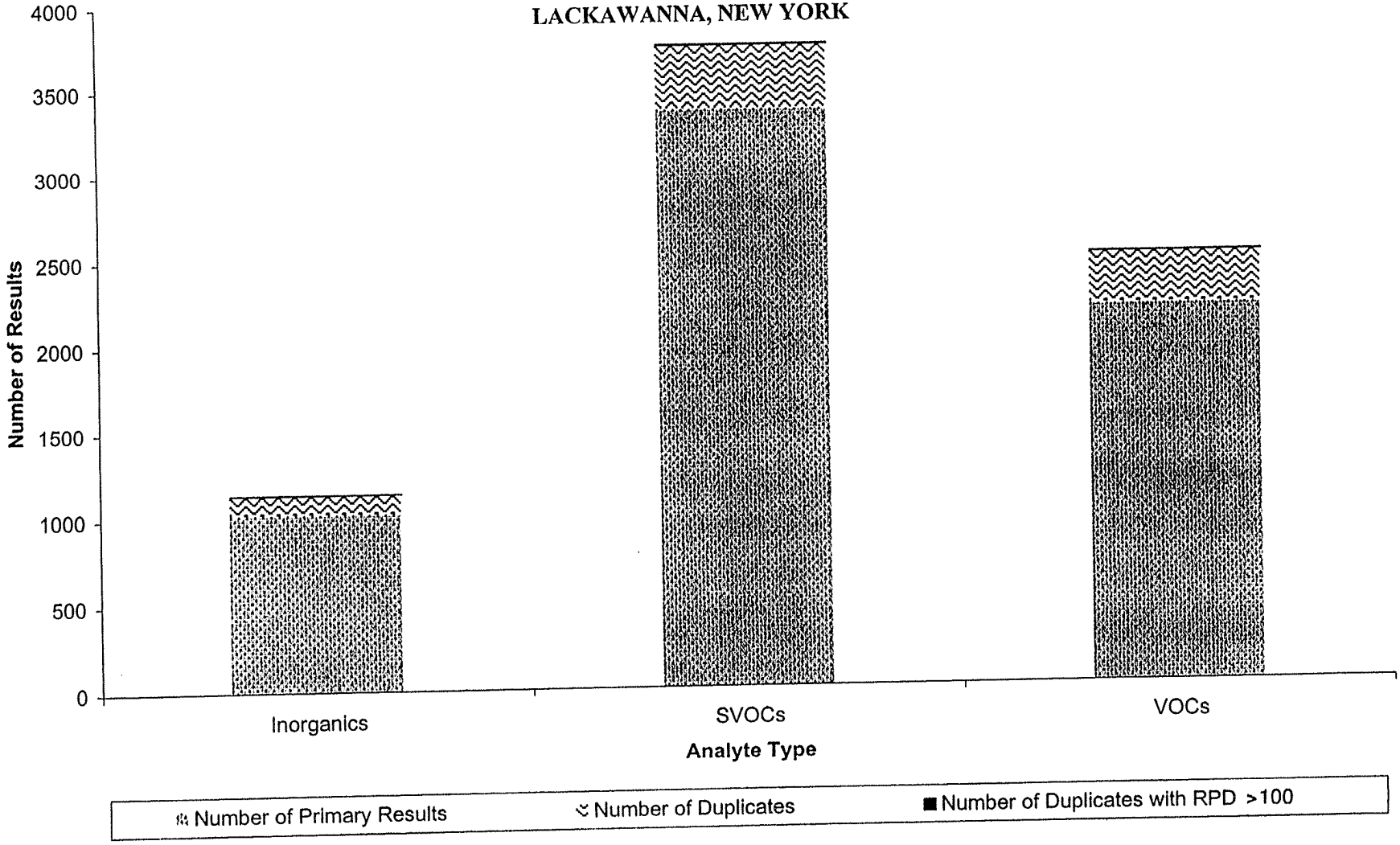


FIGURE 3-3
OCCURRENCE OF DUPLICATES IN THE GROUNDWATER DATA SET
BETHLEHEM STEEL CORPORATION
LACKAWANNA SITE
LACKAWANNA, NEW YORK

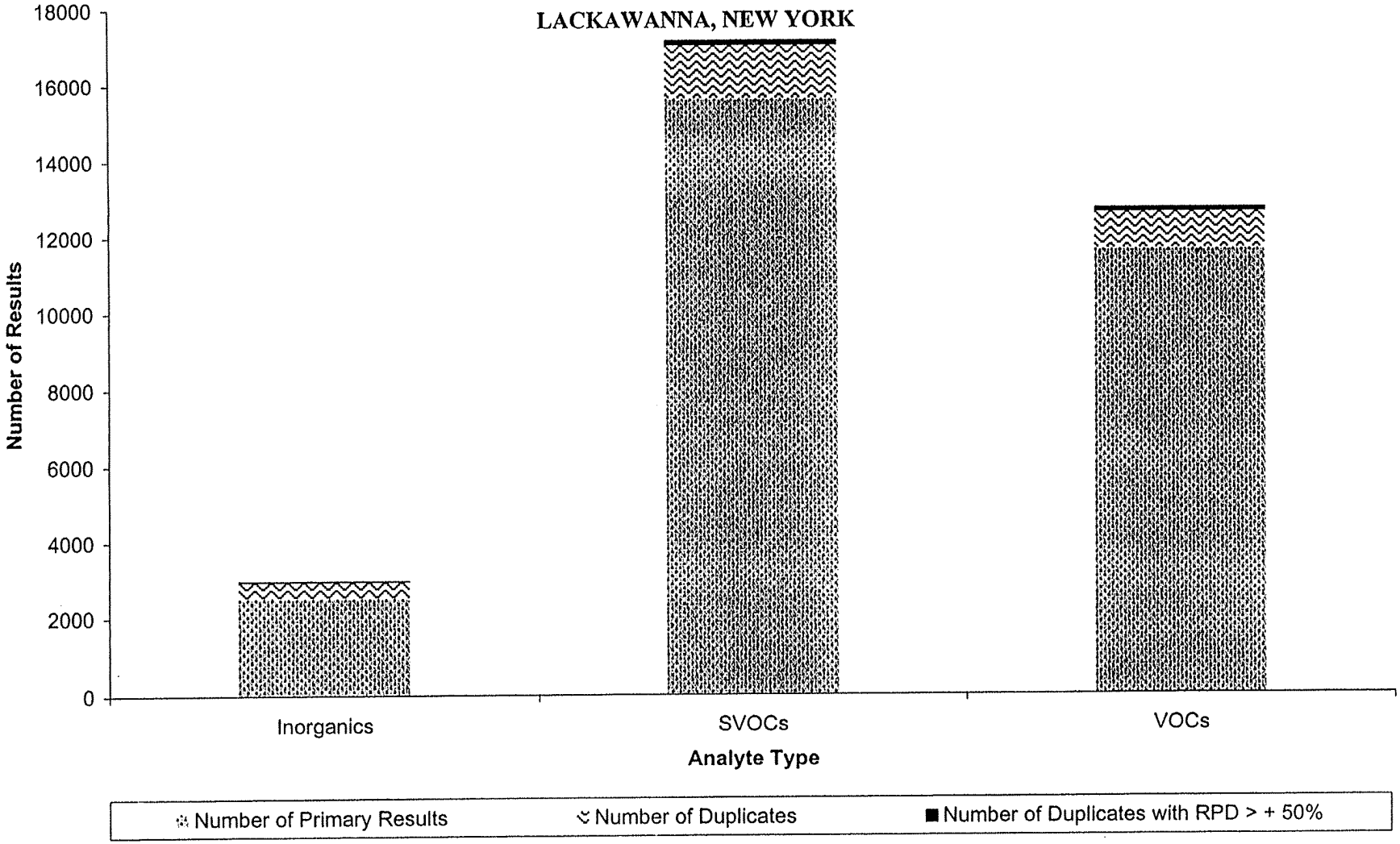
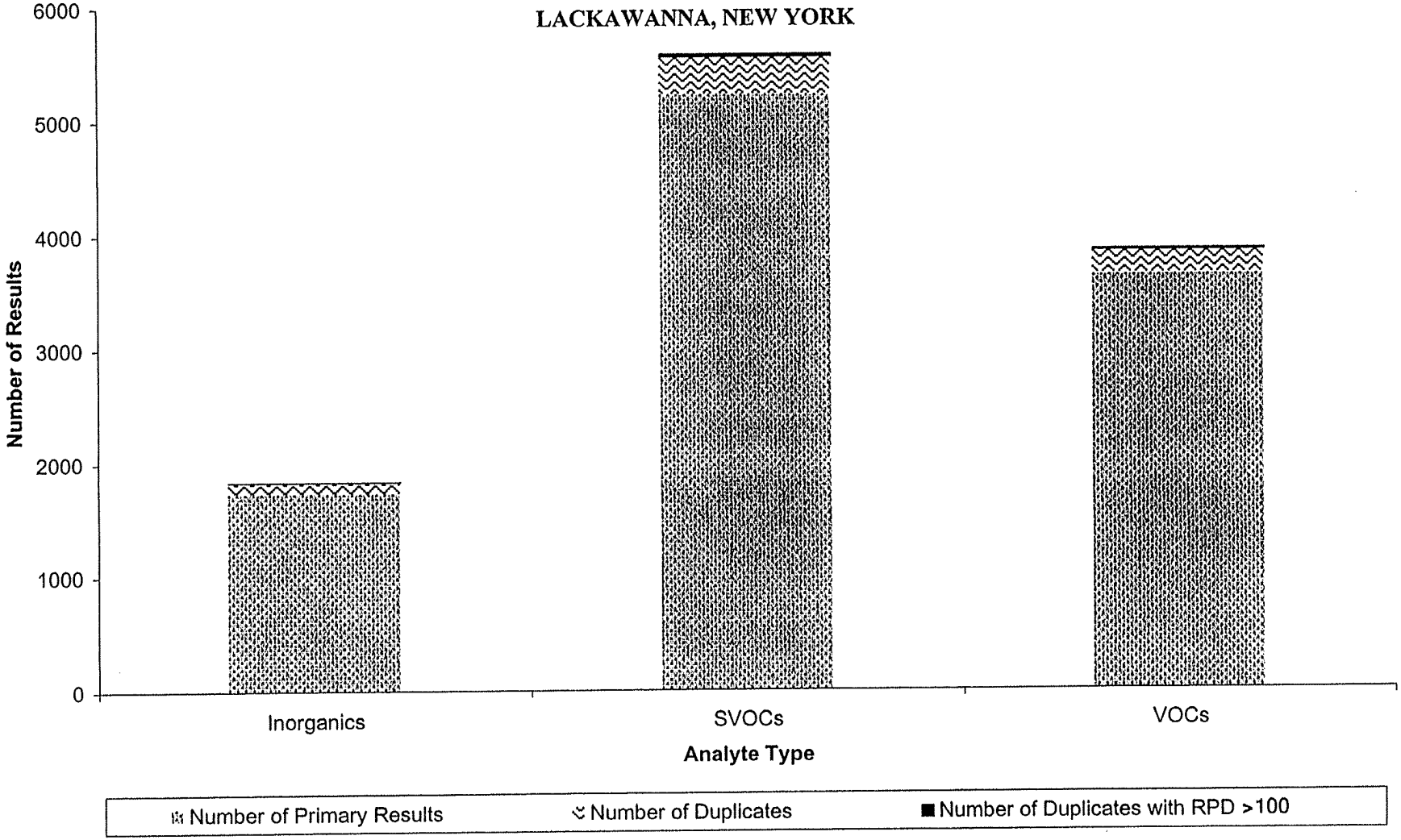


FIGURE 3-4
OCCURRENCE OF DUPLICATES IN THE SWMU MATERIAL DATA SET
BETHLEHEM STEEL CORPORATION
LACKAWANNA SITE
LACKAWANNA, NEW YORK



3. Identify duplicate pairs with RPDs greater than ± 50% for water samples and ± 100% for solid matrices. Although no EPA guidance dealing with the issue of duplicate similarity was identified, duplicate pairs with RPDs within these ranges are generally considered acceptable by data validators and laboratories. As shown in Figures 3-1 to 3-4, the number of duplicate pairs with RPDs outside the acceptable range relative to the total data base for each medium is very small. Duplicate pairs with RPDs exceeding the acceptable level are listed in Appendix A, Table A-1.

4. Identify where either the primary or duplicate sample exceeded maximum background concentrations and/or the corresponding COPC screening level~~EPA Region III Risk-Based Concentration (RBC)~~, but the duplicate-averaged result did not. Because comparisons with background and/or COPC screening levels are primary criteria for selecting COPCs (see Section 4.1), t~~T~~his comparison serves to evaluate whether duplicate averaging may cause underestimation of maximum analyte concentrations, resulting in elimination of analytes that would otherwise be selected as COPCs. (~~Comparisons with background and/or EPA Region III RBCs are primary criteria for selecting COPCs; see Sections 3.9 and 4.0.~~) These cases are identified in Appendix A for each medium. For cases in which the primary value, the duplicate value, or both were non-detect, half the method detection limit was conservatively substituted for the non-detected value to obtain the averaged value.

5. Examine each of the cases where duplicate averaging results in elimination of a chemical from further consideration as a COPC (*i.e.*, where primary or duplicate values are greater than background or the COPC screening level~~Region III RBC~~) in detail to determine whether the use of the primary or duplicate value instead of the average would result in an analyte's selection as a COPC (*i.e.*, where the average value but not the primary or duplicate value is beneath COPC screening criteria).

Results of the duplicate analysis are summarized by medium in the following subsections.

3.2.3.1 Surface Water

As shown in Appendix A, Table A-2, there are no cases where duplicate averaging resulted in elimination of a COPC in surface water.

3.2.3.2 Sediment

For sediment, two cases were identified where duplicate averaging resulted in elimination of metals based on comparison with the background concentration in Blasdell Creek sediment (i.e., barium at 96.1 mg/kg and chromium at 21.3 mg/kg; Tables 3-17 and A-3). In both cases, the primary and duplicate values were detects. However, the primary value, which exceeded the background concentration, did not exceed the EPA Region III residential soil RBC for the

metal. Thus, because barium and chromium were eliminated as COPCs on this basis, duplicate averaging did not affect COPC selection in these cases.

3.2.3.3 Groundwater

For groundwater flowing into Lake Erie or Smokes Creek, nine cases were identified where either the primary or duplicate sample value was greater than the RBC while the duplicate-averaged result was not greater than the RBC (Appendix A, Table A-4; Table 3-2).

TABLE 3-2

GROUNDWATER: SUMMARY OF CASES WHERE EITHER PRIMARY OR DUPLICATE RESULTS, BUT NOT AVERAGED RESULTS, EXCEED EPA REGION III RISK-BASED CONCENTRATIONS IN TAP WATER (µg/L)

Location Name	Analyte	Primary Result (µg/L)		Duplicate Result (µg/L)		Average Result (µg/L)	COPC Screening Levels (µg/L)[1]
MWN-11	1,2 Dichlorobenzene	5	a	0.5	a	2.75	4.7
MWS-08	1,1-Dichloroethane	2.5	a	6.0	b	4.25	5.0
MWS-20B	Antimony	1.1	a	3.1	b	2.1	3.0
MWS-01	Pyridine	10.0	a	50.0	a	30.0	37.0
MWS-16B	Pyridine	10.0	a	50.0	a	30.0	37.0
MW-1D4	Bis(2-ethylhexyl)phthalate	1.2	b	5.0	a	3.1	4.8
MWS-08	Bis(2-ethylhexyl)phthalate	1.0	b	5.0	a	3.0	4.8
MWN-31A	Bis(2-ethylhexyl)phthalate	1.0	b	7.0	b	4.0	4.8
MWN-09	Naphthalene	4.7	b	13	b	8.85	10.0

[1]COPC Screening Levels = The lower of EPA Region III RBCs for tap water or NYSDEC TOGS values for groundwater.
a = 1/2 the detection limit ("U"-qualified result)
b = measured value

- Three cases were identified in which both primary and duplicate values were non-detect (i.e., "U"-qualified), but the detection limits differed by a factor of two or more. In these cases with two different detection limits, a greater weight was placed on the lower detection limit. 1,2-Dichlorobenzene was non-detect in well MWN-11, but the detection limit of the primary sample (10 µg/L) was greater than the COPC screening level (4.7 µg/L). In addition, 1,2-dichlorobenzene was not detected in any other well discharging into Smokes Creek, and was therefore eliminated as a COPC based on a detection frequency of less than 5%. Pyridine was non-detect in Well MWS-01, but the detection limit of the duplicate sample (100 µg/L) was greater than the COPC screening level (37 µg/L). However, based on other analyses, pyridine was retained as a COPC for groundwater flowing into Smokes Creek because it was positively detected at a maximum concentration (32,000 µg/L) greater than the COPC screening level. Pyridine was non-detect in well MWS-16B, but the detection limit of the duplicate sample (100 µg/L) was greater than the COPC screening level (37 µg/L). However, based on other analyses, pyridine was retained as a COPC for groundwater flowing into Lake Erie because it was positively detected at a maximum concentration (50 µg/L) greater than the COPC

screening level. Thus, for these three cases, the duplicate averaging had no effect upon the COPC selection process.

- Two cases were identified in which both primary and duplicate values were detects. In the Coke Oven Area, the duplicate result for bis(2-ethylhexyl)phthalate in well MWN-31A was a "J"-qualified detect greater than the COPC screening level. However, because bis(2-ethylhexyl)phthalate is not a volatile constituent, it is not eligible for selection as a COPC in Coke Oven Area groundwater. Also in the Coke Oven Area, the duplicate result (13 µg/L) for naphthalene in well MWN-09 was greater than the COPC screening level (10 µg/L). However, based on other analyses, naphthalene was retained as a COPC for Coke Oven Area groundwater because it was positively detected at a maximum concentration (9,650 µg/L) greater than the COPC screening level. Thus, for these two cases, the duplicate averaging had no effect upon the COPC selection process.

- Five cases were identified in which either the primary or duplicate value was a detect, but not both. In four of these cases, the duplicate averaging had no effect on the COPC selection process, as follows:

  - The duplicate value (3.1 µg/L) for antimony in well MWS-20B exceeded the COPC screening level (3 µg/L); however, based on other analyses, antimony was retained as a COPC for groundwater flowing into Lake Erie because it was positively detected at a maximum concentration (210 µg/L) greater than the COPC screening level.

  - The duplicate detection limits (10 µg/L) for bis(2-ethylhexyl)phthalate in wells MWS-08 and MWS-1D4 exceeded the COPC screening level (4.8 µg/L). However, based on other analyses, bis(2-ethylhexyl) phthalate was retained as a COPC for groundwater flowing into Lake Erie because it was positively detected at a maximum concentration (890 µg/L) greater than the COPC screening level. In addition, because bis(2-ethylhexyl)phthalate is not a volatile constituent, it is not eligible for selection as a COPC in Slag Fill Area Zone 1 or Slag Fill Area Zone 4 groundwater.

  - The duplicate value (6 µg/L) for 1,1-dichloroethane in well MWS-08 exceeded the COPC screening level (5 µg/L), while the duplicate-averaged result (4.25 µg/L) did not. Based on other analyses, 1,1-dichloroethane was retained as a COPC for groundwater flowing into Lake Erie because it was positively detected at a maximum concentration (160 µg/L) greater than the COPC screening level.

  However, for Slag Fill Area Zone 1 groundwater, use of the duplicate result of 6 µg/L for 1,1-dichloroethane in well MWS-08 instead of the duplicate-averaged result (4.25 µg/L) would cause 1,1-dichloroethane to be retained. Therefore, even though the maximum detect was a duplicate-averaged result less than the COPC screening level, 1,1-dichloroethane was retained as a COPC for Slag Fill Area Zone 1 groundwater.

3.2.3.4 SWMU Material

For SWMU material, one case was identified where either the primary or duplicate sample value was greater than the COPC screening level, while the duplicate-averaged result was not greater than the COPC screening level (Appendix A, Table A-5). ~~No cases were identified where either the primary or duplicate sample value was greater than background, while the duplicate averaged result was not greater than background (Appendix A, Table A-5, Tables 3-13 and 3-15).~~ Bis(2-chloroethyl)ether in SWMU S-14 was not detected, but the detection limit of the primary sample (1.8 µg/L) was greater than the COPC screening level (0.58 µg/L). In this case of primary and duplicate values with two different detection limits, a greater weight was placed on the lower detection limit. In addition, bis(2-chloroethyl)ether was also not detected in any other sample for SWMU S-14, and was therefore not retained as a COPC based on a detection frequency of less than 5%. Thus, for this case, the duplicate averaging had no effect upon the COPC selection process.

3.2.3.5 Other Cases

For two specific cases, the methodology described above was not applied. No duplicate averaging was performed for total metals data in groundwater from monitoring wells MW-1D3, MW-2D3, and MW-1U1 during the third quarter 1993 sampling event. The samples from the first day of the study were obtained using a sampling method similar to that used for the other samples in the groundwater database. However, the samples from the later days were part of a groundwater filtering study, and were obtained without purging the well on that day. Because only the samples from the first day of sampling were obtained using a sampling method comparable to that used for the other samples in the groundwater database, only the first-day data were considered appropriate for use in the risk assessment.

In another case, VOC results from sample boring SC-2S/S (third quarter 1995 sampling event) were averaged. In this case, no duplicate samples were collected from the field, but the laboratory performed two additional analyses on the original field sample. Because evidence as to whether the samples were rejected or requalified was not presented in the laboratory data sheets, all three sample results were considered equally valid and were averaged to obtain the value used in the COPC selection process.

3.3 APPROACH FOR HANDLING GROUNDWATER DATA

Exposure through direct contact with groundwater will not be considered in the risk assessment because on-site workers are currently supplied with potable water through a municipal source, and abundant alternative supplies are available. However, site groundwater may serve as a medium of COPC transport to surface water as well as a source of vapor diffusion into ambient and indoor air, which may in turn serve as a medium of exposure for on- and off-site receptors. Therefore, COPCs in groundwater were selected from wells grouped on the basis of (1) flow regime (for transport to ~~recreationally important~~ surface water bodies that receptors could contact in the course of recreational or occupational activities), (2) well location (for on-site vapor releases), and (3) the entire site (for off-site

vapor releases). The methodology used to model exposures through these pathways is described in the following subsections.

~~3.3.1~~3.3.1 Groundwater Transport to Surface Water

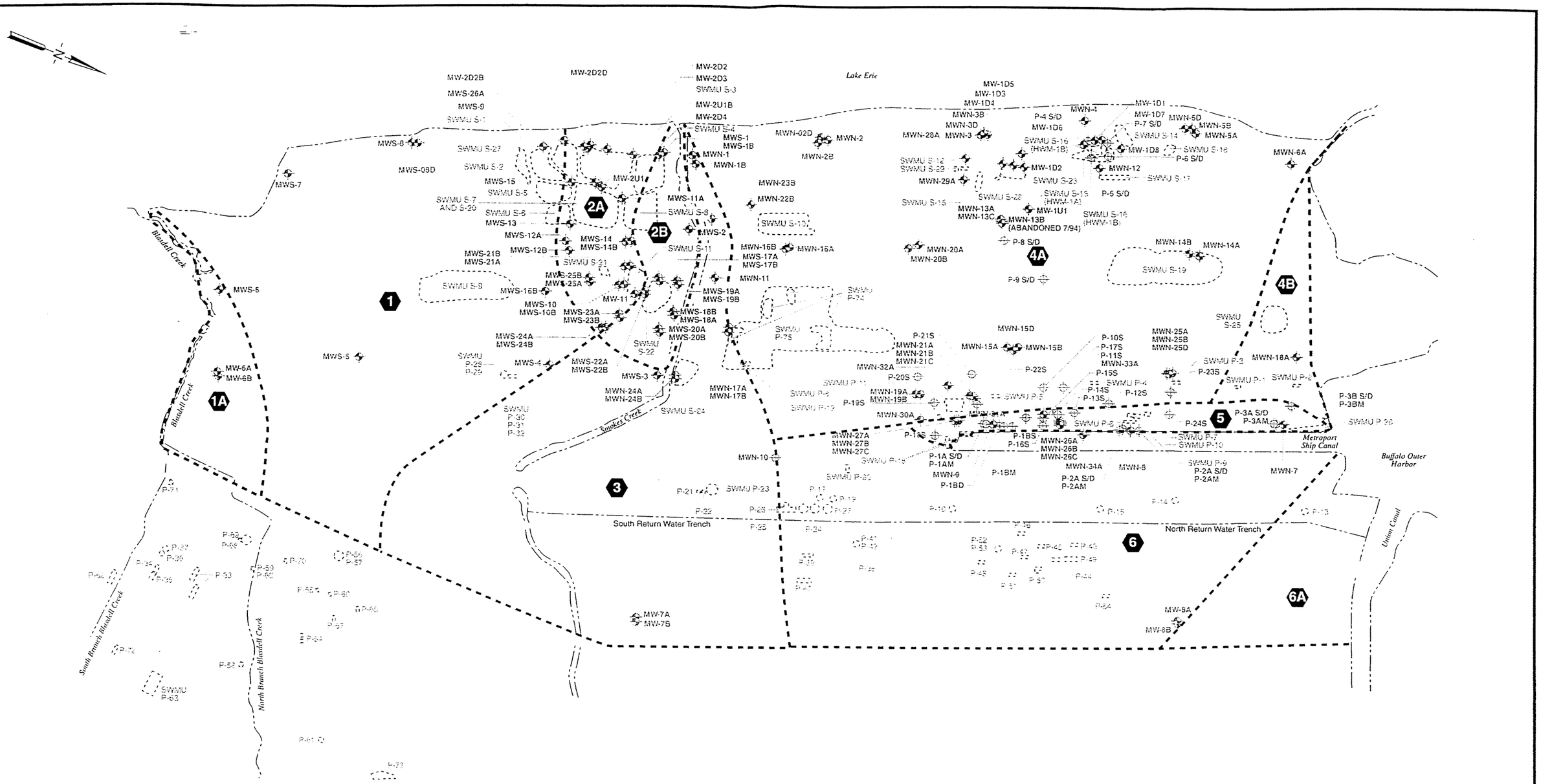
Dissolved COPCs may potentially enter Lake Erie and specific watercourses (Smokes Creek, Blasdell Creek, ~~and~~ the Gateway Metroport Ship Canal, and the North and South Return Water Trenches) through discharge of groundwater into the surface water flow regime. (Note: the Gateway Metroport Ship Canal was formerly called the Lackawanna Ship Canal and will hereafter be referenced as the Ship Canal.) The migration of groundwater to surface water was assessed for those surface waters that (1) have been identified as receiving groundwater discharge from the site and (2) are potential ~~recreational~~ contact areas for human receptors (recreational bathers, fish consumers, off-site water consumers, and/or maintenance workers). The overall flow model for the site is shown in Figure 3-5. The site is divided into three major Discharge Areas:

- The Lake Erie Discharge Area, discharging directly into Lake Erie ($Q_{GW(Lake\ Erie)}$)
- The Smokes Creek Discharge Area, discharging directly into Smokes Creek ($Q_{GW(Smokes\ Creek)}$)
- The ~~Lackawanna~~ Ship Canal Discharge Area, discharging directly into the Ship Canal ($Q_{GW(Ship\ Canal)}$).

The boundaries of these groundwater-shed areas were estimated based upon piezometric elevation data. The surface water bodies of interest with respect to potential human exposure to site-related COPCs in surface water are the Ship Canal, the North and South Return Water Trenches, Blasdell Creek, Smokes Creek, and nearshore Lake Erie.

The potential for~~Limited~~ direct contact with water in the Ship Canal is limited~~possible~~ for ~~future~~ workers at the site. Records show the following worker exposure in the last thirteen years:

- Twice a year, divers inspect the #1 Pump Station intake. This requires approximately two to three hours, and the divers wear wet suits.
- Twice a year, a boom deploy exercise is done involving two workers in a boat. This exercise requires approximately one hour.
- Buffalo Crushed Stone has not done any maintenance or dredging since they purchased the canal from BSC in 1985. They have had two oil spills since 1985, both of which were cleaned up without entering the water by using a boat and oil booms.



0 1000 2000

APPROXIMATE SCALE IN FEET

LEGEND:

- MWS-8 — Monitoring Well Location and Number
- P-2BM — Piezometer Location and Number
- SWMU S-10 — Approximate Solid Waste Management Unit (SWMU) Boundary and Number
- 1 — Discharge Area Boundary and Number

Revised May 1998

BETHLEHEM STEEL CORPORATION
Lackawanna, New York

FIGURE 3-5
GROUNDWATER DISCHARGE AREAS

Job No. 00120-195-152 **Dames & Moore**

- In February 1997, there was a tar spill from the Coke Oven on the northwest side of the canal. The cleanup, performed by HazMat team divers (outside contractors), took about three weeks.

Although contact by workers is therefore not expected to be substantial nor to occur on a regular basis, at the request of EPA, this potential ~~future~~ exposure pathway will be considered quantitatively in the human health risk assessment.

Under current operating conditions, water is being continuously pumped (24 hours per day) from the Ship Canal at a rate that far exceeds the amount of SPDES-permitted and groundwater inflows to the canal, resulting in a net flow of water into the Ship Canal from the Buffalo Outer Harbor (Lake Erie) (see Appendix E.1). ~~However, this contact is not expected to be substantial or to occur on a regular basis. Accordingly, this potential exposure pathway will be discussed qualitatively in the human health risk assessment. Access to the Ship Canal by water is controlled by signage posted at its entrance and by regular security patrols. Therefore, the Ship Canal will not be considered as a realistic exposure route for potential human receptors based on recreational uses.~~

~~WATER BALANCE FOR SHIP CANAL, 1997~~[5]

~~Source~~	~~Flow (mgd)~~	
	~~Outflow~~	~~Inflow~~
~~Pump House #1~~	~~68—88~~	
~~Groundwater~~[6]		~~0.2~~
~~Outfall 401~~		~~5.5~~
~~Outfall 410~~		~~0.2~~
~~Outfall 411~~		~~0.9~~
~~Outfall 412~~		~~3.8~~
~~Buffalo Outer Harbor~~		~~57.4—77.4~~
~~Totals~~	~~68—88~~	~~68—88~~

This pumping provides water for the operational needs of BSC's coking and galvanized products operations; it also provides water for the operational needs of Bar Technology Inc.'s 13-inch bar mill and Buffalo Crushed Stone/Gateway Trade Center. This usage is expected to continue for the foreseeable future. In addition, as the site is redeveloped, the type of new and replacement industries likely to locate on the site may also need this water for their operations. Therefore, there is ~~neither a~~ currently nor ~~a reasonably anticipated future~~ pathway whereby COPCs in the Ship Canal could migrate into the lake directly from the Ship Canal and impact recreational bathers, fish consumers, and off-site water consumers. Although the pumping operations that prevent off-site movement of Ship Canal water directly to the Buffalo Outer Harbor are expected to continue in the future, ~~, this pathway and~~

~~[5] Note: the data contained in the letter to EPA dated 4/17/98 were 1994 data. These have been updated to reflect calendar year 1997 data for the outflow and for the inflow from the SPDES outfalls.~~

~~[6] Groundwater inflow consists of approximately 15 gpm from the Ceoke Ooven Aarea and approximately 135 gpm from the rest of the area that discharges to the Ship Canal. This table and other supporting data is included in the Draft RFI First Submittal sent to the Agency on 4/30/98.~~

potential risks associated with hypothetical future exposure to off-site recreational bathers and fish and water consumers~~it~~ will, at the request of EPA, be quantitatively evaluated in the risk assessment assuming cessation of the ~~reevaluated if~~ pumping operations ~~should cease~~.

~~The North Return Water Trench (NRWT) is a man-made channel that carries wastewater and storm run-off to the Union Ship Canal from areas associated with various BSC operations. It originates in the area formerly occupied by the 32-inch Finishing Mill and flows northwesterly for approximately 3,300 feet to its point of discharge into the Union Ship Canal. The trench is approximately square in cross section and averages 8 to 10 feet in width and depth. Traveling from south to north along the trench, the first 400 feet of the trench are constructed of brick and concrete and are not roofed. The next 1,200 feet are covered (roofed) with concrete that contains openings, approximately 8 feet by 12 feet in size, at regular intervals to allow visual inspection. The following 1,400 feet are completely covered by a concrete roof and are also lined with bricks and concrete. The final 150 feet of the trench (to its point of discharge into the Union Ship Canal) are approximately 25 feet wide and formed by a sheet pile bulkhead on each side.~~

~~Current discharges to the NRWT are from SPDES permitted outfalls associated with the Coke Ovens Division. The outfalls discharge non-contact cooling water. In addition, two outfalls also discharge boiler blowdown from steam station No. 1 and strainer blowdown from pump station No. 1.~~

~~The NRWT is isolated from current site operations. Future, non-BSC workers would have no need to visit or work in or around the trench, and thus would have no reason to come into contact with the water in the NRWT, because it is used exclusively to carry BSC wastewater. Therefore, the future worker pathway is judged to be incomplete for these reasons and will not be addressed in the risk assessment.~~

~~The South Return Water Trench (SRWT) is a man-made channel that also originates in the area formerly occupied by the 32-inch Finishing Mill, but flows south from that point approximately 5,000 feet and discharges into Smokes Creek. Traveling south along the trench from its point of origin, the first section of the SRWT is constructed of concrete and brick, with an approximate cross section of 8 to 10 feet and an approximate depth below ground level of 8 to 10 feet. At about the mid-portion, the construction changes to brick and sheet piling; at the southern end, where it discharges into Smokes Creek, the trench is lined with only sheet piling. Although the depth remains fairly constant, the SRWT gradually widens to about 30 feet at its point of discharge into the creek.~~

~~Historically, the SRWT carried process water and storm run-off from areas associated with various BSC facilities, and may have helped to drain a marshy area east of the Ship Canal and west of the Hamburg Turnpike. Prior to the early 1970s, effluent from BSC operations typically consisted of storm runoff, non-contact cooling water, and other wastewaters produced by hot forming operations in the South Structural Mills Complex and the Basic Oxygen Furnace (BOF) scrubber. From approximately 1970 to 1983, WQCS #3 (BOF scrubber water) and WQCS #4 (South Structural Mills) discharged treated wastewater to the SRWT. There have been no BSC process discharges into the trench since late 1983. The~~

~~present flow in the SRWT, estimated to be 100 gpm, is from precipitation and groundwater sources only.~~

~~The SRWT is isolated from current site operations. As with the NRWT, future, non-BSC workers would have no need to visit or work in or around the trench, and thus would have no reason to come into contact with the water within it. Therefore, the future worker pathway is judged to be incomplete for these reasons and will not be addressed in the risk assessment.~~

Groundwater discharges into Blasdell Creek and the North and South Return Water Trenches are relatively minor, as illustrated by Figure 3-5. The area of the Blasdell Creek Discharge Area shown on that figure is roughly equal to 1.6×10^6 feet^2, or 0.06 square miles. The estimated total flow from this area into the creek is on the order of 20 gpm. MWS-06, which is located within the Blasdell Creek Groundwater Discharge Area, has been sampled seven times, the last time in May 1997. The analytical results from these sampling rounds indicate that the groundwater is not contaminated in this area. Groundwater discharges into the two return water trenches is~~n~~ discussed in Appendix E.2 – groundwater entering the trenches is from a relatively narrow zone of influence and does not appear to be contaminated. ~~–~~Thus, although Blasdell Creek may be used for recreational purposes and workers could come into contact with affected media in the trenches during site redevelopment, these water courses~~it~~ will not be considered as ~~a~~ potential exposure media~~um~~ for site groundwater. ~~Groundwater flow into Blasdell Creek from the Lackawanna site is only a very small component of the total flow from the site, as illustrated by Figure 3-5. The area of the Blasdell Creek Discharge Area shown on that figure is roughly equal to 1.6×10^6 feet^2, or 0.06 square miles. The estimated total flow from this area into the creek is on the order of 20 gpm. MWS-06, which is located within the Blasdell Creek Groundwater Discharge Area, has been sampled seven times, the last time in May 1997. The analytical results from these sampling rounds indicate that the groundwater is not contaminated in this area. Therefore, although Blasdell Creek may be used for recreational purposes, it will not be considered as a potential exposure medium for groundwater.~~

The assessment of potential risks associated with groundwater transport to surface water will therefore focus on Smokes Creek and nearshore Lake Erie, and the Ship Canal under future conditions assuming cessation of pumping. ~~In addition, potential risks associated with chemicals detected only in surface water bodies will be evaluated individually by surface water body in the assessment.~~ Wells assigned to the Ship Canal, Lake Erie, and Smokes Creek Discharge Areas are listed in Table 3-3. Well locations are shown on Figure 3-6. In addition, potential risks associated with chemicals detected only in surface water bodies will be evaluated individually by surface water body in the assessment (see Section 3.6).

3.3.2 Vapor Pathway

Volatile organic constituents (defined as those compounds with a Henry's law constant greater than 10^{-5} atm-m^3/mol and molecular weight less than 200 daltons) detected in groundwater will be evaluated for impacts on air quality both on- and off-site. For potential on-site exposures, volatile analytes identified as COPCs within a specific area will be evaluated as groundwater COPCs for individual SWMUs located within that area. Thus, the

TABLE 3-3

WELL GROUPINGS FOR LAKE ERIE, ~~AND~~ SMOKES CREEK, SHIP CANAL DISCHARGE AREAS

Wells in the Lake Erie Discharge Area			Wells in the Smokes Creek Discharge Area	Wells in the Ship Canal Discharge Area
MW-1D1	MWN-13A	MWS-05	MW-07A	BPP-2
MW-1D2	MWN-13B	MWS-06	MWN-01	BPP-3
MW-1D3	MWN-13C	MWS-06A	MWN-01B	BPP-5
MW-1D4	MWN-14A	MWS-07	MWN-10	MWN-07
MW-1D5	MWN-14B	MWS-08	MWN-11	MWN-08
MW-1D6	MWN-15A	MWS-09	MWN-17A	MWN-09
MW-1D7	MWN-15B	MWS-10	MWN-17B	MWN-26A
MW-1D8	MWN-16A	MWS-10B	MWN-23B	MWN-26B
MW-1U1	MWN-16B	MWS-11A	MWN-24A	MWN-27A
MW-2D2	MWN-18A	MWS-12A	MWN-24B	MWN-27B
MW-2D2B	MWN-19A	MWS-12B	MWS-01	MWN-33A
MW-2D3	MWN-19B	MWS-13	MWS-01B	MWN-34A
MW-2D4	MWN-20A	MWS-14	MWS-02	
MW-2U1	MWN-20B	MWS-14B	MWS-03	
MW-2U1B	MWN-21A	MWS-15	MWS-17A	
MW-11	MWN-21B	MWS-16B	MWS-17B	
MWN-02	MWN-21C	MWS-21A	MWS-18A	
MWN-02B	MWN-22B	MWS-21B	MWS-18B	
MWN-03	MWN-25A	MWS-23A	MWS-19A	
MWN-03B	MWN-25B	MWS-23B	MWS-19B	
MWN-04	MWN-28A	MWS-24A	MWS-20A	
MWN-05A	MWN-29A	MWS-24B	MWS-20B	
MWN-05B	MWN-30A	MWS-25A	MWS-22A	
MWN-06A	MWN-31A	MWS-25B	MWS-22B	
MWN-12	MWN-32A	MWS-26A		
	MWS-04			

groundwater COPCs for all SWMUs located in a particular area are identical. Well assignments for purposes of vapor pathway COPC selection are presented in Table 3-4. Site-wide groundwater COPCs will be used to address the potential impact of groundwater vapors on receptors (residents, recreational users).

3.4 SUMMARY OF AVAILABLE SWMU MATERIAL DATA

Samples collected in surficial (*i.e.*, the top 6 inches) and subsurface SWMU material are summarized in Table 3-5. This table provides sample numbers and depths for each source of data to be used in the risk assessment. The following sections detail selection of COPCs in SWMU material.

3.4.1 Surficial SWMU Material

Sampling to identify constituents present in surficial SWMU material was performed during the Phase II-B and II-C investigations (Table 3-5). One to five surface samples were collected at 23 of the 41~~2~~ SWMUs subject to quantitative risk assessment and analyzed for VOCs, SVOCs, metals, and cyanide using EPA methods 8240, 8270, 6010, and 9012, respectively.

3.4.2 Subsurface SWMU Material

During Phase II-B and II-C, one to seven subsurface material samples were collected and analyzed for VOCs, SVOCs, metals, and cyanide using EPA Methods 8240, 8270, 6010, and 9012, respectively. Data collected in investigations prior to 1991 will not be used in the risk assessment if they are superseded by more recent data. Subsurface samples were collected at varying depths, typically 20 to 30 feet below ground surface. The full core samples were screened every two feet to determine the highest VOC concentrations. The screening process entailed the collection of a representative sample for every two-foot interval. The samples were then placed in a sealed plastic bag or glass jar for 10 to 15 minutes to reach equilibrium. Each sample was probed using a photoionization detector. The screened sample that registered the highest PID reading for vapors was then used as the representative grab sample for that boring and taken for laboratory VOC analysis. Composite core samples were assayed for SVOC and inorganic analytes. The VOC data were combined in the COPC selection process to increase sample size.

TABLE 3-4

WELL GROUPINGS USED FOR COPC SELECTION FOR THE ON-SITE VAPOR PATHWAY

Coke Oven Area	Smokes Creek Area	Tank Farm Area	Slag Fill Area Zone 1	Slag Fill Area Zone 2	Slag Fill Area Zone 3	Slag Fill Area Zone 4	Slag Fill Area Zone 5
BPP-1	A4-10A	MWN-10	MWS-4	A2-5A	MWN-1	MW-1D1	MWN-6A
BPP-2	A4-10B	MWN-16A	MWS-5	A2-5B	MWN-1B	MW-1D2	
BPP-3	MW-11	MWN-16B	MWS-6	MW-2D2	MWN-2	MW-1D3	
BPP-4	MWNS-23B	MWN-17A	MWS-7	MW-2D2B	MWN-2B	~~MW-1D3A~~	
BPP-5	MWNS-24A	MWN-17B	MWS-8	MW-2D3	MWN-20A	~~MW-1D3B~~	
BPP-6	MWNS-24B			~~MW-2D3A~~	MWN-20B	~~MW-1D3C~~	
BPP-7	MWS-2			~~MW-2D3B~~	MWN-22B	MW-1D4	
BPP-8	MWS-3			~~MW-2D3C~~		MW-1D4A	
BPP-9	MWS-17A			MW-2D4		MW-1D5	
MWN-07	MWS-17B			MW-2U1		MW-1D6	
MWN-08	MWS-18A			MW-2U1B		MW-1D7	
MWN-09	MWS-18B			MWS-1		MW-1D8	
MWN-14A	MWS-19A			MWS-1B		MW-1U1	
MWN-14B	MWS-19B			MWS-9		~~MW-1U1A~~	
MWN-15A				MWS-10		~~MW-1U1B~~	
MWN-15B				MWS-10B		~~MW-1U1C~~	
MWN-18A				MWS-11A		MWN-3	
MWN-19A				MWS-12A		MWN-3B	
MWN-19B				MWS-12B		MWN-4	
MWN-21A				MWS-13		MWN-5A	
MWN-21B				MWS-14		MWN-5B	
MWN-21C				MWS-14B		MWN-12	
MWN-25A				MWS-15		MWN-13A	
MWN-25B				MWS-16B		MWN-13B	
MWN-26A				MWS-20A		MWN-13C	
MWN-26B				MWS-20B		MWN-28A	
MWN-27A				MWS-21A		MWN-29A	
MWN-27B				MWS-21B			
MWN-27C				MWS-22A			
MWN-30A				MWS-22B			
MWN-31A				MWS-23A			
MWN-32A				MWS-23B			
MWN-33A				MWS-24A			
MWN-34A				MWS-24B			
				MWS-25A			
				MWS-25B			
				MWS-26A			

TABLE 3-5
AVAILABILITY OF SAMPLES FROM SOLID WASTE MANAGEMENT UNITS TO BE CONSIDERED IN THE HUMAN HEALTH RISK ASSESSMENT

SWMU		Sampling Interval				
		Sample ID	Surface	Sub-surface	Quench Water	Pit Sediment
Coke Oven Area						
P-1	Quench Water Pit, North Station	P1(0-2) P-1		0-2'	Grab	
P-2	Quench Water Pit, Arctic Station	P2(0-2) P2(0-2)DUP P-2		0-2' 0-2'	Grab	
P-3	Quench Water Pit, Central Station	P3-1(0-6) P-3	0-6"		Grab	
P-4	Quench Water Pit, A Station	P4-1(0-6) P-4	0-6"		Grab	
P-5	Quench Water Pit, B Station	P5-1(0-6)	0-6"			
P-6	Lime Sludge Settling Pit	P6-1(0-6)	0-6"			
P-7	Abandoned Lime Sludge Settling Basin	P7-1(0-6) P7-2 P7-3	0-6"	 14.5' 15.2'		
P-9	Abandoned Tar Decanter Sludge Pits	P9		15'		
P-10	Contaminated Soil Near Ball Mill	P10(0-2)		0-2'		
P-11	Benzol Plant Tank Storage Area	P11-1(0-6) P-11 SB-1 SB-2 SB-3 SB-4 SB-5 SB-6 SB-7 SB-8 SB-9 SB-10 SB-11	0-6"	 4-6' 4-6' 4-6' 6-8' 6-8' 10-12' 6-8' 6-8' 6-8' 4-6' 4-6'	Grab	
P-11	Pit #17				Mid NW SE Composite	
P-18	Cooling Tower Hot and Cold Wells	P18-1 (19.5) P18-2 (0-8) P18-3 (0-30) P18-1 P18-2 P18-3 P18-4				0-19.5' 0-8" 0-30" 0-18.5" 0-6" 0-17" 0-26'
P-12	Spill Cleanup Soil Storage Area	P12-1(0-6) P12-2(0-6)	0-6" 0-6"			
S-26	Fill Area Near Coke Battery #8	S-26-1(0-30) S-26-1(20-22.5) S-26-2(0-30) S-26-2(12-14)		0-30' 20-22.5' 0-30' 12-14'		
Tank Farm Area						
P-8	Waste Oil Storage Tanks in Tank Farm	P8-1(0-6) P8-2(0-6)	0-6" 0-6"			

TABLE 3-5 (Continued)

SWMU		Sampling Interval				
		Sample ID	Surface	Sub-surface	Quench Water	Pit Sediment
P-74	Solid Fuel Mix Storage Piles in Tank Farm	P-74-1(0-6)	0-6"			
		P-74-2(0-6)	0-6"			
		P-74-3(0-6)	0-6"			
		P-74-4(0-6)	0-6"			
P-75	Tank Storage Area, Tank Farm	P-75-1(0-6)	0-6"			
		P-75-2(0-6)	0-6"			
		P-75-2(0-6)DUP	0-6"			
		P-75-3(0-6)	0-6"			
		P-75-4(0-6)	0-6"			
		P-75-5(0-6)	0-6"			
Slag Fill Area Zone 2						
S-1	Surface Impoundment A	S1-1(0-6)	0-6"			
		S1-2(0-6)	0-6"			
		S1-1(6-8)		6-8'		
		S1-1(0-24)		0-24'		
		S1-2(4-6)		4-6'		
		S1-2(0-8)		0-8'		
S-2	Surface Impoundment B	S2-1(0-6)	0-6"			
		S2-2(0-6)	0-6"			
		S2-3(0-27.3)		0-27.3'		
		S2-3(16-18)		16-18'		
		S2(12-14)		12-14'		
		S2(0-26)		0-26'		
S-3	Surface Impoundment C	A	~~Comp~~	Comp		
		B	~~Comp~~	Comp		
		C	~~Comp~~	Comp		
		D	~~Comp~~	Comp		
		E	~~Comp~~	Comp		
		F	~~Comp~~	Comp		
		HWM2-C1R2	~~Comp~~	Comp		
		HWM2-C2R1	~~Comp~~	Comp		
		HWM2-C2R1DUP	~~Comp~~	Comp		
		HWM2-C2R3	~~Comp~~	Comp		
		HWM2-C3R2	~~Comp~~	Comp		
		HWM2-C3R4	~~Comp~~	Comp		
		HWM2-C3R4DUP	~~Comp~~	Comp		
		HWM2-C4R1	~~Comp~~	Comp		
		HWM2-C4R3	~~Comp~~	Comp		
		HWM2-C5R2	~~Comp~~	Comp		
		MIDDLE#6	~~10-12'~~	10-12'		
		MIDDLE#7	~~12-14'~~	12-14'		
		MIDDLE S-4	~~6-8'~~	6-8'		
		NE S-3	~~4-6'~~	4-6'		
		NW S-4	~~6-8'~~	6-8'		
		SE S-3/S-8	~~Comp~~	Comp		
		SW S-4	~~6-8'~~	6-8'		
		SECTOR I	~~Comp~~	Comp		
		SECTOR II	~~Comp~~	Comp		
		SECTOR III	~~Comp~~	Comp		
		SECTOR IV	~~Comp~~	Comp		
		SECTOR V	~~Comp~~	Comp		

TABLE 3-5 (Continued)

SWMU		Sampling Interval				
		Sample ID	Surface	Sub-surface	Quench Water	Pit Sediment
S-3 cont'd		SECTOR VI	~~Comp~~	Comp		
		SECTOR VII	~~Comp~~	Comp		
S-4	Surface Impoundment D	S4-1(0-6)	0-6"			
		S4-2(0-6)	0-6"			
		S4-3(0-6)	0-6"			
		S4-4(0-36)		0-36'		
		S4-4(20-22)		20-22'		
		S4-5(0-38)		0-38'		
		S4-5(26-30)		26-30'		
		S4-6(0-38)		0-38'		
		S4-6(26-30)		26-30'		
		S4(22-24)		22-24'		
		S4(0-36)		0-36'		
SFA Zone 4	Lime Stabilized SPL Sludge - Slag Landfill	CORE #1	Comp			
		CORE #1-84	Comp			
		CORE #2	Comp			
		CORE #2-84	Comp			
		CORE #2DUP	Comp			
		CORE #3-84	Comp			
		CORE #4-84	Comp			
		CORE #5	Comp			
		CORE #5-84	Comp			
		CORE #5DUP	Comp			
		CORE #6	Comp			
		CORE #6-84	Comp			
		CORE #7	Comp			
		CORE #7-84	Comp			
		CORE #7DUP	Comp			
		CORE #8	Comp			
S-5	Surface Impoundment E	S5-1(0-6)	0-6"			
		S5-2(0-6)	0-6"			
		S5-1(10-12)		10-12'		
		S5-1(0-21.5)		0-21.5'		
		S5-2(18-20)		18.20'		
		S5-2(0-21)		0-21'		
S-6	Surface Impoundment F	S6-1(0-6)	0-6"			
		S6-2(0-6)	0-6"			
		S6-3(0-24.8)		0-24.8'		
		S6-3(12-14)		12-14'		
		S6(14-16)		14-16'		
		S6(0-33.7)		0-33.7'		
S-7/ S-20	Surface Impoundment G	S7-1(6-10)		6-10'		
		S7-1(0-30)		0-30'		
		S7-1(22-24)		22-24'		
		S7-1(0-30)		0-30'		
		S7-2(32-34)		32-34'		
		S7-2(30-41.5)		30-41.5'		
S-8	Surface Impoundment H	S8-1(0-Floor)	Comp			
		S8-Berm(0-Berm)	Comp			
S-11	Landfill K, Acid Tar Pit, South	S11-1(0-30)		0-30'		
		S11-1(4-10)		4-10'		
		S11-2(16-18)		16-18'		
		S11-2(0-30)		0-30'		

TABLE 3-5 (Continued)

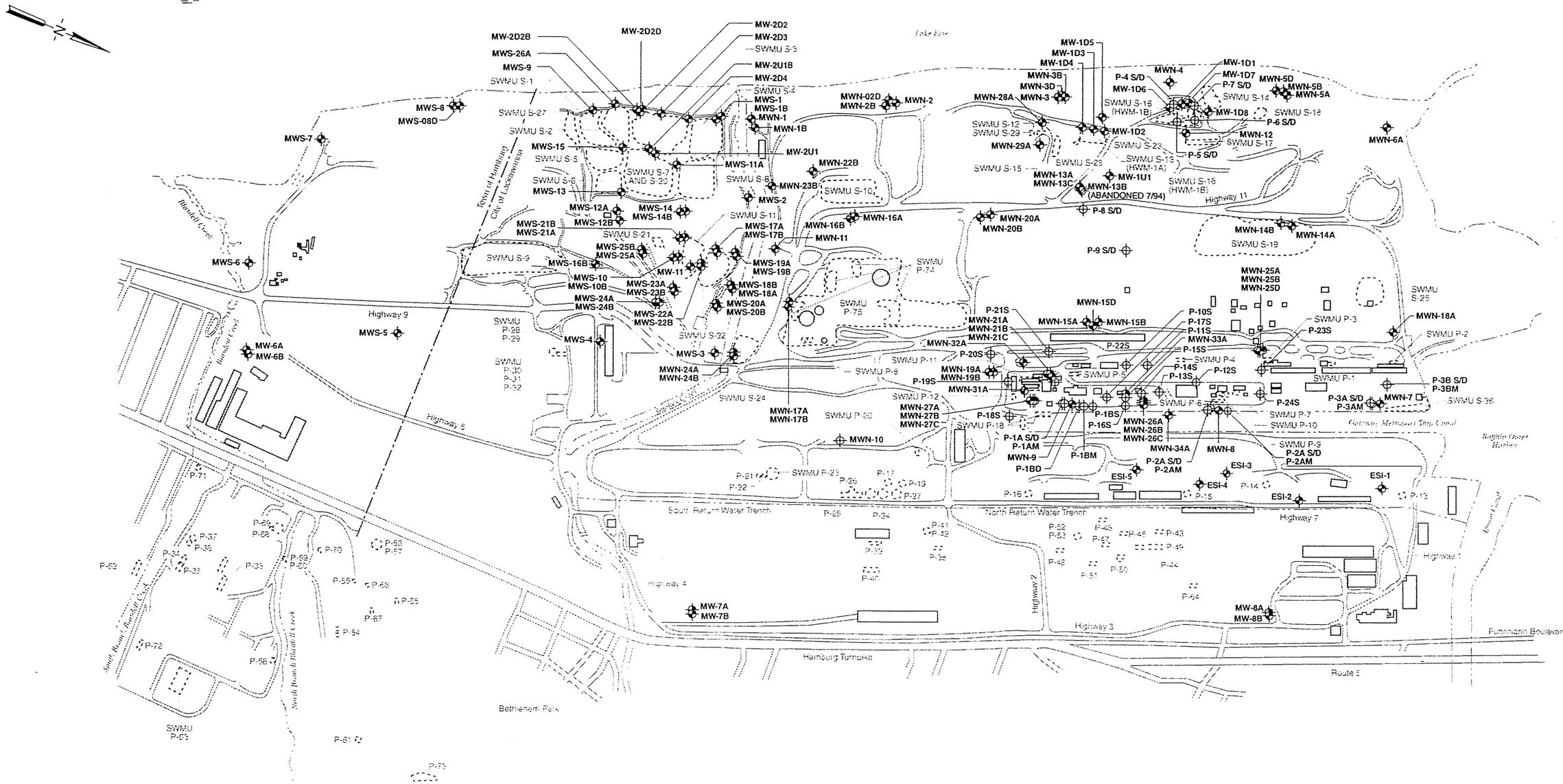
SWMU		Sampling Interval Sample ID	Surface	Sub-surface	Quench Water	Pit Sediment
~~S-13~~	~~Coal Tar Sludge Landfill Cell~~	~~Samples not available.~~				
S-16	~~Lime Stabilized SPL Sludge - Slag Landfill~~	~~CORE #1~~	~~Comp~~			
		~~CORE #1-S4~~	~~Comp~~			
		~~CORE #2~~	~~Comp~~			
		~~CORE #2-S4~~	~~Comp~~			
		~~CORE #2DUP~~	~~Comp~~			
		~~CORE #3-S4~~	~~Comp~~			
		~~CORE #4-S4~~	~~Comp~~			
		~~CORE #5~~	~~Comp~~			
		~~CORE #5-S4~~	~~Comp~~			
		~~CORE #5DUP~~	~~Comp~~			
		~~CORE #6~~	~~Comp~~			
		~~CORE #6-S4~~	~~Comp~~			
		~~CORE #7~~	~~Comp~~			
		~~CORE #7-S4~~	~~Comp~~			
		~~CORE #7DUP~~	~~Comp~~			
		~~CORE #8~~	~~Comp~~			
S-21	Sludge Storage Area	S21-1(0-6)	0-6"			
		S21-2(0-6)	0-6"			
S-22	Vacuum Carbonate Blowdown Impoundment South of Smokes Creek [Acid Tar Pit North]	A2-2 (2-6)		2-6'		
		A3-2 (4-6)		4-6'		
		A3-L (2-4 and 6-8)		Comp		
		A4-L (12-16)		12-16'		
		A4-L (16-20)		16-20'		
S-24	Tar Pit North of Lime Plant	S24-14(4-6)		4-6'		
		S24-14(2-8)		2-8'		
		S24-14(12-14)		12-14'		
		S24-14(8-14)		8-14'		
		S24-2(0-16)		0-16'		
		S24-2(6-8)	6-8"			
		S24-4(0-16)		0-16'		
		S24-4(4-6)		4-6'		
		S24-5(0-16)		0-16'		
		S24-5(8-10)		8-10'		
		S24 (4-6)		4-6'		
		S24(0-6)		0-6'		
S-27	Sludge Disposal Area (Adjacent to S-1)	S27		0-2'		
Slag Fill Area Zone 3						
S-10	Slag Quench Area J	S10-1(4-5.1)		4-5.1'		
		S10-1(0-5.1)		0-5.1'		
		S10-2(2-4)		2-4'		
		S10-2(0-5.1)		0-5.1'		
Slag Fill Area Zone 4						
S-14	General Rubble Landfill N	S14-1(0-6)	0-6"			
		S14-2(0-6)	0-6"			
		S14-3(0-6)	0-6"			
		S14-4(0-6)	0-6"			
		S14-1C		0-15.8'		
		S14-1G		6-8'		
		S14-2C		0-30'		
		S14-2CDUP		0-30'		
		S14-2G		4-6'		
		S14-2GDUP		4-6'		

TABLE 3-5 (Continued)

SWMU		Sampling Interval				
		Sample ID	Surface	Sub-surface	Quench Water	Pit Sediment
S-15	General Rubble Landfill O	S-15-1(0-6) S-15-2(0-6)	0-6" 0-6"			
S-17	Vacuum Carbonate Blowdown - Landfill Q	S-17-1(0-3) S-17-1(0-3)DUP S-17-2(0-3)		0-3' 0-3' 0-3'		
S-18	Lime/Kish Landfill	S18-KISH(0-KISH) S18-LIME(0-LIME DUST)	Grab Grab			
S-23	Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill	S23-1(4-6) S23-1(0-46) S23-2(4-6) S23-2(0-41.5)		4-6' 0-46' 4-6' 0-41.5'		
		Other Areas				
S-19	Murphy's Mountain Landfill A	S19-1(0-6) S19-2(0-6)	0-6" 0-6"			
S-19 cont'd		S19-2(0-6)DUP S19-3(0-6) S19-4(0-6)	0-6" 0-6" 0-6"			
S-25	Landfill/Impoundment under North End of Coal Pile	S25-1C S25-1G S25-2 Composite S25-2G(28-29.5)		0-21' 16-16.3' 0-29.5' 28-29.5'		
P-63	Former Mill Scale Storage Area No. 7	TP-5-1 TP-5-2 TP-5-3 TP-6-1 TP-6-2 TP-6-3 TP-7-1 TP-7-2 TP-7-3		0-0.5' 2-3' 4-4.5' 0-0.5' 2-3' 3.5-4.5' 0-0.5' 2-3' 3.5-4'		
P-73	Former Drum Storage Area	SP-ACE SP-B SP-D TP-1 TP-2 TP-3 TP-4		Comp 8-9' 5.5-6.5' 3.75-4' 4-4.5' 3-3.5' 2.5-3.5'		

Notes: Grab = Grab Sample; Comp = Composite Sample.

BETHLEHEM STEEL [illegible]0-195-1000-152



0 1000 2000

APPROXIMATE SCALE IN FEET

LEGEND:

- MWS-8 — Monitoring Well Location and Number
- P-2BM — Piezometer Location and Number
- SWMU S-19 — Approximate Solid Waste Management Unit (SWMU) Boundary and Number

BETHLEHEM STEEL CORPORATION
RCRA FACILITY INVESTIGATION
Lackawanna, New York

FIGURE 3-6
LOCATION OF MONITORING WELLS AND PIEZOMETERS

Job No. 00120-195-152 Dames & Moore

3.5 GROUNDWATER

Groundwater samples were collected during Phases I, II-A, II-B, II-C, and III. The data from all wells installed and/or used during these phases of the RFI will be used in the risk analysis except for those identified as bedrock wells (*i.e.*, MWN-02D, MWN-3D, MWN-05D, MWN-15D, MWN-25D, MWS-08D, MW-2D2D, MW-6B, MW-7B, and MW-8B). The bedrock wells were excluded from the analysis for two principal reasons. First, chemical impacts to these wells are limited. Thus, their inclusion in the data set for risk assessment would tend to reduce estimates of representative constituent concentrations in site groundwater. Second, their contribution to the total flow of site groundwater into Lake Erie, although probably minor, is less well understood than that from the fill and sand unit.

With the following exception, total metals data were used in the analysis, as requested by EPA. In the case of wells located within the Slag Fill Area Zones 1 and 5 (*i.e.*, wells MWN-06A, MWS-04, MWS-05, MWS-06, MWS-07, and MWS-08), no total metals data were available. Thus, filtered (dissolved) sample data were used for these areas. It is acknowledged that use of this measure may underestimate total metals concentrations, but as the alternative is neglecting metals from these zones altogether, use of filtered data was considered an acceptable compromise.

The data set also includes quarterly and semi-annual samples from wells that were sampled during the previously identified RFI phases for the purpose of complying with monitoring requirements for the hazardous waste management units HWMU-1 and HWMU-2. These wells are MW-1U1, MW-1D1, MW-1D2, MW-1D3, MW-1D4, MW-1D6, MW-1D7, MW-1D8, MW-2U1, MW-2D2, MW-2D3, MW-2D4, and MWN-12. Although these wells were installed under the RCRA program for hazardous waste management units, groundwater samples collected from these wells may reflect the presence of SWMU-related chemicals. Therefore, data from these wells were included in the data set for risk assessment.

3.6 SURFACE WATER

Surface water samples were collected from locations in Blasdell Creek, Smokes Creek, the Ship Canal, the North and South Return Water Trenches, nearshore Lake Erie and Outer Buffalo Harbor during the Phase II-A, II-B, and III investigations. As discussed in Section 3.3.1, t~~T~~he surface water bodies of interest with respect to potential human exposure to site-related COPCs in surface water are the Ship Canal, the North and South Return Water Trenches, Blasdell Creek, Smokes Creek and nearshore Lake Erie.

Access to the Ship Canal by water is controlled by signage posted at its entrance and by regular security patrols. Therefore, the Ship Canal itself will not be considered as a realistic exposure location for potential human receptors based on recreational uses. However, as discussed previously (see Section 3.3.1), potential exposure of recreational bathers and fish consumers in Lake Erie and off-site water consumers to COPCs in Ship Canal Discharge Area groundwater will be considered assuming future cessation of pumping.

The North Return Water Trench is a man-made channel that carries wastewater and storm run-off to the Union Ship Canal from areas associated with various ~~BSC~~ operations. It originates in the area formerly occupied by the 32-inch Finishing Mill and flows northwesterly for approximately 3,300 feet to its point of discharge into the Union Ship Canal. The trench is approximately square in cross section and averages eight to ten feet in width and depth. Traveling from south to north along the trench, the first 400 feet of the trench are constructed of brick and concrete and are not roofed. The next 1,200 feet are covered (roofed) with concrete that contains openings, approximately eight feet by 12 feet in size, at regular intervals to allow visual inspection. The following 1,400 feet are completely covered by a concrete roof and are also lined with bricks and concrete. The final 150 feet of the trench (to its point of discharge into the Union Ship Canal) are approximately 25 feet wide and formed by a sheet pile bulkhead on each side. Current discharges to the trench are from SPDES-permitted outfalls associated with the Coke Ovens Division. The outfalls discharge non-contact cooling water. In addition, two outfalls also discharge boiler blowdown from steam station No. 1 and strainer blowdown from pump station No. 1.

The South Return Water Trench is a man-made channel that also originates in the area formerly occupied by the 32-inch Finishing Mill, but flows south from that point approximately 5,000 feet and discharges into Smokes Creek. Traveling south along the trench from its point of origin, the first section of the trench is constructed of concrete and brick, with an approximate cross section of 8 to 10 feet and an approximate depth below ground level of 8 to 10 feet. At about the mid-portion, the construction changes to brick and sheet piling; at the southern end, where it discharges into Smokes Creek, the trench is lined with only sheet piling. Although the depth remains fairly constant, the trench gradually widens to about 30 feet at its point of discharge into the creek. Historically, the South Return Water Trench carried process water and storm run-off from areas associated with various BSC facilities, and may have helped to drain a ~~marshy~~ low-lying area east of the Ship Canal and west of the Hamburg Turnpike. Prior to the early 1970s, effluent from BSC operations typically consisted of storm runoff, non-contact cooling water, and other wastewaters produced by hot-forming operations in the South Structural Mills Complex and the Basic Oxygen Furnace (BOF) scrubber. From approximately 1970 to 1983, WQCS #3 (BOF scrubber water) and WQCS #4 (South Structural Mills) discharged treated wastewater to the ~~SRWT~~ South Return Water Trench. There have been no BSC process discharges into the trench since late 1983. The present flow in the ~~SRWT~~ South Return Water Trench, estimated to be 100 gpm, is from precipitation and groundwater sources only.

Both the North and South Return Water Trenches are isolated from current site operations. However, in the future, construction workers could contact surface water in the trenches in the course of site redevelopment activities. Therefore, contact with surface water in these water courses will be quantitatively evaluated in the risk assessment.

Lake Erie samples were taken at mid-depth. Samples at multiple depths were obtained from locations in Smokes Creek. Available data for these locations are included in the data set, as well as samples from two seeps into Smokes Creek.

3.7 SEDIMENT

Surficial sediment samples (0 - 6 inches) were collected from locations in Blasdell Creek, Smokes Creek, the Ship Canal, the North and South Return Water Trenches, nearshore Lake Erie and Outer Buffalo Harbor during Phase II-B, II-C, and III sampling investigations. Two core samples from zero to eight feet below the sediment surface in Smokes Creek and four samples collected by EPA from Lake Erie were included in the analysis.

As mentioned above, Smokes and Blasdell Creeks are potentially suitable for recreational use. As discussed previously, EPA has requested that potential future worker exposure to sediment in the Ship Canal be included in the risk assessment. The area containing the North and South Return Water Trenches is under consideration for redevelopment; therefore, construction workers potentially may be exposed. For this reason, the sediments from the trenches are subject to the risk assessment.

~~As mentioned above, only Smokes and Blasdell Creeks and nearshore Lake Erie are potentially suitable for recreational use, and hence subject to the risk assessment. Two core samples from zero to eight feet below the sediment surface in Smokes Creek and four samples collected by the EPA from Lake Erie were also included in the analysis.~~

3.8 COKE OVEN AREA PIT WATER

A single surface water sample was collected from ~~each of the~~ four concrete quench pits (P-1, P-2, P-3, and P-4) ~~and the No. 17 Pit of SWMU P-11~~ during the Phase II-B investigation. In addition, three samples for VOC analysis and one composite sample for SVOC and metals analysis were collected from Pit No. # 17 in SWMU P-11 during 1998. The 1998 data from the Pit # 17 samples replaced that collected earlier in the RFI; the earlier sample result was determined to be inaccurate. All of these data were included in the risk assessment data base.

3.9 SUMMARY OF BACKGROUND DATA

Samples of surface soil, surface water, and sediment collected from background areas during the phased RFI are summarized in the following sections. No background data were collected during the RFI for subsurface soil or groundwater. The applicability of background data to the COPC screening process (see Section 4.0) is discussed in the following subsections.

~~3.9.1~~3.9.1 Soil

3.9.1.1 Development of a Background Data Set for Polycyclic Aromatic Hydrocarbons in Surficial Soil

Polycyclic or polynuclear aromatic hydrocarbons (PAHs) are a group of organic compounds that are composed of two or more fused aromatic rings. These ubiquitous compounds are formed by the incomplete combustion of other hydrocarbons, leaving the carbon residue in the thermodynamically favored hydrogen-deficient, carbon-rich condensed aromatic ring system (Manahan, 1993). Common man-made sources of PAHs include motor vehicles and

other gas-burning engines, wood-burning stoves and furnaces, cigarette smoke, industrial smoke and soot, and charcoal-broiled foods (Agency for Toxic Substances and Disease Registry [ATSDR], 1995). Natural sources include volcanoes, forest fires, crude oil, and shale oil (ATSDR, 1995).

PAHs have been detected in SWMU material, sediment, groundwater, and surface water at the Lackawanna site, and 17 PAHs are on the COPI list for the Lackawanna site (Table 3-1). Because PAHs are ubiquitous in the environment, it is important to establish representative background concentrations in various media in order to determine to what degree (if any) the PAH concentrations observed at the Lackawanna site are elevated over ambient concentrations typical of urban settings. During the RFI, five surface soil samples were collected from locations remote (*i.e.*, greater than one mile away) from the Lackawanna site. The background sampling locations are: Humboldt Park, South Park, Heacock Park, Hamburg Town Park, and Blasdell School. These data are referred to as the "BSC background data set." The sampling depth was from 0-4 inches below ground surface. The samples were analyzed by EPA Methods 8240 and 8260, and the data were validated and met the QA/QC requirements. These results are summarized in Table 3-6 (background concentrations of other analytes in surficial soil are discussed below and presented later in Table 3-14).

In order to determine whether the limited BSC background data set can be considered to be representative of urban background concentrations, a literature survey was conducted to identify other data sets for urban background PAH concentrations in surficial soil with special emphasis on samples from the northeastern U.S. Four data sets were found; each of these data sets was compared to the others with respect to (1) representativeness, (2) completeness, and (3) comparability. In addition, distributions of PAHs in the samples were examined with respect to distributions for known PAH sources to ensure that the background soils data set from the literature was not from a PAH source dissimilar to that of the five off-site background samples. The data set determined to be of the highest quality by these criteria was statistically compared with the BSC background data set, and appropriate background concentrations for individual PAHs identified.

The process of (1) reviewing and selecting the best of the available background data sets, (2) comparing it with the BSC background data set, and (3) identifying appropriate background PAH concentrations for the BSC Lackawanna risk assessment is detailed in the following sections.

A literature survey was performed to identify concentrations of PAHs in urban background soils. The available data sets were critically evaluated according to criteria of representativeness, completeness, and comparability (EPA, 1992). Representativeness is the extent to which data reflect the site's characteristics. Factors that may influence representativeness include sample depth (surface or subsurface), location (urban or rural, geographical area, presence of additional sources or different source types), and sampling bias (contaminated or uncontaminated). Completeness "is a measure of the amount of usable data resulting from a data collection activity" (EPA, 1992). Completeness is achieved when the number of samples is sufficient to characterize both the typical magnitude and variability of

Table 3-6
Summary of Background Levels of PAHs in Surficial Soil (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Minimum Value *	Maximum Detected Value
Acenaphthene	0.205	0.78
Anthracene	0.14	1.9
Benzo(a)anthracene	0.26	6.7
Benzo(a)pyrene	0.205	6
Benzo(b)fluoranthene	0.21	15
Benzo(k)fluoranthene	0.13	3.3
Benzo(g,h,i)perylene	0.205	6.5
Chrysene	0.12	4.9
Dibenz(a,h)anthracene	0.205	1.8
Fluoranthene	0.35	12
Fluorene	0.205	0.81
Indeno(1,2,3-cd)pyrene	0.205	8.8
Naphthalene	0.205	0.22
Phenanthrene	0.205	8.1
Pyrene	0.3	10

* Minimum may include 1/2 of the lowest detection limit.

the data from the area. Comparability "expresses the confidence with which data are considered to be equivalent" (EPA, 1992). Data comparable to the BSC background data set should be analyzed by the same or similar methods, reported in consistent units, and satisfy the same or similar QA/QC criteria.

Four main sources of urban background concentrations of PAHs were identified: *Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)* (ATSDR, 1995), Southern California Edison and Southern California Gas (unpublished data, 1997), the Massachusetts Department of Environmental Protection's (MADEP) *Supplement to the Guidance for Disposal Site Risk Characterization* (1996), and a publication by Bradley *et al.* (1994) detailing results of a sampling program conducted in New England. These data are part of the MADEP document. The ranges of individual PAH concentrations reported by each of the sources are summarized in Tables 3-7 and 3-8. The quality of each data set is discussed in the following sections, and the comparison is summarized in Table 3-9.

ATSDR

ATSDR (1995) presents a table of background soil concentrations of PAHs for rural, agricultural, and urban soil (Table 3-7) derived from seven references dated from 1973 to 1987. No information is provided to indicate the sampling locations, dates, depths of the samples, analytical methods, or number of samples. The representativeness of this data set with respect to any given area is unknown, due to the lack of information; however, it is likely that the data cover a broad geographical area and are therefore not specific to the northeastern U.S. The completeness of the data set is also unknown, but since the data were compiled from seven references, the size of the data set is likely to be large. The comparability of the ATSDR data set to the BSC background data set is also unknown, but is likely to be low due to the former's inclusion of numerous studies by different researchers and the time span of the references. Thus, while this summary presents a useful range of observed concentrations of total PAHs for qualitative comparison, inability to determine data quality precludes use of this information for quantitative comparison.

Southern California Edison and Southern California Gas Company

Southern California Edison and Southern California Gas Company (unpublished data, 1997) have jointly compiled an extensive background database of PAHs collected from investigations at manufactured gas plant (MGP) sites (Table 3-8). The database consists of 184 samples collected from rural and urban locations in southern California. The samples were generally collected from peripheral areas of the sites with no known history of MGP use or from off-site areas such as parks. The samples were collected from near-surface or surface soil, and were consistently analyzed using EPA methods. The California Department of Toxic Substances Control (DTSC) has approved the data set as representative of background PAH concentrations; however, to our knowledge, the data set has not been published in the general literature. The comparability and completeness of the data set are high, but the representativeness of Southern California data with respect to New York State is unknown.

Table 3-7
Ranges of Background Soil Concentrations of Polycyclic Aromatic Hydrocarbons *

Compound	Concentrations (mg/kg)		
	Rural Soil	Agricultural Soil	Urban Soil
Acenaphthene	0.0017	0.006	
Acenaphthylene		0.005	
Anthracene		0.011 - 0.013	
Benzo(a)anthracene	0.005 - 0.02	0.056 - 0.110	0.169 - 59
Benzo(a)pyrene	0.002 - 1.3	0.0046 -0. 900	0.165 - 0.220
Benzo(b)fluoranthene	0.02 - 0.03	0.058 - 0.200	15 - 62
Benzo(e)pyrene		0.053 - 0.130	0.060 - 14
Benzo(g,h,i)perylene	0.01 - 0.07	0.066	0.900 - 47
Benzo(k)fluoranthene	0.01 - 0.11	0.058 - 0.250	0.300 - 26
Chrysene	0.0383	0.078 - 0.120	0.251 - 0.640
Fluoranthene	0.0003 -0.04	0.120 - 0.210	0.200 - 166
Fluorene		0.0097	
Ideno(1,2,3-c,d)pyrene	0.01 - 0.015	0.063 - 0.100	8 - 61
Phenanthrene	0.03	0.048 - 0.140	
Pyrene	0.001 - 0.0197	0.099 - 0.150	0.145 - 147

* From ATSDR, 1995.

Massachusetts Department of Environmental Protection

The Massachusetts Department of Environmental Protection (MADEP, 1996) has compiled a list of soil PAH concentrations judged by the MADEP staff to be representative of non-urban and urban locations in the state of Massachusetts (Table 3-8). The urban data consist of four data sets named: the Central Artery/Tunnel (CA/T) Project; Watertown, Worcester (Med City/Mill Brook); and ENSR-Urban Soil. The ENSR-Urban Soil data set is described in the literature by Bradley *et al.* (1994).

The CA/T Project data set consists of 750-1,000 samples that were collected by the Massachusetts Highway Department as part of the CA/T project. The soil borings were advanced in areas selected in an unbiased manner; however, the specific samples to be analyzed and the depths of the samples were selected based on evidence of visible contamination or elevated organic vapor monitor readings. This introduces a bias into the data set towards higher concentrations of oil or hazardous material. In addition, the data are not stratified by depth, so the effects of surface deposition versus subsurface sources such as historical releases from USTs are not apparent. No further details of the sampling such as dates and analytical methods are available, although it is reasonable to assume that the sampling was performed using EPA methods and that it meets QA/QC requirements. The completeness and comparability of the data set are considered very high due to the large sample population and the consistent use of EPA methods over a relatively short time period. However, the representativeness is judged to be low due to the bias in the sampling.

The Watertown data set consists of 17 samples that were analyzed for selected high molecular weight PAHs. No details of the sampling methodology were presented. The Watertown data set is therefore judged inadequate in terms of completeness, and unknown with regard to comparability and representativeness.

The Med City/Millbrook data set consists of 67-68 samples that were analyzed for individual PAHs except for benzo(b)fluoranthene and benzo(k)fluoranthene. No details of the sampling methodology were presented. Based on the number of samples, the completeness of the Med City/Millbrook data set is considered high; however no information is available to judge the comparability and representativeness.

Bradley *et al.*

The ENSR data set consists of 62 surficial (0 – 6-inch) samples from three urban locations in New England: Boston, MA; Springfield, MA; and Providence, RI. No details of the sampling methodology were presented in the MADEP report; however, Bradley *et al.* (1994) present this information in their article. Twenty independent samples and duplicates of two samples were collected in each city in areas considered not to be directly affected by industrial sites. In general, the locations were along roads and sidewalks, and in parks and open lots. The samples were analyzed by GC-MS (EPA Method 8270) for the 17 PAH compounds on EPA's Target Compound List. The data were validated, and were statistically summarized in

Table 3-8
Summary of Available Data Sets for Background Levels of PAHs in Soil (mg/kg)

Chemical	Southern California Edison and Southern California Gas [1]		MADEP						Bradley *et al.* (1994)	
			Med City/Millbrook		Watertown		CA/T Project			
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Acenaphthene	0.0197	0.197	ND	1.7	NR	NR	0.024	42	0.024	0.34
Acenaphthylene			ND	0.76	NR	NR	0.037	10	0.018	1.1
Anthracene	0.0105	0.105	ND	3.4	NR	NR	0.033	130	0.029	5.7
Benzo(a)anthracene	0.000315	5.5	ND	15	0.021	6.05	0.045	250	0.048	15
Benzo(a)pyrene	0.000215	3	ND	9.7	0.6	6.08	0.031	230	0.04	13
Benzo(b)fluoranthene	0.0005	2	NR	NR	0.6	7.08	0.045	270	0.049	12
Benzo(k)fluoranthene	0.00014	1.5	NR	NR	0.065	5.13	0.045	150	0.043	25
Benzo(g,h,i)perylene	0.0733	0.246	ND	5.2	NR	NR	0.045	77	0.2	5.9
Chrysene	0.001	3.2	ND	14	0.016	6.6	0.022	240	0.038	21
Dibenz(a,h)anthracene	0.000435	2.2	ND	1.6	0.155	0.64	0.045	39	0.02	2.9
Fluoranthene	0.0986	2.11	ND	40	NR	NR	0.035	490	0.11	39
Fluorene	0.079	0.79	ND	2	NR	NR	0.028	79	0.022	3.3
Indeno(1,2,3-cd)pyrene	0.002	5.7	ND	6	1.2	7.2	0.022	100	0.093	6
Naphthalene	0.0258	0.258	ND	1.9	NR	NR	0.016	28	0.018	0.66
Phenanthrene	0.0384	0.495	ND	16	NR	NR	0.029	480	0.071	36
Pyrene	0.0814	12.1	ND	30	NR	NR	0.034	440	0.082	11

Notes: NR = Not Reported, ND = Not Detected, No Detection Limit Reported.

[1] Smaller data set available for acenaphthene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. Includes urban and rural locations (but stat no different).

Table 3-9
Comparison of Background Data Sets with Respect to Data Quality Criteria

Data Set	Representativeness	Completeness	Comparability
ATSDR (1995)	?	+	-
Southern California Edison/ Southern California Gas (1997)	-	+	+
MADEP (1997):			
Med City/Millbrook	?	+	?
Watertown	?	?	?
CA/T Project	-	+	?
Bradley *et al.* (1994)	+	+	+

accordance with EPA risk assessment guidance, which recommends use of one-half the detection limit to represent concentrations in non-detected samples for those analytes that are detected in at least one sample. The summary statistics presented include maximum and minimum detect, arithmetic mean, upper 95% upper confidence limit on the mean, and frequency of detection.

As no statistically significant differences were found among the data from each of the three cities, the data were pooled (Bradley *et al.*, 1994). Comparison of 42 samples taken near pavement (within four to six feet of a road) with those more distant from pavement indicated that the former had significantly higher total PAH concentrations (Bradley *et al.*, 1994). The higher total PAH concentrations near roadways is most likely due to the presence of diesel and automobile exhaust particles, as well as the materials of which roads are comprised. Given the prevalence of pavement in urban areas, this aspect of the data set is considered representative of urban conditions rather than a bias. The comparability and completeness of the data set was judged to be high, and because the samples were collected in urban soils from New England, the representativeness of the data set was considered to be high. Thus, the Bradley *et al.* data set was the highest quality data set identified in the literature survey, and was selected for further evaluation (Table 3-9).

~~3.9.1.2~~Factors Influencing PAH Levels in Soil

The primary factors influencing the identity and levels of PAHs in soil are (1) the source of the PAHs, and (2) their fate and transport characteristics. The source determines the identity of PAHs emitted. Once PAHs are released into the environment, their fate and transport in soil and other media depend upon their individual physiochemical properties (*e.g.*, water solubility) and susceptibility to chemical reactions that transform them (*e.g.*, photo-oxidation). For example, studies have shown that diesel exhaust is enriched in fluoranthene, chrysene, and pyrene, while gasoline exhaust has high benzo(g,h,i)perylene concentrations (Venkataraman *et al.*, 1994). These factors are discussed in the following sections.

Sources of PAHs

A total of approximately 8,000 to 11,000 metric tons of PAHs are estimated to be released to the atmosphere in the United States on an annual basis, with 16 - 38% of the total coming from residential heating, 13 - 39% from open burning, 6 - 41% from industrial processes, 21 – 25% from mobile sources, 1 - 5% from power generation, and 1% from incineration (ATSDR, 1995). These estimates are summarized in Table 3-10.

The composition of PAH emissions varies with the combustion source. For example, emissions from residential wood combustion contain more acenaphthylene than other PAHs, whereas auto emissions contain more benzo(g,h,i)perylene and pyrene (ATSDR, 1995). Diesel exhaust is enriched in fluoranthene, chrysene, and pyrene (Venkataraman *et al.*, 1994). The proportion of benzo(a)pyrene at a coke plant was generally higher than for motor vehicles by a factor of two or more, and the proportions for benzo(g,h,i)perylene and benzo(c)phenanthrene were higher for motor vehicles than for the coke plant (Daisey *et al.*, 1986). It should be noted that the sample collection method may have a large impact on the

levels of volatile PAHs observed. When condensation traps at reduced temperature are used to collect the samples, the fraction of the more volatile compounds such as phenanthrene, anthracene, and pyrene are higher than in samples collected at ambient temperature without condensation traps (Daisey *et al.*, 1986). Most of the studies cited above were based on stack samples or samples in road tunnels collected with the condensation traps. This factor must be taken into consideration when evaluating the PAH distributions in the background soil samples, which are obtained after airborne deposition has already occurred, at an unknown distance from the source, and collected without condensation traps.

The ratios of each individual PAH to a reference PAH can reveal valuable information about sources. The reference compound is selected based upon its chemical stability, volatility, and separability. Benzo(e)pyrene is a typical reference PAH compound because it (1) reacts in the atmosphere at a relatively slow rate, (2) is found almost exclusively in the particulate phase, and (3) is resolved chromatographically by the analytical method. In the absence of benzo(e)pyrene data, the level of benzo(a)pyrene has been assumed to be equivalent to the level of benzo(e)pyrene in order to estimate the ratios (Daisey *et al.*, 1986). This assumption was used with the mean concentrations of PAHs in the BSC background and Bradley *et al.* data sets to generate the ratios in Table 3-11. For comparison, the ratios obtained from soil samples collected near roadways in Canada and England and from ambient air particles collected near coke ovens are presented in Table 3-11. These data were selected for comparison because the sampling methodology was more representative of the sampling of the BSC background and Bradley *et al.* data sets (*i.e.*, without condensation traps, after or during airborne deposition, and at some distance from the source).

For each individual PAH, the ratios in the background data sets and the reference samples near roadways and coke oven agree within a factor of three. In general, this is about the same level of variation as was observed for tunnel samples from three locations in the United States where the traffic mix of gasoline and diesel engines varies (Daisey *et al.*, 1986). Therefore, due to the variability, the power of the analysis to differentiate between different sources such as automobile traffic and coke ovens is limited. The ratios in the BSC background and Bradley *et al.* data sets agree within a factor of two. The three highest ratios in the BSC background data set are benzo(b)fluoranthene, fluoranthene, and chrysene. The three highest ratios in the Bradley *et al.* data set are fluoranthene, pyrene, and chrysene. With the exception of benzo(b)fluoranthene (see statistical evaluation below), the PAHs that are enriched in the BSC background and Bradley *et al.* data sets are those that are associated with diesel exhaust. The higher levels of benzo(g,h,i)perylene in the BSC background data set as compared to the Bradley *et al.* data set may indicate a greater contribution of gasoline exhaust in these samples. Based upon the relatively close agreement of the ratios in the BSC background and Bradley *et al.* data sets, no evidence of widely disparate PAH sources is indicated.

Fate and Transport of PAHs

PAHs are released largely to the atmosphere (ATSDR, 1995), where they occur both sorbed

Table 3-10
Estimated Source Contributions to Annual U.S. PAH Emissions

Source	Estimated Percent Contribution to ~~Total~~ Annual PAH Emissions
Industrial processes	6 - 41
Open burning	13 - 39
Residential heating	16 - 38
Automobiles and trucks	21 - 25
Power generation	1 - 5
Incineration	1

to particles and as gases. Particle-bound PAHs can be transported long distances and are removed from the atmosphere through precipitation and dry deposition to soil and surface waters. PAHs can enter surface water through atmospheric deposition and from discharges of industrial effluents, municipal wastewater, and improper disposal of used motor oil. PAHs are transported from surface waters by volatilization and sorption to settling particles. The compounds are transformed in surface waters by photo-oxidation, chemical oxidation, and microbial metabolism. In soil and sediments, microbial metabolism is the major process for degradation of PAHs. Many animals are able to metabolize and eliminate these compounds, minimizing food chain biotransfer (Eisler, 1987).

Environmental fate properties of PAHs vary as a function of molecular weight. PAHs are generally classified either as low- or high- molecular weight compounds (LMW PAHs and HMW PAHs, respectively). The LMW PAHs (*e.g.*, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, fluorene, naphthalene, and phenanthrene) have molecular weights below 200 daltons, while the HMW PAHs (*e.g.*, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, dibenz(a,h)anthracene, chrysene, indeno(1,2,3-cd) pyrene, and pyrene) have molecular weights greater than 200 daltons.

Although the general characteristics of HMW PAHs and LMW PAHs are very similar, LMW PAHs tend to exhibit slightly more mobility and water solubility, and are more subject to degradation. The LMW PAHs are slightly more subject to microbial degradation in surface water than in ground water. Because of their lipophilic nature and relatively large molecular size, both LMW and HMW PAHs readily sorb onto most soils, and have an especially strong affinity for organically enriched substrates. Because the HMW PAH compounds have relatively low water solubilities and are thus relatively resistant to leaching from soils, their primary fate in soil is adsorption. The HMW PAHs are more readily biodegradable in surface water than in soil.

The Bradley *et al.* data set and the BSC background data set were compared using the two-sample t-test (Bhattacharyya and Johnson, 1977). The two-sample t-test is a parametric statistical test that assumes that the two populations are normally distributed. The Bradley *et al.* (1994) study does not state whether the data distribution was tested; however, the summary statistics presented are the arithmetic mean and the standard deviation of the untransformed data, which are the summary statistics typically reported for a normal distribution. The small sample size of the BSC background data set and the low detection frequency precludes conclusive distribution testing. Therefore, the assumption of normality was considered reasonable.

The two-sample t-test compares the means of the two populations and based on a specified confidence limit, determines if the means are statistically similar. The equation for the t value is:

$$t = \frac{\mu_1 - \mu_2}{s_{pooled} \times \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

where:

t	=	t value
μ_1	=	mean of the sample population 1
μ_2	=	mean of the sample population 2
s_{pooled}	=	pooled sample variance
n_1	=	number of samples of population 1
n_2	=	number of samples in population 2

The pooled sample variance is given by the equation:

$$s^2_{pooled} = \frac{(n_1 - 1) \times s_1^2 + (n_2 - 1) \times s_2^2}{n_1 + n_2 - 2}$$

where:

s_1	=	standard deviation of sample population 1
s_2	=	standard deviation of sample population 2

and the other parameters are as previously defined.

The critical value is $t_{a/2}$, which is the upper a/2 point of the t distribution with the degrees of freedom (df) equal to:

$$df_{pooled} = n_1 + n_2 - 2$$

If the absolute value of the calculated t value is greater than the critical value, then the null hypothesis is rejected, and the conclusion is that the means are not statistically similar. For the comparison of the Bradley *et al.* and BSC background data sets, for a 95% confidence ($\alpha = 0.05$), and degrees of freedom of 63, the critical value was 2.00.

The results of the statistical evaluation are shown in Table 3-12. Except for benzo(b)fluoranthene, the mean concentrations of the PAHs in the Bradley *et al.* and BSC background data sets were statistically similar. Assuming that both the Bradley *et al.* and BSC background data sets are normally distributed, other than benzo(b)fluoranthene, the BSC background concentrations are statistically similar to background concentrations measured in New England urban soils. Thus, the statistical evaluation justifies the use of the BSC background concentrations of PAHs (except benzo(b)fluoranthene) for background screening in the risk assessment. However, for the sake of conservatism, the lower of the maximum values in the two data sets was selected for use in the COPC screening process. As shown in Table 3-13, the Bradley *et al.* (1994) background levels were used for acenaphthene,

benzo(b)fluoranthene, benzo(g,h,i)perylene, and indeno(1,2,3-c,d)pyrene. All other values were obtained from the BSC background data set.

3.9.1.2 Development of a Background Data Set for Other Organic Analytes and Metals in Surficial Soil

Minimum and maximum detected concentrations of other organic analytes and metals in the BSC background samples are presented in Table 3-14. In view of the close similarity of PAH results in the Bradley *et al.* (1994) and BSC background data sets, values obtained for other SVOCs and VOCs in the BSC background set were considered appropriate for use in the COPC screening process (Table 3-14). However, as several of the metals are clearly elevated, the maximum metals concentrations were compared with maximum concentrations reported in the data set for New York State published by McGovern (1984). As McGovern's paper omitted antimony, barium, and chromium, maximum New York State background concentrations for these metals were obtained from Dragun and Chiasson (1991). The lower of the maximum values from the literature and the BSC background data set was selected as the background concentration for COPC selection at the BSC Lackawanna site. As shown in Table 3-15, the literature background levels of antimony, arsenic, lead, and selenium were lower than BSC background concentrations, and were therefore selected for use in the COPC screening process.

3.9.2 Sediment

One background sediment sample was obtained at each of two locations in Smokes Creek (SC-5 and SC-(N)-BKG) (Table 3-16). One background sediment sample was obtained in 1995 at each of three locations in Blasdell Creek (BC-1, BC-2, and BC-13S) (Table 3-17). It should be noted that prior sampling locations designated BC-1 and BC-2 are different locations from those designated BC-1 and BC-2 in 1995; these prior sampling locations are not background. One background sediment sample was obtained in 1995 at each of three locations in Lake Erie (BK-1S, BK-2S, and BK-3S) (Table 3-18).

Due to the small number of sediment background samples obtained, the lower of the maximum concentration observed in background sediment samples at the BSC Lackawanna site and the maximum concentration for the same analyte in the Bradley *et al.* (1994) data set (for PAHs) and the McGovern/Dragun and Chiasson data sets (for metals) was chosen as the background concentration in sediment for COPC screening in this medium. This selection process is shown in Tables 3-19 (Smokes Creek), 3-20 (Blasdell Creek), and 3-21 (Lake Erie). For Smokes Creek sediment, the literature background levels were selected for antimony, arsenic, cadmium, lead, nickel, and selenium (Table 3-19). For Blasdell Creek sediment, the literature background values were selected for cadmium and lead (Table 3-20). For Lake Erie sediment, the literature background values were selected for selenium only (Table 3-21). Because maximum detected concentrations of organic analytes other than PAHs in the BSC background samples were not elevated, they were considered appropriate for COPC screening purposes.

No background samples were collected for sediments in the North and South Return Water Trenches. Thus, the background concentrations established for surficial soil (Table 3-13) were used for COPC screening in these trenches.

3.9.3 Surface Water

Background water samples were obtained from one location in Smokes Creek (SC-5) and three in Lake Erie (BK-1, BK-2, and BK-3). No background samples were taken in Blasdell Creek. Background surface water data are summarized in Table 3-22.

Table 3-11
Ratios of Individual PAHs to Benzo(a)pyrene

Chemical	BSC Background Soil	Bradley *et al.* [1]	Soils Near Roadways [2]		Ambient Air Particulates Near Coke Ovens [2] (U.S.)
			Canada	England	
Acenaphthene	0.3	0.2	NR	NR	NR
Acenaphthylene					
Anthracene	0.5	0.3	0.8	NR	0.3
Benzo(a)anthracene	1.1	1.0	1.5	1.8	1.2
Benzo(a)pyrene	1.0	1.0	1.0	1.0	1.0
Benzo(b)fluoranthene	2.2	1.1	0.9	NR	1.3
Benzo(k)fluoranthene	0.6	1.3	0.6	NR	1.0
Benzo(g,h,i)perylene	1.1	0.7	1.3	NR	0.6
Chrysene	0.8	1.4	1.1	1.6	1.8
Dibenz(a,h)anthracene	0.4	0.3	NR	NR	NR
Fluoranthene	1.9	2.3	1.5	1.8	NR
Fluorene	0.3	0.2	NR	NR	NR
Indeno(1,2,3-cd)pyrene	1.4	0.7	0.7	NR	0.6
Naphthalene	0.2	0.1	NR	NR	NR
Phenanthrene	1.2	1.4	NR	NR	NR
Pyrene	1.6	1.8	1.4	1.7	NR

Notes: NR = Not Reported.

[1] Bradley *et al.*, 1994.

[2] Daisey *et al.*, 1986.

Table 3-12
Statistical Comparison of BSC and Bradley *et al.* (1994) Soils PAH Data (mg/kg)

Chemical	BSC Background		Bradley *et al.*		Statistical Comparison	
	Mean	Std Dev	Mean	Std Dev	t value	Same?
Acenaphthene	0.477	0.205	0.201	0.495	-0.42	yes
Anthracene	0.688	0.692	0.351	0.868	-0.19	yes
Benzo(a)anthracene	1.672	2.812	1.319	2.541	0.56	yes
Benzo(a)pyrene	1.521	2.506	1.323	2.324	0.30	yes
Benzo(b)fluoranthene	3.318	6.532	1.435	2.537	2.27	no
Benzo(k)fluoranthene	0.966	1.313	1.681	3.965	0.03	yes
Benzo(g,h,i)perylene	1.621	2.730	0.891	1.433	0.38	yes
Chrysene	1.176	2.084	1.841	4.017	0.17	yes
Dibenz(a,h)anthracene	0.681	0.636	0.388	0.627	-0.65	yes
Fluoranthene	2.848	5.119	3.047	6.587	1.84	yes
Fluorene	0.483	0.216	0.214	0.486	-0.49	yes
Indeno(1,2,3-cd)pyrene	2.081	3.758	0.987	1.443	0.82	yes
Naphthalene	0.365	0.140	0.125	0.113	-1.98	yes
Phenanthrene	1.835	3.503	1.838	5.394	1.09	yes
Pyrene	2.392	4.255	2.398	2.579	0.49	yes

Notes:
Standard deviation was not reported, but was calculated from 95% UCL and the mean.
The critical t value for comparison is 2.00

Table 3-13
Selection of Background Levels of PAHs in Surficial Soil (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Bradley *et al.* Maximum *	BSC Maximum **	Smaller Value Is:	Background Concentration to be Used in COPC Selection
Acenaphthene	0.34	0.78	Bradley et al.	0.34
Acenaphthylene	1.1	NA	Bradley et al.	1.1
Anthracene	5.7	1.9	BSC	1.9
Benzo(a)anthracene	15	6.7	BSC	6.7
Benzo(a)pyrene	13	6	BSC	6
Benzo(b)fluoranthene	12	15	Bradley et al.	12
Benzo(k)fluoranthene	25	3.3	BSC	3.3
Benzo(g,h,i)perylene	5.9	6.5	Bradley et al.	5.9
Chrysene	21	4.9	BSC	4.9
Dibenz(a,h)anthracene	2.9	1.8	BSC	1.8
Fluoranthene	39	12	BSC	12
Fluorene	3.3	0.81	BSC	0.81
Indeno(1,2,3-cd)pyrene	6	8.8	Bradley et al.	6
Naphthalene	0.66	0.22	BSC	0.22
Phenanthrene	36	8.1	BSC	8.1
Pyrene	11	10	BSC	10

NA = not analyzed.
* Maximum urban background concentrations reported by Bradley *et al.* (1994).
** Maximum values from BSC Lackawanna surficial soil background data set.

Table 3-14
Summary of Background Levels of Other Organic Analytes and Metals in Surficial Soil (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Minimum Value *	Maximum Detected Value
Volatiles		
Benzene	0.003	0.01
Toluene	0.003	0.006
Semi-Volatiles		
Bis(2-ethylhexyl)phthalate	0.205	2.7
Di-n-butyl phthalate	0.205	0.49
Metals		
Antimony	3.7	13.9
Arsenic	4.1	46.1
Barium	31.6	84.3
Chromium	12.7	27.1
Lead	19.2	302
Mercury	0.06	0.32
Nickel	13.1	27.7
Selenium	0.31	1.1

* Minimum value may include ½ the lowest detection limit.

Table 3-15
Selection of Background Levels of Metals in Surficial Soil (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Metal	Literature Maximum *	BSC Maximum **	Smaller Value Is:	Background Concentration to be Used in COPC Selection
Antimony	1	13.9	Literature	1
Arsenic	12	46.1	Literature	12
Barium	500	84.3	BSC	84.3
Chromium	100	27.1	BSC	27.1
Lead	30	302	Literature	30
Mercury	0.6	0.32	BSC	0.32
Nickel	30	27.7	BSC	27.7
Selenium	0.6	1.1	Literature	0.6

* Maximum New York State background concentrations reported by McGovern (1984) or Dragun and Chiasson (1991).
** Maximum values from BSC Lackawanna surficial soil background data set.

Table 3-16
Summary of Background Data in Smokes Creek Sediment (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Minimum Value*	Maximum Detected Value
Volatiles		
Chloromethane	0.012	0.012
Methylene chloride	0.018	0.018
Semivolatiles		
Anthracene	0.11	0.11
Benzo(a)anthracene	0.56	1.1
Benzo(a)pyrene	0.53	1.3
Benzo(b)fluoranthene	0.68	2.4
Benzo(ghi)perylene	0.28	1.3
Benzo(k)fluoranthene	0.42	0.77
Bis(2-ethylhexyl)phthalate	0.305	1.9
Chrysene	0.61	1.8
Dibenz(a,h)anthracene	0.1	0.1
Fluoranthene	1.3	3.7
Fluorene	0.1	0.1
Indeno(1,2,3-c,d)pyrene	0.29	1.4
Phenanthrene	0.88	1.2
Pyrene	1.6	2.7
Metals		
Antimony	0.41	14.9
Arsenic	53.2	59.8
Barium	41.6	85.8
Cadmium	0.5	2.5
Chromium	9.8	25.7
Lead	30.3	634
Nickel	16.2	30.8
Selenium	0.8	18.1

* Minimum value may include ½ the lowest detection limit.

Table 3-17
Summary of Background Data in Blasdell Creek Sediment (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Minimum Value*	Maximum Detected Value
Volatiles		
1,1,2,2-Tetrachloroethane	0.004	0.004
Benzene	0.006	0.006
Methyl ethyl ketone	0.042	0.042
Semivolatiles		
Benzo(a)anthracene	0.16	0.28
Benzo(a)pyrene	0.16	0.25
Benzo(b)fluoranthene	0.35	0.45
Benzo(g,h,i)perylene	0.13	0.43
Benzo(k)fluoranthene	0.21	0.21
Bis(2-ethylhexyl)phthalate	0.13	0.13
Chrysene	0.21	0.39
Dibenz(a,h)anthracene	0.059	0.38
Fluoranthene	0.25	0.63
Indeno(1,2,3-c,d)pyrene	0.11	0.27
Phenanthrene	0.14	0.44
Pyrene	0.36	0.76
Metals		
Arsenic	5.3	8.2
Barium	71.2	96.1
Cadmium	0.42	2.5
Chromium	11.5	21.3
Lead	29.8	88.4
Mercury	0.075	0.38
Nickel	16	22.9

* Minimum value may include ½ the lowest detection limit.

Table 3-18
Summary of Background Data in Lake Erie Sediment (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Minimum Value*	Maximum Detected Value
Semivolatiles		
Benzo(a)pyrene	0.09	0.09
Chrysene	0.09	0.09
Fluoranthene	0.17	0.17
Phenanthrene	0.16	0.16
Pyrene	0.14	0.14
Metals		
Arsenic	1.9	5.1
Chromium	3.1	4.6
Lead	2.8	6
Nickel	2.55	10.2
Selenium	0.32	0.86

* Minimum value may include ½ the lowest detection limit.

Table 3-19
Selection of Background Levels of PAHs and Metals in Smokes Creek Sediment (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Literature Maximum *	BSC Maximum **	Smaller Value Is:	Background Concentration to be Used in COPC Selection
PAHs				
Anthracene	5.7	0.11	BSC	0.11
Benzo(a)anthracene	15	1.1	BSC	1.1
Benzo(a)pyrene	13	1.3	BSC	1.3
Benzo(b)fluoranthene	12	2.4	BSC	2.4
Benzo(k)fluoranthene	25	0.77	BSC	0.77
Benzo(g,h,i)perylene	5.9	1.3	BSC	1.3
Chrysene	21	1.8	BSC	1.8
Dibenz(a,h)anthracene	2.9	0.1	BSC	0.1
Fluoranthene	39	3.7	BSC	3.7
Fluorene	3.3	0.1	BSC	0.1
Indeno(1,2,3-cd)pyrene	6	1.4	BSC	1.4
Phenanthrene	36	1.2	BSC	1.2
Pyrene	11	2.7	BSC	2.7
Metals				
Antimony	1.00	14.9	Literature	1.00
Arsenic	12	59.8	Literature	12.00
Barium	500	85.8	BSC	85.80
Cadmium	1.8	2.5	Literature	1.80
Chromium	100	25.7	BSC	25.70
Lead	30	634	Literature	30.00
Nickel	30	30.8	Literature	30.00
Selenium	0.6	18.1	Literature	0.60

* Maximum urban background concentrations reported by Bradley *et al.* (1994) or maximum New York State background concentrations reported by McGovern (1984) or Dragun and Chiasson (1991).

** Maximum values from BSC Lackawanna Smokes Creek sediment background data set.

Table 3-20
Selection of Background Levels of PAHs and Metals in Blasdell Creek Sediment (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Literature Maximum *	BSC Maximum **	Smaller Value Is:	Background Concentration to be Used in COPC Selection
PAHs				
Benzo(a)anthracene	15	0.28	BSC	0.28
Benzo(a)pyrene	13	0.25	BSC	0.25
Benzo(b)fluoranthene	12	0.45	BSC	0.45
Benzo(k)fluoranthene	25	0.21	BSC	0.21
Benzo(g,h,i)perylene	5.9	0.43	BSC	0.43
Chrysene	21	0.39	BSC	0.39
Dibenz(a,h)anthracene	2.9	0.38	BSC	0.38
Fluoranthene	39	0.63	BSC	0.63
Indeno(1,2,3-cd)pyrene	6	0.27	BSC	0.27
Phenanthrene	36	0.44	BSC	0.44
Pyrene	11	0.76	BSC	0.76
Metals				
Arsenic	12	8.2	BSC	8.2
Barium	500	96.1	BSC	96.1
Cadmium	1.8	2.5	Literature	1.8
Chromium	100	21.3	BSC	21.3
Lead	30	88.4	Literature	30
Mercury	0.6	0.38	BSC	0.38
Nickel	30	22.9	BSC	22.9

* Maximum urban background concentrations reported by Bradley *et al.* (1994) or maximum New York State background concentrations reported by McGovern (1984) or Dragun and Chiasson (1991).

** Maximum values from BSC Lackawanna Blasdell Creek sediment background data set.

Table 3-21
Selection of Background Levels of PAHs and Metals in Lake Erie Sediment (mg/kg)
Bethlehem Steel Corporation Lackawanna Site

Chemical	Literature Maximum *	BSC Maximum **	Smaller Value Is:	Background Concentration to be Used in COPC Selection
PAHs				
Benzo(a)pyrene	13	0.09	BSC	0.09
Chrysene	21	0.09	BSC	0.09
Fluoranthene	39	0.17	BSC	0.17
Phenanthrene	36	0.16	BSC	0.16
Pyrene	11	0.14	BSC	0.14
Metals				
Arsenic	12.00	5.10	BSC	5.1
Chromium	100.00	4.60	BSC	4.6
Lead	30.00	6.00	BSC	6
Nickel	30.00	10.20	BSC	10.2
Selenium	0.60	0.86	Literature	0.6

* Maximum urban background concentrations reported by Bradley *et al.* (1994) or maximum New York State background concentrations reported by McGovern (1984) or Dragun and Chiasson (1991).

** Maximum values from BSC Lackawanna Lake Erie sediment background data set.

Table 3-22

SUMMARY OF BACKGROUND SURFACE WATER DATA

Chemical	Minimum Value* (µg/L)	Maximum Detected Value (µg/L)	Mean (µg/L)
Smokes Creek			
Diethyl phthalate	5.7	5.7	NA
Blasdell Creek			
(None)	NA	NA	NA
Lake Erie			
(None Detected)	NA	NA	NA

3.10 REFERENCES

ATSDR, 1995. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons.* Lewis Publishers, Boca Raton, Florida.

Bhattacharyya, G.K. and Johnson, R.A. 1977. *Statistical Concepts and Methods.* John Wiley and Sons, New York, New York. 1977.

Bradley, L.J.N., Magee, B.H. and Allen, S.L., 1994. Background levels of polycyclic aromatic hydrocarbons (PAH) and selected metals in New England urban soils. *J Soil Contam* **3(4):**1-13.

Daisey, J.M., Cheney, J.L., and Lioy, P.J. 1986. Profiles of organic particulate emissions from air pollution sources: status and needs for receptor source apportionment modeling. *J Air Pollut Control Assoc* **36(1):**17-31.

Dragun, J. and Chiasson, A. 1991. *Elements in North American Soils.* Hazardous Materials Control Resources Institute.

Eisler, R. 1987. *Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review.* U.S. Department of Interior. Fish and Wildlife Service. Contaminant Hazard Reviews Report No. 11. Biological Report 85(1.11). May, 1987.

Howard, P.H., Boethling, R.S., Jarvis, W.F., Meylan, W.M., and Michalenko, W.M. (Eds.). 1991. *Handbook of Environmental Degradation Rates.* Lewis Publishers, Inc., Chelsea, Michigan.

Manahan, S.E. 1993. *Fundamentals of Environmental Chemistry.* Lewis Publishers, Boca Raton, Ann Arbor, London, Tokyo.

Massachusetts Department of Environmental Protection (MADEP). 1997. *Draft Proposed Changes Supplement to the Guidance for Disposal Site Risk Characterization.*

McGovern, E.C. 1984. *Background Concentrations of 20 Elements in Soils with Special Regard for New York State.* New York State Department of Environmental Conservation.

Menzie, C.A., Potocki, B.B., and Santodonato, J. 1992. Exposure to carcinogenic PAHs in the environment. *Environ Sci Technol* **26(7):**1278-1284.

Southern California Edison and Southern California Gas Company, unpublished data.

U.S. Environmental Protection Agency (EPA). 1982. *Development Document for Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category.* EPA 440/1-82/024. Effluent Guidelines Division, Washington, D.C.

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

___. 1990. *Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule. Federal Register* **55(145):**30798 *et seq.* July 27, 1990.

___. 1992. *Guidance for Data Useability in Risk Assessment (Part A).* Office of Emergency and Remedial Response, Washington, D.C. PB92-963356.

U.S. Steel. 1985. *The Making, Shaping, and Treating of Steel.* Tenth Edition. Herbick & Held, Pittsburgh, PA.

Venkataraman, C., Lyons, J.M., and Friedlander, S.K. 1994. Size distributions of polycyclic aromatic hydrocarbons and elemental carbon. 1. Sampling, measurement methods, and source characterization. *Environ Sci Technol* **28(4):**555-562.

4.0 PROCESS FOR SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN IN THE RISK ASSESSMENT

Upon completion of the data evaluation process, a medium-specific list of COPCs was selected for each water body (sediment and surface water), groundwater discharge or vapor pathway area or SWMU/SWMU group (SWMU material) based on sequential application of the selection criteria discussed below. COPCs in all potential exposure media are summarized in Table 4-1.

4.1 CRITERIA FOR SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN

The following COPC selection criteria were applied sequentially to the data sets identified in Section 3.0:

- Positively detected in at least 5% of samples;
- Positively detected in at least one sample at levels above maximum background; and
- Positively detected in at least one sample at levels above applicable COPC screening levels (see section 4.1.3 below).

The decision process is illustrated in Figure 4-1.

4.1.1 Frequency of Detection

Constituents with detection frequencies of less than 5 percent in a given medium were eliminated from further consideration in that medium (EPA, 1989). A minimum of 20 samples are required for this evaluation; thus, no chemicals with fewer than 20 samples in a medium were eliminated based on frequency of detection.

4.1.2 Comparison with Background

The maximum detected concentrations of organic and inorganic COPIs present in surficial SWMU material, sediment, and surface water were compared to maximum concentrations measured in background samples (see Section 3.9). No background data were available for groundwater or subsurface material. If the maximum measured concentration was below the maximum detected background concentration, then that constituent was eliminated from further consideration as a COPC. Only measured maximum background concentrations were used for this purpose.

TABLE 4-1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Volatile Organic Chemicals								
Benzene		SFA-1, SFA-2, S-14, S-23, S-24, PA-4	PA-1, P-11	Lake Erie, ~~and~~ Smokes Creek, and Ship Canal Discharge Areas	SFA Zone 1, SFA Zone 2, SFA Zone 3, SFA Zone 4, SFA Zone 5; Coke Oven, Tank Farm, and Smokes Creek Areas	Site-wide Groundwater	Smokes Creek, Ship Canal (current), and Shi pCanal (future)	
Bromodichloromethane							Smokes Creek	
Bromoform							Smokes Creek	
Carbon disulfide				Smokes Creek Discharge Area	Smokes Creek Area	Site-wide Groundwater		
Carbon tetrachloride					SFA Zone 1			
Chlorobenzene					SFA Zone 4			
Chlorodibromomethane							Smokes Creek	
Chloroform							Smokes Creek	
1,1-Dichloroethane				Lake Erie and Smokes Creek Discharge Area	SFA Zone 1, SFA Zone 2, SFA Zone 4, and Smokes Creek Areas	Site-wide Groundwater	Blasdell Creek	
1,2-Dichloroethane					SFA Zone 2		Smokes Creek	
1,2-Dichloroethene (total)				Lake Erie Discharge Area	SFA Zone 2			
Ethylbenzene			P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie Discharge Area, Smokes Creek Discharge Area~~	SFA Zone 2, SFA Zone 4, Coke Oven Area, Smokes Creek Area	Site-wide Groundwater		
Methylene chloride				Lake Erie and Ship Canal Discharge Areas	SFA Zone 1, SFA Zone 2, and SFA Zone 4	Site-wide Groundwater	Smokes Creek	

TABLE 4-1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Pyridine				Lake Erie and Smokes Creek Discharge Areas	SFA Zone 4 and Smokes Creek Area	Site-wide Groundwater		
1,1,2,2-Tetrachlorothane		SFA-2						
Toluene		SFA-2, S-24, PA-4	P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 2, SFA Zone 3, SFA Zone 4, Tank Farm, Coke Oven and Smokes Creek Areas	Site-wide Groundwater	Ship Canal (future)	
1,1,1-Trichloroethane					SFA Zone 1			
Trichloroethene		SFA-2		Lake Erie Discharge Area	SFA Zone 2 and SFA Zone 4	Site-wide Groundwater		
Vinyl chloride				Smokes Creek Discharge Area	Smokes Creek Area		Smokes Creek	
m-Xylene and p-Xylene				Lake Erie Discharge Area	SFA Zone 2	Site-wide Groundwater		
o-Xylene				Lake Erie Discharge Area	SFA Zone 2	Site-wide Groundwater		
Xylenes (total)		SFA-2, S-24, PA-4	P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 1, SFA Zone 2, SFA Zone 3, SFA Zone 4, SFA Zone 5, Coke Oven, Tank Farm, and Smokes Creek Area	Site-wide Groundwater		
Semivolatile Organic Chemicals								
Acenaphthene				Ship Canal Discharge Area	Coke Oven Area	Site-wide Groundwater		

TABLE 4-1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Acenaphthylene	PA-2, TF, SFA-1, ~~S-19~~	PA-3, SFA-1, SFA-2, S-10, S-14, S-23, S-24, S-26, P-73	PA-1	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 1, SFA Zone 2, SFA Zone 3, SFA Zone 4, SFA Zone 5; Coke Oven and Smokes Creek Areas	Site-Wide Groundwater	Ship Canal (future)	Smokes Creek, Blasdell Creek, ~~and~~ North and South Return Water Trenches, and Ship Canal
Anthracene		PA-3, S-24, S-14, and S-23		Lake Erie Discharge Area	SFA Zone 4	Site-wide Groundwater		
Benzo(a)anthracene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-10, S-14, S-17, S-23, S-24, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, ~~and~~ North Return Water Trench, and Ship Canal~~es~~
Benzo(a)pyrene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-3, S-10, S-14, S-17, S-23, S-24, S-25, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, Lake Erie, ~~and~~ North Return Water Trench, and Ship Canal~~es~~
Benzo(b)fluoranthene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-10, S-14, S-17, S-23, S-24, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, North Return Water Trench, and Ship Canal~~Smokes Creek, Blasdell Creek, and Return Water Trenches~~
Benzo(g,h,i)perylene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-14, S-17, S-24, S-25, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, Lake Erie, North Return Water Trench, and Ship Canal~~Smokes Creek, Blasdell Creek, Lake Erie, and Return Water Trenches~~

TABLE 4-1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Benzo(k)fluoranthene	PA-2, TF, SFA-1	PA-3, S-14, S-23, S-24		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, and North Return Water Trenches
Bis(2-ethylhexyl)phthalate				Lake Erie, and Smokes Creek, and Ship Canal Discharge Areas			Smokes Creek and, Lake Erie, and Ship Canal (current)	
Chrysene	TF, SFA-1	S-23, S-24		Ship Canal Discharge Area			Ship Canal (future)	North Return Water Trenches
Dibenz(a,h)anthracene	PA-2, TF, SFA-1	PA-1, SFA-2, S-14, S-24, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, Lake Erie, andNorth and South Return Water Trenches, and Ship Canal
2,4-Dimethylphenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas				
Fluoranthene		S-23		Smokes Creek and Ship Canal Discharge Areas				
Fluorene		SFA-2, S-24, and S-23	P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge AreasLake Erie and Smokes Creek Discharge Areas	SFA Zone 2, SFA Zone 3, SFA Zone 4, and Coke Oven Area	Site-wide Groundwater		

TABLE 4-1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Indeno(1,2,3-cd)pyrene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-2, S-10, S-14, S-17, S-23, S-24, S-26, P-18, P-73		Ship Canal Discharge Area			Ship Canal (future)	Smokes Creek, Blasdell Creek, North Return Water Trench, and Ship Canal~~Smokes Creek, Blasdell Creek, and Return Water Trenches~~
2-Methylphenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas				
3-Methylphenol and 4-Methylphenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Area				
4-Methylphenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~				
Total Cresols				Lake Erie Discharge Area				
Naphthalene		SFA-1, SFA-2, S-24, S-14, S-23, and PA-4	PA-1, P-11	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 1, SFA Zone 2, SFA Zone 3, SFA Zone 4, SFA Zone 5,; Coke Oven, Tank Farm, and Smokes Creek Areas	Site-Wide Groundwater		

TABLE 4-1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Phenanthrene	PA-2, TF, SFA-1	PA-1, PA-3, SFA-1, SFA-2, S-3, S-10, S-14, S-17, S-23, S-24, S-25, S-26, P-18, P-73	PA-1	Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~	SFA Zone 2, SFA Zone 3, SFA Zone 4, ~~SFA Zone 5;~~and Coke Oven~~, Tank Farm, and Smokes Creek~~ Areas	Site-Wide Groundwater		Smokes Creek, Blasdell Creek, Lake Erie, North Return Water Trench, and Ship Canal~~Smokes Creek, Blasdell Creek, Lake Erie, and Return Water Trenches~~
Phenol				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas				
Pyrene				Ship Canal Discharge Area				
Inorganic Chemicals								
Antimony	TF, SFA-1, S-21, S-14, S-15, S-18	~~TF,~~ SFA-2, ~~S-15, S-18~~		Lake Erie and Smokes Creek Discharge Areas				South Return Water Trenches
Arsenic	PA-1, PA-4, TF, SFA-1, S-8, S-18, S-19, S-21, P-63, P-73	PA-1, PA-3, SFA-1, SFA-2, S-8~~3~~, S-10, S-14, S-17, ~~S-19, S-21,~~ S-23, S-24, S-26, P-18, P-63, P-73		Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~			Smokes Creek, Ship Canal (current), and Ship Canal (future)	Smokes Creek, Blasdell Creek, Lake Erie, North and SouthReturn Water Trenches, and Ship Canal~~Smokes Creek, Blasdell Creek, Lake Erie, and Return Water Trenches~~
Barium				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas				
Cadmium	~~S-8~~			Smokes Creek Discharge Area				

TABLE 4-1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPCs) BY SWMU MEDIA, GROUNDWATER PATHWAY, AND WATERCOURSE MEDIA

Chemical of Potential Concern	SWMU MATERIAL			GROUNDWATER			WATERCOURSES	
	Surface Material	Subsurface Material	Pit Water	Transport to Surface Water	On-Site Vapor Pathway	Off-Site Vapor Pathway	Surface Water	Sediment
Chromium	TF, S-8, S-18, PA-2, PA-4, P-63	S-10, S-25, S-26		Lake Erie and Smokes Creek Discharge Areas				
Cyanide				Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~				
Lead	TF, SFA-1, S-8, S-14, S-18, S-21, P-63	SFA-1, SFA-2, S-3, ~~14, S-18, P-18, P-63~~		Lake Erie, Smokes Creek, and Ship Canal Discharge Areas~~Lake Erie and Smokes Creek Discharge Areas~~				Smokes Creek ~~and~~, South Return Water Trench, and Ship Canal~~s~~
~~Manganese~~				~~Lake Erie Discharge Area~~				
Nickel				Lake Erie and Smokes Creek Discharge Areas				
Selenium				Lake Erie Discharge Area				
Silver				Smokes Creek Discharge Area				
Thallium	S-8, S-18	SFA-1, P-18, S-10, S-18, S-23, PA-1, PA-3		Lake Erie and Smokes Creek Discharge Areas				

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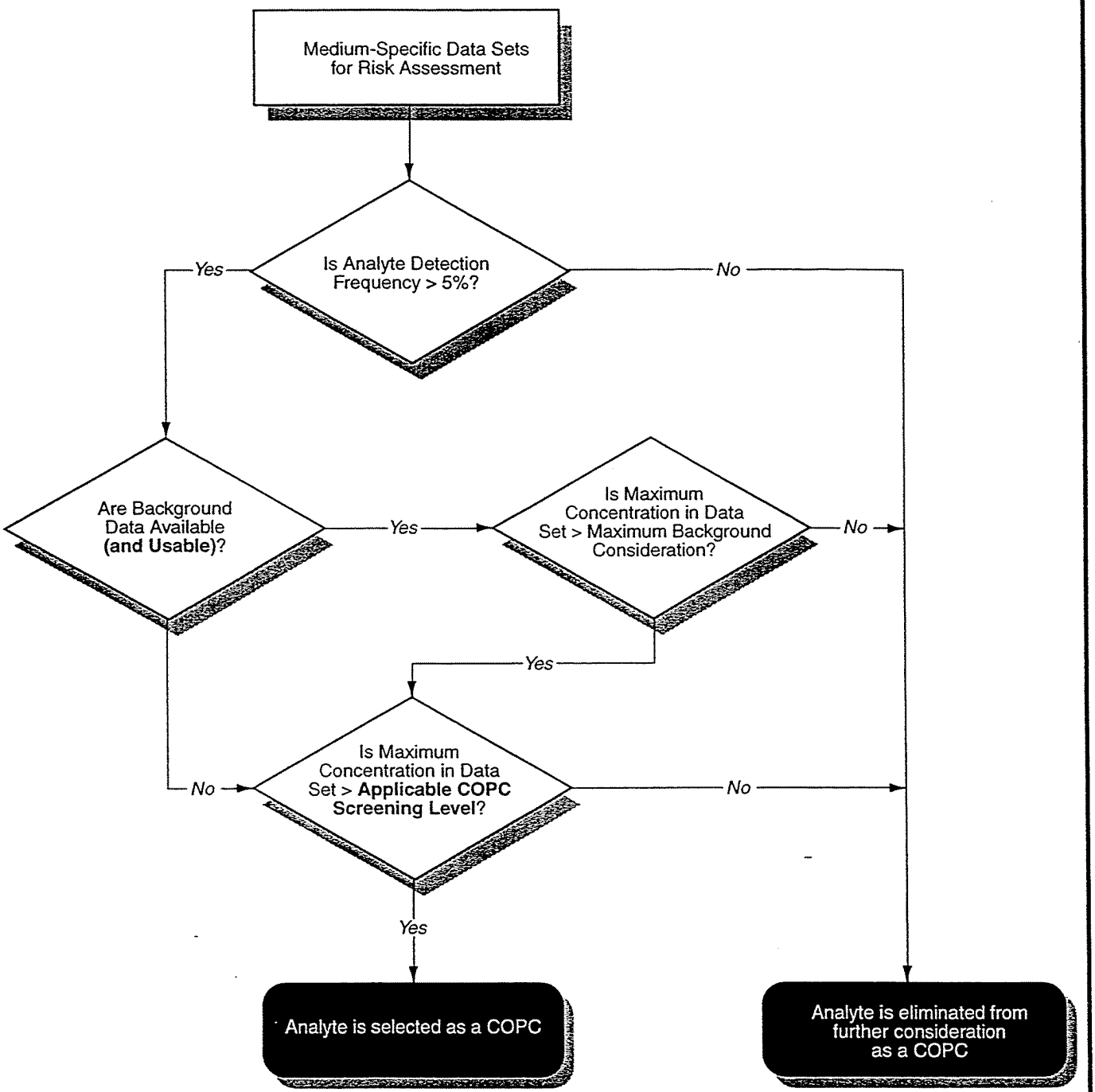

FIGURE 4-1
DECISION PROCESS FOR COPC SELECTION
BETHLEHEM STEEL CORPORATION
LACKAWANNA SITE
LACKAWANNA, NEW YORK

4.1.3 Selection and Application of COPC Screening Levels

For analytes in surficial SWMU material and sediment, COPC screening levels are equal to EPA Region III risk-based concentrations (RBCs) for residential soil (EPA, ~~1997~~1998). For volatile analytes in subsurface SWMU material, COPC screening levels are equal to EPA Soil Screening Levels (SSLs) based on inhalation (EPA, 1996). For other analytes in subsurface SWMU material, COPC screening levels are equal to EPA Region III RBCs for residential soil (EPA, ~~1997~~1998). For analytes in groundwater, surface water, and pit water, COPC screening levels are equal to the lower of New York State Ambient Water Quality Standards or Guidance Values (NYSDEC, ~~1993~~1998) and EPA Region III residential tap water RBCs (EPA, ~~1997~~1998). A summary of the type of screening level used by media is presented in Table 4-2.

Table 4-2

Summary of Screening Levels Used in the COPC Selection Process

COPC Screening Level	Surficial SWMU Material	Subsurface SWMU Material		Sediment	Surface Water	Ground-water	Pit Water
		Volatile	Other				
EPA Region III RBC for residential soil	X		X	X			
EPA Region III RBC for residential tap water					X	X	X
EPA Soil Screening Level for vapor inhalation		X					
NYSDEC Ambient Water Quality Standard or Guidance value					X	X	X

If the maximum detected constituent concentration in a medium exceeded its corresponding COPC screening level, then it was retained as a COPC for risk assessment. If the maximum detected constituent concentration in a medium did not exceed its corresponding COPC screening level, then it was dropped from further consideration as a COPC in that medium.

EPA Region III RBCs (EPA, ~~1997~~1998) are medium-specific chemical concentrations corresponding to EPA-approved toxicity criteria and exposure rates that are not expected to cause adverse health effects *(i.e.*, cancer risk greater than one in one-million [10^{-6}], non-cancer hazard quotient greater than 1) under a default residential exposure scenario. In the case of the carcinogens, use of a target risk level of 1 x 10^{-6} is expected to be protective of exposure to multiple carcinogens based on an acceptable cancer risk range of 10^{-6} to 10^{-4}. In the case of the noncarcinogens, use of the Region III RBCs, developed

on the basis of childhood exposures to noncarcinogens, are expected to be protective of cumulative risks from exposures to multiple carcinogens in adult workers.

Because the exposure rates expected for site-specific exposure scenarios (*i.e.*, worker exposure to surface material, recreational user exposure to surface water, off-site water consumers) are substantially less than those assumed in the default residential scenario used in the calculation of the RBCs, chemicals at levels below the RBCs are not expected to contribute appreciably to overall risk. Thus, as recommended by EPA Region III, it is appropriate to use these conservative screening levels to distinguish those COPCs that are significant contributors to potential risks from those that have minimal impact (EPA, 1993).

The maximum detected levels of all analytes in surficial SWMU material and sediment samples, and non-volatile analytes in subsurface SWMU material, were screened against EPA Region III RBCs for residential soil, which are based on soil ingestion. Residential soil RBCs for carcinogens are based on combined childhood and adult exposure, while RBCs for non-carcinogens are based on childhood exposure only. Because the dominant pathway of exposure to volatiles in subsurface media is inhalation, maximum detected concentrations of volatile analytes in subsurface SWMU material were screened against generic EPA SSLs for inhalation of volatiles from subsurface soil (EPA, 1996). These values are highly conservative in that they assume both residential exposure and infinite source. As discussed in Section 5.0, the EPA has deemed it inappropriate to develop either a reference dose or a slope factor for inorganic lead compounds. Thus, no RBCs can be calculated for inorganic lead compounds. Using an integrated exposure uptake-biokinetic (IEUBK) model, EPA has calculated an average lead level of 400 mg/kg as a residential soil screening level corresponding to the target blood lead level for children (EPA, 1994a and b).

The maximum detected levels of chemicals in surface water, pit water, and groundwater samples were screened against the lower of NYSDEC Ambient Water Quality Standards or Guidance Values and EPA Region III RBCs for tap water. The Region III RBCs account for exposures via both ingestion and inhalation (for volatiles). Residential tap water RBCs for carcinogens are based on combined childhood and adult exposure, while RBCs for non-carcinogens are based on childhood exposure only. The NYSDEC Standards and Guidance Values are based on a variety of assumptions and methods. For lead, the EPA has established a health advisory for lead in drinking water of 15 µg/L (EPA, 1991). Because this value is lower than the NYSDEC Standard of 25 µg/L (NYSDEC ~~1993~~1998), the EPA value is used as the COPC screening level for lead in water.

4.2 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL SWMU MATERIAL

The COPC screening process for surficial SWMU material is described in the following sections. Data sets for each SWMU or SWMU group were screened against background concentrations (see Sections 3.9.1 and 4.1.4) and EPA Region III residential soil RBCs (see Section 4.1.4). Tables detailing the selection process are provided in Appendix B.

4.2.1 Slag Fill Area Zone 2

4.2.1.1 SWMU Group SFA-1

Eleven surficial samples were collected from SWMU Group SFA-1 during the Phase II-B and Phase II-C investigations. SWMU Group SFA-1 consists of SWMUs S-1 (Surface Impoundment A), S-2 (Surface Impoundment B), S-4 (Surface Impoundment D), S-5 (Surface Impoundment E), S-6 (Surface Impoundment F), and S-27 (Sludge Disposal Area [Adjacent to SWMU S-1]). These samples were analyzed for VOCs, SVOCs, metals, and cyanide. COPCs for SWMU Group SFA-1 are summarized in Table 4-3, and the process for selecting COPCs for this SWMU group is detailed in Appendix B, Table B-1. The maximum detected concentrations of seven VOCs (benzene, carbon disulfide, ethylbenzene, methyl ethyl ketone, methylene chloride, toluene, and total xylenes) were below EPA Region III RBCs and thus were eliminated from further consideration. The maximum detected concentration for the SVOCs acenaphthene, anthracene, bis(2-ethylhexyl)phthalate, fluoranthene, fluorene, naphthalene, and pyrene were below EPA Region III RBCs; hence, these chemicals were eliminated as COPCs. The carcinogenic PAHs benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained as COPCs because their maximum measured concentrations were above both background concentrations and EPA Region III RBCs. Acenaphthylene, benzo(g,h,i)perylene, and phenanthrene were retained as COPCs because their maximum concentrations were greater than background~~, and acenaphthylene was retained because it exceeds background value~~ and they lack~~s~~ toxicity criteria. Of the nine metals detected in surface materials (antimony, arsenic, barium, cadmium, chromium, lead, mercury, nickel, and selenium), only antimony, arsenic, and lead were retained as COPCs because their maximum detected concentrations exceeded both background and RBC values. Cyanide

TABLE 4-3

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU GROUP SFA-1

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	Acenaphthylene Benzo~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(g,h,i)perylene Chrysene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Phenanthrene	Antimony Arsenic Lead

was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.2.1.2 SWMU S-8 - Surface Impoundment H

Two surface samples were collected from SWMU S-8 (Surface Impoundment H) during the Phase II-B site investigation. COPCs for SWMU S-8 are summarized in Table 4-4, and the process for selecting COPCs for this SWMU is detailed in Appendix B, Table B-2. Methylene chloride, the only VOC detected in the surface samples, was eliminated from consideration because its maximum detected concentration is lower than its EPA Region III RBC. The maximum detected concentrations for the PAHs anthracene, benzo(k)fluoranthene, chrysene, fluoranthene, naphthalene, and pyrene were below background and/or EPA Region III RBCs; thus, these chemicals were eliminated as COPCs. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, and phenanthrene were eliminated as COPCs because their maximum concentrations were lower than background levels. Mercury was eliminated as a COPC because its maximum concentration was lower than both background and its RBC. Although the maximum concentrations of barium and nickel were greater than background, these metals were eliminated as COPCs because they did not exceed RBCs. Arsenic, chromium, and lead were retained as COPCs due to exceedance of both maximum background concentrations and RBCs. Cadmium was eliminated as a COPC as its maximum detected concentration was lower than its RBC. ~~Cadmium and t~~Thallium's maximum~~a were~~ was higher than ~~their~~ its ~~respective~~ RBCs, so ~~these~~ this metals ~~were~~ was retained as a COPCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

TABLE 4-4

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU S-8

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Arsenic ~~Cadmium~~ Chromium Lead Thallium

4.2.1.3 SWMU S-21 - Sludge Storage Area

Two surface material samples were collected at SWMU S-21 (Sludge Storage Area). Both samples were analyzed for all analytes except cyanide. COPCs for SWMU S-21 are summarized in Table 4-5, and the process for selecting COPCs for this SWMU is detailed in Appendix B, Table B-3. Toluene, the only VOC detected in the surface materials, was eliminated from consideration as its maximum concentration was lower than its RBC. The maximum detected concentrations of bis(2-

TABLE 4-5

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU S-21

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Antimony Arsenic Lead

ethylhexyl)phthalate, naphthalene, benzo~~(a)a~~(a)anthracene, and indeno(1,2,3-cd)pyrene were below RBCs, and the maximum detected concentrations of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, phenanthrene, and pyrene were below background levels; thus, they were eliminated as COPCs. Barium, cadmium, chromium, mercury, and nickel were eliminated as COPCs because their maximum detected concentrations did not exceed EPA Region III RBCs. Antimony, arsenic, and lead were measured at levels exceeding both background and EPA Region III RBCs, and thus were retained as COPCs.

4.2.2 Slag Fill Area Zone 4

4.2.2.1 SWMU S-14- General Rubble Landfill N

Four surface material samples were collected at SWMU S-14 (General Rubble Landfill N). COPCs for SWMU S-14 are summarized in Table 4-6, and the process for selecting COPCs for this SWMU is detailed in Appendix B, Table B-4. Methylene chloride, the only VOC detected in the surface samples, was eliminated from consideration because its maximum detected concentration is lower than its EPA Region III RBC. The maximum detected concentrations of anthracene, benzo~~(a)a~~(a)anthracene, indeno(1,2,3-cd)pyrene, benzo(a)pyrene, dibenz(a,h)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, fluorene, phenanthrene, and pyrene were below background concentrations; thus, these chemicals were eliminated as COPCs. Although higher than background levels, maximum concentrations of acenaphthene, bis(2-ethylhexyl)phthalate and naphthalene were below corresponding RBCs, resulting in their elimination as COPCs. Of the eight metals detected (antimony, arsenic, barium, cadmium, ~~cyanide,~~ lead, mercury, nickel, and silver), ~~seven~~ six were eliminated because their maxima were lower than background and/or RBCs. Antimony and lead were retained as COPCs due to exceedance of both background concentrations and RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

TABLE 4-6

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU S-14

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Antimony Lead

~~4.2.2.2~~4.2.2.1 SWMU S-15 - General Rubble Landfill O

Two surface material samples were collected at SWMU S-15 (General Rubble Landfill O) during the site investigations. COPCs for SWMU S-15

TABLE 4-7

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU S-15

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Antimony

are summarized in Table 4-7, and the process for selecting COPCs for this SWMU is detailed in Appendix B, Table B-5. No VOCs were detected. The maximum measured concentrations of anthracene, benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene were below background concentrations and/or EPA Region III RBCs. Accordingly, these chemicals were eliminated as COPCs. ~~Arsenic, b~~Barium and mercury were eliminated because their maximum concentrations were lower than both background concentrations and RBCs. Arsenic, c~~C~~admium, lead, and nickel were eliminated because their maximum concentrations were lower than respective RBCs. Antimony was retained as a COPC because its maximum concentration was higher than both background and its EPA Region III RBC. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

~~4.2.2.3~~4.2.2.2 SWMU S-18 - Lime Dust and Kish Landfill R

Two surface material samples were collected at SWMU S-18 (Lime Dust and Kish Landfill R). COPCs for SWMU S-18 are summarized in Table 4-8, and the process for selecting COPCs for this SWMU is detailed in Appendix B, Table B-6. No VOCs were detected. The maximum measured concentrations for benzo(b)fluoranthene, benzo(g,h,i)perylene, fluoranthene, and indeno(1,2,3-cd)pyrene were below background and/or EPA Region III RBCs; hence, these chemicals were eliminated as COPCs. Cadmium, ~~chromium~~, nickel, and selenium were eliminated as COPCs because their maximum concentrations were lower than RBCs. As the maximum detected concentrations of antimony, arsenic, chromium, lead, and thallium were above ~~one or both screening criteria,~~both RBCs and available background levels, they were retained as COPCs.

TABLE 4-8

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU S-18

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Antimony Arsenic Chromium Lead Thallium

4.2.3 Coke Oven Area

4.2.3.1 SWMU Group PA-1

Three surface material samples were collected for SWMU Group PA-1 during the site investigations. SWMU Group PA-1 consists of

TABLE 4-9

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU GROUP PA-1

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Arsenic

SWMUs P-3 (Quench Water Pit, Central Station), P-4 (Quench Water Pit, A Station), and P-5 (Quench Water Pit, B Station). COPCs for SWMU Group PA-1 are summarized in Table 4-9, and the process for selecting COPCs for this SWMU group is detailed in Appendix B, Table B-7. The maximum detected concentrations for all nine VOCs detected (1,1,1-trichloroethane, 1,1,2-trichloroethane, benzene, chlorobenzene, chloroform, methylene chloride, toluene, trichlorofluoromethane, and total xylenes) were below their respective EPA Region III RBCs; thus, these constituents were eliminated from further consideration. Anthracene, benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, 2-methylphenol, 3-methylphenol and 4-methylphenol, phenanthrene, phenol, and pyrene were eliminated because their maximum concentrations were lower than background and/or RBCs (where available). Although their maximum concentrations exceeded background, di-n-butylphthalate, fluorene, and naphthalene were eliminated as COPCs as their maximum concentrations were lower than RBCs. Of the metals detected (arsenic, barium, chromium, ~~cyanide,~~ lead, and nickel), only arsenic was identified as a COPC based on exceedance of both background and RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.2.3.2 SWMU Group PA-2

Two surface material samples were collected for SWMU Group PA-2 during the Phase II-C site investigation. SWMU Group PA-2 consists of SWMUs P-6 (Lime Sludge Settling Basin) and P-7 (Abandoned Lime Sludge Settling Basin). COPCs for SWMU Group PA-2 are summarized in Table 4-10, and the process for selecting COPCs for this SWMU group is detailed in Appendix B, Table B-8. Of the eight VOCs detected in this material (benzene, chloroform, ethylbenzene, methylene chloride, toluene, 1,1,1-trichloroethane, trichlorofluoromethane, and total xylenes), none exceeded their respective EPA Region III RBCs. The SVOCs bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, 2-methylphenol, 3-methylphenol and 4-methylphenol, and phenol were eliminated because their maximum concentrations were lower than background concentrations and/or RBCs. Although their maxima were higher than background concentrations, acenaphthene, anthracene, chrysene, fluoranthene, fluorene, naphthalene, and pyrene were eliminated because their maximum concentrations did not exceed respective RBCs. Acenaphthylene, benzo(g,h,i)perylene and phenanthrene, which lack toxicity criteria (and hence RBCs), were retained because they exceeded background levels. Maximum concentrations of benzo~~(a)a~~(a)anthracene, benzo(a)pyrene,

TABLE 4-10

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU GROUP PA-2

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	Acenaphthylene Benzo~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Phenanthrene	~~None~~Chromium

benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded their respective EPA Region III RBCs, and thus were retained as COPCs. All inorganic analytes detected except chromium (arsenic, barium, ~~chromium~~, cyanide, lead, mercury, nickel, and selenium) were eliminated as COPCs because their maximum concentrations were lower than background and/or RBCs; chromium was retained because it maximum concentrations exceeded both background and the RBC.

4.2.3.3 SWMU Group PA-4

TABLE 4-11

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU GROUP PA-4

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Arsenic Chromium

Three surface material samples were collected for SWMU Group PA-4 during the Phase II-C site investigation. SWMU Group PA-4 consists of SWMUs P-11 (Benzol Plant Tank Storage Area) and P-12 (Spill Cleanup Soil Storage Area). COPCs for SWMU Group PA-4 are summarized in Table 4-11, and the process for selecting COPCs for this SWMU group is detailed in Appendix B, Table B-9. Of the six VOCs detected in surface material (benzene, methylene chloride, toluene, 1,1,1-trichloroethane, trichlorofluoromethane, and total xylenes), none exceeded EPA Region III RBCs. The maximum detected concentrations for anthracene, benzo(a)pyrene, benz~~o(a)a~~(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene were below background concentrations and/or EPA Region III RBCs, so these constituents were eliminated from consideration. Of the eight metals detected (antimony, arsenic, barium, cadmium, chromium, lead, mercury, and nickel), ~~only~~ arsenic ~~was the only one~~and chromium were retained as ~~a~~ COPCs based on exceedance of both background and Region III RBC levels. ~~All were eliminated because maximum detected concentrations were less than background, RBCs, or both.~~ Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.2.4 Tank Farm Area

4.2.4.1 SWMU Group TF

Ten surface material samples were collected for SWMU Group TF during the Phase II-C site investigation. SWMU Group TF consists of SWMUs P-8 (Waste Oil Storage Tanks in Tank Farm), P-74 (Solid Fuel Mix Storage Piles in Tank Farm), and P-75 (Tank Storage Area, Tank Farm). COPCs for SWMU Group TF are summarized in Table 4-12, and the process for selecting COPCs for this SWMU group is detailed in Appendix B, Table B-10. All eight VOCs detected (benzene, carbon disulfide, dichlorodifluoromethane, ethylbenzene, methylene chloride, toluene, trichlorofluoromethane, and total xylenes) were measured at levels below their respective EPA Region III RBC values. The maximum concentration of di-n-butyl phthalate and bis(2-ethylhexyl)phthalate, were below both background and RBC, while concentrations of acenaphthene, anthracene, fluoranthene, fluorene, naphthalene, and pyrene were above background concentrations but below RBCs. Accordingly, these constituents were eliminated as COPCs. Acenaphthylene, benzo(g,h,i)perylene and phenanthrene, which lack toxicity criteria (and hence RBCs), were retained because they exceeded background levels. Benz~~o(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were retained as COPCs due to exceedance of background and RBCs. Of the eight metals detected (antimony, arsenic, barium, cadmium, chromium, lead, mercury, and nickel), antimony, arsenic, chromium, and lead were selected as COPCs due to exceedance of both background concentrations and RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

TABLE 4-12

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU GROUP TF

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	Acenaphthylene Benz~~o(a)a~~(a)anthracene Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(g,h,i)perylene Benzo(a)pyrene Chrysene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Phenanthrene	Antimony Arsenic Chromium Lead

4.2.5 Other Areas

4.2.5.1 SWMU S-19 - Murphy's Mountain Landfill AA

TABLE 4-13

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU S-19

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Arsenic

Four surface material samples were collected at SWMU S-19 (Murphy's Mountain Landfill AA) during the Phase II-C site investigation. COPCs for SWMU S-19 are summarized in Table 4-13, and the process for selecting COPCs for this SWMU is detailed in Appendix B, Table B-11. Methylene chloride, the only VOC detected in the surface samples, was eliminated from consideration because its maximum detected concentration is lower than its EPA Region III RBC. The maximum detected concentrations of acenaphthylene, anthracene, benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene were below EPA Region III RBCs and/or background levels; thus, these chemicals were eliminated as COPCs. Lead, nickel, and selenium were eliminated as COPCs because their maxima were lower than their respective RBCs. Arsenic is the only metal measured at levels above both background and its EPA Region III RBC; it was thus retained as a COPC. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.2.5.2 SWMU P-63 - Former Mill Scale Storage Area No. 7

TABLE 4-14

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU P-63

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Arsenic Chromium Lead

Three surface material samples were collected at SWMU P-63 (Former Mill Scale Storage Area No. 7) during the Phase II-B site investigation. COPCs for SWMU P-63 are summarized in Table 4-14, and the process for selecting COPCs for this SWMU is detailed in Appendix B, Table B-12. Of the four VOCs detected (methyl ethyl ketone, o-xylene, tetrachloroethene, and toluene), none exceeded EPA Region III RBCs. As the maximum detected concentrations of all SVOCs (benzo(a)pyrene, benzo~~(a)a~~(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, di-n-butyl phthalate, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene) were below background levels and/or RBCs, they were eliminated as COPCs. Of the nine metals detected (arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, and

silver), only arsenic, chromium, and lead were selected as COPCs based on exceedance of both ~~the~~ background and RBCs.

4.2.5.3 SWMU P-73 - Former Drum Storage Area

A single surface sample was collected at SWMU P-73 (Former Drum Storage Area) during the RFI. COPCs for SWMU P-73 are summarized in Table 4-15, and the process for selecting COPCs for this SWMU is detailed in Appendix B, Table B-13. All detected VOCs (1,1,2,2-tetrachloroethane, benzene, ethylbenzene, total xylenes, methylene chloride, tetrachloroethene, toluene, and trichlorofluoromethane) were eliminated from further consideration because their maximum detected concentrations were below background and/or their corresponding EPA Region III RBCs. The SVOCs acenaphthene, anthracene, benz~~o(a)a~~(a)anthracene, benzo(a)pyrene, chrysene, di-n-butyl phthalate, fluoranthene, fluorene, naphthalene, phenanthrene, phenol, and pyrene were detected at levels below background and/or RBCs, and were thus eliminated as COPCs. Of the seven metals detected (antimony, arsenic, barium, cadmium, chromium, lead, nickel), only arsenic was retained as a COPC because its maximum detected concentration was above both background and its Region III RBC.

TABLE 4-15

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFICIAL MATERIAL, SWMU P-73

Volatile Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
None	None	Arsenic

4.3 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE SWMU MATERIAL

Subsurface samples of SWMU material were collected at various depths (see Table 3-5). During the Phase II-B and III site investigations, one to seven subsurface material samples were collected in certain SWMUs (see Table 3-5) and analyzed for VOCs, SVOCs, metals, and cyanide. Frequency of detection was not used as a subsurface COPC screening criterion because of the small sample sizes. Because there are no subsurface background data for comparison with subsurface SWMU material, volatiles and "volatile semivolatile" constituents (with Henry's Law constants greater than 10^{-5} atm-m^3/mol and molecular weight less than 200 daltons) were selected as COPCs if their maximum measured concentrations were above EPA SSLs for vapor inhalation (EPA, 1996). For ~~other~~ non-volatile SVOCs and inorganic constituents, EPA Region III residential RBCs for soil ingestion (EPA, ~~1997~~1998) were used for screening. All constituents lacking toxicity criteria (and hence RBCs and SSLs) for this comparison were retained as COPCs.

The COPC screening process for subsurface SWMU material is described in the following sections. Tables detailing the selection process are provided in Appendix C.

4.3.1 Slag Fill Area Zone 2

4.3.1.1 SWMU Group SFA-1

TABLE 4-16

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU GROUP SFA-1

Volatile and "Volatile Semivolatile" Organic Constituents	Semi-Volatile Organic Constituents	Inorganic Constituents
Acenaphthylene	Benze~~(a)a~~(a)anthracene	Arsenic
Benzene	Benzo(a)pyrene	Lead
Naphthalene	Benzo(b)fluoranthene	Thallium
Phenanthrene	Benzo(g,h,i)perylene	

Sixteen subsurface material samples were collected from SWMU Group SFA-1 during the site investigations. SWMU Group SFA-1 consists of SWMUs S-1 (Surface Impoundment A), S-2 (Surface Impoundment B), S-4 (Surface Impoundment D), S-5 (Surface Impoundment E), S-6 (Surface Impoundment F), S-7 (Surface Impoundment G), and S-27 (Sludge Disposal Area [Adjacent to SWMU S-1]). Subsurface COPCs for SWMU Group SFA-1 are summarized in Table 4-16, and the process for selecting COPCs for this SWMU group is detailed in Appendix C, Table C-1. Ten VOCs (carbon disulfide, 1,1-dichloroethane, 1,2-dichloroethane, ethylbenzene, methyl ethyl ketone, methylene chloride, toluene, 1,1,1-trichloroethane, trichloroethene, and total xylenes) were detected at levels below EPA SSLs; therefore, these compounds were eliminated as COPCs. Benzene was retained as a COPC as its maximum detected concentration exceeded the SSL. The maximum detected concentrations of the volatile PAHs acenaphthene, anthracene, and fluorene were lower than EPA SSLs, so these constituents were eliminated from further consideration. Naphthalene exceeded the EPA SSL, so it was retained as a COPC. The SVOCs benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, 2,4-dimethylphenol, fluoranthene, indeno(1,2,3-cd)pyrene, 3-methylphenol and 4-methylphenol, phenol, and pyrene were below EPA Region III RBCs; thus, these compounds were eliminated from further consideration. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were retained as COPCs based on exceedances of EPA Region III RBCs. The PAHs acenaphthylene, benzo(g,h,i)perylene, and phenanthrene were conservatively retained as COPCs because they lack toxicity criteria (and hence RBCs and SSLs). Of the eleven metals (antimony, arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and thallium) detected, arsenic ~~and~~, lead, and thallium were selected as a COPCs due to exceedance of RBCs. ~~The PAHs acenaphthylene, benzo(g,h,i)perylene, and phenanthrene were conservatively retained as COPCs because they lack toxicity criteria (and hence RBCs and SSLs).~~ Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.3.1.2 SWMU Group SFA-2

Nine subsurface samples (five of which were taken from R.E. Wright Associates [1992] and have not been validated) were included in the COPC selection process for SWMU Group SFA-2. SWMU Group SFA-2 consists of SWMUs S-11 (Landfill K, Acid Tar Pit, South) and S-22 (Vacuum Carbonate Blowdown Impoundment [Acid Tar Pit North]). Subsurface COPCs for SWMU Group SFA-2 are summarized in Table 4-17, and the process for selecting COPCs for this SWMU group is detailed in Appendix C, Table C-2. Seven of the 12 VOCs detected (carbon disulfide, 1,1-dichloroethane, ethylbenzene, methyl ethyl ketone, methylene chloride, pyridine, and 1,1,1-trichloroethane) were eliminated because their maximum detected concentrations were lower than corresponding SSLs. The remaining five VOCs (benzene, 1,1,2,2-tetrachloroethane, toluene, trichloroethene, and total xylenes) were retained as COPCs based on exceedance of EPA SSLs. The maximum detected concentrations of the volatile PAHs acenaphthene, and anthracene~~, and pyridine~~ were lower than EPA SSLs, so these constituents were eliminated from further consideration. The maximum detected concentrations of the volatile PAHs fluorene and naphthalene exceeded the EPA SSLs, so they were retained as COPCs. The SVOCs benzo(k)fluoranthene, chrysene, 2,4-dimethylphenol, fluoranthene, 2-methylphenol, 3-methylphenol and 4-methylphenol, phenol, and pyrene were eliminated as COPCs because their maximum concentrations were lower than corresponding EPA Region III RBCs. The maximum detected concentrations of benz~~o(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were above EPA Region III RBCs; thus, these chemicals were retained as COPCs. The PAHs acenaphthylene, benzo(g,h,i)perylene, and phenanthrene were conservatively retained as COPCs because they lack toxicity criteria (and hence RBCs and SSLs). Barium, cadmium, chromium, ~~cyanide,~~ mercury, nickel, selenium, and silver were eliminated ~~as~~ because their maximum concentrations were lower than corresponding RBCs; those for antimony, arsenic, and lead were exceeded, resulting in their retention as COPCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was because its maximum concentration was lower than its EPA Region III RBC.

TABLE 4-17

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU GROUP SFA-2

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Acenaphthylene	Benz~~o(a)a~~(a)anthracene	Antimony
Benzene	Benzo(a)pyrene	Arsenic
Fluorene	Benzo(b)fluoranthene	Lead
Naphthalene	Benzo(g,h,i)perylene	
Phenanthrene	Dibenz(a,h)anthracene	
1,1,2,2-Tetrachloroethane	Indeno(1,2,3-cd) pyrene	
Toluene		
Trichloroethene		
Xylenes (total)		

4.3.1.3 SWMU S-3 – Surface Impoundment C

Twenty subsurface soil samples were collected from SWMU S-3 during four sampling events that occurred from April 1984 through June 1992 in support of the Ammonia Still Lime Sludge (ASLS) Delisting Petition filed by BSC. All the samples were characterized as composite samples where portions of samples from various depths were combined and analyzed for total constituent concentrations. Subsurface COPCs for SWMU S-3 are summarized in Table 4-18, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-3. All five VOCs (1,1-dichloroethane, ethylbenzene, methyl ethyl ketone, toluene and total xylenes) and the volatile PAH naphthalene were detected at levels below EPA SSLs; therefore, these compounds were eliminated as COPCs. The maximum detected concentrations of SVOCs benzo~~(a)~~a(a)anthracene, chrysene, indeno(1,2,3-cd)pyrene, fluoranthene, and pyrene were below EPA Region III RBCs; thus, these compounds were eliminated from further consideration. Benzo(a)pyrene was retained as a COPC based on exceedance of the EPA Region III RBC. Phenanthrene was conservatively retained as a COPC because it lacks toxicity criteria (and hence SSLs). Of the ten metals detected (arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and thallium), arsenic, lead, and thallium were selected as COPCs due to exceedances of RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

TABLE 4-18

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-3

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Phenanthrene	Benzo(a)pyrene	Arsenic Lead Thallium

4.3.1.4 SWMU S-24 – Tar Pit North of Lime Plant

Six subsurface material samples were collected at SWMU S-24 (Tar Pit North of Lime Plant) during the RFI. Subsurface COPCs for SWMU S-24 are summarized in Table 4-19, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-4. The VOCs benzene, toluene, and total xylenes and the volatile PAHs anthracene, fluorene, and naphthalene all had maximum concentrations above EPA SSLs and thus were retained as COPCs. All

TABLE 4-19

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-24

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Acenaphthylene	Benzo~~(a)~~a(a)anthracene	Arsenic
Anthracene	Benzo(a)pyrene	
Benzene	Benzo(b)fluoranthene	
Fluorene	Benzo(k)fluoranthene	
Naphthalene	Benzo(g,h,i)perylene	
Phenanthrene	Chrysene	
Toluene	Dibenz(a,h)anthracene	
Xylenes (total)	Indeno(1,2,3-cd)pyrene	

other detected VOCs (chlorobenzene, ethylbenzene, methyl ethyl ketone, methylene chloride, and 1,1,1-trichloroethane) and the volatile PAH acenaphthene were eliminated because their maximum detected concentrations were lower than SSLs. The maximum detected concentrations of the SVOCs bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, 2,4-dimethylphenol, di-n-butyl phthalate, fluoranthene, isophorone, 3-& 4-methylphenol, phenol, and pyrene were below EPA Region III RBCs; thus, these constituents were eliminated as COPCs. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained as COPCs due to exceedance of their RBCs. The PAHs acenaphthylene, benzo(g,h,i)perylene, and phenanthrene were conservatively retained as COPCs because they lack toxicity criteria (and hence RBCs and SSLs). Barium, cadmium, chromium, lead, mercury, nickel, selenium, and thallium were eliminated as COPCs based on comparisons with the RBCs; arsenic was the only metal identified as a COPC. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.3.2 Slag Fill Area Zone 3

4.3.2.1 SWMU S-10 - Slag Quench Area J

Two subsurface samples were collected at SWMU S-10 (Slag Quench Area J). Subsurface COPCs for SWMU S-10 are summarized in Table 4-20, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-5. No VOCs were detected above quantifiable limits. The volatile PAHs anthracene, fluorene, and naphthalene were eliminated as their maximum detected concentrations were below EPA SSLs. The volatile PAHs acenaphthylene and phenanthrene, which lack EPA-approved toxicity criteria (and hence EPA SSLs), were conservatively retained as COPCs. The SVOCs benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, and pyrene were eliminated as COPCs because their maximum concentrations were lower than EPA Region III RBCs. The maximum detected concentrations of benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene were above EPA Region III RBCs; thus, these chemicals were retained as COPCs. Barium, cadmium, lead, mercury, and selenium were eliminated as COPCs, while arsenic, chromium, and thallium were retained based on comparison with RBCs.

TABLE 4-20

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-10

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Acenaphthylene Phenanthrene	Benzo~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Indeno(1,2,3-cd) pyrene	Arsenic Chromium Thallium

4.3.3 Slag Fill Area Zone 4

4.3.3.1 SWMU S-14 - General Rubble Landfill N

TABLE 4-21

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-14

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Acenaphthylene Anthracene Benzene Naphthalene Phenanthrene	Benzo~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd) pyrene	Arsenic

Two subsurface material samples were collected at SWMU S-14 (General Rubble Landfill N) during the Phase II-B site investigation. Subsurface COPCs for SWMU S-14 are summarized in Table 4-21, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-6. Of the ~~eight~~ seven VOCs detected (benzene, carbon disulfide, ethylbenzene, methyl ethyl ketone, toluene, trichloroethene, and total xylenes), only benzene exceeded the EPA SSL and was retained as a COPC. The volatile PAHs acenaphthene and fluorene were eliminated as their maximum detected concentrations did not exceed EPA SSLs. The maximum detected concentrations of the volatile PAHs anthracene and naphthalene exceeded their EPA SSLs, so they were retained as COPCs. The SVOCs chrysene, 2,4-dimethylphenol, fluoranthene, 2-methylphenol, 4-methylphenol, and pyrene were eliminated as COPCs because their maximum detected concentrations were lower than corresponding EPA Region III RBCs. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained because their maxima exceeded RBCs. The PAHs acenaphthylene, benzo(g,h,i)perylene, and phenanthrene, which lack EPA-approved toxicity criteria (and hence EPA Region III RBCs and SSLs), were conservatively retained as COPCs. Antimony, barium, cadmium, chromium, lead, mercury, nickel, and silver were eliminated as COPCs because their maximum detected concentrations were lower than corresponding EPA Region III RBCs; arsenic was the only metal detected at levels exceeding its RBC.

4.3.3.2 SWMU S-16 – Lime Stabilized SPL Sludge/Slag Landfill

TABLE 4-22

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-16

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	None	None

Twelve subsurface soil samples were collected from SWMU S-16 during two sampling events that occurred in April 1984 and April 1985 in support of BSC's petition to EPA to delist the waste contained in the SWMU. All the samples were characterized as composite samples where portions of samples from various depths were combined and analyzed for total constituent concentrations. Subsurface COPCs for SWMU S-16 are

summarized in Table 4-22, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-7. All eight metals (arsenic, barium, cadmium, chromium, lead, mercury, nickel, and selenium) were detected at levels below EPA Region III RBCs; therefore, these compounds were eliminated as COPCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.3.3.3 SWMU S-17 - Vacuum Carbonate Blowdown - Landfill Q

Two subsurface material samples were collected at SWMU S-17 (Vacuum Carbonate Blowdown - Landfill Q) during the Phase II-B investigation. Subsurface COPCs for SWMU S-17 are summarized in Table 4-23, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-8. Neither the detected VOCs (benzene, carbon disulfide, carbon tetrachloride, methylene chloride, toluene, 1,1,1-trichloroethane, and total xylenes) nor the volatile PAH naphthalene were identified as COPCs since the maximum detected concentrations for these compounds were below EPA SSLs. The maximum detected concentrations of the SVOCs benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, and pyrene were below EPA Region III RBCs; thus, these chemicals were eliminated as COPCs. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene were retained as COPCs due to exceedance of RBCs. Benzo(g,h,i)perylene, which lacks EPA-approved toxicity criteria (and hence EPA Region III RBCs), was conservatively retained as a COPC. Antimony, barium, cadmium, chromium, lead, nickel, selenium, and thallium were eliminated because their maximum detected concentrations were lower than corresponding RBCs, while arsenic was retained as a COPC based on exceedance of the RBC. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

TABLE 4-23

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-17

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Phenanthrene	Benzo~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Indeno(1,2,3-cd)pyrene	Arsenic

4.3.3.4 SWMU S-23 - Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill

TABLE 4-24

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-23

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Acenaphthylene	Benzo~~(a)a~~(a)anthracene	Arsenic
Anthracene	Benzo(a)pyrene	Thallium
Benzene	Benzo(b)fluoranthene	
Fluorene	Benzo(k)fluoranthene	
Naphthalene	Chrysene	
Phenanthrene	Fluoranthene	
	Indeno(1,2,3-cd)pyrene	

Two subsurface material samples were collected at SWMU S-23 (Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill) during the Phase II-B site investigation. Subsurface COPCs for SWMU S-23 are summarized in Table 4-24, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-9. Of the three detected VOCs (benzene, toluene, and total xylenes), only benzene was identified as a COPC due to exceedance of its EPA SSL. The maximum detected concentrations of the volatile PAHs anthracene, fluorene, and naphthalene exceeded their EPA SSLs, so they were retained as COPCs. The maximum detected concentrations of the SVOCs 3-& 4-methylphenol, phenol, and pyrene were below ~~or equal to~~ RBCs; thus, these chemicals were eliminated as COPCs. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, and indeno(1,2,3-cd)pyrene, were retained as COPCs because their maximum detected concentrations exceeded their respective EPA Region III RBCs. Acenaphthylene and phenanthrene, which lack EPA-approved toxicity criteria (and hence EPA SSLs), were conservatively retained as COPCs. Barium, cadmium, chromium, lead, mercury, and selenium, ~~and thallium~~ were eliminated as COPCs because their maximum detected concentrations were lower than their RBCs; arsenic and thallium ~~was~~ were the only metals detected at ~~a~~ levels exceeding ~~its~~ their RBCs.

4.3.4 Coke Oven Area

4.3.4.1 SWMU Group PA-1

TABLE 4-25

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU GROUP PA-1

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Phenanthrene	Benzo~~(a)a~~(a)anthracene	Arsenic
	Benzo(a)pyrene	Thallium
	Benzo(b)fluoranthene	
	Benzo(g,h,i)perylene	
	Dibenz(a,h)anthracene	
	Indeno(1,2,3-cd)pyrene	

Two subsurface material samples were collected at SWMU Group PA-1. SWMU Group PA-1 consists of SWMUs P-1 (Quench Water Pit, North Station) and P-2 (Quench Water Pit, Arctic Station). Subsurface COPCs for SWMU Group PA-1 are summarized in Table 4-25, and the process for selecting

COPCs for this SWMU group is detailed in Appendix C, Table C-10. Neither the detected VOCs (methylene chloride and 1,1,1-trichloroethane) nor the volatile PAHs acenaphthene, anthracene, fluorene, and naphthalene were observed at levels exceeding EPA SSLs; thus, these compounds were eliminated as COPCs. The maximum measured concentrations of the SVOCs benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, 2,4-dimethylphenol, fluoranthene, 2-methylphenol, 3-methylphenol and 4-methylphenol, phenol, and pyrene were below respective EPA Region III RBCs; these analytes were accordingly eliminated from further consideration. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained as COPCs based on exceedance of their RBCs. Benzo(g,h,i)perylene and phenanthrene, which lack EPA-approved toxicity criteria (and hence EPA Region III RBCs and SSLs), were conservatively retained as COPCs. Barium, cadmium, chromium, lead, mercury, nickel, and selenium~~, and thallium~~ were eliminated because their maximum concentrations were lower than RBCs; arsenic ~~is~~ and thallium are the only metals identified as ~~a~~ COPCs due to exceedance of ~~its~~ their RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.3.4.2 SWMU Group PA-3

A single subsurface sample was collected at SWMU P-10 (Contaminated Soil Near Bar Mill) during the Phase II-B site investigation. Subsurface COPCs for SWMU Group PA-3, which consists of SWMUs P-9 (Abandoned Tar Decanter Sludge Pits) and P-10 are summarized in Table 4-26, and the process for selecting COPCs for this SWMU group is detailed in Appendix C, Table C-11. None of the detected VOCs (benzene, methylene chloride, toluene, and total xylenes) or the volatile PAHs fluorene and naphthalene were present at levels exceeding EPA SSLs; thus, these compounds were eliminated as COPCs. The maximum detected concentrations of the volatile PAH anthracene exceeded its EPA SSL, so it was retained as a COPC. The maximum measured concentrations of the SVOCs chrysene, fluoranthene, and pyrene are below EPA Region III RBCs; these analytes were therefore eliminated as COPCs. Benzo~~(a)a benzo(k)fluoranthene,~~ (a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene were retained as COPCs based on exceedance of their RBCs. The PAHs acenaphthylene, benzo(g,h,i)perylene, and phenanthrene, which lack EPA-approved toxicity criteria (and hence EPA Region III RBCs and SSLs), were conservatively retained as COPCs. Cadmium, chromium, lead, nickel, and selenium~~, and thallium~~ were eliminated because their maximum detected concentrations were lower than RBCs;

TABLE 4-26

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU GROUP PA-3

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Acenaphthylene	Benzo~~(a)a~~(a)anthracene	Arsenic
Anthracene	Benzo(a)pyrene	Thallium
Phenanthrene	Benzo(b)fluoranthene	
	Benzo(k)fluoranthene	
	Benzo(g,h,i)perylene	
	Indeno(1,2,3-cd) Pyrene	

arsenic and thallium ~~is~~ are the only metals detected at ~~a~~ levels exceeding ~~its~~ their RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.3.4.3 SWMU Group PA-4

TABLE 4-27

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU GROUP PA-4

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Benzene Toluene Xylenes (total) ~~Napthalene~~Naphthalene	None	None

SWMU Group PA-4 consists of SWMUs P-11 (Benzol Plant Tank Storage Area) and P-12 (Spill Cleanup Soil Storage Area). Eleven subsurface material samples were collected at SWMU P-11 by R.E. Wright. Subsurface COPCs for SWMU Group PA-4 are summarized in Table 4-27, and the process for selecting COPCs for this SWMU group is detailed in Appendix C, Table C-12. Of the four detected VOCs, three (benzene, toluene, and total xylenes) were selected as COPCs due to exceedance of corresponding SSLs. Naphthalene, the only volatile semi-volatile detected, was also selected due to SSL exceedance.

~~4.3.4.3~~4.3.4.4 SWMU P-18 - Blast Furnace Cooling Tower and Hot & Cold Wells

Seven subsurface material samples were collected from SWMU P-18 (Blast Furnace Cooling Tower and Hot & Cold Wells) during the RFI. Subsurface COPCs for SWMU P-18 are summarized in Table 4-~~27~~28 and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-~~12~~13. None of the detected VOCs (benzene, carbon disulfide, methylene chloride, toluene, 1,1,1-trichloroethane, trichlorofluoromethane, and total xylenes) or the volatile PAHs anthracene, fluorene and naphthalene, were identified as COPCs since their

TABLE 4-~~27~~28

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU P-18

Volatile and Semivolatile Organic Constituents	~~Semi-Volatile~~Semivolatile Organic Constituents	Inorganic Constituents
Phenanthrene~~None~~	Benze~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene ~~Phenanthrene~~	Arsenic Lead Thallium

detected levels were well below SSLs~~EPA Region III RBCs~~. The maximum measured concentrations of the SVOCs benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, 2,4-dimethylphenol, di-n-butyl phthalate, fluoranthene, 2-methylphenol, 3-methylphenol and 4-methylphenol, 4-methylphenol, phenol, and pyrene were below RBCs; these chemicals were therefore eliminated as COPCs. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained as COPCs based on exceedances of their RBCs. The PAHs benzo(g,h,i)perylene and phenanthrene, which lack EPA-approved toxicity criteria (and hence EPA Region III RBCs and SSLs), were conservatively retained as COPCs. Antimony, barium, cadmium, chromium, mercury, nickel, selenium, and silver were eliminated from consideration as COPCs because their maximum detected concentrations were below corresponding RBCs, but arsenic, lead, and thallium were retained as COPCs due to exceedances of RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

~~4.3.4.4~~4.3.4.5 *SWMU S-26* – Fill Area Near Coke Battery *8*

Two subsurface samples were collected at SWMU S-26 (Fill Area Near Coke Battery 8). Subsurface COPCs for SWMU S-26 are summarized in Table 4-~~28~~29, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-~~13~~14. Neither the detected VOCs (benzene, carbon disulfide, methylene chloride, toluene, and total xylenes) nor the volatile PAHs acenaphthene, anthracene, fluorene, and naphthalene were present at levels above EPA SSLs; they were thus eliminated as COPCs. The SVOCs benzo(k)fluoranthene, chrysene, fluoranthene, and pyrene were eliminated because their maximum concentrations were below RBCs. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained due to exceedances of RBCs. The PAHs acenaphthylene, benzo(g,h,i)perylene, and phenanthrene, which lack EPA-approved toxicity criteria (and hence EPA Region III RBCs and SSLs), were conservatively retained as COPCs. Antimony, barium, lead, mercury, and nickel were eliminated as COPCs because their maximum detected concentrations were below RBCs; arsenic and chromium were the only metals identified as COPCs due to exceedance of RBCs.

TABLE 4-~~28~~29

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-26

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Acenaphthylene Phenanthrene	Benzo~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	Arsenic Chromium

4.3.5 Other Areas

4.3.5.1 SWMU S-25 - Landfill/Impoundment Under North End of Coal Pile

Two subsurface material samples were collected at SWMU S-25 (Landfill/Impoundment Under North End of Coal Pile) during the Phase III site investigation. Subsurface COPCs for SWMU S-25 are summarized Table 4-~~29~~30, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-~~14~~15. Neither the two detected VOCs (carbon disulfide and methylene chloride) nor the volatile PAHs anthracene and naphthalene were identified as COPCs since the maximum measured concentrations for these constituents were below EPA SSLs. The maximum detected concentrations of benz~~o(a)a~~(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene were below RBCs and were therefore eliminated COPCs. Benzo(a)pyrene was the only SVOC identified as a COPC based on exceedance of its RBC. Benzo(g,h,i)perylene and phenanthrene, which lack EPA-approved toxicity criteria (and hence RBCs and SSLs), were conservatively retained as COPCs. Antimony, barium, cadmium, lead, nickel, and silver were eliminated as COPCs because their maximum concentrations were lower than respective RBCs; chromium was the only metal identified as a COPC.

TABLE 4-~~29~~30

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU S-25

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Phenanthrene	Benzo(a)pyrene Benzo(g,h,i)perylene	Chromium

4.3.5.2 SWMU P-63 - Former Mill Scale Storage Area 2

A total of six subsurface samples was collected from SWMU P-63 (Former Mill Scale Storage Area 2). Boring TP-6-2 is the only sample that was screened for SVOCs. Subsurface COPCs for SWMU P-63 are summarized in Table 4-~~30~~31, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-~~15~~16. None of the detected VOCs (benzene, ethylbenzene, methylene chloride, total xylenes, and toluene) were present at levels exceeding the EPA SSLs; thus, these compounds were eliminated as COPCs. Similarly, the maximum measured concentrations of all SVOCs (benz~~o(a)a~~(a)anthracene, benzo(b)fluoranthene, di-n-butyl phthalate, and fluoranthene) were less than RBCs. Barium, cadmium, chromium, cyanide, lead, nickel, and selenium were also eliminated because their maximum detected concentrations were lower than RBCs. Arsenic, the only metal detected at a level exceeding its RBC, was retained as a COPC.

TABLE 4-~~30~~31

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU P-63

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	None	Arsenic

4.3.5.3 SWMU P-73 - Former Drum Storage Area

A total of six subsurface samples was collected from SWMU P-73 (Former Drum Storage Area). Subsurface COPCs for SWMU P-73 are summarized in Table 4-3132, and the process for selecting COPCs for this SWMU is detailed in Appendix C, Table C-1617. Neither the detected VOCs (benzene, bromoform, carbon disulfide, 1,2-dichloroethane, ethylbenzene, methylene chloride, 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, and total xylenes) nor the volatile PAHs acenaphthene, anthracene, fluorene, and naphthalene were detected at levels exceeding the EPA SSLs; thus, these compounds were eliminated as COPCs. The maximum measured concentrations of the SVOCs benzo(k)fluoranthene, chrysene, di-n-butyl phthalate, fluoranthene, 3-methylphenol and 4-methylphenol, phenol, and pyrene were below RBCs, resulting in the elimination of these analytes. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained as COPCs based on exceedances of their respective RBCs. The PAHs acenaphthylene, benzo(g,h,i)perylene, and phenanthrene, which lack EPA-approved toxicity criteria (and hence EPA Region III RBCs and SSLs), were conservatively selected as COPCs. Antimony, barium, cadmium, chromium, lead, nickel, and selenium were eliminated because their maximum detected concentrations were less than RBCs; arsenic was retained as the only metal detected at levels exceeding its RBC.

TABLE 4-3132

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SUBSURFACE MATERIAL, SWMU P-73

Volatile and "Volatile Semivolatile" Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Acenaphthylene Phenanthrene	Benzo~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	Arsenic

4.4 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN IN GROUNDWATER

Background samples were not available for comparison with groundwater data. Therefore, the maximum observed concentration for each detected analyte was screened only against the lower of the corresponding NYSDEC Ambient Water Quality Standard or Guidance Value (NYSDEC, ~~1993~~1998) and the EPA Region III RBC for residential tap water (EPA, ~~1997~~1998). As mentioned previously, the Safe Drinking Water Act value of 15 µg/L of lead (EPA, 1991) was used for groundwater COPC screening as it is lower than the NYSDEC standard. The lower of the two levels is referred to as the "COPC screening level" in the following sections. This screening mechanism is highly conservative as there are no direct exposure pathways to groundwater at the site under either current or foreseeable future conditions.

As discussed in Section 3.3, the site groundwater wells ~~has~~ have been grouped depending on the potential exposure pathway considered in the risk assessment. The COPC

screening process for site groundwater is described in the following sections. Tables detailing the selection process are provided in Appendix D.

4.4.1 Groundwater Transport to Surface Water

The ~~two~~ three groundwater discharge areas that might result in exposure to human receptor populations potentially contacting surface water in the vicinity of the Bethlehem Steel Corporation Lackawanna site are those that provide groundwater flow into (1) Lake Erie, ~~and~~ (2) Smokes Creek, and (3) the Ship Canal (see Section 3.3.1). The wells located in these areas are listed in Table 3-3.

4.4.1.1 Lake Erie Discharge Area

Groundwater COPCs for the Lake Erie Discharge Area are summarized in Table 4-~~32~~33, and details are provided in Appendix D, Table D-1. The detection frequencies of the VOCs acrylonitrile, carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,2-dichloroethane, trans-1,2-dichloroethene, hexachlorobenzene, tetrachloroethene, 1,1,1-trichloroethane, and 1,1,2-trichloroethane were less than 5%; accordingly, these compounds were eliminated from further consideration as COPCs. Because ~~its~~ maximum detected concentrations was below the COPC screening level, carbon disulfide was eliminated as a COPC. Benzene, 1,1-dichloroethane, 1,2-dichloroethene (total), ethylbenzene, methylene chloride, pyridine, toluene, trichloroethene, m-xylene and p-xylene, o-xylene, and total xylenes were retained as COPCs because they exceeded their respective COPC screening levels. The SVOCs benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, butyl benzyl phthalate, 4-chloro-3-methylphenol, 2-chloronaphthalene, chrysene, di-n-butyl phthalate, diethyl phthalate, 2,4-dichlorophenol, indeno(1,2,3-cd)pyrene, and pentachlorophenol were eliminated because they were detected in less than 5% of samples. The SVOCs acenaphthene, 2,4-dimethylphenol, fluoranthene, and pyrene were eliminated because their maximum concentrations were lower than corresponding COPC screening levels. Anthracene, bis(2-ethylhexyl)phthalate, fluorene, 2-methylphenol, 3-methylphenol and 4-methylphenol, 4-methylphenol, total cresols, naphthalene, phenanthrene, and phenol, whose maximum concentrations were greater than COPC screening levels, were retained as COPCs. The PAH acenaphthylene was conservatively retained as a COPC because it

TABLE 4-~~32~~33

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN THE LAKE ERIE DISCHARGE AREA

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Benzene	Acenaphthylene	Antimony
1,1-Ddichloroethane	Anthracene	Arsenic
1,2-Dichloroethene (total)	Bis(2-ethylhexyl)phthalate	Barium
Ethylbenzene	Cresols (total)	Chromium
Methylene chloride	2,4-Dimethylphenol	Cyanide
Pyridine	Fluorene	Lead
Toluene	2-Methylphenol	~~Manganese~~
Trichloroethene	3-Methylphenol & 4-Methylphenol	Nickel
m-Xylene and p-Xylene	4-Methylphenol	Selenium
o-Xylene	Naphthalene	
Xylenes (total)	Phenanthrene	
	Phenol	

lacks toxicity criteria and COPC screening levels. The metals cadmium, mercury, silver, and thallium ~~was~~ were eliminated from consideration as COPCs due to detection frequencies lower than 5%. ~~Nickel was eliminated from further consideration as a COPC because its maximum detected concentrations were lower than COPC screening levels.~~ Antimony, arsenic, barium, chromium, ~~cyanide,~~ lead, ~~manganese,~~ nickel, and selenium were retained as COPCs because their maximum detected concentrations were greater than COPC screening levels. ~~Cyanide was retained as a COPC because its maximum concentration was greater than its COPC screening level.~~

4.4.1.2 Smokes Creek Discharge Area

TABLE 4-~~33~~34

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN THE SMOKES CREEK DISCHARGE AREA

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Benzene	Acenaphthylene	Antimony
Carbon disulfide	Bis(2-ethylhexyl)phthalate	Arsenic
1,1-Dichloroethane	2,4-Dimethylphenol	Barium
Ethylbenzene	Fluoranthene	Cadmium
Pyridine	Fluorene	Chromium
Toluene	2-Methylphenol	Cyanide
Vinyl chloride	3-Methylphenol & 4-Methylphenol	Lead
Xylenes (total)	4-Methylphenol	Nickel
	Naphthalene	Silver
	Phenanthrene	Thallium
	Phenol	

~~Ground water~~Groundwater COPCs for the Smokes Creek Discharge Area are summarized in Table 4-~~33~~34, and details are provided in Appendix D, Table D-2. The VOCs 1,2-dichloroethane, hexachlorobenzene, and methylene chloride were eliminated from consideration as COPCs because their detection frequencies were lower than 5%. Although the detection frequency of vinyl chloride was also less than 5%, it was retained as a COPC because its concentration in this area is significantly above its COPC screening level. Because the maximum detected concentrations of benzene, carbon disulfide, 1,1-dichloroethane, ethylbenzene, pyridine, toluene, and total xylenes were greater than their COPC screening levels, these VOCs were retained. The SVOCs benzo~~(a)a~~(a)anthracene, butyl benzyl phthalate, 2-chloronaphthalene, chrysene, 2,4-dichlorophenol, 2,6-dinitrotoluene, di-n-octyl phthalate, diethyl phthalate, dimethyl phthalate, pentachlorophenol, and 2,3,4,6-tetrachlorophenol were eliminated because their detection frequencies were lower than 5%. Anthracene ~~2,4-dimethylphenol,~~ and pyrene were eliminated because their maximum concentrations were lower than corresponding COPC screening levels. Bis(2-ethylhexyl)phthalate, 2,4-dimethyphenol, fluoranthene, fluorene, 2-methyphenol, 3-methylphenol and 4-methylphenol, ~~&~~ 4-methylphenol, naphthalene, phenanthrene, and phenol were retained because their maximum concentrations were greater than COPC screening levels. Acenaphthylene was conservatively retained as a COPC because it lacks toxicity criteria (and hence COPC screening levels). ~~The metals m~~Mercury ~~and nickel~~ ~~were~~ was eliminated from further consideration in the risk assessment because ~~their~~ its maximum detected concentrations ~~were~~ was lower than its COPC screening levels. Antimony, arsenic, barium, cadmium, chromium, ~~cyanide,~~ lead, nickel, silver, and thallium were

retained due to exceedance of COPC screening levels. Cyanide was retained as a COPC because its maximum concentration was greater than its COPC screening level.

4.4.1.3 *Ship Canal Discharge Area*

TABLE 4-35

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN THE SHIP CANAL DISCHARGE AREA

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Benzene	Acenaphthylene	Arsenic
Ethylbenzene	Acenaphthene	Barium
Methylene chloride	Benz(a)anthracene	Cyanide
Toluene	Benzo(a)pyrene	Lead
Xylenes (total)	Benzo(b)fluoranthene	
	Benzo(g,h,i)perylene	
	Benzo(k)fluoranthene	
	Bis(2-ethylhexyl)phthalate	
	Chrysene	
	Dibenz(a,h)anthracene	
	2,4-Dimethyphenol	
	Fluoranthene	
	Fluorene	
	Indeno(1,2,3-c,d)pyrene	
	2-Methylphenol	
	3-Methylphenol & 4-Methylphenol	
	4-Methylphenol	
	Naphthalene	
	Phenanthrene	
	Phenol	
	Pyrene	

Groundwater COPCs for the Ship Canal Discharge Area are summarized in Table 4-35, and details are provided in Appendix D, Table D-3. Because the maximum detected concentrations of all detected VOCs (benzene, ethylbenzene, methylene chloride, toluene, and total xylenes) were greater than their COPC screening levels, these compounds were retained as COPCs. Anthracene was eliminated from consideration as COPCs because its maximum detected concentration was lower than the COPC screening level. Acenaphthene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, dibenz(a,h)anthracene, 2,4-dimethylphenol, fluoranthene, fluorene, indeno(1,2,3-c,d)-pyrene, 2-methyphenol, 3-methylphenol and 4-methylphenol, 4-methylphenol, naphthalene, phenanthrene, phenol, and pyrene were retained because their maximum concentrations were greater than corresponding COPC screening levels. Acenaphthylene and benzo(g,h,i)perylene were conservatively retained as COPC because they lack COPCs screening levels. The metals antimony, chromium, mercury, and nickel were eliminated from further consideration in the risk assessment because their maximum detected concentrations were lower than COPC screening levels. Arsenic, barium, and lead were retained due to exceedance of COPC screening levels. Cyanide was retained as a COPC because its maximum concentration was greater than its COPC screening level.

4.4.2 On-Site Vapor Pathway

For potential on-site exposures to airborne vapors, volatile analytes identified as groundwater COPCs within a specific area were evaluated as COPCs for individual SWMUs (or SWMU groups) located within that area. Thus, the groundwater COPCs for all SWMUs located in a particular area are identical (see Section 3.3.2). Volatile

compounds are defined as chemicals with a Henry's Law constant greater than 1 x 10^{-5} atm-m^3/mole and molecular weight less than 200 daltons. Thus, although usually classified as SVOCs, the PAHs acenaphthene, acenaphthylene, anthracene, 2-chloronaphthalene, fluorene, naphthalene, and phenanthrene were considered volatile by this criterion and so were evaluated as possible on-site groundwater COPCs. Area-by-area well assignments are presented Table 3-4.

4.4.2.1 Slag Fill Area Zone 1

Groundwater COPCs for Slag Fill Area Zone 1 are summarized in Table 4-3436, and details are provided in Appendix D, Table D-34. The maximum detected concentrations of the VOCs 1,1-dichloroethane and toluene were below their COPC screening levels; thus, these two VOCs were eliminated as COPCs. Although the maximum detected concentration of 1,1-dichloroethane was below the COPC screening level, the maximum was a duplicate-averaged result and the primary value exceeded the COPC screening level. Because the duplicate averaging had an effect on the COPC selection process in this case, 1,1-dichloroethane was retained as a COPC. The remaining five VOCs (benzene, carbon tetrachloride, methylene chloride, 1,1,1-trichloroethane, and total xylenes) were retained as COPCs because their maximum detected concentrations were greater than corresponding COPC screening levels. The volatile PAH fluorene was eliminated from further consideration because its maximum detected concentration was below its COPC screening level. Naphthalene was retained because its maximum detected concentration was above the COPC screening level. Acenaphthylene was conservatively retained because it lacks toxicity criteria and hence COPC screening levels.

TABLE 4-3436

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SLAG FILL AREA ZONE 1 GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene	Acenaphthylene
Carbon tetrachloride	Naphthalene
1,1-Dichloroethane	
Methylene chloride	
1,1,1-Trichloroethane	
Xylenes (total)	

4.4.2.2 Slag Fill Area Zone 2

Groundwater COPCs for Slag Fill Area Zone 2 are summarized in Table 4-375, and details are provided in Appendix D, Table D-54. The VOCs chlorobenzene, chloroform, pyridine, tetrachloroethene, and trans-1,2-dichloroethene were eliminated as COPCs because they were detected in less than 5% of the samples. As the maximum detected concentrations of carbon disulfide and styrene was were below their respective COPC screening levels, it they was were eliminated from further consideration in the risk assessment. The remaining eight eleven VOCs (benzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloroethene (total), ethylbenzene, methylene chloride, toluene, trichloroethene, m-xylene and p-xylene, o-xylene, and total xylenes) were retained because their maximum detected concentrations exceeded corresponding COPC screening levels. The PAHs acenaphthene and anthracene were eliminated because their maximum detected concentrations were below their respective COPC screening levels. Fluorene, naphthalene, and phenanthrene were the only SVOCs retained as COPCs due to exceedance of screening levels; acenaphthylene was conservatively retained because it lacks toxicity criteria and hence COPC screening levels.

TABLE 4-375

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SLAG FILL AREA ZONE 2 GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene	Acenaphthylene
1,1-Dichloroethane	Fluorene
1,2-Dichloroethane	Naphthalene
1,2-Dichloroethene (total)	Phenanthrene
Ethylbenzene	
Methylene chloride	
Toluene	
Trichloroethene	
m-Xylene & p-Xylene	
o-Xylene	
Xylenes (total)	

4.4.2.3 Slag Fill Area Zone 3

Groundwater COPCs for Slag Fill Area Zone 3 are summarized in Table 4-386, and details are provided in Appendix D, Table D-65. Of the six VOCs detected, three (carbon disulfide, ethylbenzene, and pyridine) were eliminated from further consideration in the risk assessment because their maximum detected concentrations were below COPC screening levels. Benzene, toluene, and total xylenes were retained due to exceedance of COPC screening levels. The volatile PAH anthracene was eliminated from further consideration because its maximum detected concentrations was below the corresponding COPC screening level. Fluorene, naphthalene, and phenanthrene were retained due to

TABLE 4-386

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SLAG FILL AREA ZONE 3 GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene	Acenaphthylene
Toluene	Fluorene
Xylenes (total)	Naphthalene
	Phenanthrene

exceedance of COPC screening levels. Acenaphthylene was conservatively retained because it lacks toxicity criteria and COPC screening levels.

4.4.2.4 Slag Fill Area Zone 4

Groundwater COPCs for Slag Fill Area Zone 4 are summarized in Table 4-397, and details are provided in Appendix D, Table D-76. The VOCs 1,1,1-trichloroethane, 1,2-dichlorobenzene, 1,1,2-trichloroethane, and acrylonitrile were eliminated as COPCs because they were detected in less than 5% of samples. Carbon disulfide was eliminated because its maximum detected concentration was below the COPC screening level. The nine other VOCs (benzene, chlorobenzene, 1,1-dichloroethane, ethylbenzene, methylene chloride, pyridine, toluene, trichloroethene, and total xylenes) were retained because their maximum concentrations were greater than COPC screening levels. Of the volatile PAHs, 2-chloronaphthalene was eliminated because its detection frequency was less than 5%. Acenaphthene was eliminated from further consideration because its maximum detected concentration was below its COPC screening level. Anthracene, fluorene, naphthalene, and phenanthrene, were retained as COPCs due to exceedance of screening levels; acenaphthylene was conservatively retained because it lacks toxicity criteria and hence COPC screening levels.

TABLE 4-397

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SLAG FILL AREA ZONE 4 GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene	Acenaphthylene
Chlorobenzene	Anthracene
1,1-Dichloroethane	Fluorene
Ethylbenzene	Naphthalene
Methylene chloride	Phenanthrene
Pyridine	
Toluene	
Trichloroethene	
Xylenes (total)	

4.4.2.5 Slag Fill Area Zone 5

Groundwater COPCs for Slag Fill Area Zone 5 are summarized in Table 4-3840, and details are provided in Appendix D, Table D-87. The VOCs benzene and total xylenes were retained because their maximum detected concentrations exceeded the COPC screening levels. The volatile PAHs fluorene and phenanthrene were eliminated from further consideration because their maximum detected concentrations were below the COPC screening levels. Naphthalene was retained because its maximum detected concentration was above the COPC screening level. Acenaphthylene was conservatively retained as a COPC because it lacks toxicity criteria and hence COPC screening levels.

TABLE 4-4038

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SLAG FILL AREA ZONE 5 GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene	Acenaphthylene
Xylenes (total)	Naphthalene

4.4.2.6 Coke Oven Area

Groundwater COPCs for the Coke Oven Area are summarized in Table 4-~~39~~41, and details are provided in Appendix D, Table D-~~9~~8. The VOCs 1,2-dichloroethane and methylene chloride were eliminated as COPCs because they were detected in less than 5% of the samples. Carbon disulfide was eliminated from further consideration in the risk assessment because its maximum detected concentration was below the COPC screening level. Benzene, ethylbenzene, toluene, and total xylenes were retained as COPCs because their maximum detected concentrations exceeded COPC screening levels. The volatile PAH anthracene was eliminated because its maximum detected concentration was below the COPC screening level. Acenaphthene, fluorene, naphthalene, and phenanthrene were retained because their maximum detected concentrations exceeded corresponding COPC screening levels. Acenaphthylene was conservatively retained because it lacks toxicity criteria and COPC screening levels.

TABLE 4-~~39~~41

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN COKE OVEN AREA GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene Ethylbenzene Toluene Xylenes (total)	Acenaphthene Acenaphthylene Fluorene Naphthalene Phenanthrene

4.4.2.7 Tank Farm Area

Groundwater COPCs for the Tank Farm Area are summarized in Table 4-4~~2~~0, and details are provided in Appendix D, Table D-~~10~~9. All detected VOCs (benzene, toluene, and total xylenes) were retained because their maximum detected concentrations exceeded their respective COPC screening levels. The volatile PAH naphthalene was retained because its maximum detected concentration was above the COPC screening level. Fluorene and phenanthrene were eliminated from further consideration because their maximum detected concentrations were below COPC screening levels.

TABLE 4-~~42~~0

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN TANK FARM AREA GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene Toluene Xylenes (total)	Naphthalene

4.4.2.8 Smokes Creek Area

Groundwater COPCs for the Smokes Creek Area are summarized Table 4-43~~1~~, and details are provided in Appendix D, Table D-1~~1~~0. Methylene chloride was eliminated as a COPC because it was detected in less than 5% of the samples. All other VOCs (benzene, carbon disulfide, 1,1-dichloroethane, ethylbenzene, pyridine, toluene, vinyl chloride, and total xylenes) were retained because their maximum detected concentrations exceeded respective COPC screening levels. The volatile PAHs anthracene and 2-chloronaphthalene were eliminated as COPCs because they were detected in less than 5% of the samples. Fluorene and phenanthrene were eliminated because their maximum detected concentrations were below COPC screening levels. Naphthalene was the only volatile PAH retained because its maximum detected concentration was greater than the corresponding COPC screening level; acenaphthylene was conservatively retained because it lacks toxicity criteria and COPC screening levels.

TABLE 4-43~~1~~

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SMOKES CREEK AREA GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene	Acenaphthylene
Carbon disulfide	Naphthalene
1,1-Dichloroethane	
Ethylbenzene	
Pyridine	
Toluene	
Vinyl chloride	
Xylenes (total)	

4.4.3 Off-Site Vapor Pathway from Groundwater

Off-site residents could potentially be exposed to volatile chemicals in site groundwater via volatilization and dispersion. As mentioned previously, volatile compounds were defined as chemicals with a Henry's Law constant greater than 1 x 10^{-5} atm-m^3/mole and molecular weight less than 200 daltons. Thus, although usually classified as SVOCs, the PAHs acenaphthene, acenaphthylene, anthracene, 2-chloronaphthalene, fluorene, naphthalene, and phenanthrene were considered volatile by this criterion and so were evaluated as possible site-wide groundwater COPCs.

TABLE 4-44~~2~~

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SITE-WIDE GROUNDWATER

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene	Acenaphthene
Carbon disulfide	Acenaphthylene
1,1-Dichloroethane	Anthracene
Ethylbenzene	Fluorene
Methylene chloride	Naphthalene
Pyridine	Phenanthrene
Toluene	
Trichloroethene	
m-Xylene & p-Xylene	
o-Xylene	
Xylenes (total)	

The site-wide groundwater COPCs are summarized in Table 4-4~~2~~, and details are provided in Appendix D, Table D-1~~2~~1. The VOCs ~~acetone,~~ acrylonitrile, chlorobenzene, chloroform, chloromethane, ~~2-chloronaphthalene,~~ 1,2-dichlorobenzene, trans-1,2-dichloroethene, 1,2-dichloroethane, hexachlorobenzene, tetrachloroethene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, and vinyl chloride were eliminated from consideration as site-wide COPCs because their detection frequencies were lower than 5%. The ~~eight~~ eleven other VOCs (benzene, carbon disulfide, 1,1-dichloroethane, ethylbenzene, methylene chloride, pyridine, toluene, trichloroethene, m-xylene and p-xylene, o-xylene, and total xylenes) were retained because their maximum detected concentrations exceeded their respective COPC screening levels. The volatile PAH 2-chloronaphthalene was eliminated from consideration because its detection frequency was less than 5%. The volatile PAHs acenaphthene, anthracene, fluorene, naphthalene, and phenanthrene were retained because their maximum detected concentrations were greater than corresponding COPC screening levels. Acenaphthylene was conservatively retained because it lacks toxicity criteria and COPC screening levels.

4.5 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN IN SURFACE WATER

As discussed previously (Section 3.6), surface water exposure pathways for human receptors are potentially complete in Smokes Creek, Blasdell Creek, ~~and~~ Lake Erie, the North and South Return Water Trenches, and the Ship Canal. Both current and hypothetical future operating conditions (assuming pumpings ~~have~~ has ceased) ~~operating~~) were examined for the Ship Canal. The following discussion describes the screening process for COPCs in surface water samples from these areas. A background data set is available for Smokes Creek surface water only. Because the only analyte detected in the Smokes Creek background was diethyl phthalate (see Section 3.9.3, Table 3-22~~10~~), no background comparison could be performed for other chemicals. Therefore, analytes were considered COPCs in surface water if their maximum detected concentrations exceeded the lower of NYSDEC Ambient Water Quality Standards or Guidance Values (NYSDEC, 1993) and EPA Region III residential tap water RBCs (EPA, ~~1997~~1998). As mentioned previously, the Safe Drinking Water Act value for lead of 15 µg/L ~~of lead~~ (EPA, 1991) was used for surface water COPC screening as it is lower than the NYSDEC standard. Tables detailing the selection process are provided in Appendix E.

4.5.1 Smokes Creek

TABLE 4-453

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SMOKES CREEK SURFACE WATER

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Benzene Bromodichloromethane Bromoform Chloroform Chlorodibromomethane 1,2-Dichloroethane Methylene chloride Vinyl chloride	Bis(2-ethylhexyl)phthalate	Arsenic

Surface water COPCs for Smokes Creek are summarized in Table 4-453, and details are provided in Appendix E, Table E-1. The VOCs 1,2-dichlorobenzene, 1,3-dichlorobenzene, toluene, and total xylenes were eliminated from further consideration in the risk assessment because they were detected in less than 5% of the samples. The maximum detected concentrations of 1,4-dichlorobenzene, trans-1,2-dichloroethene and trichloroethene were below the COPC screening levels; thus, these three VOCs were eliminated. The remaining eight VOCs (1,2-dichloroethane, benzene, bromodichloromethane, bromoform, chloroform, chlorodibromomethane, methylene chloride, and vinyl chloride) were retained because their maximum detected concentrations exceeded corresponding COPC screening levels. 2,6-Dinitrotoluene, butyl benzyl phthalate, di-n-butyl phthalate, diethyl phthalate, di-n-octyl phthalate, fluoranthene, and naphthalene were eliminated from further consideration because the maximum detected concentrations were below their respective COPC screening levels. Bis(2-ethylhexyl)phthalate, whose maximum concentration exceeded its screening level, was the only SVOC retained as a COPC for Smokes Creek surface water. Six metals (barium, cadmium, chromium, lead, nickel, and selenium) and cyanide were eliminated because their maximum detected concentrations were below respective COPC screening levels. Arsenic was retained as a COPC because its maximum detected concentration exceeded its screening level.

4.5.2 Blasdell Creek

TABLE 4-464

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN BLASDELL CREEK SURFACE WATER

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
1,1-Dichloroethane	None	None

Surface water COPCs for Blasdell Creek are summarized in Table 4-464, and details are provided in Appendix E, Table E-2. 1,1-Dichloroethane, the only VOC detected in Blasdell Creek surface water samples, was retained as a COPC because its maximum detected concentration was above the COPC screening level. Bis(2-ethylhexyl)phthalate, the only SVOC detected in Blasdell Creek surface water samples, was eliminated from further consideration because its maximum detected concentration was below the COPC screening level. Lead, the only metal detected in Blasdell Creek surface water, was eliminated because its single detection was below the screening level. Thus, no SVOCs or metals were retained as COPCs for

Blasdell Creek surface water. No cyanide was detected in Blasdell Creek surface water samples.

4.5.3 Lake Erie

Surface water COPCs for Lake Erie are summarized in Table 4-475, and details are provided in Appendix E, Table E-3. Toluene, the only VOC detected in Lake Erie surface water samples, was eliminated from further consideration in the risk assessment because its maximum detected concentration was below the COPC screening level. Thus, no VOCs were retained as COPCs for Lake Erie surface water. Bis(2-ethylhexyl)phthalate, detected in only one of ten Lake Erie surface water samples, was retained as a COPC due to exceedance of its screening level. Lead, the only target metal detected in Lake Erie surface water, was eliminated as a COPC since the maximum detected concentration was below its screening level. Thus, no metals were retained as COPCs for Lake Erie surface water. Cyanide was eliminated because its single detected concentration was lower than the screening level.

TABLE 4-475

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN LAKE ERIE SURFACE WATER

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	Bis(2-ethylhexyl)phthalate	None

4.5.4 North Return Water Trench

The evaluation of surface water COPCs for the North Return Water Trench is summarized in Table 4-48, and details are provided in Appendix E, Table E-4. Benzene and methylene chloride, the only VOCs detected in North Return Water Trench surface water samples, were eliminated from further consideration in the risk assessment because their maximum detected concentrations were below their respective COPC screening levels. Thus, no VOCs were retained as COPCs for North Return Water Trench surface water. No SVOCs were detected in either sample. Chromium and lead, the only target metals detected in North Return Water Trench surface water, were eliminated as COPCs since the maximum detected concentrations were below corresponding screening levels. Thus, no metals were retained as COPCs for North Return Water Trench surface water.

TABLE 4-48

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN NORTH RETURN WATER TRENCH SURFACE WATER

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	None ~~detected~~	None

4.5.5 South Return Water Trench

TABLE 4-49

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SOUTH RETURN WATER TRENCH SURFACE WATER

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	None detected	None

The evaluation of surface water COPCs for the North Return Water Trench is summarized in Table 4-49, and details are provided in Appendix E, Table E-5. Benzene and 1,1,1-trichloroethane, the only VOCs detected in South Return Water Trench surface water samples, were eliminated from further consideration in the risk assessment because their maximum detected concentrations were below their respective COPC screening levels. Thus, no VOCs were retained as COPCs for South Return Water Trench surface water. No SVOCs were detected in either sample. Lead and mercury, the only target metals detected in South Return Water Trench surface water, were eliminated as COPCs since the maximum detected concentrations were below corresponding screening levels. Thus, no metals were retained as COPCs for South Return Water Trench surface water.

4.5.6 Ship Canal (Current Conditions)

TABLE 4-50

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SHIP CANAL SURFACE WATER (CURRENT CONDITIONS)

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Benzene	Bis(2-ethylhexyl)phthalate	Arsenic

Surface water COPCs for the Ship Canal are summarized in Table 4-50, and details are provided in Appendix E, Table E-6. Benzene, the only VOC detected in Ship Canal surface water samples, was retained because its maximum detected concentration was greater than the COPC screening level. The SVOCs butyl benzyl phthalate, di-n-butyl phthalate, diethyl phthalate, di-n-octyl phthalate, and naphthalene were eliminated from further consideration because the maximum detected concentrations were below their respective COPC screening levels. Bis(2-ethylhexyl)phthalate, whose maximum concentration exceeded its screening level, was the only SVOC retained as a COPC for Ship Canal surface water. Five metals (antimony, barium, cadmium, chromium, and nickel) were eliminated because their maximum detected concentrations were below respective COPC screening levels. Arsenic was retained as a COPC because its maximum detected concentration exceeded its screening level.

4.5.7 Ship Canal (Hypothetical Future Conditions)

TABLE 4-51

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SHIP CANAL SURFACE WATER (HYPOTHETICAL FUTURE CONDITIONS)

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
Benzene Toluene	Acenaphthylene Bnez(a)anthracene Bnezo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenz(a,h)anthracene Indeno(1,2,3-c,d)pyrene	Arsenic

As discussed in 3.3.1, BSC has agreed to evaluate potential exposure of maintenance workers to COPCs in Ship Canal surface water under a hypothetical future scenario in which pumping no longer occurs. Maximum concentrations that Ship Canal Discharge Area groundwater COPCs (listed in Table 4-35 and Appendix D, Table D-3) could reach in Ship Canal surface water in the absence of pumping were estimated using the average concentrations of these COPCs in groundwater entering the canal and a mass balance model. These groundwater concentrations were estimated by contouring the most recent data for each COPC in Ship Canal Discharge Area wells. The mass balance model for the Ship Canal assumes complete, instantaneous mixing of the inflow with the canal water, and instantaneous loss of mixed water to balance the inflow. That is, as each increment of influx is added to the canal, it mixes completely with the resident water, and an equal volume of canal water with the new COPC concentration is lost to Lake Erie. This model is highly conservative in that it assumes no loss of COPC after entry into the canal, even though losses by such processes as biological and chemical degradation and volatilization would be substantial.

Surface water COPCs under hypothetical future conditions in which the pumps are no longer operating are summarized in Table 4-51, and details are provided in Appendix E, Table E-7. Of the five VOCs that are COPCs in Ship Canal Discharge Area groundwater, ethylbenzene, methylene chloride, and total xylenes were eliminated because their estimated maximum concentrations in Ship Canal surface water are lower than applicable screening standards. Benzene and toluene were retained as COPCs because their estimated maximum concentrations exceed screening criteria. The SVOCs acenaphthene, bis(2-ethylhexyl)phthalate, fluoranthene, fluorene, 2-methylphenol, 3-methylphenol and 4-methylphenol, 4-methylphenol, naphthalene, phenanthrene, phenol, and pyrene were eliminated from further consideration because the estimated maximum concentrations are below their respective COPC screening levels. Nine SVOCs (benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)-pyrene), whose estimated maximum concentrations exceed their respective screening levels, were retained as COPCs. Acenaphthylene was conservatively retained as a COPC in the absence of toxicity criteria, and hence screening levels. Two metals (barium and lead) and cyanide were eliminated because their estimated maximum concentrations are below

respective COPC screening levels. Arsenic was retained as a COPC because its estimated maximum concentration is greater than its screening level.

4.6 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN IN SEDIMENT

As discussed previously, exposure pathways for human receptors are potentially complete in Smokes Creek, Blasdell Creek, Lake Erie, ~~and~~ the North and South Return Water Trenches, and the Ship Canal. The following discussion describes the screening process for COPCs in sediment samples from these areas. A limited amount of background data were collected in Smokes and Blasdell Creeks and Lake Erie. As described in Section 3.9.2, background values for these water bodies were established as the lower of site background measurements and literature values (Tables 3-19 to 3-21). No background samples were collected for sediments in the North and South Return Water Trenches or the Ship Canal. Accordingly, background concentrations identified for surface soil (Tables 3-13 and 3-15) were used for COPC screening in these water bodies. This is considered a conservative screen as sediments tend to accumulate higher concentrations of metals and nonpolar organics than do exposed soils. Analytes were considered COPCs in sediment if their maximum detected concentrations exceeded maximum background concentrations and/or EPA Region III residential soil RBCs (EPA, ~~1997~~1998). Tables detailing the selection process are provided in Appendix F.

4.6.1 Smokes Creek

Sediment COPCs for Smokes Creek are summarized in Table 4-~~46~~52, and details are provided in Appendix F, Table F-1. The VOCs benzene, carbon disulfide, chlorobenzene, 1,3-dichlorobenzene, ethylbenzene, methyl ethyl ketone, methylene chloride, toluene, trichlorofluoromethane, and total xylenes were eliminated as COPCs because their maximum detected concentrations were below corresponding EPA Region III residential soil RBCs. Thus, no VOCs were retained as COPCs for Smokes Creek sediment. The SVOCs acenaphthene, butyl benzyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, isophorone, and naphthalene were eliminated as COPCs because their maximum detected concentrations were below corresponding RBCs. Although maximum detected concentrations were greater than background, anthracene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, fluorene, and pyrene were eliminated as COPCs because they were lower than RBCs. ~~Benzo(g,h,i)perylene and phenanthrene which lack toxicity~~

TABLE 4-~~46~~52

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SMOKES CREEK SEDIMENT

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	Acenaphthylene Benzo~~(a)a~~(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Phenanthrene	Arsenic Lead

~~criteria and hence RBCs, were retained because their maximum detected concentrations exceeded background levels. Acenaphthylene was conservatively retained in the absence of both background and RBCs.~~ ~~Benzo(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained as COPCs because their maximum detected concentrations exceeded background and/or RBCs. Benzo(g,h,i)perylene and phenanthrene, which lack toxicity criteria and hence RBCs, were retained because their maximum detected concentrations exceeded background levels. Acenaphthylene was conservatively retained in the absence of both background and RBCs. -Eight detected metals (antimony, barium, cadmium, chromium, mercury, nickel, selenium, and silver) were eliminated as COPCs because their maximum detected concentrations were below RBCs. Arsenic and lead were retained as COPCs because their maximum detected concentration exceeded background and the Region III RBCs. Cyanide was eliminated as a COPC because the maximum detected concentration was below the EPA Region III soil RBC.

4.6.2 Blasdell Creek

TABLE 4-~~47~~53

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN BLASDELL CREEK SEDIMENT

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	Acenaphthylene Benzo~~(a)~~a(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Phenanthrene	Arsenic

Sediment COPCs for Blasdell Creek are summarized in Table 4-~~47~~53, and details are provided in Appendix F, Table F-2. The only detected VOC, dichlorodifluoromethane, was eliminated because its maximum concentration was lower than the corresponding EPA Region III residential soil RBC. ~~Nine~~ Five SVOCs (acenaphthene, anthracene, ~~bis(2-ethylhexyl)phthalate, chrysene,~~ di-n-octyl phthalate, ~~fluoranthene,~~ fluorene, and naphthalene~~, and pyrene~~) were eliminated as COPCs because their maximum detected concentrations were below ~~background and/or~~ corresponding RBCs. Although their maximum detected concentrations exceeded background, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, and pyrene were eliminated as COPCs because they were lower than their respective RBCs. ~~—~~Benzo~~(a)~~a(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and phenanthrene were retained as COPCs due to exceedance of background concentrations and/or RBCs. Acenaphthylene was conservatively retained as a COPC in the absence of both background concentrations in Blasdell Creek and an RBC. Antimony, selenium, silver, and thallium were eliminated as COPCs because their maximum detected concentrations were below their respective RBCs. Although maximum detected concentrations of barium, cadmium, chromium, lead, mercury, and nickel exceeded background concentrations, these metals were eliminated as COPCs because RBCs were not exceeded. Arsenic was retained as a COPC due to exceedance of both background and its RBC. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

4.6.3 Lake Erie

TABLE 4-~~48~~54

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN LAKE ERIE SEDIMENT

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	Benzo(a)pyrene Benzo(g,h,i)perylene Dibenz(a,h)anthracene Phenanthrene	Arsenic

Sediment COPCs for Lake Erie are summarized in Table 4-~~48~~54, and details are provided in Appendix F, Table F-3. The maximum detected concentrations of the VOCs chloromethane,

1,1,2,2-tetrachloroethane, and toluene were below their respective EPA Region III soil RBCs; thus, no VOCs were retained as COPCs for Lake Erie sediment. Ten SVOCs (acenaphthene, anthracene, benzo~~(a)a~~(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, fluorene, indeno(1,2,3-cd)pyrene, and naphthalene) were eliminated as COPCs because their maximum detected concentrations were below the EPA Region III soil RBCs. Although their maximum detected concentrations exceeded background, chrysene, fluoranthene, and pyrene were eliminated as COPCs because they were lower than their respective RBCs. Benzo(a)pyrene and dibenz(a,h)anthracene were retained as COPCs because their maximum detected concentrations exceeded background and/or RBCs. Benzo(g,h,i)perylene was conservatively retained as a COPC because it lacks both toxicity criteria (and hence RBCs) and a background concentration in Lake Erie. Phenanthrene, which also lacks toxicity criteria, was retained because it exceeded background concentrations. The metals antimony, barium, mercury, and silver were eliminated as COPCs because their maximum detected concentrations were lower than the EPA Region III soil RBCs. Although their maximum detected concentrations exceeded background, chromium, lead, and nickel were eliminated as COPCs because they were lower than their respective RBCs. Arsenic was retained as a COPC because its maximum concentration exceeded both background and its RBC.

4.6.4 North ~~and South~~ Return Water Trenches

Sediment COPCs for the North ~~and South~~ Return Water Trenches are summarized in Table 4-4955, and details are provided in Appendix F, Table F-4. The maximum detected concentrations of ~~the VOCs tetrachloroethene and~~ total xylenes ~~were~~ was below ~~their~~ its ~~respective~~ EPA Region III soil RBCs; thus, no VOCs were retained as COPCs for North ~~and South~~ Return Water Trenches sediment. Although their maximum detected concentrations exceeded background, six~~Seven~~ SVOCs (acenaphthene, anthracene, ~~bis(2-ethylhexyl)phthalate,~~ fluoranthrene, fluorene, naphthalene, and pyrene) were eliminated as COPCs because their maximum detected concentrations were below the EPA Region III soil RBCs. Benzo~~(a)a~~(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthrene, benzo(k)fluoranthrene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained as COPCs because their maximum detected concentrations exceeded RBCs. The PAHs acenaphthylene, benzo(g,h,i)perylene and phenanthrene were conservatively retained as COPCs because their maximum detected concentrations exceeded background, and they lack toxicity

TABLE 4-5549

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN NORTH ~~AND SOUTH~~ RETURN WATER TRENCHES SEDIMENT

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	Acenaphthylene	~~Antimony~~
	Benzo~~(a)a~~(a)anthracene	Arsenic
	Benzo(a)pyrene	~~Lead~~
	Benzo(b)fluoranthrene	
	Benzo(g,h,i)perylene	
	Benzo(k)fluoranthrene	
	Chrysene	
	Dibenz(a,h)anthracene	
	Indeno(1,2,3-cd)pyrene	
	Phenanthrene	

criteria (and hence RBCs). Barium, ~~cadmium,~~ chromium, ~~cyanide, mercury,~~and nickel~~, selenium, silver and thallium~~ were eliminated as COPCs because their maximum detected concentrations were lower than ~~the~~ both background and EPA Region III soil RBCs. Although the maximum detected concentrations of lead and mercury exceeded background, they were not retained as COPCs as they did not exceed RBCs. ~~Antimony,~~ Arsenic ~~and lead were~~ was retained as a COPCs because ~~their~~ its maximum concentrations exceeded both ~~their respective~~ backgrounds and the RBCs.

4.6.5 South Return Water Trench

Sediment COPCs for the South Return Water Trench are summarized in Table 4-56, and details are provided in Appendix F, Table F-5. The maximum detected concentration of the VOC tetrachloroethene was below its EPA Region III soil RBC; thus, no VOCs were retained as COPCs for South Return Water Trench sediment. Ten SVOCs (anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthrene, indeno(1,2,3-c,d)-pyrene, and pyrene) were eliminated as COPCs because their maximum detected concentrations were below both background and EPA Region III soil RBCs. Although they lack toxicity criteria (and hence RBCs), the PAHs benzo(g,h,i)perylene and phenanthrene were eliminated because their maximum detected concentrations were below background. Dibenz(a,h)anthracene was retained as a COPC in the South Return Water Trench because its maximum detected concentration was greater than both background and the Region III RBC. Nickel was eliminated because its maximum detected concentration was below both background and its RBC. Cadmium, silver, and thallium were not selected as COPCs because their maximum detected concentrations were lower than RBCs (no background concentrations available). Although greater than background levels, the maximum detected concentrations of the metals barium, chromium, mercury, and selenium were lower than RBCs, resulting in their elimination from further consideration as COPCs. Antimony, arsenic, and lead were retained as COPCs because their maximum concentrations exceeded both their respective backgrounds and RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

TABLE 4-56

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SOUTH RETURN WATER TRENCH SEDIMENT

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	Dibenz(a,h)anthracene	Antimony Arsenic Lead

4.6.6 Ship Canal

Sediment COPCs for the Ship Canal are summarized in Table 4-57, and details are provided in Appendix F, Table F-6. The maximum detected concentration of all seven VOCs detected (benzene, carbon disulfide, ethylbenzene, methy ethyl ketone, methylene chloride, toluene, and total xylenes) were below their respective EPA Region III soil RBCs; thus, no VOCs were retained as COPCs for Ship Canal sediment. Acenaphthene, anthracene, benzo(k)fluoranthrene, bis(2-ethylhexyl)phthalate, chrysene, di-n-butyl phthalate, fluoranthene, fluorene, naphthalene, and pyrene were eliminated because their maximum detected concentrations were lower than both background levels and Region III RBCs. Butyl benzyl phthalate, 3-methylphenol and 4-methylphenol, 4-methylphenol, and phenol were eliminated because their maximum concentrations did not exceed RBCs (background not available). Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)-pyrene were retained as COPCs because their maximum detected concentrations exceeded both background levels and RBCs. The PAHs acenaphthylene, benzo(g,h,i)perylene and phenanthrene were conservatively retained as COPCs because their maximum detected concentrations exceeded background, and they lack toxicity criteria (and hence RBCs). Although the maximum detected concentrations of lead antimony, barium, chromium, mercury, nickel, and selenium exceeded background, they were not retained as COPCs as they did not exceed RBCs. Cadmium, silver, and thallium were eliminated because their maximum concentrations were lower than respective RBCs (no background available). Arsenic and lead were retained as COPCs because their maximum concentrations exceeded both background and RBCs. Cyanide was eliminated from consideration as a COPC because its maximum concentration was lower than its EPA Region III RBC.

TABLE 4-57

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SHIP CANAL SEDIMENT

Volatile Organic Constituents	Semivolatile Organic Constituents	Inorganic Constituents
None	Acenaphthylene Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthrene Benzo(g,h,i)perylene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Phenanthrene	Arsenic Lead

4.7 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN IN PIT WATER (SWMU GROUP PA-1 AND SWMU P-11)

On and off-site receptors could potentially be exposed to chemicals present in standing water in quench pits via volatilization and dispersion. Thus, volatile chemicals that are of potential concern in quench pits water have been identified. Volatile compounds were defined as chemicals with a Henry's Law constant greater than 1×10^{-5} atm-m^3/mole and molecular weight less than 200 daltons. Thus, although usually classified as SVOCs, the PAHs acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene were considered volatile by this criterion and so were evaluated as possible pit water COPCs. Background samples were not available for comparison with pit water

data; therefore, the maximum observed concentration of each detected analyte was screened only against the lower of the corresponding NYSDEC Ambient Water Quality Standard or Guidance Value (NYSDEC, 1993) and EPA Region III RBC for residential tap water (EPA, ~~1997~~1998). The lower of the two levels is referred to below as the "COPC screening level." This screening mechanism is highly conservative as there are no direct exposure pathways to quench pit water at the site under current or foreseeable future conditions.

A total of four water samples was collected from the SWMU Group PA-1 quench pits, which consist of SWMUs P-1 (Quench Water Pit, North Station), P-2 (Quench Water Pit, Arctic Station), P-3 (Quench Water Pit, Central Station), and P-4 (Quench Water Pit, A Station). Quench pit COPCs for the SWMU Group PA-1 are summarized in Table 4-5~~8~~9, and details are provided in Appendix G, Table G-1. Benzene, the only VOC detected, was retained based on exceedance of its COPC screening level. The volatile PAH naphthalene was retained because its maximum detected concentration exceeded its screening level. Anthracene, fluorene, and phenanthrene were eliminated from further consideration because their maximum detected concentrations were lower than their respective COPC screening levels. Acenaphthylene was conservatively retained in the absence of toxicity criteria and hence COPC screening levels.

TABLE 4-5~~8~~9

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SWMU GROUP PA-1 QUENCH PITS

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene	Acenaphthylene Naphthalene

~~A single surface~~Three ~~water~~ samples ~~was of~~ water from ~~collected of~~ the SWMU P-11 #17 pit ~~water~~ were collected in 1998 ~~during the Phase II B site investigation~~WHEN???. Pit water COPCs for SWMU P-11 are summarized in Table 4-~~51~~59 and details are provided in Appendix G~~H~~, Table ~~H-1~~G-2. All detected VOCs (benzene, ethylbenzene, toluene, and total xylenes) were retained because their maximum detected concentrations exceeded their respective COPC screening levels. The volatile PAHs ~~fluorene and~~ naphthalene ~~were~~ was retained because ~~their~~ its maximum detected concentrations exceeded ~~the~~ its COPC screening level~~s~~.

TABLE 4-5~~1~~9

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN IN SWMU P-11 #17 PIT

Volatile Organic Constituents	"Volatile Semivolatile" Organic Constituents
Benzene Toluene Xylenes (total)	~~Fluorene~~ Naphthalene

4.8 REFERENCES

New York State Department of Environmental Conservation (NYSDEC). ~~1993~~1998. *Ambient Water Quality Standards and Guidance Values.*

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

___. 1991. Maximum contaminant level goals and national primary drinking water regulations for lead and copper. *Federal Register* **56:** 26461-26564.

___. 1993. *Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening.* U.S. EPA Region III Technical Guidance Manual. EPA/903/R-93-001. January 1993.

___. 1994a. *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children.* EPA/540/R-93/081. Office of Emergency and Remedial Response, Washington, D.C.

___. 1994b. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.* OSWER Directive #9355.4-12. Office of Solid Waste and Emergency Response, Washington, D.C.

___. 1996. *Soil Screening Level Guidance: Technical Background Document.* Office of Solid Waste and Emergency Response. Washington, D.C. EPA/540-R-96/018.

___. ~~1997~~1998. U.S. EPA Region III Risk-Based Concentration Table. October, ~~1997~~1998.

R.E. Wright Associates. 1992. Characterization Study of the Acid Tar Pits at the Bethlehem Steel Corporation Lackawanna Facility, Lackawanna, New York. May 1992.

SECTION 5

5.0 TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN

The toxicity assessment characterizes the relationship between the magnitude of exposure to a COPC and the nature and magnitude of adverse health effects that may result from such exposure. Toxicity criteria for use in risk assessment may be based on human epidemiological studies or acute, subchronic, or chronic animal data. Chemical toxicity is divided into two categories for purposes of human health risk assessment: carcinogenic and non-carcinogenic. Potential health risks are calculated differently for these two types of effects because their toxicity criteria are based on different mechanistic assumptions and expressed in different units. The two approaches are discussed below.

Toxicity criteria for the Lackawanna COPCs were selected (in order of preference) from the following sources: (1) EPA's Integrated Risk Information System (IRIS) (EPA, 1998~~7~~a); (2) EPA Health Effects Assessment Summary Tables (HEAST) (EPA, 1997~~5~~); (3) EPA-NCEA Superfund Health Risk Technical Support Center; or (4) extrapolated values as suggested by EPA Region III (~~1997~~1998b). IRIS is the official repository of agency-wide consensus human-health information. Although values from HEAST are supported by Agency reference, they are not necessarily Agency-wide consensus values. Thus, toxicity values obtained from IRIS are given priority over those from HEAST, as recommended by EPA (1989, 1990, 1992(a)). All selected toxicity criteria for human receptors are listed in Table 5-1. This table also includes EPA Region III RBCs for residential soil and tap water, (EPA ~~1997~~1998b), EPA SSLs (EPA, 1996b) and NYSDEC Ambient Water Quality Standards and Guidance Values (NYSDEC, ~~1993~~1998) for ease of reference.

5.1 TOXICITY INDICATORS FOR NONCARCINOGENIC EFFECTS

A non-carcinogenic effect is defined as any adverse response to a chemical that is not cancer. Non-carcinogenic effects are evaluated using reference doses (RfDs) developed by EPA using a safety or uncertainty factor approach. An RfD is an estimate of the daily lifetime exposure level to humans (expressed in units of mg of chemical/kg of body weight/day), including sensitive subgroups, that is likely to be without appreciable risk of deleterious effects (EPA, 1989). RfDs are predicated on the assumption that thresholds (exposure levels below which no adverse effect is expected) exist for non-carcinogenic effects. They are usually derived by dividing empirical effects levels from oral exposure studies (typically using the most sensitive species, strain and sex of experimental animal known) by a series of uncertainty factors representing inter- and intraspecies variability and the quality and completeness of the data base. These uncertainty factors (with one exception) are assigned an arbitrary value of 10. The RfD has no incremental risk associated with it, but is the maximum daily intake that is not expected to result in any adverse effect in sensitive human receptors.

5.2 TOXICITY INDICATORS FOR CARCINOGENIC EFFECTS

Cancers are generally defined as diseases of mutation affecting cell growth and differentiation. In contrast to non-carcinogenic effects, EPA typically assumes that there is no threshold for carcinogenic responses; that is, any dose of a potential carcinogen is considered to pose some finite risk of cancer. The evidence for human carcinogenicity of a chemical is largely derived from two sources: chronic studies with laboratory animals, and human epidemiological studies where an increased incidence of cancer is associated with exposure to the chemical. EPA typically assumes that negative epidemiological data are not evidence that a chemical is not carcinogenic to humans.

Table 5-1
Toxicity [1] and Risk-Based Criteria for Chemicals of Potential Concern
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical of Potential Concern	Henry's Law Constant (atm-m^3/mol) [1]	Chronic Oral Reference Dose (mg/kg-day)	Chronic Inhalation Reference Dose (mg/kg-day)	Oral Slope Factor (mg/kg-day)$^{-1}$	Inhalation Slope Factor (mg/kg-day)$^{-1}$	EPA Region III Residential Soil RBC (mg/kg) [2]	EPA SSL for Vapor Inhalation (mg/kg) [2]	EPA Region III Tap Water RBC (µg/L) [2]	Maximum Contaminant Level (µg/L) [4]	NYSDEC Standard or Guideline (µg/L) [5]
Volatile Organic Chemicals										
1,1,1-Trichloroethane	1.72E-02 a	2.00E-02 E	2.86E-01 E	NA	NA	1.56E+03 N	1.20E+03 S	5.41E+02 N	2.00E+02	5.00E+00 POC
1,1,2,2-Tetrachloroethane	3.45E-04 a	6.00E-02 E	6.00E-02 R	2.00E-01 I	2.00E-01 I	3.19E+00 C	6.00E-01 C	5.27E-02 C	NA	5.00E+00 POC
1,1-Dichloroethane	5.62E-03 a	1.00E-01 H	1.40E-01 A	NA	NA	7.82E+03 N	1.30E+03 N	7.98E+02 N	NA	5.00E+00 POC
1,2-Dichloroethane	9.79E-04 a	3.00E-02 E	1.40E-03 E	9.10E-02 I	9.10E-02 I	7.02E+00 C	4.00E-01 C	1.16E-01 C	5.00E+00	6.00E-01 Std
1,2-Dichloroethene, Total *	6.73E-03 a	1.00E-02 H	1.00E-02 R	NA	NA	7.82E+02 N	1.20E+03 S	6.08E+01 N	5.00E+00	5.00E+00 POC
Benzene	5.55E-03 a	3.00E-03 E	1.70E-03 E	7.7E-03 to 2.73E-02 I	2.90E-02 I	2.20E+01 C	8.00E-01 C	3.64E-01 C	5.00E+00	1.00E+00 Std
Bromodichloromethane	1.60E-03 a	2.00E-02 I	2.00E-02 R	6.20E-02 I	NA	1.03E+01 C	3.00E+03 S	1.70E-01 C	1.00E+02	5.00E+01 G
Bromoform	5.35E-04 a	2.00E-02 I	2.00E-02 R	7.90E-03 I	3.90E-03 I	8.09E+01 C	5.30E+01 C	2.33E+00 C	1.00E+02	5.00E+01 G
Carbon disulfide	3.03E-02 a	1.00E-01 I	2.00E-01 I	NA	NA	7.82E+03 N	7.20E+02 S	1.04E+03 N	NA	NA
Carbon tetrachloride	3.04E-02 a	7.00E-04 I	5.71E-04 E	1.30E-01 I	5.30E-02 I	4.91E+00 C	3.00E-01 C	1.62E-01 C	5.00E+00	5.00E+00 Std
Chlorobenzene	3.70E-03 a	2.00E-02 I	5.00E-03 A	NA	NA	1.56E+03 N	1.30E+02 N	3.48E+01 N	NA	5.00E+00 POC
Chloroform	3.67E-03 a	1.00E-02 I	8.60E-05 E	6.10E-03 I	8.10E-02 I	1.05E+02 C	3.00E-01 C	1.52E-01 C	1.00E+02	7.00E+00 Std
Dibromochloromethane	7.83E-04 a	2.00E-02 I	2.00E-02 R	8.40E-02 I	NA	7.60E+00 C	1.30E+03 S	1.26E-01 C	1.00E+02	5.00E+01 G
Ethylbenzene	8.88E-06 a	1.00E-01 I	2.90E-01 I	NA	NA	7.82E+03 N	4.00E+02 S	1.34E+03 N	7.00E+02	5.00E+00 POC
Methylene chloride	2.19E-03 a	6.00E-02 I	8.60E-01 H	7.50E-03 I	1.65E-03 I	8.52E+01 C	1.30E+01 C	4.10E+00 C	5.00E+00	5.00E+00 POC
Pyridine	2.36E-05 c	1.00E-03 I	1.00E-03 R	NA	NA	7.82E+01 N	7.50E+01 N	NA	5.00E+01 G
Toluene	6.64E-03 a	2.00E-01 I	1.14E-01 I	NA	NA	1.56E+04 N	6.50E+02 S	7.47E+02 N	1.00E+03	5.00E+00 POC
Trichloroethene	1.03E-02 a	6.00E-03 E	6.00E-03 R	1.10E-02 E	6.00E-03 E	5.81E+01 C	5.00E+00 C	1.55E+00 C	5.00E+00	5.00E+00 POC
Vinyl chloride	2.70E-02 a	NA	NA	1.90E+00 H	3.00E-01 H	3.36E-01 C	3.00E-02 C	1.91E-02 C	2.00E+00	2.00E+00 Std
m-Xylene and p-Xylene **	7.50E-03 a	2.00E+00 H	2.00E+00 R	NA	NA	1.56E+05 N	4.20E+02 S	1.22E+04 N	1.00E+04	5.00E+00 POC
o-Xylene	5.19E-03 a	2.00E+00 H	2.00E+00 R	NA	NA	1.56E+05 N	4.10E+02 S	1.22E+04 N	1.00E+04	5.00E+00 POC
Xylenes, Total	6.73E-03 a	2.00E+00 I	2.00E+00 R	NA	NA	1.56E+05 N	4.10E+02 S	1.22E+04 N	1.00E+04	5.00E+00 POC
"Volatile Semivolatile" Organic Chemicals										
Acenaphthene	1.55E-04 a	6.00E-02 I	6.00E-02 R	NA	NA	4.69E+03 N	1.20E+02 S	2.19E+03 N	NA	2.00E+01 G
Acenaphthylene	1.48E-03 b	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	6.50E-05 a	3.00E-01 I	3.00E-01 R	NA	NA	2.35E+04 N	6.80E+00 S	1.10E+04 N	NA	5.00E+01 G
Fluorene	6.36E-05 a	4.00E-02 I	4.00E-02 R	NA	NA	3.13E+03 N	8.90E+01 S	1.46E+03 N	NA	5.00E+01 G
Naphthalene	4.83E-04 a	2.00E-02 I	9.00E-04 I	NA	NA	1.56E+03 N	1.80E+02 S	7.30E+02 N	NA	1.00E+01 G
Phenanthrene	1.59E-04 b	NA	NA	NA	NA	NA	NA	NA	NA	5.00E+01 G
Semivolatile Organic Chemicals										
Benz(a)anthracene	3.35E-06 a	NA	NA	7.30E-01 E	3.10E-01 E	8.75E-01 C		9.17E-02 C	NA	2.00E-03 G
Benzo(a)pyrene	1.13E-06 a	NA	NA	7.30E+00 I	3.10E+00 E	8.75E-02 C		9.17E-03 C	2.00E-01	NA
Benzo(b)fluoranthene	1.11E-04 a	NA	NA	7.30E-01 E	3.10E-01 E	8.75E-01 C		9.17E-02 C	NA	2.00E-03 G
Benzo(g,h,i)perylene	5.34E-08 b	NA	NA	NA	NA	NA		NA	NA	NA
Benzo(k)fluoranthene	8.29E-07 a	NA	NA	7.30E-02 E	3.10E-02 E	8.75E+00 C		9.17E-01 C	NA	2.00E-03 G
Bis(2-ethylhexyl)phthalate	1.02E-07 a	2.00E-02 I	NA	1.40E-02 I	1.40E-02 E	4.56E+01 C		4.78E+00 C	NA	5.00E+00 Std
Chrysene	9.46E-05 a	NA	NA	7.30E-03 E	3.10E-03 E	8.75E+01 C		9.17E+00 C	NA	2.00E-03 G
Cresols, Total ***	1.10E-06 b	NA	NA	NA	NA	NA		NA	NA	1.00E+00 TP
Dibenz(a,h)anthracene	1.47E-08 a	NA	NA	7.30E+00 E	3.10E+00 E	8.75E-02 C		9.17E-03 C	NA	NA
2,4-Dimethylphenol	2.00E-06 a	2.00E-02 I	NA	NA	NA	1.56E+03 N		7.30E+02 N	NA	5.00E+01 G
Fluoranthene	6.46E-06 b	4.00E-02 I	NA	NA	NA	3.13E+03 N		1.46E+03 N	NA	5.00E+01 G
Indeno(1,2,3-c,d)pyrene	1.60E-06 a	NA	NA	7.30E-01 E	3.10E-01 E	8.75E-01 C		9.17E-02 C	NA	2.00E-03 G
2-Methylphenol	1.20E-06 a	5.00E-02 I	NA	NA	NA	3.91E+03 N		1.83E+03 N	NA	1.00E+00 TP
3-Methylphenol & 4-Methylphenol ****	4.43E-07 c	5.00E-03 H	NA	NA	NA	3.91E+02 N		1.83E+02 N	NA	1.00E+00 TP
4-Methylphenol	4.43E-07 c	5.00E-03 H	NA	NA	NA	3.91E+02 N		1.83E+02 N	NA	1.00E+00 TP

Table 5-1
Toxicity [1] and Risk-Based Criteria for Chemicals of Potential Concern
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical of Potential Concern	Henry's Law Constant (atm-m^3/mol) [1]	Chronic Oral Reference Dose (mg/kg-day)	Chronic Inhalation Reference Dose (mg/kg-day)	Oral Slope Factor (mg/kg-day)$^{-1}$	Inhalation Slope Factor (mg/kg-day)$^{-1}$	EPA Region III Residential Soil RBC (mg/kg) [2]	EPA SSL for Vapor Inhalation (mg/kg) [3]	EPA Region III Tap Water RBC (µg/L) [2]	Maximum Contaminant Level (µg/L) [4]	NYSDEC Standard or Guideline (µg/L) [5]
Phenol	3.97E-07 a	6.00E-01 I	NA	NA	NA	4.69E+04 N		2.19E+04 N	NA	1.00E+00 TP
Pyrene	5.04E-06 b	3.00E-02 I	NA	NA	NA	2.35E+03 N		1.10E+03 N	NA	5.00E+01 G
Inorganic Chemicals										
Antimony		4.00E-04 I	NA	NA	NA	3.13E+01 N		1.46E+01 N	6.00E+00	3.00E+00 Std
Arsenic		3.00E-04 I	NA	1.50E+00 I	1.51E+01 I	4.26E-01 C		4.46E-02 C	5.00E+01	2.50E+01 Std
Barium		7.00E-02 I	1.40E-04 A	NA	NA	5.48E+03 N		2.56E+03 N	2.00E+03	1.00E+03 Std
Cadmium (water)		5.00E-04 I	NA	NA	6.30E+00 I	3.91E+01 N		1.83E+01 N	5.00E+00	5.00E+00 Std
Cadmium (food)		1.00E-03 I	NA	NA	6.30E+00 I	7.82E+01 N		3.65E+01 N	NA	NA
Chromium *		3.00E-03 I	3.00E-05 I	NA	4.10E+01 H	2.35E+02 N		1.10E+02 N	1.00E+02	5.00E+01 Std
Cyanide **		2.00E-02 I	NA	NA	NA	1.56E+03 N		7.30E+02 N	2.00E+02	2.00E+02 Std
Lead ***		NA	NA	NA	NA	4.00E+02 N		NA	NA	2.50E+01 Std
Nickel		2.00E-02 I	NA	NA	NA	1.56E+03 N		7.30E+02 N	1.00E+02	1.00E+02 Std
Selenium		5.00E-03 I	NA	NA	NA	3.91E+02 N		1.83E+02 N	5.00E+01	1.00E+01 Std
Silver		5.00E-03 I	NA	NA	NA	3.91E+02 N		1.83E+02 N	NA	5.00E+01 Std
Thallium		7.00E-05 O	NA	NA	NA	5.48E+00 N		2.56E+00 N	2.00E+00	5.00E-01 G

Notes:

[1] Sources of toxicity criteria: I=IRIS H=HEAST A=HEAST alternate W=Withdrawn from IRIS or HEAST E=EPA-NCEA Regional Support provisional value R=Route-to-route extrapolation

[2] EPA (1998b).

[3] Taken from or calculated in accordance with EPA (1996b).

[4] EPA (1996b).

[5] Class GA groundwater standard or guideline (NYSDEC [1998]).

a: EPA, 1996. *Soil Screening Guidance: Technical Background Document.* EPA/540/R-96/018. Office of Solid Waste and Emergency Response, Washington, D.C.

b: EPA, 1986. *Superfund Public Health Evaluation Manual.* EPA/540/1-86-060. Office of Emergency and Remedial Response, Washington, D.C.

c: EPA, 1989. *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models.* EPA/450/3-87-026. Office of Air and Radiation, Research Triangle Park, NC.

NA = Not available

C = Based on cancer risk of one in one million.

N = Based on non-cancer hazard index of 1.

S = Soil saturation concentration (taken from or calculated in accordance with EPA (1996).

G = Guideline (NYSDEC, 1998).

POC = Principal Organic Contaminant (NYSDEC, 1998).

Std = Standard (NYSDEC, 1998).

TP = Total Phenolic Compounds (NYSDEC, 1998).

* 1,2-Dichloroethene (total): HLC is average of values for cis and trans isomers (EPA, 1996); toxicity is conservatively assumed to be equivalent to that of the more toxic cis-isomer; in the absence of other values, the NYS 703 standard is assumed to be equivalent to that for the trans-isomer.

** m-Xylene and p-Xylene: HLC is average of values for these isomers (EPA, 1996); toxicity criteria are assumed to be equivalent to that of m-xylene (values are lacking for p-xylene).

*** Total cresols: toxicity is conservatively assumed to be equivalent to that of the most toxic isomer (4-methylphenol).

**** 3-Methylphenol and 4-methylphenol: toxicity is conservatively assumed to be equivalent to that of the more toxic isomer (4-methylphenol).

* Chromium is conservatively assumed to be in the toxic and carcinogenic hexavalent form.

** "Cyanide" is assumed to free cyanide.

*** Lead lacks standard toxicity criteria and RBCs. The residential soil RBC of 400 mg/kg represents the residential soil screening level corresponding to a 10 µg/dL blood Pb level in children (EPA, 1994a&b). The EPA has also established a health advisory for lead in drinking water at 15 µg/L (EPA, 1991).

As with the non-cancer toxicity studies, the most sensitive laboratory species is often used in cancer testing protocols.

Since risks at the low levels of exposure usually encountered by humans are difficult to assess directly by either animal or epidemiological studies, mathematical models are used to extrapolate from high experimental to low environmental doses. The slope of the extrapolated dose-response curve is used to calculate the cancer slope factor (SF), which defines the incremental lifetime cancer risk per unit of carcinogen (in units of risk per mg/kg/day). The linearized multi-stage model for low-dose extrapolation most often used by EPA (EPA, 1986, 1996a) is one of the most conservative available, and leads to a upper-bound estimate of risk (the upper 95% confidence limit on the modeled animal dose-response slope). The probability that the true risk is higher than that estimated is thus only 5%. Actual risk is likely to be lower, and could even be zero (EPA, 1986). More recent guidance provides for use of alternative low-dose-response extrapolation procedures as indicated by the nature and quality of the data base (EPA, 1996a). Dose-response relationships can also be derived from high-quality human epidemiological data.

Each chemical is assigned a weight-of-evidence classification that expresses its potential for human carcinogenicity. The EPA's weight-of-evidence classification system is shown in Table 5-2. EPA recommends that the weight-of-evidence classification be presented for each potential carcinogen to indicate the strength of evidence that it is in fact a human carcinogen (EPA, 1986, 1989, 1996a).

TABLE 5-2

EPA'S WEIGHT-OF-EVIDENCE CLASSIFICATION SYSTEM FOR HUMAN CARCINOGENICITY

Weight-of-Evidence Group	Description
A	Human carcinogen
B1	Probable human carcinogen - limited human data are available
B2	Probable human carcinogen - sufficient evidence in animals and inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of non-carcinogenicity for humans

5.3 LEAD

The approach taken by EPA to evaluate potential health effects from lead exposure is different from that used for other chemicals. Lead presents an exception to the paradigm that non-carcinogenic effects of chemicals occur only at exposure levels exceeding some physiological threshold at which natural defense mechanisms are overwhelmed. Some of lead's characteristic effects, particularly changes in the levels of certain blood enzymes, appear to occur at blood lead levels so low as to be essentially without a threshold. As a result, the EPA has deemed it inappropriate to develop either an RfD or an SF for inorganic lead.

Potential risk associated with lead exposure is assessed by means of estimated blood lead levels instead of dose-based toxicity criteria. The EPA has established a target blood lead level for children (less than eight years of age) of no more than 10 µg/dL for both short and long term exposures. Using an integrated exposure uptake-biokinetic (IEUBK) model which is specifically designed to evaluate blood lead levels in children, EPA has determined that an average soil lead level of 400 mg/kg represents the residential soil screening level corresponding to the target blood lead level for children (EPA, 1994b). The EPA has also established a health advisory for lead in drinking water at 15 µg/L (EPA, 1991). As discussed in Section 4.1.3, these values were used in the COPC selection process. An exposure model suitable for application to adult receptors will be used in the risk assessment itself.

5.4 CHEMICALS LACKING TOXICITY CRITERIA

COPIs lacking toxicity criteria (and hence EPA Region III RBCs) were retained in the COPC selection process unless their maximum detected concentrations were lower than applicable background results. Potential risks associated with exposure to such COPCs will be discussed qualitatively in the risk assessment.

5.5 REFERENCES

New York State Department of Environmental Conservation (NYSDEC). 1998. *Ambient Water Quality Standards and Guidance Values.*

U.S. Environmental Protection Agency (EPA). 1986. *Guidelines for Carcinogen Risk Assessment. Federal Register* 51:33992-34003.

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

___. 1990. *Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule. Federal Register* **55(145):**30798 *et seq.* July 27, 1990.

___. EPA, 1991. Maximum contaminant level goals and national primary drinking water regulations for lead and copper. *Federal Register* **56:** 26461-26564.

___. 1994a. *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children.* EPA/540/R-93/081. Office of Emergency and Remedial Response, Washington, D.C.

___. 1994b. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.* OSWER Directive #9355.4-12. Office of Solid Waste and Emergency Response, Washington, D.C.

~~___. 1995. *Health Effects Assessment Summary Tables* (HEAST).~~

___. 1996a. *Proposed Guidelines for Carcinogen Risk Assessment. Federal Register* **61:**17960-18011. April 23, 1996.

___. 1996b. *Soil Screening Guidance: Technical Background Document.* Office of Solid Waste and Emergency Response. Washington, D.C. EPA/540/R-96/018.

___. 1997. *Health Effects Assessment Summary Tables* (HEAST).

___. ~~1997~~1998a. Integrated Risk Information System (IRIS).

___. ~~1997~~1998b. U.S. EPA Region III Risk-Based Concentration Table. ~~March 17~~October 1, ~~1997~~1998.

APPENDIX A

Table A-1
Summary of Duplicate Pairs with Relative Percent Deviations Greater than +/- 50% for Liquid and +/-100% for Solid Media
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample ID	Duplicate ID	Location Name	Location Description	Parameter Name	CAS Number	Units	Primary Value	Primary Detection Limit	Qualifier	Duplicate Value	Duplicate Detection Limit	Duplicate Qualifier	Primary Value Used	Duplicate Value Used	Duplicate Average
Ground Water															
G_000009	G_000039	MWN-09	COKE OVEN	Acrylonitrile	107-13-1	UG/L		2500	U/		1300	U/	1250	650	950
G_000009	G_000039	MWN-09	COKE OVEN	Benzene	71-43-2	UG/L	5800	250	D/	3100	130	D/	5800	3100	4450
G_000009	G_000039	MWN-09	COKE OVEN	Bromodichloromethane	75-27-4	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Bromoform	75-25-2	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Bromomethane	74-83-9	UG/L		500	U/		250	U/	250	125	187.5
G_000009	G_000039	MWN-09	COKE OVEN	Carbon tetrachloride	56-23-5	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Chlorobenzene	108-90-7	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Chloroethane	75-00-3	UG/L		500	U/		250	U/	250	125	187.5
G_000009	G_000039	MWN-09	COKE OVEN	2-Chloroethyl vinyl ether	110-75-8	UG/L		500	U/		250	U/UJ	250	125	187.5
G_000009	G_000039	MWN-09	COKE OVEN	Chloroform	67-66-3	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Chloromethane	74-87-3	UG/L		500	U/		250	U/	250	125	187.5
G_000009	G_000039	MWN-09	COKE OVEN	Dibromochloromethane	124-48-1	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Dichlorodifluoromethane	75-71-8	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	1,1-Dichloroethane	75-34-3	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	1,2-Dichloroethane	107-06-2	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	1,1-Dichloroethene	75-35-4	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	trans-1,2-Dichloroethene	156-60-5	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	1,2-Dichloropropane	78-87-5	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	cis-1,3-Dichloropropene	10061-01-5	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	trans-1,3-Dichloropropene	10061-02-6	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Ethylbenzene	100-41-4	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Methylene chloride	75-09-2	UG/L		500	U/		250	U/	250	125	187.5
G_000009	G_000039	MWN-09	COKE OVEN	1,1,1,2-Tetrachloroethane	630-20-6	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	1,1,2,2-Tetrachloroethane	79-34-5	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Tetrachloroethene	127-18-4	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Toluene	108-88-3	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	1,1,1-Trichloroethane	71-55-6	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	1,1,2-Trichloroethane	79-00-5	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Trichloroethene	79-01-6	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Trichlorofluoromethane	75-69-4	UG/L		250	U/		130	U/	125	65	95
G_000009	G_000039	MWN-09	COKE OVEN	Vinyl chloride	75-01-4	UG/L		500	U/		250	U/	250	125	187.5
G_000009	G_000039	MWN-09	COKE OVEN	Xylenes, Total	1330-20-7	UG/L		250	U/		130	U/	125	65	95
G_000175	G_000176	MWN-09	COKE OVEN	Naphthalene	91-20-3	UG/L	4.70	10	/J	13	10		4.7	13	8.85
G_000524	G_000548	MWN-31A	COKE OVEN	Butyl benzyl phthalate	85-68-7	UG/L	2		J/J,s		10	U/UJ,h	2	5	3.5
G_000524	G_000548	MWN-31A	COKE OVEN	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L	1		J/J,s	7		J/J,h	1	7	4
G_000524	G_000548	MWN-31A	COKE OVEN	Naphthalene	91-20-3	UG/L	3700		D/J,h	730		E/J,hs	3700	730	2215
G_000526	G_000515	MWN-33A	COKE OVEN	Antimony	7440-36-0	UG/L	2.2	2.2	B/		2.2	U/	2.2	1.1	1.65
G_000526	G_000515	MWN-33A	COKE OVEN	Mercury	7439-97-6	UG/L		0.2	U/UJ,f	0.39	0.2	/J,f	0.1	0.39	0.245
G_000527	G_000549	MWN-34A	COKE OVEN	Benzene	71-43-2	UG/L	27	5			5	U/	27	2.5	14.75
G_000527	G_000549	MWN-34A	COKE OVEN	Toluene	108-88-3	UG/L	5				5	U/	5	2.5	3.75
G_000527	G_000549	MWN-34A	COKE OVEN	Xylenes, Total	1330-20-7	UG/L	2		J/	5	5	J/	2	5	3.5
G_000469	G_000570	MWN-11	SMOKES CREEK	Benzene	71-43-2	UG/L	78	10	J/J,l		1	U/UJ,l	78	0.5	39.25
G_000469	G_000570	MWN-11	SMOKES CREEK	Chlorobenzene	108-90-7	UG/L		10	U/		1	U/	5	0.5	2.75
G_000469	G_000570	MWN-11	SMOKES CREEK	Ethylbenzene	100-41-4	UG/L		10	U/		1	U/	5	0.5	2.75
G_000469	G_000570	MWN-11	SMOKES CREEK	Toluene	108-88-3	UG/L	17	10	J/J,c		1	U/UJ,c	17	0.5	8.75
G_000469	G_000570	MWN-11	SMOKES CREEK	Xylenes, Total	1330-20-7	UG/L		10	U/		1	U/	5	0.5	2.75
G_000469	G_000570	MWN-11	SMOKES CREEK	1,2-Dichlorobenzene	95-50-1	UG/L		10	U/		1	U/	5	0.5	2.75

Table A-1
Summary of Duplicate Pairs with Relative Percent Deviations Greater than +/- 50% for Liquid and +/-100% for Solid Media
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample ID	Duplicate ID	Location Name	Location Description	Parameter Name	CAS Number	Units	Primary Value	Primary Detection Limit	Qualifier	Duplicate Value	Duplicate Detection Limit	Duplicate Qualifier	Primary Value Used	Duplicate Value Used	Duplicate Average
G_000469	G_000570	MWN-11	SMOKES CREEK	1,3-Dichlorobenzene	541-73-1	UG/L		10	U/		1	U/	5	0.5	2.75
G_000469	G_000570	MWN-11	SMOKES CREEK	1,4-Dichlorobenzene	106-46-7	UG/L		10	U/		1	U/	5	0.5	2.75
G_000265	G_000266	MWN-11	SMOKES CREEK	Di-n-octyl phthalate	117-84-0	UG/L		50	U/		250	U/	25	125	75
G_000265	G_000266	MWN-11	SMOKES CREEK	4,6-Dinitro-2-methylphenol	534-52-1	UG/L		250	U/		50	U/	125	25	75
G_000530	G_000550	MWS-19A	SMOKES CREEK	Phenol	108-95-2	UG/L	3		J/J,h	6		J/	3	6	4.5
G_000320	G_000321	MWN-17B	TANK FARM	Xylenes, Total	1330-20-7	UG/L	7.8	5			5	U/	7.8	2.5	5.15
G_000022	G_000041	MWS-07	ZONE1	Anthracene	120-12-7	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Benz(a)anthracene	56-55-3	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Benzo(a)pyrene	50-32-8	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Butyl benzyl phthalate	85-68-7	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	4-Chloro-3-methylphenol	59-50-7	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Bis(2-chloroethyl)ether	111-44-4	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	2-Chloronaphthalene	91-58-7	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Chrysene	218-01-9	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Di-n-butyl phthalate	84-74-2	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Di-n-octyl phthalate	117-84-0	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	1,2-Dichlorobenzene	95-50-1	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	1,3-Dichlorobenzene	541-73-1	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	1,4-Dichlorobenzene	106-46-7	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	2,4-Dichlorophenol	120-83-2	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Diethyl phthalate	84-66-2	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Dimethyl phthalate	131-11-3	UG/L		20	U/UJ		10	U/UJ	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	2,4-Dimethylphenol	105-67-9	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	4,6-Dinitro-2-methylphenol	534-52-1	UG/L		100	U/UJ		50	U/UJ	50	25	37.5
G_000022	G_000041	MWS-07	ZONE1	2,4-Dinitrotoluene	121-14-2	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	2,6-Dinitrotoluene	606-20-2	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Fluoranthene	206-44-0	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Fluorene	86-73-7	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Hexachlorobenzene	118-74-1	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Hexachlorocyclopentadiene	77-47-4	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Hexachloroethane	67-72-1	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Isophorone	78-59-1	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	2-Methylphenol	95-48-7	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	3-Methylphenol	108-39-4	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	4-Methylphenol	106-44-5	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Naphthalene	91-20-3	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Pentachlorophenol	87-86-5	UG/L		100	U/		50	U/	50	25	37.5
G_000022	G_000041	MWS-07	ZONE1	Phenanthrene	85-01-8	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Phenol	108-95-2	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Pyrene	129-00-0	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	Pyridine	110-86-1	UG/L		20	U/UJ		10	U/UJ	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	2,3,4,6-Tetrachlorophenol	58-90-2	UG/L		100	U/		50	U/	50	25	37.5
G_000022	G_000041	MWS-07	ZONE1	1,2,4-Trichlorobenzene	120-82-1	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	2,4,5-Trichlorophenol	95-95-4	UG/L		20	U/		10	U/	10	5	7.5
G_000022	G_000041	MWS-07	ZONE1	2,4,6-Trichlorophenol	88-06-2	UG/L		20	U/		10	U/	10	5	7.5
G_000287	G_000288	MWS-08	ZONE1	Carbon tetrachloride	56-23-5	UG/L		5	U/	4.3	5	J/	2.5	4.3	3.4
G_000287	G_000288	MWS-08	ZONE1	1,1-Dichloroethane	75-34-3	UG/L		5	U/	6.0	5		2.5	6	4.25

Table A-1
Summary of Duplicate Pairs with Relative Percent Deviations Greater than +/- 50% for Liquid and +/-100% for Solid Media
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample ID	Duplicate ID	Location Name	Location Description	Parameter Name	CAS Number	Units	Primary Value	Primary Detection Limit	Qualifier	Duplicate Value	Duplicate Detection Limit	Duplicate Qualifier	Primary Value Used	Duplicate Value Used	Duplicate Average
G_000287	G_000288	MWS-08	ZONE1	1,1,1-Trichloroethane	71-55-6	UG/L		5	U/	20	5		2.5	20	11.25
G_000287	G_000288	MWS-08	ZONE1	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L	1.0	10	J/		10	U/	1	5	3
G_000661	G_000662	MW-2D2	ZONE2	Pentachlorophenol	87-86-5	UG/L	0.9	50	J/		50	U/	0.9	25	12.95
G_000294	G_000295	MW-2D2B	ZONE2	Fluorene	86-73-7	UG/L	12	50	J/		40	U/	12	20	16
G_000596	G_000597	MW-2D4	ZONE2	Acenaphthene	83-32-9	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Anthracene	120-12-7	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Benz(a)anthracene	56-55-3	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Benzo(a)pyrene	50-32-8	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Benzo(b)fluoranthene	205-99-2	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Benzo(ghi)perylene	191-24-2	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Benzo(k)fluoranthene	207-08-9	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Butyl benzyl phthalate	85-68-7	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	4-Chloro-3-methylphenol	59-50-7	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Bis(2-chloroethyl)ether	111-44-4	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	2-Chloronaphthalene	91-58-7	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Chrysene	218-01-9	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Di-n-butyl phthalate	84-74-2	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Di-n-octyl phthalate	117-84-0	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Dibenz(a,h)anthracene	53-70-3	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	1,2-Dichlorobenzene	95-50-1	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	1,3-Dichlorobenzene	541-73-1	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	1,4-Dichlorobenzene	106-46-7	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	2,4-Dichlorophenol	120-83-2	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Diethyl phthalate	84-66-2	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Dimethyl phthalate	131-11-3	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	2,4-Dimethylphenol	105-67-9	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	2-Methyl-4,6-dinitrophenol	534-52-1	UG/L		250	U/		500	U/	125	250	187.5
G_000596	G_000597	MW-2D4	ZONE2	2,4-Dinitrotoluene	121-14-2	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	2,6-Dinitrotoluene	606-20-2	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Fluoranthene	206-44-0	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Fluorene	86-73-7	UG/L	14	50	J/		100	U/	14	50	32
G_000596	G_000597	MW-2D4	ZONE2	Hexachlorobenzene	118-74-1	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Hexachlorobutadiene	87-68-3	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Hexachlorocyclopentadiene	77-47-4	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Hexachloroethane	67-72-1	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Indeno(1,2,3-cd)pyrene	193-39-5	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Isophorone	78-59-1	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Pentachlorophenol	87-86-5	UG/L		250	U/		500	U/	125	250	187.5
G_000596	G_000597	MW-2D4	ZONE2	Phenol	108-95-2	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	Pyrene	129-00-0	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	1,2,4-Trichlorobenzene	120-82-1	UG/L		50	U/		100	U/	25	50	37.5
G_000596	G_000597	MW-2D4	ZONE2	2,4,6-Trichlorophenol	88-06-2	UG/L		50	U/		100	U/	25	50	37.5
G_000233	G_000231	MW-2U1	ZONE2	Anthracene	120-12-7	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Benz(a)anthracene	56-55-3	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Benzo(a)pyrene	50-32-8	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Butyl benzyl phthalate	85-68-7	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	4-Chloro-3-methylphenol	59-50-7	UG/L		10	U/UJ,s		50	U/	5	25	15

Table A-1
Summary of Duplicate Pairs with Relative Percent Deviations Greater than +/- 50% for Liquid and +/-100% for Solid Media
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample ID	Duplicate ID	Location Name	Location Description	Parameter Name	CAS Number	Units	Primary Value	Primary Detection Limit	Qualifier	Duplicate Value	Duplicate Detection Limit	Duplicate Qualifier	Primary Value Used	Duplicate Value Used	Duplicate Average
G_000233	G_000231	MW-2U1	ZONE2	Bis(2-chloroethyl)ether	111-44-4	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	2-Chloronaphthalene	91-58-7	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Chrysene	218-01-9	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Di-n-butyl phthalate	84-74-2	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Di-n-octyl phthalate	117-84-0	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	1,2-Dichlorobenzene	95-50-1	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	1,3-Dichlorobenzene	541-73-1	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	1,4-Dichlorobenzene	106-46-7	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	2,4-Dichlorophenol	120-83-2	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Diethyl phthalate	84-66-2	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Dimethyl phthalate	131-11-3	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	4,6-Dinitro-2-methylphenol	534-52-1	UG/L		50	U/UJ,s		250	U/	25	125	75
G_000233	G_000231	MW-2U1	ZONE2	2,4-Dinitrotoluene	121-14-2	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	2,6-Dinitrotoluene	606-20-2	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Fluoranthene	206-44-0	UG/L	5	10	J/J,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Hexachlorobenzene	118-74-1	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Hexachlorocyclopentadiene	77-47-4	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Hexachloroethane	67-72-1	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Isophorone	78-59-1	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Naphthalene	91-20-3	UG/L	190	10	/J,s	370	50		190	370	280
G_000233	G_000231	MW-2U1	ZONE2	Pentachlorophenol	87-86-5	UG/L		50	U/UJ,s		250	U/	25	125	75
G_000233	G_000231	MW-2U1	ZONE2	Phenol	108-95-2	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Pyrene	129-00-0	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	Pyridine	110-86-1	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	2,3,4,6-Tetrachlorophenol	58-90-2	UG/L		50	U/UJ,s		250	U/	25	125	75
G_000233	G_000231	MW-2U1	ZONE2	1,2,4-Trichlorobenzene	120-82-1	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000233	G_000231	MW-2U1	ZONE2	2,4,5-Trichlorophenol	95-95-4	UG/L		50	U/UJ,s		250	U/	25	125	75
G_000233	G_000231	MW-2U1	ZONE2	2,4,6-Trichlorophenol	88-06-2	UG/L		10	U/UJ,s		50	U/	5	25	15
G_000586	G_000587	MW-2U1	ZONE2	Anthracene	120-12-7	UG/L	2.9	40	J/	6.6	40	J/	2.9	6.6	4.75
G_000613	G_000614	MW-2U1	ZONE2	2-Methylphenol	95-48-7	UG/L	10	40	J/		40	U/	10	20	15
G_000613	G_000614	MW-2U1	ZONE2	Selenium	7782-49-2	UG/L	5.9	5.0			5.0	U/	5.9	2.5	4.2
G_000629	G_000630	MW-2U1	ZONE2	Cyanide	57-12-5	MG/L	0.021	0.010			0.010	U/	0.021	0.005	0.013
G_000016	G_000040	MWS-01	ZONE2	Ethylbenzene	100-41-4	UG/L	8.6	5			5	U/	8.6	2.5	5.55
G_000016	G_000040	MWS-01	ZONE2	Anthracene	120-12-7	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Benz(a)anthracene	56-55-3	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Benzo(a)pyrene	50-32-8	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Butyl benzyl phthalate	85-68-7	UG/L	14	20			100	U/	14	50	32
G_000016	G_000040	MWS-01	ZONE2	4-Chloro-3-methylphenol	59-50-7	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Bis(2-chloroethyl)ether	111-44-4	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	2-Chloronaphthalene	91-58-7	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Chrysene	218-01-9	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Di-n-butyl phthalate	84-74-2	UG/L		20	U/UJ		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Di-n-octyl phthalate	117-84-0	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	1,2-Dichlorobenzene	95-50-1	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	1,3-Dichlorobenzene	541-73-1	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	1,4-Dichlorobenzene	106-46-7	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	2,4-Dichlorophenol	120-83-2	UG/L		20	U/		100	U/	10	50	30

Table A-1
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Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample ID	Duplicate ID	Location Name	Location Description	Parameter Name	CAS Number	Units	Primary Value	Primary Detection Limit	Qualifier	Duplicate Value	Duplicate Detection Limit	Duplicate Qualifier	Primary Value Used	Duplicate Value Used	Duplicate Average
G_000016	G_000040	MWS-01	ZONE2	Diethyl phthalate	84-66-2	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Dimethyl phthalate	131-11-3	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	2,4-Dimethylphenol	105-67-9	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	4,6-Dinitro-2-methylphenol	534-52-1	UG/L		100	U/		500	U/	50	250	150
G_000016	G_000040	MWS-01	ZONE2	2,4-Dinitrotoluene	121-14-2	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	2,6-Dinitrotoluene	606-20-2	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Fluoranthene	206-44-0	UG/L	10	20			100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Fluorene	86-73-7	UG/L	20	20			100	U/	20	50	35
G_000016	G_000040	MWS-01	ZONE2	Hexachlorobenzene	118-74-1	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Hexachlorocyclopentadiene	77-47-4	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Hexachloroethane	67-72-1	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Isophorone	78-59-1	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	2-Methylphenol	95-48-7	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	3-Methylphenol	108-39-4	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	4-Methylphenol	106-44-5	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Pentachlorophenol	87-86-5	UG/L		100	U/		500	U/	50	250	150
G_000016	G_000040	MWS-01	ZONE2	Phenanthrene	85-01-8	UG/L	30	20			100	U/	30	50	40
G_000016	G_000040	MWS-01	ZONE2	Phenol	108-95-2	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Pyrene	129-00-0	UG/L	10	20			100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	Pyridine	110-86-1	UG/L		20	U/UJ		100	U/UJ	10	50	30
G_000016	G_000040	MWS-01	ZONE2	2,3,4,6-Tetrachlorophenol	58-90-2	UG/L		100	U/		500	U/	50	250	150
G_000016	G_000040	MWS-01	ZONE2	1,2,4-Trichlorobenzene	120-82-1	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	2,4,5-Trichlorophenol	95-95-4	UG/L		20	U/		100	U/	10	50	30
G_000016	G_000040	MWS-01	ZONE2	2,4,6-Trichlorophenol	88-06-2	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Anthracene	120-12-7	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Benz(a)anthracene	56-55-3	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Benzo(a)pyrene	50-32-8	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Butyl benzyl phthalate	85-68-7	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	4-Chloro-3-methylphenol	59-50-7	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Bis(2-chloroethyl)ether	111-44-4	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	2-Chloronaphthalene	91-58-7	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Chrysene	218-01-9	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Di-n-butyl phthalate	84-74-2	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Di-n-octyl phthalate	117-84-0	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	1,2-Dichlorobenzene	95-50-1	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	1,3-Dichlorobenzene	541-73-1	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	1,4-Dichlorobenzene	106-46-7	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	2,4-Dichlorophenol	120-83-2	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Diethyl phthalate	84-66-2	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Dimethyl phthalate	131-11-3	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	2,4-Dimethylphenol	105-67-9	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	4,6-Dinitro-2-methylphenol	534-52-1	UG/L		100	U/		500	U/	50	250	150
G_000298	G_000299	MWS-16B	ZONE2	2,4-Dinitrotoluene	121-14-2	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	2,6-Dinitrotoluene	606-20-2	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L	18	20	J/		100	U/	18	50	34
G_000298	G_000299	MWS-16B	ZONE2	Fluoranthene	206-44-0	UG/L		20	U/UJ,Q		100	U/UJ,Q	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Fluorene	86-73-7	UG/L		20	U/		100	U/	10	50	30

Table A-1
Summary of Duplicate Pairs with Relative Percent Deviations Greater than +/- 50% for Liquid and +/-100% for Solid Media
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample ID	Duplicate ID	Location Name	Location Description	Parameter Name	CAS Number	Units	Primary Value	Primary Detection Limit	Qualifier	Duplicate Value	Duplicate Detection Limit	Duplicate Qualifier	Primary Value Used	Duplicate Value Used	Duplicate Average
G_000298	G_000299	MWS-16B	ZONE2	Hexachlorobenzene	118-74-1	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Hexachlorocyclopentadiene	77-47-4	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Hexachloroethane	67-72-1	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Isophorone	78-59-1	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	3-Methylphenol & 4-Methylphenol	C_0000000201	UG/L		20.00	U/		100.00	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	2-Methylphenol	95-48-7	UG/L	15	20	J/		100	U/	15	50	32.5
G_000298	G_000299	MWS-16B	ZONE2	Naphthalene	91-20-3	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Pentachlorophenol	87-86-5	UG/L		100	U/		500	U/	50	250	150
G_000298	G_000299	MWS-16B	ZONE2	Phenanthrene	85-01-8	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Phenol	108-95-2	UG/L	49	20		140	100		49	140	94.5
G_000298	G_000299	MWS-16B	ZONE2	Pyrene	129-00-0	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	Pyridine	110-86-1	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	2,3,4,6-Tetrachlorophenol	58-90-2	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	1,2,4-Trichlorobenzene	120-82-1	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	2,4,5-Trichlorophenol	95-95-4	UG/L		20	U/		100	U/	10	50	30
G_000298	G_000299	MWS-16B	ZONE2	2,4,6-Trichlorophenol	88-06-2	UG/L		20	U/		100	U/	10	50	30
G_000533	G_000516	MWS-20B	ZONE2	Antimony	7440-36-0	UG/L		2.2	U/	3.1	2.2	B/	1.1	3.1	2.1
G_000533	G_000516	MWS-20B	ZONE2	Lead	7439-92-1	UG/L		1	U/UJ,v	1.1	1	BW/J,v	0.5	1.1	0.8
G_000533	G_000516	MWS-20B	ZONE2	Selenium	7782-49-2	UG/L		2	U/UJ,mv		10	U/UJ,mv	1	5	3
G_000533	G_000516	MWS-20B	ZONE2	Benzene	71-43-2	UG/L	19	1		36	5		19	36	27.5
G_000097	G_000099	MWN-01	ZONE3	Naphthalene	91-20-3	UG/L	190	30			30	U/	190	15	102.5
G_000489	G_000490	MWN-02B	ZONE3	Lead	7439-92-1	UG/L	7.5	3	J/J,c	4.2	3	J/J,c	7.5	4.2	5.85
G_000489	G_000490	MWN-02B	ZONE3	Thallium	7440-28-0	UG/L		10	W/UJ,		50	UW/UJ,m	5	25	15
G_000489	G_000490	MWN-02B	ZONE3	Cyanide	57-12-5	MG/L	0.062	0.01	J/J,m	0.68	0.01	J/J,m	0.062	0.68	0.371
G_000489	G_000490	MWN-02B	ZONE3	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L	1.2	10	J/		10	U/	1.2	5	3.1
G_000673	G_000674	MW-1D4	ZONE4	Methylene chloride	75-09-2	UG/L		5.0	U/	1.1	5.0	J/	2.5	1.1	1.8
G_000690	G_000691	MW-1D6	ZONE4	Di-n-butyl phthalate	84-74-2	UG/L	1.0	10	J/		10	U/	1	5	3
G_000690	G_000691	MW-1D6	ZONE4	Chromium	7440-47-3	UG/L	3.2	10.0	B/	18.1	10.0		3.2	18.1	10.65
G_000690	G_000691	MW-1D6	ZONE4	Lead	7439-92-1	UG/L		3.0	U/	4.0	3.0		1.5	4	2.75
G_000690	G_000691	MW-1D6	ZONE4	2-Methylphenol	95-48-7	UG/L	130	10			10	U/	130	5	67.5
G_000003	G_000038	MWN-03	ZONE4	Benzene	71-43-2	UG/L	4	1		21	5		4	21	12.5
G_000124	G_000127	MWN-03	ZONE4	Nickel	7440-02-0	UG/L		40.0	U/		5000	U/	20	2500	1260
G_000473	G_000553	MWN-12	ZONE4	Benzene	71-43-2	UG/L	4.2	5.0	J/	7.8	5.0		4.2	7.8	6
G_000457	G_000569	MWN-12	ZONE4	Selenium	7782-49-2	UG/L		5.0	U/	6.8	5.0	S/	2.5	6.8	4.65
G_000457	G_000569	MWN-12	ZONE4												
Sediment															
S_000280	S_000293	BC-12S	BLASDELL CREEK	Benz(a)anthracene	56-55-3	UG/KG	1700			560		J/	1700	560	1130
S_000280	S_000293	BC-12S	BLASDELL CREEK	Benzo(a)pyrene	50-32-8	UG/KG	4500			530		J/J,i	4500	530	2515
S_000280	S_000293	BC-12S	BLASDELL CREEK	Di-n-octyl phthalate	117-84-0	UG/KG		1100	U/	170		J/J,i	550	170	360
S_000280	S_000293	BC-12S	BLASDELL CREEK	Antimony	7440-36-0	MG/KG	1.9	2.2	B/J,m		1	U/UJ,m	1.9	0.5	1.2
S_000280	S_000293	BC-12S	BLASDELL CREEK	Arsenic	7440-38-2	MG/KG	164	4.6		7.2	4.6		164	7.2	85.6
S_000280	S_000293	BC-12S	BLASDELL CREEK	Barium	7440-39-3	MG/KG	137	3	B/	42.2	3	B/	137	42.2	89.6
S_000280	S_000293	BC-12S	BLASDELL CREEK	Chromium	7440-47-3	MG/KG	30.8	.5		8.2	.5		30.8	8.2	19.5
S_000280	S_000293	BC-12S	BLASDELL CREEK	Selenium	7782-49-2	MG/KG	3.1	3	BW/J,v		1.9	U/	3.1	0.95	2.025
S_000280	S_000293	BC-12S	BLASDELL CREEK	Benz(a)anthracene	56-55-3	UG/KG	1400	1500	J/	5300	1500	/J,h	1400	5300	3350
S_000054	S_000055	BC-3	BLASDELL CREEK	Benzo(b)fluoranthene	205-99-2	UG/KG	1900	1500		6500	1500	/J,h	1900	6500	4200
S_000054	S_000055	BC-3	BLASDELL CREEK	Chrysene	218-01-9	UG/KG	1400	1500	J/	6000	1500	/J,h	1400	6000	3700
S_000054	S_000055	BC-3	BLASDELL CREEK	Fluoranthene	206-44-0	UG/KG	3300	1500	/J,c	11000	1500	/J,h	3300	11000	7150
S_000054	S_000055	BC-3	BLASDELL CREEK	Indeno(1,2,3-cd)pyrene	193-39-5	UG/KG	960	1500	J/	3400	1500	/J,h	960	3400	2180

Table A-1

Summary of Duplicate Pairs with Relative Percent Deviations Greater than +/- 50% for Liquid and +/-100% for Solid Media

Human Health Risk Assessment for Bethlehem Steel Corporation

Lackawanna Site

Lackawanna, New York

Sample ID	Duplicate ID	Location Name	Location Description	Parameter Name	CAS Number	Units	Primary Value	Primary Detection Limit	Qualifier	Duplicate Value	Duplicate Detection Limit	Duplicate Qualifier	Primary Value Used	Duplicate Value Used	Duplicate Average
S_000054	S_000055	BC-3	BLASDELL CREEK	Pyrene	129-00-0	UG/KG	2800	1500		9700	1500	/J,c	2800	9700	6250
S_000354	S_000342	SC-2S/S	SMOKES CREEK	Carbon disulfide	75-15-0	UG/KG	20				12	U/	20	6	13
S_000354	S_000342	SC-2S/S	SMOKES CREEK	Methyl ethyl ketone	78-93-3	UG/KG	100		/J,c		25	U/	100	12.5	67.8333
S_000354	S_000342	SC-2S/S	SMOKES CREEK	Anthracene	120-12-7	UG/KG		890	U/	140		J/	445	140	292.5
S_000354	S_000342	SC-2S/S	SMOKES CREEK	Di-n-butyl phthalate	84-74-2	UG/KG		890	U/	140		JB/J	445	140	292.5
S_000354	S_000342	SC-2S/S	SMOKES CREEK	Di-n-octyl phthalate	117-84-0	UG/KG		890	U/	140		J/	445	140	292.5
S_000357	S_000358	SC-3/S	SMOKES CREEK	Fluorene	86-73-7	UG/KG		890	U/	98		J/	445	140	292.5
S_000191	S_000193	SC-4	SMOKES CREEK	Isophorone	78-59-1	UG/KG		670	U/	1100			445	98	271.5
S_000216	S_000220	SRS-1	SOUTH RETURN TRENCH	Toluene	108-88-3	UG/KG	68	9.3			9.7	U/	335	1100	717.5
SWMU Material				Bis(2-ethylhexyl)phthalate	117-81-7	UG/KG		3900	U/	570	1600	J/	68	4.85	36.425
S_000037	S_000038	P2 (0-2)	SWMU P-2	1,1,1-Trichloroethane	71-55-6	UG/KG		6.5	U/UJ,i	19	6.5	/J,i	1950	570	1260
S_000037	S_000038	P2 (0-2)	SWMU P-2	Chromium	7440-47-3	MG/KG	70.9	1.3	/J,f	216	1.3	/J,f	3.25	19	11.125
S_000113	S_000116	P75-2 (0-6)	SWMU P-75	Mercury	7439-97-6	MG/KG	5.1	0.12	/J,c	1.6	0.12	/J,c	70.9	216	143.45
S_000401	S_000402	S14-2C	SWMU S-14	Acenaphthene	83-32-9	UG/KG		1800	U/	180			5.1	1.6	3.35
S_000401	S_000402	S14-2C	SWMU S-14	Butyl benzyl phthalate	85-68-7	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	4-Chloro-3-methylphenol	59-50-7	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Bis(2-chloroethyl)ether	111-44-4	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	2-Chloronaphthalene	91-58-7	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Di-n-butyl phthalate	84-74-2	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Di-n-octyl phthalate	117-84-0	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	1,2-Dichlorobenzene	95-50-1	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	1,3-Dichlorobenzene	541-73-1	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	1,4-Dichlorobenzene	106-46-7	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	2,4-Dichlorophenol	120-83-2	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Diethyl phthalate	84-66-2	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Dimethyl phthalate	131-11-3	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	2,4-Dimethylphenol	105-67-9	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	4,6-Dinitro-2-methylphenol	534-52-1	UG/KG		1800	U/	86			900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	2,4-Dinitrotoluene	121-14-2	UG/KG		9200	U/		1800	U/	4600	900	2750
S_000401	S_000402	S14-2C	SWMU S-14	2,6-Dinitrotoluene	606-20-2	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Bis(2-ethylhexyl)phthalate	117-81-7	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Hexachlorobenzene	118-74-1	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Hexachlorobutadiene	87-68-3	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Hexachlorocyclopentadiene	77-47-4	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Hexachloroethane	67-72-1	UG/KG		1800	U/		360	U/UJ,c	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Isophorone	78-59-1	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	2-Methylphenol	95-48-7	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	3-Methylphenol	108-39-4	UG/KG		1800	U/	57		J/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	4-Methylphenol	106-44-5	UG/KG		1800	U/		360	U/	900	57	478.5
S_000401	S_000402	S14-2C	SWMU S-14	Pentachlorophenol	87-86-5	UG/KG		1800	U/	200		J/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	Phenol	108-95-2	UG/KG		9200	U/		1800	U/	4600	200	550
S_000401	S_000402	S14-2C	SWMU S-14	Pyridine	110-86-1	UG/KG		1800	U/		360	U/	900	900	2750
S_000401	S_000402	S14-2C	SWMU S-14	2,3,4,6-Tetrachlorophenol	58-90-2	UG/KG		1800	U/		360	U/	900	180	540
S_000401	S_000402	S14-2C	SWMU S-14	1,2,4-Trichlorobenzene	120-82-1	UG/KG		9200	U/		1800	U/	4600	180	540
S_000401	S_000402	S14-2C	SWMU S-14	2,4,5-Trichlorophenol	95-95-4	UG/KG		1800	U/		360	U/	900	900	2750
S_000403	S_000406	S14-2G	SWMU S-14	2,4,6-Trichlorophenol	88-06-2	UG/KG		1800	U/		360	U/	900	180	540
				Benzene	71-43-2	UG/KG	1300		/J,i	350		/J,s	1300	350	825

Table A-1
Summary of Duplicate Pairs with Relative Percent Deviations Greater than +/- 50% for Liquid and +/-100% for Solid Media
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample ID	Duplicate ID	Location Name	Location Description	Parameter Name	CAS Number	Units	Primary Value	Primary Detection Limit	Qualifier	Duplicate Value	Duplicate Detection Limit	Duplicate Qualifier	Primary Value Used	Duplicate Value Used	Duplicate Average
S_000403	S_000406	S14-2G	SWMU S-14	Carbon disulfide	75-15-0	UG/KG	6		/J,i	27		/J,s	6	27	16.5
S_000403	S_000406	S14-2G	SWMU S-14	Toluene	108-88-3	UG/KG	2700		E/J,i	620		/J,s	2700	620	1660
S_000403	S_000406	S14-2G	SWMU S-14	Trichloroethene	79-01-6	UG/KG	3		J/J,i		27	U/	3	13.5	8.25
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Anthracene	120-12-7	UG/KG	110	350	J/	1700	350		110	1700	905
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Benz(a)anthracene	56-55-3	UG/KG	340	350	J/	1800	350		340	1800	1070
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Benzo(a)pyrene	50-32-8	UG/KG	140	350	J/	1200	350		140	1200	670
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Benzo(b)fluoranthene	205-99-2	UG/KG	340	350	J/	2000	350		340	2000	1170
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Benzo(ghi)perylene	191-24-2	UG/KG	99	350	J/	570	350		99	570	334.5
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Benzo(k)fluoranthene	207-08-9	UG/KG	110	350	J/	890	350		110	890	500
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Chrysene	218-01-9	UG/KG	330	350	J/	1700	350		330	1700	1015
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Fluoranthene	206-44-0	UG/KG	710	350		3700	350		710	3700	2205
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Fluorene	86-73-7	UG/KG		350	U/	570	350	/J,c	175	570	372.5
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Indeno(1,2,3-cd)pyrene	193-39-5	UG/KG	85	350	J/	680	350		85	680	382.5
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Phenanthrene	85-01-8	UG/KG	370	350		3200	350		370	3200	1785
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Pyrene	129-00-0	UG/KG	510	350		2800	350		510	2800	1655
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Arsenic	7440-38-2	MG/KG	2.3	1.1	/J,m		1.1	U/UJ,m	2.3	0.55	1.425
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Nickel	7440-02-0	MG/KG	389	107			105	U/	389	52.5	220.75
S_000083	S_000086	S19-2 (0-6)	SWMU S-19	Cyanide	57-12-5	MG/KG	10.5	2.7			2.6	U/	10.5	1.3	5.9
G_000948	G_000949	HWM2-C2R1	SWMU S-3	Methyl ethyl ketone	78-93-3	UG/KG		5.0	U/		50	U/	2.5	25	13.75
G_000952	G_000953	HWM2-C3R4	SWMU S-3	Naphthalene	91-20-3	UG/KG	3200	26000	J/		26000	U/	3200	13000	8100
G_000952	G_000953	HWM2-C3R4	SWMU S-3	Selenium	7782-49-2	MG/KG		5.0	U/		1.0	U/	2.5	0.5	1.5
G_000952	G_000953	HWM2-C3R4	SWMU S-3	Thallium	7440-28-0	MG/KG	32	20			20	U/	32	10	21
Surface Water															
S_000236	S_000235	LE-5	LAKE ERIE	Toluene	108-88-3	UG/L		0.50	U/	0.44	0.50	J/	0.25	0.44	0.345
S_000236	S_000235	LE-5	LAKE ERIE	Bis(2-ethylhexyl)phthalate	117-81-7	UG/L		10	U/	37	10		5	37	21
S_000236	S_000235	LE-5	LAKE ERIE	Lead	7439-92-1	UG/L	3.0	3.0			3.0	U/	3	1.5	2.25
G_000815	G_000816	SS-7	SHIP CANAL	Mercury	7439-97-6	UG/L	1.1	0.2	/J		0.2	U/UJ	1.1	0.1	0.6
S_000351	S_000343	SC-2S	SMOKES CREEK	Butyl benzyl phthalate	85-68-7	UG/L		5	U/UJ,s	.2		J/	2.5	0.2	1.35
S_000351	S_000343	SC-2S	SMOKES CREEK	Di-n-butyl phthalate	84-74-2	UG/L		5	U/UJ,s	.4		J/	2.5	0.4	1.45
S_000351	S_000343	SC-2S	SMOKES CREEK	Di-n-octyl phthalate	117-84-0	UG/L		5	U/UJ,s	.2		J/	2.5	0.2	1.35
S_000351	S_000343	SC-2S	SMOKES CREEK	Diethyl phthalate	84-66-2	UG/L		5	U/UJ,i	.2		J/	2.5	0.2	1.35
S_000351	S_000343	SC-2S	SMOKES CREEK	Hexachlorobenzene	118-74-1	UG/L		5	U/UJ,s		1	U/	2.5	0.5	1.5
S_000351	S_000343	SC-2S	SMOKES CREEK	Chromium	7440-47-3	UG/L		5.7	U/UJ,d	19.4	.5	*/J,d	2.85	19.4	11.125
S_000351	S_000343	SC-2S	SMOKES CREEK	Lead	7439-92-1	UG/L		1	UN/	4.3	2.7	N/J,m	0.5	4.3	2.4
S_000351	S_000343	SC-2S	SMOKES CREEK	Selenium	7782-49-2	UG/L	3.8	3	BW/J,v		3	UW/	3.8	1.5	2.65

Table A-2
Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in Surface Water
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample Location	Location Name	Parameter Name	Primary Value (µg/L)	Duplicate Value (µg/L)	Duplicate Average (µg/L)	RPD	Maximum Background Concentration (µg/L)	Minimum Residential Tap Water Criterion (µg/L) *	Is Average Result Greater than Background?	Is Primary Result Greater than Background?	Is Duplicate Result Greater than Background?	Does Duplicate Averaging Result in non-Selection?	Is Average Result Greater than Tap Water Criterion?	Is Primary Result Greater than Tap Water Criterion?	Is Duplicate Result Greater than Tap Water Criterion?	Does Duplicate Averaging Result in non-Selection?
LAKE ERIE	LE-5	Bis(2-ethylhexyl)phthalate	5 a	37 b	21	-152%	NA	4.78E+00	NA	NA	NA	No	Yes	Yes	Yes	No
LAKE ERIE	LE-5	Lead	3 b	1.5 a	2.25	67%	NA	1.50E+01	NA	NA	NA	No	No	No	No	No
LAKE ERIE	LE-5	Toluene	0.25 a	0.44 b	0.345	-55%	NA	5.00E+00	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S	Butyl benzyl phthalate	2.5 a	0.2 b	1.35	170%	NA	5.00E+01	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S	Chromium	2.85 a	19.4 b	11.125	-149%	NA	5.00E+01	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S	Diethyl phthalate	2.5 a	0.2 b	1.35	170%	5.7	5.00E+01	No	No	No	No	No	No	No	No
SMOKES CREEK	SC-2S	Di-n-butyl phthalate	2.5 a	0.4 b	1.45	145%	NA	5.00E+01	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S	Di-n-octyl phthalate	2.5 a	0.2 b	1.35	170%	NA	5.00E+01	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S	Hexachlorobenzene	2.5 a	0.5 a	1.5	133%	NA	6.59E-03	NA	NA	NA	No	Yes	Yes	Yes	No
SMOKES CREEK	SC-2S	Lead	0.5 a	4.3 b	2.4	-158%	NA	1.50E+01	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S	Selenium	3.8 b	1.5 a	2.65	87%	NA	1.00E+01	NA	NA	NA	No	No	No	No	No
SHIP CANAL	SS-7	Mercury	1.1 b	0.1 a	0.6	167%	NA	7.00E-01	NA	NA	NA	No	No	No	No	No

Notes:

* Minimum residential tap water criterion is the lower of the NYS 703 standard or guideline for Class GA groundwater (NYSDEC, 1998) and the U.S. EPA Region III tap water risk-based concentration (EPA, 1998).

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.

Mercury is assumed to be inorganic.

NA = not available or not applicable.

a = 1/2 detection limit

b = measured value

Table A-3
Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in Sediment
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample Location	Location Name	Parameter Name	Primary Value (mg/kg)	Duplicate Value (mg/kg)	Duplicate Average (mg/kg)	RPD	Maximum Background Concentration (mg/kg)	Region 3 RBC for Residential Soil (mg/kg) *	Is Average Result Greater than Background?	Is Primary Result Greater than Background?	Is Duplicate Result Greater than Background?	Does Duplicate Averaging Result in non-Selection?	Is Average Result Greater than RBC?	Is Primary Result Greater than RBC?	Is Duplicate Result Greater than RBC?	Does Duplicate Averaging Result in non-Selection?
BLASDELL CREEK	BC-3	Benz(a)anthracene	1.40 b	5.30 b	3.35	-116%	0.28	8.75E-04	Yes	Yes	Yes	No	Yes	Yes	Yes	No
BLASDELL CREEK	BC-3	Benzo(b)fluoranthene	1.90 b	6.50 b	4.20	-110%	0.45	8.75E-04	Yes	Yes	Yes	No	Yes	Yes	Yes	No
BLASDELL CREEK	BC-3	Chrysene	1.40 b	6.00 b	3.70	-124%	0.39	8.75E-02	Yes	Yes	Yes	No	No	No	No	No
BLASDELL CREEK	BC-3	Fluoranthene	3.30 b	11.00 b	7.15	-108%	0.63	3.13E+00	Yes	Yes	Yes	No	No	No	No	No
BLASDELL CREEK	BC-3	Indeno(1,2,3-cd)pyrene	0.96 b	3.40 b	2.18	-112%	0.27	8.75E-04	Yes	Yes	Yes	No	Yes	Yes	Yes	No
BLASDELL CREEK	BC-3	Pyrene	2.80 b	9.70 b	6.25	-110%	0.76	2.35E+00	Yes	Yes	Yes	No	No	No	No	No
BLASDELL CREEK	BC-12S	Antimony	1.90 b	0.50 a	1.20	117%	NA	3.13E+01	NA	NA	NA	No	No	No	No	No
BLASDELL CREEK	BC-12S	Arsenic	164.00 b	7.20 b	85.60	183%	8.2	4.26E-01	Yes	Yes	No	No	Yes	Yes	Yes	No
BLASDELL CREEK	BC-12S	Barium	137.00 b	42.20 b	89.60	106%	96.1	5.48E+03	No	Yes	No	Yes	No	No	No	No
BLASDELL CREEK	BC-12S	Benz(a)anthracene	1.70 b	0.56 b	1.13	101%	0.28	8.75E-04	Yes	Yes	Yes	No	Yes	Yes	No	No
BLASDELL CREEK	BC-12S	Benzo(a)pyrene	4.50 b	0.53 b	2.52	158%	0.25	8.75E-05	Yes	Yes	Yes	No	Yes	Yes	Yes	No
BLASDELL CREEK	BC-12S	Chromium	30.80 b	8.20 b	19.50	116%	21.3	2.35E+02	No	Yes	No	Yes	No	No	No	No
BLASDELL CREEK	BC-12S	Di-n-octyl phthalate	0.55 a	0.17 b	0.36	106%	NA	1.56E+00	NA	NA	NA	No	No	No	No	No
BLASDELL CREEK	BC-12S	Selenium	3.10 b	0.95 a	2.03	106%	NA	3.91E+02	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S/S	Anthracene	0.45 a	0.14 b	0.29	104%	0.11	2.35E+01	Yes	Yes	Yes	No	No	No	No	No
SMOKES CREEK	SC-2S/S	Carbon disulfide	0.02 b	0.01 a	0.01	108%	NA	7.82E+00	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S/S	Di-n-butyl phthalate	0.45 a	0.14 b	0.29	104%	NA	7.82E+00	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S/S	Di-n-octyl phthalate	0.45 a	0.14 b	0.29	104%	NA	1.56E+00	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-2S/S	Fluorene	0.45 a	0.10 b	0.27	128%	0.1	3.13E+00	Yes	Yes	No	No	No	No	No	No
SMOKES CREEK	SC-2S/S	Methyl ethyl ketone	0.10 b	0.01 a	0.07	156%	NA	4.69E+01	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-3/S	Isophorone	0.34 a	1.10 b	0.72	-107%	NA	6.72E-01	NA	NA	NA	No	No	No	No	No
SMOKES CREEK	SC-4	Toluene	0.07 b	0.00 a	0.04	173%	NA	1.56E+01	NA	NA	NA	No	No	No	No	No
SOUTH RETURN TRENCH	SRS-1	Bis(2-ethylhexyl)phthalate	1.95 a	0.57 b	1.26	110%	2.7	4.56E-02	No	No	No	No	No	No	No	No

Notes:

* EPA, 1998.

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

NA = not available or not applicable.

a = 1/2 detection limit

b = measured value

Table A-4
Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in Ground Water
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Location Name	Parameter Name	Primary Value (ug/L)	Duplicate Value (ug/L)	Duplicate Average (ug/L)	RPD	Minimum Residential Tap Water Criterion (µg/L) *	Is Average Result Greater than Tap Water Criterion?	Is Primary Result Greater than Tap Water Criterion?	Is Duplicate Result Greater than Tap Water Criterion?	Does Duplicate Averaging Result in non-Selection?
MW-1D4	Bis(2-ethylhexyl)phthalate	1.2 b	5 a	3.1	-123%	4.78E+00	No	No	Yes	Yes
MW-1D6	Chromium	3.2 b	18.1 b	10.65	-140%	5.00E+01	No	No	No	No
MW-1D6	Di-n-butyl phthalate	1 b	5 a	3	-133%	5.00E+01	No	No	No	No
MW-1D6	Lead	1.5 a	4 b	2.75	-91%	1.50E+01	No	No	No	No
MW-1D6	Methylene chloride	2.5 a	1.1 b	1.8	78%	4.10E+00	No	No	No	No
MW-2D2	Pentachlorophenol	0.9 b	25 a	12.95	-186%	5.58E-01	Yes	Yes	Yes	No
MW-2D2B	Fluorene	12 b	20 a	16	-50%	5.00E+01	No	No	No	No
MW-2D4	1,2,4-Trichlorobenzene	25 a	50 a	37.5	-67%	1.94E+02	Yes	Yes	Yes	No
MW-2D4	1,2-Dichlorobenzene	25 a	50 a	37.5	-67%	3.00E+00	Yes	Yes	Yes	No
MW-2D4	1,3-Dichlorobenzene	25 a	50 a	37.5	-67%	3.00E+00	Yes	Yes	Yes	No
MW-2D4	1,4-Dichlorobenzene	25 a	50 a	37.5	-67%	4.73E-01	Yes	Yes	Yes	No
MW-2D4	2,4,6-Trichlorophenol	25 a	50 a	37.5	-67%	1.00E+00	Yes	Yes	Yes	No
MW-2D4	2,4-Dichlorophenol	25 a	50 a	37.5	-67%	5.00E+00	Yes	Yes	Yes	No
MW-2D4	2,4-Dimethylphenol	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No
MW-2D4	2,4-Dinitrotoluene	25 a	50 a	37.5	-67%	5.00E+00	Yes	Yes	Yes	No
MW-2D4	2,6-Dinitrotoluene	25 a	50 a	37.5	-67%	5.00E+00	Yes	Yes	Yes	No
MW-2D4	2-Chloronaphthalene	25 a	50 a	37.5	-67%	1.00E+01	Yes	Yes	Yes	No
MW-2D4	2-Methyl-4,6-dinitrophenol	125 a	250 a	187.5	-67%	1.00E+00	Yes	Yes	Yes	No
MW-2D4	4-Chloro-3-methylphenol	25 a	50 a	37.5	-67%	1.00E+00	Yes	Yes	Yes	No
MW-2D4	Acenaphthene	25 a	50 a	37.5	-67%	2.00E+01	Yes	Yes	Yes	No
MW-2D4	Anthracene	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No
MW-2D4	Benz(a)anthracene	25 a	50 a	37.5	-67%	2.00E-03	Yes	Yes	Yes	No
MW-2D4	Benzo(a)pyrene	25 a	50 a	37.5	-67%	9.17E-03	Yes	Yes	Yes	No
MW-2D4	Benzo(b)fluoranthene	25 a	50 a	37.5	-67%	2.00E-03	Yes	Yes	Yes	No
MW-2D4	Benzo(ghi)perylene	25 a	50 a	37.5	-67%	NA	NA	NA	NA	No
MW-2D4	Benzo(k)fluoranthene	25 a	50 a	37.5	-67%	2.00E-03	Yes	Yes	Yes	No
MW-2D4	Bis(2-chloroethyl)ether	25 a	50 a	37.5	-67%	6.09E-02	Yes	Yes	Yes	No
MW-2D4	Bis(2-ethylhexyl)phthalate	25 a	50 a	37.5	-67%	4.78E+00	Yes	Yes	Yes	No
MW-2D4	Butyl benzyl phthalate	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No
MW-2D4	Chrysene	25 a	50 a	37.5	-67%	2.00E-03	Yes	Yes	Yes	No
MW-2D4	Dibenz(a,h)anthracene	25 a	50 a	37.5	-67%	9.17E-03	Yes	Yes	Yes	No
MW-2D4	Diethyl phthalate	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No
MW-2D4	Dimethyl phthalate	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No
MW-2D4	Di-n-butyl phthalate	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No
MW-2D4	Di-n-octyl phthalate	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No
MW-2D4	Fluoranthene	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No
MW-2D4	Fluorene	14 b	50 a	32	-113%	5.00E+01	No	No	No	No
MW-2D4	Hexachlorobenzene	25 a	50 a	37.5	-67%	6.59E-03	Yes	Yes	Yes	No
MW-2D4	Hexachlorobutadiene	25 a	50 a	37.5	-67%	1.35E-01	Yes	Yes	Yes	No
MW-2D4	Hexachlorocyclopentadiene	25 a	50 a	37.5	-67%	1.46E-01	Yes	Yes	Yes	No
MW-2D4	Hexachloroethane	25 a	50 a	37.5	-67%	7.54E-01	Yes	Yes	Yes	No
MW-2D4	Indeno(1,2,3-cd)pyrene	25 a	50 a	37.5	-67%	2.00E-03	Yes	Yes	Yes	No
MW-2D4	Isophorone	25 a	50 a	37.5	-67%	5.00E+01	No	No	No	No

Table A-4
Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in Ground Water
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Location Name	Parameter Name	Primary Value (ug/L)		Duplicate Value (ug/L)		Duplicate Average (ug/L)	RPD	Minimum Residential Tap Water Criterion (µg/L) *	Is Average Result Greater than Tap Water Criterion?	Is Primary Result Greater than Tap Water Criterion?	Is Duplicate Result Greater than Tap Water Criterion?	Does Duplicate Averaging Result in non-Selection?
MW-2D4	Pentachlorophenol	125	a	250	a	187.5	-67%	5.58E-01	Yes	Yes	Yes	No
MW-2D4	Phenol	25	a	50	a	37.5	-67%	1.00E+00	Yes	Yes	Yes	No
MW-2D4	Pyrene	25	a	50	a	37.5	-67%	5.00E+01	No	No	No	No
MW-2U1	1,2,4-Trichlorobenzene	5	a	25	a	15	-133%	1.94E+02	Yes	No	Yes	No
MW-2U1	1,2-Dichlorobenzene	5	a	25	a	15	-133%	3.00E+00	Yes	Yes	Yes	No
MW-2U1	1,3-Dichlorobenzene	5	a	25	a	15	-133%	3.00E+00	Yes	No	Yes	No
MW-2U1	1,4-Dichlorobenzene	5	a	25	a	15	-133%	4.73E-01	Yes	Yes	Yes	No
MW-2U1	2,3,4,6-Tetrachlorophenol	25	a	125	a	75	-133%	1.00E+00	Yes	Yes	Yes	No
MW-2U1	2,4,5-Trichlorophenol	25	a	125	a	75	-133%	1.00E+00	Yes	Yes	Yes	No
MW-2U1	2,4,6-Trichlorophenol	5	a	25	a	15	-133%	1.00E+00	Yes	Yes	Yes	No
MW-2U1	2,4-Dichlorophenol	5	a	25	a	15	-133%	5.00E+00	Yes	Yes	Yes	No
MW-2U1	2,4-Dinitrotoluene	5	a	25	a	15	-133%	5.00E+00	Yes	No	Yes	No
MW-2U1	2,6-Dinitrotoluene	5	a	25	a	15	-133%	5.00E+00	Yes	No	Yes	No
MW-2U1	2-Chloronaphthalene	5	a	25	a	15	-133%	1.00E+01	Yes	No	Yes	No
MW-2U1	2-Methylphenol	10	b	20	a	15	-67%	1.83E+03	Yes	No	Yes	No
MW-2U1	4,6-Dinitro-2-methylphenol	25	a	125	a	75	-133%	3.65E+00	Yes	Yes	Yes	No
MW-2U1	4-Chloro-3-methylphenol	5	a	25	a	15	-133%	1.00E+00	Yes	No	Yes	No
MW-2U1	Anthracene	5	a	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Anthracene	2.9	b	6.6	b	4.75	-78%	5.00E+01	No	No	No	No
MW-2U1	Benz(a)anthracene	5	a	25	a	15	-133%	2.00E-03	Yes	Yes	Yes	No
MW-2U1	Benzo(a)pyrene	5	a	25	a	15	-133%	9.17E-03	Yes	Yes	Yes	No
MW-2U1	Bis(2-chloroethyl)ether	5	a	25	a	15	-133%	6.09E-02	Yes	Yes	Yes	No
MW-2U1	Bis(2-ethylhexyl)phthalate	5	a	25	a	15	-133%	4.78E+00	Yes	Yes	Yes	No
MW-2U1	Butyl benzyl phthalate	5	a	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Chrysene	5	a	25	a	15	-133%	2.00E-03	Yes	Yes	Yes	No
MW-2U1	Cyanide	21	b	5	a	13	123%	2.00E+05	No	No	No	No
MW-2U1	Diethyl phthalate	5	a	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Dimethyl phthalate	5	a	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Di-n-butyl phthalate	5	a	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Di-n-octyl phthalate	5	a	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Fluoranthene	5	b	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Hexachlorobenzene	5	a	25	a	15	-133%	6.59E-03	Yes	Yes	Yes	No
MW-2U1	Hexachlorocyclopentadiene	5	a	25	a	15	-133%	1.46E-01	Yes	Yes	Yes	No
MW-2U1	Hexachloroethane	5	a	25	a	15	-133%	7.54E-01	Yes	Yes	Yes	No
MW-2U1	Isophorone	5	a	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Naphthalene	190	b	370	b	280	-64%	1.00E+01	Yes	Yes	Yes	No
MW-2U1	Pentachlorophenol	25	a	125	a	75	-133%	5.58E-01	Yes	Yes	Yes	No
MW-2U1	Phenol	5	a	25	a	15	-133%	1.00E+00	Yes	Yes	Yes	No
MW-2U1	Pyrene	5	a	25	a	15	-133%	5.00E+01	No	No	No	No
MW-2U1	Pyridine	5	a	25	a	15	-133%	3.65E+01	No	No	No	No
MW-2U1	Selenium	5.9	b	2.5	a	4.2	81%	1.00E+01	No	No	No	No
MWN-01	Benzene	19	b	36	b	27.5	-62%	3.64E-01	Yes	Yes	Yes	No
MWN-02B	Cyanide	62	b	680	b	371	-167%	2.00E+05	Yes	No	Yes	No

Table A-4
Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in Ground Water
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Location Name	Parameter Name	Primary Value (ug/L)	Duplicate Value (ug/L)	Duplicate Average (ug/L)	RPD	Minimum Residential Tap Water Criterion (µg/L) *	Is Average Result Greater than Tap Water Criterion?	Is Primary Result Greater than Tap Water Criterion?	Is Duplicate Result Greater than Tap Water Criterion?	Does Duplicate Averaging Result in non-Selection?
MWN-02B	Lead	7.5 b	4.2 b	5.85	56%	1.50E+01	No	No	No	No
MWN-02B	Naphthalene	190 b	15 a	102.5	171%	1.00E+01	Yes	Yes	Yes	No
MWN-02B	Thallium	5 a	25 a	15	-133%	5.00E-01	Yes	Yes	Yes	No
MWN-03	2-Methylphenol	130 b	5 a	67.5	185%	1.83E+03	Yes	Yes	No	No
MWN-03	Benzene	4 b	21 b	12.5	-136%	3.64E-01	Yes	Yes	Yes	No
MWN-09	1,1,1,2-Tetrachloroethane	125 a	65 a	95	63%	4.06E-01	Yes	Yes	Yes	No
MWN-09	1,1,1-Trichloroethane	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	1,1,2,2-Tetrachloroethane	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	1,1,2-Trichloroethane	125 a	65 a	95	63%	1.88E-01	Yes	Yes	Yes	No
MWN-09	1,1-Dichloroethane	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	1,1-Dichloroethene	125 a	65 a	95	63%	4.36E-02	Yes	Yes	Yes	No
MWN-09	1,2-Dichloroethane	125 a	65 a	95	63%	1.16E-01	Yes	Yes	Yes	No
MWN-09	1,2-Dichloropropane	125 a	65 a	95	63%	1.55E-01	Yes	Yes	Yes	No
MWN-09	2-Chloroethyl vinyl ether	250 a	125 a	187.5	67%	NA	NA	NA	NA	No
MWN-09	Acrylonitrile	1250 a	650 a	950	63%	1.24E-01	Yes	Yes	Yes	No
MWN-09	Benzene	5800 b	3100 b	4450	61%	3.64E-01	Yes	Yes	Yes	No
MWN-09	Bromodichloromethane	125 a	65 a	95	63%	1.70E-01	Yes	Yes	Yes	No
MWN-09	Bromoform	125 a	65 a	95	63%	2.33E+00	Yes	Yes	Yes	No
MWN-09	Bromomethane	250 a	125 a	187.5	67%	5.00E+00	Yes	Yes	Yes	No
MWN-09	Carbon tetrachloride	125 a	65 a	95	63%	1.62E-01	Yes	Yes	Yes	No
MWN-09	Chlorobenzene	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	Chloroethane	250 a	125 a	187.5	67%	3.64E+00	Yes	Yes	Yes	No
MWN-09	Chloroform	125 a	65 a	95	63%	1.52E-01	Yes	Yes	Yes	No
MWN-09	Chloromethane	250 a	125 a	187.5	67%	1.49E+00	Yes	Yes	Yes	No
MWN-09	cis-1,3-Dichloropropene	125 a	65 a	95	63%	4.00E-01	Yes	Yes	Yes	No
MWN-09	Dibromochloromethane	125 a	65 a	95	63%	1.26E-01	Yes	Yes	Yes	No
MWN-09	Dichlorodifluoromethane	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	Ethylbenzene	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	Methylene chloride	250 a	125 a	187.5	67%	4.10E+00	Yes	Yes	Yes	No
MWN-09	Naphthalene	4.7 b	13 b	8.85	-94%	1.00E+01	No	No	Yes	Yes
MWN-09	Tetrachloroethene	125 a	65 a	95	63%	1.07E+00	Yes	Yes	Yes	No
MWN-09	Toluene	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	trans-1,2-Dichloroethene	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	trans-1,3-Dichloropropene	125 a	65 a	95	63%	4.00E-01	Yes	Yes	Yes	No
MWN-09	Trichloroethene	125 a	65 a	95	63%	1.55E+00	Yes	Yes	Yes	No
MWN-09	Trichlorofluoromethane	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-09	Vinyl chloride	250 a	125 a	187.5	67%	1.91E-02	Yes	Yes	Yes	No
MWN-09	Xylenes, Total	125 a	65 a	95	63%	5.00E+00	Yes	Yes	Yes	No
MWN-11	1,2-Dichlorobenzene	5 a	0.5 a	2.75	164%	3.00E+00	No	Yes	No	Yes
MWN-11	1,3-Dichlorobenzene	5 a	0.5 a	2.75	164%	3.00E+00	No	No	No	No
MWN-11	1,4-Dichlorobenzene	5 a	0.5 a	2.75	164%	4.73E-01	Yes	Yes	Yes	No
MWN-11	4,6-Dinitro-2-methylphenol	125 a	25 a	75	133%	3.65E+00	Yes	Yes	Yes	No
MWN-11	Benzene	78 b	0.5 a	39.25	197%	3.64E-01	Yes	Yes	Yes	No

Table A-4
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Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Location Name	Parameter Name	Primary Value (ug/L)	Duplicate Value (ug/L)	Duplicate Average (ug/L)	RPD	Minimum Residential Tap Water Criterion (µg/L) *	Is Average Result Greater than Tap Water Criterion?	Is Primary Result Greater than Tap Water Criterion?	Is Duplicate Result Greater than Tap Water Criterion?	Does Duplicate Averaging Result in non-Selection?
MWN-11	Chlorobenzene	5 a	0.5 a	2.75	164%	5.00E+00	No	No	No	No
MWN-11	Di-n-octyl phthalate	25 a	125 a	75	-133%	5.00E+01	Yes	No	Yes	No
MWN-11	Ethylbenzene	5 a	0.5 a	2.75	164%	5.00E+00	No	No	No	No
MWN-11	Toluene	17 b	0.5 a	8.75	189%	5.00E+00	Yes	Yes	No	No
MWN-11	Xylenes, Total	5 a	0.5 a	2.75	164%	5.00E+00	No	No	No	No
MWN-12	Benzene	4.2 b	7.8 b	6	-60%	3.64E-01	Yes	Yes	Yes	No
MWN-12	Nickel	20 a	2500 a	1260	-197%	1.00E+02	Yes	No	Yes	No
MWN-12	Selenium	2.5 a	6.8 b	4.65	-92%	1.00E+01	No	No	No	No
MWN-17B	Xylenes, Total	7.8 b	2.5 a	5.15	103%	5.00E+00	Yes	Yes	No	No
MWN-31A	Bis(2-ethylhexyl)phthalate	1 b	7 b	4	-150%	4.78E+00	No	No	Yes	Yes
MWN-31A	Butyl benzyl phthalate	2 b	5 a	3.5	-86%	5.00E+01	No	No	No	No
MWN-31A	Naphthalene	3700 b	730 b	2215	134%	1.00E+01	Yes	Yes	Yes	No
MWN-33A	Antimony	2.2 b	1.1 a	1.65	67%	3.00E+00	No	No	No	No
MWN-33A	Mercury	0.1 a	0.39 b	0.245	-118%	7.00E-01	No	No	No	No
MWN-34A	Benzene	27 b	2.5 a	14.75	166%	3.64E-01	Yes	Yes	Yes	No
MWN-34A	Toluene	5 b	2.5 a	3.75	67%	5.00E+00	No	No	No	No
MWN-34A	Xylenes, Total	2 b	5 b	3.5	-86%	5.00E+00	No	No	No	No
MWS-01	1,2,4-Trichlorobenzene	10 a	50 a	30	-133%	1.94E+02	Yes	Yes	Yes	No
MWS-01	1,2-Dichlorobenzene	10 a	50 a	30	-133%	3.00E+00	Yes	Yes	Yes	No
MWS-01	1,3-Dichlorobenzene	10 a	50 a	30	-133%	3.00E+00	Yes	Yes	Yes	No
MWS-01	1,4-Dichlorobenzene	10 a	50 a	30	-133%	4.73E-01	Yes	Yes	Yes	No
MWS-01	2,3,4,6-Tetrachlorophenol	50 a	250 a	150	-133%	1.00E+00	Yes	Yes	Yes	No
MWS-01	2,4,5-Trichlorophenol	10 a	50 a	30	-133%	1.00E+00	Yes	Yes	Yes	No
MWS-01	2,4,6-Trichlorophenol	10 a	50 a	30	-133%	1.00E+00	Yes	Yes	Yes	No
MWS-01	2,4-Dichlorophenol	10 a	50 a	30	-133%	5.00E+00	Yes	Yes	Yes	No
MWS-01	2,4-Dimethylphenol	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-01	2,4-Dinitrotoluene	10 a	50 a	30	-133%	5.00E+00	Yes	Yes	Yes	No
MWS-01	2,6-Dinitrotoluene	10 a	50 a	30	-133%	5.00E+00	Yes	Yes	Yes	No
MWS-01	2-Chloronaphthalene	10 a	50 a	30	-133%	1.00E+01	Yes	No	Yes	No
MWS-01	2-Methylphenol	10 a	50 a	30	-133%	1.83E+03	Yes	No	Yes	No
MWS-01	3-Methylphenol	10 a	50 a	30	-133%	1.83E+03	No	No	No	No
MWS-01	4,6-Dinitro-2-methylphenol	50 a	250 a	150	-133%	3.65E+00	Yes	Yes	Yes	No
MWS-01	4-Chloro-3-methylphenol	10 a	50 a	30	-133%	1.00E+00	Yes	No	Yes	No
MWS-01	4-Methylphenol	10 a	50 a	30	-133%	1.83E+02	Yes	No	Yes	No
MWS-01	Anthracene	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-01	Benz(a)anthracene	10 a	50 a	30	-133%	2.00E-03	Yes	Yes	Yes	No
MWS-01	Benzo(a)pyrene	10 a	50 a	30	-133%	9.17E-03	Yes	Yes	Yes	No
MWS-01	Bis(2-chloroethyl)ether	10 a	50 a	30	-133%	6.09E-02	Yes	Yes	Yes	No
MWS-01	Bis(2-ethylhexyl)phthalate	10 a	50 a	30	-133%	4.78E+00	Yes	Yes	Yes	No
MWS-01	Butyl benzyl phthalate	14 b	50 a	32	-113%	5.00E+01	No	No	No	No
MWS-01	Chrysene	10 a	50 a	30	-133%	2.00E-03	Yes	Yes	Yes	No
MWS-01	Diethyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-01	Dimethyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No

Table A-4

Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in Ground Water
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Location Name	Parameter Name	Primary Value (ug/L)	Duplicate Value (ug/L)	Duplicate Average (ug/L)	RPD	Minimum Residential Tap Water Criterion (µg/L) *	Is Average Result Greater than Tap Water Criterion?	Is Primary Result Greater than Tap Water Criterion?	Is Duplicate Result Greater than Tap Water Criterion?	Does Duplicate Averaging Result in non-Selection?
MWS-01	Di-n-butyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-01	Di-n-octyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-01	Ethylbenzene	8.6 b	2.5 a	5.55	110%	5.00E+00	Yes	Yes	No	No
MWS-01	Fluoranthene	10 b	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-01	Fluorene	20 b	50 a	35	-86%	5.00E+01	No	No	No	No
MWS-01	Hexachlorobenzene	10 a	50 a	30	-133%	6.59E-03	Yes	Yes	Yes	No
MWS-01	Hexachlorocyclopentadiene	10 a	50 a	30	-133%	1.46E-01	Yes	Yes	Yes	No
MWS-01	Hexachloroethane	10 a	50 a	30	-133%	7.54E-01	Yes	Yes	Yes	No
MWS-01	Isophorone	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-01	Pentachlorophenol	50 a	250 a	150	-133%	5.58E-01	Yes	Yes	Yes	No
MWS-01	Phenanthrene	30 b	50 a	40	-50%	5.00E+01	No	No	No	No
MWS-01	Phenol	10 a	50 a	30	-133%	1.00E+00	Yes	Yes	Yes	No
MWS-01	Pyrene	10 b	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-01	Pyridine	10 a	50 a	30	-133%	3.65E+01	No	No	Yes	Yes
MWS-07	1,2,4-Trichlorobenzene	10 a	5 a	7.5	67%	1.94E+02	Yes	Yes	No	No
MWS-07	1,2-Dichlorobenzene	10 a	5 a	7.5	67%	3.00E+00	Yes	Yes	Yes	No
MWS-07	1,3-Dichlorobenzene	10 a	5 a	7.5	67%	3.00E+00	Yes	Yes	No	No
MWS-07	1,4-Dichlorobenzene	10 a	5 a	7.5	67%	4.73E-01	Yes	Yes	Yes	No
MWS-07	2,3,4,6-Tetrachlorophenol	50 a	25 a	37.5	67%	1.00E+00	Yes	Yes	Yes	No
MWS-07	2,4,5-Trichlorophenol	10 a	5 a	7.5	67%	1.00E+00	Yes	Yes	Yes	No
MWS-07	2,4,6-Trichlorophenol	10 a	5 a	7.5	67%	1.00E+00	Yes	Yes	Yes	No
MWS-07	2,4-Dichlorophenol	10 a	5 a	7.5	67%	5.00E+00	Yes	Yes	Yes	No
MWS-07	2,4-Dimethylphenol	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	2,4-Dinitrotoluene	10 a	5 a	7.5	67%	5.00E+00	Yes	Yes	No	No
MWS-07	2,6-Dinitrotoluene	10 a	5 a	7.5	67%	5.00E+00	Yes	Yes	No	No
MWS-07	2-Chloronaphthalene	10 a	5 a	7.5	67%	1.00E+01	No	No	No	No
MWS-07	2-Methylphenol	10 a	5 a	7.5	67%	1.83E+03	No	No	No	No
MWS-07	3-Methylphenol	10 a	5 a	7.5	67%	1.83E+03	No	No	No	No
MWS-07	4,6-Dinitro-2-methylphenol	50 a	25 a	37.5	67%	3.65E+00	Yes	Yes	Yes	No
MWS-07	4-Chloro-3-methylphenol	10 a	5 a	7.5	67%	1.00E+00	No	No	No	No
MWS-07	4-Methylphenol	10 a	5 a	7.5	67%	1.83E+02	No	No	No	No
MWS-07	Anthracene	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Benz(a)anthracene	10 a	5 a	7.5	67%	2.00E-03	Yes	Yes	Yes	No
MWS-07	Benzo(a)pyrene	10 a	5 a	7.5	67%	9.17E-03	Yes	Yes	Yes	No
MWS-07	Bis(2-chloroethyl)ether	10 a	5 a	7.5	67%	6.09E-02	Yes	Yes	Yes	No
MWS-07	Bis(2-ethylhexyl)phthalate	10 a	5 a	7.5	67%	4.78E+00	Yes	Yes	Yes	No
MWS-07	Butyl benzyl phthalate	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Chrysene	10 a	5 a	7.5	67%	2.00E-03	Yes	Yes	Yes	No
MWS-07	Diethyl phthalate	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Dimethyl phthalate	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Di-n-butyl phthalate	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Di-n-octyl phthalate	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Fluoranthene	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No

Table A-4

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Human Health Risk Assessment for Bethlehem Steel Corporation

Lackawanna Site

Lackawanna, New York

Location Name	Parameter Name	Primary Value (ug/L)	Duplicate Value (ug/L)	Duplicate Average (ug/L)	RPD	Minimum Residential Tap Water Criterion (µg/L) *	Is Average Result Greater than Tap Water Criterion?	Is Primary Result Greater than Tap Water Criterion?	Is Duplicate Result Greater than Tap Water Criterion?	Does Duplicate Averaging Result in non-Selection?
MWS-07	Fluorene	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Hexachlorobenzene	10 a	5 a	7.5	67%	6.59E-03	Yes	Yes	Yes	No
MWS-07	Hexachlorocyclopentadiene	10 a	5 a	7.5	67%	1.46E-01	Yes	Yes	Yes	No
MWS-07	Hexachloroethane	10 a	5 a	7.5	67%	7.54E-01	Yes	Yes	Yes	No
MWS-07	Isophorone	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Naphthalene	10 a	5 a	7.5	67%	1.00E+01	No	No	No	No
MWS-07	Pentachlorophenol	50 a	25 a	37.5	67%	5.58E-01	Yes	Yes	Yes	No
MWS-07	Phenanthrene	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Phenol	10 a	5 a	7.5	67%	1.00E+00	Yes	Yes	Yes	No
MWS-07	Pyrene	10 a	5 a	7.5	67%	5.00E+01	No	No	No	No
MWS-07	Pyridine	10 a	5 a	7.5	67%	3.65E+01	No	No	No	No
MWS-08	1,1,1-Trichloroethane	2.5 a	20 b	11.25	-156%	5.00E+00	Yes	No	Yes	No
MWS-08	1,1-Dichloroethane	2.5 a	6 b	4.25	-82%	5.00E+00	No	No	Yes	Yes
MWS-08	Bis(2-ethylhexyl)phthalate	1 b	5 a	3	-133%	4.78E+00	No	No	Yes	Yes
MWS-08	Carbon tetrachloride	2.5 a	4.3 b	3.4	-53%	1.62E-01	Yes	Yes	Yes	No
MWS-16B	1,2,4-Trichlorobenzene	10 a	50 a	30	-133%	1.94E+02	Yes	Yes	Yes	No
MWS-16B	1,2-Dichlorobenzene	10 a	50 a	30	-133%	3.00E+00	Yes	Yes	Yes	No
MWS-16B	1,3-Dichlorobenzene	10 a	50 a	30	-133%	3.00E+00	Yes	Yes	Yes	No
MWS-16B	1,4-Dichlorobenzene	10 a	50 a	30	-133%	4.73E-01	Yes	Yes	Yes	No
MWS-16B	2,3,4,6-Tetrachlorophenol	10 a	50 a	30	-133%	1.00E+00	Yes	Yes	Yes	No
MWS-16B	2,4,5-Trichlorophenol	10 a	50 a	30	-133%	1.00E+00	Yes	Yes	Yes	No
MWS-16B	2,4,6-Trichlorophenol	10 a	50 a	30	-133%	1.00E+00	Yes	Yes	Yes	No
MWS-16B	2,4-Dichlorophenol	10 a	50 a	30	-133%	5.00E+00	Yes	Yes	Yes	No
MWS-16B	2,4-Dimethylphenol	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	2,4-Dinitrotoluene	10 a	50 a	30	-133%	5.00E+00	Yes	Yes	Yes	No
MWS-16B	2,6-Dinitrotoluene	10 a	50 a	30	-133%	5.00E+00	Yes	Yes	Yes	No
MWS-16B	2-Chloronaphthalene	10 a	50 a	30	-133%	1.00E+01	Yes	No	Yes	No
MWS-16B	2-Methylphenol	15 b	50 a	32.5	-108%	1.83E+03	Yes	Yes	Yes	No
MWS-16B	3-Methylphenol & 4-Methylphenol	10 a	50 a	30	-133%	1.00E+00	Yes	No	Yes	No
MWS-16B	4,6-Dinitro-2-methylphenol	50 a	250 a	150	-133%	3.65E+00	Yes	Yes	Yes	No
MWS-16B	4-Chloro-3-methylphenol	10 a	50 a	30	-133%	1.00E+00	Yes	No	Yes	No
MWS-16B	Anthracene	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Benz(a)anthracene	10 a	50 a	30	-133%	2.00E-03	Yes	Yes	Yes	No
MWS-16B	Benzo(a)pyrene	10 a	50 a	30	-133%	9.17E-03	Yes	Yes	Yes	No
MWS-16B	Bis(2-chloroethyl)ether	10 a	50 a	30	-133%	6.09E-02	Yes	Yes	Yes	No
MWS-16B	Bis(2-ethylhexyl)phthalate	18 b	50 a	34	-94%	4.78E+00	Yes	Yes	Yes	No
MWS-16B	Butyl benzyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Chrysene	10 a	50 a	30	-133%	2.00E-03	Yes	Yes	Yes	No
MWS-16B	Diethyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Dimethyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Di-n-butyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Di-n-octyl phthalate	10 a	50 a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Fluoranthene	10 a	50 a	30	-133%	5.00E+01	No	No	No	No

Table A-4
Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in Ground Water
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Location Name	Parameter Name	Primary Value (ug/L)		Duplicate Value (ug/L)		Duplicate Average (ug/L)	RPD	Minimum Residential Tap Water Criterion (µg/L) *	Is Average Result Greater than Tap Water Criterion?	Is Primary Result Greater than Tap Water Criterion?	Is Duplicate Result Greater than Tap Water Criterion?	Does Duplicate Averaging Result in non-Selection?
MWS-16B	Fluorene	10	a	50	a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Hexachlorobenzene	10	a	50	a	30	-133%	6.59E-03	Yes	Yes	Yes	No
MWS-16B	Hexachlorocyclopentadiene	10	a	50	a	30	-133%	1.46E-01	Yes	Yes	Yes	No
MWS-16B	Hexachloroethane	10	a	50	a	30	-133%	7.54E-01	Yes	Yes	Yes	No
MWS-16B	Isophorone	10	a	50	a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Naphthalene	10	a	50	a	30	-133%	1.00E+01	Yes	No	Yes	No
MWS-16B	Pentachlorophenol	50	a	250	a	150	-133%	5.58E-01	Yes	Yes	Yes	No
MWS-16B	Phenanthrene	10	a	50	a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Phenol	49	b	140	b	94.5	-96%	1.00E+00	Yes	Yes	Yes	No
MWS-16B	Pyrene	10	a	50	a	30	-133%	5.00E+01	No	No	No	No
MWS-16B	Pyridine	10	a	50	a	30	-133%	3.65E+01	No	No	Yes	Yes
MWS-19A	Phenol	3	b	6	b	4.5	-67%	1.00E+00	Yes	Yes	Yes	No
MWS-20B	Antimony	1.1	a	3.1	b	2.1	-95%	3.00E+00	No	No	Yes	Yes
MWS-20B	Lead	0.5	a	1.1	b	0.8	-75%	1.50E+01	No	No	No	No
MWS-20B	Selenium	1	a	5	a	3	-133%	1.00E+01	No	No	No	No

Notes:

* Minimum residential tap water criterion is the lower of the NYS 703 standard or guideline for Class GA groundwater (NYSDEC, 1998) and the U.S. EPA Region III tap water risk-based concentration (EPA, 1998).

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBC's. A value of 15 µg/L (protective of children) is used for screening purposes.

Mercury is assumed to be inorganic.

NA = not available or not applicable.

a = 1/2 detection limit

b = measured value

Table A-5
Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in SWMU Material
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample Location	Location Name	Parameter Name	Primary Value (mg/kg)		Duplicate Value (mg/kg)		Duplicate Average (mg/kg)	RPD	Maximum Background Concentration (mg/kg)	Region 3 RBC for Residential Soil (mg/kg) *	Is Average Result Greater than Background?	Is Primary Result Greater than Background?	Is Duplicate Result Greater than Background?	Does Duplicate Averaging Result in non-Selection?	Is Average Result Greater than RBC?	Is Primary Result Greater than RBC?	Is Duplicate Result Greater than RBC?	Does Duplicate Averaging Result in non-Selection?
SWMU P-2	P2 (0-2)	1,1,1-Trichloroethane	0.003	a	0.019	b	0.011	-142%	NA	1.56E+00	NA	NA	NA	No	No	No	No	No
SWMU P-2	P2 (0-2)	Chromium	70.9	b	216	b	143.5	-101%	NA	2.35E+02	NA	NA	NA	No	No	No	No	No
SWMU P-75	P75-2 (0-6)	Mercury	5.1	b	1.6	b	3.35	104%	0.32	2.35E+01	Yes	Yes	Yes	No	No	No	No	No
SWMU S-14	S14-2C	Bis(2-chloroethyl)ether	0.9	a	0.18	a	0.54	133%	NA	5.81E-04	NA	NA	NA	No	No	Yes	No	Yes
SWMU S-14	S14-2C	Acenaphthene	0.9	a	0.18	b	0.54	133%	NA	4.69E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Butyl benzyl phthalate	0.9	a	0.18	a	0.54	133%	NA	1.56E+01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	4-Chloro-3-methylphenol	0.9	a	0.18	a	0.54	133%	NA	NA	NA	NA	NA	No	NA	NA	NA	No
SWMU S-14	S14-2C	2-Chloronaphthalene	0.9	a	0.18	a	0.54	133%	NA	6.26E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Di-n-butyl phthalate	0.9	a	0.18	a	0.54	133%	NA	7.82E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Di-n-octyl phthalate	0.9	a	0.18	a	0.54	133%	NA	1.56E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	1,2-Dichlorobenzene	0.9	a	0.18	a	0.54	133%	NA	7.04E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	1,3-Dichlorobenzene	0.9	a	0.18	a	0.54	133%	NA	2.35E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	1,4-Dichlorobenzene	0.9	a	0.18	a	0.54	133%	NA	2.66E-02	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	2,4-Dichlorophenol	0.9	a	0.18	a	0.54	133%	NA	2.35E-01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Diethyl phthalate	0.9	a	0.18	a	0.54	133%	NA	6.26E+01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Dimethyl phthalate	0.9	a	0.18	a	0.54	133%	NA	7.82E+02	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	2,4-Dimethylphenol	0.9	a	0.086	b	0.493	165%	NA	1.56E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	4,6-Dinitro-2-methylphenol	4.6	a	0.9	a	2.75	135%	NA	7.82E-03	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	2,4-Dinitrotoluene	0.9	a	0.18	a	0.54	133%	NA	1.56E-01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	2,6-Dinitrotoluene	0.9	a	0.18	a	0.54	133%	NA	7.82E-02	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Bis(2-ethylhexyl)phthalate	0.9	a	0.18	a	0.54	133%	NA	4.56E-02	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Hexachlorobenzene	0.9	a	0.18	a	0.54	133%	NA	3.99E-04	NA	NA	NA	No	Yes	Yes	No	No
SWMU S-14	S14-2C	Hexachlorobutadiene	0.9	a	0.18	a	0.54	133%	NA	8.19E-03	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Hexachlorocyclopentadiene	0.9	a	0.18	a	0.54	133%	NA	5.48E-01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Hexachloroethane	0.9	a	0.18	a	0.54	133%	NA	4.56E-02	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Isophorone	0.9	a	0.18	a	0.54	133%	NA	6.72E-01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	2-Methylphenol	0.9	a	0.057	b	0.479	176%	NA	3.91E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	3-Methylphenol	0.9	a	0.18	a	0.54	133%	NA	3.91E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	4-Methylphenol	0.9	a	0.2	b	0.55	127%	NA	3.91E-01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Pentachlorophenol	4.6	a	0.9	a	2.75	135%	NA	5.32E-03	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Phenol	0.9	a	0.18	a	0.54	133%	NA	4.69E+01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	Pyridine	0.9	a	0.18	a	0.54	133%	NA	7.82E-02	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	2,3,4,6-Tetrachlorophenol	4.6	a	0.9	a	2.75	135%	NA	2.35E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	1,2,4-Trichlorobenzene	0.9	a	0.18	a	0.54	133%	NA	7.82E-01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	2,4,5-Trichlorophenol	0.9	a	0.18	a	0.54	133%	NA	7.82E+00	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2C	2,4,6-Trichlorophenol	0.9	a	0.18	a	0.54	133%	NA	5.81E-02	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2G	Benzene	1.3	b	0.35	b	0.825	115%	NA	2.20E-02	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2G	Carbon disulfide	0.006	b	0.027	b	0.017	-127%	NA	7.82E+00	NA	NA	NA	No	No	No	No	No

Table A-5
Evaluation of the Impact of Duplicate Averaging on Selection of Chemicals of Potential Concern in SWMU Material
Human Health Risk Assessment for Bethlehem Steel Corporation
Lackawanna Site
Lackawanna, New York

Sample Location	Location Name	Parameter Name	Primary Value (mg/kg)		Duplicate Value (mg/kg)		Duplicate Average (mg/kg)	RPD	Maximum Background Concentration (mg/kg)	Region 3 RBC for Residential Soil (mg/kg) *	Is Average Result Greater than Background?	Is Primary Result Greater than Background?	Is Duplicate Result Greater than Background?	Does Duplicate Averaging Result in non-Selection?	Is Average Result Greater than RBC?	Is Primary Result Greater than RBC?	Is Duplicate Result Greater than RBC?	Does Duplicate Averaging Result in non-Selection?
SWMU S-14	S14-2G	Toluene	2.7	b	0.62	b	1.66	125%	NA	1.56E+01	NA	NA	NA	No	No	No	No	No
SWMU S-14	S14-2G	Trichloroethene	0.003	b	0.0135	a	0.008	-127%	NA	5.81E-02	NA	NA	NA	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Anthracene	0.11	b	1.7	b	0.905	-176%	1.9	2.35E+01	No	No	No	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Benz(a)anthracene	0.34	b	1.8	b	1.07	-136%	6.7	8.75E-04	No	No	No	No	Yes	No	Yes	No
SWMU S-19	S19-2 (0-6)	Benzo(a)pyrene	0.14	b	1.2	b	0.67	-158%	6	8.75E-05	No	No	No	No	Yes	Yes	Yes	No
SWMU S-19	S19-2 (0-6)	Benzo(b)fluoranthene	0.34	b	2	b	1.17	-142%	12	8.75E-04	No	No	No	No	Yes	No	Yes	No
SWMU S-19	S19-2 (0-6)	Benzo(ghi)perylene	0.099	b	0.57	b	0.335	-141%	5.9	NA	No	No	No	No	NA	NA	NA	No
SWMU S-19	S19-2 (0-6)	Benzo(k)fluoranthene	0.11	b	0.89	b	0.5	-156%	3.3	8.75E-03	No	No	No	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Chrysene	0.33	b	1.7	b	1.015	-135%	4.9	8.75E-02	No	No	No	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Fluoranthene	0.71	b	3.7	b	2.205	-136%	12	3.13E+00	No	No	No	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Fluorene	0.175	a	0.57	b	0.373	-106%	0.81	3.13E+00	No	No	No	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Indeno(1,2,3-cd)pyrene	0.085	b	0.68	b	0.383	-156%	6	8.75E-04	No	No	No	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Phenanthrene	0.37	b	3.2	b	1.785	-159%	8.1	NA	No	No	No	No	NA	NA	NA	No
SWMU S-19	S19-2 (0-6)	Pyrene	0.51	b	2.8	b	1.655	-138%	10	2.35E+00	No	No	No	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Arsenic	2.3	b	0.55	a	1.425	123%	12	4.26E-01	No	No	No	No	Yes	Yes	Yes	No
SWMU S-19	S19-2 (0-6)	Nickel	389	b	52.5	a	220.8	152%	27.7	1.56E+03	Yes	Yes	Yes	No	No	No	No	No
SWMU S-19	S19-2 (0-6)	Cyanide	10.5	b	1.3	a	5.9	156%	NA	1.56E+03	NA	NA	NA	No	No	No	No	No
SWMU S-3	HWM2-C2R1	Methyl ethyl ketone	0.003	a	0.025	a	0.014	-164%	NA	4.69E+01	NA	NA	NA	No	No	No	No	No
SWMU S-3	HWM2-C3R4	Naphthalene	3.2	b	13	a	8.1	-121%	0.22	1.56E+00	Yes	Yes	Yes	No	No	No	No	No
SWMU S-3	HWM2-C3R4	Selenium	2.5	a	0.5	a	1.5	133%	0.6	3.91E+02	Yes	Yes	No	No	No	No	No	No
SWMU S-3	HWM2-C3R4	Thallium	32	b	10	a	21	105%	NA	5.48E+00	NA	NA	NA	No	Yes	Yes	Yes	No

Notes:
* EPA, 1998.
Chromium is conservatively assumed to be in the hexavalent form.
NA = not available or not applicable.
a = 1/2 detection limit
b = measured value

APPENDIX B

Table B-1
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group SFA-1 (SWMUs S-1, S-2, S-4, S-5, S-6, and S-27)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Benzene	11	2	18%	1.6	0.01	22	No	>BKG,<RBC
Carbon disulfide	11	1	9%	0.002	NA	7,821	No	<RBC
Ethylbenzene	11	1	9%	2.5	NA	7,821	No	<RBC
Methyl ethyl ketone	11	2	18%	0.590	NA	46,929	No	<RBC
Methylene chloride	11	2	18%	0.01	NA	85	No	<RBC
Toluene	11	3	27%	3.6	0.006	15,643	No	>BKG,<RBC
Xylenes, Total	11	1	9%	12	NA	156,429	No	<RBC
Semivolatiles								
Bis(2-ethylhexyl)phthalate	11	3	27%	0.98	2.7	46	No	<BKG,<RBC
Acenaphthene	11	1	9%	170	0.34	4,693	No	>BKG,<RBC
Anthracene	11	1	9%	460	1.9	23,464	No	>BKG,<RBC
Fluoranthene	11	7	64%	1500	12	3,129	No	>BKG,<RBC
Fluorene	11	1	9%	710	0.81	3,129	No	>BKG,<RBC
Naphthalene	11	4	36%	1500	0.22	1,564	No	>BKG,<RBC
Pyrene	11	6	55%	1200	10	2,346	No	>BKG,<RBC
Benz(a)anthracene	11	5	45%	630	6.7	0.87	**Yes**	>BKG,>RBC
Benzo(a)pyrene	11	5	45%	330	6	0.087	**Yes**	>BKG,>RBC
Benzo(b)fluoranthene	11	7	64%	490	12	0.87	**Yes**	>BKG,>RBC
Benzo(k)fluoranthene	11	3	27%	150	3.3	8.7	**Yes**	>BKG,>RBC
Chrysene	11	7	64%	540	4.9	87	**Yes**	>BKG,>RBC
Dibenz(a,h)anthracene	11	1	9%	38	1.8	0.087	**Yes**	>BKG,>RBC
Indeno(1,2,3-c,d)pyrene	11	6	55%	210	6	0.87	**Yes**	>BKG,>RBC
Acenaphthylene	11	1	9%	200	1.1	NA	**Yes**	>BKG,No RBC
Benzo(ghi)perylene	11	4	36%	170	5.9	NA	**Yes**	>BKG,No RBC
Phenanthrene	11	4	36%	1900	8.1	NA	**Yes**	>BKG,No RBC
Metals								
Barium	11	5	45%	82.4	84.3	5,475	No	<BKG,<RBC

Table B-1
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group SFA-1 (SWMUs S-1, S-2, S-4, S-5, S-6, and S-27)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Cadmium	11	5	45%	27	NA	78	No	<RBC
Chromium	3	3	100%	49.1	27.1	235	No	>BKG,<RBC
Mercury	11	5	45%	5.6	0.32	23	No	>BKG,<RBC
Nickel	11	5	45%	139	27.7	1,564	No	>BKG,<RBC
Selenium	8	1	13%	1.9	0.6	391	No	>BKG,<RBC
Antimony	11	5	45%	375	1	31	**Yes**	>BKG,>RBC
Arsenic	11	11	100%	21	12	0.43	**Yes**	>BKG,>RBC
Lead	11	11	100%	3,670	30	400	**Yes**	>BKG,>RBC
Miscellaneous								
Cyanide	11	4	36%	32.2	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
NA = not available.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table B-2
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-8
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Methylene chloride	2	1	50%	0.006	NA	85	No	<RBC
Semivolatiles								
Benzo(ghi)perylene	2	2	100%	0.95	5.9	NA	No	<BKG
Phenanthrene	2	2	100%	3.3	8.1	NA	No	<BKG
Anthracene	2	1	50%	0.8	1.9	23,464	No	<BKG,<RBC
Benzo(k)fluoranthene	2	2	100%	1.9	3.3	8.7	No	<BKG,<RBC
Chrysene	2	2	100%	2.4	4.9	87	No	<BKG,<RBC
Fluoranthene	2	2	100%	5.3	12	3,129	No	<BKG,<RBC
Pyrene	2	2	100%	3.4	10	2,346	No	<BKG,<RBC
Benz(a)anthracene	2	2	100%	2.1	6.7	0.87	No	<BKG,>RBC
Benzo(a)pyrene	2	2	100%	1.3	6	0.087	No	<BKG,>RBC
Benzo(b)fluoranthene	2	2	100%	1.9	12	0.87	No	<BKG,>RBC
Dibenz(a,h)anthracene	2	1	50%	0.4	1.8	0.087	No	<BKG,>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	1	6	0.87	No	<BKG,>RBC
Naphthalene	2	1	50%	0.39	0.22	1,564	No	>BKG,<RBC
Metals								
Cadmium	2	2	100%	49.9	NA	78	No	<BKG,<RBC
Mercury	2	1	50%	0.19	0.32	23	No	<BKG,<RBC
Barium	2	2	100%	252	84.3	5,475	No	>BKG,<RBC
Nickel	2	1	50%	131	27.7	1,564	No	>BKG,<RBC
Arsenic	2	2	100%	74.4	12	0.43	**Yes**	>BKG,>RBC
Chromium	2	2	100%	436	27.1	235	**Yes**	>BKG,>RBC
Lead	2	2	100%	2,160	30	400	**Yes**	>BKG,>RBC
Thallium	2	2	100%	22.9	NA	5.5	**Yes**	>RBC

Table B-2
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-8
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Miscellaneous								
Cyanide	1	1	100%	19	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
NA = not available.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table B-3
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-21
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Toluene	2	1	50%	0.007	0.006	15,643	No	>BKG,<RBC
Semivolatiles								
Benzo(ghi)perylene	2	1	50%	0.39	5.9	NA	No	<BKG
Phenanthrene	2	2	100%	0.4	8.1	NA	No	<BKG
Benzo(k)fluoranthene	2	1	50%	0.33	3.3	8.7	No	<BKG,<RBC
Bis(2-ethylhexyl)phthalate	2	1	50%	0.3	2.7	46	No	<BKG,<RBC
Chrysene	2	2	100%	0.51	4.9	87	No	<BKG,<RBC
Fluoranthene	2	2	100%	0.81	12	3,129	No	<BKG,<RBC
Pyrene	2	2	100%	0.78	10	2,346	No	<BKG,<RBC
Benzo(a)pyrene	2	2	100%	0.55	6	0.087	No	<BKG,>RBC
Benzo(b)fluoranthene	2	2	100%	1.1	12	0.87	No	<BKG,>RBC
Benz(a)anthracene	2	1	50%	0.8	6.7	0.87	No	<BKG,<RBC
Indeno(1,2,3-c,d)pyrene	2	1	50%	0.48	NA	0.87	No	<BKG,<RBC
Naphthalene	2	1	50%	0.27	0.22	1,564	No	>BKG,<RBC
Metals								
Cadmium	2	2	100%	8.1	NA	78	No	<RBC
Barium	2	2	100%	124	84.3	5,475	No	>BKG,<RBC
Chromium	2	2	100%	292	27.1	390	No	>BKG,<RBC
Mercury	2	1	50%	0.34	0.32	23	No	>BKG,<RBC
Nickel	2	2	100%	356	27.7	1,564	No	>BKG,<RBC
Antimony	2	1	50%	78.1	1	31	Yes	>BKG,>RBC
Arsenic	2	2	100%	60.5	12	0.43	Yes	>BKG,>RBC
Lead	2	2	100%	1650	30	400	Yes	>BKG,>RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

Mercury is assumed to be inorganic.

NA = not available.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

No RBC = no Region III RBC available.

< BKG = Maximum Detect was less than background.

< RBC = Maximum Detect was less than Region III RBC.

> BKG = Maximum Detect was greater than background.

> RBC = Maximum Detect was greater than Region III RBC.

Table B-4
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-14
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Methylene chloride	4	4	100%	0.043	NA	85	No	<RBC
Semivolatiles								
Benzo(ghi)perylene	4	4	100%	1.3	5.9	NA	No	<BKG
Phenanthrene	4	4	100%	3.7	8.1	NA	No	<BKG
Pyrene	4	4	100%	3.4	10	NA	No	<BKG
Anthracene	4	3	75%	1.2	1.9	23,464	No	<BKG,<RBC
Benzo(k)fluoranthene	4	4	100%	0.73	3.3	8.7	No	<BKG,<RBC
Bis(2-ethylhexyl)phthalate	4	1	25%	0.33	2.7	46	No	<BKG,<RBC
Chrysene	4	4	100%	2.5	4.9	87	No	<BKG,<RBC
Fluoranthene	4	4	100%	4.1	12	3,129	No	<BKG,<RBC
Fluorene	4	1	25%	0.55	0.81	3,129	No	<BKG,<RBC
Benz(a)anthracene	4	4	100%	2.9	6.7	0.87	No	<BKG,>RBC
Benzo(a)pyrene	4	4	100%	1.9	NA	0.087	No	>RBC
Benzo(b)fluoranthene	4	4	100%	3.5	12	0.87	No	<BKG,>RBC
Dibenz(a,h)anthracene	4	2	50%	0.27	1.8	0.087	No	<BKG,>RBC
Indeno(1,2,3-c,d)pyrene	4	4	100%	1.4	6	0.87	No	<BKG,>RBC
Acenaphthene	4	1	25%	0.75	0.34	4,693	No	>BKG,<RBC
Naphthalene	4	4	100%	0.75	0.22	1,564	No	>BKG,<RBC
Metals								
Mercury	4	4	100%	0.31	0.32	23	No	<BKG,<RBC
Arsenic	4	4	100%	11.3	12	0.43	No	<BKG,>RBC
Cadmium	4	3	75%	10.1	NA	78	No	<RBC
Silver	4	1	25%	3.3	NA	391	No	<RBC
Barium	4	4	100%	208	84.3	5,475	No	>BKG,<RBC
Nickel	4	4	100%	130	27.7	1,564	No	>BKG,<RBC
Antimony	4	4	100%	44.7	1	31	**Yes**	>BKG,>RBC
Lead	4	4	100%	911	30	400	**Yes**	>BKG,>RBC

Table B-4
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-14
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Miscellaneous								
Cyanide	4	1	25%	8.8	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).

< RBC = Maximum Detect was less than Region III RBC.

Mercury is assumed to be inorganic.

Cyanide is assumed to be free cyanide.

NA = not available.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

No RBC = no Region III RBC available.

< BKG = Maximum Detect was less than background.

< RBC = Maximum Detect was less than Region III RBC.

> BKG = Maximum Detect was greater than background.

> RBC = Maximum Detect was greater than Region III RBC.

Table B-5
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-15
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Semivolatiles								
Benzo(ghi)perylene	2	2	100%	0.4	5.9	NA	No	<BKG
Phenanthrene	2	2	100%	1.1	8.1	NA	No	<BKG
Anthracene	2	1	50%	0.4	1.9	23,464	No	<BKG,<RBC
Benzo(k)fluoranthene	2	2	100%	0.26	3.3	8.7	No	<BKG,<RBC
Chrysene	2	2	100%	0.64	4.9	87	No	<BKG,<RBC
Fluoranthene	2	2	100%	1.7	12	3,129	No	<BKG,<RBC
Fluorene	2	1	50%	0.11	0.81	3,129	No	<BKG,<RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	0.77	6	0.87	No	<BKG,<RBC
Pyrene	2	2	100%	1.5	10	2,346	No	<BKG,<RBC
Benz(a)anthracene	2	2	100%	1.5	6.7	0.87	No	<BKG,>RBC
Benzo(a)pyrene	2	2	100%	0.55	6	0.087	No	<BKG,>RBC
Benzo(b)fluoranthene	2	2	100%	1.5	12	0.87	No	<BKG,>RBC
Naphthalene	2	2	100%	0.63	NA	1,564	No	<BKG,<RBC
Metals								
Barium	2	2	100%	41.2	84.3	5,475	No	<BKG,<RBC
Mercury	2	2	100%	0.21	0.32	23	No	<BKG,<RBC
Arsenic	2	2	100%	8.7	12	0.43	No	<BKG,>RBC
Cadmium	2	2	100%	1.2	NA	78	No	<RBC
Lead	2	2	100%	52.8	30	400	No	>BKG,<RBC
Nickel	2	2	100%	37.7	27.7	1,564	No	>BKG,<RBC
Antimony	2	2	100%	42.7	1	31	Yes	>BKG,>RBC

Table B-5
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-15
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Miscellaneous								
Cyanide	2	1	50%	13.6	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

Mercury is assumed to be inorganic.

Cyanide is assumed to be free cyanide.

NA = not available.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

No RBC = no Region III RBC available.

< BKG = Maximum Detect was less than background.

< RBC = Maximum Detect was less than Region III RBC.

> BKG = Maximum Detect was greater than background.

> RBC = Maximum Detect was greater than Region III RBC.

Table B-6
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-18
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Semivolatiles								
Benzo(ghi)perylene	2	1	50%	0.11	5.9	NA	No	<BKG
Fluoranthene	2	1	50%	0.08	12	3,129	No	<BKG,<RBC
Benzo(b)fluoranthene	2	1	50%	0.10	12	0.87	No	<BKG,<RBC
Indeno(1,2,3-c,d)pyrene	2	1	50%	0.10	6	0.87	No	<BKG,<RBC
Metals								
Cadmium	2	1	50%	16.7	NA	78	No	<RBC
Nickel	2	1	50%	144	27.7	1,564	No	>BKG,<RBC
Selenium	2	2	100%	9.7	0.6	391	No	>BKG,<RBC
Antimony	2	2	100%	87.5	1	31	**Yes**	>BKG,>RBC
Arsenic	2	2	100%	16.7	12	0.43	**Yes**	>BKG,>RBC
Chromium	2	1	50%	253	27.1	235	**Yes**	>BKG,>RBC
Lead	2	2	100%	452	30	400	**Yes**	>BKG,>RBC
Thallium	2	1	50%	7.1	NA	5.5	**Yes**	>RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

NA = not available.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

No RBC = no Region III RBC available.

< BKG = Maximum Detect was less than background.

< RBC = Maximum Detect was less than Region III RBC.

> BKG = Maximum Detect was greater than background.

> RBC = Maximum Detect was greater than Region III RBC.

Table B-7
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group PA-1 (SWMUs P-3, P-4, and P-5)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
1,1,1-Trichloroethane	3	3	100%	0.043	NA	1,564	No	<RBC
1,1,2-Trichloroethane	3	1	33%	0.003	NA	11	No	<RBC
Chlorobenzene	3	1	33%	0.001	NA	1,564	No	<RBC
Chloroform	3	1	33%	0.002	NA	105	No	<RBC
Methylene chloride	3	3	100%	0.26	NA	85	No	<RBC
Trichlorofluoromethane	3	2	67%	0.038	NA	23,464	No	<RBC
Xylenes, Total	3	2	67%	0.013	NA	156,429	No	<RBC
Benzene	3	2	67%	0.017	0.01	22	No	>BKG,<RBC
Toluene	3	3	100%	0.064	0.006	15,643	No	>BKG,<RBC
Semivolatiles								
Benzo(ghi)perylene	3	1	33%	0.52	5.9	NA	No	<BKG
Phenanthrene	3	2	67%	4.2	8.1	NA	No	<BKG
Anthracene	3	2	67%	0.97	1.9	23,464	No	<BKG,<RBC
Benzo(k)fluoranthene	3	1	33%	0.24	3.3	8.7	No	<BKG,<RBC
Bis(2-ethylhexyl)phthalate	3	1	33%	0.74	2.7	46	No	<BKG,<RBC
Chrysene	3	2	67%	1.3	4.9	87	No	<BKG,<RBC
Fluoranthene	3	3	100%	2.5	12	3,129	No	<BKG,<RBC
Indeno(1,2,3-c,d)pyrene	3	1	33%	0.72	6	0.87	No	<BKG,<RBC
Pyrene	3	2	67%	1.7	10	2,346	No	<BKG,<RBC
Benz(a)anthracene	3	2	67%	1.3	6.7	0.87	No	<BKG,>RBC
Benzo(a)pyrene	3	2	67%	0.87	6	0.087	No	<BKG,>RBC
Benzo(b)fluoranthene	3	2	67%	1.7	12	0.87	No	<BKG,>RBC
2-Methylphenol	3	1	33%	0.35	NA	3,911	No	<RBC
3-Methylphenol & 4-Methylphenol	3	2	67%	1.1	NA	391	No	<RBC
Phenol	3	1	33%	0.7	NA	46,929	No	<RBC
Acenaphthene	3	1	33%	0.4	0.34	4,693	No	>BKG,<RBC
Di-n-butyl phthalate	3	3	100%	0.61	0.49	7,821	No	>BKG,<RBC

Table B-7
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group PA-1 (SWMUs P-3, P-4, and P-5)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Fluorene	3	2	67%	1.1	0.81	3,129	No	>BKG,<RBC
Naphthalene	3	2	67%	2.7	0.22	1,564	No	>BKG,<RBC
Metals								
Lead	3	3	100%	12.5	30	400	No	<BKG,<RBC
Nickel	3	2	67%	7	27.7	1,564	No	<BKG,<RBC
Barium	3	1	33%	222	84.3	5,475	No	>BKG,<RBC
Chromium	3	3	100%	99.4	27.1	235	No	>BKG,<RBC
Arsenic	3	3	100%	15.4	12	0.43	**Yes**	>BKG,>RBC
Miscellaneous								
Cyanide	3	1	33%	10.1	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

Cyanide is assumed to be free cyanide.

NA = not available.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

No RBC = no Region III RBC available.

< BKG = Maximum Detect was less than background.

< RBC = Maximum Detect was less than Region III RBC.

> BKG = Maximum Detect was greater than background.

> RBC = Maximum Detect was greater than Region III RBC.

Table B-8
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group PA-2 (SWMU P-6 and P-7)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Benzene	2	1	50%	0.005	0.01	22	No	<BKG,<RBC
1,1,1-Trichloroethane	2	2	100%	0.018	NA	1,564	No	<RBC
Chloroform	2	1	50%	0.001	NA	105	No	<RBC
Ethylbenzene	2	1	50%	0.004	NA	7,821	No	<RBC
Methylene chloride	2	2	100%	0.013	NA	85	No	<RBC
Trichlorofluoromethane	2	1	50%	0.055	NA	23,464	No	<RBC
Xylenes, Total	2	2	100%	0.036	NA	156,429	No	<RBC
Toluene	2	2	100%	0.024	0.006	15,643	No	>BKG,<RBC
Semivolatiles								
Bis(2-ethylhexyl)phthalate	2	1	50%	0.78	2.7	46	No	<BKG,<RBC
Di-n-butyl phthalate	2	1	50%	0.26	0.49	7,821	No	<BKG,<RBC
2-Methylphenol	2	1	50%	0.16	NA	3,911	No	<RBC
3-Methylphenol & 4-Methylphenol	2	2	100%	1.5	NA	391	No	<RBC
Phenol	2	2	100%	1.3	NA	46,929	No	<RBC
Acenaphthene	2	1	50%	1.1	0.34	4,693	No	>BKG,<RBC
Anthracene	2	2	100%	23	1.9	23,464	No	>BKG,<RBC
Chrysene	2	2	100%	31	4.9	87	No	>BKG,<RBC
Fluoranthene	2	2	100%	62	12	3,129	No	>BKG,<RBC
Fluorene	2	2	100%	21	0.81	3,129	No	>BKG,<RBC
Naphthalene	2	2	100%	44	0.22	1,564	No	>BKG,<RBC
Pyrene	2	2	100%	58	10	2,346	No	>BKG,<RBC
Benz(a)anthracene	2	2	100%	35	6.7	0.87	**Yes**	>BKG,>RBC
Benzo(a)pyrene	2	2	100%	20	6.00	0.087	**Yes**	>BKG,>RBC
Benzo(b)fluoranthene	2	2	100%	24	12	0.87	**Yes**	>BKG,>RBC
Benzo(k)fluoranthene	2	2	100%	13	3.3	8.7	**Yes**	>BKG,>RBC
Dibenz(a,h)anthracene	2	2	100%	2.7	1.8	0.087	**Yes**	>BKG,>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	13	6	0.87	**Yes**	>BKG,>RBC

Table B-8
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group PA-2 (SWMU P-6 and P-7)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Acenaphthylene	2	1	50%	19	1.1	NA	**Yes**	>BKG,No RBC
Benzo(ghi)perylene	2	2	100%	12	5.9	NA	**Yes**	>BKG,No RBC
Phenanthrene	2	2	100%	66	8.1	NA	**Yes**	>BKG,No RBC
Metals								
Barium	2	1	50%	32.1	84.3	5,475	No	<BKG,<RBC
Arsenic	2	1	50%	4	12	0.43	No	<BKG,>RBC
Lead	2	2	100%	192	30	400	No	>BKG,<RBC
Mercury	2	1	50%	0.65	0.32	23	No	>BKG,<RBC
Nickel	2	1	50%	61.6	27.7	1,564	No	>BKG,<RBC
Selenium	2	1	50%	0.73	0.60	391	No	>BKG,<RBC
Chromium	2	2	100%	343	27.1	235	**Yes**	>BKG,>RBC
Miscellaneous								
Cyanide	2	1	50%	6.8	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

Mercury is assumed to be inorganic.

Cyanide is assumed to be free cyanide.

NA = not available.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

No RBC = no Region III RBC available.

< BKG = Maximum Detect was less than background.

< RBC = Maximum Detect was less than Region III RBC.

> BKG = Maximum Detect was greater than background.

> RBC = Maximum Detect was greater than Region III RBC.

Table B-9
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group PA-4 (SWMUs P-11 and P-12)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Benzene	3	3	100%	0.0047	0.01	22	No	<BKG,<RBC
Toluene	3	1	33%	0.001	0.006	15,643	No	<BKG,<RBC
1,1,1-Trichloroethane	3	1	33%	0.045	NA	1,564	No	<RBC
Methylene chloride	3	1	33%	0.021	NA	85	No	<RBC
Trichlorofluoromethane	3	1	33%	0.003	NA	23,464	No	<RBC
Xylenes, Total	3	2	67%	0.0017	NA	156,429	No	<RBC
Semivolatiles								
Benzo(ghi)perylene	3	2	67%	0.35	5.9	NA	No	<BKG
Phenanthrene	3	2	67%	0.87	8.1	NA	No	<BKG
Anthracene	3	2	67%	0.23	1.9	23,464	No	<BKG,<RBC
Benz(a)anthracene	3	2	67%	0.70	6.7	0.87	No	<BKG,<RBC
Benzo(b)fluoranthene	3	2	67%	0.86	12	0.87	No	<BKG,<RBC
Benzo(k)fluoranthene	3	2	67%	0.38	3.3	8.7	No	<BKG,<RBC
Chrysene	3	2	67%	0.67	4.9	87	No	<BKG,<RBC
Dibenz(a,h)anthracene	3	1	33%	0.08	1.8	0.087	No	<BKG,<RBC
Fluoranthene	3	2	67%	1.3	12	3,129	No	<BKG,<RBC
Indeno(1,2,3-c,d)pyrene	3	2	67%	0.36	6	0.87	No	<BKG,<RBC
Pyrene	3	2	67%	0.87	10	2,346	No	<BKG,<RBC
Benzo(a)pyrene	3	2	67%	0.56	6	0.087	No	<BKG,>RBC
Naphthalene	3	2	67%	0.29	0.22	1,564	No	>BKG,<RBC
Metals								
Nickel	3	2	67%	10.4	27.7	1,564	No	<BKG,<RBC
Cadmium	3	2	67%	8.9	NA	78	No	<RBC
Antimony	2	1	50%	9.6	1	31	No	>BKG,<RBC
Barium	3	3	100%	247	84.3	5,475	No	>BKG,<RBC
Lead	3	3	100%	50.7	30	400	No	>BKG,<RBC
Mercury	3	3	100%	4.2	0.32	23	No	>BKG,<RBC

Table B-9
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group PA-4 (SWMUs P-11 and P-12)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Arsenic	3	3	100%	30.5	12	0.43	Yes	>BKG,>RBC
Chromium	3	3	100%	254	27.1	235	Yes	>BKG,>RBC
Miscellaneous								
Cyanide	3	1	33%	4.5	NA	1564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
NA = not available.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table B-10
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group TF (SWMUs P-8, P-74 and P-75)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Carbon disulfide	8	1	13%	0.006	NA	7,821	No	<RBC
Dichlorodifluoromethane	9	4	44%	0.073	NA	15,643	No	<RBC
Ethylbenzene	9	3	33%	0.027	NA	7,821	No	<RBC
Trichlorofluoromethane	10	6	60%	0.05	NA	23,464	No	<RBC
Methylene chloride	11	10	91%	0.079	NA	85	No	<RBC
Xylenes, Total	11	6	55%	0.47	NA	156,429	No	<RBC
Benzene	11	7	64%	0.02	0.01	22	No	>BKG,<RBC
Toluene	11	11	100%	0.18	0.006	15,643	No	>BKG,<RBC
Semivolatiles								
Bis(2-ethylhexyl)phthalate	10	1	10%	0.15	2.7	46	No	<BKG,<RBC
Di-n-butyl phthalate	10	1	10%	0.22	0.49	7,821	No	<BKG,<RBC
Acenaphthene	10	5	50%	97	0.34	4,693	No	>BKG,<RBC
Anthracene	10	9	90%	89	1.9	23,464	No	>BKG,<RBC
Fluoranthene	10	10	100%	540	12	3,129	No	>BKG,<RBC
Fluorene	10	7	70%	64	0.81	3,129	No	>BKG,<RBC
Naphthalene	10	10	100%	84	0.22	1,564	No	>BKG,<RBC
Pyrene	10	10	100%	750	10	2,346	No	>BKG,<RBC
Benz(a)anthracene	10	10	100%	310	6.7	0.87	**Yes**	>BKG,>RBC
Benzo(a)pyrene	10	10	100%	400	6	0.087	**Yes**	>BKG,>RBC
Benzo(b)fluoranthene	10	10	100%	640	12	0.87	**Yes**	>BKG,>RBC
Benzo(k)fluoranthene	10	10	100%	320	3.3	8.7	**Yes**	>BKG,>RBC
Chrysene	10	10	100%	330	4.9	87	**Yes**	>BKG,>RBC
Dibenz(a,h)anthracene	10	10	100%	89	1.8	0.087	**Yes**	>BKG,>RBC
Indeno(1,2,3-c,d)pyrene	10	10	100%	400	6	0.87	**Yes**	>BKG,>RBC
Acenaphthylene	10	6	60%	42	1.1	NA	**Yes**	>BKG,No RBC
Benzo(ghi)perylene	10	10	100%	380	5.9	NA	**Yes**	>BKG,No RBC
Phenanthrene	10	10	100%	350	8.1	NA	**Yes**	>BKG,No RBC

Table B-10
Summary of COPC Selection Process
Surficial SWMU Material
SWMU Group TF (SWMUs P-8, P-74 and P-75)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Metals								
Nickel	10	8	80%	26.90	27.70	1,564	No	<BKG,<RBC
Cadmium	10	4	40%	4.7	NA	78	No	<RBC
Barium	10	9	90%	119	84.3	5,475	No	>BKG,<RBC
Mercury	10	8	80%	22.9	0.32	23	No	>BKG,<RBC
Antimony	10	8	80%	80.8	1	31	**Yes**	>BKG,>RBC
Arsenic	10	10	100%	90.3	12	0.43	**Yes**	>BKG,>RBC
Chromium	10	10	100%	797	27.1	235	**Yes**	>BKG,>RBC
Lead	10	10	100%	960	30	400	**Yes**	>BKG,>RBC
Miscellaneous								
Cyanide	10	6	60%	123	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
NA = not available.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table B-11
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-19
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Methylene chloride	4	4	100%	0.01	NA	85	No	<RBC
Semivolatiles								
Acenaphthylene	4	1	25%	0.17	1.1	NA	No	<BKG
Benzo(ghi)perylene	4	1	25%	0.33	5.9	NA	No	<BKG
Phenanthrene	4	3	75%	1.79	8.1	NA	No	<BKG
Anthracene	4	1	25%	0.91	1.9	23,464	No	<BKG,<RBC
Benzo(k)fluoranthene	4	1	25%	0.50	3.3	8.7	No	<BKG,<RBC
Chrysene	4	2	50%	1.02	4.9	87	No	<BKG,<RBC
Fluoranthene	4	3	75%	2.21	12.00	3,129	No	<BKG,<RBC
Fluorene	4	1	25%	0.37	0.81	3,129	No	<BKG,<RBC
Indeno(1,2,3-c,d)pyrene	4	1	25%	0.38	6.00	0.87	No	<BKG,<RBC
Naphthalene	4	2	50%	0.11	0.22	1,564	No	<BKG,<RBC
Pyrene	4	3	75%	1.66	10.00	2,346	No	<BKG,<RBC
Benz(a)anthracene	4	2	50%	1.07	6.70	0.87	No	<BKG,>RBC
Benzo(a)pyrene	4	1	25%	0.67	6.00	0.087	No	<BKG,>RBC
Benzo(b)fluoranthene	4	3	75%	1.17	12	0.87	No	<BKG,>RBC
Dibenz(a,h)anthracene	4	1	25%	0.15	1.8	0.087	No	<BKG,>RBC
Metals								
Lead	4	4	100%	199	30	400	No	>BKG,<RBC
Nickel	4	1	25%	220.75	27.7	1,564	No	>BKG,<RBC
Selenium	4	2	50%	2.1	0.6	391	No	>BKG,<RBC
Arsenic	4	3	75%	54.6	12	0.43	**Yes**	>BKG,>RBC

Table B-11
Summary of COPC Selection Process
Surficial SWMU Material
SWMU S-19
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Miscellaneous								
Cyanide	4	3	75%	9.5	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Cyanide is assumed to be free cyanide.
NA = not available.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table B-12
Summary of COPC Selection Process
Surficial SWMU Material
SWMU P-63
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Methyl ethyl ketone	1	1	100%	0.041	NA	46,929	No	<RBC
o-Xylene	3	1	33%	0.004	NA	156,429	No	<RBC
Tetrachloroethene	3	1	33%	0.004	NA	12	No	<RBC
Toluene	3	1	33%	0.007	0.006	15,643	No	>BKG,<RBC
Semivolatiles								
Benzo(ghi)perylene	1	1	100%	0.25	5.9	NA	No	<BKG
Phenanthrene	1	1	100%	0.23	8.1	NA	No	<BKG
Benz(a)anthracene	1	1	100%	0.78	6.7	0.87	No	<BKG,<RBC
Benzo(b)fluoranthene	1	1	100%	0.67	12	0.87	No	<BKG,<RBC
Benzo(k)fluoranthene	1	1	100%	0.13	3.3	8.7	No	<BKG,<RBC
Chrysene	1	1	100%	0.39	4.9	87	No	<BKG,<RBC
Di-n-butyl phthalate	3	1	33%	0.1	0.49	7,821	No	<BKG,<RBC
Fluoranthene	1	1	100%	0.88	12	3,129	No	<BKG,<RBC
Indeno(1,2,3-c,d)pyrene	1	1	100%	0.34	6	0.87	No	<BKG,<RBC
Pyrene	1	1	100%	0.73	10	2,346	No	<BKG,<RBC
Benzo(a)pyrene	1	1	100%	0.55	6	0.087	No	<BKG,>RBC
Metals								
Cadmium	3	1	33%	11.8	NA	78	No	<RBC
Silver	3	1	33%	1.6	NA	391	No	<RBC
Barium	3	3	100%	368	84.3	5,475	No	>BKG,<RBC
Mercury	2	1	50%	1.2	0.32	23	No	>BKG,<RBC
Nickel	3	3	100%	95.5	27.7	1,564	No	>BKG,<RBC
Selenium	3	3	100%	5.2	0.6	391	No	>BKG,<RBC
Arsenic	3	3	100%	51.5	12	0.43	Yes	>BKG,>RBC
Chromium	3	3	100%	296	27.1	235	Yes	>BKG,>RBC
Lead	3	3	100%	458	30	400	Yes	>BKG,>RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
NA = not available.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table B-13
Summary of COPC Selection Process
Surficial SWMU Material
SWMU P-73
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Benzene	1	1	100%	0.006	0.01	22	No	<BKG,<RBC
Ethylbenzene	1	1	100%	0.003	NA	7,821	No	<RBC
Methylene chloride	1	1	100%	0.005	NA	85	No	<RBC
1,1,2,2-Tetrachloroethane	1	1	100%	0.003	NA	3.2	No	<RBC
Tetrachloroethene	1	1	100%	0.003	NA	12	No	<RBC
Trichlorofluoromethane	1	1	100%	0.007	NA	23,464	No	<RBC
Xylenes, Total	1	1	100%	0.007	NA	156,429	No	<RBC
Toluene	1	1	100%	0.008	0.006	15,643	No	>BKG,<RBC
Semivolatiles								
Phenanthrene	1	1	100%	2.1	8.1	NA	No	<BKG
Acenaphthene	1	1	100%	0.33	0.34	4,693	No	<BKG,<RBC
Anthracene	1	1	100%	0.65	1.9	23,464	No	<BKG,<RBC
Chrysene	1	1	100%	1.50	4.9	87	No	<BKG,<RBC
Di-n-butyl phthalate	1	1	100%	0.18	0.49	7,821	No	<BKG,<RBC
Fluoranthene	1	1	100%	2.9	12	3,129	No	<BKG,<RBC
Fluorene	1	1	100%	0.35	0.81	3,129	No	<BKG,<RBC
Pyrene	1	1	100%	2.2	10	2,346	No	<BKG,<RBC
Benz(a)anthracene	1	1	100%	1.40	6.7	0.87	No	<BKG,>RBC
Benzo(a)pyrene	1	1	100%	0.85	6	0.087	No	<BKG,>RBC
Phenol	1	1	100%	0.26	NA	46,929	No	<RBC
Naphthalene	1	1	100%	0.24	0.22	1,564	No	>BKG,<RBC
Metals								
Nickel	1	1	100%	14.4	27.7	1,564	No	<BKG,<RBC
Cadmium	1	1	100%	0.68	NA	78	No	<RBC
Antimony	1	1	100%	14.4	1	31	No	>BKG,<RBC
Barium	1	1	100%	123	84.3	5,475	No	>BKG,<RBC
Chromium	1	1	100%	94.2	27.1	235	No	>BKG,<RBC

Table B-13
Summary of COPC Selection Process
Surficial SWMU Material
SWMU P-73
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Lead	1	1	100%	65.5	30	400	No	>BKG,<RBC
Arsenic	1	1	100%	36.3	12	0.43	Yes	>BKG,>RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

NA = not available.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

No RBC = no Region III RBC available.

< BKG = Maximum Detect was less than background.

< RBC = Maximum Detect was less than Region III RBC.

> BKG = Maximum Detect was greater than background.

> RBC = Maximum Detect was greater than Region III RBC.

APPENDIX C

Table C-1
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group SFA-1 (SWMUs S-1, S-2, S-4, S-5, S-6, S-7, and S-20)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Carbon disulfide	16	1	6%	0.01	720 *	No	<SSL
1,1-Dichloroethane	15	1	7%	0.036	1,300	No	<SSL
1,2-Dichloroethane	15	1	7%	0.005	0.4	No	<SSL
Ethylbenzene	16	4	25%	1.4	400 *	No	<SSL
Methyl ethyl ketone	15	2	13%	0.03	21,000 /b	No	<SSL
Methylene chloride	16	6	38%	6.4	13	No	<SSL
Toluene	16	11	69%	12	650 *	No	<SSL
1,1,1-Trichloroethane	16	1	6%	0.054	1,200	No	<SSL
Trichloroethene	16	2	13%	3	5	No	<SSL
Xylenes, Total	16	10	63%	5.3	410 *	No	<SSL
Benzene	16	9	56%	9.5	0.8	**Yes**	>SSL
"Volatile Semivolatiles"							
Acenaphthene	16	4	25%	0.3	120 */b	No	<SSL
Anthracene	16	4	25%	0.34	6.8 */b	No	<SSL
Fluorene	16	5	31%	46	89 */b	No	<SSL
Naphthalene	16	12	75%	1,600	180 */b	**Yes**	>SSL
Acenaphthylene	16	4	25%	46	NA	**Yes**	No SSL
Phenanthrene	16	8	50%	130	NA	**Yes**	No SSL
Semivolatiles							
2,4-Dimethylphenol	15	1	7%	0.12	1,564	No	<RBC
3-Methylphenol & 4-Methylphenol	12	6	50%	20	391	No	<RBC
Benzo(k)fluoranthene	16	2	13%	0.6	8.7	No	<RBC
Bis(2-ethylhexyl)phthalate	16	1	6%	0.19	46	No	<RBC
Chrysene	16	7	44%	3.0	87	No	<RBC
Fluoranthene	16	7	44%	80	3,129	No	<RBC
Indeno(1,2,3-c,d)pyrene	16	1	6%	0.25	0.87	No	<RBC
Phenol	15	2	13%	12	46,929	No	<RBC
Pyrene	16	8	50%	64	2,346	No	<RBC
Benz(a)anthracene	16	6	38%	3.2	0.87	**Yes**	>RBC
Benzo(a)pyrene	16	1	6%	0.49	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	16	7	44%	2	0.87	**Yes**	>RBC

Table C-1
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group SFA-1 (SWMUs S-1, S-2, S-4, S-5, S-6, S-7, and S-20)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Benzo(ghi)perylene	16	1	6%	0.38	NA	Yes	No RBC
Metals							
Antimony	15	1	7%	16.2	31	No	<RBC
Barium	16	9	56%	129	5,475	No	<RBC
Cadmium	15	14	93%	37.7	78	No	<RBC
Chromium	15	15	100%	203	235	No	<RBC
Mercury	16	10	63%	0.8	23	No	<RBC
Nickel	16	13	81%	135	1,564	No	<RBC
Selenium	14	4	29%	11.1	391	No	<RBC
Silver	12	4	33%	6.1	391	No	<RBC
Arsenic	16	16	100%	31.1	0.43	Yes	>RBC
Lead	16	16	100%	1,630	400	Yes	>RBC
Thallium	16	6	38%	5.9	5.5	Yes	>RBC
Miscellaneous							
Cyanide	12	11	92%	24.2	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-2
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group SFA-2 (SWMUs S-11 and S-22)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Carbon disulfide	2	1	50%	0.02	720 *	No	<SSL
1,1-Dichloroethane	7	2	29%	1.7	1,300	No	<SSL
Ethylbenzene	7	4	57%	37	400 *	No	<SSL
Methyl ethyl ketone	7	2	29%	0.99	21,000 /b	No	<SSL
Methylene chloride	7	1	14%	1.7	13	No	<SSL
Pyridine	7	5	71%	57	75 /b	No	<SSL
1,1,1-Trichloroethane	7	4	57%	44	1200 *	No	<SSL
1,1,2,2-Tetrachloroethane	7	1	14%	2.90	0.6	Yes	>SSL
Benzene	7	7	100%	29,000	0.8	Yes	>SSL
Toluene	7	7	100%	3,400	650 *	Yes	>SSL
Trichloroethene	7	1	14%	17	5	Yes	>SSL
Xylenes, Total	7	7	100%	3,270	410 *	Yes	>SSL
"Volatile Semivolatiles"							
Acenaphthene	2	2	100%	0.91	120 */b	No	<SSL
Anthracene	7	3	43%	5	6.8 */b	No	<SSL
Fluorene	7	5	71%	340	89 */b	Yes	>SSL
Naphthalene	7	7	100%	850	180 */b	Yes	>SSL
Acenaphthylene	7	5	71%	5.4	NA	Yes	No SSL
Phenanthrene	7	6	86%	180	NA	Yes	No SSL
Semivolatiles							
2,4-Dimethylphenol	7	1	14%	2.50	1,564	No	<RBC
2-Methylphenol	7	2	29%	0.60	3,911	No	<RBC
3-Methylphenol & 4-Methylphenol	2	1	50%	1.1	391	No	<RBC
4-Methylphenol	5	3	60%	2.40	391	No	<RBC
Benzo(k)fluoranthene	2	2	100%	1.3	8.7	No	<RBC
Chrysene	7	5	71%	46	87	No	<RBC
Fluoranthene	7	5	71%	110	3,129	No	<RBC
Phenol	7	5	71%	23	46,929	No	<RBC
Pyrene	7	5	71%	73	2,346	No	<RBC
Benz(a)anthracene	7	5	71%	49	0.87	Yes	>RBC
Benzo(a)pyrene	7	4	57%	22	0.087	Yes	>RBC
Benzo(b)fluoranthene	2	2	100%	2.5	0.87	Yes	>RBC

Table C-2
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group SFA-2 (SWMUs S-11 and S-22)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Dibenz(a,h)anthracene	2	2	100%	0.63	0.087	Yes	>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	2.1	0.87	Yes	>RBC
Benzo(ghi)perylene	2	2	100%	1.9	NA	Yes	No RBC
Metals							
Barium	7	6	86%	167	5,475	No	<RBC
Cadmium	7	5	71%	19	78	No	<RBC
Chromium	7	7	100%	170	235	No	<RBC
Mercury	7	5	71%	4	23	No	<RBC
Nickel	7	6	86%	44.2	1,564	No	<RBC
Selenium	5	4	80%	5.4	391	No	<RBC
Silver	7	5	71%	3.6	391	No	<RBC
Antimony	7	3	43%	39.90	31	Yes	>RBC
Arsenic	7	7	100%	39.10	0.43	Yes	>RBC
Lead	7	7	100%	878	400	Yes	>RBC
Miscellaneous							
Cyanide	12	7	58%	75	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

[*] Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Includes 3-methylphenol & 4-methylphenol; results conservatively evaluated as the more toxic 4-methylphenol.
Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-3
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-3
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
1,1-Dichloroethane	8	1	13%	0.0072	1,300 *	No	<SSL
Ethylbenzene	8	2	25%	1.3	400	No	<SSL
Methyl ethyl ketone	8	3	38%	0.085	21,000 /b	No	<SSL
Toluene	8	2	25%	0.0068	650 *	No	<SSL
Xylenes, Total	8	5	63%	5	410 *	No	<SSL
"Volatile Semivolatiles"							
Naphthalene	20	16	80%	8.1	180 */b	No	<SSL
Phenanthrene	8	4	50%	1.5	NA	**Yes**	No SSL
Semivolatiles							
Benz(a)anthracene	8	2	25%	0.44	0.87	No	<RBC
Chrysene	8	2	25%	0.60	87	No	<RBC
Fluoranthene	8	4	50%	2.25	3,129	No	<RBC
Indeno(1,2,3-c,d)pyrene	14	1	7%	0.53	0.87	No	<RBC
Pyrene	8	5	63%	1.5	2,346	No	<RBC
Benzo(a)pyrene	20	6	30%	0.69	0.087	**Yes**	>RBC
Metals							
Barium	20	13	65%	1,660	5,475	No	<RBC
Cadmium	20	12	60%	3.3	78	No	<RBC
Chromium	20	20	100%	172	235	No	<RBC
Mercury	14	6	43%	0.268	23	No	<RBC
Nickel	20	12	60%	64.6	1,564	No	<RBC
Selenium	14	6	43%	2.6	391	No	<RBC
Silver	14	8	57%	3.0	391	No	<RBC

Table C-3
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-3
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Arsenic	20	12	60%	16.2	0.43	**Yes**	>RBC
Lead	20	20	100%	7,520	400	**Yes**	>RBC
Thallium	8	5	63%	43.0	5.5	**Yes**	>RBC
Miscellaneous							
Cyanide	28	26	93%	43	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-4
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-24
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Chlorobenzene	5	1	20%	0.001	130	No	<SSL
Ethylbenzene	5	1	20%	0.017	400 *	No	<SSL
Methylene chloride	6	1	17%	0.015	13	No	<SSL
Methyl ethyl ketone	6	1	17%	0.008	21,000 /b	No	<SSL
1,1,1-Trichloroethane	6	2	33%	0.007	1,200 *	No	<SSL
Benzene	6	5	83%	40,000	0.80	Yes	>SSL
Toluene	6	6	100%	14,000	650 *	Yes	>SSL
Xylenes, Total	6	5	83%	4,800	410 *	Yes	>SSL
"Volatile Semivolatiles"							
Acenaphthene	6	1	17%	32	120 */b	No	<SSL
Anthracene	6	6	100%	210	6.8 */b	Yes	>SSL
Fluorene	6	6	100%	330	89 */b	Yes	>SSL
Naphthalene	6	6	100%	1,800	180 */b	Yes	>SSL
Acenaphthylene	6	2	33%	31	NA	Yes	No SSL
Phenanthrene	6	6	100%	850	NA	Yes	No SSL
Semivolatiles							
2,4-Dimethylphenol	6	1	17%	35	1,564	No	<RBC
3-Methylphenol & 4-Methylphenol	6	1	17%	60	391	No	<RBC
Bis(2-ethylhexyl)phthalate	6	2	33%	24	46	No	<RBC
Butyl benzyl phthalate	6	1	17%	24	15,643	No	<RBC
Di-n-butyl phthalate	6	1	17%	26	7,821	No	<RBC
Fluoranthene	6	6	100%	520	3,129	No	<RBC
Isophorone	6	1	17%	95	672	No	<RBC
Phenol	6	1	17%	25	46,929	No	<RBC
Pyrene	6	6	100%	390	2,346	No	<RBC
Benz(a)anthracene	6	6	100%	220	0.87	Yes	>RBC
Benzo(a)pyrene	6	5	83%	140	0.087	Yes	>RBC
Benzo(b)fluoranthene	6	6	100%	160	0.87	Yes	>RBC
Benzo(k)fluoranthene	6	3	50%	91	8.7	Yes	>RBC
Chrysene	6	6	100%	180	87	Yes	>RBC
Dibenz(a,h)anthracene	6	2	33%	29	0.087	Yes	>RBC
Indeno(1,2,3-c,d)pyrene	6	4	67%	68	0.87	Yes	>RBC

Table C-4
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-24
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Benzo(ghi)perylene	6	3	50%	66	NA	Yes	No RBC
Metals							
Barium	6	5	83%	121	5,475	No	<RBC
Cadmium	6	3	50%	2.1	78	No	<RBC
Chromium	6	6	100%	49.6	235	No	<RBC
Lead	6	6	100%	92.5	400	No	<RBC
Mercury	6	3	50%	0.82	23	No	<RBC
Nickel	6	3	50%	11.3	1,564	No	<RBC
Selenium	2	2	100%	4.4	391	No	<RBC
Thallium	6	1	17%	4.4	5.5	No	<RBC
Arsenic	6	6	100%	20.1	0.43	Yes	>RBC
Miscellaneous							
Cyanide	5	2	40%	5	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

[*] Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Includes 3-methylphenol & 4-methylphenol; results conservatively evaluated as the more toxic 4-methylphenol.

Cadmium RBC based on dietary reference dose (EPA, 1998).

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

Mercury is assumed to be inorganic.

Cyanide is assumed to be free cyanide.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

SSL = U.S. EPA Soil Screening Level (EPA, 1996).

No SSL or No RBC = no EPA SSL or Region III RBC available.

NA = not available.

< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-5
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-10
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
"Volatile Semivolatiles"							
Anthracene	2	2	100%	1.3	6.8 */b	No	<SSL
Fluorene	2	1	50%	0.63	89 */b	No	<SSL
Naphthalene	2	1	50%	2.1	180 */b	No	<SSL
Acenaphthylene	2	1	50%	0.26	NA	**Yes**	No SSL
Phenanthrene	2	2	100%	4.6	NA	**Yes**	No SSL
Semivolatiles							
Benzo(k)fluoranthene	2	2	100%	1.5	8.7	No	<RBC
Bis(2-ethylhexyl)phthalate	2	2	100%	0.47	46	No	<RBC
Chrysene	2	2	100%	2.5	87	No	<RBC
Fluoranthene	2	2	100%	5.7	3,129	No	<RBC
Pyrene	2	2	100%	4.6	2,346	No	<RBC
Benz(a)anthracene	2	2	100%	3.2	0.87	**Yes**	>RBC
Benzo(a)pyrene	2	2	100%	1.4	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	2	2	100%	2.4	0.87	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	1	0.87	**Yes**	>RBC
Metals							
Barium	2	2	100%	156	5,475	No	<RBC
Cadmium	2	2	100%	15.2	78	No	<RBC
Lead	2	2	100%	49.9	400	No	<RBC
Mercury	2	1	50%	0.16	23	No	<RBC
Selenium	2	2	100%	3.60	391	No	<RBC

Table C-5
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-10
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Arsenic	2	1	50%	11.3	0.43	Yes	>RBC
Chromium	2	2	100%	871	235	Yes	>RBC
Thallium	2	2	100%	28.4	5.5	Yes	>RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-6
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-14
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Carbon disulfide	2	1	50%	0.017	720 *	No	<SSL
Ethylbenzene	2	2	100%	0.13	400 *	No	<SSL
Methyl ethyl ketone	2	2	100%	0.045	21,000 /b	No	<SSL
Toluene	2	2	100%	1.660	650 *	No	<SSL
Trichloroethene	2	1	50%	0.008	5	No	<SSL
Xylenes, Total	2	2	100%	3.5	410 *	No	<SSL
Benzene	2	2	100%	0.825	0.8	**Yes**	>SSL
"Volatile Semivolatiles"							
Acenaphthene	2	2	100%	5.6	120 */b	No	<SSL
Fluorene	2	2	100%	41	89 */b	No	<SSL
Anthracene	2	2	100%	26	6.8 */b	**Yes**	>SSL
Naphthalene	2	2	100%	1,400	180 */b	**Yes**	>SSL
Acenaphthylene	2	2	100%	32	NA	**Yes**	No SSL
Phenanthrene	2	2	100%	130	NA	**Yes**	No SSL
Semivolatiles							
2,4-Dimethylphenol	2	1	50%	0.49	1,564	No	<RBC
2-Methylphenol	2	1	50%	0.48	3,911	No	<RBC
4-Methylphenol	2	1	50%	0.55	391	No	<RBC
Chrysene	2	2	100%	28	87	No	<RBC
Fluoranthene	2	2	100%	79	3,129	No	<RBC
Pyrene	2	2	100%	56	2,346	No	<RBC
Benz(a)anthracene	2	2	100%	30	0.87	**Yes**	>RBC
Benzo(a)pyrene	2	2	100%	27	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	2	2	100%	27	0.87	**Yes**	>RBC
Benzo(k)fluoranthene	2	2	100%	20	8.7	**Yes**	>RBC
Dibenz(a,h)anthracene	2	2	100%	3.5	0.087	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	17	0.87	**Yes**	>RBC

Table C-6
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-14
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Benzo(ghi)perylene	2	2	100%	15	NA	**Yes**	No RBC
Metals							
Antimony	2	2	100%	3.2	31	No	<RBC
Barium	2	2	100%	79	5,475	No	<RBC
Cadmium	2	2	100%	7.8	78	No	<RBC
Chromium	2	2	100%	200	235	No	<RBC
Lead	2	2	100%	225.5	400	No	<RBC
Mercury	2	2	100%	0.36	23	No	<RBC
Nickel	2	2	100%	135	1,564	No	<RBC
Silver	2	2	100%	4.95	391	No	<RBC
Arsenic	2	2	100%	12.8	0.43	**Yes**	>RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

[*] Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-7
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-16
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Metals							
Arsenic	5	5	100%	0.40	0.43	No	<RBC
Barium	5	5	100%	415	5,475	No	<RBC
Cadmium	5	5	100%	0.18	78	No	<RBC
Chromium	12	12	100%	122	235	No	<RBC
Lead	12	12	100%	170	400	No	<RBC
Mercury	5	5	100%	0.014	23	No	<RBC
Nickel	5	5	100%	19.4	1,564	No	<RBC
Selenium	5	5	100%	0.11	391	No	<RBC
Miscellaneous							
Cyanide	10	10	100%	278	1,564	No	<RBC

[a] EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-8
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-17
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Benzene	2	2	100%	0.01	0.8	No	<SSL
Carbon disulfide	2	2	100%	0.008	720 *	No	<SSL
Carbon tetrachloride	2	1	50%	0.004	0.3	No	<SSL
Methylene chloride	2	2	100%	0.012	13	No	<SSL
Toluene	2	2	100%	0.024	650 *	No	<SSL
1,1,1-Trichloroethane	2	2	100%	0.026	1,200 *	No	<SSL
Xylenes, Total	1	1	100%	0.021	410 *	No	<SSL
"Volatile Semivolatiles"							
Naphthalene	2	1	50%	0.65	180 */b	No	<SSL
Phenanthrene	2	2	100%	1.1	NA	**Yes**	No SSL
Semivolatiles							
Benzo(k)fluoranthene	2	2	100%	2.25	8.7	No	<RBC
Bis(2-ethylhexyl)phthalate	2	1	50%	0.53	46	No	<RBC
Chrysene	2	2	100%	2.8	87	No	<RBC
Fluoranthene	2	2	100%	2.85	3,129	No	<RBC
Pyrene	2	2	100%	2.65	2,346	No	<RBC
Benz(a)anthracene	2	2	100%	2.35	0.87	**Yes**	>RBC
Benzo(a)pyrene	2	2	100%	3.35	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	2	2	100%	3.55	0.87	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	2.45	0.87	**Yes**	>RBC
Benzo(ghi)perylene	2	2	100%	2.85	NA	**Yes**	No RBC
Metals							
Antimony	2	2	100%	12.5	31	No	<RBC
Barium	2	2	100%	103	5,475	No	<RBC
Cadmium	2	2	100%	7.9	78	No	<RBC

Table C-8
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-17
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Chromium	2	2	100%	113	235	No	<RBC
Lead	2	2	100%	90.2	400	No	<RBC
Nickel	2	2	100%	27.2	1,564	No	<RBC
Selenium	2	2	100%	0.77	391	No	<RBC
Thallium	2	2	100%	4.6	5.5	No	<RBC
Arsenic	2	2	100%	8.4	0.43	**Yes**	>RBC
Miscellaneous							
Cyanide	2	2	100%	1.3	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-9
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-23
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Toluene	2	2	100%	42	650 *	No	<SSL
Xylenes, Total	2	2	100%	42	410 *	No	<SSL
Benzene	2	2	100%	48	0.8	**Yes**	>SSL
"Volatile Semivolatiles"							
Anthracene	2	2	100%	1,300	6.8 */b	**Yes**	>SSL
Fluorene	2	2	100%	1,600	89 */b	**Yes**	>SSL
Naphthalene	2	2	100%	11,000	180 */b	**Yes**	>SSL
Acenaphthylene	2	2	100%	1,400	NA	**Yes**	No SSL
Phenanthrene	2	2	100%	5,500	NA	**Yes**	No SSL
Semivolatiles							
3-Methylphenol & 4-Methylphenol	2	1	50%	190	391	No	<RBC
Phenol	2	2	100%	270	46,929	No	<RBC
Pyrene	2	2	100%	2,300	2,346	No	<RBC
Benz(a)anthracene	2	2	100%	1,100	0.87	**Yes**	>RBC
Benzo(a)pyrene	2	2	100%	780	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	2	2	100%	950	0.87	**Yes**	>RBC
Benzo(k)fluoranthene	2	2	100%	490	8.7	**Yes**	>RBC
Chrysene	2	1	50%	610	87	**Yes**	>RBC
Fluoranthene	2	2	100%	3,500	3,129	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	2	1	50%	280	0.87	**Yes**	>RBC
Metals							
Barium	2	2	100%	138	5,475	No	<RBC
Cadmium	2	1	50%	1.8	78	No	<RBC
Chromium	2	2	100%	120	235	No	<RBC
Lead	2	2	100%	27.4	400	No	<RBC

Table C-9
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-23
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Mercury	2	1	50%	0.4	23	No	<RBC
Selenium	2	2	100%	2.6	391	No	<RBC
Arsenic	2	2	100%	9.2	0.43	**Yes**	>RBC
Thallium	2	2	100%	5.7	5.48	**Yes**	>RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-10
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group PA-1 (SWMUs P-1 and P-2)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Methylene chloride	2	1	50%	0.028	13	No	<SSL
1,1,1-Trichloroethane	2	2	100%	0.077	1,200 *	No	<SSL
"Volatile Semivolatiles"							
Acenaphthene	2	1	50%	0.49	120 */b	No	<SSL
Anthracene	2	2	100%	2.1	6.8 */b	No	<SSL
Fluorene	2	1	50%	1.03	89 */b	No	<SSL
Naphthalene	2	2	100%	1.95	180 */b	No	<SSL
Phenanthrene	2	2	100%	7.2	NA	**Yes**	No SSL
Semivolatiles							
2,4-Dimethylphenol	2	1	50%	0.93	1,564	No	<RBC
2-Methylphenol	2	1	50%	1.28	3,911	No	<RBC
3-Methylphenol & 4-Methylphenol	2	1	50%	2.4	391	No	<RBC
Benzo(k)fluoranthene	2	2	100%	3.35	8.7	No	<RBC
Bis(2-ethylhexyl)phthalate	2	2	100%	0.67	46	No	<RBC
Chrysene	2	2	100%	4.15	87	No	<RBC
Fluoranthene	2	2	100%	9.05	3,129	No	<RBC
Phenol	2	2	100%	2.65	46,929	No	<RBC
Pyrene	2	2	100%	7.40	2,346	No	<RBC
Benz(a)anthracene	2	2	100%	5.05	0.87	**Yes**	>RBC
Benzo(a)pyrene	2	2	100%	4.6	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	2	2	100%	4.1	0.87	**Yes**	>RBC
Dibenz(a,h)anthracene	2	1	50%	0.63	0.087	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	2.5	0.87	**Yes**	>RBC
Benzo(ghi)perylene	2	1	50%	2	NA	**Yes**	No RBC
Metals							
Barium	2	2	100%	92.75	5,475	No	<RBC

Table C-10
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group PA-1 (SWMUs P-1 and P-2)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Cadmium	2	2	100%	2.95	78	No	<RBC
Chromium	2	2	100%	143.45	235	No	<RBC
Lead	2	2	100%	25.85	400	No	<RBC
Mercury	2	1	50%	0.12	23	No	<RBC
Nickel	2	2	100%	8.35	1,564	No	<RBC
Selenium	2	2	100%	1.85	391	No	<RBC
Arsenic	2	2	100%	15.35	0.43	**Yes**	>RBC
Thallium	2	2	100%	6.18	5.48	**Yes**	>RBC
Miscellaneous							
Cyanide	1	1	100%	7.1	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-11
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group PA-3 (SWMUs P-9 and P-10)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Benzene	1	1	100%	0.003	0.8	No	<SSL
Methylene chloride	1	1	100%	0.01	13	No	<SSL
Toluene	1	1	100%	0.003	650 *	No	<SSL
Xylenes, Total	1	1	100%	0.007	410 *	No	<SSL
"Volatile Semivolatiles"							
Fluorene	1	1	100%	38	89 */b	No	<SSL
Naphthalene	1	1	100%	23	180 */b	No	<SSL
Anthracene	1	1	100%	56	6.8 */b	**Yes**	>SSL
Acenaphthylene	1	1	100%	33	NA	**Yes**	No SSL
Phenanthrene	1	1	100%	15	NA	**Yes**	No SSL
Semivolatiles							
Chrysene	1	1	100%	39	87	No	<RBC
Fluoranthene	1	1	100%	140	3,129	No	<RBC
Pyrene	1	1	100%	82	2,346	No	<RBC
Benz(a)anthracene	1	1	100%	45	0.87	**Yes**	>RBC
Benzo(a)pyrene	1	1	100%	26	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	1	1	100%	35	0.87	**Yes**	>RBC
Benzo(k)fluoranthene	1	1	100%	26	8.750	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	1	1	100%	15	0.87	**Yes**	>RBC
Benzo(ghi)perylene	1	1	100%	14	NA	**Yes**	No RBC
Metals							
Cadmium	1	1	100%	3.5	78	No	<RBC
Chromium	1	1	100%	184	235	No	<RBC
Lead	1	1	100%	18.1	400	No	<RBC
Nickel	1	1	100%	6.8	1,564	No	<RBC

Table C-11
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group PA-3 (SWMUs P-9 and P-10)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Selenium	1	1	100%	1.5	391	No	<RBC
Arsenic	1	1	100%	5.3	0.43	**Yes**	>RBC
Thallium	1	1	100%	6	5.5	**Yes**	>RBC
Miscellaneous							
Cyanide	1	1	100%	52.2	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

Cyanide is assumed to be free cyanide.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

SSL = U.S. EPA Soil Screening Level (EPA, 1996).

No SSL or No RBC = no EPA SSL or Region III RBC available.

NA = not available.

< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-12
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU Group PA-4 (SWMUs P-11 and P-12)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Ethylbenzene	11	9	82%	170	400 *	No	<SSL
Benzene	11	11	100%	2,800	0.8	Yes	>SSL
Toluene	11	10	91%	1,700	650 *	Yes	>SSL
Xylenes, Total	11	10	91%	1,100	410 *	Yes	>SSL
"Volatile Semivolatiles"							
Naphthalene	11	11	100%	1,100	180 */b	Yes	>SSL

Notes:

[a] EPA Soil Screening Level (SSL) for vapor inhalation (EPA, 1996).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration(the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996)

< SSL = Maximum Detect was less than EPA SSL.

> SSL = Maximum Detect was greater than EPA SSL.

Table C-13
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU P-18
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Benzene	7	5	71%	0.052	0.8	No	<SSL
Carbon disulfide	7	5	71%	0.014	720 *	No	<SSL
Methylene chloride	7	3	43%	0.004	13	No	<SSL
Toluene	7	4	57%	0.005	650 *	No	<SSL
1,1,1-Trichloroethane	7	2	29%	0.003	1,200 *	No	<SSL
Trichlorofluoromethane	7	1	14%	0.003	1,000 **	No	<SSL
Xylenes, Total	7	3	43%	0.032	410 *	No	<SSL
"Volatile Semivolatiles"							
Anthracene	7	6	86%	3.3	6.8 */b	No	<SSL
Fluorene	7	2	29%	1.4	89 */b	No	<SSL
Naphthalene	7	4	57%	1.8	180 */b	No	<SSL
Phenanthrene	7	6	86%	17	NA	**Yes**	No SSL
Semivolatiles							
2,4-Dimethylphenol	7	1	14%	0.1	1,564	No	<RBC
2-Methylphenol	7	1	14%	0.46	3,911	No	<RBC
3-Methylphenol & 4-Methylphenol	3	1	33%	0.72	391	No	<RBC
4-Methylphenol	4	2	50%	2	391	No	<RBC
Benzo(k)fluoranthene	7	4	57%	2.9	8.7	No	<RBC
Bis(2-ethylhexyl)phthalate	7	5	71%	2.1	46	No	<RBC
Chrysene	7	7	100%	7.7	87	No	<RBC
Di-n-butyl phthalate	7	5	71%	1.7	7,821	No	<RBC
Fluoranthene	7	7	100%	22	3,129	No	<RBC
Phenol	7	2	29%	1	46,929	No	<RBC
Pyrene	7	7	100%	20	2,346	No	<RBC
Benz(a)anthracene	7	6	86%	20	0.87	**Yes**	>RBC
Benzo(a)pyrene	7	6	86%	4.2	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	7	7	100%	11	0.87	**Yes**	>RBC
Dibenz(a,h)anthracene	7	3	43%	1.2	0.087	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	7	5	71%	5.3	0.87	**Yes**	>RBC
Benzo(ghi)perylene	7	6	86%	6.7	NA	**Yes**	No RBC

Table C-13
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU P-18
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Metals							
Antimony	4	4	100%	13.9	31	No	<RBC
Barium	7	7	100%	202	5,475	No	<RBC
Cadmium	7	6	86%	20.3	78	No	<RBC
Chromium	7	7	100%	58.8	235	No	<RBC
Mercury	7	2	29%	0.59	23	No	<RBC
Nickel	7	4	57%	39.5	1,564	No	<RBC
Selenium	4	1	25%	9.9	391	No	<RBC
Silver	4	4	100%	37.2	391	No	<RBC
Arsenic	7	7	100%	91	0.43	**Yes**	>RBC
Lead	7	7	100%	14,000	400	**Yes**	>RBC
Thallium	7	6	86%	26.5	5.5	**Yes**	>RBC
Miscellaneous							
Cyanide	6	6	100%	314	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

[*] Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-14
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-26
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Benzene	2	1	50%	0.005	0.8	No	<SSL
Carbon disulfide	2	2	100%	0.008	720 *	No	<SSL
Methylene chloride	2	2	100%	0.005	13	No	<SSL
Toluene	2	1	50%	0.008	650 *	No	<SSL
Xylenes, Total	2	2	100%	0.013	410 *	No	<SSL
"Volatile Semivolatiles"							
Acenaphthene	2	1	50%	0.3	120 */b	No	<SSL
Anthracene	2	2	100%	2.6	6.8 */b	No	<SSL
Fluorene	2	2	100%	1.9	89 */b	No	<SSL
Naphthalene	2	2	100%	8.2	180 */b	No	<SSL
Acenaphthylene	2	2	100%	1.2	NA	**Yes**	No SSL
Phenanthrene	2	2	100%	9.2	NA	**Yes**	No SSL
Semivolatiles							
Benzo(k)fluoranthene	2	2	100%	1.2	8.7	No	<RBC
Chrysene	2	2	100%	3	87	No	<RBC
Fluoranthene	2	2	100%	9.5	3,129	No	<RBC
Pyrene	2	2	100%	6.8	2,346	No	<RBC
Benz(a)anthracene	2	2	100%	3.6	0.87	**Yes**	>RBC
Benzo(a)pyrene	2	2	100%	2.8	0.087	**Yes**	>RBC
Benzo(b)fluoranthene	2	2	100%	3.6	0.87	**Yes**	>RBC
Dibenz(a,h)anthracene	2	2	100%	0.29	0.087	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	1.4	0.87	**Yes**	>RBC
Benzo(ghi)perylene	2	2	100%	1.4	NA	**Yes**	No RBC

Table C-14
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-26
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Metals							
Antimony	2	1	50%	27.4	31	No	<RBC
Barium	2	2	100%	170	5,475	No	<RBC
Lead	2	2	100%	11.5	400	No	<RBC
Mercury	2	2	100%	0.19	23	No	<RBC
Nickel	2	1	50%	8.7	1,564	No	<RBC
Arsenic	2	2	100%	14.9	0.43	**Yes**	>RBC
Chromium	2	2	100%	1,400	235	**Yes**	>RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-15
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-25
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Carbon disulfide	2	1	50%	0.002	720 *	No	<SSL
Methylene chloride	2	1	50%	0.001	13	No	<SSL
"Volatile Semivolatiles"							
Anthracene	2	1	50%	0.04	6.8 */b	No	<SSL
Naphthalene	2	1	50%	0.3	180 */b	No	<SSL
Phenanthrene	2	2	100%	0.28	NA	**Yes**	No SSL
Semivolatiles							
Benz(a)anthracene	2	2	100%	0.2	0.87	No	<RBC
Benzo(b)fluoranthene	2	2	100%	0.26	0.87	No	<RBC
Benzo(k)fluoranthene	2	1	50%	0.18	8.7	No	<RBC
Chrysene	2	2	100%	0.25	87	No	<RBC
Dibenz(a,h)anthracene	2	1	50%	0.044	0.087	No	<RBC
Fluoranthene	2	2	100%	0.35	3,129	No	<RBC
Indeno(1,2,3-c,d)pyrene	2	1	50%	0.17	0.87	No	<RBC
Pyrene	2	2	100%	0.33	2,346	No	<RBC
Benzo(a)pyrene	2	1	50%	0.18	0.087	**Yes**	>RBC
Benzo(ghi)perylene	2	1	50%	0.15	NA	**Yes**	No RBC
Metals							
Antimony	2	2	100%	1.1	31	No	<RBC
Barium	2	2	100%	229	5,475	No	<RBC
Cadmium	2	2	100%	7.9	78	No	<RBC

Table C-15
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU S-25
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Lead	2	2	100%	60.7	400	No	<RBC
Nickel	2	2	100%	39	1,564	No	<RBC
Silver	2	2	100%	10	391	No	<RBC
Chromium	2	2	100%	1,580	235	**Yes**	>RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-16
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU P-63
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Benzene	6	2	33%	0.011	0.8	No	<SSL
Ethylbenzene	6	3	50%	0.006	400 *	No	<SSL
Methylene chloride	6	1	17%	0.011	13	No	<SSL
Toluene	6	4	67%	0.018	650 *	No	<SSL
Xylenes, Total	6	2	33%	0.02	410 *	No	<SSL
Semivolatiles							
Benz(a)anthracene	1	1	100%	0.51	0.87	No	<RBC
Benzo(b)fluoranthene	1	1	100%	0.69	0.87	No	<RBC
Di-n-butyl phthalate	6	1	17%	0.09	7,821	No	<RBC
Fluoranthene	1	1	100%	0.43	3,129	No	<RBC
Metals							
Barium	6	6	100%	138	5,475	No	<RBC
Cadmium	6	2	33%	4	78	No	<RBC
Chromium	6	6	100%	41	235	No	<RBC
Lead	6	6	100%	153	400	No	<RBC
Nickel	6	6	100%	39	1,564	No	<RBC
Selenium	6	5	83%	2	391	No	<RBC
Arsenic	6	6	100%	58	0.43	**Yes**	>RBC

Table C-16
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU P-63
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Miscellaneous							
Cyanide	6	1	17%	4	1,564	No	<RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

Table C-17
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU P-73
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Volatiles							
Benzene	6	2	33%	0.008	0.8	No	<SSL
Bromoform	6	1	17%	0.002	53	No	<SSL
Carbon disulfide	6	2	33%	0.005	720 *	No	<SSL
1,2-Dichloroethane	6	1	17%	0.002	0.4	No	<SSL
Ethylbenzene	6	2	33%	0.003	400 *	No	<SSL
Methylene chloride	6	5	83%	0.015	13	No	<SSL
1,1,2,2-Tetrachloroethane	6	1	17%	0.003	0.6	No	<SSL
Tetrachloroethene	6	1	17%	0.005	11	No	<SSL
Toluene	6	3	50%	0.027	650 *	No	<SSL
Xylenes, Total	6	3	50%	0.005	410 *	No	<SSL
"Volatile Semivolatiles"							
Acenaphthene	6	2	33%	1	120 */b	No	<SSL
Anthracene	6	2	33%	2.3	6.8 */b	No	<SSL
Fluorene	6	2	33%	0.84	89 */b	No	<SSL
Naphthalene	6	1	17%	0.37	180 */b	No	<SSL
Acenaphthylene	6	1	17%	0.19	NA	**Yes**	No SSL
Phenanthrene	6	2	33%	9.3	NA	**Yes**	No SSL
Semivolatiles							
3-Methylphenol & 4-Methylphenol	6	1	17%	0.16	391	No	<RBC
Benzo(k)fluoranthene	6	2	33%	4.5	8.7	No	<RBC
Chrysene	6	2	33%	5.5	87	No	<RBC
Di-n-butyl phthalate	6	3	50%	0.41	7,821	No	<RBC
Fluoranthene	6	2	33%	9.20	3,129	No	<RBC
Phenol	6	2	33%	0.64	46,929	No	<RBC
Pyrene	6	2	33%	12	2,346	No	<RBC
Benz(a)anthracene	6	2	33%	5	0.87	**Yes**	>RBC
Benzo(a)pyrene	6	2	33%	4.7	0.087	**Yes**	>RBC

Table C-17
Summary of COPC Selection Process
Subsurface SWMU Material
SWMU P-73
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	COPC Screening Level [a] (mg/kg)	Human Health COPC?	Rationale
Benzo(b)fluoranthene	6	2	33%	8.9	0.87	**Yes**	>RBC
Dibenz(a,h)anthracene	6	1	17%	0.84	0.087	**Yes**	>RBC
Indeno(1,2,3-c,d)pyrene	6	1	17%	4.4	0.87	**Yes**	>RBC
Benzo(ghi)perylene	6	1	17%	2.4	NA	**Yes**	No RBC
Metals							
Antimony	4	3	75%	10.3	31	No	<RBC
Barium	6	6	100%	152	5,475	No	<RBC
Cadmium	6	1	17%	0.84	78	No	<RBC
Chromium	6	6	100%	37.8	235	No	<RBC
Lead	6	6	100%	68.2	400	No	<RBC
Nickel	6	6	100%	35.4	1,564	No	<RBC
Selenium	6	2	33%	1.2	391	No	<RBC
Arsenic	6	6	100%	26.4	0.43	**Yes**	>RBC

[a] For volatiles, EPA Soil Screening Levels for vapor inhalation (EPA, 1996); for semi-volatiles and metals, EPA Region III Risk-Based Concentrations for residential soil ingestion (EPA, 1998).

[b] SSL calculated per EPA SSL guidance (EPA, 1996).

* Soil saturation concentration (the concentration at which the absorptive limit of the soil has been reached; concentrations greater than the saturation concentration indicate the presence of free phase) (EPA, 1996).

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
SSL = U.S. EPA Soil Screening Level (EPA, 1996).
No SSL or No RBC = no EPA SSL or Region III RBC available.
NA = not available.
< SSL or < RBC = Maximum Detect was greater than EPA SSL or Region III RBC.
> SSL or > RBC = Maximum Detect was greater than EPA SSL or Region III RBC.

APPENDIX D

Table D-1
Summary of COPC Selection Process
Groundwater
Lake Erie Discharge Area
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
1,1,1-Trichloroethane	282	5	2%	14	541	5	NYS	No	<DF
1,1,2-Trichloroethane	282	1	0.4%	2.3	0.19	5	RBC	No	<DF
1,2-Dichlorobenzene	294	1	0.3%	28.0	64	3	NYS	No	<DF
1,2-Dichloroethane	291	11	4%	300	0.12	0.6	RBC	No	<DF
Acrylonitrile	272	2	1%	7.9	0.12	5	RBC	No	<DF
Carbon tetrachloride	291	1	0.3%	3.4	0.16	5	RBC	No	<DF
Chlorobenzene	291	8	3%	54	35	5	NYS	No	<DF
Chloroform	291	1	0.3%	2.9	0.15	7	RBC	No	<DF
Hexachlorobenzene	294	1	0.3%	12	0.01	0.04	RBC	No	<DF
Tetrachloroethene	282	1	0.4%	19	1.1	5	RBC	No	<DF
trans-1,2-Dichloroethene	272	3	1%	16	122	5	NYS	No	<DF
Carbon disulfide	37	13	35%	66.5	1,043	NA	RBC	No	<Std
1,1-Dichloroethane	291	80	27%	160	798	5	NYS	**Yes**	>Std
1,2-Dichloroethene, Total	19	2	11%	7.5	55	5	NYS	**Yes**	>Std
Benzene	413	339	82%	470,000	0.36	1	RBC	**Yes**	>Std
Ethylbenzene	302	103	34%	25,000	1,340	5	NYS	**Yes**	>Std
Methylene chloride	282	30	11%	200	4.1	5	RBC	**Yes**	>Std
m-Xylene & p-Xylene	52	41	79%	110	NA	5	NYS	**Yes**	>Std
o-Xylene	52	43	83%	53	12,167	5	NYS	**Yes**	>Std
Pyridine	264	18	7%	50	37	50	RBC	**Yes**	>Std
Toluene	293	209	71%	77,000	747	5	NYS	**Yes**	>Std
Trichloroethene	282	54	19%	46	1.6	5	RBC	**Yes**	>Std
Xylenes, Total	254	177	70%	390,000	12,167	5	NYS	**Yes**	>Std
Semivolatiles									
2,4-Dichlorophenol	296	1	0.3%	2.0	110	5	NYS	No	<DF
2-Chloronaphthalene	294	1	0.3%	1.0	487	10	NYS	No	<DF
4-Chloro-3-Methylphenol	296	3	1%	20	NA	1	NYS	No	<DF
Benz(a)anthracene	294	5	2%	9	0.09	0.002	NYS	No	<DF
Benzo(a)pyrene	294	3	1%	8	0.01	NA	RBC	No	<DF

Table D-1
Summary of COPC Selection Process
Groundwater
Lake Erie Discharge Area
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Benzo(b)fluoranthene	45	1	2%	4	0.09	0.002	NYS	No	<DF
Benzo(ghi)perylene	45	1	2%	2.0	NA	NA	NA	No	<DF
Butyl benzyl phthalate	294	1	0.3%	4	7,300	50	NYS	No	<DF
Chrysene	294	6	2%	10	9.2	0.002	NYS	No	<DF
Diethyl phthalate	294	1	0.3%	1.3	29,200	50	NYS	No	<DF
Di-n-butyl phthalate	294	2	1%	5.0	3,650	50	NYS	No	<DF
Indeno(1,2,3-c,d)pyrene	45	1	2%	2	0.09	0.002	NYS	No	<DF
Pentachlorophenol	296	4	1%	13	0.56	1	RBC	No	<DF
Acenaphthene	45	11	24%	4.4	2,190	20	NYS	No	<Std
Fluoranthene	294	73	25%	38	1,460	50	NYS	No	<Std
Pyrene	294	58	20%	30	1,095	50	NYS	No	<Std
2,4-Dimethylphenol	296	107	36%	74	730	50	NYS	**Yes**	>Std
2-Methylphenol	269	109	41%	620	1,825	1	NYS	**Yes**	>Std
3-Methylphenol & 4-Methylphenol	179	96	54%	3,400	183	1	NYS	**Yes**	>Std
4-Methylphenol	91	34	37%	168	183	1	NYS	**Yes**	>Std
Anthracene	294	30	10%	59	10,950	50	NYS	**Yes**	>Std
Bis(2-ethylhexyl)phthalate	295	82	28%	890	4.8	5	RBC	**Yes**	>Std
Cresols, Total	9	4	44%	39	182.5	1	NYS	**Yes**	>Std
Fluorene	294	192	65%	73	1,460	50	NYS	**Yes**	>Std
Naphthalene	415	319	77%	280,000	730	10	NYS	**Yes**	>Std
Phenanthrene	294	192	65%	120	NA	50	NYS	**Yes**	>Std
Phenol	323	141	44%	16,000	21,900	1	NYS	**Yes**	>Std
Acenaphthylene	292	179	61%	130	NA	NA	NA	**Yes**	No Std
Metals (Total *)									
Cadmium	139	4	2.9%	63	18	5	NYS	No	<DF
Mercury	140	4	3%	3	11	0.7	NYS	No	<DF
Silver	139	3	2%	68	183	50	NYS	No	<DF
Thallium	85	4	5%	18	2.6	0.5	NYS	No	<DF
Antimony	87	8	9%	10.1	15	3	NYS	**Yes**	>Std
Arsenic	139	33	24%	114.0	0.04	25	RBC	**Yes**	>Std

Table D-1
Summary of COPC Selection Process
Groundwater
Lake Erie Discharge Area
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Barium	138	37	27%	25,400	2,555	1,000	NYS	Yes	>Std
Chromium	157	36	23%	1,140	110	50	NYS	Yes	>Std
Lead	158	34	22%	358	15	25	RBC	Yes	>Std
Nickel	87	11	13%	184	730	100	NYS	Yes	>Std
Selenium	118	38	32%	19	183	10	NYS	Yes	>Std
Miscellaneous									
Cyanide	274	172	62%	18,000	730	200	NYS	Yes	>Std

* Total metals data used in the analysis, except for the data from wells MWN-06A, MWS-04, MWS-05, MWS-06, MWS-07, and MWS-08. These wells had no total metals data available, so the dissolved metals data were used.

Notes:

1,2-Dichloroethene, Total is evaluated as "1,2-Dichloroethylene (mixture)" for RBC and "trans-Dichloroethene" for NYS.
m-Xylene & p-Xylene is evaluated as m-Xylene.
The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Total cresols is conservatively evaluated as 4-methylphenol, the most toxic isomer.
Cadmium RBC based on reference dose in water (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
< DF = Detection Frequency was less than 5%.
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-2
Summary of COPC Selection Process
Groundwater
Smokes Creek Discharge Area
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
1,2-Dichloroethane	45	1	2%	6	0.12	1	RBC	No	<DF
Hexachlorobenzene	45	1	2%	2	0.007	0.04	RBC	No	<DF
Methylene chloride	46	2	4%	7	4.1	5	RBC	No	<DF
Vinyl chloride	45	2	4%	1,100	0.019	2	RBC	Yes	High concentration
1,1-Dichloroethane	45	8	18%	36	798	5	NYS	Yes	>Std
Benzene	76	60	79%	230,000	0.36	1	RBC	Yes	>Std
Carbon disulfide	7	1	14%	1,300	1,043	NA	RBC	Yes	>Std
Ethylbenzene	57	8	14%	5,600	1,340	5	NYS	Yes	>Std
Pyridine	43	12	28%	250,000	37	50	RBC	Yes	>Std
Toluene	58	32	55%	16,000	747	5	NYS	Yes	>Std
Xylenes, Total	58	25	43%	8,400	12,167	5	NYS	Yes	>Std
Semivolatiles									
2,3,4,6-Tetrachlorophenol	46	1	2%	3	1,095	1	NYS	No	<DF
2,4-Dichlorophenol	46	1	2%	10	110	5	NYS	No	<DF
2,6-Dinitrotoluene	45	1	2%	11	37	5	NYS	No	<DF
2-Chloronaphthalene	45	1	2%	3	487	10	NYS	No	<DF
Benz(a)anthracene	45	1	2%	15	0.092	0.002	NYS	No	<DF
Butyl benzyl phthalate	45	1	2%	32	7,300	50	NYS	No	<DF
Chrysene	45	1	2%	14	9.2	0.002	NYS	No	<DF
Diethyl phthalate	45	2	4%	13	29,200	50	NYS	No	<DF
Dimethyl phthalate	45	2	4%	11	365,000	50	NYS	No	<DF
Di-n-octyl phthalate	46	1	2%	2	730	50	NYS	No	<DF
Pentachlorophenol	46	1	2%	5	0.56	1	RBC	No	<DF
Anthracene	45	5	11%	28	10,950	50	NYS	No	<Std
Pyrene	45	9	20%	38	1,095	50	NYS	No	<Std
2,4-Dimethylphenol	46	20	43%	405	730	50	NYS	Yes	>Std
2-Methylphenol	46	23	50%	2,350	1,825	1	NYS	Yes	>Std
3-Methylphenol & 4-Methylphenol	28	18	64%	10,250	183	1	NYS	Yes	>Std
4-Methylphenol	18	7	39%	1,000	183	1	NYS	Yes	>Std
Bis(2-ethylhexyl)phthalate	46	8	17%	33	4.8	5	RBC	Yes	>Std
Fluoranthene	45	9	20%	56	1,460	50	NYS	Yes	>Std
Fluorene	46	13	28%	140	1,460	50	NYS	Yes	>Std

Table D-2
Summary of COPC Selection Process
Groundwater
Smokes Creek Discharge Area
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Naphthalene	68	40	59%	3,500	730	10	NYS	**Yes**	>Std
Phenanthrene	45	15	33%	170	NA	50	NYS	**Yes**	>Std
Phenol	46	32	70%	26,000	21,900	1.0	NYS	**Yes**	>Std
Acenaphthylene	45	11	24%	110	NA	NA	NA	**Yes**	No Std
Metals (Total *)									
Mercury	24	3	13%	0.52	11	0.7	NYS	No	<Std
Antimony	22	9	41%	210	15	3	NYS	**Yes**	>Std
Arsenic	23	11	48%	51	0.045	25	RBC	**Yes**	>Std
Barium	24	9	38%	2,090	2,555	1,000	NYS	**Yes**	>Std
Cadmium	24	6	25%	116	18	5	NYS	**Yes**	>Std
Chromium	22	12	55%	1,900	110	50	NYS	**Yes**	>Std
Lead	24	11	46%	1,470	15	25	RBC	**Yes**	>Std
Nickel	24	6	25%	370	730	100	NYS	**Yes**	>Std
Silver	24	3	13%	100	183	50	NYS	**Yes**	>Std
Thallium	20	5	25%	89.1	2.6	0.5	NYS	**Yes**	>Std
Miscellaneous									
Cyanide	40	33	83%	26,500	730	200	NYS	**Yes**	>Std

* Only total metals data were used in the analysis.

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Cadmium RBC based on reference dose in water (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
< DF = Detection Frequency was less than 5%.
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-3
Summary of COPC Selection Process
Groundwater
Ship Canal Discharge Area
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Benzene	26	20	77%	39,000	0.36	1	RBC	Yes	>Std
Ethylbenzene	17	6	35%	770	1,340	5	NYS	Yes	>Std
Methylene chloride	17	1	6%	3,400	4.1	5	RBC	Yes	>Std
Toluene	17	9	53%	7,200	747	5	NYS	Yes	>Std
Xylenes, Total	17	10	59%	7,100	12,167	5	NYS	Yes	>Std
Semivolatiles									
Anthracene	15	1	7%	4	10,950	50	NYS	No	<Std
2,4-Dimethylphenol	15	2	13%	340	730	50	NYS	Yes	>Std
2-Methylphenol	15	2	13%	62	1,825	1	NYS	Yes	>Std
3-Methylphenol & 4-Methylphenol	7	1	14%	15	183	1	NYS	Yes	>Std
4-Methylphenol	8	1	13%	42	183	1	NYS	Yes	>Std
Acenaphthene	2	2	100%	330	2,190	20	NYS	Yes	>Std
Benz(a)anthracene	15	2	13%	97	0.092	0.002	NYS	Yes	>Std
Benzo(a)pyrene	15	2	13%	69	0.009	NA	RBC	Yes	>Std
Benzo(b)fluoranthene	2	1	50%	62	0.092	0.002	NYS	Yes	>Std
Benzo(k)fluoranthene	2	1	50%	65	0.92	0.002	NYS	Yes	>Std
Bis(2-ethylhexyl)phthalate	15	2	13%	5	4.8	5	RBC	Yes	>Std
Chrysene	15	2	13%	76	9.2	0.002	NYS	Yes	>Std
Dibenz(a,h)anthracene	2	1	50%	19	0.009	NA	RBC	Yes	>Std
Fluoranthene	15	5	33%	215	1,460	50	NYS	Yes	>Std
Fluorene	15	7	47%	600	1,460	50	NYS	Yes	>Std
Indeno(1,2,3-c,d)pyrene	3	1	33%	35	0.092	0.002	NYS	Yes	>Std
Naphthalene	24	23	96%	9,650	730	10	NYS	Yes	>Std
Phenanthrene	15	5	33%	320	NA	50	NYS	Yes	>Std
Phenol	15	7	47%	220	21,900	1	NYS	Yes	>Std
Pyrene	15	4	27%	165	1,095	50	NYS	Yes	>Std
Acenaphthylene	15	3	20%	81	NA	NA	NA	Yes	No Std
Benzo(ghi)perylene	2	1	50%	29	NA	NA	NA	Yes	No Std

Table D-3
Summary of COPC Selection Process
Groundwater
Ship Canal Discharge Area
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
*Metals (Total *)*									
Antimony	6	1	17%	2	15	3	NYS	No	<Std
Chromium	6	3	50%	23	110	50	NYS	No	<Std
Mercury	6	2	33%	0.63	11	0.7	NYS	No	<Std
Nickel	6	2	33%	22	730	100	NYS	No	<Std
Arsenic	5	4	80%	740	0.045	25	RBC	Yes	>Std
Barium	6	4	67%	1,160	2,555	1,000	NYS	Yes	>Std
Lead	5	5	100%	142	15	25	RBC	Yes	>Std
Miscellaneous									
Cyanide	13	11	85%	800	730	200	NYS	Yes	>Std

* Only total metals data were used in the analysis.

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.

Mercury is assumed to be inorganic.

Cyanide is assumed to be free cyanide.

< Std = Maximum Detect was less than minimum standard.

> Std = Maximum Detect was greater than minimum standard.

NA = not available.

No Std = No RBC or NYSDEC screening level available.

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-4
Summary of COPC Selection Process
Groundwater
Slag Fill Area Zone 1
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Toluene	16	1	6%	2.6	747	5	NYS	No	<Std
1,1,1-Trichloroethane	16	1	6%	11	541	5	NYS	**Yes**	>Std
Benzene	31	8	26%	91	0.36	1.0	RBC	**Yes**	>Std
Carbon tetrachloride	16	1	6%	3.4	0.16	5	RBC	**Yes**	>Std
Methylene chloride	16	1	6%	5.8	4.1	5	RBC	**Yes**	>Std
Xylenes, Total	16	2	13%	6.4	12,167	5	NYS	**Yes**	>Std
1,1-Dichloroethane	16	1	6%	4.3 *	810	5	NYS	**Yes**	Primary > Std
"Volatile Semivolatiles"									
Fluorene	15	1	7%	2.6	1,460	50	NYS	No	<Std
Naphthalene	30	5	17%	800	730	10	NYS	**Yes**	>Std
Acenaphthylene	15	2	13%	8.7	NA	NA	NA	**Yes**	No Std

* Maximum detect was a duplicate-averaged result. Primary result of 6 µg/L exceeded the minimum COPC screening level.

Notes:

< Std = Maximum Detect was less than minimum standard.

> Std = Maximum Detect was greater than minimum standard.

NA = not available.

No Std = No RBC or NYSDEC screening level available.

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

Primary > Std = Primary result exceeded the minimum standard, so analyte retained as COPC.

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-5
Summary of COPC Selection Process
Groundwater
Slag Fill Area Zone 2
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Chlorobenzene	110	1	1%	1.4	35	5	NYS	No	<DF
Chloroform	109	1	1%	2.9	0.15	7	RBC	No	<DF
Pyridine	103	4	4%	250,000	37	50	RBC	No	<DF
Tetrachloroethene	105	1	1%	19	1.1	5	RBC	No	<DF
trans-1,2-Dichloroethene	101	3	3%	16	122	5	NYS	No	<DF
Carbon disulfide	21	4	19%	66.5	1,043	NA	RBC	No	<Std
1,1-Dichloroethane	109	60	55.0%	110	798	5	NYS	**Yes**	>Std
1,2-Dichloroethane	109	11	10%	300	0.12	1	RBC	**Yes**	>Std
1,2-Dichloroethene, Total	8	2	25%	7.45	55	5	NYS	**Yes**	>Std
Benzene	154	134	87%	110,000	37	50	RBC	**Yes**	>Std
Ethylbenzene	112	60	54%	40	1,340	5	NYS	**Yes**	>Std
Methylene chloride	105	11	10%	130	4.1	5	RBC	**Yes**	>Std
m-Xylene & p-Xylene	16	15	94%	110	NA	5	NYS	**Yes**	>Std
o-Xylene	16	15	94%	53	12,167	5	NYS	**Yes**	>Std
Toluene	108	83	77%	700	747	5	NYS	**Yes**	>Std
Trichloroethene	105	26	25%	31	1.6	5	RBC	**Yes**	>Std
Xylenes, Total	96	65	68%	1,000	12,167	5	NYS	**Yes**	>Std
"Volatile Semivolatiles"									
Acenaphthene	24	6	25%	4.4	2,190	20	NYS	No	<Std
Anthracene	108	10	9%	15	10,950	50	NYS	No	<Std
Fluorene	109	74	68%	73	1,460	50	NYS	**Yes**	>Std
Naphthalene	153	119	78%	3,500	730	10	NYS	**Yes**	>Std
Phenanthrene	108	75	69%	110	NA	50	NYS	**Yes**	>Std
Acenaphthylene	108	72	67%	91	NA	NA	NA	**Yes**	No Std

Notes:
1,2-Dichloroethene, Total is evaluated as "1,2-Dichloroethylene (mixture)" for RBC and "trans-Dichloroethene" for NYS.
m-Xylene & p-Xylene is evaluated as m-Xylene
< DF = Detection Frequency was less than 5%.
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-6
Summary of COPC Selection Process
Groundwater
Slag Fill Area Zone 3
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Carbon disulfide	2	2	100%	6.8	1,043	NA	RBC	No	<Std
Ethylbenzene	13	1	8%	2.4	1,340	5	NYS	No	<Std
Pyridine	10	1	10%	11	37	50	RBC	No	<Std
Benzene	19	19	100%	72	0.36	1.0	RBC	**Yes**	>Std
Toluene	13	11	85%	32	747	5	NYS	**Yes**	>Std
Xylenes, Total	13	7	54%	40	12,167	5	NYS	**Yes**	>Std
"Volatile Semivolatiles"									
Anthracene	13	4	31%	28	10,950	50	NYS	No	<Std
Fluorene	13	8	62%	140	1,460	50	NYS	**Yes**	>Std
Naphthalene	19	17	89%	1,400	730	10	NYS	**Yes**	>Std
Phenanthrene	13	10	77%	170	NA	50	NYS	**Yes**	>Std
Acenaphthylene	13	7	54%	110	NA	NA	NA	**Yes**	No Std

Notes:
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-7
Summary of COPC Selection Process
Groundwater
Slag Fill Area Zone 4
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Acrylonitrile	128	2	2%	7.9	0.12	5	RBC	No	<DF
1,1,1-Trichloroethane	133	4	3%	14	541	5	NYS	No	<DF
1,1,2-Trichloroethane	133	1	1%	2.3	0.19	5	RBC	No	<DF
1,2-Dichlorobenzene	142	1	1%	28	64	3	NYS	No	<DF
Carbon disulfide	12	5	42%	19	1,043	NA	RBC	No	<Std
1,1-Dichloroethane	138	22	16%	160	798	5	NYS	Yes	>Std
Benzene	174	153	88%	2,200	0.36	1.0	RBC	Yes	>Std
Chlorobenzene	138	7	5%	54	35	5	NYS	Yes	>Std
Ethylbenzene	138	35	25%	35	1,340	5	NYS	Yes	>Std
Methylene chloride	133	16	12%	200	4.1	5	RBC	Yes	>Std
Pyridine	129	16	12%	50	37	50	RBC	Yes	>Std
Toluene	133	104	78%	170	747	5	NYS	Yes	>Std
Trichloroethene	133	27	20%	46	1.6	5	RBC	Yes	>Std
Xylenes, Total	106	90	85%	140	12,167	5	NYS	Yes	>Std
"Volatile Semivolatiles"									
2-Chloronaphthalene	142	1	1%	1.0	487	10	NYS	No	<DF
Acenaphthene	21	5	24%	2.4	2,190	20	NYS	No	<Std
Anthracene	142	18	13%	59	10,950	50	NYS	Yes	>Std
Fluorene	142	104	73%	72	1,460	50	NYS	Yes	>Std
Naphthalene	178	159	89%	1,900	730	10	NYS	Yes	>Std
Phenanthrene	142	98	69%	120	NA	50	NYS	Yes	>Std
Acenaphthylene	140	92	66%	130	NA	NA	NA	Yes	No Std

Notes:
< DF = Detection Frequency was less than 5%.
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-8
Summary of COPC Selection Process
Groundwater
Slag Fill Area Zone 5
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Benzene	6	5	83%	6.9	0.36	1	RBC	**Yes**	>Std
Xylenes, Total	3	3	100%	11	12,167	5	NYS	**Yes**	>Std
"Volatile Semivolatiles"									
Fluorene	3	3	100%	11	1,460	50	NYS	No	<Std
Phenanthrene	3	3	100%	21	NA	50	NYS	No	<Std
Naphthalene	6	6	100%	49	730	10	NYS	**Yes**	>Std
Acenaphthylene	3	1	33%	5	NA	NA	NA	**Yes**	No Std

Notes:
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-9
Summary of COPC Selection Process
Groundwater
Coke Oven Zone
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Methylene chloride	32	1	3%	3,400	4.1	5	RBC	No	<DF
1,2-Dichloroethane	32	1	3%	39	0.12	0.6	RBC	No	<DF
Carbon disulfide	14	2	14%	5	1,043	NA	RBC	No	<Std
Xylenes, Total	49	27	55%	390,000	12,167	5	NYS	**Yes**	>Std
Toluene	49	28	57%	77,000	747	5	NYS	**Yes**	>Std
Ethylbenzene	49	18	37%	25,000	1,340	5	NYS	**Yes**	>Std
Benzene	58	49	84%	470,000	0.36	1	RBC	**Yes**	>Std
"Volatile Semivolatiles"									
Anthracene	30	2	7%	4.1	10,950	50	NYS	No	<Std
Phenanthrene	30	14	47%	320	NA	50	NYS	**Yes**	>Std
Naphthalene	55	39	71%	280,000	730	10	NYS	**Yes**	>Std
Fluorene	30	12	40%	600	1,460	50	NYS	**Yes**	>Std
Acenaphthene	5	2	40%	330	2,190	20	NYS	**Yes**	>Std
Acenaphthylene	30	10	33%	81	NA	NA	NA	**Yes**	No Std

Notes:
< DF = Detection Frequency was less than 5%.
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-10
Summary of COPC Selection Process
Groundwater
Tank Farm Zone
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Benzene	12	4	33%	58	0.36	1.0	RBC	**Yes**	>Std
Toluene	9	2	22%	8.3	747	5	NYS	**Yes**	>Std
Xylenes, Total	9	2	22%	5.2	12,167	5	NYS	**Yes**	>Std
"Volatile Semivolatiles"									
Fluorene	9	1	11%	3.3	1,460	50	NYS	No	<Std
Phenanthrene	9	2	22%	5.2	NA	50	NYS	No	<Std
Naphthalene	12	5	42%	130	730	10	NYS	**Yes**	>Std

Notes:
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-11
Summary of COPC Selection Process
Groundwater
Smokes Creek Zone
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Methylene chloride	25	1	4%	7	4.1	5	RBC	No	<DF
1,1-Dichloroethane	24	3	13%	10	798	5	NYS	**Yes**	>Std
Benzene	43	36	84%	230,000	0.36	1.0	RBC	**Yes**	>Std
Carbon disulfide	3	1	33%	1,300	1,043	NA	RBC	**Yes**	>Std
Ethylbenzene	33	3	9%	5,600	1,340	5	NYS	**Yes**	>Std
Pyridine	20	8	40%	130,000	37	50	RBC	**Yes**	>Std
Toluene	34	18	53%	16,000	747	5	NYS	**Yes**	>Std
Vinyl chloride	24	2	8%	1,100	0.019	2	RBC	**Yes**	>Std
Xylenes, Total	34	12	35%	8,400	12,167	5	NYS	**Yes**	>Std
"Volatile Semivolatiles"									
2-Chloronaphthalene	25	1	4%	3	487	10	NYS	No	<DF
Anthracene	25	1	4%	3	10,950	50	NYS	No	<DF
Fluorene	25	2	8%	18	1,460	50	NYS	No	<Std
Phenanthrene	25	4	16%	18	NA	50	NYS	No	<Std
Naphthalene	36	18	50%	1,200	730	10	NYS	**Yes**	>Std
Acenaphthylene	25	3	12%	9	NA	NA	NA	**Yes**	No Std

Notes:
< DF = Detection Frequency was less than 5%.
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

Table D-12
Summary of COPC Selection Process
Groundwater
Site-Wide
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
1,1,1-Trichloroethane	347	4	1%	14	541	5	NYS	No	<DF
1,1,2-Trichloroethane	347	1	0.3%	2.3	0.19	5	RBC	No	<DF
1,2-Dichlorobenzene	365	1	0.3%	28	64	3	NYS	No	<DF
1,2-Dichloroethane	356	12	3%	300	0.12	1	RBC	No	<DF
Acrylonitrile	335	2	0.6%	7.9	0.12	5	RBC	No	<DF
Chlorobenzene	364	8	2%	54	35	5	NYS	No	<DF
Chloroform	356	2	0.6%	2.9	0.15	7	RBC	No	<DF
Chloromethane	356	1	0.3%	30	1.5	5	RBC	No	<DF
Hexachlorobenzene	357	2	0.6%	12	0.007	0.04	RBC	No	<DF
Tetrachloroethene	347	1	0.3%	19	1.1	5	RBC	No	<DF
trans-1,2-Dichloroethene	337	3	0.9%	16	122	5	NYS	No	<DF
Vinyl chloride	347	2	0.6%	1,100	0.02	2	RBC	No	<DF
1,1-Dichloroethane	356	87	24%	160	798	5	NYS	**Yes**	>Std
Benzene	521	425	82%	470,000	0.36	1	RBC	**Yes**	>Std
Carbon disulfide	53	14	26%	1,300	1,043	NA	RBC	**Yes**	>Std
Ethylbenzene	382	119	31%	25,000	1,340	5	NYS	**Yes**	>Std
Methylene chloride	348	32	9%	3,400	4.1	5	RBC	**Yes**	>Std
m-Xylene & p-Xylene	52	41	79%	110	NA	5	NYS	**Yes**	>Std
o-Xylene	52	43	83%	53	12,167	5	NYS	**Yes**	>Std
Pyridine	319	30	9%	250,000	37	50	RBC	**Yes**	>Std
Toluene	374	253	68%	77,000	747	5	NYS	**Yes**	>Std
Trichloroethene	347	54	16%	46	1.6	5	RBC	**Yes**	>Std
Xylenes, Total	335	214	64%	390,000	12,167	5	NYS	**Yes**	>Std
"Volatile Semivolatiles"									
2-Chloronaphthalene	357	2	1%	3.0	487	10	NYS	No	<DF
Acenaphthene	53	13	25%	330	2,190	20	NYS	**Yes**	>Std
Anthracene	357	36	10%	58.5	10,950	50	NYS	**Yes**	>Std
Fluorene	358	212	59%	600	1,460	50	NYS	**Yes**	>Std
Naphthalene	513	383	75%	280,000	730	10	NYS	**Yes**	>Std
Phenanthrene	357	212	59%	320	NA	50	NYS	**Yes**	>Std
Acenaphthylene	355	193	54%	130	NA	NA	NA	**Yes**	No Std

Notes:

Table D-12
Summary of COPC Selection Process
Groundwater
Site-Wide
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale

m-Xylene & p-Xylene is evaluated as m-Xylene
< DF = Detection Frequency was less than 5%.
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.
NA = not available.
No Std = No RBC or NYSDEC screening level available.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

APPENDIX E

Table E-1
Summary of COPC Selection Process
Surface Water
Smokes Creek
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	COPC?	Rationale
Volatiles									
1,2-Dichlorobenzene	25	1	4%	0.1	64	3	NYS	No	<DF
1,3-Dichlorobenzene	25	1	4%	0.1	14	3	NYS	No	<DF
Toluene	33	1	3%	0.2	747	5	NYS	No	<DF
Xylenes, Total	33	1	3%	0.2	12,167	5	NYS	No	<DF
1,4-Dichlorobenzene	25	2	8%	0.1	0.47	3	RBC	No	<Std
trans-1,2-Dichloroethene	20	2	10%	1	122	5	NYS	No	<Std
Trichloroethene	20	2	10%	0.41	1.6	5	RBC	No	<Std
1,2-Dichloroethane	20	2	10%	3	0.12	0.6	RBC	**Yes**	>Std
Benzene	32	11	34%	4	0.36	1	RBC	**Yes**	>Std
Bromodichloromethane	20	1	5%	0.4	0.17	50	RBC	**Yes**	>Std
Bromoform	16	8	50%	5	2.3	50	RBC	**Yes**	>Std
Dibromochloromethane	20	8	40%	1	0.13	NA	RBC	**Yes**	>Std
Chloroform	20	10	50%	8.8	0.15	7	RBC	**Yes**	>Std
Methylene chloride	20	3	15%	14	4.1	5	RBC	**Yes**	>Std
Vinyl chloride	20	1	5%	2	0.019	2	RBC	**Yes**	>Std
Semivolatiles									
Naphthalene	14	4	29%	1.3	730	10	NYS	No	<Std
Fluoranthene	15	1	7%	0.1	1,460	50	NYS	No	<Std
Di-n-Octyl phthalate	15	2	13%	1.4	730	50	NYS	No	<Std
Di-n-butyl phthalate	15	6	40%	1.5	3,650	50	NYS	No	<Std
Diethyl phthalate	12	7	58%	1.4	29,000	50	NYS	No	<Std
Butyl benzyl phthalate	15	6	40%	1.4	7,300	50	NYS	No	<Std
2,6-Dinitrotoluene	15	1	7%	0.2	37	5	NYS	No	<Std
Bis(2-ethylhexyl)phthalate	15	6	40%	24	4.8	5	RBC	**Yes**	>Std

Table E-1
Summary of COPC Selection Process
Surface Water
Smokes Creek
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	COPC?	Rationale
Metals (Total) *									
Selenium	15	8	53%	7.3	183	10	NYS	No	<Std
Nickel	15	2	13%	17	730	100	NYS	No	<Std
Lead	15	3	20%	5.2	15	25	RBC	No	<Std
Chromium	15	7	47%	21	110	50	NYS	No	<Std
Cadmium	12	1	8%	4.1	18	5	NYS	No	<Std
Barium	15	8	53%	50	2,555	1,000	NYS	No	<Std
Arsenic	15	4	27%	7.0	0.04	25	RBC	**Yes**	>Std
Miscellaneous									
Cyanide	7	4	57%	44	730	200	NYS	No	<Std

* Only total metals data used in the analysis.

Notes:

Cadmium RBC based on reference dose in water (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.
Cyanide is assumed to be free cyanide.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).
No Std = No RBC or NYSDEC screening level available.
NA = not available.
< Std = Maximum Detect was less than minimum standard.
> Std = Maximum Detect was greater than minimum standard.

Table E-2
Summary of COPC Selection Process
Surface Water
Blasdell Creek
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	COPC?	Rationale
Volatiles									
1,1-Dichloroethane	6	1	17%	6.2	798	5	NYS	Yes	>Std
Semivolatiles									
Bis(2-ethylhexyl)phthalate	6	1	17%	2.2	4.8	5	RBC	No	<Std
Metals (Total) *									
Lead	6	1	17%	9.2	15	25	RBC	No	<Std

* Only total metals data used in the analysis.

Notes:

Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

No Std = No RBC or NYSDEC screening level available.

< Std = Maximum Detect was less than minimum standard.

> Std = Maximum Detect was greater than minimum standard.

Table E-3
Summary of COPC Selection Process
Surface Water
Lake Erie
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	COPC?	Rationale
Volatiles									
Toluene	10	1	10%	0.35	747	5	NYS	No	<Std
Semivolatiles									
Bis(2-ethylhexyl)phthalate	10	1	10%	21	4.8	5	RBC	**Yes**	>Std
Metals (Total) *									
Lead	10	4	40%	5.7	15	25	RBC	No	<Std
Miscellaneous									
Cyanide	3	1	33%	20	730	200	NYS	No	<Std

* Only total metals data used in the analysis.

Notes:

Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.

Cyanide is assumed to be free cyanide.

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

No Std = No RBC or NYSDEC screening level available.

< Std = Maximum Detect was less than minimum standard.

> Std = Maximum Detect was greater than minimum standard.

Table E-4
Summary of COPC Selection Process
Surface Water
North Return Water Trench
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Benzene	2	1	50%	0.2	0.36	1	RBC	No	<Std
Methylene chloride	2	1	50%	0.9	4.1	5	RBC	No	<Std
Metals (Total)									
Chromium	2	1	50%	12.4	110	50	NYS	No	<Std
Lead	2	2	100%	5.6	15	25	RBC	No	<Std

Notes:

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

< Std = Maximum Detect was less than minimum standard.

Table E-5
Summary of COPC Selection Process
Surface Water
South Return Water Trench
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Benzene	2	1	50%	0.2	0.36	1	RBC	No	<Std
1,1,1-Trichloroethane	2	1	50%	0.3	541	5	NYS	No	<Std
Metals (Total)									
Lead	2	1	50%	8.3	15	25	RBC	No	<Std
Mercury	2	1	50%	0.6	11	0.7	NYS	No	<Std

Notes:

Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

< Std = Maximum Detect was less than minimum standard.

Table E-6
Summary of COPC Selection Process
Surface Water
Ship Canal (Current Conditions)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Benzene	26	2	8%	1	0.36	1	RBC	Yes	>Std
Semivolatiles									
Butyl benzyl phthalate	20	1	5%	0.2	7,300	50	NYS	No	<Std
Diethyl phthalate	20	4	20%	0.4	29,200	50	NYS	No	<Std
Di-n-butyl phthalate	17	3	18%	0.2	3,650	50	NYS	No	<Std
Di-n-octyl phthalate	20	1	5%	0.2	730	50	NYS	No	<Std
Naphthalene	19	3	16%	0.6	730	10	NYS	No	<Std
Bis(2-ethylhexyl)phthalate	13	6	46%	20	4.8	5	RBC	Yes	>Std
Metals (Total)									
Antimony	17	1	6%	2.8	15	3	NYS	No	<Std
Barium	17	12	71%	25.6	2,555	1,000	NYS	No	<Std
Cadmium	17	2	12%	3.3	18	5	NYS	No	<Std
Chromium	17	2	12%	40.4	110	50	NYS	No	<Std
Nickel	17	2	12%	22.0	730	100	NYS	No	<Std
Arsenic	17	5	29%	6.3	0.045	25	RBC	Yes	>Std

Notes:

Cadmium RBC based on reference dose in water (EPA, 1998).

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

No Std = No RBC or NYSDEC screening level available.

NA = not available.

< Std = Maximum Detect was less than minimum standard.

> Std = Maximum Detect was greater than minimum standard.

Table E-7
Summary of COPC Selection Process
Surface Water
Ship Canal (Hypothetical Future Conditions)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Estimated Maximum Concentration in Ship Canal with Pumps Off (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles						
Ethylbenzene	0.3	1,340	5	NYS	No	<Std
Methylene chloride	0.1	4.1	5	RBC	No	<Std
Xylenes, Total	3	12,167	5	NYS	No	<Std
Benzene	30	0.36	1	RBC	**Yes**	>Std
Toluene	10	747	5	NYS	**Yes**	>Std
Semivolatiles						
2-Methylphenol	0.3	1,825	1	NYS	No	<Std
3-Methylphenol & 4-Methylphenol	0.4	183	1	NYS	No	<Std
4-Methylphenol	0.3	183	1	NYS	No	<Std
Acenaphthene	0.1	2,190	20	NYS	No	<Std
Bis(2-ethylhexyl)phthalate	0.2	5	5	RBC	No	<Std
Fluoranthene	0.8	1,460	50	NYS	No	<Std
Pyrene	0.6	1,095	50	NYS	No	<Std
Naphthalene	10	730	10	NYS	No	=Std
Fluorene	3.0	1,460	50	NYS	No	<Std
Phenanthrene	3	NA	50	NYS	No	<Std
Phenol	0.7	21,900	1	NYS	No	<Std
Benz(a)anthracene	0.3	0.092	0.002	NYS	**Yes**	>Std
Benzo(a)pyrene	0.4	0.009	NA	RBC	**Yes**	>Std
Benzo(b)fluoranthene	0.4	0.092	0.002	NYS	**Yes**	>Std
Benzo(k)fluoranthene	0.4	0.92	0.002	NYS	**Yes**	>Std
Chrysene	0.4	9.2	0.002	NYS	**Yes**	>Std
Dibenz(a,h)anthracene	0.3	0.0092	NA	RBC	**Yes**	>Std
Indeno(1,2,3-c,d)pyrene	0.3	0.092	0.002	NYS	**Yes**	>Std
Acenaphthylene	0.3	NA	NA	NA	**Yes**	No Std
Benzo(ghi)perylene	0.3	NA	NA	NA	**Yes**	No Std
Metals (Dissolved)						
Barium	3	2,555	1,000	NYS	No	<Std
Lead	0.04	15	25	RBC	No	<Std

Table E-7
Summary of COPC Selection Process
Surface Water
Ship Canal (Hypothetical Future Conditions)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Estimated Maximum Concentration in Ship Canal with Pumps Off (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Arsenic	2	0.045	25	RBC	Yes	>Std
Miscellaneous						
Cyanide	0.2	730	100	NYS	No	<Std

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L (protective of children) is used for screening purposes.
Cyanide is assumed to be free cyanide.
NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).
RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).
No Std = No RBC or NYSDEC screening level available.
NA = not available.
> Std = Maximum Detect was greater than minimum standard.
< Std = Maximum Detect was less than minimum standard.

APPENDIX E.1

ESTIMATED WATER BALANCE FOR GATEWAY METROPORT SHIP CANAL

ESTIMATED WATER BALANCE FOR THE GATEWAY METROPORT SHIP CANAL

Prepared for:

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK

JOB NUMBER: 00120-194-152
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ESTIMATED WATER BALANCE FOR GATEWAY METROPORT SHIP CANAL

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2 - GALVANIZED PRODUCT DIVISION, 1997 AVERAGE MONTHLY FLOW BY SPDES OUTFALL (MGD)
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FIGURE (Follows Tables)

1 - LOCATION OF PUMP HOUSES AND SPDES OUTFALL AT THE LACKAWANNA SITE

APPENDIX

A - STORMWATER SHEET FLOW EVALUATION FOR THE GATEWAY METROPORT CANAL

ESTIMATED WATER BALANCE FOR GATEWAY METROPORT SHIP CANAL

1.0 PURPOSE

This report provides an estimated water balance for the Gateway Metroport Ship Canal (the Ship Canal). It describes the amount of water withdrawn from, used, and/or discharged to the Ship Canal by Bethlehem Steel Corporation and other entities. It also describes the contribution to the water budget of (1) precipitation (directly and via stormwater systems and sheet flow) and (2) groundwater.

2.0 BACKGROUND

A water balance for the Ship Canal was provided to the U.S. Environmental Protection Agency in an interim Human Health Risk Assessment document and an interim Draft RFI document (BSC 1998a, 1998b). In comments on these documents, the Agency has requested that a more detailed accounting be provided of Ship Canal water withdrawal, discharge, and precipitation inflows. At issue is whether and to what degree there is a net inflow of water to the canal as a result of water withdrawals from the canal.

Water is withdrawn via Pump House No. 1 from the Ship Canal for cooling uses by BSC's Coke Oven Division. No other BSC or non-BSC operation on the Lackawanna site uses water from the canal under normal conditions or discharges water to the canal (personal communication with Myles Lalley, BSC's Coke Oven Division, July 1998). Under certain abnormal shutdown conditions for Pump House No. 6 (see Section 4.2, below), water taken from the Ship Canal via Pump House No. 1 can be directed to BSC's Galvanized Products Division's (Galv Products) facility (personal communication with Robert Allen, BSC, October 1998).

3.0 PUMPING SYSTEM DESCRIPTION

Two pumping systems, Pump House No. 1 and Pump House No. 6, are used to provide water to operations on the Lackawanna site, as described below. The location of the pump houses and their associated intakes is shown on Figure 1. Pump House No. 1, which is located on the east side of the Ship Canal (see Figure 1), draws water from the Ship Canal. Pump House No. 6, which is located on the northern end of BSC's property, approximately 150 feet west of the Ship Canal entrance (see Figure 1), draws water from the Buffalo Outer Harbor, not the Ship Canal.

3.1 PUMP HOUSE NO. 1

Pump House No. 1 has three electric pumps (No. 4, No. 5, and No. 7) and two back-up steam pumps (No. 1 and No. 4). Electric pump No. 4 is new, having recently replaced the old No. 4 electric pump. The three electric pumps run full time and currently produce an estimated 73.2 million gallons per day (mgd) (the previous pumping rate was about 10 mgd lower with the old No. 4 pump). The steam pumps are used as back-up for periods when the electric pumps are being repaired or maintained, or in case of a power failure. Normal pumping rates for these pumps are as follows:

Pump	Rate (mgd)
No. 4 electric	21.6
No. 5 electric	21.6
No. 7 electric	30.0
Total	73.2

Pump	Rate (mgd)
Standby Steamer No. 1	30.0
Standby Steamer No. 4	30.0
Total	60.0

During a power failure, all three electric pumps would go off-line. In such a case, Steamer No. 1 automatically goes into service, providing approximately 30 mgd. Steamer No. 4 can be operational within a few hours, providing an additional approximately 30 mgd. During regularly scheduled maintenance, in case of an electric pump breakdown, or to meet increased plant water requirements, each steamer can be brought on-line as a replacement or additional water source.

3.2 PUMP HOUSE NO. 6

Pump House No. 6 contains three electric pumps, Nos. 9, 10 and 11. Only one pump can be operated at a time because of water line capacity limits. Two of the pumps are run off of one electric feed (buss); the third pump is operated off of a separate buss. Each pump is rated at 30 mgd. As noted above, water is drawn from the Buffalo Outer Harbor via these pumps.

4.0 WATER USE

4.1 COKE DIVISION WATER USE

The Coke Division facility at the Lackawanna site obtains a total of approximately 78 mgd from the Ship Canal for various plant cooling uses. All of the water from Pump House No. 1 (approximately 73.2 mgd) is used by the Coke Oven Division. In addition, approximately 4.8 mgd of Buffalo Outer Harbor water is obtained from Pump House No. 6.

Purchased (potable) water is not used for process purposes such as cooling by the Coke Division. Purchased water is only used to supply the potable water needs of the facility and for a few air conditioners. All of the potable water is discharged to the facility's sanitary sewer.

4.2 OTHER USERS

Approximately 25.2 mgd of water from Pump House No. 6 is distributed to the Galv Products and Bar Tech facilities, which are located on the east side of the Hamburg Turnpike (State Route 5) (see Figure 1). The Galv Products facility is owned and operated by BSC; the Bar Tech facility is not. Should all of the No. 6 Pump House pumps go down, water could be supplied to the Galv Products facility by sending Ship Canal water from the Coke Oven Division facility via a 20-inch line. However, the amount of water that could be transferred via this routing would not be sufficient to keep the Galv Products facility in operation (personal communication, Jim Wahl, BSC's Galv Products Division, November 1998).

4.2.1 Galvanized Products Division

The Galv Products facility uses approximately 21.5 mgd of water from Pump House No. 6 for processes and about 1.0 mgd of purchased potable water for non-contact cooling purposes (personal communication with Ray David, BSC's Galv Products Division, August 1998).

4.2.2 Bar Technology Corporation

The Galv Products facility sends approximately 3.7 mgd of the water from Pump House No. 6 to the Bar Tech facility (personal communication, Larry Bugman, Bar Tech, August 1998). Bar Tech does not use potable water for cooling or other industrial needs.

5.0 WATER LOSSES AND DISCHARGE

5.1 COKE DIVISION

Approximately 68.8 mgd is discharged by the Coke Division through State Pollutant Discharge Elimination System (SPDES)-permitted outfalls. These discharges are detailed for 1997 on Table 1 and are summarized in the following table.

SPDES Outfall	Receiving Water Body	Amount (mgd)
Series 400	Ship Canal	10.7
Series 300	North Return Water Trench	4.6
No. 223	Smokes Creek	53.5
Total		68.8

The Coke Division estimates that it consumes or loses roughly 9 mgd of water through (1) process uses, (2) evaporative losses from the coke quenching operation (estimated to be 0.34 mgd), (3) steam losses, and (4) chronic waterline leaks. The majority of steam condensate is collected and returned to the canal via the 400 series SPDES outfalls. Some water is lost to the ground in the many areas where small steam relief valves are located and via waterline leaks.

The following table provides the average daily water use and discharge values for the Coke Division. The numbers are based on the reported 1997 SPDES averages for each discharge location (see Table 1). In addition, it includes a value for SPDES Outfall No. 404, which was added on April 1, 1998, and which will discharge non-contact cooling water and steam condensate from the Coke Division facility.

Source	Receiving Water Body	Type of Discharge	Amount (mgd)
Outfall 401	Ship Canal	Non-contact cooling water, stormwater and groundwater (via infiltration into broken pipeline)	5.5
Outfall 404	Ship Canal	Non-contact cooling water and steam condensate	0.1
Outfall 410	Ship Canal	Non-contact cooling water and steam condensate	0.2
Outfall 411	Ship Canal	Non-contact cooling water, condensate, stormwater, and groundwater (via infiltration into broken pipeline)	0.9
Outfall 412	Ship Canal	Non-contact cooling water, steam condensate and groundwater (via infiltration into broken pipeline)	3.8
Series 300 Outfalls	North Return Water Trench	Non-contact blowdown and cooling water	4.6
Outfall 223	Smokes Creek	Non-contact cooling and treated wastewater from the wastewater treatment plant	53.5
Total			**68.6**

5.2 OTHER USERS

5.2.1 Galvanized Products Division

Gal Product's SPDES discharges by outfall for 1997 are provided in Table 2. There are some losses from evaporation, but these are offset by some groundwater leakage to pits; this groundwater then becomes part of the SPDES discharges from the facility. The following table summarizes the Gal Products discharges.

SPDES Outfall	Receiving Water Body	Amount (mgd)
No. 216	Smokes Creek	2.06
No. 217	Smokes Creek	17.95
No. 104	Blasdell Creek	0.17
No. 113	Blasdell Creek	0.05
No. 139	Blasdell Creek	2.41
Total		22.64

5.2.2 Bar Technology Corporation

Bar Tech's SPDES discharges by outfall for 12 consecutive months starting in August 1997 are provided in Table 3. There are some losses from evaporation, but these are offset by some groundwater leakage to pits; this groundwater then becomes part of the SPDES discharges from the facility. The following table summarizes the Bar Tech discharges.

SPDES Outfall	Receiving Water Body	Amount (mgd)
No. 111	Blasdell Creek	3.33
No. 116	Blasdell Creek	0.21
No. 143	Blasdell Creek	0.16
Total		3.70

6.0 OTHER CONTRIBUTIONS

Precipitation enters the Ship Canal by three means: directly (i.e., precipitation falls directly into the canal), sheet flow from land surrounding the canal, and stormwater discharge.

6.1 DIRECT PRECIPITATION

The average annual precipitation at the site is 36 inches (BSC 1998b, p. 2-2), whereas the average annual evaporation from Lake Erie is 27 inches (BSC 1998b, p. 2-3). The surface area of the canal, which is 4,000 feet long by 200 feet wide, is 800,000 ft^2. This surface area multiplied by the average annual precipitation yields an average direct rainfall input to the canal of 0.05 mgd. The surface area multiplied by the average annual evaporation yields an average evaporation of 0.04 mgd. Subtracting the evaporative loss from the direct precipitation input into the canal yields a net precipitation input of 0.01 mgd.

6.2 SHEET FLOW

There is an area (amounting to a total of 443,000 square feet - see appendix A) surrounding the Ship Canal that could produce storm water sheet flow runoff into the canal during very heavy precipitation events. Conservatively assuming that the average annual rainfall for this area of 36 inches per year occurs only during such very heavy events, the estimated total runoff that could enter the canal as sheet flow would be 0.01 mgd. The supporting evaluation is provided in Appendix A.

6.3 STORMWATER DISCHARGE

Storm water from the Coke Division area is collected only from the roof drains of the machine shop and the small paved parking area adjoining the main office building (see Figure 1). Stormwater from these areas is discharged to SPDES Outfalls 401 (0.1 mgd) and 411 (0.1 mgd.) As can be seen, these flows are very small compared to the total

SPDES discharges. In the water balances, these flows are accounted for in the total discharge values for these outfalls.

6.4 GROUNDWATER CONTRIBUTIONS

Groundwater discharge into the Ship Canal amounts to approximately 0.2 mgd (see Section 2.7.2.5, First Interim Submittal, Draft RFI Report, BSC 1998b).

7.0 OVERALL SHIP CANAL WATER BALANCE

The following water balance values are based on the reported 1997 SPDES averages for each discharge location (Table 1), the estimated flows for new Outfall No. 404, the estimated annual contribution from direct precipitation, the estimated annual contribution from sheet flow (see Appendix A), and the estimated groundwater discharge amounts (presented in the Draft RFI Report).

The following table identifies all water entering the Ship Canal from the above-named sources:

Source	Water In (mgd)
Groundwater	0.2
Outfall 401	5.5
Outfall 404	0.1
Outfall 410	0.2
Outfall 411	0.9
Outfall 412	3.8
Sheet Flow	0.01
Net Direct Precipitation	0.01
Total	10.72

As stated above, the amount of water withdrawn from the Ship Canal by Pump House No. 1 is approximately 73.2 mgd. Therefore, for this amount to be withdrawn on a daily basis, approximately 63 mgd must be drawn in to the canal from the Buffalo Outer Harbor.

8.0 REFERENCES

Bethlehem Steel Corporation, 1998a. Human Health Risk Assessment, Final Interim Deliverable No. 1, May 1998.

Bethlehem Steel Corporation, 1998b. First Interim Submittal, Draft RFI Report, April 1998.

Bethlehem Steel Corporation, 1998c. State Pollutant Discharge Elimination System (SPDES) Reports, 1997.

Nussbaumer and Clark, 1990. Sanitary Sewerage, Purchased Water, Raw Water Audit Report.

Nussbaumer and Clark, 1991. Addendum to Sanitary Sewerage, Purchased Water, Raw Water Audit Report.

Personal communication with Myles Lalley and Jim Lawrence, BSC's Coke Division, Lackawanna, New York Facility, July 1998.

Personal Communication with Ray David, BSC's Galvanized Product Division, August 1998.

Personal Communication with Jim Wahl, BSC's Galvanized Products Division, November 1998.

Personal communication with Larry Bugman, Bar Technology Corporation, Lackawanna, New York, August, 1998.

TABLE 1

LACKAWANNA COKE DIVISION, 1997 AVERAGE MONTHLY FLOW BY SPDES OUTFALL (mgd)

	Outfall				
	401	**410**	**411**	**412**	**Totals**
January	6.7	0.10	0.65	2.2	9.65
February	3.6	0.15	0.65	2.9	7.3
March	3.6	0.15	1.70	3.1	8.55
April	6.1	0.11	0.63	3.8	10.64
May	6.5	0.13	0.71	3.8	11.14
June	6.4	0.28	0.88	5.4	12.96
July	4.1	0.28	0.92	3.7	9.00
August	5.5	0.25	1.10	4.1	10.95
September	7.6	0.45	0.92	4.3	13.27
October	4.5	0.22	0.69	4.1	9.51
November	5.9	0.10	0.91	4.1	11.01
December	5.9	0.17	0.82	3.8	10.69

TABLE 2

GALVANIZED PRODUCTS DIVISION
1997 AVERAGE MONTHLY FLOW BY SPDES OUTFALL (mgd)

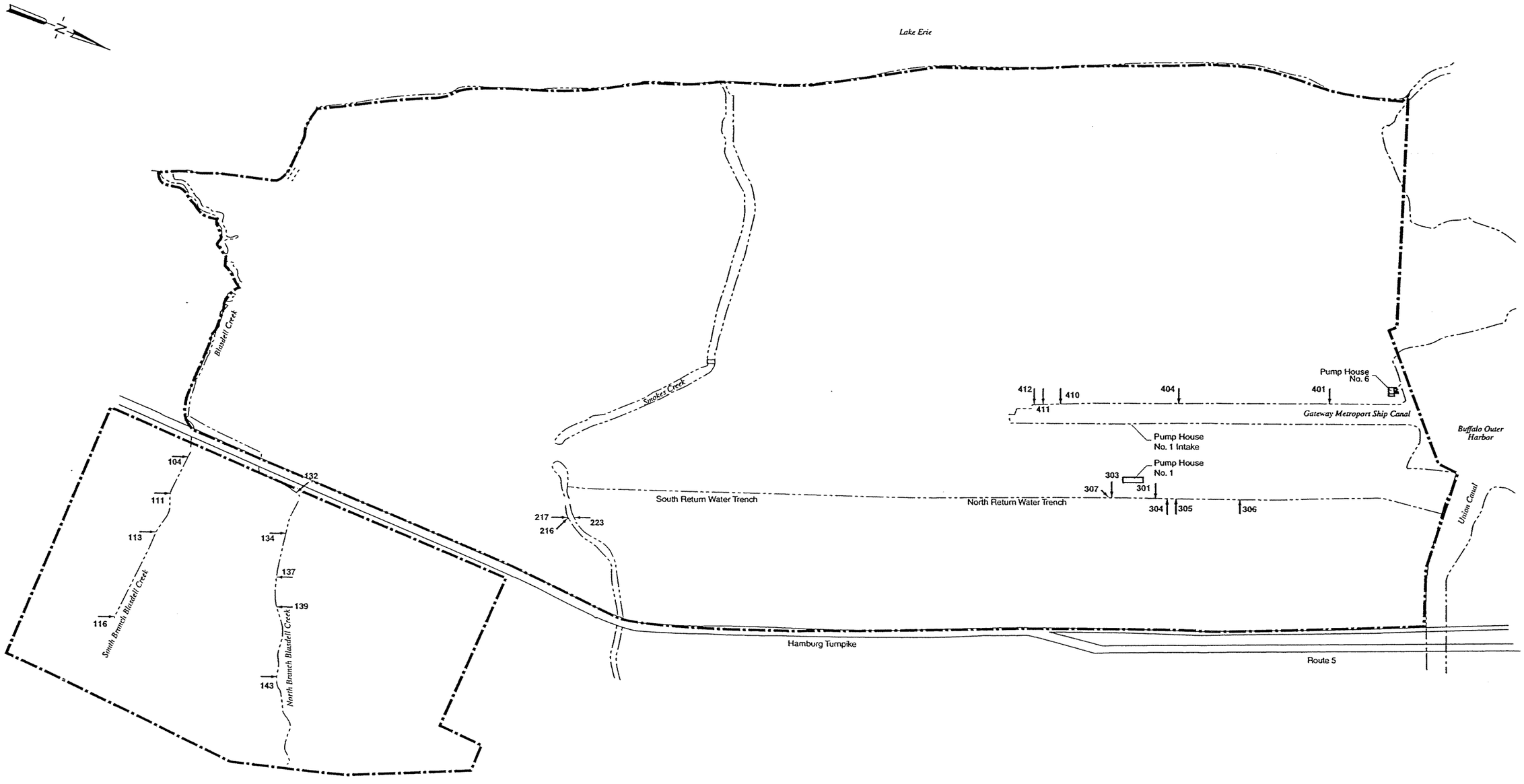
Average Monthly Flows

Outfalls	Jan-97	Feb-97	Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	1997 AVE
216	2.24	2.01	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.03	2.12	2.16	2.06
217	14.66	17.26	18.08	18.05	18.05	18.05	18.05	18.05	18.05	19.06	18.67	19.33	17.95
104	0.09	0.17	0.03	0.03	0.06	0.22	0.21	0.23	0.24	0.24	0.25	0.26	0.17
113	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
139	2.22	1.95	2.1	2.07	2.16	3.41	2.83	2.77	2.59	2.43	2.37	1.98	2.41
141	For 1997, OUTFALL CLOSED OFF - NOW DISCHARGES VIA 139												-
Totals	19.26	21.44	22.28	22.22	22.34	23.75	23.16	23.12	22.95	23.81	23.46	23.78	22.64

TABLE 3

BAR TECHNOLOGY CORPORATION
AVERAGE MONTHLY FLOWS FOR 8/97-7/98
BY SPDES OUTFALL (mgd)

	Outfall				
Date	**111**	**116**	**137**	**143**	**Total**
August 1997	9.34	0.34	-0-	0.15	9.83
September	3.28	0.31	-0-	0.15	3.74
October	3.78	0.27	-0-	0.14	4.19
November	4.39	0.24	-0-	0.19	4.82
December	2.41	0.36	-0-	0.15	2.92
January 1998	2.68	0.12	-0-	0.17	2.97
February	1.82	0.15	-0-	0.17	2.14
March	2.72	0.17	-0-	0.16	3.05
April	2.67	0.15	-0-	0.19	3.01
May	2.19	0.13	-0-	0.16	2.48
June	2.68	0.16	-0-	0.14	2.98
July	1.98	0.13	-0-	0.13	2.24
Average	**3.33**	**0.21**	**-0-**	**0.16**	**3.70**



LEGEND:

Site Boundary

113 → SPDES Outfall Location Number

BETHLEHEM STEEL CORPORATION
Lackawanna, New York

FIGURE 1
LOCATION OF PUMP HOUSES AND SPDES OUTFALLS AT THE LACKAWANNA SITE

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APPENDIX A

STORMWATER SHEET FLOW EVALUATION FOR THE GATEWAY METROPORT SHIP CANAL

STORMWATER SHEET FLOW EVALUATION FOR THE GATEWAY METROPORT SHIP CANAL

Prepared for:

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK

JOB NUMBER: 00120-194-152
November 17, 1998

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STORMWATER SHEET FLOW EVALUATION FOR THE GATEWAY METROPORT SHIP CANAL

Table of Contents

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Figures

A-1 Area of Potential Sheet Flow to Canal

A-2 Cross Section A-A' Sheet Flow - Ship Canal

STORMWATER SHEET FLOW EVALUATION FOR THE GATEWAY METROPORT SHIP CANAL

1.0 Objective

The objective of this evaluation was to estimate the amount of surface water (stormwater) runoff that may enter the Gateway Metroport Ship Canal (the Ship Canal) at Bethlehem Steel Corporation's (BSC) Lackawanna, New York site.

2.0 Site Conditions

2.1 The western border of the Ship Canal is occupied by BSC's Coke Division facilities. The stormwater from this area is regulated through the State Pollutant Discharge Elimination System (SPDES) permit program. Stormwater is either discharged from the plant site through identified SPDES-permitted points infiltrates into the ground.

2.2 A small area between the Coke Oven facilities and the west side of the Ship Canal was identified to have a potential for surface water to enter the canal via sheet flow from very heavy precipitation events (see Figure A-1). However, it must be noted that the slope in this area is very small (on the order of less than 1 to 2%,) and the surface is primarily permeable slag fill.

2.3 The eastern border of the Ship Canal is occupied by the Gateway Trade Center Industrial Park. Stormwater in this area flows to the east, away from the canal, to a french drain that lies approximately 300 feet to the east of, and runs parallel to, the canal . The french drain is regulated by a General Permit issued to Gateway under the SPDES permit program. It is our understanding that water collected in the drain discharges to the subsurface.

2.4 A small area between the Gateway Trade Center Storage Area and the Ship Canal was identified to have a potential for surface water to enter the canal via sheet flow from precipitation events. This area is very narrow (approximately 7 feet wide) and covered with concrete. Also, there is an old, elevated concrete railroad track bed (which sits on permeable slag) that separates the 7-foot concrete strip from the Gateway Trade Center Storage Area.

2.5 The site was inspected and the above conditions observed on July 21, 1998 by Mr. J. Britton Quinby, P.E.

3.0 Procedures

3.1 Measure the area identified as contributing sheet flow to the canal.

3.2 Estimate the amount of stormwater that infiltrates into the ground and contributes to evapotranspiration, leaving the remainder as sheet flow.

3.3 Identify the average amount of precipitation the site receives per year.

3.4 Calculate the amount of sheet flow (per year) by multiplying the area times the amount of precipitation per year times the portion (i.e. %) that is sheet flow.

4.0 References

4.1 BSC site drawing showing 1-foot contours and the area around the Ship Canal (Figure A-1).

4.2 Seelye, E.E., 1960, Data Book For Civil Engineers, John Wiley and Sons.

4.3 Bethlehem Steel Corporation, Weather station data for January 15, 1991 to March 15, 1992.

4.4 Buffalo Crushed Stone, Individual National Pollutant Discharge Elimination System (NPDES) Permit Application for Stormwater Discharges (Gateway Trade Center), 1992.

5.0 Assumptions

5.1 From Reference 4.3: the average yearly amount of precipitation for the site is 36 in/yr.

5.2 From Reference 4.2: The amount of sheet flow can be estimated from a "coefficient of runoff" assumed for the soil (coefficient of runoff via the rational formula).

5.3 Stormwater flow and control on Gateway site is as presented in Reference 4.4.

6.0 Calculations

6.1 From Figure A-1:

West and South Edge Area = 415,000 sf

Eastern Edge Area = 7 ft x 4,000 ft = 28,000 sf

6.2 From Reference 4.2:

West & South	Coefficient of Runoff = 0.10 to 0.40 Assumed value = 0.25
East Edge	Coefficient of Runoff = 0.95

(i.e., 25 % of the precipitation enters the canal as direct runoff from the west and south edges of the canal, and 95% of the precipitation enters the canal as direct runoff from the eastern area).

6.3 From Reference 4.3: Yearly precipitation = 36 in.

6.4 Amount of Sheet Flow to Ship Canal:

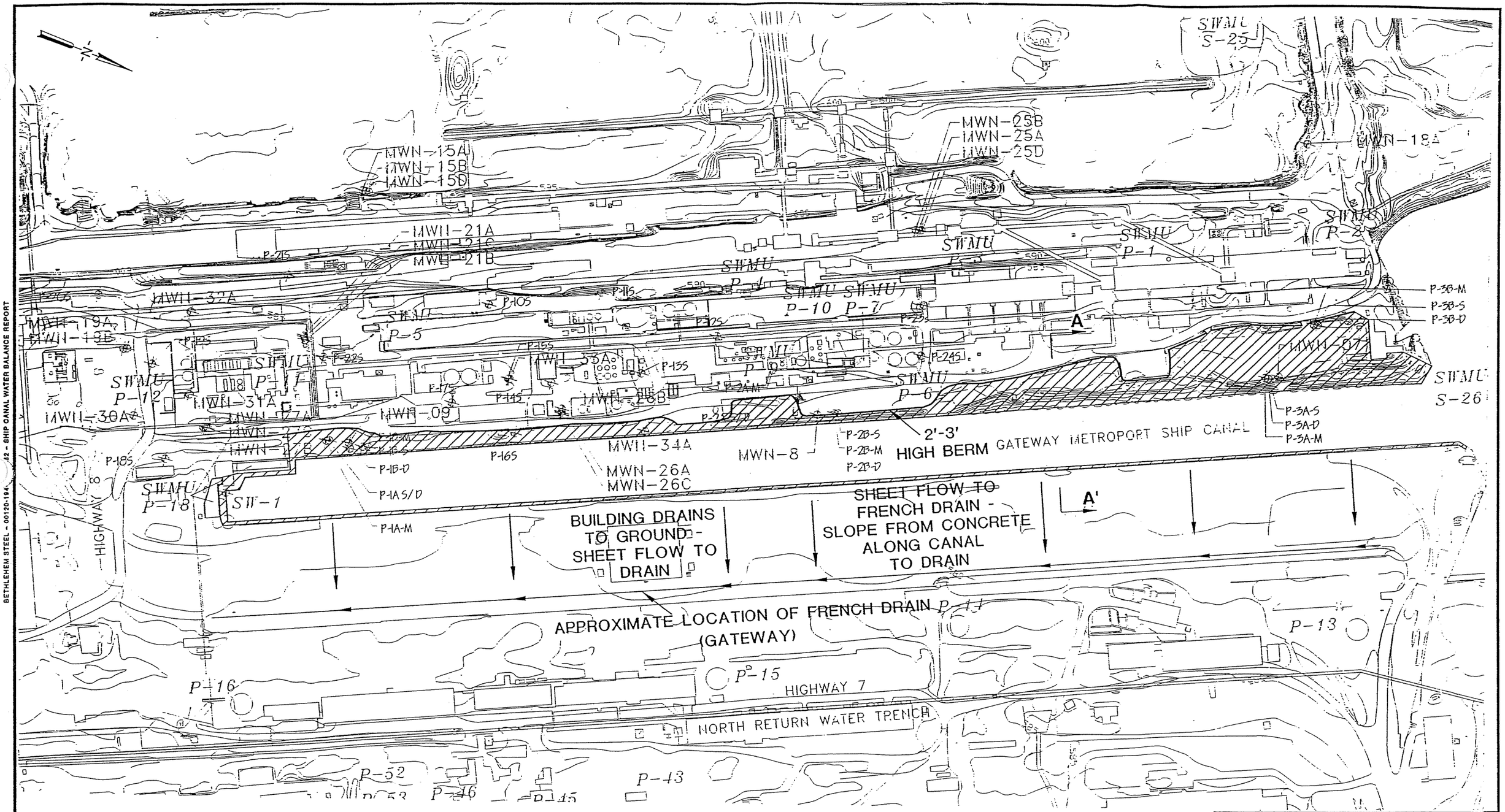
From West and South: (415,000) sf x 3 ft x 0.25 = 311,250 cf

From East: (28,000) sf x 3 ft x 0.95 = 79,800 Hf

Total = 391,050 cf

= 2,925,054 gallons

= 3.0 million gallons per year



LEGEND:

////// Area of Potential Sheet Flow to Canal (See Figure A-2 For Cross Section Detail)

0 300 600

APPROXIMATE SCALE IN FEET

BETHLEHEM STEEL CORPORATION
Lackawanna, New York

FIGURE A-1
AREA OF POTENTIAL SHEET FLOW TO SHIP CANAL

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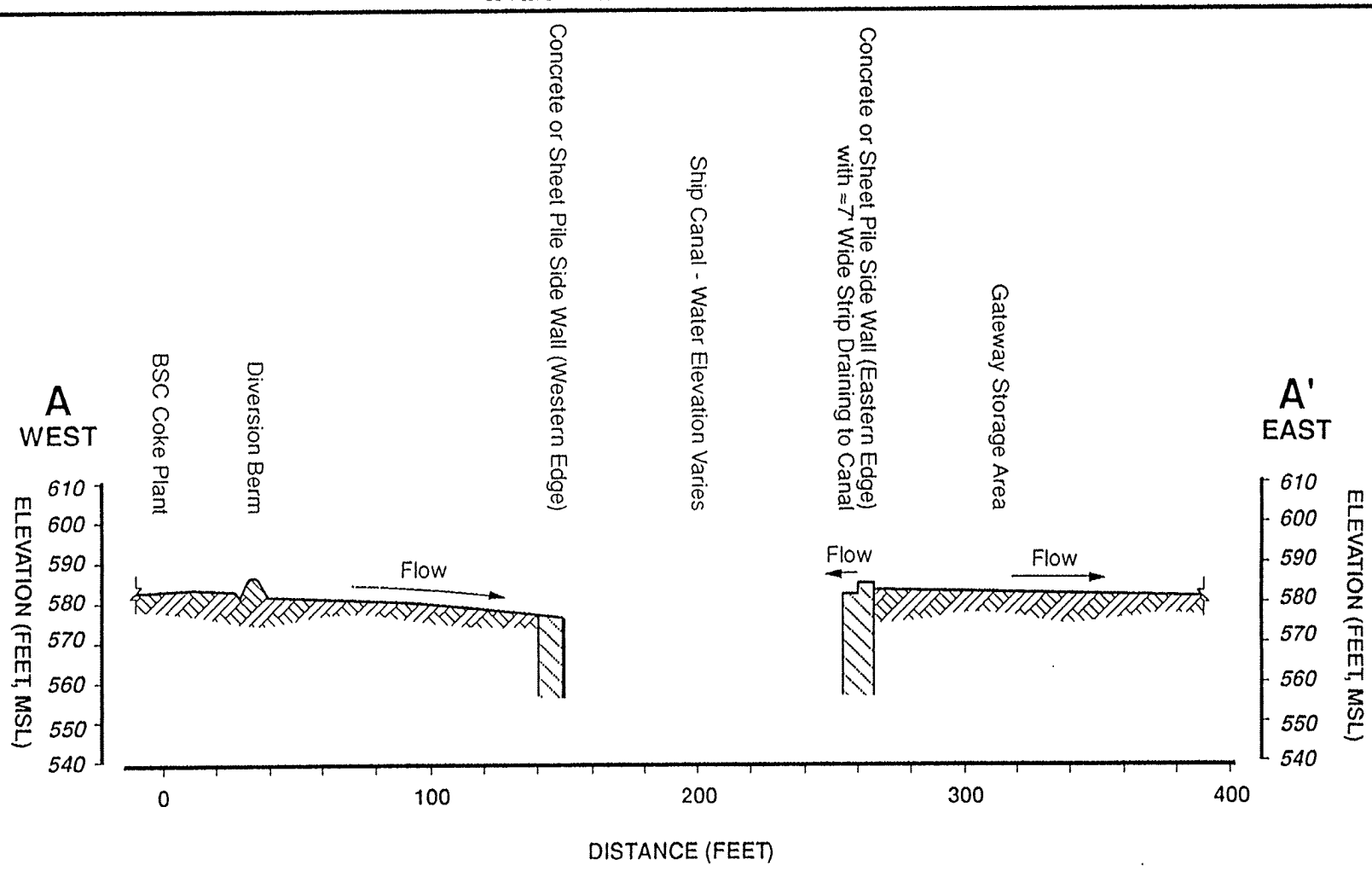

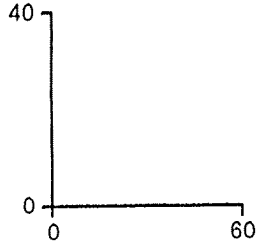

NOTE: For location of Cross Section, see Figure A-1.

BETHLEHEM STEEL CORPORATION
Lackawanna, New York

FIGURE A-2
CROSS SECTION A-A'
AREA OF POTENTIAL SHEET FLOW - SHIP CANAL

Job No. 00120-194-152 Dames & Moore

APPENDIX E.2

ESTIMATED GROUNDWATER INFILTRATION INTO THE RETURN WATER TRENCHES

APPENDIX E.2

NORTH AND SOUTH RETURN WATER TRENCHES GROUNDWATER INFILTRATION

General Description

The North and South Return Water Trenches are 8 to 10 feet deep, run parallel to the Ship Canal, and extend from the Union Ship Canal to Smokes Creek. The North Return Water Trench (NRWT) is about 3,300 feet long and drains into the Union Ship Canal. The South Return Water Trench (SRWT) is about 5,000 feet long and drains into Smokes Creek. Both trenches originate near Pumphouse No. 1, located about 800 feet north of the south end of the Ship Canal. Comparisons of water levels in the trenches with levels in nearby monitoring wells and piezometers (BSC, 1998) suggest that groundwater levels are approximately 1 foot higher than the water in the trenches. This indicates the potential for groundwater flow into the trenches.

Analytical Results for Nearby Wells

Recent data are available for wells that are located potentially upgradient of the trenches; these data are for wells MW-7A and MW-8A, which are both screened in fill. Organic constituent data are available for MW-7A, which is upgradient of the trenches, but situated along a flow line toward Smokes Creek rather that toward the SRWT. These data (May 1997) contain no detected organic constituents (69 analytes), and show values for other parameters that are consistent with background values (see Appendix I of the Second Interim Deliverable, Draft RFI Report) (BSC 1998a). Field analyses were performed (May 1997) for MW-8A; these values (e.g., pH >8) may indicate some impact from slag fill (BSC 1998a).

Much older data are also available for both wells from the 1981 Dames & Moore report (Dames & Moore, 1981), which is presented as Appendix A.1 of the Second Interim Deliverable, Draft RFI Report (BSC 1998b). Analytes for the 1981 sampling include total and dissolved iron, zinc, lead, and chromium; ammonia, sulfides, phenol, chloride, sulfate, total dissolved solids, total cyanide, oil and grease, pH, total organic carbon, and total suspended solids. Average values for phenol and dissolved lead were 24 ppb and 100 ppb for MW-7A, and 47 ppb and 70 ppb for MW-8A. However, it is best to rely on the most recent data because (1) it best represents current conditions, (2) it represents many more parameters (at least for MW-7A), and (3) it was obtained using currently accepted methods.

The above-described data indicate that no or only very small amounts of hazardous constituents are present in groundwater that could migrate into the trenches.

Groundwater analytical data from MWN-10, which is located downgradient of the SRWT, were also examined in order to assess possible constituent loadings from groundwater to the trenches. This well is approximately 550 feet west of the SRWT. One benzene detection (0.43 J µg/L) was obtained from a total of seven separate sampling and analysis rounds. Phenol was also detected once (January 1991) at a concentration of 13 µg/L. Total recoverable phenolics were detected four times (1991) at between 8 and 110 µg/L. Cyanide was detected three times (Jan. 1991 through Jan. 1992), at between 30 and 50 µg/L.

Estimation of Zone of Hydraulic Influence for the Trenches

To estimate the zone of influence that each of the trenches has on the local groundwater, a standard hydrologic equation for a french drain was employed. The groundwater influx for each of the trenches is estimated to be on the order of 100 gpm, essentially equal to the flow within the SRWT, which receives no discharges from current Lackawanna site operations. The SRWT flow rate represents approximately six percent of the total average flow in the NRWT (approximately 3.6 cfs, or 1,630 gpm), which receives additional flow from current Lackawanna site operations.

The distance from the center of the trench extending perpendicular to the length of the trench to the point where there is no effect on the groundwater level (Lo) is given by the following formula (Driscoll 1986; p. 741):

$$Lo = (k*x*(H^2 - h^2))/(2880\ Q), \text{ where:}$$

k = hydraulic conductivity, gpd/ft^2
x = length of trench, ft
H = saturated thickness of aquifer, ft
h = depth of water in a fully penetrating trench, ft
Q = discharge, gpm

This formula applies to only one side a trench. Although the trenches do not fully penetrate the aquifer, it was assumed that they do, and that H = 20 feet (approximate aquifer

thickness, as obtained from boring logs for nearby wells), and h = 19 feet (aquifer thickness minus one foot of head difference, as observed). Given the conservative assumption that the hydraulic conductivity of the trench walls are approximately equal to that of the aquifer (it is actually much less), i.e., 0.001 cm/s (21.2 gpd/ft^2), the zone of influence of the trenches extends a maximum of between 19 and 29 feet from their longitudinal centerlines.

Conclusions

Groundwater is estimated to be entering both the North and South Return Water Trenches at a rate of approximately 100 gpm. Available groundwater data indicate that little if any hazardous constituents would be entering the trenches with this groundwater.

References

Bethlehem Steel Corporation, 1998. Internal Review Draft, Watercourse Assessment Reports, North and South Return Water Trenches.

Bethlehem Steel Corporation, 1998a. First Interim Submittal, Draft RFI Report. April 1998.

Bethlehem Steel Corporation, 1998b. Second Interim Submittal, Draft RFI Report. July 1998.

Dames & Moore, 1981. Summary Report, Monitoring Well Program. February 16, 1981.

Driscoll, F.G., 1986. *Groundwater and Wells*, Second Edition. Johnson Filtration Systems, Inc., St. Paul, Minnesota.

APPENDIX F

Table F-1
Summary of COPC Selection Process
Sediment
Smokes Creek
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Benzene	15	3	20%	0.02	NA	22	No	<RBC
Carbon disulfide	13	5	38%	0.037	NA	7,821	No	<RBC
Chlorobenzene	15	1	7%	0.002	NA	1,564	No	<RBC
1,3-Dichlorobenzene	15	2	13%	0.03	NA	2,346	No	<RBC
Ethylbenzene	15	1	7%	0.002	NA	7,821	No	<RBC
Methyl ethyl ketone	13	3	23%	0.078	NA	46,929	No	<RBC
Toluene	15	3	20%	0.27	NA	15,643	No	<RBC
Trichlorofluoromethane	13	3	23%	0.13	NA	23,464	No	<RBC
Xylenes, Total	15	2	13%	0.012	NA	156,429	No	<RBC
Methylene chloride	13	2	15%	0.025	0.018	85	No	>BKG,<RBC
Semivolatiles								
Acenaphthene	13	3	23%	0.71	NA	4,693	No	<RBC
Butyl benzyl phthalate	13	1	8%	0.07	NA	15,643	No	<RBC
Di-n-butyl phthalate	13	1	8%	0.29	NA	7,821	No	<RBC
di-n-Octyl phthalate	13	2	15%	0.29	NA	1,564	No	<RBC
Isophorone	13	1	8%	0.72	NA	672	No	<RBC
Naphthalene	13	6	46%	0.69	NA	1,564	No	<RBC
Anthracene	13	9	69%	46	0.11	23,464	No	>BKG,<RBC
Bis(2-ethylhexyl)phthalate	13	12	92%	5.90	1.9	46	No	>BKG,<RBC
Chrysene	13	13	100%	83	1.8	87	No	>BKG,<RBC
Fluoranthene	13	13	100%	180	3.7	3,129	No	>BKG,<RBC
Fluorene	13	8	62%	33	0.1	3,129	No	>BKG,<RBC
Pyrene	13	13	100%	190	2.7	2,346	No	>BKG,<RBC
Benz(a)anthracene	13	13	100%	85	1.1	0.87	**Yes**	>BKG,>RBC
Benzo(a)pyrene	13	13	100%	61	1.3	0.087	**Yes**	>BKG,>RBC
Benzo(b)fluoranthene	13	13	100%	62	2.4	0.87	**Yes**	>BKG,>RBC
Benzo(k)fluoranthene	13	10	77%	48	0.77	8.7	**Yes**	>BKG,>RBC
Dibenz(a,h)anthracene	13	10	77%	19	0.1	0.087	**Yes**	>BKG,>RBC
Indeno(1,2,3-c,d)pyrene	13	13	100%	38	1.4	0.87	**Yes**	>BKG,>RBC
Benzo(ghi)perylene	13	13	100%	35	1.3	NA	**Yes**	>BKG,No RBC
Phenanthrene	13	13	100%	170	1.2	NA	**Yes**	>BKG,No RBC
Acenaphthylene	13	1	8%	7	NA	NA	**Yes**	No BKG,No RBC

Table F-1
Summary of COPC Selection Process
Sediment
Smokes Creek
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Metals								
Mercury	13	1	8%	0.78	NA	23	No	<RBC
Silver	13	8	62%	8	NA	391	No	<RBC
Antimony	13	10	77%	23.4	1	31	No	>BKG,<RBC
Barium	13	12	92%	215	85.8	5,475	No	>BKG,<RBC
Cadmium	13	5	38%	8.6	1.8	78	No	>BKG,<RBC
Chromium	13	13	100%	197	25.7	235	No	>BKG,<RBC
Nickel	13	13	100%	58.2	30	1,564	No	>BKG,<RBC
Selenium	12	12	100%	13	0.6	391	No	>BKG,<RBC
Arsenic	13	13	100%	34.7	12	0.43	**Yes**	>BKG,>RBC
Lead	13	13	100%	465	30	400	**Yes**	>BKG,>RBC
Miscellaneous								
Cyanide	13	6	46%	43.5	NA	1,564	No	<RBC

* Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
NA = not available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table F-2
Summary of COPC Selection Process
Sediment
Blasdell Creek
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Dichlorodifluoromethane	6	4	67%	0.019	NA	15,643	No	<RBC
Semivolatiles								
Fluorene	10	7	70%	3.9	NA	3,129	No	<RBC
Acenaphthene	10	4	40%	2.3	NA	4,693	No	<RBC
Anthracene	10	9	90%	7.8	NA	23,464	No	<RBC
di-n-Octyl phthalate	10	1	10%	0.36	NA	1,564	No	<RBC
Naphthalene	10	7	70%	0.67	NA	1,564	No	<RBC
Bis(2-ethylhexyl)phthalate	10	3	30%	0.91	0.13	46	No	>BKG,<RBC
Chrysene	10	10	100%	16	0.39	87	No	>BKG,<RBC
Fluoranthene	10	10	100%	46	0.63	3,129	No	>BKG,<RBC
Pyrene	10	10	100%	34	0.76	2,346	No	>BKG,<RBC
Benz(a)anthracene	10	10	100%	19	0.28	0.87	**Yes**	>BKG,>RBC
Benzo(a)pyrene	10	10	100%	13	0.25	0.087	**Yes**	>BKG,>RBC
Benzo(b)fluoranthene	10	10	100%	29	0.45	0.87	**Yes**	>BKG,>RBC
Benzo(k)fluoranthene	10	7	70%	12	0.21	8.7	**Yes**	>BKG,>RBC
Dibenz(a,h)anthracene	10	8	80%	4	0.38	0.087	**Yes**	>BKG,>RBC
Indeno(1,2,3-c,d)pyrene	10	10	100%	8.2	0.27	0.87	**Yes**	>BKG,>RBC
Benzo(g,h,i)perylene	10	8	80%	7.7	0.43	NA	**Yes**	>BKG,No RBC
Phenanthrene	10	10	100%	36	0.44	NA	**Yes**	>BKG,No RBC
Acenaphthylene	10	1	10%	0.044	NA	NA	**Yes**	No BKG,No RBC

Table F-2
Summary of COPC Selection Process
Sediment
Blasdell Creek
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) *	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Metals								
Antimony	13	3	23%	1.7	NA	31	No	<RBC
Selenium	13	8	62%	2.15	NA	391	No	<RBC
Silver	13	3	23%	8.1	NA	391	No	<RBC
Thallium	13	3	23%	3.4	NA	5.5	No	<RBC
Barium	13	13	100%	239	96.1	5,475	No	>BKG,<RBC
Cadmium	12	5	42%	8.5	1.8	78	No	>BKG,<RBC
Chromium	12	12	100%	109	21.3	235	No	>BKG,<RBC
Lead	12	12	100%	158.5	30	400	No	>BKG,<RBC
Mercury	13	6	46%	0.42	0.38	23	No	>BKG,<RBC
Nickel	13	12	92%	66.4	22.9	1,564	No	>BKG,<RBC
Arsenic	13	12	92%	146	8.2	0.43	**Yes**	>BKG,>RBC
Miscellaneous								
Cyanide	6	5	83%	4.5	NA	1,564	No	<RBC

* Maximum regional background concentration used for lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
NA = not available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table F-3
Summary of COPC Selection Process
Sediment
Lake Erie
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg)	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Chloromethane	10	1	10%	0.013	NA	49	No	<RBC
1,1,2,2-Tetrachloroethane	10	1	10%	0.0045	NA	3.2	No	<RBC
Toluene	10	1	10%	0.0041	NA	15,643	No	<RBC
Semivolatiles								
Acenaphthene	10	1	10%	0.17	NA	4,693	No	<RBC
Anthracene	10	2	20%	0.35	NA	23,464	No	<RBC
Benz(a)anthracene	10	2	20%	0.78	NA	0.87	No	<RBC
Benzo(b)fluoranthene	10	7	70%	0.64	NA	0.87	No	<RBC
Benzo(k)fluoranthene	10	2	20%	0.31	NA	8.7	No	<RBC
Bis(2-ethylhexyl)phthalate	10	5	50%	0.63	NA	46	No	<RBC
Di-n-butyl phthalate	10	1	10%	0.12	NA	7,821	No	<RBC
Fluorene	10	1	10%	0.19	NA	3,129	No	<RBC
Indeno(1,2,3-c,d)pyrene	10	3	30%	0.31	NA	0.87	No	<RBC
Naphthalene	10	1	10%	0.33	NA	1,564	No	<RBC
Chrysene	10	6	60%	0.73	0.09	87	No	>BKG,<RBC
Fluoranthene	10	8	80%	1.45	0.17	3,129	No	>BKG,<RBC
Pyrene	10	9	90%	1.2	0.14	2,346	No	>BKG,<RBC
Benzo(a)pyrene	10	3	30%	0.4	0.09	0.087	**Yes**	>BKG,>RBC
Phenanthrene	10	9	90%	0.91	0.16	NA	**Yes**	>BKG,No RBC
Dibenz(a,h)anthracene	10	1	10%	0.18	NA	0.087	**Yes**	>RBC
Benzo(ghi)perylene	10	2	20%	0.3	NA	NA	**Yes**	No BKG,No RBC

Table F-3
Summary of COPC Selection Process
Sediment
Lake Erie
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg)	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Metals								
Antimony	10	5	50%	14.3	NA	31	No	<RBC
Barium	10	10	100%	47	NA	5,475	No	<RBC
Mercury	10	2	20%	0.33	NA	23	No	<RBC
Silver	10	4	40%	5.5	NA	391	No	<RBC
Chromium	10	10	100%	146	4.6	235	No	>BKG,<RBC
Lead	10	10	100%	37.8	6.0	400	No	>BKG,<RBC
Nickel	10	10	100%	35.8	10.2	1564	No	>BKG,<RBC
Arsenic	10	10	100%	6.7	5.1	0.43	**Yes**	>BKG,>RBC

Notes:
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
NA = not available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table F-4
Summary of COPC Selection Process
Sediment
North Return Water Trench
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) [A]	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Xylenes, Total	2	1	50%	0.0055	NA	156,429	No	No BKG,<RBC
Semivolatiles								
Acenaphthene	2	1	50%	14	0.34	4,693	No	>BKG,<RBC
Anthracene	2	2	100%	150	1.9	23,464	No	>BKG,<RBC
Fluoranthene	2	2	100%	390	12	3,129	No	>BKG,<RBC
Fluorene	2	2	100%	180	0.81	3,129	No	>BKG,<RBC
Naphthalene	2	1	50%	85	0.22	1,564	No	>BKG,<RBC
Pyrene	2	2	100%	340	10	2,346	No	>BKG,<RBC
Benz(a)anthracene	2	2	100%	160	6.7	0.87	**Yes**	>BKG,>RBC
Benzo(a)pyrene	2	2	100%	120	6	0.087	**Yes**	>BKG,>RBC
Benzo(b)fluoranthene	2	2	100%	140	12	0.87	**Yes**	>BKG,>RBC
Benzo(k)fluoranthene	2	2	100%	60	3.3	8.7	**Yes**	>BKG,>RBC
Chrysene	2	2	100%	140	4.9	87	**Yes**	>BKG,>RBC
Dibenz(a,h)anthracene	2	2	100%	19	1.8	0.087	**Yes**	>BKG,>RBC
Indeno(1,2,3-c,d)pyrene	2	2	100%	68	6	0.87	**Yes**	>BKG,>RBC
Acenaphthylene	2	1	50%	57	1.1	NA	**Yes**	>BKG,No RBC
Benzo(ghi)perylene	2	2	100%	59	5.9	NA	**Yes**	>BKG,No RBC
Phenanthrene	2	2	100%	550	8.1	NA	**Yes**	>BKG,No RBC

Table F-4
Summary of COPC Selection Process
Sediment
North Return Water Trench
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) [A]	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Metals								
Barium	2	2	100%	60.3	84.3	5,475	No	<BKG,<RBC
Chromium	2	2	100%	24	27.1	235	No	<BKG,<RBC
Nickel	2	2	100%	13	27.7	1,564	No	<BKG,<RBC
Lead	2	2	100%	100	30	400	No	>BKG,<RBC
Mercury	2	2	100%	1.8	0.32	23	No	>BKG,<RBC
Arsenic	2	2	100%	13.7	12	0.43	**Yes**	>BKG,>RBC

[A] Maximum regional background concentrations used for arsenic and lead.

Notes:

Chromium is conservatively assumed to be in the hexavalent form.

Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.

Mercury is assumed to be inorganic.

RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).

No RBC = no EPA Region III RBC available.

NA = not available or not applicable.

< BKG = Maximum Detect was less than background.

< RBC = Maximum Detect was less than Region III RBC.

> BKG = Maximum Detect was greater than background.

> RBC = Maximum Detect was greater than Region III RBC.

Table F-5
Summary of COPC Selection Process
Sediment
South Return Water Trench
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) ^	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Tetrachloroethene	4	1	25%	0.0052	NA	12	No	<RBC
Semivolatiles								
Anthracene	4	1	19%	0.8	1.9	23,464	No	<BKG,<RBC
Benz(a)anthracene	4	4	100%	1.5	6.7	0.87	No	<BKG,>RBC
Benzo(a)pyrene	4	4	100%	1.9	6	0.087	No	<BKG,>RBC
Benzo(b)fluoranthene	4	4	100%	3.7	12	0.87	No	<BKG,>RBC
Benzo(ghi)perylene	4	4	100%	1.7	5.9	NA	No	<BKG,No RBC
Benzo(k)fluoranthene	4	4	100%	1.0	3.3	8.7	No	<BKG,<RBC
Bis(2-ethylhexyl)phthalate	4	2	50%	1.3	2.7	46	No	<BKG,<RBC
Chrysene	4	1	25%	0.5	4.9	87	No	<BKG,<RBC
Fluoranthene	4	4	100%	3.5	12	3,129	No	<BKG,<RBC
Indeno(1,2,3-c,d)pyrene	4	4	100%	1.8	6	0.87	No	<BKG,>RBC
Phenanthrene	4	4	100%	2.3	8.1	NA	No	<BKG,No RBC
Pyrene	4	4	100%	2.9	10	2,346	No	<BKG,<RBC
Dibenz(a,h)anthracene	4	4	100%	2.7	1.8	0.087	Yes	>BKG,>RBC

Table F-5
Summary of COPC Selection Process
Sediment
South Return Water Trench
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) [A]	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Metals								
Barium	4	4	100%	139	84.3	5,475	No	>BKG,<RBC
Cadmium	4	2	50%	3.5	NA	78	No	No BKG,<RBC
Chromium	4	4	100%	127	27.1	235	No	>BKG,<RBC
Mercury	4	3	75%	1.4	0.32	23	No	>BKG,<RBC
Nickel	4	4	100%	24.9	27.7	1,564	No	<BKG,<RBC
Selenium	4	4	100%	4.4	0.6	391	No	>BKG,<RBC
Silver	4	1	25%	2.1	NA	391	No	No BKG,<RBC
Thallium	4	1	25%	2.1	NA	5.5	No	No BKG,<RBC
Antimony	4	3	75%	53.3	1	31	**Yes**	>BKG,>RBC
Arsenic	4	4	100%	102.0	12	0.43	**Yes**	>BKG,>RBC
Lead	4	4	100%	1,010	30	400	**Yes**	>BKG,>RBC
Miscellaneous								
Cyanide	4	2	50%	1.4	NA	1,564	No	No BKG,<RBC

[A] Maximum regional background concentrations used for arsenic and lead.

Notes:

Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no EPA Region III RBC available.
NA = not available or not applicable.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

Table F-6
Summary of COPC Selection Process
Sediment
Ship Canal
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) [A]	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Volatiles								
Benzene	16	1	6%	0.0077	NA	22	No	No BKG,<RBC
Carbon disulfide	16	2	13%	0.002	NA	7,821	No	No BKG,<RBC
Ethylbenzene	16	1	6%	0.009	NA	7,821	No	No BKG,<RBC
Methyl ethyl ketone	16	8	50%	0.12	NA	46,929	No	No BKG,<RBC
Methylene chloride	7	1	14%	0.003	NA	85	No	No BKG,<RBC
Toluene	16	2	13%	0.013	NA	15,643	No	No BKG,<RBC
Xylenes, Total	16	2	13%	0.015	NA	156,429	No	No BKG,<RBC
Semivolatiles								
Benzo(k)fluoranthene	13	6	46%	2.8	3.3	8.7	No	<BKG,<RBC
Bis(2-ethylhexyl)phthalate	17	12	71%	1.03	2.7	46	No	<BKG,<RBC
Di-n-butyl phthalate	17	2	12%	0.13	0.5	7,821	No	<BKG,<RBC
Acenaphthene	17	14	82%	2.8	0.34	4,693	No	>BKG,<RBC
Anthracene	17	16	94%	5.4	1.9	23,464	No	>BKG,<RBC
Chrysene	17	17	100%	9	4.9	87	No	>BKG,<RBC
Fluoranthene	17	17	100%	18	12	3,129	No	>BKG,<RBC
Fluorene	17	15	88%	2	0.81	3,129	No	>BKG,<RBC
Naphthalene	17	17	100%	9	0.22	1,564	No	>BKG,<RBC
Pyrene	17	17	100%	15	10	2,346	No	>BKG,<RBC
3-Methylphenol & 4-Methylphenol	5	2	40%	1.8	NA	391	No	No BKG,<RBC
4-Methylphenol	12	6	50%	1	NA	391	No	No BKG,<RBC
Butyl benzyl phthalate	14	1	7%	0.09	NA	15,643	No	No BKG,<RBC
Phenol	17	1	6%	1.01	NA	46,929	No	No BKG,<RBC
Benz(a)anthracene	17	17	100%	9	6.7	0.87	**Yes**	>BKG,>RBC
Benzo(a)pyrene	17	16	94%	10	6	0.087	**Yes**	>BKG,>RBC
Benzo(b)fluoranthene	17	17	100%	14	12	0.87	**Yes**	>BKG,>RBC
Dibenz(a,h)anthracene	17	14	82%	2.4	1.8	0.087	**Yes**	>BKG,>RBC
Indeno(1,2,3-c,d)pyrene	17	16	94%	7	6	0.87	**Yes**	>BKG,>RBC
Acenaphthylene	17	13	76%	1.5	1.1	NA	**Yes**	>BKG,No RBC
Benzo(ghi)perylene	17	16	94%	6.7	5.9	NA	**Yes**	>BKG,No RBC
Phenanthrene	17	17	100%	12	8	NA	**Yes**	>BKG,No RBC

Table F-6
Summary of COPC Selection Process
Sediment
Ship Canal
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (mg/kg)	Maximum Background Concentration (mg/kg) [A]	Region III Residential Soil RBC (mg/kg)	Human Health COPC?	Rationale
Metals								
Antimony	17	3	18%	13.9	1	31	No	>BKG,<RBC
Barium	17	17	100%	120	84.3	5,475	No	>BKG,<RBC
Chromium	17	17	100%	68	27.1	235	No	>BKG,<RBC
Mercury	17	14	82%	7.30	0.32	23	No	>BKG,<RBC
Nickel	17	17	100%	65.0	27.7	1,564	No	>BKG,<RBC
Selenium	17	5	29%	2	0.6	391	No	>BKG,<RBC
Cadmium	17	4	24%	2.0	NA	78	No	No BKG,<RBC
Silver	17	5	29%	7	NA	391	No	No BKG,<RBC
Thallium	17	1	6%	2	NA	5.5	No	No BKG,<RBC
Arsenic	17	17	100%	15.9	12	0.43	**Yes**	>BKG,>RBC
Lead	17	17	100%	583	30	400	**Yes**	>BKG,>RBC
Miscellaneous								
Cyanide	10	2	20%	5.9	NA	1,564	No	No BKG,<RBC

[A] Maximum regional background concentrations used for arsenic and lead.

Notes:

The mixture 3-methylphenol & 4-methylphenol is conservatively evaluated as the more toxic 4-methylphenol.
Cadmium RBC based on dietary reference dose (EPA, 1998).
Chromium is conservatively assumed to be in the hexavalent form.
Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes.
Mercury is assumed to be inorganic.
Cyanide is assumed to be free cyanide.
RBC = U.S. EPA Region III risk-based concentration for residential soil (EPA, 1998).
No RBC = no Region III RBC available.
NA = not available.
< BKG = Maximum Detect was less than background.
< RBC = Maximum Detect was less than Region III RBC.
> BKG = Maximum Detect was greater than background.
> RBC = Maximum Detect was greater than Region III RBC.

APPENDIX G

Table G-1
Summary of COPC Selection Process
Coke Oven Area Quench Pits
SWMU Group PA-1 (SWMUs P-1, P-2, P-3, and P-4)
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Benzene	4	3	75%	6.3	0.36	1	RBC	**Yes**	>Std
"Volatile Semivolatiles"									
Anthracene	4	1	25%	2.7	10,950	50	NYS	No	<Std
Fluorene	4	2	50%	14	1,460	50	NYS	No	<Std
Phenanthrene	4	2	50%	49	NA	50	NYS	No	<Std
Naphthalene	4	2	50%	62	730	10	NYS	**Yes**	>Std
Acenaphthylene	4	1	25%	2.7	NA	NA	NA	**Yes**	No Std

Notes:

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

No Std = No RBC or NYSDEC screening level available.

NA = not available.

< Std = Maximum Detect was less than minimum standard.

> Std = Maximum Detect was greater than minimum standard.

Table G-2
Summary of COPC Selection Process
Benzol Yard Pit #17
SWMU P-11
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Value (µg/L)	EPA Region III Tap Water RBC (µg/L)	NYSDEC Standard (µg/L)	Lower of Two Levels	Human Health COPC?	Rationale
Volatiles									
Benzene	3	3	100%	34,000	0.36	1	RBC	**Yes**	>Std
Ethylbenzene	3	2	67%	600	1,340	5	NYS	**Yes**	>Std
Toluene	3	3	100%	3,100	747	5	NYS	**Yes**	>Std
Xylenes, Total	3	1	33%	360	12,167	5	NYS	**Yes**	>Std
"Volatile Semivolatiles"									
Naphthalene	1	1	100%	660	730	10	NYS	**Yes**	>Std

Notes:

NYS = NYSDEC ambient water quality standard or guidance value for Class GA groundwater (NYSDEC, 1998).

RBC = U.S. EPA Region III risk-based concentration for tap water (EPA, 1998).

NA = not available.

< Std = Maximum Detect was less than minimum standard.

> Std = Maximum Detect was greater than minimum standard.

APPENDIX B

HHRA ID No. 2
(BSC 1999)

Bethlehem Steel Corporation

ROBERT B. ALLEN
MANAGER
WASTE MANAGEMENT AND REMEDIATION
ENVIRONMENTAL AFFAIRS DEPARTMENT

BETHLEHEM, PA 18016

PHONE: (610) 694-1210

January 12, 1999

Mr. Dale J. Carpenter
Project Manager
United States Environmental Protection Agency - Region II
RCRA Programs Branch
Division of Environmental Planning and Protection
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Human Health Risk Assessment Revised Interim Deliverable No. 2;
Statement of Objections
Bethlehem Steel Corporation, Lackawanna Site RFI
Administrative Order on Consent (AOC)
Docket No. II RCRA-90-3008(h)-0201

Dear Mr. Carpenter:

Transmitted herewith is the Human Health Risk Assessment, Revised Interim Deliverable No. 2 (ID No. 2), for the Bethlehem Steel Corporation (BSC) Lackawanna site. These revisions have been made in response to your letter dated July 1, 1998 and subsequent, related correspondence (see Attachment A).

In the remainder of this letter, we describe what other changes have been made to this document, and how revisions are noted and provided in this submittal.

Document Revisions

The revised version of ID No. 2 is submitted as a new document. Text that has been added is indicated by underlining; text that has been deleted is indicated by ~~strikethrough~~, except in the following cases:

- Table of Contents: this has been newly generated

- Tables do not show ~~strikethrough~~ and underline because this would make the tables confusing and hard to follow. Mark up is also not shown on figures for the same reason.

In this revision of Interim Deliverable No. 2, BSC has responded to EPA's general comments as follows:

- EPA General Comment 2: BSC has clarified the rationale for exposure pathway selection and revised relevant tables to include all possible SWMUs and applicable exposure pathways for each scenario.

- EPA General Comment 3: In Section 1 of the document it is noted that if BSC demonstrates to EPA that its existing OSHA program covers exposures of current workers to environmental conditions, then current workers will not be a part of the risk assessment. BSC is currently preparing documentation of the OSHA program, and how it provides adequate worker protection. This document will be submitted separately to EPA.

- EPA General Comment 4: BSC has altered the future commercial/industrial and construction worker scenarios to contemplate industrial development, including building, on all SWMUs. In addition, a utility/maintenance worker scenario has been added. As a result of these changes, several complementary modifications have been made in the future commercial/industrial and construction worker scenarios and the current and future recreational bather scenario:

    - Because future commercial/industrial and construction workers are now assumed to be present on (with commercial/industrial workers also occupying buildings on) every individual SWMU, modeling of potential exposure of these receptors to ambient vapors from other SWMUs has been eliminated. In this manner, the worst case (i.e. immediate proximity) for each individual SWMU is examined. Similarly, because these receptors will be exposed to groundwater vapors on a zone-by-zone basis, the site-wide groundwater pathway has been eliminated.

    - Of the twelve receptor scenarios to be quantitatively evaluated in the Tier 1 risk assessment, potential risks associated with inhalation of vapors from subsurface SWMU material and groundwater will be calculated for eight (current non-BSC worker; future commercial/industrial worker; future construction worker; future utility/maintenance worker; current and future trespasser; future marina worker; future greenway user; current and future off-site resident). Because the potential exposure of each of these scenarios would be greater than that for the recreational bather, the vapor pathway for this scenario has been eliminated, as needlessly duplicative.

BSC's response to EPA's specific comments on the May 1998 draft are summarized in Table 1.

Additional Enclosure

Also enclosed with this submittal is a document entitled Statement of Objections. This document presents BSC's objections regarding the Agency's prohibition of certain risk assessment scenarios pertaining to feasible redevelopment and remediation. This submittal of Interim Deliverable No. 2 is done so under protest, and without prejudice to BSC's previous positions and responses to Agency comments or directives. This Statement of Objections is submitted for the Administrative Record in this matter, and with the hope that, after its review, the Agency will reconsider it's position on this matter.

****

If you have any questions regarding this submittal, please contact me at 610-694-1210.

Very truly yours,
BETHLEHEM STEEL CORPORATION

R. B. Allen

Robert B. Allen
Manager, Site Management and Remediation

Enclosure

cc: Permits Administration Branch (EPA-II)
Mr. R. Basso (EPA-II)
Mr. J. Reidy, P.E. (EPA-II)
Mr. E. Dassatti (NYSDEC-Albany) (2 copies)
Mr. R. Murphy (NYSDEC-Albany)
Mr. L. Thomas (NYSDEC-Albany)
Mr. S. Radon (NYSDEC-Buffalo)
Laura Lefebvre (TRC Environmental Corp.) (2 copies)

BSC(37)152

ATTACHMENT A

LIST OF CORRESPONDENCE REGARDING REVISION OF FINAL INTERIM DELIVERABLE NO. 1 AND INTERIM DELIVERABLE NO. 2, BETHLEHEM STEEL CORPORATION'S LACKAWANNA, NY SITE

Date	Type	Subject
July 1, 1998	Letter from Dale J. Carpenter (USEPA Region II) to Robert B. Allen (BSC)	Comments on BSC's April 17, 1998 Response Letter, Final Interim Deliverable No. 1 Submitted May 1, 1998, and Draft Interim Deliverable No. 2 Submitted May 8, 1998
July 20, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II)	Response to Agency Letter Dated July 1, 1998
August 27, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II)	Request for Meeting to Discuss EPA Comments in August 14, 1998 Letter
September 10, 1998	Letter from Amy R. Chester (USEPA Region II) to Morgan G. Graham (Phillips, Lytle, *et al*)	EPA and BSC Meeting on September 16, 1998
September 17, 1998	Letter from Amy R. Chester (USEPA Region II) to Morgan G. Graham (Phillips, Lytle, *et al*)	The request for BSC to submit a Meeting Summary to the EPA by September 25, 1998
September 22, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II), Amy Chester (USEPA Region II)	Summary of and Proposals for Additional Agreements Related to the EPA/BSC meeting on September 16, 1998
October 21, 1998	Letter from Dale J. Carpenter (USEPA Region II) to Robert B. Allen (BSC)	Comments on BSC's September 22, 1998 "Summary of and Proposals for Additional Agreements Related to the EPA/BSC Meeting on September 16, 1998"
November 4, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II)	Intention to modify Final Interim Deliverable No. 1 and Interim Deliverable No. 2 in response to EPA's July 1, 1998, September 25, 1998, and October 21, 1998 comments.
December 3, 1998	Letter from Robert B. Allen (BSC) to Dale J. Carpenter (USEPA Region II)	Documentation of postponement of Interim Deliverable No. 2 submission.
December 14, 1998	Letter from Dale J. Carpenter (USEPA Region II) to Robert B. Allen (BSC)	Response to BSC letters of November 4 and December 3, 1998.

Table 1.
Summary of BSC's Responses to EPA's Specific Comments on the May 1998 (First) Draft of Interim Deliverable No. 2 Human Health Risk Assessment, Lackawanna Site

EPA Specific Comment Number	BSC Response/Comment
1	Cited text has been eliminated
2 - 4, 8, 9, 16, 27	Future construction worker scenario has been expanded to include all SWMUs, a utility/maintenance worker scenario has been added, Tables 1-1 and 1-2 have been deleted, and Table 2-1 has been modified as requested.
5	The agency is not correct in stating that groundwater consumption is not being evaluated becuase BSC refused to include it. The Agency agreed to eliminate this pathway at a meeting on March 7, 1996. Subsequently, the approved Human Health Risk Assessment Work Plan dated April 1997 stated that 'groundwater consumption is not a pathway to be considered this risk assessment' (Section 4.1 p. 15) The text in ID No. 2 indicates that the pathway will not be considered.
6, 7, 22	See response to EPA General Comment 3
10	No change made. Exposure to groundwater in Zone 1 is not expected if a marina is developed.
11, 12, 15	Comment has been addressed as requested.
13	As agreed in our meeting of September 16, 1998, the oral and dermal relative absorption factors developed by BSC and presented in the May 6, 1998 draft of ID No. 2 are generally acceptable, and will be used in development of Tier 2 RBSLs. Thus, Section 3.0 of the May draft has been removed.
14	Section 3.0 has been removed from ID No. 2. However, it is noted that the sentence referred to is not "technically incorrect." Calderbank (1989) states: "It should be recognized that processes that deactivate pesticide residues and remove them to ultimate sinks (such as binding to soil colloids) for all practical purposes, effectively remove them from the environment."
17, 21, 28, 29, 30, 33	BSC has clarified the rationale for exposure pathway selection and revised relevant tables to include all possible SWMUs and applicable exposure pathways for each scenario.
18	This particular section has been eliminated, but 100 cm (39 inches) is the default depth to source assumed in the ASTM RBCA subsurface vapor screening model.
19	Meteorological data have been added to ID No. 2 as Appendix A.
20	Explanatory text has been inserted.
23	Exposure duration has been changed to 6.6 years, the value recommended in the 1997 *Exposure Factors Handbook.*
24	The baseline blood lead value ($PbB_{baseline}$)for all receptor scenarios has been changed to 2.0 µg/dL in accordance with *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (EPA, 1996). The correct value for the biokinetic slope factor is 0.4 µg/L/µg/day (EPA, 1996); all tables have been made consistent.
25, 31	The soil ingestion rate for the construction worker has been changed to 50 mg/day as requested.
26, 30	Construction worker exposure to Return Water Trench sediments is being considered. A Ship Canal maintenance worker scenario has been added to address potential exposure to Ship Canal sediment and surface water.
32	As requested, reference to the NYSDEC draft RBCA document has been eliminated.
34	Potential inhalation of particles from uncovered SWMUs has been added as a pathway for the greenway user and several other scenarios (non-BSC worker, marina worker, fenceline resident).
35	Comment noted.

HUMAN HEALTH RISK ASSESSMENT FOR BETHLEHEM STEEL CORPORATION'S LACKAWANNA, NEW YORK SITE

INTERIM DELIVERABLE NO. 2: EXPOSURE PATHWAY CONCEPTUAL SITE MODEL AND TIER 1 EQUATIONS AND PARAMETER VALUES

JANUARY 1999

BETHLEHEM STEEL CORPORATION
2600 HAMBURG TURNPIKE
LACKAWANNA, NEW YORK 14218

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FIGURES (follow tables)

No. Title

2-1 Conceptual Site Model Potential Exposure Pathways

3-1 Non-BSC Occupants of Lackawanna Site

APPENDICES

Appendix A Meteorological Data

Appendix B Subchronic Toxicity Data

INTERIM DELIVERABLE NO. 2
HUMAN HEALTH RISK ASSESSMENT
BETHLEHEM STEEL CORPORATION, LACKAWANNA, NY SITE

1.0 INTRODUCTION

The risk assessment process consists of five major elements:

- Data review and analysis;
- Exposure assessment;
- Toxicity assessment;
- Risk characterization; and
- Uncertainty analysis.

The data review and analysis step – *i.e.,* methods used to (1) develop a data set for the risk assessment to be conducted for the Bethlehem Steel Corporation (BSC) Lackawanna site, and (2) select chemicals of potential concern (COPCs) at the site -- were detailed in Interim Deliverable No. 1, ~~conditionally approved by U.S. Environmental Protection Agency, Region II (EPA Region II) on April 2, 1998~~ which was resubmitted with further revisions in December 1998.

The primary objectives of the next step in the process, exposure assessment, are to, consistent with the approved Human Health Risk Assessment Workplan, (1) identify potentially complete exposure pathways to defined human receptor populations, and (2) estimate the magnitude, frequency, and duration of potential exposure to site-related hazardous constituents via these pathways. This document, the second of three interim deliverables to be submitted for agency review during the risk assessment process, is a pathways analysis report detailing the exposure scenarios to be considered in the risk assessment and the equations and parameter values to be used in calculation of Tier 1 risk-based screening levels (RBSLs).

1.1 SCOPE OF THE HUMAN HEALTH RISK ASSESSMENT FOR THE LACKAWANNA SITE

The EPA has directed that BSC's Human Health Risk Assessment (HHRA) for the Lackawanna site should be a conservative, baseline risk assessment that analyzes potential adverse health effects caused by releases, in the absence of any actions to control or mitigate the releases. The human health risk assessment for the BSC Lackawanna site will therefore be based on defined receptor scenarios associated with (1) current use patterns, (2) unrestricted future commercial/industrial development in all areas of the site, including the Coke Oven Area and Slag Fill Areas (SFAs) 2 through 5, and (3) recreational development of SFA Zone 1, including a marina and "greenway" path from Route 5 to the lake front. The purpose of the analysis of future conditions is to systematically evaluate potential risks to human health associated with potentially complete exposure pathways on a SWMU-by-SWMU basis, without regard to physical practicability, current deed restrictions, or the existence of other more likely future scenarios such as that recently proposed by BSC for redevelopment of its Lackawanna property. This is also consistent with discussions and agreements with EPA and the State of New York, whereby BSC will include in the risk assessment certain water-related recreational uses that may potentially be feasible, in the future, for certain discrete portions of the Lackawanna site. Inclusion of many of these hypothetical exposure scenarios in this document does not constitute an endorsement by BSC, at

this time, of such land uses, nor does it create any commitment or expectation on the part of BSC regarding the future realization for such land uses. As such, while the resultant profile of potential risk will provide useful information for risk managers, it is recognized that it characterizes only one end of a spectrum of possible future scenarios.

Current and future on- and off-site receptor scenarios to be evaluated at the BSC Lackawanna site are summarized in Table 1-1.

Table 1-1. Summary of Current and Future Receptor Scenarios to be Evaluated in the Human Health Risk Assessment for the BSC Lackawanna Site

CURRENT	FUTURE
ON-SITE RECEPTORS	
• Non-BSC commercial/industrial workers • Ship Canal maintenance workers • Trespassers	• Commercial/industrial workers • Construction workers • Utility/maintenance workers • Ship Canal maintenance workers • Marina workers (Zone 1) • Trespassers • Greenway users
Off-Site Receptors	
• Residents • Water consumers • Fish consumers • Recreational bathers	• Residents • Water consumers • Fish consumers • Recreational bathers

Current BSC workers are covered by BSC's OSHA health and safety program. If BSC demonstrates to EPA that its existing OSHA program covers exposure of current workers to site environmental conditions, then current workers will not be included in the HHRA. In either event, current non-BSC workers will be included in the quantitative risk assessment. The scope of the risk assessment with respect to receptors and exposure pathways is fully discussed in Section 2. ~~The human health risk assessment for the Lackawanna site will be based on receptor scenarios associated with current use and potential future industrial/commercial use and recreational development on the site. BSC is currently evaluating potential future redevelopment options for the Lackawanna site.~~

~~The future use scenario for the Lackawanna site will be based on the following assumptions:~~

- ~~SWMUs where redevelopment is considered feasible are indicated in Table 1-1;~~
- ~~Other areas of the site potentially available for redevelopment are:~~
  - ~~Zone 1 of the Slag Fill Area;~~

~~• the area owned by BSC known as the Hamburg Turnpike Corridor; and~~

~~• the Tank Farm Area.~~

~~• Areas currently occupied by active BSC operations (Galvanized Products Division and Coke Oven Division) will continue to be used for these operations;~~

~~• The land currently deed restricted will, regardless of future redevelopment options and actions, retain deeded restrictions that will prohibit disruption of SWMU related waste materials that remain on the site and the use of site groundwater for any purpose;~~

~~• Areas currently set aside for waste management, i.e., Zones 2 and 4, will continue to be used for this purpose, and future industrial, commercial, or other intensive or intrusive uses of these areas will not be allowed. These may, at some time in the future, be managed as non intrusive and essentially natural or dormant uses; however, any such use is too speculative at this time to assess under the recreational or other use scenario in this risk assessment. The SWMUs/SWMU Groups that are excluded from future development are listed in Table 1 2; and• Planned slag reclamation of Zones 3 and 5 will take many years to complete and future redevelopment is not planned at this time. Redevelopment in these zones will, therefore, not be addressed in this risk assessment.~~

1.2 DOCUMENT ORGANIZATION

Interim Deliverable No. 2 for the Lackawanna site is organized into the following additional sections:

- Section 2.0 - Exposure Pathway Conceptual Model for the Lackawanna Site
- ~~Section 3.0 Bioavailability of Soil Associated Chemicals of Potential Concern at the Lackawanna Site~~Section 3.0 Equations and Parameter values for Development of Tier I Risk-Based Screening Levels for the Current Non-BSC Commercial/Industrial Worker Scenario.
- Section 4.0 – Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for the Future Commercial/Industrial Worker Scenario ~~at the Lackawanna Site~~
- Section 5.0 – Equation and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for the Future Construction Workers at the Lackawanna Site
- Section 6.0 - Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for the Future Utility/Maintenance Workers.
- Section 7.0 - Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for the Future Ship Canal Maintenance Worker Scenario
- Section ~~6~~8.0 – Equation and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for the ~~Present~~ Current and Future ~~Adolescent~~ Trespassers ~~at the Lackawanna Site~~Scenario
- Section ~~7~~9.0 – Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for the Future Marina Workers ~~at the Lackawanna Site~~Scenario

- Section ~~8~~10.0 - Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for the Future Greenway Users ~~at the Lackawanna Site~~ Scenario

- Section ~~9~~11.0 - Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for Current~~Present~~ and Future Recreational Bather Scenario ~~at the Lackawanna Site~~

- Section ~~10~~12.0 - Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for Current~~Present~~ and Future Fish Consumer Scenario ~~at the Lackawanna Site~~

- Section ~~11~~13.0 - Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for Current~~Present~~ and Future Off-site (Fenceline) Resident Scenario ~~at the Lackawanna Site~~

- Section ~~12~~14.0 - Equations and Parameter Values for Development of Tier 1 Risk-Based Screening Levels for Current~~Present~~ and Future Off-site Water Consumer Scenario ~~at the Lackawanna Site~~

- Appendix A - Meteorological Data

- Appendix B - Subchronic Toxicity Criteria

2.0 EXPOSURE PATHWAY CONCEPTUAL MODEL FOR THE LACKAWANNA SITE

The potential exposure scenarios to be considered in the human health risk assessment for the BSC Lackawanna site are summarized in the site-wide exposure pathway conceptual site model (CSM; Figure 2-1 and Table 2-1). This model represents our understanding of the sources of COPCs, the means by which they are released and transported within and among media, and the exposure pathways and routes by which they might contact human receptors.

2.1 POTENTIAL SOURCES AND EXPOSURE MEDIA

The SWMUs and ~~water courses~~watercourses to be considered in the human health risk assessment were identified in Interim Deliverable No. 1. These SWMUs, and affected media associated with them, are listed in Table 2-2. COPCs at the BSC Lackawanna site include metals, cyanide, volatile organic chemicals (VOCs), polycyclic aromatic hydrocarbons (PAHs), and other semivolatile organic chemicals (SVOCs). Potential current and future source and/or exposure media for human receptors at the BSC Lackawanna site include:

- Surficial and subsurface materials within SWMUs (and, in some cases, adjacent to SWMUs);
- Standing water in Coke Oven Area pits;
- Airborne particles and vapors;
- Groundwater;
- Surface water in Lake Erie, Smokes Creek, Blasdell Creek, the North and South Return Water Trenches, and the Ship Canal;
- Sediment in Lake Erie, Smokes Creek, Blasdell Creek, the North and South Return Water Trenches, and the Ship Canal; and
- Fish from Lake Erie, Smokes Creek, and Blasdell Creek.

Groundwater consumption is not a pathway to be considered in this risk assessment because potable water needs at the Lackawanna site and in its vicinity are provided exclusively by the Erie County Water Authority and the City of Buffalo Water Authority from their surface water intakes in Lake Erie and the southern end of the Niagara River. However, inhalation of vapors emanating from groundwater could occur, and, therefore, the groundwater vapor inhalation pathway will be considered in this risk assessment. In addition, potential impacts of site groundwater on potable municipal surface water intakes in the Niagara River will be evaluated.

2.2 POTENTIAL ~~MIGRATION~~ FATE AND TRANSPORT ~~PATHWAYS~~MECHANISMS

The concentration and distribution of COPCs at the BSC Lackawanna site may be affected by one or more of the following general fate and transport mechanisms:

- Leaching of COPCs from subsurface SWMU materials into groundwater underlying SWMUs;
- Migration of dissolved COPCs in groundwater to surface water in adjacent surface water bodies, including Smokes Creek, the Ship Canal, and Lake Erie;
- Trophic transfer of COPCs in aquatic systems;
- Volatilization of COPCs from SWMU material and/or groundwater into soil gas and advective transport to ambient and indoor air;
- Suspension and transport in ambient air of COPCs adsorbed to particles;
- Transport via surface water runoff of COPCs adsorbed to soil particles; and
- Biological or chemical transformation of COPCs.

2.3 POTENTIAL HUMAN RECEPTOR POPULATIONS

Potential human receptor populations include:

- On-site non-BSC commercial/industrial workers (~~present~~current)
- On-site commercial/industrial workers (future);
- On-site construction workers (future);
- On-site utility/maintenance worker (future);
- Ship Canal maintenance workers (~~present~~ current and future);
- On-site trespassers (~~present~~ current and future);
- Recreational bathers (~~present~~ current and future);
- Fish consumers (~~present~~ current and future);
- Marina workers in Zone 1 (future);
- Marina users in Zone 1 (future);
- Greenway users in Zone 1 (future);

- Off-site residents (~~present~~ current and future); and

- Off-site surface water consumers (~~present~~ current and future).

Receptor scenarios to be considered in the risk assessment are summarized in Figure 2-1 and Table 2-1. The suite of receptor scenarios selected for evaluation in the Tier 1 risk assessment is intended to represent the full range of potential exposure media and pathways associated with the site, and to provide unambiguous information regarding the sources and mechanisms of potential risks.

Residential development of the site will not occur, and hence will not be considered as a potential future exposure scenario in the risk assessment. However, residential areas adjacent to the site will be conservatively accommodated in the fenceline receptor scenario. Other potential current off-site human receptor populations to be included in the risk assessment include (1) recreational bathers (adults and children) who may occasionally use water bodies on or near the site (i.e., Lake Erie, Blasdell Creek, and Smokes Creek), (2) consumers (adults and children) of fish caught along the Lake Erie shoreline in the vicinity of the Lackawanna site and in Smokes and Blasdell Creeks, and (3) domestic water consumers (adults and children) served by municipal water intakes in the Niagara River downstream of the Lackawanna site. Because the site is guarded and fenced, the incidence of trespassing has been observed to be and is expected to remain insignificant. However, an on-site adolescent trespasser scenario will be quantitatively evaluated.

At EPA's request, BSC agreed to consider the specified hypothetical future on-site commercial/industrial and recreational development scenarios in the Tier 1 risk assessment. Their inclusion in this document does not constitute a commitment or endorsement by BSC, or any expectation on the part of BSC regarding their future realization. Because employees at the hypothetical future Zone 1 marina would likely experience greater exposure than would marina users, only a marina worker scenario will be included in the risk assessment.

Despite the very low frequency of contact maintenance work in the Ship Canal (see Section 3.3.1, Interim Deliverable No. 1 [Dames & Moore, 1998] and Section 7.0 of this document), BSC has agreed to EPA's request that a current and future Ship Canal maintenance worker scenario be included in the Tier 1 risk assessment. Although divers in the Ship Canal wear diving suits and other protective equipment which substantially prevents contact with Ship Canal water and sediment, both full body contact with surface water and sediment ingestion will be conservatively assumed for this Tier 1 assessment.

Current BSC workers are limited to the Coke Oven Area and the Galvanized Products Division, while non-BSC workers are present in northern, southern, and eastern areas of the site (see Figure 3-1). It is assumed in the risk assessment that commercial/industrial workers (and buildings to house them) may be present anywhere on the site, regardless of feasibility. Thus, although contact of remedial workers with SWMU material would be mitigated by an appropriate health and safety plan, a construction worker scenario involving excavation during hypothetical construction at every SWMU will be included.

Similarly, potential exposure of utility/maintenance workers excavating underground pipelines or other subsurface features to COPCs will be evaluated at every SWMU.

The following points clarify assumptions that have been made in developing the receptor scenarios.

- SWMU conditions are assumed to remain unchanged (except for intrusive scenarios). Thus, no contact with surface material is assumed at covered SWMUs for receptor populations other than construction and utility/maintenance workers.

- Where analytical data for surface material at uncovered SWMUs are lacking, subsurface results will be substituted for on-site scenarios. This is highly conservative with respect to volatile organic compounds, which would be expected to dissipate rapidly if exposed to the atmosphere, but could under- or overestimate surficial concentrations of metals or semivolatile organics.

- Potential risks associated with inhalation of airborne particles from SWMUs by certain receptor scenarios that do not have direct contact with SWMUs -- current non-BSC workers, current and future fenceline residents, and future Zone 1 marina workers and greenway users -- will be conservatively evaluated in Tier 1 by assuming that receptors are actually present on the SWMU. In cases where the target cancer risk and/or non-cancer hazard levels are exceeded, modeling will be used in Tier 2 to refine exposure estimates. For on-site receptor populations, "direct contact" with SWMU material includes particle inhalation (as well as ingestion, dermal contact, and vapor inhalation).

- Potential risks associated with COPC vapors from site groundwater and subsurface SWMU material will be evaluated in a comprehensive, scenario-specific manner. The overall objective of this approach is conservative evaluation of potential exposure and risk associated with all individual source areas (SWMUs) and media.

  - Site-wide groundwater will be used as the composite source for off-site fenceline residents and for on-site non-BSC commercial/industrial workers, for the groundwater vapor pathway while Zone 1 groundwater (groundwater vapor zones are described in Section 3.3.2 of Interim Deliverable No. 1) is considered the source for hypothetical future Zone 1 marina workers and greenway users. Potential exposure to vapors emanating from Coke Oven Area pits and subsurface SWMU material will be estimated for these scenarios using emission and air dispersion modeling.

  - On-site receptors who may be present anywhere in the interior of the site (*i.e.*, trespassers and future commercial/industrial, construction, and utility/maintenance workers) are assumed to spend their entire exposure

duration on, or in a building on top of a particular SWMU. Thus, all of their exposure is derived from that SWMU, and dispersion modeling will not be performed. Because vapor inhalation is a component of the "direct contact" pathway, inhalation of ambient vapor from subsurface SWMU material will not be considered separately for future construction workers excavating in SWMUs. Similarly, "zonal" groundwater sources will be used to estimate groundwater vapor exposure for these scenarios.

- Inhalation of vapors and particles from SWMUs will not be evaluated for Ship Canal maintenance workers, recreational bathers, or fish consumers, as these scenarios are designed to evaluate potential risks associated with other specific media, and any potential exposure of such individuals to vapors and particles would be well below that evaluated under other scenarios.

- Ship Canal maintenance workers, recreational bathers, and fish consumers may contact site-related COPCs via groundwater flow into surface water. To ensure that potential exposure and risks associated with this migration pathway are accommodated in the risk assessment, screening levels will be developed for both surface water (the contact medium) and groundwater (the source medium) for the recreational bather and fish consumer scenarios. Only surface water screening levels will be developed for Ship Canal maintenance workers, but these levels will be compared to both existing surface water COPC measurements and conservatively modeled concentrations assuming that the pumps that currently withdraw water (including groundwater discharge) from the Ship Canal have ceased operating. In addition, surface water RBSLs for the recreational bather fish consumer and water consumer scenarios will be compared to modeled COPC concentrations in Lake Erie following pump shutdown. Only groundwater will be considered as a source to off-site water consumers because of their distance from the site and the low concentration of most analytes in Lake Erie surface water. ~~BSC agreed to consider hypothetical future marina and greenway scenarios on a conditional basis in the risk assessment. Their inclusion in this document does not constitute a commitment or endorsement by BSC, or any expectation on the part of BSC regarding their future realization. The following are the assumptions that are part of the receptor scenarios.~~

~~• Because employees at the hypothetical marina would experience greater exposure than users, only a marina worker scenario will be considered in the risk assessment.~~

~~• Current industrial~~ BSC ~~workers are limited to the Coke Oven Area and Galvanized Products Division, and Buffalo Crushed Stone reclamation slag workers. Because the safety and health of these workers is protected under OSHA, they are not subject to the risk assessment. However, as the site is redeveloped in the future, it is assumed that industrial workers may be present~~

~~anywhere that building is feasible. Such l~~Locations ~~where building is not feasible are indicated in Table 1-1.~~

- ~~Contract laborers or industrial employees excavating underground pipelines or other subsurface features could be exposed for limited time periods to COPCs in subsurface as well as surface materials in certain areas except where construction is not feasible (Table 1-1).~~

- ~~Implementation of an appropriate health and safety plan is assumed for construction workers involved in future remedial work involving excavation. Therefore, these potential receptors will not be included in the risk assessment.~~

~~Because the site is guarded and fenced, the incidence of trespassing into fenced areas has been observed to be and is expected to remain insignificant. However, quantitative consideration evaluation of an adolescent trespasser scenario will be performed.~~

- ~~Residential development of the site is not expected to occur, and hence will not be considered as a potential future exposure scenario in the risk assessment. Although residential areas immediately off-site are not present in all directions, a "fenceline resident" scenario (adults and children) will be considered in the risk assessment.~~

- ~~Other potential current and future human receptors that will be included in the risk assessment are (1) recreational bathers (adults and children) who may occasionally use water bodies on or near the site (i.e., Lake Erie, Blasdell Creek, and Smokes Creek); (2) people (adults and children) consuming fish caught along the Lake Erie shore in the vicinity of the Lackawanna site and in Smokes and Blasdell Creeks; and (3) domestic water consumers (adults and children) served by municipal water intakes in the Niagara River downstream of the Lackawanna site.~~

2.4 POTENTIALLY COMPLETE EXPOSURE PATHWAYS

Exposure pathways consist of four elements:

- A source and mechanism(s) of constituent release to the environment;
- An environmental transport medium for the released constituent;
- A point of potential human contact with the affected medium; and
- A route of entry into humans (inhalation, ingestion, or dermal contact with the affected medium).

If any of these components is missing, then the pathway is incomplete and does not contribute to receptor exposure. The rationale for selection of potentially complete

exposure pathways to be evaluated in Tier 1 of the human health risk assessment for the BSC Lackawanna site is presented in Table 2-1.

TABLE 2-1
POTENTIAL HUMAN EXPOSURE PATHWAYS TO BE CONSIDERED IN DEVELOPING TIER 1 RISK-BASED SCREENING LEVELS (RBSLS) FOR THE BSC LACKAWANNA SITE (PRELIMINARY)

Receptor Population	Potential Source Medium	Exposure Medium	Potential Exposure Route	Will Pathway be Used to Develop RBSL?	Rationale/Comment
Current On-Site Non-BSC Commercial/Industrial Worker	Groundwater	Air	Ambient vapor inhalation	Yes	Site-wide groundwater will be used as vapor source
			Indoor vapor inhalation	Yes	Where groundwater data are available
	Groundwater (potable use)	Air	Vapor inhalation	No	Site groundwater is not a potable source
		Groundwater	Ingestion Dermal contact		
	SWMU subsurface material	Air	Ambient vapor inhalation	Yes	Vapors from subsurface material in SWMUs in other areas of the site could be dispersed to non-BSC worker locations
			Indoor vapor inhalation	No, but see Section 3.0	No SWMUs are located in these areas with the exception of P-63 See Figure 3-1 and Section 3.0
			Particle inhalation	No	Workers are not expected to have direct contact with subsurface material
		Subsurface material	Ingestion Dermal contact		
	SWMU surface material	Air	Ambient vapor inhalation Particle inhalation	Yes	Vapors and particles from uncovered SWMUs in other areas of the site could be dispersed to non-BSC worker locations
		Surface material	Ingestion Dermal contact	No, but see Section 3.0	No SWMUs are located in these areas with the exception of P-63 See Figure 3 and Section 3.0
	Coke Oven Area Pits	Air	Ambient vapor inhalation	Yes	Vapors from Coke Oven Area pits could be dispersed to non-BSC worker locations

TABLE 2-1 (continued)

Receptor Population	Potential Source Medium	Exposure Medium	Potential Exposure Route	Will Pathway be Used to Develop RBSL?	Rationale/Comment
Future On-Site Commercial/Industrial Worker[1]	Groundwater	Air	Ambient vapor inhalation	Yes	Zone by Zone sources
			Indoor vapor inhalation	Yes	
	Groundwater (potable use)	Air	~~Potable~~ Vapor Inhalation	No	Site groundwater is not a potable source
		Groundwater	Ingestion Dermal contact		
	SWMU subsurface material	Air	Ambient vapor inhalation	Yes	On a SWMU by SWMU basis
			Indoor vapor inhalation	Yes	
			Particle inhalation	No	Workers are not expected to have direct contact with subsurface material
		Subsurface material	Ingestion Dermal contact		
	SWMU surface material	Air	Ambient vapor inhalation Particle inhalation	Yes	Potential exposure pathway for SWMUS where uncovered surficial material is present
		Surface material	Ingestion Dermal contact		
	Coke Oven Area Pits	Air	Ambient vapor inhalation	Yes	

[1] Hypothetical future on-site receptor population. Inclusion of these hypothetical exposure scenarios in this document does not constitute an endorsement by BSC, at this time, of such land uses, nor does it create any commitment or expectation on the part of BSC regarding their future realization.

TABLE 2-1 (continued)

Receptor Population	Potential Source Medium	Exposure Medium	Potential Exposure Route	Will Pathway be Used to Develop RBSL?	Rationale/Comment
Future On-Site Construction Worker[1]	Groundwater	Air	Ambient vapor inhalation	Yes ~~(in feasible redevelopment locations)~~	
	SWMU subsurface material	Air	Ambient vapor inhalation Particle inhalation	Yes	
		Subsurface material	Ingestion Dermal contact		
	SWMU surface material	Air	Ambient vapor inhalation Particle inhalation		
		Surface material	Ingestion Dermal contact		
	Surface Water	Surface Water	Ingestion Dermal contact	Yes	Surface water and sediment in the North and South Return Water Trenches and SWMU P-18 could be contacted by construction workers during potential future redevelopment activities
	Sediment	Air	Ambient vapor inhalation Particle inhalation		
		Sediment	Ingestion Dermal contact		
	Coke Oven Area Pits	Air	Ambient vapor inhalation	Yes	
Future Ship Canal Maintenance Worker	Groundwater	Surface Water	Ingestion Dermal contact	Yes	Groundwater in the Ship Canal Discharge Area could impact surface water in the Ship Canal in the future if pumping operations should cease
	Surface Water	Surface Water	Ingestion Dermal contact	Yes	Surface water and sediment in the Ship Canal could be contacted by construction workers during future maintenance activities
	Sediment	Sediment	Ingestion Dermal contact		

[1] Hypothetical future on-site receptor population. Inclusion of these hypothetical exposure scenarios in this document does not constitute an endorsement by BSC, at this time, of such land uses, nor does it create any commitment or expectation on the part of BSC regarding their future realization.

TABLE 2-1 (continued)

Receptor Population	Potential Source Medium	Exposure Medium	Potential Exposure Route	Will Pathway be Used to Develop RBSL?	Rationale/Comment
On-Site Trespasser (~~child~~ adolescent)	Groundwater	Air	Ambient vapor inhalation	Yes	On a Zone by Zone basis
	SWMU subsurface material	Air	Ambient vapor inhalation	Yes	On a SWMU by SWMU basis
			Particle inhalation	No	Trespassers are not expected to have direct contact with subsurface material
		Subsurface material	Dermal contact Ingestion		
	SWMU surface material	Air	Ambient vapor inhalation Particle inhalation	Yes	Potential exposure pathway in areas where uncovered surficial material is present
		Surface material	Ingestion Dermal contact		
	Coke Oven Area Pits	Air	Ambient vapor inhalation	Yes	Vapors from Coke Oven Area pits could be dispersed to trespasser locations
Zone 1 Marina ~~User Worker~~Worker[2] ~~(adult and child)~~	Groundwater	Air	Ambient vapor inhalation	Yes	Zone 1 groundwater
	SWMU subsurface material	Air	Ambient vapor inhalation	Yes	
		Subsurface material	Dermal contact Ingestion	No	No non-NFA SWMUs exist in Zone 1~~, and Marina Users are not expected to have direct contact with subsurface material~~
	SWMU surface material	Air	Ambient vapor inhalation Particle inhalation	Yes	Vapors and particles from uncovered SWMUs in other areas of the site could be dispersed to Zone 1
		Surface material	Ingestion Dermal contact	No	No non-NFA SWMUs exist in Zone 1
	Coke Oven Area Pits	Air	Ambient vapor inhalation	Yes	Vapors from Coke Oven Area pits could be dispersed to Zone 1

[2] Hypothetical future on-site receptor population. Consistent with 1996 discussions and agreements with EPA and the State of New York, BSC will consider certain water-related recreations uses (i.e., a marina-based recreational/commercial area in Zone 1 of the Slag Fill Area and a potential "greenway" path from Route 5 to the lake front), in the RFI risk assessment. Inclusion of these hypothetical recreational exposure scenarios in this document does not constitute an endorsement by BSC, at this time, of such site land uses, nor does it create any commitment or expectation on the part of BSC regarding their future realization.

TABLE 2-1 (continued)

Receptor Population	Potential Source Medium	Exposure Medium	Potential Exposure Route	Will Pathway be Used to Develop RBSL?	Rationale/Comment
~~On-Site~~ Zone 1 Greenway User (adult and child)	Groundwater	Air	Ambient vapor inhalation	Yes	
	SWMU subsurface material	Air	Ambient vapor inhalation	Yes	Vapors from subsurface material in SWMUs in other areas of the site could be dispersed to Zone 1
		Subsurface material	Ingestion Dermal contact	No	
	SWMU surface material	Air	Ambient vapor inhalation Particle inhalation	Yes	Vapors and particles from uncovered SWMUs in other areas of the site could be dispersed to Zone 1
		Surface material	Ingestion Dermal contact	~~Depending on location~~No	~~Greenway may or may not be located close to SWMUs~~No SWMUs subject to risk assessment in Zone 1
	Coke Oven Area Pits	Air	Ambient vapor inhalation	Yes	Vapors from Coke Oven Area pits could be dispersed to Greenway area
Recreational Bather (adult and child)	Groundwater	~~Air~~	~~Ambient vapor inhalation~~	~~Yes~~	
		Surface water	Ingestion Dermal contact	Yes	Groundwater in the Lake Erie and Smokes Creek Discharge Areas could impact surface water in Lake Erie and Smokes Creek
	Surface Water	Surface water	Ingestion Dermal contact	Yes	Recreational bathers are expected to use Lake Erie, Smokes Creek, and Blasdell Creek
	Sediment	Sediment	Ingestion	Yes	Recreational bathers are expected to use Lake Erie, Smokes Creek, and Blasdell Creek
	~~SWMU subsurface material~~	~~Air~~	~~Ambient vapor inhalation~~	~~Yes~~	
	~~SWMU surface material~~	~~Sediment~~	~~Ingestion, vapor inhalation Particle inhalation~~	~~Yes~~	

TABLE 2-1 (continued)

Receptor Population	Potential Source Medium	Exposure Medium	Potential Exposure Route	Will Pathway be Used to Develop RBSL?	Rationale/Comment
Off-Site Fenceline Resident (adult and child)	Groundwater	Air	Ambient vapor inhalation	Yes	Groundwater vapors from the site could be dispersed to off-site residential areas
			Indoor vapor inhalation	No	Groundwater flows away from residential areas towards the lake, therefore COPCs are not present in off-site groundwater
	Groundwater (potable use)	Air	Potable groundwater vapor inhalation	No	RBSLs for groundwater direct contact pathways will not be developed
		Potable groundwater	Ingestion Dermal contact		
	SWMU subsurface material	Air	~~Outdoor~~Ambient vapor inhalation ~~(site boundary)~~	Yes	Vapors from subsurface material in SWMUs in other areas of the site could be dispersed to off-site residential areas
	SWMU surface material	Air	~~Outdoor~~Ambient vapor inhalation Particle inhalation ~~(site boundary)~~	Yes	Vapors and particles from uncovered SWMUs could be dispersed to off-site residential areas
	Coke Oven Area Pits	Air	~~Outdoor~~Ambient vapor inhalation	Yes	Vapors from Coke Oven Area pits could be dispersed to off-site residential areas
Off-Site Surface Water Consumer (adult and child) continued)	Groundwater to surface water	Air	Potable surface water vapor inhalation	Yes	
		Surface water (potable use)	Ingestion Dermal contact		
Fish Consumer (adult and child)	Groundwater to surface water Surface water	Surface water to Fish	Ingestion	Yes	

TABLE 2-2
STATUS SUMMARY OF SOLID WASTE MANAGEMENT UNITS CONTAINING COPCs THAT WILL BE ASSESSED DURING TIER I OF THE HUMAN HEALTH RISK ASSESSMENT FOR THE BETHLEHEM STEEL CORPORATION LACKAWANNA SITE

SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
COKE OVEN AREA							
P-18	Blast Furnace Cooling Tower Hot & Cold Wells	Two uncovered pits, 28 feet deep, containing sediment covered with approximately 20 feet of water (precipitation).	Inactive.	NA	NA	No samples collected	X
S-26	Fill Area Near Coke Oven Battery #8	Steel making (BOF) slag fill area adjacent to north end of Ship Canal. Sand, gravel, and slag; about 50% vegetated, but otherwise uncovered.	Inactive.	S	X	NA	NA
SWMU Group PA-1							
P-1	Quench Water Pit, North Station	Uncovered concrete pit, 8 feet deep.	Active (part of coke production process; water quench for hot, incandescent coke).	NA	X (adjacent to pit)	X	No samples collected
P-2	Quench Water Pit, Arctic Station	Uncovered concrete pit, 10 feet deep.	Active (part of coke production process; water quench for hot, incandescent coke).	NA	X	X	No samples collected
P-3	Quench Water Pit, Central Station	Uncovered concrete pit, 12 feet deep.	Inactive. Formerly used for coke quenching (ended in the early 1970s); now used to collect water pumped from coke wharf sump, fire protection line water, and low flow, non-contact cooling water, prior to discharge to Ship Canal via Outfall #401. Cleaned out after removed from service.	X (adjacent to pit)	No samples collected	X	No samples collected

TABLE 2-2 (Continued)

SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
P-4	Quench Water Pit, A Station	Uncovered, concrete pit, 13-20 feet deep (sloping bottom). Contains precipitation.	Inactive since 1990; formerly used for coke quenching. Cleaned out after removal from service.	X (adjacent to pit)	No samples collected	X	No samples collected
P-5	Quench Water Pit, B Station	Uncovered concrete pit, 14 feet deep.	Active. Formerly used in coke quenching (ended 1977); now used to collect storm water and condensate prior to discharge to Ship Canal via Outfall # 411. Cleaned out after removal from use in coke quenching.	X (adjacent to pit)	No samples collected	No samples collected	No samples collected
SWMU Group PA-2							
P-6	Lime Sludge Settling Basin	Uncovered concrete pit, about 20 feet deep. Contains precipitation.	Inactive since 1994. Prior to 1983, used as a settling basin to remove lime sludge from treated weak ammonia liquor (WAL). From 1983 to 1994, used as holding/flow equalization tank for WAL prior to treatment in onsite biological treatment plant. Cleaned out after removal from service.	X (adjacent to pit)	No samples collected	No samples collected	No samples collected
P-7	Abandoned Lime Sludge Settling Basin	Concrete pit, about 21 feet deep, backfilled with slag; covered with asphalt pad (south portion) and gravel (north portion).	Inactive since 1960. Formerly used as lime sludge settling basin for treated WAL.	X	No samples collected	NA	NA

TABLE 2-2 (Continued)

SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
SWMU Group PA-3							
P-9	Abandoned Tar Decanter Sludge Pits	Concrete pit, about 18 feet deep, filled with slag; covered with asphalt pad (north portion) and gravel (south portion).	Inactive since 1960. Formerly used to store tar decanter sludge.	No samples collected	X	NA	NA
P-10	Contaminated Soil Near Ball Mill	Tar spill location. Tar and impacted soils were removed, and area paved with asphalt.	No longer present.	No samples collected	X	NA	NA
SWMU Group PA-4							
P-11	Benzol Plant Tank Storage Area	Part of Benzol Plant. Access restricted by chain link fence around entire Benzol Plant. Entrance to and work performed within entire Benzol Plant is governed by process safety management plan (required by OSHA). By-products and products formerly delivered by underground pipelines were replaced by above-ground lines by 1991. Contains Pit #17 (uncovered).	Active. Used for storage of coke by-products recovered in Benzol Plant (BTX). Pit #17 provides containment for condensate blowdown and is used to collect groundwater. Also serves as emergency backup sump. Normally contains a few feet of water (precipitation and groundwater). Current groundwater inflow characterized as seepage.	X	X	X (Pit #17)	No samples collected

TABLE 2-2 (Continued)

SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
P-12	Spill Cleanup Soil Storage Area	Level, approximately 1,100 ft^2 area partially enclosed by low concrete wall.	Inactive. Formerly used (1987 - 1992) to store, on plastic liner, a pile of about 350 tons of combined slag fines, soils, and waste from debenzolized wash oil spill. Perforated PVC piping system collected pile leachate, which was returned to plant for wash oil residue recovery. All materials removed and shipped offsite in 1992.	X	No samples collected	NA	NA
TANK FARM AREA							
S-24	Tar Pit North of Lime Plant	Approximately 1-acre relatively level area bordering the north side of Smokes Creek. Area was originally a pit used for disposal of agitator sludge from the Benzol Plant. After disposal ceased, area was covered with slag. Approximately 75% of surface is vegetated, including some 10- to 15-foot cottonwood trees.	Inactive since the 1950s.	According to Table 3-5 in ID#1, we have one surface sample	X	NA	NA
SWMU Group TF							
P-8	Waste Oil Storage Tanks in Tank Farm	Former site of two waste oil storage tanks. Area now contains two concrete pads surrounded by an earthen berm.	Inactive. Tanks were cleaned out and removed in 1995.	X	No samples collected	NA	NA
P-74	Solid Fuel Mix Storage Piles in Tank Farm	Located within bermed Tank Farm Area. Piles established in 1987 to store blend of tank cleanout residues, coke breeze, and coal fines prior to sale as fuel and removal from site.	Inactive. Removal and surface cleanup in 1991.	X	No samples collected	NA	NA

TABLE 2-2 (Continued)

SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
P-75	Tank Storage Area, Tank Farm	Approximately 18-acre bermed tank storage area originally consisting of seven large tanks (3 to 5 million gallon capacity) and nine smaller tanks used to store fuel oil, products, and wastes, most of which have been removed. Area now contains concrete pads of former tanks, plus two tanks used for storage and one empty tank. Area sparsely to partly vegetated, especially along berms.	Active. Two tanks used to store WAL.	X	No samples collected	NA	NA
SLAG FILL AREA ZONE 2							
S-3	Surface Impoundment C/Former Hazardous Waste Management Unit 2	Uncovered 3.52-acre impoundment constructed as an excavation in slag fill; contains mixed waste sludge. Average depth is 22 feet. Surrounded by 5- to 15-foot slag berm.	Inactive. Delisted as hazardous waste unit in 1997 by EPA and NYSDEC.	S	X	NA	NA
S-8	Surface Impoundment H	2.5-acre excavation in slag.	Never used	X	No samples collected	NA	NA
S-21	Sludge Storage Area	8-foot high pile, enclosed by slag berm; sparsely vegetated. Pile contains precipitation dust from operation of scrap melter.	Inactive	X	No samples collected	NA	NA
SWMU Group SFA-1							
S-1	Surface Impoundment A	Approximately 2-acre bermed impoundment excavated in slag containing iron-rich oily mill scale. Partially water covered; vegetated at margins.	Inactive.	X	X	NA	NA
S-2	Surface Impoundment B	Approximately 3-acre impoundment excavated in slag containing sludges from WQCS Nos. 3, 7, and 9, and the blast furnace final thickener. The uncovered surface is dry and moderately vegetated.	Inactive.	X	X	NA	NA

TABLE 2-2 (Continued)

SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
S-4	Surface Impoundment D	Approximately 3.5-acre area used for disposal of sediments dredged from Smokes Creek. The impoundment berms are approximately 16 feet higher than the surface of the disposed material. The uncovered surface is well vegetated, mostly by poplar trees reaching 30 to 50 feet.	Inactive.	X	X	NA	NA
S-5	Surface Impoundment E	Approximately 1-acre bermed impoundment excavated in slag and containing iron-rich oily sludges (see S-1). Partially water covered; vegetated in northern portion.	Inactive.	X	X	NA	NA
S-6	Surface Impoundment F	Approximately 1-acre bermed impoundment excavated in slag and containing iron-rich sludges. Uncovered surface is moderately vegetated (no standing water).	Inactive.	X	X	NA	NA
S-7	Surface Impoundment G	Approximately 4.5-acre bermed impoundment excavated in slag. Contains water treatment solids/sludges from the BOF final thickener (WQCS No. 3), WQCS No. 7, and WQCS No. 9. Surface capped with an interim synthetic cap consisting of a 6-mil membrane overlain by a 6-inch thick proprietary prototype cap consisting of a blended Portland cement, sludge, and slag matrix. Weathering has altered the cap surface to a fine-to-medium gravel-like consistency.	Inactive.	No samples collected	X	NA	NA
S-20	Drying Area for Sludge from Impoundment F (SWMU S-6)	Surface of SWMU S-7 was used as a drying area for sludge removed from SWMU S-6 prior to capping of the unit.	Incorporated into SWMU S-7.	No samples collected	X	NA	NA
S-27	Sludge Disposal Area (Adjacent to SWMU S-1)	Approximately 0.5-acre area occupied by several overlapping piles (approximately 6 to 8 feet high) formerly removed from SWMU S-1. Uncovered surface of piles is moderately vegetated.	Inactive.	No samples collected	X	NA	NA

TABLE 2-2 (Continued)

SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
SWMU Group SFA-2							
S-11	Landfill K, Acid Tar Pit, South	Approximately 1-acre area originally excavated in slag and filled with steel and coke-making wastes, including spent pickle liquor, open hearth precipitator dust, lime dust, and discarded drums. Surface is level and covered with gravel-sized slag and debris. About 50% of the surface is vegetated.	Inactive.	S	X	NA	NA
S-22	Vacuum Carbonate Blowdown Impoundment (Acid Tar Pit North)	Approximately 1-acre area originally excavated in slag and filled with vacuum carbonate blowdown (spent carbonate solution) from the coke-making and coke off-gas processes. Area is bordered on three sides by a 5- to 8-foot berm and the surface of the waste is approximately 3 to 5 feet below surrounding (external to berm) grade. Light to moderate vegetative cover consisting of shrubs and trees up to 40 feet high on portions of area where tarry materials are not exposed.	Inactive.	S	X	NA	NA
SLAG FILL AREA ZONE 3							
S-10	Slag Quench Area J	Approximately 2-acre, 15- to 25-foot deep uncovered depression formerly used for placement and quenching of molten BOF slag using WAL mixed with water from the coke plant system. Area is sparsely vegetated except at margins, which are moderately vegetated.	Inactive.	S	X	NA	NA
SLAG FILL AREA ZONE 4							
S-14	General Rubble Landfill N	Approximately 0.5-acre, heavily vegetated (but otherwise uncovered) area formerly used for storage of slag and other steel- making materials primarily from the slag pits in the open-hearth steel making shops. Other stored materials included brick rubble from the open-hearth shops, scrap billets, and steel and iron "buttons." The materials were stored here prior to reclamation of metallics.	Inactive.	X	X	NA	NA

TABLE 2-2 (Continued)

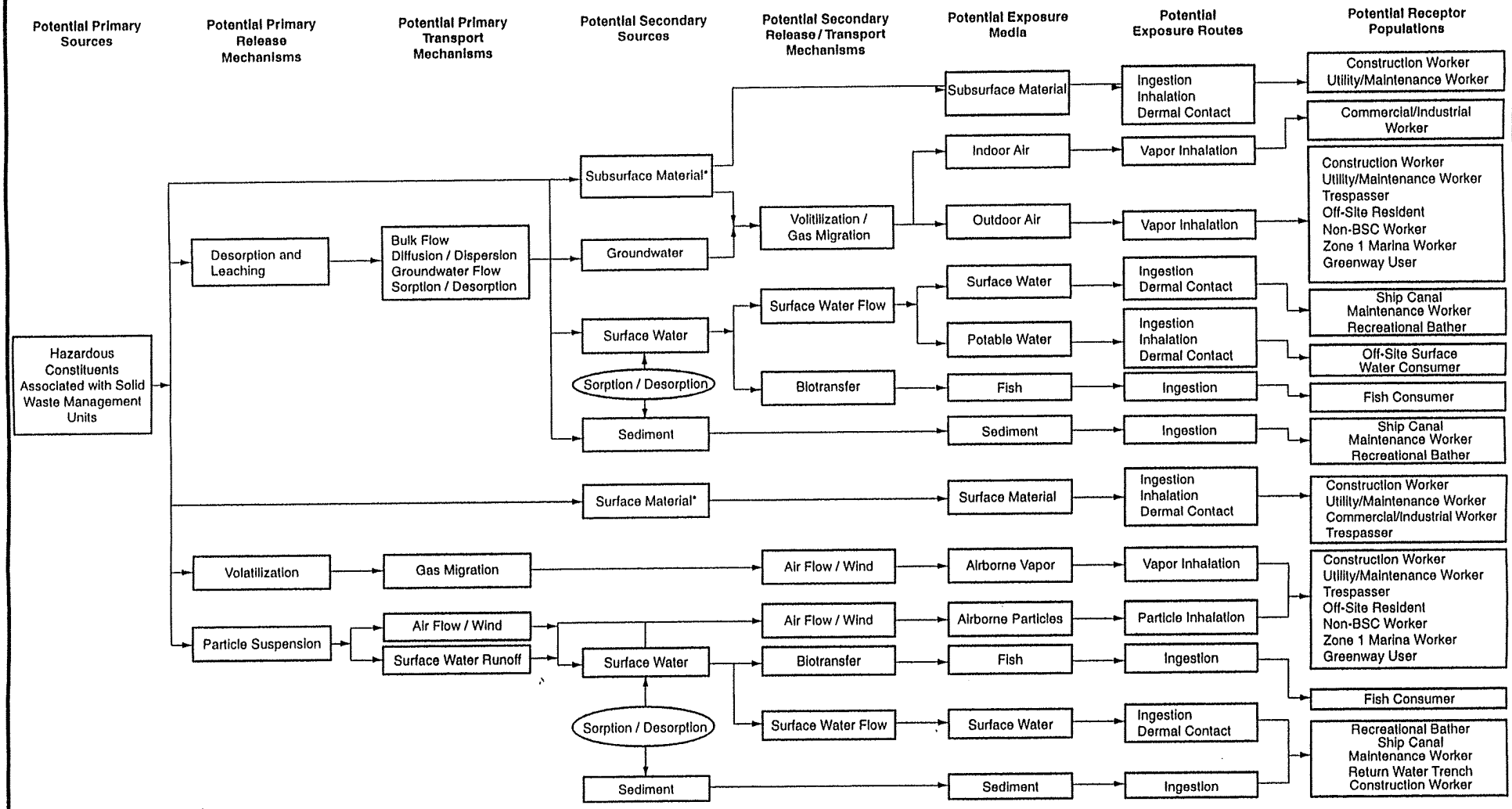
SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
S-15	General Rubble Landfill O	Approximately 9,000 ft^2, sparsely vegetated, uncovered area used for storage of same materials as described for SWMU S-14 prior to reclamation of metallics.	Inactive.	X	No samples collected	NA	NA
S-16	Lime Stabilized SPL Sludge/Slag Landfill	Approximately 0.18 acre landfill extending 20 feet in depth containing slag and spent pickle liquor hazardous waste delisting petition is pending		No samples collected	No COPCs selected (see Table 4-22, ID #1)	NA	NA
S-17	Vacuum Carbonate Blowdown - Landfill Q	Approximately 6,000 ft^2 uncovered area occupied by two parallel trenches and formerly used for disposal of vacuum carbonate blowdown solution from the coke ovens off-gas processing unit. About 75% of area is vegetated.	Inactive. Disposed material was removed and the area filled with slag in the late 1980s.	S	X	NA	NA
S-18	Lime/kish Landfill	Approximately 9,400 ft^2, irregularly shaped, uncovered slag fill area containing approximately 15 to 20 piles of materials. The piles generally contain 100 to 150 cubic yards of lime dust and kish (primarily carbon fines) formerly generated by the BOF process. Slag fill and pile surfaces are mostly bare of vegetation.	Inactive.	X	No samples collected	NA	NA
S-23	Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill	Approximately 0.5-acre, crescent-shaped area, approximately 12 feet high, formerly used for disposal of tar materials from coking operations and tar storage tank cleaning, combined with coke breeze. Surface is covered with pea-stone and gravel-sized slag and is sparsely vegetated; some cottonwood trees to 25 feet high.	Inactive.	No samples collected	X	NA	NA
OTHER AREAS							
S-19	Murphy's Mountain Landfill	Approximately 8-acre uncovered debris pile, approximately 15 feet high, created as part of a fugitive dust control project in 1982-1983. It was designed to function as a windbreak and consists of Zone 5 slag reclamation and general plant construction debris. Surface of pile is sparsely vegetated, with 25-foot poplars at margin.	Inactive.	X	No samples collected	NA	NA

TABLE 2-2 (Continued)

SWMU Number	SWMU Name	Description	Current Status	Medium Containing Chemicals of Potential Concern			
				Surface Material	Subsurface Material	Pit Water	Pit Sediment
S-25	Landfill/ Impoundment under North End of Coal Pile	Approximately 1-acre area formerly used for reclamation of metals from iron- and steel-making slag. Area was subsequently leveled and used for storage of construction-related materials. It is now covered with coal.	Inactive.	No samples collected	X	NA	NA
P-63	Former Mill Scale Storage Area #2	Approximately 1.8-acre uncovered area where mill scale was stored from 1984 to 1992.	Inactive.	X	X	NA	NA
P-73	Former Drum Storage Area East of the Cold Strip Mill	Five discontinuous uncovered areas totaling less than 0.25 acre where drummed materials were received and stored. Typical materials were lubricants and additives. All stored materials were removed in 1983. A portion of the area is now covered by the hydrogen gas plant.	Inactive.	X	X	NA	NA

Notes:

NA = Not applicable.
X = Medium contains one or more COPCs.
S = Subsurface sample data will be used as a surrogate for surficial media.



* Refers to soil, slag fill, and waste material at Lackawanna site.

** Hypothetical future on-site receptor population. Consistent with 1996 discussions and agreements with EPA and the State of New York, BSC will consider certain water-related recreational uses that may potentially be feasible, in the future, for certain discrete portions of the Lackawanna site (i.e., a marina-based recreational/commercial area in Zone 1 of the Slag Fill Area and a potential "greenway" path from Route 5 to the lake front) in the RFI risk assessment. At EPA's request, BSC will also consider unrestricted commercial/industrial development of the site as the only future land use outside of Zone 1. Inclusion of these hypothetical exposure scenarios in this document does not constitute an endorsement by BSC, at this time, of such site land uses, nor does it create any commitment or expectation on the part of BSC regarding the future realization of such land uses.

BETHLEHEM STEEL CORPORATION
RCRA FACILITY INVESTIGATION
Lackawanna, New York

FIGURE 2-1
CONCEPTUAL SITE MODEL
POTENTIAL EXPOSURE PATHWAYS
Job No. 00120-195-152 Dames & Moore

3.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE CURRENT NON-BSC COMMERCIAL/INDUSTRIAL WORKER SCENARIO

Current non-BSC commercial/industrial workers at the Lackawanna site are located in the areas designated in Figure 3-1. These workers could contact site-related COPCs via (1) inhalation of airborne particles from uncovered SWMUs, and (2) inhalation of ambient vapors emanating from subsurface SWMU material, site-wide groundwater, and the Coke Oven Area pits. Because there are in general no SWMUs in the areas occupied by these workers, direct contact with SWMU material and inhalation of indoor vapors from SWMUs are not complete exposure pathways. The only exception is SWMU P-63, which is located on land occupied by Bar Technologies. For this SWMU only, RBSLs calculated for the direct contact of future commercial/industrial workers with this SWMU (see Section 4) will be considered as applicable to non-BSC workers. Otherwise, non-BSC workers are restricted from access to areas of the site occupied by on-going BSC operations or owned by BSC. Potentially complete pathways for the current non-BSC commercial/industrial worker scenario are summarized in Table 3-1.

Equations that will be used to calculate Tier 1 RBSLs for the various pathways are presented in the sections below and in Tables 3-2 to 3-6, and exposure parameter values to be used in calculating Tier 1 RBSLs for the current non-BSC commercial/industrial worker scenario are presented in Table 3-7. Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

3.1 INHALATION OF AIRBORNE PARTICLES FROM UNCOVERED SWMUS

COPCs associated with airborne particles from exposed material in uncovered SWMUs could be inhaled by non-BSC commercial/industrial workers. SWMUs where surficial material is exposed to the atmosphere are the following:

- Coke Oven area: SWMU Groups PA-1 (P-1 to P-5), PA-2 (P-6 and P-7) and PA-4 (P-11 and P-12), and S-26;
- Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22), S-3, S-8, and S-21;
- Slag Fill Area Zone 3: SWMU S-10;
- Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, and S-18;
- Other areas: SWMUs S-19, P-63, and P-73.

Subsurface results will be used as a surrogate for surficial data for the following uncovered SWMUs where no surface samples were taken: SWMU Group SFA-2, P-18, S-26, S-3, S-10, and S-17. This is highly conservative with respect to VOCs (but not non-volatile COPCs), which would be expected to dissipate rapidly if exposed to the atmosphere.

In evaluating this pathway in Tier 1, receptors will be conservatively assumed to be inhaling particles within the source area. Dispersion modeling will be used in Tier 2 for any SWMUs that exceed target criteria in Tier 1. Equations that will be used to develop RBSLs for the particle inhalation pathway are presented in Table 3-2. Exposure parameter values are presented in Table 3-7.

3.2 INHALATION OF VAPORS FROM SUBSURFACE SWMU MATERIAL

As shown in Table 3-1, current non-BSC commercial/industrial workers could be exposed to migrating ambient vapors from subsurface materials in the following SWMUs:

- Coke Oven Area: SWMU Groups PA-3 (P-9 and P-10) and PA-4 (P-11 to P-12);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S- 27) and SFA-2 (S-11 and S-22); and SWMU S-24; and
- Slag Fill Area Zone 4: SWMUs S-14 and S-23.

The RBSLs for evolution of vapors from subsurface SWMU material ($RBSL_{nw/samb}$) will be back-calculated from corresponding $RBC_{nw/air}$ values using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Tables 3-3 and 3-4). The model is used to predict the movement and steady-state vapor emission rates assuming there are no losses through volatilization, leaching, or biodegradation. Media containing the representative COPC concentrations is conservatively assumed to be continuous from 100 cm below the ground surface (the assumed depth to source) throughout the full extent of the soil column (*i.e.*, to groundwater).

Airborne concentrations of volatile COPCs at worker locations will be related to SWMU-specific emissions based on a unit concentration (1 mg/kg) in soil using EPA's air dispersion model ISCST Model version 3 with meteorological data collected at an on-site monitoring station in 1991. These data are presented in Appendix A. This model uses steady-state Gaussian plume dispersion curves to model continuous release from a given source area using sector-averaging and statistical wind summaries. Emissions from each source will be modeled using a unit emission rate (ER_{unit}) of 1 g/sec for all sources except for SWMU S-24, which will be split into two source areas (ER_{unit} = 2 g/sec) in

order to best fit its actual shape. The windrose of the meteorological data indicates that the dominant wind direction is toward the northeast.

Equations that will be used to develop RBSLs for the subsurface vapor inhalation pathway are presented in Table 3-4. Exposure parameter values are presented in Table 3-7. RBSLs for evolution of vapors from subsurface material at each SWMU and atmospheric dispersion to Zone 1 will be back-calculated for each volatile COPC from corresponding $RBC_{NW-/air}$ values (Equations NW-4 and NW-5, Table 3-4). Using the ISCST3-predicted air concentrations, a screening level emission rate will be estimated from each SWMU using a simple linear relationship (Equation NW-6, Table 3-4). The soil screening level ($RBSL_{nw-/samb}$) will be estimated by using the linear relationship between the predicted chemical-specific emission rate ($Q_{chemical}$), screening level emission rate ($ER_{screening}$), and the unit soil concentration (S_{unit}) initially used in Farmer's model (Equation NW-7, Table 3-4). By combining Equations NW-6 and NW-7, RBSLs for current non-BSC commercial/industrial workers will be estimated by calculating the ratio of the ISCST3-predicted air concentration of each volatile COPC to the chemical-specific emission rates using Farmer's model (Equation NW-8a, Table 3-4). Substituting the equation for Farmer's model into Equation NW-8a, RBSLs for current non-BSC commercial/industrial exposure to vapors from subsurface SWMU material will be estimated according to Equation NW-8b (Table 3-4).

3.3 INHALATION OF VAPORS FROM GROUNDWATER

As shown Table 3-1, current non-BSC commercial/industrial workers could be exposed to vapors emanating from site-wide groundwater. RBSLs for evolution of vapors from site-wide groundwater and atmospheric dispersion to worker locations will be back-calculated for each volatile COPC using the Farmer's model described above. Emissions from the site-wide groundwater plume will be modeled using three source areas, with ER_{unit} = 3 g/sec. This division is necessary to accurately approximate the shape of the source area for modeling purposes. An average groundwater depth of 35 feet is assumed. A corresponding groundwater RBSL will be estimated by back-calculating from $RBC_{nw/air}$ values (Equations NW-4 and NW-5), as shown in Table 3-5. Exposure parameter values are presented in Table 3-7.

3.4 INHALATION OF VAPORS FROM PITS

As shown in Table 3-1 current non-BSC commercial/industrial workers could be exposed to ambient vapors emanating from standing water in pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #17 at SWMU P-11). RBSLs for evolution of vapors from the pits and atmospheric dispersion to worker locations will be back-calculated for each volatile COPC from corresponding $RBC_{nw-/air}$ values using the equations presented in Table 3-6. Exposure parameter values are presented in Table 3-7. The chemical specific volatilization rate ($VF_{nw/pit}$) from the quench pits will be estimated using the stagnant film model presented in EPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models* (1989a) (Table 3-6, Equation NW-10a).

Table 3-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Current Non-BSC Commercial/Industrial Worker Scenario

Potential Sources	Exposure Pathway Description	
	Inhalation of Airborne Particles from Surface	Inhalation of Ambient Vapors
COKE OVEN AREA		
PA-1 (P-1, P-2, P-3, P-4, and P-5)	**X**	NT
PA-2 (P-6 and P-7)	**X**	ND
PA-3 (P-9 and P-10)	ND, NE (c)	**X**
PA-4 (P-11 and P-12)	**X**	**X**
P-18	ND, NE (c)*	NT
S-26	**S**	NT
PA-1 Pits	NA	**X**
Pit #17 at SWMU P-11	NA	**X**
Groundwater	NA	Site-wide
TANK FARM AREA		
TF (P-8, P-74, and P-75)	**X**	ND
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 1 (NO SWMUS)		
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 2		
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	**X**	**X**
SFA-2 (S-11 and S-22)	**S**	**X**
S-3	**S**	NT
S-8	**X**	ND
S-21	**X**	ND
S-24	ND, NE (c)	**X**
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 3		
S-10	**S**	NT
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 4		
S-14	**X**	**X**
S-15	**X**	ND
S-16	ND, NE (c)	NC
S-17	**S**	NT
S-18	**X**	ND
S-23	ND, NE (c)	**X**
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 5 (NO SWMUS)		
Groundwater	NA	Site-wide
OTHER AREAS		
S-19	**X**	ND
S-25	ND, NE (c)	NT
P-63	**X**	NV

Table 3-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Current Non-BSC Commercial/Industrial Worker Scenario

Potential Sources	Exposure Pathway Description	
	Inhalation of Airborne Particles from Surface	Inhalation of Ambient Vapors
P-73	X	NT
Smokes Creek Area groundwater	NA	Site-wide
Site-wide groundwater	NA	X
WATERCOURSES		
Lake Erie	NA	
Smokes Creek		
Blasdell Creek		
North & South Return Water Trenches		
Ship Canal		

Notes:

X	=	considered complete pathway to be evaluated.
S	=	considered complete pathway to be evaluated by using subsurface soil material data as surrogate for surface material data.
NA	=	not applicable.
NC	=	no COPCs present.
ND	=	no data collected.
NE	=	no exposure.
NE [c]	=	no exposure because SWMU is covered. *SWMU P-18 is covered with water.
NT	=	no toxicity criteria available for volatile subsurface COPC(s).
NV	=	no volatile COPCs present.
Site-wide	=	site-wide groundwater is assumed source of groundwater vapor exposure.

Table 3-2. Current Non-BSC Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Airborne Particle Inhalation Pathway

Non-Cancer $RBSL_{nw/pi}$:

NW- 1

$$RBSL_{nw/pi}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{THQ \times BW_{nw} \times AT_n \times RfD_i}{ED_{nw} \times EF_{nw} \times \left(10^{-6}\ kg/mg \times IR_a \times VF_p\right)}$$

Cancer $RBSL_{nw/soil}$:

NW- 2a

$$RBSL_{nw/pi}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{TR \times BW_{nw} \times AT_c}{ED_{nw} \times EF_{nw} \times \left(10^{-6}\ kg/mg \times SF_i \times IR_a \times VF_p\right)}$$

where the particle emission factor VF_p (ASTM, 1995) =

NW-2b

$$VF_p\left[\frac{kg\text{-}soil}{m^3 - air}\right] = \frac{P_e \times W_S}{U_{air} \times \delta_{air}} \times 10^3 \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

where:

Parameter	Definition	Units
$RBSL_{nw/pi}$	RBSL for inhalation of airborne particles for non-BSC worker	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{nw}	Non-BSC worker body weight	kg
ED_{nw}	Non-BSC worker exposure duration	years
EF_{nw}	Non-BSC worker exposure frequency	days/year
$IR_{a/nw}$	Non-BSC worker inhalation rate	m^3/day
P_e	Areal total respirable particulate emission flux from SWMU	g/cm^2-sec
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
RfD_i	Inhalation reference dose	mg/kg-day
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_p	Total respirable particle concentration from SWMU	kg-soil/m^3-air
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm

Table 3-3. Farmer's Emission Model

Farmer's emission rate equation:

NW-3a

$$Q_{chemical}\left[\frac{g}{sec}\right] = D^{air} \times \frac{C_T}{R_g} \times \frac{\theta_{as}^{3.33}}{\theta_T^2} \times \frac{1}{d} \times A \times 10^{-3}\ \frac{g}{mg}$$

where the total solute concentration is:

NW-3b

$$C_T\left[\frac{mg}{cm^3}\right] = S_{unit} \times \rho_s \times \left(1 + \frac{\theta_{ws} \times \rho_L}{\rho_s}\right) \times 10^{-3}\ \frac{kg}{g}$$

and the gas partition coefficient is:

NW-3c

$$R_g\left[\frac{cm^3}{cm^3}\right] = \theta_{as} + \frac{\theta_{ws} + \rho_s \times K_{oc} \times f_{oc}}{H'}$$

where:

Parameter	Definition	Units
A	Area of source	m^2
C_T	Total solute concentration	mg/cm^3
d	Depth to subsurface source	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
f_{oc}	Organic carbon content	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
$Q_{chemical}$	Emission rate	g/sec
R_g	Gas partition coefficient	cm^3/cm^3
S_{unit}	Unit concentration of COPC in soil	mg/kg
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 3-4. Current Non-BSC Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Subsurface Soil Vapor Inhalation Pathway

Non-Cancer $RBC_{nw/air}$:

NW-4

$$RBC_{nw/air}\left[\frac{\mu g}{m^3}\right] = \frac{THQ \times RfD_i \times BW_{nw} \times AT_n}{ED_{nw} \times EF_{nw} \times IR_{a/nw}} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBC_{nw/air}$:

NW-5

$$RBC_{nw/air}\left[\frac{\mu g}{m^3}\right] = \frac{TR \times BW_{nw} \times AT_c}{SF_i \times ED_{nw} \times EF_{nw} \times IR_{a/nw}} \times 10^3 \frac{\mu g}{mg}$$

Screening-level emission rate:

NW-6

$$\frac{RBC_{nw/air}\ (mg/m^3)}{ISCST3_{air}\ (mg/m^3)} = \frac{ER_{screening}\ (g/sec)}{ER_{unit}\ (1\ g/sec)}$$

NW-7

$$\frac{ER_{screening}\ (g/sec)}{Q_{chemical}\ (g/sec)} = \frac{RBSL_{nw/samb}\ (mg/kg\text{-}soil)}{S_{unit}\ (1\ mg/kg)}$$

$RBSL_{nw/samb}$:

NW-8a

$$RBSL_{nw/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{nw/air} \times ER_{unit} \times S_{unit}}{Q_{chemical} \times ISCT3_{air}}$$

NW-8b

$$RBSL_{nw/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{nw/air} \times 10^6\ mg/kg}{VF_{air}}$$

where the volatilization factor from subsurface material to ambient air is:

NW-8c

$$VF_{air}\left[\frac{\mu g\text{-}soil}{m^3-air}\right] = \frac{ISCST3_{air} \times D^{air} \times \rho_s \times \left(1 + \frac{\theta_{ws} \times \rho_L}{\rho_s}\right) \times \theta_{as}^{3.33} \times A \times H'}{\theta_T^2 \times d \times (\theta_{as} \times H' + \theta_{ws} + \rho_s \times K_{oc} \times f_{oc}) \times ER_{unit}} \times 10^4 \frac{cm^2}{m^2}$$

where:

Parameter Definition		Units
$RBC_{nw/air}$	RBC for volatile COPC in air for non-BSC worker	$\mu g/m^3$
$RBSL_{nw/samb}$	RBSL in subsurface material for vapor in ambient air for non-BSC worker	mg/kg
A	Area of subsurface source	m^2
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{nw}	Non-BSC worker body weight	kg

Parameter	Definition	Units
d	Depth to subsurface source	cm
ED_{nw}	Non-BSC worker exposure duration	years
EF_{nw}	Non-BSC worker exposure frequency	days/year
$ER_{screening}$	Screening-level emission rate	g/sec
ER_{unit}	Unit emission rate	g/sec
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
f_{oc}	Organic carbon content	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
$IR_{a/nw}$	Non-BSC worker inhalation rate	m^3/day
$ISCT3_{air}$	ISCT3-modeled concentration of COPC in air	g/m^3
$Q_{chemical}$	Chemical-specific emission rate	g/sec
RfD_i	Chronic inhalation reference dose	mg/kg-day
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
S_{unit}	Unit concentration of COPC in soil	mg/kg
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
VF_{air}	Subsurface to ambient air volatilization factor	$\mu g/m^3$
θ_{gs}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 3-5. Current Non-BSC Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Site-Wide Groundwater Vapor Inhalation Pathway

$RBC_{nw/air}$ values calculated per Equations NW-4 and NW-5

$RBSL_{nw/wamb}$:

NW- 9a

$$RBSL_{nw/wamb}\left[\frac{\mu g}{L}\right] = \frac{RBC_{nw/air}}{VF_{wamb}} \times 10^{-3}\frac{mg}{\mu g}$$

Volatilization factor from groundwater to ambient air (ASTM, 1995):

NW-9b

$$VF_{wamb}\left[\frac{kg-soil}{m^3-air}\right] = \frac{H'}{\left(1+\frac{U_{air}\times\delta_{air}\times L_{GW}}{D_{ws}^{eff}\times W_{GW}}\right)} \times 10^3\frac{L}{m^3}$$

Effective diffusion coefficient between groundwater and the SWMU surface (ASTM, 1995):

NW-9c

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = \left(h_{cap}+h_v\right)\times\left(\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right)^{-1}$$

Effective diffusion coefficient in soil based on vapor-phase concentration (ASTM, 1995), is:

NW-9d

$$D_S^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\times\frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{water}\times\frac{1}{H'}\times\frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Effective diffusion coefficient through the capillary fringe (ASTM, 1995):

NW-9e

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\times\frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{water}\times\frac{1}{H'}\times\frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

Parameter Definition		Units
$RBC_{nw/air}$	RBC for volatile COPC in air for non-BSC worker	$\mu g/m^3$
$RBSL_{nw/wamb}$	RBSL in groundwater for vapor in ambient air for non-BSC worker	$\mu g/L$
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
D_{cap}^{eff}	Effective diffusion coefficient in capillary fringe region	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
h_{cap}	Thickness of capillary fringe	cm
h_v	Thickness of vadose zone	cm
L_{GW}	Depth to groundwater ($h_{cap} + h_v$)	cm
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{wamb}	Volatilization factor from groundwater to ambient air	kg-soil/m^3-air
W_{GW}	Width of groundwater source	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil

Table 3-6. Current Non-BSC Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Pit Vapor Inhalation Pathway

$RBC_{nw/air}$ values calculated per Equations NW-4 and NW-5

$RBSL_{nw/pit}$:

NW-10a

$$RBSL_{nw/pit}\left[\frac{\mu g}{L}\right] = \frac{RBC_{nw/air}}{VF_{nw/pit}} \times 10^3 \frac{\mu g\text{-}m^3}{g\text{-}L}$$

Volatilization rate from the pits:

NW-10b

$$VF_{nw/pit}\left[\frac{\mu g}{g}\right] = ISCST3_{air} \times \frac{k_L}{1 + \frac{k_L}{k_G \times H'}} \times A \times \frac{1}{ER_{unit}}$$

Gas-phase mass transfer coefficient:

NW-10c

$$k_G\left[\frac{m}{sec}\right] = 4.82 \times 10^{-3} \times U_{10}^{0.78} \times Sc_G^{-0.67} \times de^{-0.11} \quad \text{where}$$

Effective diameter of impoundment:

NW-10d

$$de[m] = \sqrt{\frac{4 \times A}{\pi}}$$

Schmidt number on the gas side:

NW-10e

$$Sc_G = \frac{\mu_G}{\rho_G \times D^{air}}$$

Liquid-phase transfer coefficient:

NW-10f

$$k_L\left[\frac{m}{sec}\right] = 10^{-6} + 144 \times 10^{-4} \times U^{*2.2} \times Sc_L^{-0.5} \quad \text{where}$$

Schmidt number on the liquid side:

W-10g

$$Sc_L = \frac{\mu_L}{\rho_L \times D^{water}}$$

Friction velocity:

NW-10h

$$U^*\left[\frac{m}{sec}\right] = 0.01 \times U_{10} \times \sqrt{6.1 + 0.63 \times U_{10}}$$

where:

Parameter	Definition	Units
$RBC_{nw/air}$	RBC for volatile COPC in air for non-BSC worker	$\mu g/m^3$
$RBSL_{nw/pit}$	RBSL in pit water for vapor in ambient air for non-BSC worker	$\mu g/L$
A	Liquid area (pit)	m^2
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
de	Effective diameter of impoundment (pit)	m
ER_{unit}	Unit emission rate	g/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
$ISCT3_{air}$	ISCT3-modeled concentration of COPC in air	g/m^3
k_G	Gas-phase mass transfer coefficient	m/sec
k_L	Liquid-phase mass transfer coefficient	m/sec
Sc_G	Schmidt number on the gas side	unitless
Sc_L	Schmidt number on the liquid side	unitless
U^*	Friction velocity	m/sec
U_{10}	Wind speed at 10 meters above liquid surface (pit)	m/sec
VF_{pit}	Volatilization rate from pit	$\mu g/g$
μ_G	Viscosity of air	g/cm-sec
μ_L	Viscosity of water	g/cm-sec
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	$g\text{-soil}/cm^3\text{-soil}$

Table 3-7. Current Non-BSC Commercial/Industrial Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	2,409	days	EPA, 1989b	ED x 365 days/year
BW_{nw}	Body weight	71.8	kg	EPA, 1997	Recommended value
ED_{nw}	Exposure duration	6.6	years	EPA, 1997	Recommended value
EF_{nw}	Exposure frequency	250	days/year	Professional judgment	Recommended value
$IR_{a/nw}$	Inhalation rate	13.25	m^3/day	EPA, 1997	Mean of recommended long-term inhalation rate for male and female adults
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	

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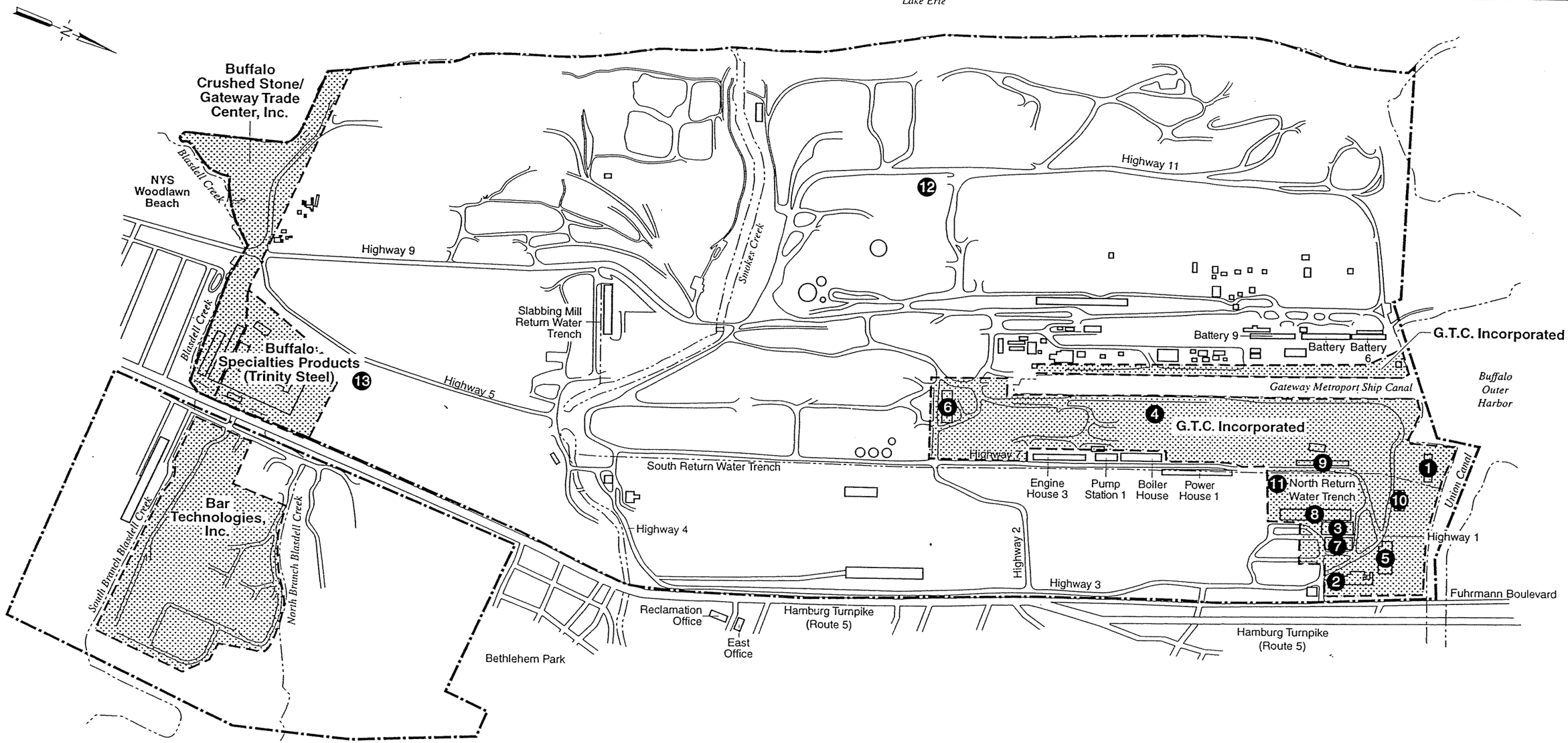


LEGEND:

- BSC Study Area Boundary
- Existing Structure
- Approximate Property Boundary of Non-BSC Businesses Within the Site Boundary
- Property Not Owned by BSC
- G.T.C. — Gateway Trade Center
- 1 — Occupant Designation (See Key at Right)

Key To Occupants

Gateway Industrial Park Tenants

1. Buffalo Transfer
2. Engineered Air Division of Thermal Components, Inc.
2. Erie County Water Authority
3. Buffalo Polymer Processors
3. Gateway Welding, Inc.
3. Staroba Plastic Metal Prod.
3. Metro Plastics
4. Fluro-Seal
4. M.A.T. Distributors
5. American Stainless Corp.
6. Ferrous Manufacturing Corp.
6. J.B. Conomos
7. Highland Equipment
8. Integrated Technologies
9. Paul Riefler, Inc.
10. S.J.B. Services
11. Shred-It

Additional Tenant Companies Occupying the Lackawanna Site

12. Mid Continent
13. Westway Trading

Property Owners Within Lackawanna Site Area

- Buffalo Crushed Stone
- Buffalo Specialities Products (Trinity Steel)
- Bar Technologies
- Gateway Trade Center Incorporated

NOTE: Buffalo Crushed Stone also leases portions of the Slag Fill Area.

0 1000 2000

APPROXIMATE SCALE IN FEET

BETHLEHEM STEEL CORPORATION
Lackawanna, New York

FIGURE 3-1
NON-BSC OCCUPANTS OF LACKAWANNA SITE

Job No. 00120-195-152 Dames & Moore

4.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE FUTURE COMMERCIAL/INDUSTRIAL WORKER SCENARIO

When the BSC Lackawanna site is redeveloped, future on-site commercial/industrial workers may contact COPCs via (1) direct contact (ingestion, inhalation, dermal contact) with exposed surficial SWMU material ~~where redevelopment is feasible (see Table 1-2), and~~ (2) inhalation of ambient vapors emanating from subsurface SWMU material and groundwater and Coke Oven Area Pits, and (3) inhalation of~~and~~ indoor vapors emanating from subsurface SWMU material and groundwater ~~vapors emanating from subsurface SWMU material and groundwater in these areas. In addition, these workers could inhale ambient vapors from the Coke Oven Area pits.~~ This scenario makes the ~~conservative~~ assumption that SWMU conditions remain unchanged in the future, regardless of redevelopment. Potentially complete pathways for the commercial/industrial worker scenario are depicted in Figure 2-1; and potential source areas where these pathways could result in commercial/industrial worker exposure are summarized in Table 4-1.

Equations that will be used to calculate Tier 1 RBSLs for the various pathways are presented in the sections below and Tables 4-2 to 4-7~~11~~, and exposure parameter values to be used in calculating Tier 1 RBSLs for the commercial/industrial worker scenario are presented in Tables 4-~~12~~-8 and 4-~~13~~9. Toxicity criteria were presented in Interim Deliverable No. 1~~, oral and dermal relative absorption factors are presented in Section 3.0 (Tables 3-1 and 3-2)~~. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

4.1 DIRECT CONTACT WITH SURFICIAL SWMU MATERIAL

COPCs associated with exposed material in uncovered SWMUs ~~except for those SWMUs excluded from redevelopment, (see Table 1-2)~~ could be contacted by future commercial/industrial workers. As shown in Figure 2-1, potential routes of exposure include inadvertent ingestion, inhalation of particles and vapors, and dermal contact with exposed surficial material.

SWMUs where surficial material is exposed to the atmosphere are:

- Coke Oven area: SWMU Groups PA-1 (P-1 to P-5), PA-2 (P-6 and P-7) and PA-4 (P-11 and P-12), and SWMU S-26;
- Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22), and SWMUs S-3, S-8, and S-21;
- Slag Fill Area Zone 3: SWMU S-10;
- Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, and S-18;

- Other areas: SWMUs S-19, P-63, and P-73.

Subsurface results will be used as a surrogate for surficial data for the following uncovered SWMUs where no surface samples were taken: SWMU Group SFA-2, and S-26, S-3, S-10, and S-17. This is highly conservative with respect to VOCs (but not non-volatile COPCs), which would be expected to dissipate rapidly if exposed to the atmosphere.

~~SWMUs where surficial material is exposed to the atmosphere and future commercial/industrial workers may be present are the following:~~

- ~~Coke Oven area: SWMU Group PA-1 (P-3, P-4, and P-5) and SWMU Group PA-2 (P-6 and P-7), and SWMU Group PA-4 (P-11 and P-12);~~
- ~~Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75); and~~
- ~~Other areas: SWMUs S-19, P-63, and P-73.~~

~~Subsurface results were used as a surrogate for surficial data for the uncovered SWMUs S-26 and S-25, where no surface samples were taken. This is highly conservative with respect to volatile compounds, which would be expected to dissipate rapidly if exposed to the atmosphere.~~

Equations that will be used to develop RBSLs for the direct contact pathway are presented in Table 4-2. Exposure parameter values are presented in Tables 4-~~12~~ 8 and 4-~~13~~9. In order to quantify dermal exposure to COPCs in soil, it is necessary to know (1) what area of the body surface is exposed to soil; (2) what mass of soil adheres to the skin per unit area; and (3) the bioavailability of chemicals present in soil. In the human health risk assessment to be conducted for the BSC Lackawanna site, dermal exposure to soil will be evaluated in accordance with EPA's *Exposure Factors Handbook* (EPA, 1997), in which the mass of soil adhering to major body parts of individuals participating in a variety of indoor and outdoor activities was quantified. For industrial workers, the Equipment Operators No. 1 and 2 scenarios (four males aged 21 to 54 years assayed after earth scraping with heavy machinery under dusty conditions in August) is considered to provide a conservative representation of potential exposure at the Lackawanna site (Table 4-~~10~~9). For commercial workers, dermal exposure to soil is expected to be negligible, and therefore, will not be quantified in the risk assessment. For purposes of developing Tier 1 RBSLs, the potential dermal absorption of particle-associated COPCs will be conservatively assumed to be equal to their oral absorption (*i.e.*, the dermal relative absorption factor (RAF_d) will be set to 1.0). Further, sorption to particulate matter will be conservatively assumed to have no effect on the oral absorption of COPCs (*i.e.*, the oral relative absorption factor (RAF_o) will be set to 1.0).

4.2 INHALATION OF VAPORS FROM SUBSURFACE SWMU MATERIAL

As shown in Table 4-1 ~~and Figure 2-1~~ commercial/industrial workers could be exposed to ambient or indoor vapors emanating from subsurface material ~~in the Coke Oven Area SWMU Group PA-3 (P-9 and P-10)~~ in the following SWMUs:

- Coke Oven Area: SWMU Groups PA-3 (P-9 and P-10) and PA-4 (P-11 and P-12);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S22) and SWMU S-24; and
- Slag Fill Area Zone 4; SWMUs S-14 and S-23.

~~which are located in areas where these workers will not be present in the future~~:

Equations that will be used to compute subsurface SWMU RBSLs for the indoor and outdoor vapor exposure pathways are discussed in the following sections.

4.2.1 Inhalation of Ambient Vapors from Subsurface SWMU Materials ~~in the Coke Oven Area~~

~~Because commercial/industrial workers may be present in the Coke Oven Area in the future,~~ RBSLs for ambient COPCs derived from subsurface SWMU material ~~in this area~~ will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs will be back-calculated for each volatile COPC from corresponding $RBC_{iw/air}$ values (Equations IW-~~7~~5 and IW-~~8~~6), as shown in Table 4-3. Exposure parameter values are presented in Table 4-~~12~~8.

4.2.2 Inhalation of Indoor Vapors from Subsurface SWMU Materials ~~in the Coke Oven Area~~

~~Because commercial/industrial workers may be present in buildings in the Coke Oven Area in the future,~~ RBSLs for indoor COPCs derived from subsurface SWMU material ~~this area~~ will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs will be back-calculated for each volatile COPC from corresponding $RBC_{IW/air}$ values (Equations IW-~~5~~7 and IW-~~6~~8), as shown in Table 4-4. Exposure parameter values are presented in Table 4-~~8~~12.

~~4.2.3Inhalation of Ambient Vapors from Subsurface SWMU Materials in Other Areas~~

~~The RBSLs for subsurface SWMU material in other areas of the site will be back-calculated using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Table 4-5). The model is used to predict the movement and steady-state vapor emission rates assuming there are no~~

~~losses through volatilization, leaching, or biodegradation. Contamination is assumed to be continuous from 100 cm (39 inches) below the ground surface throughout the full extent of the soil column.~~

~~Airborne concentrations of volatile COPCs at potential commercial/industrial worker locations will be related to SWMU-specific emissions based on a unit concentration (1 mg/kg) in soil using EPA's air dispersion model ISCST Model version 3 with meteorological data collected at an on-site monitoring station in 1991. This model uses steady-state Gaussian plume dispersion curves to model continuous release from a given source area using sector-averaging and statistical wind summaries. Emissions from each source will be modeled using a unit emission rate (ER_{unit}) of 1 g/sec for all sources except for SWMU S-24, which will be split into two source areas (ER_{unit} = 2 g/sec). The windrose of the meteorological data indicates that the dominant wind direction is toward the northeast.~~

~~The equations that will be used to develop RBSLs for the ambient subsurface vapor inhalation pathway from SWMUs outside of the Coke Oven Area are presented in Table 4-6. Exposure parameter values are presented in Table 4-12. RBSLs for evolution of vapors from subsurface material at each SWMU and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding $RBC_{work/air}$ values (Equations W-7 and W-8, Table 4-3). Using the ISCST3 predicted air concentrations, a screening level emission rate will be estimated from each SWMU using a simple linear relationship (Equation W-16, Table 4-6). The soil screening level ($RBSL_{ew/samb}$) will be estimated by using the linear relationship between the predicted chemical-specific emission rate ($Q_{chemical}$), screening level emission rate ($ER_{screening}$), and the unit soil concentration (S_{unit}) initially used in Farmer's model (Equation W-17, Table 4-6). By combining Equations W-16 and W-17, RBSLs for commercial/industrial workers will be estimated by calculating the ratio of the ISCST3 predicted air concentration of each volatile COPC to the chemical-specific emission rates using Farmer's model (Equation W-18, Table 4-6). Substituting the equation for Farmer's model into Equation W-18, RBSLs for commercial/industrial worker exposure to vapors from subsurface SWMU material will be estimated according to Equation W-19 (Table 4-6).~~

4.3 INHALATION OF VAPORS FROM GROUNDWATER

As shown in Table 4-1 ~~and Figure 2-1~~, future commercial/industrial workers could be exposed to ~~ambient and~~ indoor vapors emanating from groundwater. ~~in those SWMUs where building is possible.~~ In addition, these receptors could be exposed to ambient vapors from groundwater in any area of the site. ~~areas located in potential redevelopment area and the Coke Oven Area. In addition, commercial/industrial workers could be exposed to ambient vapors from site-wide groundwater.~~ Equations that will be used to compute groundwater RBSLs for the indoor and outdoor vapor exposure pathways are discussed in the following sections.

4.3.1 Inhalation of Ambient Vapors from Groundwater ~~in the Coke Oven Area, the Tank Farm Area, and SFA Zone 1~~

~~RBSLs for evolution of ambient COPC vapors from groundwater in areas where commercial/industrial workers may be present in the future – the Coke Oven Area, the Tank Farm Area and SFA Zone 1 – will be back-calculated for each volatile COPC from corresponding $RBC_{work/air}$ values (Equations W-57 and W-68, Table 4-3). Equations that will be used to develop RBSLs for the ambient groundwater vapor inhalation pathway in these areas are presented in Table 4-57. Exposure parameter values are presented in Table 4-128.~~

As shown in Table 4-1, commercial/industrial workers could be exposed to ambient and indoor vapors emanating from groundwater anywhere on the site. RBSLs for ambient COPC vapors derived from groundwater in these areas will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs will be back-calculated for each volatile COPC from corresponding $RBC_{iw/air}$ values (Equations IW-5 and IW-6), as shown in Table 4-3. Exposure parameter values are presented in Table 4-8.

4.3.2 Inhalation of Indoor Vapors from Groundwater ~~in the Coke Oven Area, the Tank Farm Area, and SFA Zone 1~~

As shown in Table 4-1, RBSLs for evolution of indoor COPC vapors from groundwater ~~in~~ will be developed for the Coke Oven Area, the Tank Farm Area, the Smokes Creek Area, and all Slag Fill Area zones. RBSLs for indoor COPC vapors derived from groundwater will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs ~~areas where commercial/industrial workers may be present in the future – the Coke Oven Area, the Tank Farm Area and SFA Zone 1 –~~ will be back-calculated for each volatile COPC from corresponding $RBC_{IW/air}$ values (Equations IW-~~5~~7 and IW-~~6~~8, Table 4-3). Equations that will be used to develop RBSLs for the indoor groundwater vapor inhalation pathway in these areas are presented in Table 4-~~6~~8. Exposure parameter values are presented in Table 4-~~12~~8.

~~4.3.3Inhalation of Ambient Vapors from Site-Wide Groundwater~~

~~RBSLs for evolution of ambient vapors from site-wide groundwater and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding $RBC_{work/air}$ values using the Farmer's model described above. Emissions from the site-wide groundwater plume will be modeled using three source areas, with ER_{unit} = 3 g/sec. An average groundwater depth of 35 feet is assumed. Equations that will be used to develop RBSLs for the site-wide groundwater vapor inhalation pathway are presented in Table 4-9. Exposure parameter values are presented in Table 4-12.~~

4.4 INHALATION OF VAPORS FROM PITS

~~As shown in Table 42-1 and Figure 2-1, future commercial/industrial workers could be exposed to ambient vapors emanating from standing water in pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #17 at SWMU P-11). RBSLs for evolution of ambient COPC vapors from these pits will be back-calculated for each volatile COPC from corresponding $RBC_{work/air}$ values (Equations W-57 and W-68, Table 4-3) using the equations in Table 4-7. for both future workers located in the Coke Oven Area (Table 4-10) and future workers located in feasible locations elsewhere on the site (Table 4-11). Exposure parameter values are presented in Table 4-812.~~

As shown in Table 4-1, future commercial/industrial workers could be exposed to ambient vapors emanating from standing water in Coke Oven Area pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #17 at SWMU P-11). Equations that will be used to develop RBSLs for the pit vapor inhalation pathway are presented in Table 4-7. The chemical-specific volatilization rate ($VF_{iw/pit}$) from the pits will be estimated using the stagnant film model presented in EPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models* (EPA, 1989a) (Equation IW-11b, Table 4-7). Exposure parameter values are presented in Table 4-8.

Table 4-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Commercial/Industrial Worker Scenario

Potential Sources	Exposure Pathway Description		
	Direct Contact (including airborne particle inhalation)	Inhalation of Ambient Vapors	Inhalation of Indoor Vapors
COKE OVEN AREA			
PA-1 (P-1, P-2, P-3, P-4, and P-5)	X	NT	NT
PA-2 (P-6 and P-7)	X	ND	ND
PA-3 (P-9 and P-10)	ND, NE (c)	X	X
PA-4 (P-11 and P-12)	X	X	X
P-18	ND, NE (c)*	NT	NT
S-26	S	NT	NT
PA-1 Pits	NA	X	NA
Pit #17 at SWMU P-11	NA	X	NA
Groundwater	NA	X	X
TANK FARM AREA			
TF (P-8, P-74, and P-75)	X	ND	ND
Groundwater	NA	X	X
SLAG FILL AREA ZONE 1 (NO SWMUS)			
Groundwater	NA	X	X
SLAG FILL AREA ZONE 2			
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	X	X	X
SFA-2 (S-11 and S-22)	S	X	X
S-3	S	NT	NT
S-8	X	ND	ND
S-21	X	ND	ND
S-24	ND, NE (c)	X	X
Groundwater	NA	X	X
SLAG FILL AREA ZONE 3			
S-10	S	NT	NT
Groundwater	NA	X	X
SLAG FILL AREA ZONE 4			
S-14	X	X	X
S-15	X	ND	ND
S-16	ND, NE (c)	NC	NC
S-17	S	NT	NT
S-18	X	ND	ND
S-23	ND, NE (c)	X	X
Groundwater	NA	X	X
SLAG FILL AREA ZONE 5 (NO SWMUS)			
Groundwater	NA	X	X

Table 4-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Commercial/Industrial Worker Scenario

Potential Sources	Exposure Pathway Description		
	Direct Contact (including airborne particle inhalation)	Inhalation of Ambient Vapors	Inhalation of Indoor Vapors
OTHER AREAS			
S-19	X	ND	ND
S-25	ND, NE (c)	NT	NT
P-63	X	NV	NV
P-73	X	NT	NT
Smokes Creek Area groundwater	NA	X	X
Site-wide groundwater	NA	Zonal	
WATERCOURSES			
Lake Erie	NE	NA	
Smokes Creek			
Blasdell Creek			
North & South Return Water Trenches			
Ship Canal			

Notes:

X	=	considered complete pathway to be evaluated.
S	=	considered complete pathway to be evaluated by using subsurface soil material data as surrogate for surface material data.
NA	=	not applicable.
NC	=	no COPCs present.
ND	=	no data collected.
NE	=	no exposure.
NE [c]	=	no exposure because SWMU is covered. *SWMU P-18 is covered with water.
NT	=	no toxicity criteria available for volatile subsurface COPC(s).
NV	=	no volatile COPCs present.
Zonal	=	zonal groundwater is assumed source of groundwater vapor exposure.

Table 4-2. Future Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Direct Contact Pathway

Non-Cancer $RBSL_{iw/dc}$:

IW- 1

$$RBSL_{iw/dc}\left[\frac{mg}{kg\text{-}soil}\right]=\frac{THQ \times BW_{iw} \times AT_n}{EF_{iw} \times ED_{iw} \times \left(10^{-6}\ kg/mg \times \frac{1}{RfD_o} \times (IR_{s/iw} \times RAF_o + SA_{iw} \times M \times RAF_d) + \left(\frac{1}{RfD_i} \times IR_{a/iw} \times (VF_{ss} + VF_p)\right)\right)}$$

Cancer $RBSL_{iw/dc}$:

IW- 2

$$RBSL_{iw/dc}\left[\frac{mg}{kg\text{-}soil}\right]=\frac{TR \times BW_{iw} \times AT_c}{EF_{iw} \times ED_{iw} \times \left(10^{-6}\ kg/mg \times SF_o \times (IR_{s/iw} \times RAF_o + SA_{iw} \times M \times RAF_d) + \left(SF_i \times IR_{a/iw} \times (VF_{ss} + VF_p)\right)\right)}$$

Chemical-specific volatilization factor for surficial material to ambient air (ASTM, 1995):

IW- 3a

$$VF_{ss}\left[\frac{kg-soil}{m^3-air}\right]=\frac{2 \times W_S \times \rho_s}{U_{air} \times \delta_{air}} \times \sqrt{\frac{D_s^{eff} \times H'}{\pi \times [\theta_{ws} + K_{oc} \times f_{oc} \times \rho_s + H' \times \theta_{as}] \times \tau}} \times 10^3\ \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

or the mass-limited volatilization factor from surficial material to ambient air (ASTM, 1995):

IW- 3b

$$VF_{ss}\left[\frac{kg-soil}{m^3-air}\right]=\frac{W_S \times \rho_s \times d}{U_{air} \times \delta_{air} \times \tau} \times 10^3\ \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

(whichever is less)

Effective diffusion coefficient in soil based on vapor-phase concentration (ASTM, 1995):

IW-3c

$$D_s^{eff}\left[\frac{cm^2}{s}\right]=D^{air} \times \frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{water} \times \frac{1}{H'} \times \frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Particle emission factor (ASTM, 1995):

IW-3d

$$VF_p\left[\frac{kg\text{-}soil}{m^3-air}\right]=\frac{P_e \times W_S}{U_{air} \times \delta_{air}} \times 10^3\ \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

RBSL for lead in soil (EPA, 1996b):

IW-4a

$$RBSL_{iw/Pb}\left[\frac{mg}{kg-soil}\right]=\frac{\left(PbB_{adult,central,goal} - PbB_{baseline}\right) \times AT}{BKSF \times IR_{S+D} \times AF_S \times EF_S}$$

where

IW-4b

$$PbB_{adult,central,goal}=\frac{PbB_{fetal,0.95,goal}}{GSD^{1.645} \times R_{fetal/maternal}}$$

where:

Parameter Definition		Units
$RBSL_{iw/dc}$	RBSL for direct contact for commercial/industrial worker	mg/kg
$RBSL_{iw/Pb}$	RBSL for lead in surface material for commercial/industrial worker	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{iw}	Commercial/industrial worker body weight	kg
d	Depth to subsurface source	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
ED_{iw}	Commercial/industrial worker exposure duration	years
EF_{iw}	Commercial/industrial worker exposure frequency	days/year
f_{oc}	Mass fraction of organic carbon in soil	g-organic carbon/g-soil
H'	Dimensionless Henry's Law constant	L-water/L-air
$IR_{a/iw}$	Commercial/industrial worker inhalation rate	m^3/day
$IR_{s/iw}$	Commercial/industrial worker soil ingestion rate	mg/day
K_{oc}	Organic carbon/water partition coefficient	L-water/kg-organic carbon
M	Soil-to-skin adherence factor	cm^2/day
P_e	Areal total respirable particulate emission flux from SWMU	g/cm^2-sec
RAF_d	Dermal relative absorption factor	mg-absorbed/mg- applied
RAF_o	Oral relative absorption factor	mg-absorbed/mg-ingested
RfD_i	Chronic inhalation reference dose	mg/kg-day
RfD_o	Chronic oral reference dose	mg/kg-day
SA_{iw}	Skin surface area exposed	cm^2
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_p	Total respirable particle concentration from SWMU	kg-soil/m^3-air
VF_{ss} (chemical-specific)	Surface material to ambient air volatilization factor	kg-soil/m^3-air
VF_{ss} (site-specific)	Surface material to ambient air volatilization factor	kg-soil/m^3-air
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_s	Soil bulk density	g-soil/cm^3-soil
τ	Averaging time for surface emission vapor flux	sec
AF_S	Absorption fraction	unitless
AT	Averaging time for adult lead model	days/year
BKSF	Biokinetic slope factor	µg/dL/:g/day
EF_S	Exposure frequency for adult lead model	days/year
GSD	Geometric standard deviation of blood lead levels	µg/dL
IR_{S+D}	Soil and dust ingestion rate for adult lead model	g/day
$PbB_{adult,central,goal}$	Target blood lead level	µg/dL
$PbB_{baseline}$	Baseline blood lead level	µg/dL
$PbB_{fetal,0.95,goal}$	Target 95th percentile PbB in fetus	µg/dL
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	unitless

Table 4-3. Future Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Subsurface Soil Vapor Inhalation Pathway

Non-Cancer $RBC_{iw/air}$:

IW-5

$$RBC_{iw/air}\left[\frac{\mu g}{m^3}\right] = \frac{THQ \times RfD_i \times BW_{iw} \times AT_n}{ED_{iw} \times EF_{iw} \times IR_{a/iw}} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBC_{iw/air}$:

IW-6

$$RBC_{iw/air}\left[\frac{\mu g}{m^3}\right] = \frac{TR \times BW_{iw} \times AT_c}{SF_i \times ED_{iw} \times EF_{iw} \times IR_{a/iw}} \times 10^3 \frac{\mu g}{mg}$$

$RBSL_{iw/samb}$:

IW-7a

$$RBSL_{iw/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{iw/air}}{VF_{samb}} \times 10^{-3} \frac{mg}{\mu g}$$

Chemical-specific volatilization factor from subsurface material to ambient air (ASTM, 1995):

IW-7b

$$VF_{samb}\left[\frac{kg-soil}{m^3-air}\right] = \frac{H' \times \rho_s}{(\theta_{ws} + K_{oc} \times f_{oc} \times \rho_s + H' \times \theta_{as}) \times \left(1 + \frac{U_{air} \times \delta_{air} \times d}{D_s^{eff} \times W_S}\right)} \times 10^3 \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

where D_s^{eff} is as defined in Equation IW-3c,
or
Site-specific volatilization factor from subsurface material to ambient air (GSI, 1995):

IW-7c

$$VF_{samb}\left[\frac{kg-soil}{m^3-air}\right] = \frac{W_S \times \rho_s \times D}{U_{air} \times d_{air} \times \tau} \times 10^3 \frac{cm^3-kg}{m^3-g}$$

whichever is less.

where:

Parameter Definition		Units
$RBC_{iw/air}$	RBC for volatile COPC in air for commercial/industrial worker	$\mu g/m^3$
$RBSL_{iw/samb}$	RBSL in subsurface material for vapor in ambient air for commercial/industrial worker	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{iw}	Body weight	kg
d	Depth to subsurface source	cm
D	Thickness of affected subsurface material	cm
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
ED_{iw}	Commercial/industrial worker exposure duration	years
EF_{iw}	Commercial/industrial worker exposure frequency	days/year

Parameter Definition		Units
f_{oc}	Mass fraction of organic carbon in soil	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{samb} (site-specific)	Subsurface material to ambient air volatilization factor	$kg\text{-}soil/m^3\text{-}air$
VF_{samb} (chemical -specific)	Subsurface material to ambient air volatilization factor	$kg\text{-}soil/m^3\text{-}air$
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	$cm^3\text{-}air/cm^3\text{-}soil$
θ_{ws}	Volumetric water content in vadose zone soils	$cm^3\text{-}water/cm^3\text{-}soil$
ρ_s	Soil bulk density	$g\text{-}soil/cm^3\text{-}soil$
τ	Averaging time for surface emission vapor flux	sec

Table 4-4. Future Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Indoor Subsurface Soil Vapor Inhalation Pathway

$RBC_{iw/air}$ values calculated per Equations IW-5 and IW-6

$RBSL_{iw/sesp}$:

IW-8a

$$RBSL_{iw/sesp}\left[\frac{mg}{kg-soil}\right]=\frac{RBC_{iw/air}}{VF_{sesp}}\times 10^{-3}\,\frac{mg}{\mu g}$$

Chemical-specific volatilization factor from subsurface material to indoor air (ASTM, 1995):

IW-8b

$$VF_{sesp}\left[\frac{kg-soil}{m^3-air}\right]=\frac{\left(\frac{H'\times\rho_s}{\theta_{ws}+K_{oc}\times f_{oc}\times\rho_s+H'\theta_{as}}\right)\times\left(\frac{D_s^{eff}/d}{ER\times L_B}\right)}{1+\left(\frac{D_s^{eff}/d}{ER\times L_B}\right)+\left(\frac{D_s^{eff}/d}{D_{crack}^{eff}/L_{crack}\times\eta}\right)}\times 10^3\,\frac{cm^3-kg}{m^3-g}$$

where D_s^{eff} is as defined in Equation IW-3c and the effective diffusivity through foundation cracks is:

IW-8c

$$D_{crack}^{eff}\left[\frac{cm^2}{sec}\right]=D^{air}\frac{\theta_{acrack}^{3.33}}{\theta_T^2}+\left(\frac{D^{water}}{H'}\right)\left(\frac{\theta_{wcrack}^{3.33}}{\theta_T^2}\right)$$

(ASTM, 1995)
or
Chemical-specific volatilization factor from subsurface material to indoor air (ASTM, 1995):

IW-8d

$$VF_{sesp}\left[\frac{kg-soil}{m^3-air}\right]=\frac{\rho_s\times D}{L_B\times ER\times\tau}\times 10^3\,\frac{cm^3-kg}{m^3-g}$$

whichever is less.

where:

Parameter Definition		Units
$RBC_{iw/air}$	RBC for volatile COPC in air for commercial/industrial worker	$\mu g/m^3$
$RBSL_{iw/sesp}$	RBSL in subsurface material for vapor in indoor air for commercial/industrial worker	mg/kg
d	Depth to subsurface source	cm
D	Thickness of affected subsurface material	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D_{crack}^{eff}	Effective diffusion coefficient through foundation cracks	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
ED_{iw}	Commercial/industrial worker exposure duration	years
EF_{iw}	Commercial/industrial worker exposure frequency	days/year

Parameter Definition		Units
ER	Enclosed space air exchange rate in commercial building	L/sec
f_{oc}	Mass fraction of organic carbon in soil	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
L_B	Enclosed space volume/infiltration area ratio in commercial building	cm
L_{crack}	Enclosed space foundation wall thickness	cm
VF_{assp} (site-specific)	Subsurface material to indoor air volatilization factor	kg-soil/m^3-air
VF_{assp} (chemical - specific)	Subsurface material to indoor air volatilization factor	kg-soil/m^3-air
η	Areal fraction of cracks in foundations/walls	cm^2-cracks/cm^2-total area
θ_{acrack}	Volumetric air content in foundation/wall cracks	cm^3-air/cm^3-total volume
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{wcrack}	Volumetric water content in foundation/wall cracks	cm^3-water/cm^3-total volume
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_s	Soil bulk density	g-soil/cm^3-soil
τ	Averaging time for surface emission vapor flux	sec

Table 4-5. Future Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Groundwater Vapor Inhalation Pathway

$RBC_{iw/air}$ values calculated per Equations IW-5 and IW-6

$RBSL_{iw/wamb}$:

IW-9a

$$RBSL_{iw/wamb}\left[\frac{\mu g}{L}\right] = \frac{RBC_{iw/air}}{VF_{wamb}}$$

Volatilization factor from groundwater to ambient air (ASTM, 1995):

IW-9b

$$VF_{wamb}\left[\frac{L-water}{m^3-air}\right] = \frac{H'}{\left(1+\frac{U_{air}\times\delta_{air}\times L_{GW}}{D_{ws}^{eff}\times W_{GW}}\right)} \times 10^3\,\frac{L}{m^3}$$

Effective diffusion coefficient between groundwater and the SWMU surface (ASTM, 1995):

IW-9c

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = \left(h_{cap}+h_v\right)\times\left(\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right)^{-1}$$

where D_s^{eff} is as defined in Equation IW-3c, and the effective diffusion coefficient through the capillary fringe (ASTM, 1995) is:

IW-9d

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\times\frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{water}\times\frac{1}{H'}\times\frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

Parameter Definition		Units
$RBC_{iw/air}$	RBC for volatile COPC in air for commercial/industrial worker	$\mu g/m^3$
$RBSL_{iw/wesp}$	RBSL in groundwater for vapor in ambient air for commercial/industrial worker	$\mu g/L$
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
D_{cap}^{eff}	Effective diffusion coefficient in capillary fringe region	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
h_{cap}	Thickness of capillary fringe	cm
h_v	Thickness of vadose zone	cm
L_{GW}	Depth to groundwater ($h_{cap} + h_v$)	cm
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{wamb}	Groundwater to ambient air volatilization factor	L-water/m^3-air
W_{GW}	Width of groundwater source	cm
δ_{air}	Mixing zone height	cm
θ_{acap}	Volumetric air content in capillary fringe soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{wcap}	Volumetric water content in capillary fringe soils	cm^3-water/cm^3-soil

Table 4-6. Future Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Indoor Groundwater Vapor Inhalation Pathway

$RBC_{iw/air}$ values calculated per Equations IW-5 and IW-6

$RBSL_{iw/wesp}$:

IW-10a

$$RBSL_{iw/wesp}\left[\frac{\mu g}{L}\right] = \frac{RBC_{iw/air}}{VF_{wesp}}$$

Volatilization factor from groundwater to indoor air (ASTM, 1995):

IW-10b

$$VF_{wesp}\left[\frac{L-water}{m^3-air}\right] = \frac{H'\left(\frac{D_{ws}^{eff}/L_{GW}}{ER \times L_B}\right)}{1+\left(\frac{D_{ws}^{eff}/L_{GW}}{ER \times L_B}\right)+\left(\frac{D_{ws}^{eff}/L_{GW}}{\left(D_{crack}^{eff}/L_{crack}\right)h}\right)} \times 10^3 \frac{L}{m^3}$$

where D_s^{eff} is as defined in Equation IW-3c, D_{crack}^{eff} is as defined in Equation IW-8c, and D_{ws}^{eff} is as defined in Equation IW-9c.

where:

Parameter Definition		Units
$RBC_{iw/air}$	RBC for volatile COPC in air for commercial/industrial worker	$\mu g/m^3$
$RBSL_{iw/wesp}$	RBSL in groundwater for vapor in indoor air for commercial/industrial worker	$\mu g/L$
D_{crack}^{eff}	Effective diffusion coefficient through foundation cracks	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
ER	Enclosed space air exchange rate in commercial building	L/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
L_B	Enclosed space volume/infiltration area ratio in commercial building	cm
L_{crack}	Enclosed space foundation wall thickness	cm
L_{GW}	Depth to groundwater ($h_{cap} + h_v$)	cm
VF_{wesp}	Groundwater to indoor air volatilization factor	L-water/m^3-air
η	Areal fraction of cracks in foundations/walls	cm^2-cracks/cm^2-total area

Table 4-7. Future Commercial/Industrial Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Pit Vapor Inhalation Pathway

$RBC_{iw/air}$ values calculated per Equations IW-5 and IW-6

$RBSL_{iw/pit}$:

IW-11a

$$RBSL_{iw/pit}\left[\frac{\mu g}{L}\right] = \frac{RBC_{iw/air}}{VF_{iw/pit}} \times 10^{-3}\frac{m^3}{L}$$

Volatilization rate from the pits:

IW-11b

$$VF_{iw/pit}\ [\text{dimensionless}] = \frac{k_L}{1 + \frac{k_L}{k_G \times H'}} \times \frac{A}{U_{air} \times W \times \delta_{air}} \times \frac{10^6\ cm^3}{m^3}$$

Gas-phase mass transfer coefficient:

IW-11c

$$k_G\left[\frac{m}{sec}\right] = 4.82 \times 10^{-3} \times U_{10}^{0.78} \times Sc_G^{-0.67} \times de^{-0.11}$$ where

Effective diameter of impoundment:

IW-11d

$$de[m] = \sqrt{\frac{4 \times A}{\pi}}$$

Schmidt number on the gas side:

IW-11e

$$Sc_G = \frac{\mu_G}{\rho_G \times D^{air}}$$

Liquid-phase transfer coefficient:

IW-11f

$$k_L\left[\frac{m}{sec}\right] = 10^{-6} + 144 \times 10^{-4} \times U^{*2.2} \times Sc_L^{-0.5}$$

where

Schmidt number on the liquid side:

IW-11g

$$Sc_L = \frac{\mu_L}{\rho_L \times D^{water}}$$

Friction velocity:

IW-11h

$$U^*\left[\frac{m}{sec}\right] = 0.01 \times U_{10} \times \sqrt{6.1 + 0.63 \times U_{10}}$$

where:

Parameter Definition		Units
$RBC_{iw/air}$	RBC for volatile COPC in air for commercial/industrial worker	$\mu g/m^3$
$RBSL_{iw/pit}$	RBSL in pit water for vapor in ambient air for commercial/industrial worker	µg/L
A	Liquid area (pit)	m^2
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
de	Effective diameter of impoundment (pit)	m
H'	Dimensionless Henry's Law constant	L-water/L-air
k_G	Gas-phase mass transfer coefficient	m/sec
k_L	Liquid-phase mass transfer coefficient	m/sec
Sc_G	Schmidt number on the gas side	unitless
Sc_L	Schmidt number on the liquid side	unitless
U^*	Friction velocity	m/sec
U_{10}	Wind speed at 10 meters above liquid surface (pit)	m/sec
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
$VF_{iw/pit}$	Groundwater to indoor air volatilization factor	L-water/m^3-air

Parameter Definition		Units
W	Width of pit	cm
δ_{air}	Mixing zone height	cm
μ_G	Viscosity of air	g/cm-sec
μ_L	Viscosity of water	g/cm-sec
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 4-8. Future Commercial/Industrial Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	2,409	days	EPA, 1989b	ED x 365 days/year
BW_{iw}	Body weight	71.8	kg	EPA, 1997	Recommended value
ED_{iw}	Exposure duration	6.6	years	EPA, 1997	Recommended value
EF_{iw}	Exposure frequency	250	days/year	Professional judgment	Recommended value
$IR_{a/iw}$	Inhalation rate	13.25	m^3/day	EPA, 1997	Mean of recommended long-term inhalation rates for male and female adults
$IR_{s/iw}$	Soil ingestion rate	50	mg/day	EPA, 1997	Recommended adult soil intake rate
$SA_{iw} \times M$	Soil-to-skin adherence factor (industrial only)	793.3	mg/day	See Table 4-9	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
ADULT LEAD MODEL PARAMETERS (EPA, 1996b)					
AF_S	Absorption fraction	0.12	unitless	Recommended by EPA, 1996b	
AT	Averaging time for adult lead model	365	days/year	Recommended by EPA, 1996b	
BKSF	Biokinetic slope factor	0.4	µg/dL/µg/day	Recommended by EPA, 1996b	
$EF_{S/i}$	Exposure frequency for adult lead model (industrial)	219	days/year	Recommended by EPA, 1996b	
$EF_{S/c}$	Exposure frequency for adult lead model (commercial)	50	days/year	Recommended by EPA, 1996b	
GSD	Geometric standard deviation of blood lead levels	1.8	µg/dL	Recommended by EPA, 1996b	
IR_{S+D}	Soil and dust ingestion rate for adult lead model	0.05	g/day	Recommended by EPA, 1996b	
$PbB_{adult,central,goal}$	Target blood lead level	4.2	µg/dL	Calculated per Equation IW-4b	
$PbB_{baseline}$	Baseline blood lead level	2.0	µg/dL	Recommended by EPA, 1996b	
$PbB_{fetal,0.95,goal}$	Target 95th percentile PbB in fetus	10	µg/dL	Acceptable blood lead level for children (EPA, 1994)	
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	0.9	unitless	Recommended by EPA, 1996b	
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
RfD_o	Chronic oral reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	

Table 4-8. Future Commercial/Industrial Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
SF_o	Oral slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
RAF_d	Dermal relative absorption factor	1.0	mg-absorbed/ mg applied	Default	
RAF_o	Oral relative absorption factor	1.0	mg-absorbed/ mg-ingested	Default	

Table 4-9. Estimated Mass of Soil in Contact with Skin: Future Industrial Worker Scenario

Exposure Metric	Hands	Arms	Head
Average of mean total surface area of body part in adult males and females (cm^2) [a]	793	2,190	1,145
Mean soil adherence to body part (mg/cm^2) [b, c]	0.265	0.18	0.165
Total mass of soil adhering to body part (mg) [d]	210.1	394.2	188.9
Total amount of soil adhering to body (mg/day) [e]	**793.3**		

[a, b] Data from EPA, 1997.

[c] Mean of geometric mean results for Equipment Operators No. 1 and 2 scenarios (EPA, 1997).

[d] Calculated as the product of mean soil adherence and total body part surface area.

[e] Calculated as the sum of soil mass adhering to exposed body parts.

5.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE FUTURE CONSTRUCTION WORKER SCENARIO

When the BSC Lackawanna site is redeveloped, future construction workers ~~may~~ could potentially contact site-related COPCs via 1) direct contact with surficial and subsurface media (ingestion, inhalation, dermal contact)~~, in areas where building is feasible~~ and 2) inhalation of ambient vapors emanating from groundwater and ~~subsurface SWMU material as well as~~ the Coke Oven Area pits. This scenario makes the ~~conservative~~ assumption that conditions at all units remain unchanged. Potentially complete pathways for the construction worker scenario are depicted in Figure 2-1 and Table 2-1, and potential source areas where these pathways could result in construction worker exposure are summarized in Table 5-1.

Equations that will be used to calculate Tier 1 RBSLs for the various pathways are presented in the sections below and Tables 5-2 to 5-~~5~~7, and exposure parameter values to be used in calculating Tier 1 RBSLs for the construction worker scenario are presented in Tables 5-~~8~~6 and 5-~~7~~9. Because of the relatively short exposure duration period for this scenario (one year; see Table 5-5), subchronic toxicity criteria will be used to assess potential non-cancer hazards. Available subchronic non-cancer toxicity criteria ~~to be used in this evaluation~~ are presented in Appendix B. ~~Table 5-10~~; carcinogenic toxicity criteria were presented in Interim Deliverable No. 1. ~~Oral and dermal relative absorption factors are presented in Section 3.0 (Tables 3-1 and 3-2).~~ Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

5.1 DIRECT CONTACT WITH SURFICIAL AND SUBSURFACE SWMU MATERIAL

COPCs in both ~~Exposed~~ surficial and subsurface material in SWMUs ~~where building may be feasible~~ could be contacted by future construction workers. ~~-~~As shown in Figure 2-1 and Table 2-1, potential routes of exposure include inadvertent ingestion, inhalation of particles and vapors, and dermal contact with ~~exposed~~ SWMU ~~surficial~~ material.

SWMUs where ~~surficial material is exposed to the atmosphere and building is feasible~~ construction worker exposure to SWMU material could occur are:

- Coke Oven Area: SWMU Groups PA-1 (P-1 to P-5) ~~and~~ PA-2 (P-6 and P-7) PA-3 (P-9 and P-10) and PA-4 (P-11 and P-12) and SWMUs P-18 (following water removal) and S-26;
- Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22), and SWMUs S-3, S-8, S-24 and S-21;

- Slag Fill Area Zone 3: SWMU S-10;
- Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, S-18 and S-23; and;
- Other areas: SWMUs S-19, S-25 P-63, and P-73, and sediment in the North and South Return Water Trenches.

~~• Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);~~

~~• Other areas: SWMUs S-19, S-25, P-63, P-73; and~~

~~• North and South Return Water Trenches (sediment).~~

~~Subsurface results will be used as a surrogate for surficial data for the uncovered SWMU S-25, where no surface samples were taken. This is highly conservative with respect to volatile compounds, which would be expected to dissipate rapidly if exposed to the atmosphere.~~

Equations that will be used to develop RBSLs for the direct contact pathway are presented in Table 5-2. Exposure parameter values are presented in Tables 5-~~6~~8 and 5-~~7~~9, and available subchronic toxicity criteria are listed in Appendix B. In order to quantify dermal exposure to COPCs in soil, it is necessary to know (1) what area of the body surface is exposed to soil; (2) what mass of soil adheres to the skin per unit area; and (3) the bioavailability of chemicals present in soil. In the human health risk assessment to be conducted for the BSC Lackawanna site, dermal exposure to soil will be evaluated in accordance with EPA's *Exposure Factors Handbook* (EPA, 1997), in which the mass of soil adhering to major body parts of individuals participating in a variety of indoor and outdoor activities was quantified. For construction workers, the Construction Worker scenario (eight males aged 21 to 30 years assayed after working for eight hours in mixed bare earth and concrete surfaces, dust and debris in September) is considered to provide a conservative representation of potential exposure at the Lackawanna site (Table 5-~~7~~9). For purposes of developing Tier 1 RBSLs, the potential dermal absorption of particle-associated COPCs will be conservatively assumed to be equal to their oral absorption (*i.e.*, the dermal relative absorption factor (RAF_d) will be set to 1.0). Further, sorption to particulate matter will be conservatively assumed to have no effect on the oral absorption of COPCs (*i.e.*, the oral relative absorption factor (RAF_o) will be set to 1.0).

~~**5.2INHALATION OF VAPORS FROM SUBSURFACE SWMU MATERIAL**~~

~~As shown in Table 5-1 and Figure 2-1, construction workers could be exposed to vapors emanating from subsurface material.~~

~~in the following SWMUs:~~

~~• Coke Oven Area: SWMU Group PA-3 (P-9 and P-10);~~

- Slag Fill Area Zone 2: SWMU Group SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S27), SFA-2 (S-11 and S-22) and SWMU S-24; and

- Slag Fill Area Zone 4: SWMUs S-14 and S-23.

The RBSLs for subsurface SWMU material ($RBSL_{cw/sub}$) will be back-calculated using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Table 5-3). The model is used to predict the movement and steady-state vapor emission rates assuming there are no losses through volatilization, leaching, or biodegradation. Contamination is assumed to be continuous from 100 cm below the ground surface throughout the full extent of the soil column.

Airborne concentrations of volatile COPCs at potential receptor locations will be related to SWMU-specific emissions based on a unit concentration (1 mg/kg) in soil using EPA's air dispersion model ISCST Model version 3 with meteorological data collected at an on-site monitoring station in 1991. This model uses steady-state Gaussian plume dispersion curves to model continuous release from a given source area using sector-averaging and statistical wind summaries. Emissions from each source will be modeled using a unit emission rate (ER_{unit}) of 1 g/sec for all sources except for SWMU S-24, which will be split into two source areas (ER_{unit} = 2 g/sec). The windrose of the meteorological data indicates that the dominant wind direction is toward the northeast.

The equations that will be used to develop RBSLs for the subsurface vapor inhalation pathway are presented in Table 5-4. Exposure parameter values are presented in Table 5-8, and available subchronic toxicity criteria are listed in Table 5-10. RBSLs for evolution of vapors from subsurface material at each SWMU and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding $RBC_{cw/air}$ values (Equations CW-8 and CW-9, Table 5-4). Using the ISCST3-predicted air concentrations, a screening level emission rate will be estimated from each SWMU using a simple linear relationship (Equation CW-10, Table 5-4). The soil screening level ($RBSL_{cw/samb}$) will be estimated by using the linear relationship between the predicted chemical-specific emission rate ($Q_{chemical}$), screening level emission rate ($ER_{screening}$), and the unit soil concentration (S_{unit}) initially used in Farmer's model (Equation CW-11, Table 5-4). By combining Equations CW-10 and CW-11, RBSLs for construction workers will be estimated by calculating the ratio of the ISCST3-predicted air concentration of each volatile COPC to the chemical-specific emission rates using Farmer's model (Equation CW-12, Table 5-4). Substituting the equation for Farmer's model into Equation CW-12, RBSLs for construction worker exposure to vapors from subsurface SWMU material will be estimated according to Equation CW-13 (Table 5-4).

~~5.3~~5.2 INHALATION OF VAPORS FROM GROUNDWATER

As shown in Table 5-1 ~~and Figure 2-1~~, construction workers on the site could be exposed to vapors emanating from groundwater while working in ~~Zones 1 and 5 and the Tank Farm Area~~any area of the site. RBSLs for ambient COPC vapors derived from subsurface SWMU material in these areas will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). Equations that will be used to develop RBSLs for the groundwater vapor inhalation pathway ~~in these areas~~ are presented in Table 5-~~4~~53. Exposure parameter values are presented in Table 5-~~6~~85, and available subchronic toxicity criteria are listed in Appendix B..

~~RBSLs for evolution of vapors from site-wide groundwater and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding $RBC_{cw/air}$ values using the Farmer's model described above. Emissions from the site-wide ground water plume will be modeled using three source areas, with ER_{unit} = 3 g/sec. An average ground water depth of 35 feet is assumed. A corresponding groundwater $RBSL_{cw/wamb}$ will be estimated by back-calculating from $RBC_{cw/air}$ values (Equations CW-8 and CW-9, Table 5-4), as shown in Table 5-6. Exposure parameter values are presented in Table 5-8, and available subchronic toxicity criteria are listed in Table 5-10.~~

~~5.4~~5.3 INHALATION OF VAPORS FROM PITS

~~As shown in Table 5-1 and Figure 2-1, construction workers could be exposed to ambient vapors emanating from standing water in Coke Oven Area pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #17 at SWMU P-11. Equations that will be used to develop RBSLs for the pit vapor inhalation pathway are presented in Table 5-7. The chemical-specific volatilization rate ($VF_{cw/pit}$) from the pits will be estimated using the stagnant film model presented in EPA's Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) – Air Emission Models (EPA, 1989a) (Equation CW-22, Table 5-7). Exposure parameter values are presented in Table 5-8, and available subchronic toxicity criteria are listed in Table 5-10.~~

As shown in Table 5-1, construction workers could be exposed to ambient vapors emanating from standing water in Coke Oven Area pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #17 at SWMU P-11). Equations that will be used to develop RBSLs for the pit vapor inhalation pathway are presented in Table 5-4. The chemical-specific volatilization rate ($VF_{cw/pit}$) from the pits will be estimated using the stagnant film model presented in EPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models* (EPA, 1989a) (Equation CW-8b, Table 5-4). Exposure parameter values are presented in Table 5-5, and available subchronic toxicity criteria are listed in Appendix B.

Table 5-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Construction Worker Scenario

Potential Sources	Exposure Pathway Description		
	Direct Contact with Surface Material	Direct Contact with Subsurface Material	Inhalation of Ambient Vapors
COKE OVEN AREA			
PA-1 (P-1, P-2, P-3, P-4, and P-5)	X	X	DC
PA-2 (P-6 and P-7)	X	ND	ND
PA-3 (P-9 and P-10)	ND	X	DC
PA-4 (P-11 and P-12)	X	X	DC
P-18	S	X	DC
S-26	S	X	DC
PA-1 Pits	NA		X
Pit #17 at SWMU P-11	NA		X
Groundwater	NA		X
TANK FARM AREA			
TF (P-8, P-74, and P-75)	X	ND	ND
Groundwater	NA		X
SLAG FILL AREA ZONE 1 (NO SWMUS)			
Groundwater	NA		X
SLAG FILL AREA ZONE 2			
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	X	X	DC
SFA-2 (S-11 and S-22)	S	X	DC
S-3	S	X	DC
S-8	X	ND	ND
S-21	X	ND	ND
S-24	ND	X	DC
Groundwater	NA		X
SLAG FILL AREA ZONE 3			
S-10	ND	X	DC
Groundwater	NA		X
SLAG FILL AREA ZONE 4			
S-14	X	X	DC
S-15	X	ND	ND
S-16	ND	NC	NC
S-17	S	X	DC
S-18	X	ND	ND
S-23	ND	X	DC
Groundwater	NA		X
SLAG FILL AREA ZONE 5 (NO SWMUS)			
Groundwater	NA		X
OTHER AREAS			
S-19	X	ND	ND
S-25	ND	X	NT

Table 5-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Construction Worker Scenario

Potential Sources	Exposure Pathway Description		
	Direct Contact with Surface Material	Direct Contact with Subsurface Material	Inhalation of Ambient Vapors
P-63	X	X	NV
P-73	X	X	NT
Smokes Creek Area groundwater	NA		X
Site-wide groundwater	NA		Zonal
WATERCOURSES			
Lake Erie	NE		NA
Smokes Creek			
Blasdell Creek			
North & South Return Water Trench sediment	X		DC
North & South Return Water Trench water	NC		
Ship Canal	NE		NA

Notes:

X = considered complete pathway to be evaluated.
S = considered complete pathway to be evaluated by using subsurface soil material data as surrogate for surface material data.
DC = not considered separately because direct contact is being evaluated.
NA = not applicable.
NC = no COPCs present.
ND = no data collected.
NE = no exposure.
NT = no toxicity criteria available for volatile subsurface COPC(s).
NV = no volatile COPCs present.
Zonal = zonal groundwater is assumed source of groundwater vapor exposure.

Table 5-2. Future Construction Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Direct Contact Pathway

Non-Cancer $RBSL_{cw/dc}$:

CW- 1

$$RBSL_{cw/dc}\left[\frac{mg}{kg\ soil}\right]=\frac{THQ\times BW_{cw}\times AT_n}{EF_{cw}\times ED_{cw}\times\left(10^{-6}\ kg/mg\times\frac{1}{sRfD_o}\times\left(IR_{s/cw}\times RAF_o+SA_{cw}\times M\times RAF_d\right)+\left(\frac{1}{sRfD_i}\times IR_{a/cw}\times\left(VF_{ss}+VF_p\right)\right)\right)}$$

Cancer $RBSL_{cw/dc}$:

CW- 2

$$RBSL_{cw/dc}\left[\frac{mg}{kg\ soil}\right]=\frac{TR\times BW_{cw}\times AT_c}{EF_{cw}\times ED_{cw}\times\left(10^{-6}\ kg/mg\times SF_o\times\left(IR_{s/cw}\times RAF_o+SA_{cw}\times M\times RAF_d\right)+\left(SF_i\times IR_{a/cw}\times\left(VF_{ss}+VF_p\right)\right)\right)}$$

Chemical-specific volatilization factor for surficial material to ambient air (ASTM, 1995):

CW- 3a

$$VF_{ss}\left[\frac{kg-soil}{m^3-air}\right]=\frac{2\times W_S\times\rho_s}{U_{air}\times\delta_{air}}\times\sqrt{\frac{D_s^{eff}\times H'}{\pi\times[\theta_{ws}+K_{oc}\times f_{oc}\times\rho_s+H'\times\theta_{as}]\times\tau}}\times 10^3\ \frac{cm^3-kg}{m^3-g}$$

or the mass-limited volatilization factor from surficial material to ambient air (ASTM, 1995):

CW- 3b

$$VF_{ss}\left[\frac{kg-soil}{m^3-air}\right]=\frac{W_S\times\rho_s\times d}{U_{air}\times\delta_{air}\times\tau}\times 10^3\ \frac{cm^3-kg}{m^3-g}$$

(whichever is less)

Effective diffusion coefficient in soil based on vapor-phase concentration (ASTM, 1995):

CW-3c

$$D_s^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\times\frac{\theta_{as}^{3.33}}{\theta_T^2}+D^{water}\times\frac{1}{H'}\times\frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Particle emission factor (ASTM, 1995):

CW-3d

$$VF_p\left[\frac{kg-soil}{m^3-air}\right]=\frac{P_e\times W_S}{U_{air}\times\delta_{air}}\times 10^3\ \frac{cm^3-kg}{m^3-g}$$

RBSL for lead in soil (EPA, 1996):

CW-4a

$$RBSL_{cw/Pb}\left[\frac{mg}{kg-soil}\right]=\frac{\left(PbB_{adult,central,goal}-PbB_{baseline}\right)\times AT}{BKSF\times IR_{S+D}\times AF_S\times EF_S}$$

where

CW-4b

$$PbB_{adult,central,goal}=\frac{PbB_{fetal,0.95,goal}}{GSD^{1.645}\times R_{fetal/maternal}}$$

where:

Parameter Definition		Units
$RBSL_{cw/dc}$	RBSL for direct contact for construction worker	mg/kg
$RBSL_{cw/Pb}$	RBSL for lead in surface material for construction worker	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{cw}	Construction worker body weight	kg
d	Depth to subsurface source	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
ED_{cw}	Construction worker exposure duration	years
EF_{cw}	Construction worker exposure frequency	days/year
f_{oc}	Mass fraction of organic carbon in soil	g-organic carbon/g-soil
H'	Dimensionless Henry's Law constant	L-water/L-air
$IR_{a/cw}$	Construction worker inhalation rate	m^3/day
$IR_{s/cw}$	Construction worker soil ingestion rate	mg/day
K_{oc}	Organic carbon/water partition coefficient	L-water/kg-organic carbon
M	Soil-to-skin adherence factor	cm^2/day
P_e	Areal total respirable particulate emission flux from SWMU	g/cm^2-sec
RAF_d	Dermal relative absorption factor	mg-absorbed/mg- applied
RAF_o	Oral relative absorption factor	mg-absorbed/mg-ingested
SA_{cw}	Skin surface area exposed	cm^2
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$
$sRfD_i$	Subchronic inhalation reference dose	mg/kg-day
$sRfD_o$	Subchronic oral reference dose	mg/kg-day
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_p	Total respirable particle concentration from SWMU	kg-soil/m^3-air
VF_{ss} (chemical-specific)	Surface material to ambient air volatilization factor	kg-soil/m^3-air
VF_{ss} (site-specific)	Surface material to ambient air volatilization factor	kg-soil/m^3-air
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_s	Soil bulk density	g-soil/cm^3-soil
τ	Averaging time for surface emission vapor flux	sec
AF_S	Absorption fraction	unitless
AT	Averaging time for adult lead model	days/year
BKSF	Biokinetic slope factor	µg/dL/µg/day
EF_S	Exposure frequency for adult lead model	days/year
GSD	Geometric standard deviation of blood lead levels	µg/dL
IR_{S+D}	Soil and dust ingestion rate for adult lead model	g/day
$PbB_{adult,central,goal}$	Target blood lead level	µg/dL
$PbB_{baseline}$	Baseline blood lead level	µg/dL
$PbB_{fetal,0.95,goal}$	Target 95th percentile PbB in fetus	µg/dL
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	unitless

Table 5-3. Future Construction Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Groundwater Vapor Inhalation Pathway

Non-Cancer $RBC_{cw/air}$:

CW-5

$$RBC_{cw/air}\left[\frac{\mu g}{m^3}\right] = \frac{THQ \times sRfD_i \times BW_{cw} \times AT_n}{ED_{cw} \times EF_{cw} \times IR_{a/cw}} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBC_{cw/air}$

CW-6

$$RBC_{cw/air}\left[\frac{\mu g}{m^3}\right] = \frac{TR \times BW_{cw} \times AT_c}{SF_i \times ED_{cw} \times EF_{cw} \times IR_{a/cw}} \times 10^3 \frac{\mu g}{mg}$$

$RBSL_{cw/wamb}$:

CW-7a

$$RBSL_{cw/wamb}\left[\frac{\mu g}{L}\right] = \frac{RBC_{cw/air}}{VF_{wamb}} \times 10^{-3} \frac{mg}{\mu g}$$

Volatilization factor from groundwater to ambient air (ASTM, 1995):

CW-7b

$$VF_{wamb}\left[\frac{L-water}{m^3-air}\right] = \frac{H'}{\left(1 + \frac{U_{air} \times \delta_{air} \times L_{GW}}{D_{ws}^{eff} \times W_{GW}}\right)} \times 10^3 \frac{L}{m^3}$$

Effective diffusion coefficient between groundwater and the SWMU surface (ASTM, 1995):

CW-7c

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = \left(h_{cap} + h_v\right) \times \left(\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}}\right)^{-1}$$

where D_s^{eff} is as defined in Equation CW-3c

Effective diffusion coefficient through the capillary fringe (ASTM, 1995):

CW-7d

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air} \times \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{water} \times \frac{1}{H'} \times \frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

Parameter Definition		Units
$RBC_{cw/air}$	RBC for volatile COPC in air for construction worker	$\mu g/m^3$
$RBSL_{cw/wamb}$	RBSL in groundwater for vapor in ambient air for construction worker	µg/L
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{cw}	Construction worker body weight	kg
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
D_{cap}^{eff}	Effective diffusion coefficient in capillary fringe region	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
ED_{cw}	Construction worker exposure duration	years
EF_{cw}	Construction worker exposure frequency	days/year
H'	Dimensionless Henry's Law constant	L-water/L-air
h_{cap}	Thickness of capillary fringe	cm
h_v	Thickness of vadose zone	cm

Table 5-4. Future Construction Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Pit Vapor Inhalation Pathway

$RBC_{cw/air}$ values calculated per Equations CW-5 and CW-6

$RBSL_{cw/pit}$:

CW-8a

$$RBSL_{cw/pit}\left[\frac{\mu g}{L}\right] = \frac{RBC_{cw/air}}{VF_{cw/pit}} \times 10^{-3}\,\frac{m^3}{L}$$

Volatilization rate from the pits:

CW-8b

$$VF_{cw/pit}\ [\text{dimensionless}] = \frac{k_L}{1 + \frac{k_L}{k_G \times H'}} \times \frac{A}{U_{air} \times W \times \delta_{air}} \times \frac{10^6\,cm^3}{m^3}$$

Gas-phase mass transfer coefficient:

CW-8c

$$k_G\left[\frac{m}{sec}\right] = 4.82 \times 10^{-3} \times U_{10}^{0.78} \times Sc_G^{-0.67} \times de^{-0.11} \quad \text{where}$$

Effective diameter of impoundment:

CW-8d

$$de[m] = \sqrt{\frac{4 \times A}{\pi}}$$

Schmidt number on the gas side:

CW-8e

$$Sc_G = \frac{\mu_G}{\rho_G \times D^{air}}$$

Liquid-phase transfer coefficient:

CW-8f

$$k_L\left[\frac{m}{sec}\right] = 10^{-6} + 144 \times 10^{-4} \times U^{*2.2} \times Sc_L^{-0.5} \quad \text{where}$$

Schmidt number on the liquid side:

CW-8g

$$Sc_L = \frac{\mu_L}{\rho_L \times D^{water}}$$

Friction velocity:

CW-8h

$$U^*\left[\frac{m}{sec}\right] = 0.01 \times U_{10} \times \sqrt{6.1 + 0.63 \times U_{10}}$$

where:

Parameter Definition		Units
$RBC_{cw/air}$	RBC for volatile COPC in air for construction worker	$\mu g/m^3$
$RBSL_{cw/pit}$	RBSL in pit water for vapor in ambient air for construction worker	$\mu g/L$
A	Liquid area (pit)	m^2
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
de	Effective diameter of impoundment (pit)	m
H'	Dimensionless Henry's Law constant	L-water/L-air
k_G	Gas-phase mass transfer coefficient	m/sec
k_L	Liquid-phase mass transfer coefficient	m/sec
Sc_G	Schmidt number on the gas side	unitless
Sc_L	Schmidt number on the liquid side	unitless
U^*	Friction velocity	m/sec
U_{10}	Wind speed at 10 meters above liquid surface (pit)	m/sec
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
$VF_{cw/pit}$	Groundwater to indoor air volatilization factor	L-water/m^3-air
W	Width of pit	cm

Parameter Definition		Units
$IR_{a/uw}$	Construction worker inhalation rate	m^3/day
L_{GW}	Depth to groundwater ($h_{cap} + h_v$)	cm
$sRfD_i$	Subchronic inhalation reference dose	mg/kg-day
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{wamb}	Groundwater to ambient air volatilization factor	L-water/m^3-air
W_{GW}	Width of groundwater source	cm
δ_{air}	Mixing zone height	cm
θ_{acap}	Volumetric air content in capillary fringe soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{wcap}	Volumetric water content in capillary fringe soils	cm^3-water/cm^3-soil

Parameter Definition		Units
δ_{air}	Mixing zone height	cm
μ_G	Viscosity of air	g/cm-sec
μ_L	Viscosity of water	g/cm-sec
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 5-5. Future Construction Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	365	days	EPA, 1989b	ED x 365 days/year
BW_{cw}	Body weight	71.8	kg	EPA, 1997	Recommended value
ED_{cw}	Exposure duration	1	years	Professional judgment	
EF_{cw}	Exposure frequency	100	days/year	Professional judgment	
$IR_{a/cw}$	Inhalation rate	13	m^3/day	EPA, 1997	Hourly average for outdoor workers (1.3 m^3/hour x 10 hours work/day)
$IR_{s/cw}$	Soil ingestion rate	50	mg/day	EPA, 1997	Recommended value
SA_{cw} x M	Soil-to-skin adherence factor	765.8	mg/day	See Table 5-6	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
ADULT LEAD MODEL PARAMETERS (EPA, 1996)					
AF_S	Absorption fraction	0.12	unitless	Recommended by EPA, 1996c	
AT	Averaging time for adult lead model	365	days/year		
BKSF	Biokinetic slope factor	0.4	µg/dL/µg/day	Recommended by EPA, 1996c	
EF_S	Exposure frequency for adult lead model	219	days/year	Recommended by EPA, 1996c	
GSD	Geometric standard deviation of blood lead levels	1.8	µg/dL	Recommended by EPA, 1996c	
IR_{S+D}	Soil and dust ingestion rate for adult lead model	0.05	g/day	Recommended by EPA, 1996c	
$PbB_{adult,central,goal}$	Target blood lead level	4.2	µg/dL	Calculated per Equation CW-4b	
$PbB_{baseline}$	Baseline blood lead level	2.0	µg/dL	Recommended by EPA, 1996c	
$PbB_{fetal,0.95,goal}$	Target 95th percentile PbB in fetus	10	µg/dL	Acceptable blood lead level for children (EPA, 1994a)	
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	0.9	unitless	Recommended by EPA, 1996c	

Table 5-5. Future Construction Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
$sRfD_i$	Subchronic inhalation reference dose	Chemical-specific	mg/kg-day	See Appendix B	
$sRfD_o$	Subchronic oral reference dose	Chemical-specific	mg/kg-day	See Appendix B	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
SF_o	Oral slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
RAF_d	Dermal relative absorption factor	1.0	mg-absorbed/ mg-ingested	Default	
RAF_o	Oral relative absorption factor	1.0	mg-absorbed/ mg-ingested	Default	

Table 5-6. Estimated Mass of Soil in Contact with Skin: Future Construction Worker Scenario

Exposure Metric	Hands	Arms	Legs	Head
Average of mean total surface area of body part in adult males and females (cm^2) [a]	793	2,190	4,965	1,140
Mean soil adherence to body part (mg/cm^2-day) [b, c]	0.24	0.098	.066	0.029
Total mass of soil adhering to body part (mg) [d]	190.3	214.6	327.7	33.2
Total amount of soil adhering to body (mg/day) [e]	765.8			

[a, b] Data from EPA, 1997.

[c] Geometric mean results for Construction Worker scenario (EPA, 1997).

[d] Calculated as the product of mean soil adherence and total body part surface area.

[e] Calculated as the sum of soil mass adhering to body parts.

6.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE FUTURE UTILITY/MAINTENANCE WORKER SCENARIO

When the BSC Lackawanna site is redeveloped, future utility/maintenance workers could potentially contact site-related COPCs via (1) direct contact with surficial and subsurface media (ingestion, inhalation, dermal contact), and (2) inhalation of ambient vapors emanating from groundwater and the Coke Oven Area pits. This scenario makes the assumption that conditions at all units remain unchanged. Potentially complete pathways for the utility/maintenance worker scenario are depicted in Figure 2-1 and Table 2-1, and potential source areas where these pathways could result in utility/maintenance worker exposure are summarized in Table 6-1.

Equations that will be used to calculate Tier 1 RBSLs for the various pathways are presented in the sections below and Tables 6-2 to 6-4, and exposure parameter values to be used in calculating Tier 1 RBSLs for the utility/maintenance worker scenario are presented in Tables 6-5 and 6-6. Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

6.1 DIRECT CONTACT WITH SURFICIAL AND SUBSURFACE SWMU MATERIAL

COPCs associated with both surficial and subsurface material in SWMUs could be contacted by future utility/maintenance workers. As shown in Figure 2-1, Table 2-1, and Table 6-1, potential routes of exposure include inadvertent ingestion, inhalation of particles and vapors, and dermal contact with SWMU material.

SWMUs where utility/maintenance worker exposure to surficial material could occur are:

- Coke Oven Area: SWMU Groups PA-1 (P-1 to P-5), PA-2 (P-6 and P-7), PA-3 (P-9 and P-10), and PA-4 (P-11 and P-12), and SWMUs P-18 (following water removal) and S-26;
- Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22), and SWMUs S-3, S-8, S-21, and S-24;
- Slag Fill Area Zone 3: SWMU S-10;
- Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, S-18, and S-23;
- Other areas: SWMUs S-19, S-25, P-63, and P-73, and sediment in the North and South Return Water Trenches.

Equations that will be used to develop RBSLs for the direct contact pathway are presented in Table 6-2. Exposure parameter values are presented in Tables 6-5 and 6-6. In order to quantify dermal exposure to COPCs in soil, it is necessary to know (1) what area of the body surface is exposed to soil; (2) what mass of soil adheres to the skin per unit area; and (3) the bioavailability of chemicals present in soil. In the human health risk assessment to be conducted for the BSC Lackawanna site, dermal exposure to soil will be evaluated in accordance with EPA's *Exposure Factors Handbook* (EPA, 1997), in which the mass of soil adhering to major body parts of individuals participating in a variety of indoor and outdoor activities was quantified. For utility/maintenance workers, the mean of the Utility Worker No. 1 and No. 2 scenarios (eleven males aged 23 to 45 years assayed after working for 9.5 hours cleaning, fixing mains, and excavating with backhoe and shovel in July and August) is considered to provide a conservative representation of potential exposure at the Lackawanna site (Table 6-6). For purposes of developing Tier 1 RBSLs, the potential dermal absorption of particle-associated COPCs will be conservatively assumed to be equal to their oral absorption (*i.e.*, the dermal relative absorption factor (RAF_d) will be set to 1.0). Further, sorption to particulate matter will be conservatively assumed to have no effect on the oral absorption of COPCs (*i.e.*, the oral relative absorption factor (RAF_o) will be set to 1.0).

6.2 INHALATION OF VAPORS FROM GROUNDWATER

As shown in Table 6-1, utility/maintenance workers on the site could be exposed to vapors emanating from groundwater while working in any area of the site. RBSLs for ambient COPCs derived from groundwater in these areas will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs will be back-calculated for each volatile COPC from corresponding $RBC_{uw/air}$ values (Equations UW-5 and UW-6, Table 6-3). Equations that will be used to develop RBSLs for the groundwater vapor inhalation pathway are presented in Table 6-3. Exposure parameter values are presented in Table 6-5 .

6.3 INHALATION OF VAPORS FROM PITS

As shown in Table 6-1, utility/maintenance workers could be exposed to ambient vapors emanating from standing water in Coke Oven Area pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #17 at SWMU P-11. Equations that will be used to develop RBSLs for the pit vapor inhalation pathway are presented in Table 6-4. The chemical-specific volatilization rate ($VF_{uw/pit}$) from the pits will be estimated using the stagnant film model presented in EPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) – Air Emission Models* (EPA, 1989a) (Equation UW-8b, Table 6-4). Exposure parameter values are presented in Table 6-5.

Table 6-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Utility/Maintenance Worker Scenario

Potential Sources	Exposure Pathway Description		
	Direct Contact with Surface Material	Direct Contact with Subsurface Material	Inhalation of Ambient Vapors
COKE OVEN AREA			
PA-1 (P-1, P-2, P-3, P-4, and P-5)	X	X	DC
PA-2 (P-6 and P-7)	X	ND	ND
PA-3 (P-9 and P-10)	ND	X	DC
PA-4 (P-11 and P-12)	X	X	DC
P-18	S	X	DC
S-26	S	X	DC
PA-1 Pits	NA		X
Pit #17 at SWMU P-11	NA		X
Groundwater	NA		X
TANK FARM AREA			
TF (P-8, P-74, and P-75)	X	ND	ND
Groundwater	NA		X
SLAG FILL AREA ZONE 1 (NO SWMUS)			
Groundwater	NA		X
SLAG FILL AREA ZONE 2			
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	X	X	DC
SFA-2 (S-11 and S-22)	S	X	DC
S-3	S	X	DC
S-8	X	ND	ND
S-21	X	ND	ND
S-24	ND	X	DC
Groundwater	NA		X
SLAG FILL AREA ZONE 3			
S-10	ND	X	DC
Groundwater	NA		X
SLAG FILL AREA ZONE 4			
S-14	X	X	DC
S-15	X	ND	ND
S-16	ND	NC	NC
S-17	S	X	DC
S-18	X	ND	ND
S-23	ND	X	DC
Groundwater	NA		X
SLAG FILL AREA ZONE 5 (NO SWMUS)			
Groundwater	NA		X
OTHER AREAS			
S-19	X	ND	ND
S-25	ND	X	NT

Table 6-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Utility/Maintenance Worker Scenario

Potential Sources	Exposure Pathway Description		
	Direct Contact with Surface Material	Direct Contact with Subsurface Material	Inhalation of Ambient Vapors
P-63	X	X	NV
P-73	X	X	NT
Smokes Creek Area groundwater	NA		X
Site-wide groundwater	NA		Zonal
WATERCOURSES			
Lake Erie	NE		NA
Smokes Creek			
Blasdell Creek			
North & South Return Water Trenches			
Ship Canal			

Notes:

X = considered complete pathway to be evaluated.
S = considered complete pathway to be evaluated by using subsurface soil material data as surrogate for surface material data.
DC = not considered separately because direct contact is being evaluated.
NA = not applicable.
NC = no COPCs present.
ND = no data collected.
NE = no exposure.
NT = no toxicity criteria available for volatile subsurface COPC(s).
NV = no volatile COPCs present.
Zonal = zonal groundwater is assumed source of groundwater vapor exposure.

Table 6-2. Future Utility/Maintenance Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Direct Contact Pathway

Non-Cancer $RBSL_{uw/soil}$:

UW- 1

$$RBSL_{uw/dc}\left[\frac{mg}{kg\ soil}\right]=\frac{THQ \times BW_{uw} \times AT_n}{EF_{uw} \times ED_{uw} \times \left(10^{-6}\ kg/mg \times \frac{1}{RfD_o} \times \left(IR_{s/uw} \times RAF_o + SA_{uw} \times M \times RAF_d\right) + \left(\frac{1}{RfD_i} \times IR_{a/uw} \times \left(VF_{ss} + VF_p\right)\right)\right)}$$

Cancer $RBSL_{uw/soil}$:

UW- 2

$$RBSL_{uw/soil}\left[\frac{mg}{kg\ soil}\right]=\frac{TR \times BW_{cw} \times AT_c}{EF_{cw} \times ED_{cw} \times \left(10^{-6}\ kg/mg \times SF_o \times \left(IR_{s/cw} \times RAF_o + SA_{cw} \times M \times RAF_d\right) + \left(SF_i \times IR_{a/cw} \times \left(VF_{ss} + VF_p\right)\right)\right)}$$

Chemical-specific volatilization factor for surficial material to ambient air (ASTM, 1995):

UW- 3a

$$VF_{ss}\left[\frac{kg-soil}{m^3-air}\right] = \frac{2 \times W_S \times \rho_s}{U_{air} \times \delta_{air}} \times \sqrt{\frac{D_s^{eff} \times H'}{\pi \times [\theta_{ws} + K_{oc} \times f_{oc} \times \rho_s + H' \times \theta_{as}] \times \tau}} \times 10^3\ \frac{cm^3-kg}{m^3-g}$$

or the mass-limited volatilization factor from surficial material to ambient air (ASTM, 1995):

UW- 3b

$$VF_{ss}\left[\frac{kg-soil}{m^3-air}\right] = \frac{W_S \times \rho_s \times d}{U_{air} \times \delta_{air} \times \tau} \times 10^3\ \frac{cm^3-kg}{m^3-g}$$

(whichever is less)

Effective diffusion coefficient in soil based on vapor-phase concentration (ASTM, 1995):

UW-3c

$$D_s^{eff}\left[\frac{cm^2}{s}\right] = D^{air} \times \frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{water} \times \frac{1}{H'} \times \frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Particle emission factor (ASTM, 1995):

UW-3d

$$VF_p\left[\frac{kg-soil}{m^3-air}\right] = \frac{P_e \times W_S}{U_{air} \times \delta_{air}} \times 10^3\ \frac{cm^3-kg}{m^3-g}$$

RBSL for lead in soil (EPA, 1996b):

UW-4a

$$RBSL_{uw/Pb}\left[\frac{mg}{kg-soil}\right]=\frac{\left(PbB_{adult,central,goal} - PbB_{baseline}\right) \times AT}{BKSF \times IR_{S+D} \times AF_S \times EF_S}$$

where

UW-4b

$$PbB_{adult,central,goal} = \frac{PbB_{fetal,0.95,goal}}{GSD^{1.645} \times R_{fetal/maternal}}$$

where:

Parameter Definition		Units
$RBSL_{cw/dc}$	RBSL for direct contact for construction worker	mg/kg
$RBSL_{cw/Pb}$	RBSL for lead in surface material for construction worker	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{cw}	Construction worker body weight	kg
d	Depth to subsurface source	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
ED_{cw}	Construction worker exposure duration	years
EF_{cw}	Construction worker exposure frequency	days/year
f_{oc}	Mass fraction of organic carbon in soil	g-organic carbon/g-soil
H'	Dimensionless Henry's Law constant	L-water/L-air
$IR_{a/cw}$	Construction worker inhalation rate	m^3/day
$IR_{s/cw}$	Construction worker soil ingestion rate	mg/day
K_{oc}	Organic carbon/water partition coefficient	L-water/kg-organic carbon
M	Soil-to-skin adherence factor	cm^2/day
P_e	Areal total respirable particulate emission flux from SWMU	g/cm^2-sec
RAF_d	Dermal relative absorption factor	mg-absorbed/mg- applied
RAF_o	Oral relative absorption factor	mg-absorbed/mg-ingested
SA_{cw}	Skin surface area exposed	cm^2
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$
$sRfD_i$	Subchronic inhalation reference dose	mg/kg-day
$sRfD_o$	Subchronic oral reference dose	mg/kg-day
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_p	Total respirable particle concentration from SWMU	kg-soil/m^3-air
VF_{ss} (chemical-specific)	Surface material to ambient air volatilization factor	kg-soil/m^3-air
VF_{ss} (site-specific)	Surface material to ambient air volatilization factor	kg-soil/m^3-air
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_s	Soil bulk density	g-soil/cm^3-soil
τ	Averaging time for surface emission vapor flux	sec
AF_S	Absorption fraction	unitless
AT	Averaging time for adult lead model	days/year
BKSF	Biokinetic slope factor	µg/dL/µg/day
EF_S	Exposure frequency for adult lead model	days/year
GSD	Geometric standard deviation of blood lead levels	µg/dL
IR_{S+D}	Soil and dust ingestion rate for adult lead model	g/day
$PbB_{adult,central,goal}$	Target blood lead level	µg/dL
$PbB_{baseline}$	Baseline blood lead level	µg/dL
$PbB_{fetal,0.95,goal}$	Target 95th percentile PbB in fetus	µg/dL
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	unitless

Table 6-3. Future Utility/Maintenance Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Groundwater Vapor Inhalation Pathway

Non-Cancer $RBC_{uw/air}$:

UW-5

$$RBC_{uw/air}\left[\frac{\mu g}{m^3}\right] = \frac{THQ \times RfD_i \times BW_{uw} \times AT_n}{ED_{uw} \times EF_{uw} \times IR_{a/uw}} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBC_{uw/air}$

UW-6

$$RBC_{uw/air}\left[\frac{\mu g}{m^3}\right] = \frac{TR \times BW_{uw} \times AT_c}{SF_i \times ED_{uw} \times EF_{uw} \times IR_{a/uw}} \times 10^3 \frac{\mu g}{mg}$$

$RBSL_{uw/wamb}$:

UW-7a

$$RBSL_{uw/wamb}\left[\frac{\mu g}{L}\right] = \frac{RBC_{uw/air}}{VF_{wamb}} \times 10^{-3} \frac{mg}{\mu g}$$

Volatilization factor from groundwater to ambient air (ASTM, 1995):

UW-7b

$$VF_{wamb}\left[\frac{L-water}{m^3-air}\right] = \frac{H'}{\left(1 + \frac{U_{air} \times \delta_{air} \times L_{GW}}{D_{ws}^{eff} \times W_{GW}}\right)} \times 10^3 \frac{L}{m^3}$$

Effective diffusion coefficient between groundwater and the SWMU surface (ASTM, 1995):

UW-7c

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = \left(h_{cap} + h_v\right) \times \left(\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}}\right)^{-1}$$

where D_s^{eff} is as defined in Equation UW-3c

Effective diffusion coefficient through the capillary fringe (ASTM, 1995):

UW-7d

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air} \times \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{water} \times \frac{1}{H'} \times \frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

Parameter Definition		Units
$RBC_{uw/air}$	RBC for volatile COPC in air for utility/maintenance worker	$\mu g/m^3$
$RBSL_{uw/wamb}$	RBSL in groundwater for vapor in ambient air for utility/maintenance worker	µg/L
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{uw}	Utility/Maintenance worker body weight	kg
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
D_{cap}^{eff}	Effective diffusion coefficient in capillary fringe region	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
ED_{uw}	Utility/Maintenance worker exposure duration	years
EF_{uw}	Utility/Maintenance worker exposure frequency	days/year
H'	Dimensionless Henry's Law constant	L-water/L-air

Parameter Definition		Units
h_{cap}	Thickness of capillary fringe	cm
h_v	Thickness of vadose zone	cm
$IR_{a/uw}$	Utility/Maintenance worker inhalation rate	m^3/day
L_{GW}	Depth to groundwater ($h_{cap} + h_v$)	cm
RfD_i	Chronic inhalation reference dose	mg/kg-day
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{wamb}	Groundwater to ambient air volatilization factor	L-water/m^3-air
W_{GW}	Width of groundwater source	cm
δ_{air}	Mixing zone height	cm
θ_{acap}	Volumetric air content in capillary fringe soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{wcap}	Volumetric water content in capillary fringe soils	cm^3-water/cm^3-soil

Table 6-4. Future Utility/Maintenance Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Pit Vapor Inhalation Pathway

$RBC_{uw/air}$ values calculated per Equations UW-5 and UW-6

$RBSL_{uw/pit}$:

UW-8a

$$RBSL_{uw/pit}\left[\frac{\mu g}{L}\right] = \frac{RBC_{uw/air}}{VF_{uw/pit}} \times 10^{-3}\frac{m^3}{L}$$

Volatilization rate from the pits:

UW-8b

$$VF_{uw/pit}\ [\text{dimensionless}] = \frac{k_L}{1+\frac{k_L}{k_G \times H'}} \times \frac{A}{U_{air} \times W \times \delta_{air}} \times \frac{10^6\ cm^3}{m^3}$$

Gas-phase mass transfer coefficient:

UW-8c

$$k_G\left[\frac{m}{sec}\right] = 4.82 \times 10^{-3} \times U_{10}^{0.78} \times Sc_G^{-0.67} \times de^{-0.11} \quad \text{where}$$

Effective diameter of impoundment:

UW-8d

$$de[m] = \sqrt{\frac{4 \times A}{\pi}}$$

Schmidt number on the gas side:

UW-8e

$$Sc_G = \frac{\mu_G}{\rho_G \times D^{air}}$$

Liquid-phase transfer coefficient:

UW-8f

$$k_L\left[\frac{m}{sec}\right] = 10^{-6} + 144 \times 10^{-4} \times U^{*2.2} \times Sc_L^{-0.5} \quad \text{where}$$

Schmidt number on the liquid side:

UW-8g

$$Sc_L = \frac{\mu_L}{\rho_L \times D^{water}}$$

Friction velocity:

UW-8h

$$U^*\left[\frac{m}{sec}\right] = 0.01 \times U_{10} \times \sqrt{6.1 + 0.63 \times U_{10}}$$

where:

Parameter Definition		Units
$RBC_{uw/air}$	RBC for volatile COPC in air for utility/maintenance worker	$\mu g/m^3$
$RBSL_{uw/pit}$	RBSL in pit water for vapor in ambient air for utility/maintenance worker	$\mu g/L$
A	Liquid area (pit)	m^2
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
de	Effective diameter of impoundment (pit)	m
H'	Dimensionless Henry's Law constant	L-water/L-air
k_G	Gas-phase mass transfer coefficient	m/sec
k_L	Liquid-phase mass transfer coefficient	m/sec
Sc_G	Schmidt number on the gas side	unitless
Sc_L	Schmidt number on the liquid side	unitless
U^*	Friction velocity	m/sec
U_{10}	Wind speed at 10 meters above liquid surface (pit)	m/sec
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
$VF_{uw/pit}$	Groundwater to indoor air volatilization factor	L-water/m^3-air

Parameter	Definition	Units
W	Width of pit	cm
δ_{air}	Mixing zone height	cm
μ_G	Viscosity of air	g/cm-sec
μ_L	Viscosity of water	g/cm-sec
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	$g\text{-soil}/cm^3\text{-soil}$

Table 6-5. Future Utility/Maintenance Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	365	days	EPA, 1989b	ED x 365 days/year
BW_{uw}	Body weight	71.8	kg	EPA, 1997	Recommended value
ED_{uw}	Exposure duration	6.6	years	EPA, 1997	Recommended value
EF_{uw}	Exposure frequency	10	days/year	Professional judgment	Assumes 2 weeks x 5 working days/week on the site
$IR_{a/uw}$	Inhalation rate	13	m^3/day	EPA, 1997	Hourly average for outdoor workers (1.3 m^3/hour x 10 hours work/day)
$IR_{s/uw}$	Soil ingestion rate	50	mg/day	EPA, 1997	Recommended value
SA_{uw} x M	Soil-to-skin adherence factor	895.4	mg/day	See Table 6-6	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
ADULT LEAD MODEL PARAMETERS (EPA, 1996b)					
AF_S	Absorption fraction	0.12	unitless	Recommended by EPA, 1996b	
AT	Averaging time for adult lead model	365	days/year	Recommended by EPA, 1996b	
BKSF	Biokinetic slope factor	0.4	µg/dL/µg/day	Recommended by EPA, 1996b	
EF_S	Exposure frequency for adult lead model[1]	50	days/year	Recommended by EPA, 1996b	
GSD	Geometric standard deviation of blood lead levels	1.8	µg/dL	Recommended by EPA, 1996b	
IR_{S+D}	Soil and dust ingestion rate for adult lead model	0.05	g/day	Recommended by EPA, 1996b	

[1] Although the expected exposure frequency for the utility/maintenance worker scenario is less than that required to achieve steady-state blood lead concentrations (EPA, 1996b), the exposure frequency will be assumed to be 50 days/year (recommended by EPA for a commercial worker scenario) for purposes of lead exposure modeling in order to provide a conservative means of identifying potential risks associated with this element in Tier 1.

Table 6-5. Future Utility/Maintenance Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
$PbB_{adult,central,goal}$	Target blood lead level	4.2	µg/dL	Calculated per Equation UW-4b	
$PbB_{baseline}$	Baseline blood lead level	2.0	µg/dL	Recommended by EPA, 1996b	
$PbB_{fetal,0.95,goal}$	Target 95th percentile PbB in fetus	10	µg/dL	Acceptable blood lead level for children (EPA, 1994)	
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	0.9	unitless	Recommended by EPA, 1996b	
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
RAF_d	Dermal relative absorption factor	1.0	mg-absorbed/ mg-ingested	Default	
RAF_o	Oral relative absorption factor	1.0	mg-absorbed/ mg-ingested	Default	
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
RfD_o	Chronic oral reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
SF_o	Oral slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	

Table 6-6. Estimated Mass of Soil in Contact with Skin: Future Utility/maintenance Worker Scenario

Exposure Metric	Hands	Arms	Head
Average of mean total surface area of body part in adult males and females (cm^2) [a]	793	2,190	1,140
Mean soil adherence to body part (mg/cm^2-day) [b, c]	0.3	0.25	0.1
Total mass of soil adhering to body part (mg) [d]	233.9	547.5	114
Total amount of soil adhering to body (mg/day) [e]		**895.4**	

[a, b] Data from EPA, 1997.

[c] Mean of geometric mean results for Utility Workers Nos. 1 and 2 scenarios (EPA, 1997).

[d] Calculated as the product of mean soil adherence and total body part surface area.

[e] Calculated as the sum of soil mass adhering to body parts.

7.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE CURRENT AND FUTURE SHIP CANAL MAINTENANCE WORKER SCENARIO

The requirement for maintenance of the Ship Canal has historically been limited. Records show the following worker exposure in the last thirteen years:

- Twice a year, divers inspect the #1 Pump Station intake. This requires approximately two to three hours, and the divers wear protective equipment.
- Twice a year, a boom deploy exercise is done involving two workers in a boat. This exercise requires approximately one hour.
- Buffalo Crushed Stone has not done any maintenance or dredging since they purchased the Canal from BSC in 1985. They have had two oil spills since 1985, both of which were cleaned up without entering the water using a boat and oil booms.
- In February 1997, there was a tar spill from the coke oven on the northwest side of the Canal. The cleanup, performed by divers wearing protective equipment, (outside Hazmat contractors), took about three weeks.

Although contact by workers is therefore not expected to be substantial or to occur on a regular basis, at the request of EPA, a future Ship Canal maintenance worker exposure scenario will be included in the human health risk assessment. As shown in Figure 2-1 and Table 2-1, potentially complete exposure pathways for the Ship Canal maintenance worker include (1) dermal contact with surface water, (2) incidental ingestion of surface water, and (3) incidental ingestion of sediment. It is noted that the use of diving suits and other routine protective measures by divers in the Ship Canal would largely prevent these hypothetical exposures. Both current conditions and a hypothetical future scenario in which the pumps that continuously empty water from the Ship Canal (resulting in a net flow of water into the Ship Canal from the Buffalo Outer Harbor) have ceased operating will be considered. Under this assumption, the influence of groundwater from the Coke Oven Area discharge Area on Ship Canal surface water must be estimated.

Equations that will be used to calculate RBSLs for the various pathways are presented in the sections below and in Tables 7-1 and 7-2. Exposure parameter values to be used in calculating Tier 1 RBSLs for the Ship Canal maintenance worker scenario are presented in Table 7-3. Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

7.1 DIRECT CONTACT WITH SURFACE WATER IN THE SHIP CANAL

Maintenance workers could contact site-related COPCs in surface water. As noted above, both current conditions (*i.e.*, potential exposure to COPCs detected in Ship Canal surface water) and hypothetical future conditions in which pumping has ceased (*i.e.*,

potential exposure to modeled concentrations of COPCs transported from Coke Oven Discharge Area groundwater to Ship Canal surface water) will be considered.

Under current operating conditions, as discussed in Interim Deliverable No. 1 (Section 3.3.1 and Appendix E.1), water is being continuously pumped (24 hours per day) from the Ship Canal at a rate that far exceeds the amount of SPDES-permitted and groundwater inflows to the canal, resulting in a net flow of water into the Ship Canal from the Lake Erie. Maximum concentrations that Ship Canal Discharge Area groundwater COPCs could reach in Ship Canal surface water in the absence of pumping were estimated using the average concentrations of these COPCs in groundwater entering the Canal and a mass balance model. These groundwater concentrations were estimated by contouring the most recent data for each COPC in Ship Canal Discharge Area wells. The mass balance model for the Ship Canal assumes complete, instantaneous mixing of the inflow with the Canal water, and instantaneous loss of mixed water to balance the inflow. That is, as each increment of influx is added to the Canal, it mixes completely with the resident water, and an equal column of Canal water with the new COPC concentration is lost to Lake Erie. This model is highly conservative in that it assumes no loss of COPC after entry into the Canal, even though losses by such processes as biological and chemical degradation and volatilization would be substantial.

Equations that will be used to develop RBSLs for the direct contact pathway are presented in Table 7-1, and exposure parameter values in Table 7-3.

7.2 INGESTION OF SEDIMENT IN THE SHIP CANAL

As shown in Figure 2-1 and Table 2-1, people engaged in contact maintenance work in the Ship Canal may incidentally ingest sediment containing site-related COPCs re workers actually protected. Equations that will be used to develop RBSLs for the sediment ingestion pathway are presented in Table 7-2. For purposes of developing Tier 1 RBSLs, particle sorption will be conservatively assumed to have no effect on the oral bioavailability of sediment COPCs. Exposure parameter values are presented in Table -3. Although lead is a COPC in Ship Canal sediment (see Section 4.6.6, Interim Deliverable No. 1 [Dames & Moore, 1998]), no Tier 1 RBSL can be calculated for this element because the infrequency of expected exposure to sediments by Ship Canal maintenance workers precludes application of EPA's adult lead model (EPA, 1996b). However, as a conservative estimate of potential hazard to this receptor scenario in Tier 1 of the risk assessment, the lead RBSL calculated for future commercial workers (see Table 4-8) will be compared to the representative lead concentration in Ship Canal sediment.

Table 7-1. Future Ship Canal Maintenance Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Surface Water Contact Pathway

Non-Cancer $RBSL_{sc/sw}$:

SC- 1

$$RBSL_{sc/sw}\left[\frac{\mu g}{L}\right] = \frac{THQ \times BW_{sc} \times AT_n}{ED_{sc} \times EF_{sc} \times ET_{sc} \times \left[\left(\frac{1}{RfD_d} \times SA_{sc} \times PC \times 10^{-3}\,L/cm^3\right) + \left(\frac{1}{RfD_o} \times IR_{w/sc}\right)\right]} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBSL_{sc/sw}$:

SC- 2

$$RBSL_{sc/sw}\left[\frac{\mu g}{L}\right] = \frac{TR \times BW_{sc} \times AT_c}{ED_{sc} \times EF_{sc} \times ET_{sc} \times \left[(SF_d \times SA_{sc} \times PC \times 10^{-3}\,L/cm^3) + SF_o \times IR_{w/sc}\right]} \times 10^3 \frac{\mu g}{mg}$$

where:

Parameter	Definition	Units
$RBSL_{sc/sw}$	RBSL in surface water for Ship Canal maintenance workers	µg/L
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{sc}	Ship Canal maintenance worker body weight	kg
ED_{sc}	Ship Canal maintenance worker exposure duration	years
EF_{sc}	Ship Canal maintenance worker exposure frequency	days/year
ET_{sc}	Ship Canal maintenance worker exposure time	hours/day
$IR_{w/sc}$	Ship Canal maintenance worker water ingestion rate	L/hour
PC	Permeability coefficient	cm/hour
RfD_d	Chronic dermal reference dose	mg/kg-day
RfD_o	Chronic oral reference dose	mg/kg-day
SA_{sc}	Ship Canal maintenance worker body surface area	cm^2
SF_d	Dermal slope factor	$(mg/kg\text{-}day)^{-1}$
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless

Table 7-2. Future Ship Canal Maintenance Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Sediment Ingestion Pathway

Non-Cancer $RBSL_{sc/sed}$

SC-3

$$RBSL_{sc/sed}\left[\frac{mg}{kg\text{-}sed}\right] = \frac{THQ \times BW_{sc} \times AT_n \times RfD_o}{ED_{sc} \times EF_{sc} \times 10^{-6}\ kg/mg \times (IR_{sed/sc} \times RAF_o)}$$

Cancer $RBSL_{sc/sed}$

SC-4

$$RBSL_{sc/sed}\left[\frac{mg}{kg\text{-}sed}\right] = \frac{TR \times BW_{sc} \times AT_c}{ED_{sc} \times EF_{rec} \times 10^{-6}\ kg/mg \times SF_o \times (IR_{sed/sc} \times RAF_o)}$$

where:

Parameter	Definition	Units
$RBSL_{sc/sed}$	RBSL in sediment for Ship Canal maintenance workers	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{sc}	Ship Canal maintenance worker body weight	kg
ED_{sc}	Ship Canal maintenance worker exposure duration	years
EF_{sc}	Ship Canal maintenance worker exposure frequency	days/year
$IR_{sed/sc}$	Sediment ingestion rate	mg/day
RAF_o	Oral relative absorption factor	mg-absorbed/mg-ingested
RfD_o	Chronic oral reference dose	mg/kg-day
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless

Table 7-3. Future Ship Canal Maintenance Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	2,409	days		ED x 365 days/year
BW_{sc}	Body weight	71.8	kg	EPA, 1997	Recommended body weight for male and female adults
ED_{sc}	Exposure duration	6.6	years	EPA, 1997	Recommended value
EF_{sc}	Exposure frequency	10	events/year	Professional judgment	Assumes contact daily for two weeks
ET_{sc}	Exposure time	2	hours/event	Professional judgment	
$IR_{sed/sc}$	Incidental sediment ingestion rate	12.5	mg/event	Professional judgment	One-quarter of estimated daily soil intake rate for adults (outdoor activities)
$IR_{w/sc}$	Incidental water ingestion rate	0.05	L/hour	EPA, 1989b	Default value
SA_{sc}	Skin surface area exposed	20,000	cm^2/event	EPA, 1997	Recommended central tendency value for bathing/swimming
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
PC	Permeability coefficient	Chemical-specific	cm/hour	See Interim Deliverable No. 3	
RfD_d	Chronic dermal reference dose	Chemical-specific	mg/kg-day	$RfD_d = RfD_o$ x Oral absorption fraction (see Interim Deliverable No. 3)	
RfD_o	Chronic oral reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_d	Dermal slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	$SF_d = SF_o$/ Oral absorption fraction (see Interim Deliverable No. 3)	
SF_o	Oral slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
RAF_o	Oral relative absorption factor	1.0	mg-absorbed/ mg-ingested	Default	

~~6.0~~8.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE ~~PRESENT~~ CURRENT AND FUTURE ~~ADOLESCENT~~ TRESPASSER SCENARIO

Trespassers are assumed to be adolescent males aged 15-18 years old who are capable of bypassing security to wander around the site. Potentially complete pathways for the trespasser scenario are depicted in Figure 2-1 and Table 2-1, and potential source areas where these pathways could result in trespasser exposure are summarized in Table ~~6-~~8-1.

Equations that will be used to calculate Tier 1 RBSLs for the various pathways are presented in the sections below and Tables ~~6-~~8-2 to ~~6-~~8-5, and exposure parameter values to be used in calculating Tier 1 RBSLs for the trespasser scenario are presented in Tables ~~6-~~8-6 and ~~6-~~8-7. Because of the relatively short exposure duration period for this scenario (four years; see Table 8-6), subchronic toxicity criteria will be used to assess potential non-cancer hazards. Subchronic non-cancer toxicity criteria to be used in this evaluation are presented in Table ~~6-~~8-8; carcinogenic toxicity criteria were presented in Interim Deliverable No. 1. Oral and dermal relative absorption factors are presented in Section 3.0 (Tables 3-1 and 3-2). Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

~~6.1~~8.1 DIRECT CONTACT WITH SURFICIAL SWMU MATERIAL

COPCs associated with exposed material in SWMUs without covers could be contacted by trespassers. As shown in Figure 2-1 and Table 2-1, potential routes of exposure include inadvertent ingestion, inhalation of particles and vapors, and dermal contact with exposed surficial material.

SWMUs where surficial material is exposed to the atmosphere are:

- Coke Oven area: SWMU Groups PA-1 (P-1 to P-5), PA-2 (P-6 and P-7) and PA-4 (P-11 and P-12), and SWMU S-26;
- Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22), and SWMUs S-3, S-8, and S-21;
- Slag Fill Area Zone 3: SWMU S-10;
- Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, and S-18;
- Other areas: SWMUs S-19, P-63, and P-73.

Subsurface results will be used as a surrogate for surficial data for the following uncovered SWMUs where no surface samples were taken: SWMU Groups PA-4 and SFA-2, and S-26, S-3, S-10, and S-17. This is highly conservative with respect to VOCs

(but not non-volatile COPCs), which would be expected to dissipate rapidly if exposed to the atmosphere.

~~Coke Oven area: SWMU Group PA-1 (P-3, P-4, and P-5), SWMU Group PA-2 (P-6 and P-7), and SWMU Group PA-4 (P-11 and P-12), and S-26;~~

- ~~Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);~~
- ~~Slag Fill Area Zone 2: SWMU Group SFA-1 (S-1, S-2, S-4, S-5, S-6, S-27), SFA-2 (S-11 and S-22) and SWMUs S-3, S-8, and S-21;~~
- ~~Slag Fill Area Zone 3: SWMU S-10;~~
- ~~Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, and S-18; and~~
- ~~Other areas: SWMUs S-19, S-25, P-63, and P-73.~~

~~Subsurface results were used as a surrogate for surficial data for the following uncovered SWMUs where no surface samples were taken: S-26, SWMU Group SFA-2, S-3, S-10, S-17, and S-25. This is highly conservative with respect to volatile compounds, which would be expected to dissipate rapidly if exposed to the atmosphere.~~

Equations that will be used to develop RBSLs for the direct contact pathway are presented in Table ~~6-~~8-2. Exposure parameter values are presented in Tables ~~6-~~8-6 and ~~6-~~8-7, and available subchronic toxicity criteria are listed in Appendix B. Although lead is a COPC in several SWMUs (see Section 4.2, Interim Deliverable No. 1 [Dames & Moore, 1998])]), no Tier 1 RBSL can be calculated for this element because the infrequency of trespassers' expected exposure to SWMU material precludes application of EPA's adult lead model (EPA, 1996b). However, as a conservative estimate of potential hazard to this receptor scenario in Tier 1 of the risk assessment, the lead RBSL calculated for future commercial workers (see Table 4-8) will be compared to the representative concentrations of lead in SWMUs where it is a COPC. In order to quantify dermal exposure to COPCs in soil, it is necessary to know (1) what area of the body surface is exposed to soil; (2) what mass of soil adheres to the skin per unit area; and (3) the bioavailability of chemicals present in soil. In the human health risk assessment to be conducted for the BSC Lackawanna site, dermal exposure to soil will be evaluated in accordance with EPA's *Exposure Factors Handbook* (1997), in which the mass of soil adhering to major body parts of individuals participating in a variety of indoor and outdoor activities was quantified. For the adolescent trespasser scenario, the mean of the Soccer No. 1, 2, and 3 scenarios (seven to eight males aged 13 to 34 years assayed after playing soccer for 40 minutes in March or November) was considered to best represent potential exposure to trespassers at the BSC Lackawanna site (Table ~~6-~~8-7). For purposes of developing Tier 1 RBSLs, the potential dermal absorption of particle-associated COPCs will be conservatively assumed to be equal to their oral absorption (*i.e.*, the dermal relative absorption factor (RAF_d) will be set to 1.0). Further, sorption to particulate matter will be conservatively assumed to have no effect on the oral absorption of COPCs (*i.e.*, the oral relative absorption factor (RAF_o) will be set to 1.0).

~~6.2~~8.2 INHALATION OF VAPORS FROM SUBSURFACE SWMU MATERIAL

As shown in Table ~~6-~~8-1, adolescent trespassers could be exposed to vapors emanating from subsurface material in the following SWMUs:

- Coke Oven Area: SWMU Groups PA-3 (P-9 and P-10) and PA-4 (P-1 to P-5);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S- 27) and SFA-2 (S-11 and S-22) and SWMU S-24; and
- Slag Fill Area Zone 4: SWMUs S-14 and S-23.

~~• Coke Oven Area: SWMU Group PA-3 (S-9 and S-10);~~

~~• Slag Fill Area Zone 2: SWMU Group SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27), SFA-2 (S-11 and S-22) and SWMU S-24; and~~

~~• Slag Fill Area Zone 4: SWMUs S-14 and S-23.~~

Because trespassers may be present anywhere on the site, RBSLs ($RBSL_{tres/sub}$) for COPCs in subsurface SWMU material for this scenario will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs will be back-calculated for each volatile COPC from corresponding $RBC_{tres/air}$ values (Equations T-7 and T-8), as shown in Table ~~6-~~8-3. Exposure parameter values are presented in Table ~~6-~~8-6, and available subchronic toxicity criteria are listed in Table ~~6-~~8-8.

~~6.3~~8.3 INHALATION OF VAPORS FROM GROUNDWATER

~~As shown in Table 6_1 and Figure 6_1, adolescent trespassers on the site could be exposed to vapors emanating from groundwater in Slag Fill Area Zones 1 to 5, the Coke Oven Area, the Tank Farm Area, and the Smokes Creek Area. Equations that will be used to develop RBSLs for the groundwater vapor inhalation pathway are presented in Table 6_4. Exposure parameter values are presented in Table 6_6, and available subchronic toxicity criteria are listed in Table 6_8.~~

As shown in Table 8-1, trespassers could be exposed to ambient vapors emanating from groundwater in SFA Zones 1 and 5 and the Tank Farm and Coke Oven Areas. RBSLs for ambient COPC vapors derived from subsurface SWMU material in these areas will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs will be back-calculated for each volatile COPC from corresponding $RBC_{tres/air}$ values (Equations T-5 and T-6), as shown in Table 8-4. Exposure parameter values are presented in Table 8-6.

~~6.~~48.4 INHALATION OF VAPORS FROM PITS

~~Trespassers could be exposed to ambient vapors emanating from standing water in Coke Oven Area pits (SWMU Group PA-1(: SWMUs P-1, P-2, P-3, and P-4), and Pit #17 at SWMU P-11). Equations that will be used to develop RBSLs for the pit vapor inhalation pathway are presented in Table 6-7-5. Exposure parameter values are presented in Table 6-7-6, and available subchronic toxicity criteria are listed in Table 6-7-8~~

As shown in Table 8-1, trespassers could be exposed to ambient vapors emanating from standing water in Coke Oven Area pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #17 at SWMU P-11). Equations that will be used to develop RBSLs for the pit vapor inhalation pathway are presented in Table 8-5. The chemical-specific volatilization rate ($VF_{tres/pit}$) from the pits will be estimated using the stagnant film model presented in EPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models* (EPA, 1989a) (Equation T-9d, Table 8-5). Exposure parameter values are presented in Table 8-6.

Table 8-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Current and Future Trespasser Scenario

Potential Sources	Exposure Pathway Description	
	Direct Contact (including airborne particle inhalation)	Inhalation of Ambient Vapors
COKE OVEN AREA		
PA-1 (P-1, P-2, P-3, P-4, and P-5)	**X**	NT
PA-2 (P-6 and P-7)	**X**	ND
PA-3 (P-9 and P-10)	ND, NE (c)	**X**
PA-4 (P-11 and P-12)	**X**	**X**
P-18	ND, NE (c)*	NT
S-26	**S**	NT
PA-1 Pits	NA	**X**
Pit #17 at SWMU P-11	NA	**X**
Groundwater	NA	**X**
TANK FARM AREA		
TF (P-8, P-74, and P-75)	**X**	ND
Groundwater	NA	**X**
SLAG FILL AREA ZONE 1 (NO SWMUS)		
Groundwater	NA	**X**
SLAG FILL AREA ZONE 2		
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	**X**	**X**
SFA-2 (S-11 and S-22)	**S**	**X**
S-3	**S**	NT
S-8	**X**	ND
S-21	**X**	ND
S-24	ND, NE (c)	**X**
Groundwater	NA	**X**
SLAG FILL AREA ZONE 3		
S-10	**S**	NT
Groundwater	NA	**X**
SLAG FILL AREA ZONE 4		
S-14	**X**	**X**
S-15	**X**	ND
S-16	ND, NE (c)	NC
S-17	**S**	NT
S-18	**X**	ND
S-23	ND, NE (c)	**X**
Groundwater	NA	**X**
SLAG FILL AREA ZONE 5 (NO SWMUS)		
Groundwater	NA	**X**
OTHER AREAS		
S-19	**X**	ND
S-25	ND, NE (c)	NT
P-63	**X**	NV
P-73	**X**	NT

Table 8-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Current and Future Trespasser Scenario

Potential Sources	Exposure Pathway Description	
	Direct Contact (including airborne particle inhalation)	Inhalation of Ambient Vapors
Smokes Creek Area groundwater	NA	X
Site-wide groundwater	NA	Zonal
WATERCOURSES		
Lake Erie	NE	NA
Smokes Creek		
Blasdell Creek		
North & South Return Water Trenches		
Ship Canal		

Notes:

X	=	considered complete pathway to be evaluated.
S	=	considered complete pathway to be evaluated by using subsurface soil material data as surrogate for surface material data.
NA	=	not applicable.
NC	=	no COPCs present.
ND	=	no data collected.
NE	=	no exposure.
NE [c]	=	no exposure because SWMU is covered. *SWMU P-18 is covered with water.
NT	=	no toxicity criteria available for volatile subsurface COPC(s).
NV	=	no volatile COPCs present.
Zonal	=	zonal groundwater is assumed source of groundwater vapor exposure.

Table 8-2. Current and Future Trespasser Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Direct Contact Pathway

Non-Cancer $RBSL_{tres/dc}$:

T- 1

$$RBSL_{tres/dc}\left[\frac{mg}{kg-soil}\right]=\frac{THQ\times BW_{tres}\times AT_n}{EF_{tres}\times ED_{tres}\times\left(10^{-6}\ kg/mg\times\frac{1}{sRfD_o}\times\left(IR_{s/tres}\times RAF_o+SA_{tres}\times M\times RAF_d\right)+\left(\frac{1}{sRfD_i}\times IR_{a/tres}\times ET_{tres}\times\left(VF_{ss}+VF_p\right)\right)\right)}$$

Cancer $RBSL_{tres/dc}$:

T- 2

$$RBSL_{tres/dc}\left[\frac{mg}{kg-soil}\right]=\frac{TR\times BW_{tres}\times AT_c}{EF_{tres}\times ED_{tres}\times\left(10^{-6}\ kg/mg\times SF_o\times\left(IR_{s/tres}\times RAF_o+SA_{tres}\times M\times RAF_d\right)+\left(SF_i\times IR_{a/tres}\times ET_{tres}\times\left(VF_{ss}+VF_p\right)\right)\right)}$$

Chemical-specific volatilization factor for surficial material to ambient air (ASTM, 1995):

T- 3a

$$VF_{ss}\left[\frac{kg-soil}{m^3-air}\right]=\frac{2\times W_S\times\rho_s}{U_{air}\times\delta_{air}}\times\sqrt{\frac{D_s^{eff}\times H'}{\pi\times\left[\theta_{ws}+K_{oc}\times f_{oc}\times\rho_s+H'\times\theta_{as}\right]\times\tau}}\times 10^3\ \frac{cm^3-kg}{m^3-g}$$

or the mass-limited volatilization factor from surficial material to ambient air (ASTM, 1995):

T- 3b

$$VF_{ss}\left[\frac{kg-soil}{m^3-air}\right]=\frac{W_S\times\rho_s\times d}{U_{air}\times\delta_{air}\times\tau}\times 10^3\ \frac{cm^3-kg}{m^3-g}$$

(whichever is less)

Effective diffusion coefficient in soil based on vapor-phase concentration (ASTM, 1995):

T-3c

$$D_s^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\times\frac{\theta_{as}^{3.33}}{\theta_T^2}+D^{water}\times\frac{1}{H'}\times\frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Particle emission factor (ASTM, 1995):

T-3d

$$VF_p\left[\frac{kg-soil}{m^3-air}\right]=\frac{P_e\times W_S}{U_{air}\times\delta_{air}}\times 10^3\ \frac{cm^3-kg}{m^3-g}$$

RBSL for lead in soil (EPA, 1996):

W-4a

$$RBSL_{tres/Pb}\left[\frac{mg}{kg-soil}\right]=\frac{\left(PbB_{adult,central,goal}-PbB_{baseline}\right)\times AT}{BKSF\times IR_{S+D}\times AF_S\times EF_S}$$

where

W-4b

$$PbB_{adult,central,goal}=\frac{PbB_{fetal,0.95,goal}}{GSD^{1.645}\times R_{fetal/maternal}}$$

where:

Parameter Definition		Units
$RBSL_{tres/dc}$	RBSL for direct contact for trespasser	mg/kg
$RBSL_{tres/Pb}$	RBSL for lead in surface material for trespasser	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{tres}	Trespasser body weight	kg
d	Depth to subsurface source	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
ED_{tres}	Trespasser exposure duration	years
EF_{tres}	Trespasser exposure frequency	days/year
ET_{tres}	Trespasser exposure time	hours/day
f_{oc}	Mass fraction of organic carbon in soil	g-organic carbon/g-soil
H'	Dimensionless Henry's Law constant	L-water/L-air
$IR_{a/tres}$	Trespasser inhalation rate	m^3/day
$IR_{s/tres}$	Trespasser soil ingestion rate	mg/day
K_{oc}	Organic carbon/water partition coefficient	L-water/kg-organic carbon
M	Soil-to-skin adherence factor	cm^2/day
P_e	Areal total respirable particulate emission flux from SWMU	g/cm^2-sec
RAF_d	Dermal relative absorption factor	mg-absorbed/mg- applied
RAF_o	Oral relative absorption factor	mg-absorbed/mg-ingested
SA_{tres}	Skin surface area exposed	cm^2
SF_i	Inhalation slope factor	$(mg/kg-day)^{-1}$
SF_o	Oral slope factor	$(mg/kg-day)^{-1}$
$sRfD_i$	Subchronic inhalation reference dose	mg/kg-day
$sRfD_o$	Subchronic oral reference dose	mg/kg-day
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_p	Total respirable particle concentration from SWMU	kg-soil/m^3-air
VF_{ss} (chemical-specific)	Surface material to ambient air volatilization factor	kg-soil/m^3-air
VF_{ss} (site-specific)	Surface material to ambient air volatilization factor	kg-soil/m^3-air
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_s	Soil bulk density	g-soil/cm^3-soil
τ	Averaging time for surface emission vapor flux	sec
AF_S	Absorption fraction	unitless
AT	Averaging time for adult lead model	days/year
BKSF	Biokinetic slope factor	µg/dL/µg/day
EF_S	Exposure frequency for adult lead model	days/year
GSD	Geometric standard deviation of blood lead levels	µg/dL
IR_{S+D}	Soil and dust ingestion rate for adult lead model	g/day
$PbB_{adult,central,goal}$	Target blood lead level	µg/dL
$PbB_{baseline}$	Baseline blood lead level	µg/dL
$PbB_{fetal,0.95,goal}$	Target 95th percentile PbB in fetus	µg/dL
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	unitless

Table 8-3. Current and Future Trespasser Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Subsurface Soil Vapor Inhalation Pathway

Non-Cancer $RBC_{tres/air}$:

T-5

$$RBC_{tres/air}\left[\frac{\mu g}{m^3}\right] = \frac{THQ \times sRfD_i \times BW_{tres} \times AT_n}{ED_{tres} \times EF_{tres} \times IR_{a/tres} \times ET_{tres}} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBC_{tres/air}$

T-6

$$RBC_{tres/air}\left[\frac{\mu g}{m^3}\right] = \frac{TR \times BW_{tres} \times AT_c}{SF_i \times ED_{tres} \times EF_{tres} \times IR_{a/tres} \times ET_{tres}} \times 10^3 \frac{\mu g}{mg}$$

$RBSL_{tres/samb}$:

T-7a

$$RBSL_{tres/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{tres/air}}{VF_{samb}} \times 10^{-3} \frac{mg}{\mu g}$$

Chemical-specific volatilization factor from subsurface material to ambient air (ASTM, 1995):

T-7b

$$VF_{samb}\left[\frac{kg-soil}{m^3-air}\right] = \frac{H' \times \rho_s}{(\theta_{ws} + K_{oc} \times f_{oc} \times \rho_s + H' \times \theta_{as}) \times \left(1 + \frac{U_{air} \times \delta_{air} \times d}{D_s^{eff} \times W_S}\right)} \times 10^3 \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

where D_s^{eff} is as defined in Equation T-3c,
or
Site-specific volatilization factor from subsurface material to ambient air (GSI, 1995):

T-7c

$$VF_{samb}\left[\frac{kg-soil}{m^3-air}\right] = \frac{W_S \times \rho_s \times D}{U_{air} \times \delta_{air} \times \tau} \times 10^3 \frac{cm^3-kg}{m^3-g}$$

whichever is less.

where:

Parameter Definition		Units
$RBC_{tres/air}$	RBC for volatile COPC in air for trespasser	$\mu g/m^3$
$RBSL_{tres/samb}$	RBSL in subsurface material for vapor in ambient air for trespasser	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{tres}	Body weight	kg
d	Depth to subsurface source	cm
D	Thickness of affected subsurface material	cm
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
ED_{tres}	Trespasser exposure duration	years
EF_{tres}	Trespasser exposure frequency	days/year
ET_{tres}	Trespasser exposure time	hours/day
f_{oc}	Mass fraction of organic carbon in soil	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{samb} (site-specific)	Subsurface material to ambient air volatilization factor	$kg\text{-}soil/m^3\text{-}air$
VF_{samb} (chemical -specific)	Subsurface material to ambient air volatilization factor	$kg\text{-}soil/m^3\text{-}air$

Parameter Definition		Units
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_s	Soil bulk density	g-soil/cm^3-soil
τ	Averaging time for surface emission vapor flux	sec

Table 8-4. Current and Future Trespasser Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Groundwater Vapor Inhalation Pathway

$RBC_{tres/air}$ values calculated per Equations T-5 and T-6

$RBSL_{tres/wamb}$:

T-8a

$$RBSL_{tres/wamb}\left[\frac{\mu g}{L}\right] = \frac{RBC_{tres/air}}{VF_{wamb}}$$

Volatilization factor from groundwater to ambient air (ASTM, 1995):

T-8b

$$VF_{wamb}\left[\frac{L-water}{m^3-air}\right] = \frac{H'}{\left(1+\frac{U_{air}\times\delta_{air}\times L_{GW}}{D_{ws}^{eff}\times W_{GW}}\right)} \times 10^3\ \frac{L}{m^3}$$

Effective diffusion coefficient between groundwater and the SWMU surface (ASTM, 1995):

T-8c

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = \left(h_{cap}+h_v\right)\times\left(\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right)^{-1}$$

where D_s^{eff} is as defined in Equation T-3c.

Effective diffusion coefficient through the capillary fringe (ASTM, 1995):

T-8d

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\times\frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{water}\times\frac{1}{H'}\times\frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

Parameter Definition		Units
$RBC_{tres/air}$	RBC for volatile COPC in air for trespasser	$\mu g/m^3$
$RBSL_{tres/wcap}$	RBSL in groundwater for vapor in ambient air for trespasser	$\mu g/L$
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
D_{cap}^{eff}	Effective diffusion coefficient in capillary fringe region	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
h_{cap}	Thickness of capillary fringe	cm
h_v	Thickness of vadose zone	cm
L_{GW}	Depth to groundwater ($h_{cap}+h_v$)	cm
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{wamb}	Groundwater to ambient air volatilization factor	L-water/m^3-air
W_{GW}	Width of groundwater source	cm
δ_{air}	Mixing zone height	cm
θ_{acap}	Volumetric air content in capillary fringe soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{wcap}	Volumetric water content in capillary fringe soils	cm^3-water/cm^3-soil

Table 8-5. Current and Future Trespasser Scenario: Equations Used to Calculate Risk-Based Screening Levels for the Ambient Pit Vapor Inhalation Pathway

$RBC_{tres/air}$ values calculated per Equations T-5 and T-6

$RBSL_{tres/pit}$:

T-9a

$$RBSL_{tres/pit}\left[\frac{\mu g}{L}\right] = \frac{RBC_{tres/air}}{VF_{tres/pit}} \times 10^{-3}\frac{m^3}{L}$$

Volatilization rate from the pits:

T-9b

$$VF_{tres/pit}\ [\text{dimensionless}] = \frac{k_L}{1+\frac{k_L}{k_G \times H'}} \times \frac{A}{U_{air} \times W \times \delta_{air}} \times \frac{10^6\,cm^3}{m^3}$$

Gas-phase mass transfer coefficient:

T-9c

$$k_G\left[\frac{m}{sec}\right] = 4.82 \times 10^{-3} \times U_{10}^{0.78} \times Sc_G^{-0.67} \times de^{-0.11} \quad \text{where}$$

Effective diameter of impoundment:

T-9d

$$de[m] = \sqrt{\frac{4 \times A}{\pi}}$$

Schmidt number on the gas side:

T-9e

$$Sc_G = \frac{\mu_G}{\rho_G \times D^{air}}$$

Liquid-phase transfer coefficient:

T-9f

$$k_L\left[\frac{m}{sec}\right] = 10^{-6} + 144 \times 10^{-4} \times U^{*2.2} \times Sc_L^{-0.5} \quad \text{where}$$

Schmidt number on the liquid side:

T-9g

$$Sc_L = \frac{\mu_L}{\rho_L \times D^{water}}$$

Friction velocity:

T-9h

$$U^*\left[\frac{m}{sec}\right] = 0.1 \times U_{10} \times \sqrt{6.1 + 0.63 \times U_{10}}$$

where:

Parameter	Definition	Units
$RBC_{tres/air}$	RBC for volatile COPC in air for trespasser	µg/m³
$RBSL_{tres/pit}$	RBSL in pit water for vapor in ambient air for trespasser	µg/L
A	Liquid area (pit)	m²
D^{air}	Molecular diffusion coefficient in air	cm²/sec
D^{water}	Molecular diffusion coefficient in water	cm²/sec
de	Effective diameter of impoundment (pit)	m
H'	Dimensionless Henry's Law constant	L-water/L-air
k_G	Gas-phase mass transfer coefficient	m/sec
k_L	Liquid-phase mass transfer coefficient	m/sec
Sc_G	Schmidt number on the gas side	unitless
Sc_L	Schmidt number on the liquid side	unitless
U^*	Friction velocity	m/sec
U_{10}	Wind speed at 10 meters above liquid surface (pit)	m/sec
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec

Parameter Definition		Units
$VF_{tres/pit}$	Groundwater to indoor air volatilization factor	L-water/m^3-air
W	Width of pit	cm
δ_{air}	Mixing zone height	cm
μ_G	Viscosity of air	g/cm-sec
μ_L	Viscosity of water	g/cm-sec
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 8-6. Current and Future Trespasser Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
$PbB_{fetal,0.95,goal}$	Target 95th percentile PbB in fetus	10	µg/dL	Acceptable blood lead level for children (EPA, 1994)	
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	0.9	unitless	Recommended by EPA, 1996b	
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
$sRfD_i$	Subchronic inhalation reference dose	Chemical-specific	mg/kg-day	See Appendix B	
$sRfD_o$	Subchronic oral reference dose	Chemical-specific	mg/kg-day	See Appendix B	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
SF_o	Oral slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
RAF_d	Dermal relative absorption factor	1.0	mg-absorbed/mg applied	Default	
RAF_o	Oral relative absorption factor	1.0	mg-absorbed/mg-ingested	Default	

Table 8-6. Current and Future Trespasser Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value.
AT_n	Averaging time for non-carcinogenic effects	1,460	days	ED x 365 days/year	
BW_{tres}	Body weight	66	kg	EPA, 1997	Mean body weight of males aged 15 to 18
ED_{tres}	Exposure duration	4	years	Professional judgment	Number of years including ages 15 through 18
EF_{tres}	Exposure frequency	6	days/year	Professional judgment	Estimate based on average of 1 occurrence/month from April through September.
ET_{tres}	Exposure time	2	hours/day	Professional judgment	
$IR_{a/tres}$	Inhalation rate	1.0	m^3/hour	EPA, 1997	Recommended inhalation rate for adults and children engaged in light activities
$IR_{s/tres}$	Soil ingestion rate	50	mg/day	EPA, 1997	Recommended adult soil intake rate
SA_{tres} x M	Soil-to-skin adherence factor	187.2	mg/day	See Table 8-7	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
ADULT LEAD MODEL PARAMETERS (EPA, 1996b)					
AF_S	Absorption fraction	0.12	unitless	Recommended by EPA, 1996b	
AT	Averaging time for adult lead model	365	days/year	Recommended by EPA, 1996b	
BKSF	Biokinetic slope factor	0.4	µg/dL/µg/day	Recommended by EPA, 1996b	
EF_S	Exposure frequency for adult lead model[1]	50	days/year	Recommended by EPA, 1996b	
GSD	Geometric standard deviation of blood lead levels	1.8	µg/dL	Recommended by EPA, 1996b	
IR_{S+D}	Soil and dust ingestion rate for adult lead model	0.05	g/day	Recommended by EPA, 1996b	
$PbB_{adult,central,goal}$	Target blood lead level	4.2	µg/dL	Calculated per Equation T-4b	
$PbB_{baseline}$	Baseline blood lead level	2.0	µg/dL	Recommended by EPA, 1996b	

[1] Although the expected exposure frequency for the trespasser scenario is less than that required to achieve steady-state blood lead concentrations (EPA, 1996b), the exposure frequency will be assumed to be 50 days/year (recommended by EPA for a commercial worker scenario) for purposes of lead exposure modeling in order to provide a conservative means of identifying potential risks associated with this element in Tier 1.

~~7.0~~9.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE FUTURE MARINA WORKER SCENARIO

If Zone 1 of the Lackawanna site is redeveloped for use as a marina, future on-site marina workers may contact site-related COPCs via inhalation of airborne particles from uncovered SWMUs, and ambient vapors emanating from subsurface material and groundwater as well as the Coke Oven Area pits. Because there are no SWMUs in Zone 1 for which further assessment is required, direct contact with surficial material is not considered a potentially complete pathway for this scenario. Potentially complete pathways for the marina worker scenario are depicted in Figure 2-1 and Table 2-1, and potential source areas where these pathways could result in marina worker exposure are summarized in Table ~~7~~-9-1.

Equations that will be used to calculate Tier 1 RBSLs for the various pathways are presented in the sections below and Tables ~~7~~-9-2 to ~~7~~-9-6, and exposure parameter values to be used in calculating Tier 1 RBSLs for the marina worker scenario are presented in Table ~~7~~-9-7. Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

9.1 INHALATION OF AIRBORNE PARTICLES FROM UNCOVERED SWMUS

COPCs associated with airborne particles from exposed material in uncovered SWMUs could be inhaled by marina workers in Zone 1. SWMUs where surficial material is exposed to the atmosphere are the following:

- Coke Oven area: SWMU Groups PA-1 (P-1 to P-5), PA-2 (P-6 and P-7) and PA-4 (P-11 and P-12), and SWMU S-26;
- Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22), and SWMUs S-3, S-8, and S-21;
- Slag Fill Area Zone 3: SWMU S-10;
- Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, and S-18;
- Other areas: SWMUs S-19, P-63, and P-73.

Subsurface results will be used as a surrogate for surficial data for the following uncovered SWMUs where no surface samples were taken: SWMU Group SFA-2, and S-26, S-3, S-10, and S-17. This is highly conservative with respect to VOCs (but not non-volatile COPCs), which would be expected to dissipate rapidly if exposed to the atmosphere.

In evaluating this pathway in Tier 1, receptors will be conservatively assumed to be inhaling particles within the source area. Dispersion modeling will be used in Tier 2 for any SWMUs that exceed target criteria in Tier 1. Equations that will be used to develop $RBSL_{mw/pi}$ values for the particle inhalation pathway are presented in Table 9-2. Exposure parameter values are presented in Tables 9-7.

~~7.1~~9.2 INHALATION OF VAPORS FROM SUBSURFACE SWMU MATERIAL

As shown in ~~Figure 2-1 and~~ Table ~~7-~~9-1, marina workers could be exposed to vapors emanating from subsurface material in the following SWMUs:

- Coke Oven Area: SWMU Groups PA-3 (P-9 and P-10) and PA-4 (P-11 to P-12);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S- 27) and SFA-2 (S-11 and S-22) and SWMU S-24; and
- Slag Fill Area Zone 4: SWMUs S-14 and S-23.

~~• Coke Oven Area: SWMU Group PA-3 (P-9 and P-10);~~

~~• Slag Fill Area Zone 2: SWMU Group SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27), SFA-2 (S-11 and S-22) and SWMU S-24; and~~

~~• Slag Fill Area Zone 4: SWMUs S-14 and S-23.~~

~~RBSLs for evolution of vapors from subsurface material at each SWMU and atmospheric dispersion to Zone 1 will be back-calculated using a model developed by Farmer *et al.* (1978, 1980) (Table 7-32) from corresponding $RBC_{mw/air}$ values (Equations MW-42 and MW-53, Table 7-43). The Farmer *et al.* model (1978, 1980) estimates the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil.~~

The RBSLs for evolution of vapors from subsurface SWMU material ($RBSL_{mw/samb}$) will be back-calculated from corresponding $RBC_{mw/air}$ values using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Tables 9-3 and 9-4). The model is used to predict the movement and steady-state vapor emission rates assuming there are no losses through volatilization, leaching, or biodegradation. Media containing the representative COPC concentrations is conservatively assumed to be continuous from 100 cm below the ground surface (the assumed depth to source) throughout the full extent of the soil column (*i.e.*, to groundwater).

Airborne concentrations of volatile COPCs in Zone 1 will be related to SWMU-specific emissions based on a unit concentration (1 mg/kg) in soil using EPA's air dispersion

model ISCST version 3 with meteorological data collected at an on-site monitoring station in 1991. These data are presented in Appendix A. ~~-~~This model uses steady-state Gaussian plume dispersion curves to model continuous release from a given source area using sector-averaging and statistical wind summaries. Emissions from each source will be modeled using a unit emission rate (ER_{unit}) of 1 g/sec for all sources except for SWMU S-24, which will be split into two source areas (ER_{unit} = 2 g/sec) in order to best fit its actual shape. The windrose of the meteorological data indicates that the dominant wind direction is toward the northeast. ~~Marina workers will be located in Zone 1.~~

Equations that will be used to develop RBSLs for the subsurface vapor inhalation pathway are presented in Table ~~7-9-43~~. Exposure parameter values are presented in Table ~~7-~~9-7. RBSLs for evolution of vapors from subsurface material at each SWMU and atmospheric dispersion to Zone 1 will be back-calculated for each volatile COPC from corresponding $RBC_{mw/air}$ values (Equations MW-~~4~~2 and MW-~~3~~5, Table ~~7-9-34~~). Using the ISCST3-predicted air concentrations, a screening level emission rate will be estimated from each SWMU using a simple linear relationship (Equation MW-~~4~~6, Table ~~7-9-43~~). The soil screening level ($RBSL_{mw/samb}$) will be estimated by using the linear relationship between the predicted chemical-specific emission rate ($Q_{chemical}$), screening level emission rate ($ER_{screening}$), and the unit soil concentration (S_{unit}) initially used in Farmer's model (Equation MW-~~7~~5, Table ~~7-9-43~~). By combining Equations MW-~~6~~4 and MW-~~7~~5, RBSLs for marina workers will be estimated by calculating the ratio of the ISCST3-predicted air concentration of each volatile COPC to the chemical-specific emission rates using Farmer's model (Equation MW-~~9a~~6, Table ~~7-9-43~~). Substituting the equation for Farmer's model into Equation MW-~~9a~~6, RBSLs for marina worker exposure to vapors from subsurface SWMU material will be estimated according to Equation MW-~~7-~~9b (Table ~~7-9-43~~).

~~7.2~~9.3 INHALATION OF VAPORS FROM GROUNDWATER

~~As shown in Table 7-1 and Figure 2-1, marina workers in Zone 1 could be exposed to vapors emanating from groundwater in Zone 1 and elsewhere on the site. Equations that will be used to develop RBSLs for the groundwater vapor inhalation pathway in Zone 1 are presented in Table 7-54. Exposure parameter values are presented in Table 7-7.~~

~~RBSLs for evolution of vapors from site-wide groundwater and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding $RBC_{mw/air}$ values using the Farmer's model described above. Emissions from the site-wide ground water plume will be modeled using three source areas, with ER_{unit} = 3 g/sec. An average ground water depth of 35 feet is assumed. A corresponding groundwater $RBSL_{mw/wamb}$ will be estimated by back-calculating from $RBC_{mw/air}$ values (Equations MW-2 and MW-3, Table 7-3), as shown in Table 7-5. Exposure parameter values are presented in Table 7-7.~~

As shown in Table 9-1, future marina workers could be exposed to ambient vapors emanating from groundwater in SFA Zone 1. RBSLs for ambient COPC vapors derived

from subsurface SWMU material in this area will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs will be back-calculated for each volatile COPC from corresponding $RBC_{mw/air}$ values (Equations MW-4 and MW-5), as shown in Table 9-5. Exposure parameter values are presented in Table 9-7.

~~7.3~~9.4 INHALATION OF VAPORS FROM PITS

As shown in Table ~~7-~~9-1, marina workers in Zone 1 could be exposed to ambient vapors emanating from standing water in pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #17 at SWMU P-11). RBSLs for evolution of vapors from the pits and atmospheric dispersion to Zone 1 will be back-calculated for each volatile COPC from corresponding $RBC_{mw/air}$ values using the relation presented in Table 9-6. Exposure parameter values are presented in Table 9-7. The chemical-specific volatilization rate ($VF_{mw/pit}$) from the quench pits will be estimated using the stagnant film model presented in EPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models* (1989a) (Table 9-6, Equation MW-10a).

~~Equations that will be used to develop RBSLs for the pit vapor inhalation pathway are presented in Table 7-6. Exposure parameter values are presented in Table 7-7.~~

Table 9-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Marina Worker Scenario

Potential Sources	Exposure Pathway Description	
	Inhalation of Airborne Particles	Inhalation of Ambient Vapors
COKE OVEN AREA		
PA-1 (P-1, P-2, P-3, P-4, and P-5)	X	NT
PA-2 (P-6 and P-7)	X	ND
PA-3 (P-9 and P-10)	ND, NE (c)	X
PA-4 (P-11 and P-12)	X	X
P-18	ND, NE (c)*	NT
S-26	S	NT
PA-1 Pits	NA	X
Pit #17 at P-11	NA	X
Groundwater	NA	Zone 1
TANK FARM AREA		
TF (P-8, P-74, and P-75)	X	ND
Groundwater	NA	Zone 1
SLAG FILL AREA ZONE 1 (NO SWMUS)		
Groundwater	NA	X
SLAG FILL AREA ZONE 2		
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	X	X
SFA-2 (S-11 and S-22)	S	X
S-3	S	NT
S-8	X	ND
S-21	X	ND
S-24	ND, NE (c)	X
Groundwater	NA	Zone 1
SLAG FILL AREA ZONE 3		
S-10	S	NT
Groundwater	NA	Zone 1
SLAG FILL AREA ZONE 4		
S-14	X	X
S-15	X	ND
S-16	ND, NE (c)	NC
S-17	S	NT
S-18	X	ND
S-23	ND, NE (c)	X
Groundwater	NA	Zone 1
SLAG FILL AREA ZONE 5 (NO SWMUS)		
Groundwater	NA	Zone 1
OTHER AREAS		
S-19	X	ND
S-25	ND, NE (c)	NT
P-63	X	NV
P-73	X	NT

Table 9-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Marina Worker Scenario

Potential Sources	Exposure Pathway Description	
	Inhalation of Airborne Particles	Inhalation of Ambient Vapors
Smokes Creek Area groundwater	NA	Zone 1
Site-wide groundwater	NA	Zone 1
WATERCOURSES		
Lake Erie	NA	
Smokes Creek		
Blasdell Creek		
North & South Return Water Trenches		
Ship Canal		

Notes:

X	=	considered complete pathway to be evaluated.
S	=	considered complete pathway to be evaluated by using subsurface soil material data as surrogate for surface material data.
NA	=	not applicable.
NC	=	no COPCs present.
ND	=	no data collected.
NE	=	no exposure.
NE [c]	=	no exposure because SWMU is covered. *SWMU P-18 is covered with water.
NT	=	no toxicity criteria available for volatile subsurface COPC(s).
NV	=	no volatile COPCs present.
Zone 1	=	Zone 1 groundwater is assumed source of groundwater vapor exposure.

Table 9-2. Future Marina Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Airborne Particle Inhalation Pathway

Non-Cancer $RBSL_{mw/pi}$:

MW-1

$$RBSL_{mw/pi}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{THQ \times BW_{mw} \times AT_n \times RfD_i}{ED_{mw} \times EF_{mw} \times \left(10^{-6}\ kg/mg \times IR_{a/mw} \times VF_p\right)}$$

Cancer $RBSL_{mw/pi}$:

MW-2a

$$RBSL_{mw/pi}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{TR \times BW_{mw} \times AT_c}{ED_{mw} \times EF_{mw} \times SF_i \times \left(10^{-6}\ kg/mg \times IR_{a/mw} \times VF_p\right)}$$

where the particle emission factor VF_p (ASTM, 1995) =

MW-2b

$$VF_p\left[\frac{kg\text{-}soil}{m^3 - air}\right] = \frac{P_e \times W_S}{U_{air} \times \delta_{air}} \times 10^3\ \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

where:

Parameter	Definition	Units
$RBSL_{mw/pi}$	RBSL for inhalation of airborne particles for marina worker	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{mw}	Marina worker body weight	kg
ED_{mw}	Marina worker exposure duration	years
EF_{mw}	Marina worker exposure frequency	days/year
$IR_{a/mw}$	Marina worker inhalation rate	m^3/day
P_e	Areal total respirable particulate emission flux from SWMU	g/cm^2-sec
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
RfD_i	Inhalation reference dose	mg/kg-day
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_p	Total respirable particle concentration from SWMU	kg-soil/m^3-air
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm

Table 9-3. Farmer's Emission Model

Farmer's emission rate equation:

MW-3a

$$Q_{chemical}\left[\frac{g}{sec}\right] = D^{air} \times \frac{C_T}{R_g} \times \frac{\theta_{as}^{3.33}}{\theta_T^2} \times \frac{1}{L} \times A \times 10^{-3} \frac{g}{mg}$$

where the total solute concentration is:

MW-3b

$$C_T\left[\frac{mg}{cm^3}\right] = S_{unit} \times \rho_s \times \left(1 + \frac{\theta_{ws} \times \rho_L}{\rho_s}\right) \times 10^{-3} \frac{kg}{g}$$

and the gas partition coefficient is:

MW-3c

$$R_g\left[\frac{cm^3}{cm^3}\right] = \theta_{as} + \frac{\theta_{ws} + \rho_s \times K_{oc} \times f_{oc}}{H'}$$

where:

Parameter	Definition	Units
A	Area of source	m^2
C_T	Total solute concentration	mg/cm^3
d	Depth to subsurface source	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
f_{oc}	Organic carbon content	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
$Q_{chemical}$	Emission rate	g/sec
R_g	Gas partition coefficient	cm^3/cm^3
S_{unit}	Unit concentration of COPC in soil	mg/kg
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 9-4. Future Marina Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Subsurface Soil Vapor Inhalation Pathway

Non-Cancer $RBC_{mw/air}$:

MW-4

$$RBC_{mw/air}\left[\frac{\mu g}{m^3}\right] = \frac{THQ \times RfD_i \times BW_{mw} \times AT_n}{ED_{mw} \times EF_{mw} \times IR_{a/mw}} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBC_{mw/air}$:

MW-5

$$RBC_{mw/air}\left[\frac{\mu g}{m^3}\right] = \frac{TR \times BW_{mw} \times AT_c}{SF_i \times ED_{mw} \times EF_{mw} \times IR_{a/mw}} \times 10^3 \frac{\mu g}{mg}$$

Screening-level emission rate:

MW-6

$$\frac{RBC_{mw/air}\ (\mu g/m^3)}{ISCST3_{air}\ (\mu g/m^3)} = \frac{ER_{screening}\ (g/sec)}{ER_{unit}\ (1\ g/sec)}$$

MW-7

$$\frac{ER_{screening}\ (g/sec)}{Q_{chemical}\ (g/sec)} = \frac{RBSL_{mw/samb}\ (mg/kg\text{-}soil)}{S_{unit}\ (1\ mg/kg)}$$

$RBSL_{mw/samb}$:

MW-8a

$$RBSL_{mw/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{mw/air} \times ER_{unit} \times S_{unit}}{Q_{chemical} \times ISCT3_{air}}$$

MW-8b

$$RBSL_{mw/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{mw/air} \times 10^6\ mg/kg}{VF_{air}}$$

where the volatilization factor from subsurface material to ambient air is:

MW-8c

$$VF_{air}\left[\frac{\mu g\text{-}soil}{m^3-air}\right] = \frac{ISCST3_{air} \times D^{air} \times \rho_s \times \left(1 + \frac{\theta_{ws} \times \rho_L}{\rho_s}\right) \times \theta_{as}^{3.33} \times A \times H'}{\theta_T^2 \times d \times (\theta_{as} \times H' + \theta_{ws} + \rho_s \times K_{oc} \times f_{oc}) \times ER_{unit}} \times 10^4 \frac{cm^2}{m^2}$$

where:

Parameter Definition		Units
$RBC_{mw/air}$	RBC for volatile COPC in air for marina worker	$\mu g/m^3$
$RBSL_{mw/samb}$	RBSL in subsurface material for vapor in ambient air for marina worker	mg/kg
A	Area of subsurface source	m^2
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
BW_{mw}	Marina worker body weight	kg
d	Depth to subsurface source	cm

Parameter	Definition	Units
ED_{mw}	Marina worker exposure duration	years
EF_{mw}	Marina worker exposure frequency	days/year
$ER_{screening}$	Screening-level emission rate	g/sec
ER_{unit}	Unit emission rate	g/sec
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
f_{oc}	Organic carbon content	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
$IR_{a/mw}$	Marina worker inhalation rate	m^3/day
$ISCT3_{air}$	ISCT3-modeled concentration of COPC in air	g/m^3
$Q_{chemical}$	Chemical-specific emission rate	g/sec
RfD_i	Chronic inhalation reference dose	mg/kg-day
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
S_{unit}	Unit concentration of COPC in soil	mg/kg
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
VF_{air}	Subsurface to ambient air volatilization factor	$\mu g/m^3$
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 9-5. Future Marina Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the SFA Zone 1 Ambient Groundwater Vapor Inhalation Pathway

$RBC_{mw/air}$ values calculated per Equations MW-4 and MW-5

$RBSL_{mw/wamb}$:

MW- 9a

$$RBSL_{mw/wamb}\left[\frac{\mu g}{L}\right] = \frac{RBC_{mw/air}}{VF_{wamb}}$$

Volatilization factor from groundwater to ambient air (ASTM, 1995):

MW-9b

$$VF_{wamb}\left[\frac{L-water}{m^3-air}\right] = \frac{H'}{\left(1+\frac{U_{air}\times\delta_{air}\times L_{GW}}{D_{ws}^{eff}\times W_{GW}}\right)}\times 10^3\ \frac{L}{m^3}$$

Effective diffusion coefficient between groundwater and the SWMU surface (ASTM, 1995):

MW-9c

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = \left(h_{cap}+h_v\right)\times\left(\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right)^{-1}$$

Effective diffusion coefficient in soil based on vapor-phase concentration (ASTM, 1995), is:

MW-9d

$$D_s^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\times\frac{\theta_{as}^{3.33}}{\theta_T^2}+D^{water}\times\frac{1}{H'}\times\frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Effective diffusion coefficient through the capillary fringe (ASTM, 1995):

MW-9e

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\times\frac{\theta_{acap}^{3.33}}{\theta_T^2}+D^{water}\times\frac{1}{H'}\times\frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

Parameter Definition		Units
$RBC_{mw/air}$	RBC for volatile COPC in air for marina worker	$\mu g/m^3$
$RBSL_{mw/wamb}$	RBSL in groundwater for vapor in ambient air for marina worker	$\mu g/L$
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
D_{cap}^{eff}	Effective diffusion coefficient in capillary fringe region	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
h_{cap}	Thickness of capillary fringe	cm
h_v	Thickness of vadose zone	cm
L_{GW}	Depth to groundwater ($h_{cap} + h_v$)	cm
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{wamb}	Volatilization factor from groundwater to ambient air	$kg\text{-soil}/m^3\text{-air}$
W_{GW}	Width of groundwater source	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	$cm^3\text{-air}/cm^3\text{-soil}$
θ_T	Total soil porosity	$cm^3/cm^3\text{-soil}$
θ_{ws}	Volumetric water content in vadose zone soils	$cm^3\text{-water}/cm^3\text{-soil}$

Table 9-6. Future Marina Worker Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Pit Vapor Inhalation Pathway

$RBC_{mw/air}$ values calculated per Equations MW-4 and MW-5

$RBSL_{mw/pit}$:

MW-10a

$$RBSL_{mw/pit}\left[\frac{\mu g}{L}\right] = \frac{RBC_{mw/air}}{VF_{mw/pit}} \times 10^3 \frac{\mu g - m^3}{g - L}$$

Volatilization rate from the pits:

MW-10b

$$VF_{mw/pit}\left[\frac{\mu g}{g}\right] = ISCST3_{air} \times \frac{k_L}{1 + \frac{k_L}{k_G \times H'}} \times A \times \frac{1}{ER_{unit}}$$

Gas-phase mass transfer coefficient:

MW-10c

$$k_G\left[\frac{m}{sec}\right] = 4.82 \times 10^{-3} \times U_{10}^{0.78} \times Sc_G^{-0.67} \times de^{-0.11} \quad \text{where}$$

Effective diameter of impoundment:

MW-10d

$$de[m] = \sqrt{\frac{4 \times A}{\pi}}$$

Schmidt number on the gas side:

MW-10e

$$Sc_G = \frac{\mu_G}{\rho_G \times D^{air}}$$

Liquid-phase transfer coefficient:

MW-10f

$$k_L\left[\frac{m}{sec}\right] = 10^{-6} + 144 \times 10^{-4} \times U^{*2.2} \times Sc_L^{-0.5} \quad \text{where}$$

Schmidt number on the liquid side:

MW-10g

$$Sc_L = \frac{\mu_L}{\rho_L \times D^{wat}}$$

Friction velocity:

MW-10h

$$U^*\left[\frac{m}{sec}\right] = 0.01 \times U_{10} \times \sqrt{6.1 + 0.63 \times U_{10}}$$

where:

Parameter Definition		Units
$RBC_{mw/air}$	RBC for volatile COPC in air for marina worker	$\mu g/m^3$
$RBSL_{mw/pit}$	RBSL in pit water for vapor in ambient air for marina worker	$\mu g/L$
A	Liquid area (pit)	m^2
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
de	Effective diameter of impoundment (pit)	m
ER_{unit}	Unit emission rate	g/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
$ISCT3_{air}$	ISCT3-modeled concentration of COPC in air	g/m^3
k_G	Gas-phase mass transfer coefficient	m/sec
k_L	Liquid-phase mass transfer coefficient	m/sec
Sc_G	Schmidt number on the gas side	unitless
Sc_L	Schmidt number on the liquid side	unitless
U^*	Friction velocity	m/sec
U_{10}	Wind speed at 10 meters above liquid surface (pit)	m/sec
VF_{pit}	Volatilization rate from pit	$\mu g/g$
μ_G	Viscosity of air	g/cm-sec
μ_L	Viscosity of water	g/cm-sec
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	$g\text{-soil}/cm^3\text{-soil}$

Table 9-7. Future Marina Worker Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	2,409	days	EPA, 1989b	ED x 365 days/year
BW_{mw}	Body weight	71.8	kg	EPA, 1997	Recommended value
ED_{mw}	Exposure duration	6.6	years	EPA, 1997	Recommended value
EF_{mw}	Exposure frequency	195	days/year	Professional judgment	Assumes five days per week in spring, summer, and fall
$IR_{a/mw}$	Inhalation rate	13.25	m^3/day	EPA, 1997	Mean of recommended long-term inhalation rate for male and female adults
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
RfD_I	Chronic inhalation reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_I	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	

~~8.0~~10.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE FUTURE GREENWAY USER SCENARIO

Greenway users are assumed to be adults and children who reside in the Lackawanna area and would regularly engage in active recreational activities in a proposed greenway area in Zone 1 between Route 5 and the Lake. The exact location of the greenway has yet to be determined. Because the only ~~are no~~ SWMUs in this area has a no further assessment designation, it is assumed for the risk assessment that no direct contact with SWMU material could occur. However, greenway users could be exposed to airborne particles from uncovered SWMUs, and ambient vapors emanating from subsurface material in SWMUs ~~and site-wide~~as well as Zone 1 groundwater and the Coke Oven Area Pits. Potentially complete pathways for the greenway user scenario are summarized in Figure 2-1, and potential source areas where these pathways could result in exposure to this population are summarized in Table ~~8-~~10-1.

Equations that will be used to calculate RBSLs for the various pathways are presented in the sections below and in Tables ~~8-~~10-2 to ~~8-~~10-5. Exposure parameter values to be used in calculating Tier 1 RBSLs for the greenway user scenario are presented in Table ~~8-~~10-6. Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

10.1 INHALATION OF AIRBORNE PARTICLES FROM UNCOVERED SMWUS

COPCs associated with airborne particles from exposed material in uncovered SWMUs could be inhaled by greenway users in Zone 1. SWMUs where surficial material is exposed to the atmosphere are the following:

- Coke Oven area: SWMU Groups PA-1 (P-1 to P-5), PA-2 (P-6 and P-7) and PA-4 (P-11 and P-12), and SWMU S-26;
- Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22), S-3, S-8, and S-21;
- Slag Fill Area Zone 3: SWMU S-10;
- Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, and S-18;
- Other areas: SWMUs S-19, P-63, and P-73.

Subsurface results will be used as a surrogate for surficial data for the following uncovered SWMUs where no surface samples were taken: SWMU Group SFA-2, and SWMUs S-26, S-3, S-10, and S-17. This is highly conservative with respect to VOCs

(but not non-volatile COPCs), which would be expected to dissipate rapidly if exposed to the atmosphere.

In evaluating this pathway in Tier 1, receptors will be conservatively assumed to be inhaling particles within the source area. Dispersion modeling will be used in Tier 2 for any SWMUs that exceed target criteria in Tier 1. Equations that will be used to develop $RBSL_{g/soil}$ values for the particle inhalation pathway are presented in Table 10-2. Exposure parameter values are presented in Table 10-7.

~~8.1~~10.2 INHALATION OF VAPORS FROM SUBSURFACE SWMU MATERIAL

As shown in Table ~~8-~~10-1, greenway users could be exposed to vapors emanating from subsurface material in the following SWMUs:

- Coke Oven Area: SWMU Groups PA-3 (P-9 and P-10) and PA-4 (P-11 to P-12);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S- 27) and SFA-2 (S-11 and S-22) and SWMU S-24; and
- Slag Fill Area Zone 4: SWMUs S-14 and S-23.

~~- Coke Oven Area: SWMU Group PA-3 (P-9 and P-10);~~

~~- Slag Fill Area Zone 2: SWMU Group SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27), SFA-2 (S-11 and S-22) and SWMU S-24; and~~

~~- Slag Fill Area Zone 4: SWMUs S-14 and S-23.~~

The RBSLs for evolution of vapors from subsurface SWMU material ($RBSL_{g/samb}$) will be back-calculated from corresponding $RBC_{g/air}$ values using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Tables 10-3 and 10-4). The model is used to predict the movement and steady-state vapor emission rates assuming there are no losses through volatilization, leaching, or biodegradation. Media containing the representative COPC concentrations is conservatively assumed to be continuous from 100 cm below the ground surface (the assumed depth to source) throughout the full extent of the soil column (*i.e.*, to groundwater).

~~The RBSLs for on-site subsurface SWMU material ($RBSL_{g/sub}$) will be back-calculated using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Table 8-32). The model is used to predict the movement and steady-state vapor emission rates assuming there are no losses through~~

~~volatilization, leaching, or biodegradation. Contamination is assumed to be continuous from 100 cm below the ground surface throughout the full extent of the soil column.~~

Airborne concentrations of volatile COPCs in the greenway area (assumed to be in Zone 1) will be related to SWMU-specific emissions based on a unit concentration (1 mg/kg) in soil using EPA's air dispersion model ISCST ~~Model~~ version 3 with meteorological data collected at an on-site monitoring station in Lackawanna, New York in 1991. These data are presented in Appendix A. ~~-~~This model uses steady-state Gaussian plume dispersion curves to model continuous release from a given source area using sector-averaging and statistical wind summaries. Emissions from each source will be modeled using a unit emission rate (ER_{unit}) of 1 g/sec for all sources except for SWMU S-24, which will be split into two source areas (ER_{unit} = 2 g/sec) in order to best fit its actual shape. The windrose of the meteorological data indicates that the dominant wind direction is towards the northeast. ~~Greenway users will be located in Zone 1.~~

Equations used to develop RBSLs for the subsurface vapor inhalation pathway are presented in Table ~~8-~~10-~~34~~. Exposure parameter values are presented in Table ~~8-~~10-~~76~~. RBSLs for evolution of vapors from subsurface material at each SWMU and atmospheric dispersion to the greenway area will be back-calculated for each volatile COPC from corresponding $RBC_{g/air}$ values (Equations G-~~42~~ and G-~~53~~, Table ~~8-~~10-~~43~~). Using the ISCST3-predicted air concentrations, a screening level emission rate will be estimated from each SWMU using a simple linear relationship (Equation G-~~6~~4, Table 8-10-4). The soil screening level ($RBSL_{g/samb}$) will be estimated by using the linear relationship between the predicted chemical-specific emission rate ($Q_{chemical}$), screening level emission rate ($ER_{screening}$), and the unit soil concentration (S_{unit}) initially used in Farmer's model (Equation G-~~75~~, Table ~~8-~~10-~~43~~). Combining Equations G-4-~~6~~ and G-~~57~~, RBSLs for greenway users will be estimated by calculating the ratio of the ISCST3-predicted air concentration of each volatile COPC to the chemical-specific emission rates using Farmer's model (Equation G-~~68~~a, Table ~~8-~~10-~~34~~). Substituting the equation for Farmer's model into Equation G-~~68~~a, RBSLs for greenway users' exposure to vapors from subsurface SWMU material will be estimated according to Equation G-~~7-~~8b (Table ~~8-~~10-~~34~~).

~~8.2~~10.3 INHALATION OF VAPORS FROM ~~SITE-WIDE~~ZONE 1 GROUNDWATER

As shown in Table 10-1, future greenway users could be exposed to ambient vapors emanating from groundwater in SFA Zone 1. RBSLs for ambient COPC vapors derived from subsurface SWMU material in this area will be modeled in accordance with the highly conservative method presented in the ASTM RBCA standard (ASTM, 1995). These RBSLs will be back-calculated for each volatile COPC from corresponding $RBC_{g/air}$ values (Equations G-4 and G-5), as shown in Table 10-5. Exposure parameter values are presented in Table 10-7.

~~8.3~~10.4 INHALATION OF VAPORS FROM PITS

As shown in Table 10-1, greenway users could be exposed to vapors emanating from Coke Oven Area pits (SWMU Group PA-1: SWMUs P-1, P-2, P-3, and P-4, and Pit #147 at SWMU P-11). RBSLs for evolution of vapors from the pits and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding $RBC_{g/air}$ values using the relation presented in Table ~~8-~~10-6~~5~~. The chemical-specific volatilization rate ($VF_{g/pit}$) from the pits will be estimated using the stagnant film model presented in EPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models* (EPA, 1989a) (Equation G-10~~b~~2, Table ~~8-~~10-6~~5~~). Exposure parameter values are presented in Table ~~8-~~10-7~~6~~.

Table 10-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Greenway User Scenario

Potential Sources	Exposure Pathway Description	
	Inhalation of Airborne Particles	Inhalation of Ambient Vapors
COKE OVEN AREA		
PA-1 (P-1, P-2, P-3, P-4, and P-5)	X	NT
PA-2 (P-6 and P-7)	X	ND
PA-3 (P-9 and P-10)	ND, NE (c)	X
PA-4 (P-11 and P-12)	ND	X
P-18	ND, NE (c)*	NT
S-26	S	NT
PA-1 Pits	NA	X
Pit #17 at P-11	NA	X
Groundwater	NA	Zone 1
TANK FARM AREA		
TF (P-8, P-74, and P-75)	X	ND
Groundwater	NA	Zone 1
SLAG FILL AREA ZONE 1 (NO SWMUS)		
Groundwater	NA	X
SLAG FILL AREA ZONE 2		
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	X	X
SFA-2 (S-11 and S-22)	S	X
S-3	S	NT
S-8	X	ND
S-21	X	ND
S-24	ND, NE (c)	X
Groundwater	NA	Zone 1
SLAG FILL AREA ZONE 3		
S-10	S	NT
Groundwater	NA	Zone 1
SLAG FILL AREA ZONE 4		
S-14	X	X
S-15	X	ND
S-16	ND, NE (c)	NC
S-17	S	NT
S-18	X	ND
S-23	ND, NE (c)	X
Groundwater	NA	Zone 1
SLAG FILL AREA ZONE 5 (NO SWMUS)		
Groundwater	NA	Zone 1
OTHER AREAS		
S-19	X	ND
S-25	ND, NE (c)	NT
P-63	X	NV
P-73	X	NT

Table 10-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the Future Greenway User Scenario

Potential Sources	Exposure Pathway Description	
	Inhalation of Airborne Particles	Inhalation of Ambient Vapors
Smokes Creek Area groundwater	NA	Zone 1
Site-wide groundwater	NA	Zone 1
WATERCOURSES		
Lake Erie	NA	
Smokes Creek		
Blasdell Creek		
North & South Return Water Trenches		
Ship Canal		

Notes:

X	=	considered complete pathway to be evaluated.
S	=	considered complete pathway to be evaluated by using subsurface soil material data as surrogate for surface material data.
NA	=	not applicable.
NC	=	no COPCs present.
ND	=	no data collected.
NE	=	no exposure.
NE [c]	=	no exposure because SWMU is covered. *SWMU P-18 is covered with water.
NT	=	no toxicity criteria available for volatile subsurface COPC(s).
NV	=	no volatile COPCs present.
Zone 1	=	Zone 1 groundwater is assumed source of groundwater vapor exposure.

Table 10-2. Future Greenway User Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Airborne Particle Inhalation Pathway

Non-Cancer $RBSL_{g/pi}$:

G-1

$$RBSL_{g/pi}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{THQ \times AT_n \times RfD_i}{EF_g \times ET_g \times \left(10^{-6}\ kg/mg \times IFA_g \times VF_p\right)}$$

Cancer $RBSL_{g/pi}$:

G-2a

$$RBSL_{g/pi}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{TR \times AT_c}{EF_g \times ET_g \times \left(SF_i \times 10^{-6}\ kg/mg \times IFA_g \times VF_p\right)}$$

where the particle emission factor VF_p (ASTM, 1995) is:

G-2b

$$VF_p\left[\frac{kg\text{-}soil}{m^3 - air}\right] = \frac{P_e \times W_S}{U_{air} \times \delta_{air}} \times 10^3\ \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

where:

Parameter Definition		Units
$RBSL_{g/pi}$	RBSL in SWMU for inhalation of airborne particles for greenway user	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
ED_g	Greenway user exposure duration	years
EF_g	Greenway user exposure frequency	days/year
ET_g	Greenway user exposure time	hours/day
IFA_{res}	Age-adjusted residential inhalation factor	m^3-year/kg-hour
P_e	Areal total respirable particulate emission flux from SWMU	g/cm^2-sec
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
RfD_i	Inhalation reference dose	mg/kg-day
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_p	Total respirable particle concentration from SWMU	kg-soil/m^3-air
W_S	Width of source area parallel to the wind	cm
δ_{air}	Mixing zone height	cm

Table 10-3. Farmer's Emission Model

Farmer's emission rate equation:

G-3a

$$Q_{chemical}\left[\frac{g}{sec}\right] = D^{air} \times \frac{C_T}{R_g} \times \frac{\theta_{as}^{3.33}}{\theta_T^2} \times \frac{1}{L} \times A \times 10^{-3}\ \frac{g}{mg}$$

where the total solute concentration is:

G-3b

$$C_T\left[\frac{mg}{cm^3}\right] = S_{unit} \times \rho_s \times \left(1 + \frac{\theta_{ws} \times \rho_L}{\rho_s}\right) \times 10^{-3}\ \frac{kg}{g}$$

and the gas partition coefficient is:

G-3c

$$R_g\left[\frac{cm^3}{cm^3}\right] = \theta_{as} + \frac{\theta_{ws} + \rho_s \times K_{oc} \times f_{oc}}{H'}$$

where:

Parameter	Definition	Units
A	Area of source	m^2
C_T	Total solute concentration	mg/cm^3
d	Depth to subsurface source	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
f_{oc}	Organic carbon content	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
$Q_{chemical}$	Emission rate	g/sec
R_g	Gas partition coefficient	cm^3/cm^3
S_{unit}	Unit concentration of COPC in soil	mg/kg
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 10-4. Future Greenway User Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Subsurface SWMU Material Vapor Inhalation Pathway

Non-cancer $RBC_{g/air}$:

G-4

$$RBC_{g/air}\left[\frac{\mu g}{m^3}\right] = \frac{THQ \times AT_n \times RfD_i}{EF_g \times ET_g \times IFA_g} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBC_{g/air}$:

G-5

$$RBC_{g/air}\left[\frac{\mu g}{m^3}\right] = \frac{TR \times AT_c}{SF_i \times EF_g \times ET_g \times IFA_g} \times 10^3 \frac{\mu g}{mg}$$

Screening-level emission rate:

G-6

$$\frac{RBC_{g/air}\ (\mu g/m^3)}{ISCST3_{air}\ (\mu g/m^3)} = \frac{ER_{screening}\ (g/sec)}{ER_{unit}\ (1\ g/sec)}$$

G-7

$$\frac{ER_{screening}\ (g/sec)}{Q_{chemical}\ (g/sec)} = \frac{RBSL_{g/samb}\ (mg/kg\text{-}soil)}{S_{unit}\ (1\ mg/kg)}$$

$RBSL_{g/samb}$:

G-8a

$$RBSL_{g/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{g/air} \times ER_{unit} \times S_{unit}}{Q_{chemical} \times ISCT3_{air}}$$

G-8b

$$RBSL_{g/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{g/air}}{VF_{air}} \times 10^6 \frac{mg}{kg}$$

where:

G-8c

$$VF_{air}\left[\frac{(\mu g\text{-}soil)}{m^3\text{-}air}\right] = \frac{ISCST3_{air} \times D^{air} \times \rho_s \times \left(1 + \frac{\theta_{ws} \times \rho_L}{\rho_s}\right) \times \theta_{as}^{3.33} \times A \times H'}{\theta_T^2 \times d \times (\theta_{as} \times H' + \theta_{ws} + \rho_s \times K_{oc} \times f_{oc}) \times ER_{unit}} \times 10^4 \frac{cm^2}{m^2}$$

where:

Parameter Definition		Units
$RBC_{g/air}$	RBC for volatile COPC in air for greenway user	$\mu g/m^3$
$RBSL_{g/samb}$	RBSL in subsurface material for vapor in ambient air for greenway user	mg/kg
A	Area of subsurface source	m^2
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days

Parameter	Definition	Units
BW_g	Greenway user body weight	kg
d	Depth to subsurface source	cm
ED_g	Greenway user exposure duration	years
EF_g	Greenway user exposure frequency	days/year
$ER_{screening}$	Screening-level emission rate	g/sec
ER_{unit}	Unit emission rate	g/sec
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
f_{oc}	Organic carbon content	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
$IR_{a/g}$	Greenway user inhalation rate	m^3/day
$ISCT3_{air}$	ISCT3-modeled concentration of COPC in air	g/m^3
$Q_{chemical}$	Chemical-specific emission rate	g/sec
RfD_i	Chronic inhalation reference dose	mg/kg-day
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
S_{unit}	Unit concentration of COPC in soil	mg/kg
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
VF_{air}	Subsurface to ambient air volatilization factor	$\mu g/m^3$
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 10-5. Future Greenway User Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the SFA Zone 1 Ambient Groundwater Vapor Inhalation Pathway

$RBC_{g/air}$ values calculated per Equations G-4 and G-5

$RBSL_{g/wamb}$:

G- 9a

$$RBSL_{g/wamb}\left[\frac{\mu g}{L}\right] = \frac{RBC_{g/air}}{VF_{wamb}}$$

Volatilization factor from groundwater to ambient air (ASTM, 1995):

G-9b

$$VF_{wamb}\left[\frac{L-water}{m^3-air}\right] = \frac{H'}{\left(1+\frac{U_{air}\times\delta_{air}\times L_{GW}}{D_{ws}^{eff}\times W_{GW}}\right)}\times 10^3\,\frac{L}{m^3}$$

Effective diffusion coefficient between groundwater and the SWMU surface (ASTM, 1995):

G-9c

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right] = \left(h_{cap}+h_v\right)\times\left(\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right)^{-1}$$

Effective diffusion coefficient in soil based on vapor-phase concentration (ASTM, 1995), is:

G-9d

$$D_s^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\times\frac{\theta_{as}^{3.33}}{\theta_T^2}+D^{water}\times\frac{1}{H'}\times\frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Effective diffusion coefficient through the capillary fringe (ASTM, 1995):

G-9e

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^{air}\times\frac{\theta_{acap}^{3.33}}{\theta_T^2}+D^{water}\times\frac{1}{H'}\times\frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where:

Parameter Definition		Units
$RBC_{g/air}$	RBC for volatile COPC in air for greenway user	$\mu g/m^3$
$RBSL_{g/wamb}$	RBSL in groundwater for vapor in ambient air for greenway user	$\mu g/L$
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
D_{cap}^{eff}	Effective diffusion coefficient in capillary fringe region	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
h_{cap}	Thickness of capillary fringe	cm
h_v	Thickness of vadose zone	cm
L_{GW}	Depth to groundwater ($h_{cap}+h_v$)	cm
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{wamb}	Volatilization factor from groundwater to ambient air	kg-soil/m^3-air
W_{GW}	Width of groundwater source	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil

Table 10-6. Future Greenway User Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Ambient Pit Vapor Inhalation Pathway

$RBC_{g/air}$ values calculated per Equations G-4 and G-5

$RBSL_{g/pit}$:

G-10a

$$RBSL_{g/pit}\left[\frac{\mu g}{L}\right] = \frac{RBC_{g/air}}{VF_{g/pit}} \times 10^3 \frac{\mu g - m^3}{g - L}$$

Volatilization rate from the pits:

G-10b

$$VF_{g/pit}\left[\frac{\mu g}{g}\right] = ISCST3_{air} \times \frac{k_L}{1 + \frac{k_L}{k_G \times H'}} \times A \times \frac{1}{ER_{unit}}$$

Gas-phase mass transfer coefficient:

G-10c

$$k_G\left[\frac{m}{sec}\right] = 4.82 \times 10^{-3} \times U_{10}^{0.78} \times Sc_G^{-0.67} \times de^{-0.11} \quad \text{where}$$

Effective diameter of impoundment:

G-10d

$$de[m] = \sqrt{\frac{4 \times A}{\pi}}$$

Schmidt number on the gas side:

G-10e

$$Sc_G = \frac{\mu_G}{\rho_G \times D^{air}}$$

Liquid-phase transfer coefficient:

G-10f

$$k_L\left[\frac{m}{sec}\right] = 10^{-6} + 144 \times 10^{-4} \times U^{*2.2} \times Sc_L^{-0.5} \quad \text{where}$$

Schmidt number on the liquid side:

G-10g

$$Sc_L = \frac{\mu_L}{\rho_L \times D^{wat}}$$

Friction velocity:

G-10h

$$U^*\left[\frac{m}{sec}\right] = 0.01 \times U_{10} \times \sqrt{6.1 + 0.63 \times U_{10}}$$

where:

Parameter Definition		Units
$RBC_{g/air}$	RBC for volatile COPC in air for greenway user	$\mu g/m^3$
$RBSL_{g/pit}$	RBSL in pit water for vapor in ambient air for greenway user	$\mu g/L$
A	Liquid area (pit)	m^2
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
de	Effective diameter of impoundment (pit)	m
ER_{unit}	Unit emission rate	g/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
$ISCT3_{air}$	ISCT3-modeled concentration of COPC in air	g/m^3
k_G	Gas-phase mass transfer coefficient	m/sec
k_L	Liquid-phase mass transfer coefficient	m/sec
Sc_G	Schmidt number on the gas side	unitless
Sc_L	Schmidt number on the liquid side	unitless
U^*	Friction velocity	m/sec
U_{10}	Wind speed at 10 meters above liquid surface (pit)	m/sec
VF_{pit}	Volatilization rate from pit	$\mu g/g$
μ_G	Viscosity of air	g/cm-sec
μ_L	Viscosity of water	g/cm-sec
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 10-7. Future Greenway User Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	10,950	days		Total ED (30 years) x 365 days/year
BW_c	Body weight (child)	16.6	kg	EPA, 1997	Mean body weight of male and female children aged 1 to 6 years
BW_a	Body weight (adult)	71.8	kg	EPA, 1997	Recommended body weight for male and female adults
ED_c	Exposure duration (child)	6	years	EPA, 1991	Ages 1 to 6 years
ED_a	Exposure duration (adult)	24	years	EPA, 1991	Ages 7 to 30 years
EF_g	Exposure frequency	52	days/year	Professional judgment	Presence assumed twice a week for the 13 weeks of summer, once a week for the 26 weeks of spring and fall
ET_g	Exposure time	2	hours/day	Professional judgment	
$IR_{a/c}$	Inhalation rate (child)	1.2	m^3/hour	EPA, 1997	Recommended short-term inhalation rate for children engaged in moderate activities
$IR_{a/a}$	Inhalation rate (adult)	1.6	m^3/hour	EPA, 1997	Recommended short-term inhalation rate for adults engaged in moderate activities
IFA_g	Age-adjusted inhalation factor	0.97	m^3-year/kg-hour	Calculated by analogy to RAGS Vol. I Part B (EPA, 1991): $IFA_g = \frac{IR_{a/c} \times ED_c}{BW_c} + \frac{IR_{a/a} \times ED_a}{BW_a}$	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
CHEMICAL-SPECIFIC TOXICITY PARAMETERS					
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	

~~9.0~~11.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE ~~PRESENT~~ CURRENT AND FUTURE RECREATIONAL BATHER SCENARIO

Recreational bathers are assumed to be adults and children who reside in the Lackawanna area and regularly wade and swim in Blasdell Creek, Smokes Creek, and nearshore Lake Erie in the vicinity of the BSC Lackawanna site during the summer. ~~In addition to direct contact with surface water and sediment, recreational bathers could be exposed to airborne vapors emanating from SWMUs and site-wide groundwater. Potentially complete pathways for the recreational bather scenario are summarized in Figure 9-11-1, and potential source areas where these pathways could result in exposure to this population are summarized in Table 9-11-1.~~

Equations that will be used to calculate RBSLs for the various pathways are presented in the sections below and in Tables ~~9-~~11-1 to ~~9-~~11-3. Exposure parameter values to be used in calculating Tier 1 RBSLs for the recreational bather scenario are presented in Table 11-4. ~~The oral relative absorption factors for COPCs in sediment are presented in Section 3.0 (Table 3-1).~~ Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

~~9.1~~11.1 DIRECT CONTACT WITH SURFACE WATER IN BLASDELL CREEK, SMOKES CREEK OR NEARSHORE LAKE ERIE

Any recreational bathers in Lake Erie, Blasdell Creek, or Smokes Creek in the vicinity of the site may contact site-related COPCs in surface water. As in the fish consumer scenario (Section 12.0), both COPCs detected in surface water and COPCs identified for the groundwater-to-surface water pathway will be considered for the recreational bather. That is, RBSLs protective of recreational bathers will be developed for both COPCs detected in surface water and those detected in groundwater that discharges into Smokes Creek and nearshore Lake Erie. As no significant contaminated groundwater flow into Blasdell Creek is known to occur, only surface water results from this creek will be compared to RBSLs in the risk assessment. Surface water RBSLs for recreational bathers will also be compared to modeled concentrations of COPCs in Lake Erie assuming shutdown of the Ship Canal pumps.

Equations that will be used to develop RBSLs for the direct contact pathway are presented in Table ~~9-~~11-1, and exposure parameter values in Table ~~9-~~11-4. $RBSL_{rec/sw}$ values for recreational exposure to surface water will be calculated with the conservative assumption that all chemicals in the surface water data set are site-related.

~~9.2~~11.2 GROUNDWATER-TO-SURFACE WATER PATHWAY

Groundwater RBSLs for recreational contact with surface water in Lake Erie and Smokes Creek will be back-calculated from corresponding surface water RBSLs using a steady-state mass balance model assuming a well-mixed system (EPA, 1988). The ratio of the inflow rate divided by the total outflow rate is essentially the dilution factor (DF) for the

groundwater as it enters and is mixed in Lake Erie or Smokes Creek. This model is conservative because no chemical decay or removal processes (*i.e.*, biological and chemical degradation, volatilization losses, partitioning to sediments) are assumed to occur in the surface water. Therefore, the use of this model is likely to provide conservative estimates of the RBSL in groundwater for recreational users.

The flow parameters for Lake Erie and Smokes Creek are discussed in the following sections. Equations used to develop RBSLs for the groundwater-to-surface water direct contact pathway are presented in Table ~~9-~~11-2. Exposure parameter values are presented in Table ~~9-~~11-4.

~~9.2.1~~11.2.1 Lake Erie

The groundwater discharge into Lake Erie was estimated using site-specific parameters from the Phase IIA RFI report (Dames & Moore, 1993). As indicated by the hydraulic contours in Interim Deliverable No. 1 (Figure 3-5), the groundwater flow direction along the Lake Erie shoreline is towards the lake. The groundwater discharge into Lake Erie occurs primarily from the sand and fill units. Approximately 90% of the groundwater discharges in the shore zone extending from the shoreline to a distance of 200 feet into the lake; the remaining 10% of the groundwater discharges further offshore and undergoes greater dilution. The total average annual discharge rate from the Lake Erie Discharge Area is estimated at 1.0 cubic feet per second (cfs).

For the purposes of the model, 100% of the groundwater is conservatively assumed to discharge into the shore zone extending from the shoreline to a distance of 200 feet into the lake. Constituent dispersion in the near shore coastal zone results in "coastal entrapment" of pollutants, with the formation of a polluted effluent plume generally following the shorelines (Csanady, 1970). Therefore, additional emphasis is placed on dilution and dispersion in the nearshore zone. Surface water flow through the zone extending 200 feet from shore is calculated to be about 0.67% of the total flow in the nearshore (shoreline to 1,500 feet) area which results in a outflow rate of 135 cfs. The groundwater dilution factor for the zone extending 200 feet from the shore of Lake Erie is therefore 135 cfs/1.0 cfs, or 135-fold.

~~9.2.2~~11.2.2 Smokes Creek

Groundwater discharge into Smokes Creek will be estimated using site-specific parameters in Appendix E of the Phase IIB report (Dames & Moore, 1994). As indicated by the hydraulic contours in Interim Deliverable No. 1 (Figure 3-5), the groundwater flow direction adjacent to Smokes Creek is towards the creek. Groundwater discharge into Smokes Creek occurs primarily from the sand and fill units underlying the creek bed. The average annual groundwater discharge rate into the creek is estimated as 0.37 cfs. According to NYSDEC SPDES and Discharge Monitoring reports, the average discharge from Smokes Creek is about 150 to 200 cfs. The discharge value of 120 cfs is selected to represent the outflow from Smokes Creek since the lower value results in less dilution and is therefore a more conservative estimate. The groundwater dilution factor for Smokes Creek is thus estimated as 120 cfs/0.37 cfs, or 324-fold.

~~9.3~~11.3 INGESTION OF SEDIMENT IN BLASDELL CREEK, SMOKES CREEK, AND NEARSHORE LAKE ERIE

As shown in ~~Figure 2-1 and~~ Table ~~9-~~11-1, people engaged in recreational bathing activities in Blasdell Creek, Smokes Creek, and nearshore Lake Erie in the vicinity of the site may incidentally ingest sediment containing site-related COPCs. Equations used to develop RBSLs for the sediment ingestion pathway are presented in Table ~~9-~~11-4. Exposure parameter values are presented in Table ~~9-~~11-9. Lead was selected as a COPC in Smokes Creek sediment (see Section 4.6.1, Interim Deliverable No. 1 [Dames & Moore, 1998]). However, an RBSL for lead in this medium cannot be calculated because the low magnitude and frequency of sediment exposure expected for this scenario precludes application of either child or adult lead models (EPA, 1994, 1996b). As a conservative estimate of potential hazard to this receptor scenario in Tier 1 of the risk assessment, the lead RBSL calculated for future commercial workers (see Table 4-8) will be compared to the representative lead concentration in Smokes Creek sediment. ~~$RBSL_{rec/sed}$ values for recreational exposure to sediment will be calculated under the conservative assumption that all chemicals in the sampled sediments are site-related.~~ Particle sorption will be conservatively assumed to have no effect on the oral bioavailability of sediment COPCs.

~~9.4INHALATION OF VAPORS FROM SUBSURFACE SWMU MATERIAL~~

~~As shown in Figure 2-1 and Table 9-10-1, recreational bathers at Blasdell Creek, Smokes Creek, or nearshore Lake Erie could be exposed to vapors emanating from subsurface material in the following SWMUs:~~

~~Coke Oven Area: SWMU Groups PA-3 (P-9 and P-10) and PA-4 (P-1 to P-5);~~

~~Tank Farm Area: S-24;~~

~~Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22); and~~

~~Slag Fill Area Zone 4: SWMUs S-14 and S-23.~~

- ~~Coke Oven Area: SWMU Group PA-3 (P-9 and P-10);~~
- ~~Slag Fill Area Zone 2: SWMU Group SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27), SFA-2 (S-11 and S-22) and SWMU S-24; and~~
- ~~Slag Fill Area Zone 4: SWMUs S-14 and S-23.~~

~~The RBSLs for on-site subsurface SWMU material ($RBSL_{rec/sub}$) will be back-calculated using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Table 9-10-5). The model is used to predict the movement and steady-state vapor emission rates assuming there are~~

no losses through volatilization, leaching, or biodegradation. Contamination is assumed to be continuous from 100 cm below the ground surface throughout the full extent of the soil column.

Airborne concentrations of volatile COPCs at the three water bodies will be related to SWMU-specific emissions based on a unit concentration (1 mg/kg) in soil using EPA's air dispersion model ISCST Model version 3 with meteorological data collected at an on-site monitoring station in Lackawanna, New York in 1991. These data are presented in Appendix A. This model uses steady-state Gaussian plume dispersion curves to model continuous release from a given source area using sector-averaging and statistical wind summaries. Emissions from each source were modeled using a unit emission rate (ER_{unit}) of 1 g/sec for all sources except for SWMU S-24, which was will be split into two source areas (ER_{unit} = 2 g/sec) in order to best fit its actual shape. The windrose of the meteorological data indicates that the dominant wind direction is towards the northeast. Recreational bathers in Lake Erie will be located every 100 meters along the shoreline (west) of the property. Recreational bathers in Smokes Creek will be placed on both the north and south banks every 100 meters starting at SWMU S-24 and going directly west until Lake Erie is reached.

Equations that will be used to develop RBSLs for the subsurface vapor inhalation pathway are presented in Table 9-10-6. Exposure parameter values are presented in Table 9-10-9. RBSLs for evolution of vapors from subsurface material at each SWMU and atmospheric dispersion to the three water bodies will be back-calculated for each volatile COPC from corresponding $RBC_{rec/air}$ values (Equations R-8 and R-9, Table 9-10-6). Using the ISCST3-predicted air concentrations, a screening level emission rate will be estimated from each SWMU using a simple linear relationship (Equation R-10, Table 9-10-6). The soil screening level ($RBSL_{rec/samb}$) will be estimated by using the linear relationship between the predicted chemical-specific emission rate ($Q_{chemical}$), screening level emission rate ($ER_{screening}$), and the unit soil concentration (S_{unit}) initially used in Farmer's model (Equation R-11, Table 9-10-6). Combining Equations R-10 and R-11, RBSLs for recreational bathers will be estimated by calculating the ratio of the ISCST3-predicted air concentration of each volatile COPC to the chemical-specific emission rates using Farmer's model (Equation R-12a, Table 9-10-6). Substituting the equation for Farmer's model into Equation R-12a, RBSLs for recreational bathers' exposure to vapors from subsurface SWMU material will be estimated according to Equation R-13 12b (Table 9-10-6).

9.5INHALATION OF VAPORS FROM SITE-WIDE GROUNDWATER

As shown in Figure 2-1 and Table 9-10-1, recreational bathers could be exposed to vapors emanating from site-wide groundwater. RBSLs for evolution of vapors from site-wide groundwater and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding $RBC_{rec/air}$ values using the Farmer's model described above. Emissions from the site-wide ground water plume will be modeled using three source areas, with ER_{unit} = 3 g/sec.

An average ground water depth of 35 feet is assumed. A corresponding groundwater $RBSL_{rec/wamb}$ will be estimated by back-calculating from $RBC_{rec/air}$ values (Equations R-8 and R-9, Table 9-10-6), as shown in Table 9-10-7. Exposure parameter values are presented in Table 9-10-9.

9.6INHALATION OF VAPORS FROM PITS

As shown in Figure 2-1 and Table 9-10-1, recreational bathers could be exposed to vapors emanating from pits on the Lackawanna site (SWMU Group PA-1 and Pit #147 at SWMU P-11). RBSLs for evolution of vapors from the pits and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding RBCrec/air values using the relation presented in Table 9-10-8. Exposure parameter values are presented in Table 9-10-9. The chemical-specific volatilization rate ($VF_{rec/pit}$) from the quench pits will be estimated using the stagnant film model presented in EPA's Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) – Air Emission Models (EPA, 1989a) (Equation R-15b8, Table 9-10-8).

Table 11-1. Current and Future Recreational Bather Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Surface Water Contact Pathway

Non-Cancer $RBSL_{rec/sw}$:

R- 1

$$RBSL_{rec/sw}\left[\frac{\mu g}{L}\right] = \frac{THQ \times AT_n}{EF_{rec} \times ET_{rec} \times \left[\left(\frac{1}{RfD_d} \times SAF_{rec} \times PC \times 10^{-3}\, L/cm^3\right) + \left(\frac{1}{RfD_o} \times IFW_{rec}\right)\right]} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBSL_{rec/sw}$:

R- 2

$$RBSL_{rec/sw}\left[\frac{\mu g}{L}\right] = \frac{TR \times AT_c}{EF_{rec} \times ET_{ec} \times \left[(SF_d \times SAF_{ec} \times PC \times 10^{-3}\, L/cm^3) + SF_o \times IFW_{rec})\right]} \times 10^3 \frac{\mu g}{mg}$$

where:

Parameter	Definition	Units
$RBSL_{rec/sw}$	RBSL in surface water for recreational bathers	µg/L
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
EF_{rec}	Exposure frequency	days/year
ET_{rec}	Exposure time	hours/day
IFW_{rec}	Age-adjusted recreational water ingestion factor	L-year/kg-hour
SAF_{rec}	Age-adjusted surface area factor	cm^2-year/kg
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
PC	Permeability coefficient	cm/hour
RfD_d	Chronic dermal reference dose	mg/kg-day
RfD_o	Chronic oral reference dose	mg/kg-day
SF_d	Dermal slope factor	$(mg/kg\text{-}day)^{-1}$
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$

Table 11-2. Current and Future Recreational Bather Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Groundwater-to-Surface Water Direct Contact Pathway

$RBSL_{rec/sw}$ calculated per Equations R-1 and R-2

$RBSL_{rec/gw/LE}$ (Lake Erie discharge area):

R- 3a

$$RBSL_{rec/gw/LE}\left[\frac{\mu g}{L}\right] = RBSL_{rec/sw} \times DF_{rec/gw\rightarrow sw/LE}$$

where the dilution factor $DF_{rec/gw\rightarrow sw/LE}$ =

R-3b

$$DF_{rec/gw\rightarrow sw/LE} = \frac{Q_{outflow/LE}}{Q_{inflow/LE}}$$

$RBSL_{rec/gw/SC}$ (Smokes Creek discharge area):

R-4a

$$RBSL_{rec/gw/SC}\left[\frac{\mu g}{L}\right] = RBSL_{rec/sw} \times DF_{rec/gw\rightarrow sw/SC}$$

where the dilution factor $DF_{rec/gw\rightarrow sw/SC}$ =

R-4b

$$DF_{rec/gw\rightarrow sw/SC} = \frac{Q_{outflow/SC}}{Q_{inflow/SC}}$$

where:

Parameter	Definition	Units
$RBSL_{rec/sw}$	RBSL in surface water for recreational bathers	µg/L
$RBSL_{rec/gw/LE}$	RBSL in Lake Erie Discharge Area groundwater for recreational bathers	µg/L
$RBSL_{rec/gw/SC}$	RBSL in Smokes Creek Discharge Area groundwater for recreational bathers	µg/L
$DF_{rec/gw\rightarrow sw/LE}$	Dilution factor from Lake Erie Discharge Area groundwater to Lake Erie surface water	unitless
$DF_{rec/gw\rightarrow sw/SC}$	Dilution factor from Smokes Creek Discharge Area groundwater to Smokes Creek surface water	unitless
$Q_{inflow/LE}$	Rate of groundwater flow into Lake Erie	cfs
$Q_{inflow/SC}$	Rate of groundwater flow into Smokes Creek	cfs
$Q_{outflow/LE}$	Rate of water flow in Lake Erie	cfs
$Q_{outflow/SC}$	Rate of water flow in Smokes Creek	cfs

Table 11-3. Current and Future Recreational Bather Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Sediment Ingestion Pathway

Non-Cancer $RBSL_{rec/sed}$

R-5

$$RBSL_{rec/sed}\left[\frac{mg}{kg-sed}\right]=\frac{THQ\times AT_n\times RfD_o}{EF_{rec}\times 10^{-6}\ kg/mg\times(IFS_{rec}\times RAF_o)}$$

Cancer $RBSL_{rec/sed}$

R-6

$$RBSL_{rec/sed}\left[\frac{mg}{kg-sed}\right]=\frac{TR\times AT_c}{EF_{rec}\times 10^{-6}\ kg/mg\times SF_o\times(IFS_{rec}\times RAF_o)}$$

where:

Parameter	Definition	Units
$RBSL_{rec/sed}$	RBSL in sediment for recreational bathers	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
EF_{rec}	Exposure frequency	days/year
IFS_{rec}	Age-adjusted recreational sediment ingestion factor	mg-year/kg-day
RAF_o	Oral relative absorption factor	mg-absorbed/mg-ingested
RfD_o	Chronic oral reference dose	mg/kg-day
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless

Table 11-4. Current and Future Recreational Bather Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	10,950	days		Total ED (30 years) x 365 days/year
BW_c	Body weight (child)	16.6	kg	EPA, 1997	Mean body weight of male and female children aged 1 to 6 years
BW_a	Body weight (adult)	71.8	kg	EPA, 1997	Recommended body weight for male and female adults
ED_c	Exposure duration (child)	6	years	EPA, 1989b	Ages 1 to 6 years
ED_a	Exposure duration (adult)	24	years	EPA, 1989b	Ages 7 to 30 years
EF_{rec}	Exposure frequency	6	events/year	Professional judgment	Assumes contact twice a month during three months of summer
ET_{rec}	Exposure time	1	hours/event	EPA, 1997	Recommended value
$IR_{sed/c}$	Sediment ingestion rate (child)	25	mg/event	EPA, 1997	One-quarter of estimated daily soil intake rate for young children (outdoor activities)
$IR_{sed/a}$	Sediment ingestion rate (adult)	12.5	mg/event	EPA, 1997	One-quarter of estimated daily soil intake rate for adults (outdoor activities)
IFS_{rec}	Age-adjusted sediment ingestion factor	13.2	mg-year/kg-event	Calculated by analogy to RAGS Vol. I Part B (EPA, 1991): $IFS_{rec} = \frac{IR_{sed/c} \times ED_c}{BW_c} + \frac{IR_{sed/a} \times ED_a}{BW_a}$	
$IR_{w/c}$	Recreational water ingestion rate (child)	0.05	L/hour	EPA, 1989b	Default value
$IR_{w/a}$	Recreational water ingestion rate (adult)	0.05	L/hour	EPA, 1989b	Default value
IFW_{rec}	Age-adjusted recreational water ingestion factor	0.035	L-year/kg-hour	Calculated by analogy to RAGS Vol. I Part B (EPA, 1991): $IFW_{rec} = \frac{IR_{w/c} \times ED_c}{BW_c} + \frac{IR_{w/a} \times ED_a}{BW_a}$	
SA_c	Skin surface area exposed (child)	7,200	cm^2/event	EPA, 1997	Average of median male and female body surface areas (ages 3 < 6)
SA_a	Skin surface area exposed (adult)	20,000	cm^2/event	EPA, 1997	Recommended central tendency value for bathing/swimming (adults)

Table 11-4. Current and Future Recreational Bather Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
SAF_{rec}	Age-adjusted surface area factor	9,288	cm^2-year/kg	Calculated by analogy to RAGS Vol. I Part B (EPA, 1991): $SAF_{rec} = \frac{SA_c \times ED_c}{BW_c} + \frac{SA_a \times ED_a}{BW_a}$	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
PC	Permeability coefficient	Chemical-specific	cm/hour	See Appendix B	
RfD_d	Chronic dermal reference dose	Chemical-specific	mg/kg-day	$RfD_d = RfD_o$ x Oral absorption fraction (see Appendix B)	
RfD_o	Chronic oral reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_d	Dermal slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	$SF_d = SF_o$/ Oral absorption fraction (see Appendix B)	
SF_o	Oral slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
RAF_o	Oral relative absorption factor	1.0	mg-absorbed/ mg-ingested	Default	

~~10.0~~12.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE ~~PRESENT~~ CURRENT AND FUTURE FISH CONSUMER SCENARIO

Fish consumers are considered to be adults and children who reside in the Lackawanna area and regularly catch and eat fish in Smokes Creek and nearshore Lake Erie in the vicinity of the BSC Lackawanna site. As shown in Figure 2-1, biotransfer of COPCs in surface water to fish tissue is the exposure pathway of concern for this scenario. As in the recreational bather (Section 11~~9~~.0) and off-site water consumer (Section ~~2~~14.0) scenarios, both COPCs detected in surface water and COPCs identified for the groundwater-to-surface water pathway are considered for the fish consumer.

Equations that will be used to calculate RBSLs for these pathways are presented in the sections below, and in Table ~~10~~12-1. Exposure parameter values to be used in calculating Tier 1 RBSLs for the fish consumer scenario are presented in Table ~~10~~-12-2. Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

~~10.1~~12.1 SURFACE WATER

In order to evaluate potential health risks to fish consumers due to bioaccumulation of COPCs in surface water in Lake Erie, Blasdell Creek, and Smokes Creek, surface water concentrations corresponding to acceptable fish tissue concentrations (RBC_{fish}) (Table ~~10~~-12-1, Equations FC-1 and FC-2) will be calculated using published bioconcentration factors (BCFs) as indicated in Table ~~10~~-12-1, Equation FC-3. Surface water RBSLs for fish consumers will also be compared to modeled concentrations of COPCs in Lake Erie assuming shutdown of the Ship Canal pumps.

~~10.2~~12.2 GROUNDWATER-TO-SURFACE WATER-TO-FISH INGESTION PATHWAY

Groundwater RBSLs for fish consumers taking fish from Lake Erie and Smokes Creek will be back-calculated from $RBSL_{fish/sw}$ as shown in Table ~~10~~-12-1 (Equations FC-4a and FC-5a) using the respective dilution factors ($DF_{fc/gw\rightarrow sw/LE}$ and $DF_{fc/gw\rightarrow sw/SC}$) (Equation FC-4b and FC-5b) for these areas. These factors for the fish consumer scenario are equal to those for the recreational bather scenario -- 135 and 324 for Lake Erie and Smokes Creek, respectively -- as discussed in Section 11~~9~~.0.

Table 12-1. Current and Future Fish Consumer Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Fish Consumption Pathway

Non-cancer RBC_{fish}:

FC- 1

$$RBC_{fish}\left[\frac{mg}{kg}\right] = \frac{THQ \times RfD_o \times AT_n}{EF_{res} \times FIF} \times 10^3 \frac{g}{kg}$$

Cancer RBC_{fish}:

FC- 2

$$RBC_{fish}\left[\frac{mg}{kg}\right] = \frac{TR \times AT_c}{SF_o \times EF_{res} \times FIF} \times 10^3 \frac{g}{kg}$$

$RBSL_{fish/sw}$:

FC- 3

$$RBSL_{fish/sw}\left[\frac{\mu g}{L}\right] = \frac{RBC_{fish}}{BCF} \times 10^3 \frac{\mu g}{mg}$$

$RBSL_{fish/gw/LE}$ (Lake Erie discharge area):

FC- 4a

$$RBSL_{fish/gw/LE}\left[\frac{\mu g}{L}\right] = RBSL_{fish/sw} \times DF_{fc/gw\rightarrow sw/LE}$$

where the dilution factor $DF_{fc/gw\rightarrow sw/LE}$ =

FC-4b

$$D_{fc/gw\rightarrow sw/LE} = \frac{Q_{outflow/LE}}{Q_{inflow/LE}}$$

$RBSL_{fish/gw/SC}$ (Smokes Creek discharge area):

FC- 5a

$$RBSL_{fish/gw/SC}\left[\frac{\mu g}{L}\right] = RBSL_{fish/sw} \times DF_{fc/gw\rightarrow sw/SC}$$

where the dilution factor $DF_{fc/gw\rightarrow sw/SC}$ =

FC-5b

$$D_{fc/gw\rightarrow sw/SC} = \frac{Q_{outflow/SC}}{Q_{inflow/SC}}$$

where:

Parameter Definition		Units
RBC_{fish}	Risk-based concentration in fish tissue	mg/kg
$RBSL_{fish/gw/LE}$	RBSL in Lake Erie Discharge Area groundwater for fish consumers	µg/L
$RBSL_{fish/gw/SC}$	RBSL in Smokes Creek Discharge Area groundwater for fish consumers	µg/L
$RBSL_{fish/sw}$	RBSL in surface water for fish consumers	µg/L
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days

Parameter Definition		Units
EF_{res}	Residential exposure frequency	days/year
FIF	Age-adjusted fish ingestion factor	g-year/kg-day
$DF_{fc/gw \rightarrow sw/LE}$	Dilution factor from Lake Erie Discharge Area groundwater to Lake Erie surface water	unitless
$DF_{fc/gw \rightarrow sw/SC}$	Dilution factor from Smokes Creek Discharge Area groundwater to Smokes Creek surface water	unitless
$Q_{inflow/LE}$	Rate of groundwater flow into Lake Erie	cfs
$Q_{inflow/SC}$	Rate of groundwater flow into Smokes Creek	cfs
$Q_{outflow/LE}$	Rate of water flow in Lake Erie	cfs
$Q_{outflow/SC}$	Rate of water flow in Smokes Creek	cfs
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
BCF	Bioconcentration factor	L/kg
RfD_o	Chronic oral reference dose	mg/kg-day
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$

Table 12-2. Current and Future Fish Consumer Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	10,950	days		Total ED x 365 days/year
BW_c	Body weight (child)	16.6	kg	EPA, 1997	Mean body weight of male and female children aged 1 to 6 years
BW_a	Body weight (adult)	71.8	kg	EPA, 1997	Recommended body weight for male and female adults
ED_c	Exposure duration (child)	6	years	EPA, 1991	Ages 1 to 6 years
ED_a	Exposure duration (adult)	24	years	EPA, 1991	Ages 7 to 30 years
EF_{res}	Residential exposure frequency	350	days/year	EPA, 1989b	Default value
$IR_{fish/c}$	Fish ingestion rate (child)	9	g/day	Professional judgment	One-half of adult ingestion rate
$IR_{fish/a}$	Fish ingestion rate (adult)	18	g/day	EPA, 1997	95th percentile value for freshwater anglers in New York State
FIF	Age-adjusted fish ingestion factor	9.3	g-year/kg-day	Calculated by analogy to RAGS Vol. I Part B (EPA, 1991): $FIF_{fc} = \frac{IR_{fish/c} \times ED_c}{BW_c} + \frac{IR_{fish/a} \times ED_a}{BW_a}$	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
CHEMICAL-SPECIFIC TOXICITY PARAMETERS AND EXPOSURE CRITERIA					
RfD_o	Chronic oral reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_o	Oral slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
BCF	Surface water-to-fish bioconcentration factor	Chemical-specific	L/kg	See Interim Deliverable No. 3	

~~11.0~~13.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE ~~PRESENT~~ CURRENT AND FUTURE OFF-SITE (FENCELINE) RESIDENT SCENARIO

The off-site resident population is assumed to consist of adults and children living on the fenceline of the BSC Lackawanna site. Potentially complete pathways for the fenceline resident scenario are summarized in Figure 2-1, and potential on-site source areas for the fenceline resident scenario are summarized in Table ~~11~~-13-1.

Equations that will be used to calculate RBSLs for the various pathways are presented in the sections below and in Tables ~~11~~-13-2 to ~~11~~-13-5. Exposure parameter values to be used in calculating Tier 1 RBSLs for the fenceline resident scenario are presented in Table ~~11~~-13-6. Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

13.1 INHALATION OF AIRBORNE PARTICLES FROM UNCOVERED SMWUS

COPCs associated with airborne particles from exposed material in uncovered SWMUs could be inhaled by residents at the fenceline. SWMUs where surficial material is exposed to the atmosphere are the following:

- Coke Oven area: SWMU Groups PA-1 (P-1 to P-5), PA-2 (P-6 and P-7) and PA-4 (P-11 and P-12), and SWMU S-26;
- Tank Farm Area: SWMU Group TF (P-8, P-74, and P-75);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S-27) and SFA-2 (S-11 and S-22), S-3, S-8, and S-21;
- Slag Fill Area Zone 3: SWMU S-10;
- Slag Fill Area Zone 4: SWMUs S-14, S-15, S-17, and S-18;
- Other areas: SWMUs S-19, P-63, and P-73.

Subsurface results will be used as a surrogate for surficial data for the following uncovered SWMUs where no surface samples were taken: SWMU Group SFA-2, and SWMU S-26, S-3, S-10, and S-17. This is highly conservative with respect to VOCs (but not non-volatile COPCs), which would be expected to dissipate rapidly if exposed to the atmosphere.

In evaluating this pathway in Tier 1, receptors will be conservatively assumed to be inhaling particles within the source area. Dispersion modeling will be used in Tier 2 for any SWMUs that exceed target criteria in Tier 1. Equations that will be used to develop $RBSL_{res/soil}$ values for the particle inhalation pathway are presented in Table 13-2. Exposure parameter values are presented in Tables 13-7.

~~11.1~~13.2 INHALATION OF VAPORS FROM SUBSURFACE SWMU MATERIAL

As shown in Table ~~11~~13-1, fenceline residents could be exposed to vapors emanating from subsurface material in the following SWMUs:

- Coke Oven Area: SWMU Groups PA-3 (P-9 and P-10) and PA-4 (P-11 to P-12);
- Slag Fill Area Zone 2: SWMU Groups SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, and S- 27) and~~,~~ SFA-2 (S-11 and S-22) and SWMU S24; and
- Slag Fill Area Zone 4: SWMUs S-14 and S-23.

~~RBSLs for evolution of vapors from subsurface material at each SWMU ($RBSL_{res/sub}$) and atmospheric dispersion to the property boundary will be back-calculated using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Table 11-32). The model is used to predict the movement and steady-state vapor emission rates assuming there are no losses through volatilization, leaching, or biodegradation. Contamination is assumed to be continuous from 100 cm below the ground surface throughout the full extent of the soil column.~~

The RBSLs for evolution of vapors from subsurface SWMU material ($RBSL_{res/samb}$) will be back-calculated from corresponding $RBC_{res/air}$ values using a model developed by Farmer *et al.* (1978, 1980) to estimate the emission rate of chemicals from landfills without internal gas generation, assuming that diffusion is the controlling transport mechanism through soil (Tables 13-3 and 13 -4). The model is used to predict the movement and steady-state vapor emission rates assuming there are no losses through volatilization, leaching, or biodegradation. Media containing the representative COPC concentrations is conservatively assumed to be continuous from 100 cm below the ground surface (the assumed depth to source) throughout the full extent of the soil column (*i.e.*, to groundwater).

Airborne concentrations of volatile COPCs at the property boundary will be related to SWMU-specific emissions based on a unit concentration (1 mg/kg) in soil using EPA's air dispersion model ISCST ~~Model~~-version 3 with meteorological data collected at an on-site monitoring station in 1991. These data are presented in Appendix A. This model uses steady-state Gaussian plume dispersion curves to model continuous release from a given source area using sector-averaging and statistical wind summaries. Emissions from each source will be modeled using a unit emission rate (ER_{unit}) of 1 g/sec for all sources except for SWMU S-24, which will be split into two source areas (ER_{unit} = 2 g/sec) in order to best fit its actual shape. The windrose of the meteorological data indicates that the dominant wind direction is towards the northeast. Fenceline residents will be placed every 100 meters along the northern, eastern, and southern boundaries of the site.

Equations that will be used to develop RBSLs for the subsurface vapor inhalation pathway are presented in Table ~~11~~-13-~~43~~. Exposure parameter values are presented in Table ~~11~~-13-7~~6~~. RBSLs for evolution of vapors from subsurface material at each SWMU and atmospheric dispersion to potential receptor locations will be back-calculated for each volatile COPC from corresponding $RBC_{res/air}$ values (Equations FR-~~42~~ and FR-~~53~~, Table ~~11~~-13-~~43~~). Using the ISCST3-predicted air concentrations, a screening level emission rate will be estimated from each SWMU using a simple linear relationship (Equation FR-~~64~~, Table ~~11~~-13-~~43~~). The soil screening level ($RBSL_{res/samb}$) will be estimated by using the linear relationship between the predicted chemical-specific emission rate ($Q_{chemical}$), screening level emission rate ($ER_{screening}$), and the unit soil concentration (S_{unit}) initially used in Farmer's model (Equation FR-~~75~~, Table ~~11~~-13-~~43~~). By combining Equations FR-~~64~~ and FR-~~75~~, RBSLs for off-site residents will be estimated by calculating the ratio of the ISCST3-predicted air concentration of each volatile COPC to the chemical-specific emission rates using Farmer's model (Equation FR-~~8a6~~, Table ~~11~~13-3). Substituting the equation for Farmer's model into Equation FR-~~8a6~~, RBSLs for residential exposure to vapors from subsurface SWMU material will be estimated according to Equation FR-~~8b7~~ (Table ~~11~~-13-~~43~~).

~~11.2~~13.3 INHALATION OF VAPORS FROM SITE-WIDE GROUNDWATER

As shown in Table ~~11~~-13-1, fenceline residents could be exposed to vapors emanating from site-wide groundwater. RBSLs for evolution of vapors from site-wide groundwater and atmospheric dispersion to the property boundary will be back-calculated for each volatile COPC using the Farmer's model described above. Emissions from the site-wide groundwater plume will be modeled using three source areas, with ER_{unit} = 3 g/sec. This division is necessary to accurately approximate the shape of the source area for modeling purposes. An average groundwater depth of 35 feet is assumed. A corresponding groundwater RBSL will be estimated by back-calculating from $RBC_{res/air}$ values (Equations FR-2 and FR-3), as shown in Table ~~11~~-13-~~54~~. Exposure parameter values are presented in Table ~~11~~-13-7~~6~~.

~~11.3~~13.4 INHALATION OF VAPORS FROM COKE OVEN AREA PITS

As shown in Table ~~11~~-13-1, fenceline residents could be exposed to vapors emanating from pits on the Lackawanna site (SWMU Group PA-1 and ~~the pit~~Pit #17 at SWMU P-11). RBSLs for evolution of vapors from the pits and atmospheric dispersion to the property boundary will be back-calculated for each volatile COPC from corresponding $RBC_{res/air}$ values using the equation presented in Table ~~11~~-13-~~65~~. Exposure parameter values are presented in Table ~~11~~-13-7~~6~~. The chemical-specific volatilization rate ($VF_{res/pit}$) from the quench pits will be estimated using the stagnant film model presented in EPA's *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models* (1989a) (Table ~~11~~-13-~~65~~, Equation FR-10a~~1~~).

Table 13-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the the Current and Future Fenceline Resident Scenario

Potential Sources	Exposure Pathway Description	
	Inhalation of Airborne Particles	Inhalation of Ambient Vapors
COKE OVEN AREA		
PA-1 (P-1, P-2, P-3, P-4, and P-5)	X	NT
PA-2 (P-6 and P-7)	X	ND
PA-3 (P-9 and P-10)	ND, NE(c)	X
PA-4 (P-11 and P-12)	X	X
P-18	ND, NE(c)	NT
S-26	S	NT
PA-1 Pits	NA	X
Pit #17 at P-11	NA	X
Groundwater	NA	Site-wide
TANK FARM AREA		
TF (P-8, P-74, and P-75)	X	ND
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 1 (NO SWMUS)		
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 2		
SFA-1 (S-1, S-2, S-4, S-5, S-6, S-7, S-20, S-27)	X	X
SFA-2 (S-11 and S-22)	S	X
S-3	S	NT
S-8	X	ND
S-24	ND, NE (c)	X
S-21	X	ND
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 3		
S-10	S	NT
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 4		
S-14	X	X
S-15	X	ND
S-16	ND, NE (c)	NC
S-17	S	NT
S-18	X	ND
S-23	ND, NE (c)	X
Groundwater	NA	Site-wide
SLAG FILL AREA ZONE 5 (NO SWMUS)		
Groundwater	NA	Site-wide
OTHER AREAS		
S-19	X	ND
S-25	ND, NE (c)	NT
P-63	X	NV
P-73	X	NT

Table 13-1. Summary of Potential Source Areas and Potentially Complete Exposure Pathways for the the Current and Future Fenceline Resident Scenario

Potential Sources	Exposure Pathway Description	
	Inhalation of Airborne Particles	Inhalation of Ambient Vapors
Smokes Creek Area groundwater	NA	Site-wide
Site-wide groundwater	NA	X
WATERCOURSES		
Lake Erie	NA	
Smokes Creek		
Blasdell Creek		
North & South Return Water Trenches		
Ship Canal		

Notes:

X	=	considered complete pathway to be evaluated.
S	=	considered complete pathway to be evaluated by using subsurface soil material data as surrogate for surface material data.
NA	=	not applicable.
NC	=	no COPCs present.
ND	=	no data collected.
NE	=	no exposure.
NE [c]	=	no exposure because SWMU is covered. *SWMU P-18 is covered with water.
NT	=	no toxicity criteria available for volatile subsurface COPC(s).
NV	=	no volatile COPCs present.
Site-wide	=	site-wide groundwater is assumed source of groundwater vapor exposure.

Table 13-2. Current and Future Fenceline Resident Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Airborne Particle Inhalation Pathway

Non-Cancer $RBSL_{res/pi}$:

FR- 1

$$RBSL_{res/pi}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{THQ \times AT_n \times RfD_i}{EF_{res} \times \left(10^{-6}\ kg/mg \times IFA_{res} \times VF_p\right)}$$

Cancer $RBSL_{rew/pi}$:

FR- 2a

$$RBSL_{res/pi}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{TR \times AT_c}{EF_{res} \times \left(10^{-6}\ kg/mg \times SF_i \times IFA_{res} \times VF_p\right)}$$

where the particle emission factor VFp (ASTM, 1995) =

FR-2b

$$VF_p\left[\frac{kg\text{-}soil}{m^3 - air}\right] = \frac{P_e \times W_S}{U_{air} \times \delta_{air}} \times 10^3\ \frac{cm^3\text{-}kg}{m^3\text{-}g}$$

where:

Parameter	Definition	Units
$RBSL_{res/pi}$	RBSL in SWMU for inhalation of airborne particles for fenceline resident	mg/kg
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
EF_{res}	Residential exposure frequency	days/year
IFA_{res}	Age-adjusted residential inhalation factor	m^3-year/kg-day
P_e	Areal total respirable particulate emission flux from SWMU	g/cm^2-sec
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$
RfD_i	Inhalation reference dose	mg/kg-day
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_p	Total respirable particle concentration from SWMU	kg-soil/m^3-air
W_S	Width of source area parallel to the wind, or ground water flow direction	cm
δ_{air}	Mixing zone height	cm

Table 13-3. Farmer's Emission Model

Farmer's emission rate equation:

FR- 3a

$$Q_{chemical}\left[\frac{g}{sec}\right] = D^{air} \times \frac{C_T}{R_g} \times \frac{\theta_{as}^{3.33}}{\theta_T^2} \times \frac{1}{L} \times A \times 10^{-3} \frac{g}{mg}$$

where the total solute concentration is:

FR- 3b

$$C_T\left[\frac{mg}{cm^3}\right] = S_{unit} \times \rho_s \times \left(1 + \frac{\theta_{ws} \times \rho_L}{\rho_s}\right) \times 10^{-3} \frac{kg}{g}$$

and the gas partition coefficient is:

FR- 3c

$$R_g\left[\frac{cm^3}{cm^3}\right] = \theta_{as} + \frac{\theta_{ws} + \rho_s \times K_{oc} \times f_{oc}}{H'}$$

where:

Parameter	Definition	Units
A	Area of source	m^2
C_T	Total solute concentration	mg/cm^3
d	Depth to subsurface source	cm
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
f_{oc}	Organic carbon content	unitless
H'.	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
$Q_{chemical}$	Emission rate	g/sec
R_g	Gas partition coefficient	cm^3/cm^3
S_{unit}	Unit concentration of COPC in soil	mg/kg
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 13-4. Current and Future Fenceline Resident Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Subsurface SWMU Material Vapor Inhalation Pathway

Non-cancer $RBC_{res/air}$:

FR- 4

$$RBC_{res/air}\left[\frac{\mu g}{m^3}\right] = \frac{THQ \times AT_n \times RfD_i}{EF_{res} \times ED_{res} \times IFA_{res}} \times 10^3 \frac{\mu g}{mg}$$

Cancer $RBC_{res/air}$:

FR- 5

$$RBC_{res/air}\left[\frac{\mu g}{m^3}\right] = \frac{TR \times AT_c}{SF_i \times EF_{res} \times ED_{res} \times IFA_{res}} \times 10^3 \frac{\mu g}{mg}$$

Screening-level emission rate:

FR- 6

$$\frac{RBC_{res/air}\ (\mu g/m^3)}{ISCST3_{air}\ (\mu g/m^3)} = \frac{ER_{screening}\ (g/sec)}{ER_{unit}\ (g/sec)}$$

FR- 7

$$\frac{ER_{screening}\ (g/sec)}{Q_{chemical}\ (g/sec)} = \frac{RBSL_{res/samb}\ (mg/kg\text{-}soil)}{S_{unit}\ (mg/kg)}$$

$RBSL_{res/samb}$:

FR- 8a

$$RBSL_{res/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{res/air} \times ER_{unit} \times S_{unit}}{Q_{chemical} \times ISCT3_{air}}$$

FR- 8b

$$RBSL_{res/samb}\left[\frac{mg}{kg-soil}\right] = \frac{RBC_{res/air} \times 10^6\ mg/kg}{VF_{air}}$$

where:

FR- 8c

$$VFair\left[\frac{(\mu g\text{-}soil)}{m^3\text{-}air}\right] = \frac{ISCST3_{air} \times D^{air} \times \rho_s \times \left(1 + \frac{\theta_{ws} \times \rho_L}{\rho_s}\right) \times \theta_{as}^{3.33} \times A \times H'}{\theta_T^2 \times d \times (\theta_{as} \times H' + \theta_{ws} + \rho_s \times K_{oc} \times f_{oc}) \times ERunit} \times 10^4 \frac{cm^2}{m^2}$$

where:

Parameter Definition		Units
$RBC_{res/air}$	RBC for volatile COPC in air for fenceline resident	$\mu g/m^3$
$RBSL_{res/samb}$	RBSL in subsurface material for vapor in ambient air for fenceline resident	mg/kg
A	Area of subsurface source	m^2
AT_c	Averaging time for carcinogenic effects	days

Parameter	Definition	Units
AT_n	Averaging time for non-carcinogenic effects	days
BW_g	Fenceline resident body weight	kg
d	Depth to subsurface source	cm
ED_g	Fenceline resident exposure duration	years
EF_g	Fenceline resident exposure frequency	days/year
$ER_{screening}$	Screening-level emission rate	g/sec
ER_{unit}	Unit emission rate	g/sec
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
f_{oc}	Organic carbon content	unitless
H'	Dimensionless Henry's Law constant	L-water/L-air
K_{oc}	Organic carbon:water partition coefficient	L/kg
$IR_{a/g}$	Fenceline resident inhalation rate	m^3/day
$ISCT3_{air}$	ISCT3-modeled concentration of COPC in air	g/m^3
$Q_{chemical}$	Chemical-specific emission rate	g/sec
RfD_i	Chronic inhalation reference dose	mg/kg-day
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
S_{unit}	Unit concentration of COPC in soil	mg/kg
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
VF_{air}	Subsurface to ambient air volatilization factor	$\mu g/m^3$
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 13-5. Current and Future Fenceline Resident Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for Inhalation of Vapors from Site-Wide Groundwater

$RBC_{res/air}$ values calculated per Equations FR-4 and FR-5

$RBSL_{res/wamb}$:

FR-9a

$$RBSL_{res/wamb}\left[\frac{\mu g}{L}\right] = \frac{RBC_{res/air}}{VF_{gw}} \times 10^{3}\ \frac{\mu g - m^{3}}{g - L}$$

where:

FR-9b

$$VF_{gw}\left[\frac{\mu g}{g}\right] = \frac{ISCST3_{air} \times D^{air} \times \theta_{as}^{3.33} \times A_{GW} \times H'}{ER_{unit} \times \theta_{T}^{2} \times L_{GW}} \times 10^{-2}\ \frac{m}{cm}$$

where:

Parameter	Definition	Units
$RBC_{res/air}$	RBC for volatile COPC in air for fenceline resident	$\mu g/m^3$
$RBSL_{res/wamb}$	RBSL in groundwater for vapor in ambient air for fenceline resident	$\mu g/L$
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
D_{cap}^{eff}	Effective diffusion coefficient in capillary fringe region	cm^2/sec
D_s^{eff}	Effective diffusion coefficient in soil based on vapor-phase concentration	cm^2/sec
D_{ws}^{eff}	Effective diffusion coefficient between ground water and SWMU surface	cm^2/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
h_{cap}	Thickness of capillary fringe	cm
h_v	Thickness of vadose zone	cm
L_{GW}	Depth to groundwater ($h_{cap} + h_v$)	cm
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/sec
VF_{wamb}	Volatilization factor from groundwater to ambient air	kg-soil/m^3-air
W_{GW}	Width of groundwater source	cm
δ_{air}	Mixing zone height	cm
θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil
θ_T	Total soil porosity	cm^3/cm^3-soil
θ_{ws}	Volumetric water content in vadose zone soils	cm^3-water/cm^3-soil

Table 13-6. Current and Future Fenceline Resident Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Pit Vapor Inhalation Pathway

$RBC_{res/air}$ values calculated per Equations FR-4 and FR-5

$RBSL_{res/pit}$:

FR-10a

$$RBSL_{res/pit}\left[\frac{\mu g}{L}\right] = \frac{RBC_{res/air}}{VF_{res/pit}} \times 10^{-3}\ \frac{m^3}{L}$$

where the chemical specific volatilization rate $VF_{res/pit}$ is:

FR-10b

$$VF_{res/pit}\ [\text{dimensionless}] = ISCST3_{air} \times \frac{k_L}{1 + \frac{k_L}{k_G \times H'}} \times A \times \frac{1}{ER_{unit}}$$

Gas-phase mass transfer coefficient:

FR-10c

$$k_G\left[\frac{m}{sec}\right] = 4.82 \times 10^{-3} \times U_{10}^{0.78} \times Sc_G^{-0.67} \times de^{-0.11} \quad \text{where}$$

Effective diameter of impoundment:

FR-10d

$$de[m] = \sqrt{\frac{4 \times A}{\pi}}$$

Schmidt number on the gas side:

FR-10e

$$Sc_G = \frac{\mu_G}{\rho_G \times D^{air}}$$

Liquid-phase transfer coefficient:

FR-10f

$$k_L\left[\frac{m}{sec}\right] = 10^{-6} + 144 \times 10^{-4} \times U^{*2.2} \times Sc_L^{-0.5} \quad \text{where}$$

Schmidt number on the liquid side:

FR-10g

$$Sc_L = \frac{\mu_L}{\rho_L \times D^{wat}}$$

Friction velocity:

FR-10h

$$U^*\left[\frac{m}{sec}\right] = 0.01 \times U_{10} \times \sqrt{6.1 + 0.63 \times U_{10}}$$

where:

Parameter Definition		Units
$RBC_{res/air}$	RBC for volatile COPC in air for fenceline resident	$\mu g/m^3$
$RBSL_{res/pit}$	RBSL in pit water for vapor in ambient air for fenceline resident	$\mu g/L$
A	Liquid area (pit)	m^2
D^{air}	Molecular diffusion coefficient in air	cm^2/sec
D^{water}	Molecular diffusion coefficient in water	cm^2/sec
de	Effective diameter of impoundment (pit)	m
ER_{unit}	Unit emission rate	g/sec
H'	Dimensionless Henry's Law constant	L-water/L-air
$ISCT3_{air}$	ISCT3-modeled concentration of COPC in air	g/m^3
k_G	Gas-phase mass transfer coefficient	m/sec
k_L	Liquid-phase mass transfer coefficient	m/sec
Sc_G	Schmidt number on the gas side	unitless
Sc_L	Schmidt number on the liquid side	unitless
U^*	Friction velocity	m/sec
U_{10}	Wind speed at 10 meters above liquid surface (pit)	m/sec
VF_{pit}	Volatilization rate from pit	$\mu g/g$
μ_G	Viscosity of air	g/cm-sec
μ_L	Viscosity of water	g/cm-sec
ρ_L	Density of water	g/cm^3
ρ_s	Soil bulk density	g-soil/cm^3-soil

Table 13-7. Current and Future Fenceline Resident Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	10,950	days		Total ED (30 years) x 365 days/year
BW_c	Body weight (child)	16.6	kg	EPA, 1997	Mean body weight of male and female children aged 1 to 6 years
BW_a	Body weight (adult)	71.8	kg	EPA, 1997	Recommended body weight for male and female adults
ED_c	Residential exposure duration (child)	6	years	EPA, 1991	Ages 1 to 6 years
ED_a	Residential exposure duration (adult)	24	years	EPA, 1991	Ages 7 to 30 years
EF_{res}	Residential exposure frequency	350	days/year	EPA, 1989b	Default value
$IR_{a/c}$	Inhalation rate (child)	8.7	m^3/day	EPA, 1997	Recommended mean long-term inhalation rate for children aged 1 to 12 years
$IR_{a/a}$	Inhalation rate (adult)	13.3	m^3/day	EPA, 1997	Recommended mean long-term inhalation rate for adult males and females
IFA_{res}	Age-adjusted inhalation factor	7.6	m^3-year/kg-day	Calculated by analogy to RAGS Vol. I Part B (EPA, 1991): $IFA_{res} = \frac{IR_{a/c} \times ED_c}{BW_c} + \frac{IR_{a/a} \times ED_a}{BW_a}$	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989b	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989b	Default
CHEMICAL-SPECIFIC TOXICITY PARAMETERS					
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	

~~12.0~~14.0 EQUATIONS AND PARAMETER VALUES FOR DEVELOPMENT OF TIER 1 RISK-BASED SCREENING LEVELS FOR THE ~~PRESENT~~ CURRENT AND FUTURE OFF-SITE WATER CONSUMER SCENARIO

The off-site water consumer population is assumed to consist of adults and children whose domestic water supply is surface water derived from intakes downstream of the mouth of the Niagara River. Because the only COPC in Lake Erie surface water is bis(2-ethylhexyl)phthalate (see Interim Deliverable No. 1, Table 4-~~44~~47), and its maximum detected concentration (21 µg/L; see Interim Deliverable No. 1, Table E-3) exceeds the MCL (6 µg/L; EPA, 1996a) less than four-fold, only COPCs identified for the groundwater-to-surface water pathway will be considered for the off-site water consumer. That is, RBSLs protective of off-site water consumers will be developed only for COPCs detected in groundwater that discharges into Smokes Creek and nearshore Lake Erie.

Equations that will be used to calculate RBSLs for the various pathways are presented in the sections below and in Table ~~12~~-14-1. Exposure parameter values to be used in calculating Tier 1 RBSLs for the off-site water consumer scenario are presented in Table ~~12~~-14-2. Toxicity criteria were presented in Interim Deliverable No. 1. Other chemical-specific parameter values, site-specific parameter values, and intermediate calculations will be presented in Interim Deliverable No. 3.

Groundwater RBSLs for off-site water consumers will be back-calculated from corresponding federal Maximum Contaminant Levels (MCLs) (EPA, 1996a) or, for chemicals lacking MCLs, risk-based tap water concentrations (RBC_{tw}) (EPA, 199~~8~~7) using a steady-state mass balance model assuming a well-mixed system (Table ~~12~~-14-1). Inhalation as well as ingestion routes will be included in these RBCs for volatile organic compounds (*i.e.*, compounds having a Henry's Law constant greater than 10^{-5} and molecular weight less than 200 daltons). Because the water consumer RBSLs are preferentially based on MCLs, which are of variable derivation, potential human health risks for this scenario will be evaluated in terms of ratios of site groundwater COPC concentrations to RBSLs rather than as screening-level cancer risks and hazard quotients as in other scenarios. Therefore, for COPCs that lack MCLs but have both cancer and non-cancer toxicity criteria, the lower of the RBCs calculated per Equations WC-1 and WC-2 will be selected for comparison, and the risk ratio will be computed without regard to carcinogenic vs. non-carcinogenic status. RBSLs for water consumers will also be compared to modeled concentrations of COPCs in the water supply assuming shutdown of the Ship Canal pumps.

~~12.1~~14.1 LAKE ERIE

The water intakes for the off-site water consumers are located downstream from the mouth of the Niagara River. Flow from the nearshore zone in Lake Erie enters the Niagara River through a narrow and relatively shallow channel, which results in fast currents and very turbulent water. It is therefore assumed that the nearshore flow completely mixes with the entire flow in the Niagara River. The entire flow from the Lake into the Niagara River is about 200,000 cfs (USACOE, 1991). Accordingly, the dilution factor for surface water in the nearshore zone of the Lake entering the Niagara

River is estimated as 200,000 cfs /135 cfs, or around 1,480-fold. The combined dilution factor for groundwater from the area along the Lake shore that eventually enters the Niagara River is the product of the nearshore zone dilution (135- fold; see Section 9.0) and the dilution at the mouth of the River (1,480-fold). The resulting combined dilution factor for Lake Erie discharge area groundwater is approximately 200,000-fold. The water consumer RBSL for ground water emptying directly into Lake Erie will therefore be calculated in accordance with Equation WC-3 (Table ~~12-~~14-1).

~~12.2~~14.2 SMOKES CREEK

As previously described (Section 10.0), the dilution factor for groundwater entering Smokes Creek is 324-fold. The outflow from Smokes Creek empties into Lake Erie. The net flow into the nearshore zone of Lake Erie is assumed to be equal to the total outflow of Smokes Creek. The dilution factor for Smokes Creek surface water entering the nearshore zone of Lake Erie is therefore 135 cfs/120cfs, or 1.1. The combined dilution factor for Smokes Creek discharge area groundwater is the product of dilution in Smokes Creek (324-fold), nearshore zone dilution (1.1), and dilution in the Niagara River (1,480-fold), or approximately 480,000. The water consumer RBSL for ground water emptying directly into Lake Erie will therefore be calculated in accordance with Equation WC-4 (Table ~~12-~~14-1).

Table 14-1. Present and Future Off-Site Water Consumer Scenario: Equations to be Used to Calculate Risk-Based Screening Levels for the Direct Contact Pathway

Non-Cancer RBC_{tw} (EPA, 1998):

WC- 1

$$RBC_{tw}\left[\frac{\mu g}{L}\right] = \frac{THQ \times AT_n}{EF_{res} \times \left[\left(K \times IFA_{res} \times \frac{1}{RfD_i}\right) + \left(IFW_{res} \times \frac{1}{RfD_o}\right)\right]} \times 10^3 \frac{\mu g}{mg}$$

Cancer RBC_{tw} (EPA, 1998):

WC- 2

$$RBC_{tw}\left[\frac{\mu g}{L}\right] = \frac{TR \times AT_c}{EF_{res} \times [(K \times IFA_{res} \times SF_i) + (IFW_{res} \times SF_o)]} \times 10^3 \frac{\mu g}{mg}$$

$RBSL_{wc/gw/LE}$ (Lake Erie discharge area):

WC- 3

$$RBSL_{wc/gw/LE}\left[\frac{\mu g}{L}\right] = (MCL \text{ or } RBC_{tw}) \times DF_{wc/gw \rightarrow sw/LE}$$

$RBSL_{wc/gw/SC}$ (Smokes Creek discharge area):

WC- 4

$$RBSL_{res/gw/SC}\left[\frac{\mu g}{L}\right] = (MCL \text{ or } RBC_{tw}) \times DF_{wc/gw \rightarrow sw/SC}$$

where:

Parameter Definition		Units
RBC_{tw}	RBC in drinking water	µg/L
$RBSL_{wc/gw/LE}$	RBSL in Lake Erie Discharge Area groundwater for off-site water consumers	µg/L
$RBSL_{wc/gw/SC}$	RBSL in Smokes Creek Discharge Area groundwater for off-site water consumers	µg/L
AT_c	Averaging time for carcinogenic effects	days
AT_n	Averaging time for non-carcinogenic effects	days
$DF_{wc/gw \rightarrow sw/LE}$	Dilution factor for groundwater entering Lake Erie and thence to Niagara intakes	unitless
$DF_{wc/gw \rightarrow sw/SC}$	Dilution factor for groundwater entering Smokes Creek and thence to Niagara intakes	unitless
EF_{res}	Residential exposure frequency	days/year
IFA_{res}	Age-adjusted residential inhalation factor	m^3-year/kg-day
IFW_{res}	Age-adjusted residential water ingestion factor	L-year/kg-day
K	Volatilization factor	L/m^3
MCL	Maximum contaminant limit	µg/L
THQ	Target hazard quotient	unitless
TR	Target cancer risk level	unitless
RfD_i	Chronic inhalation reference dose	mg/kg-day
RfD_o	Chronic oral reference dose	mg/kg-day
SF_i	Inhalation slope factor	$(mg/kg\text{-}day)^{-1}$
SF_o	Oral slope factor	$(mg/kg\text{-}day)^{-1}$

Table 14-2. Present and Future Off-Site Water Consumer Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
EXPOSURE PARAMETERS					
AT_c	Averaging time for carcinogenic effects	27,375	days	EPA, 1997	Recommended value
AT_n	Averaging time for non-carcinogenic effects	10,950	days		Total ED (30 years) x 365 days/year
BW_c	Body weight (child)	16.6	kg	EPA, 1997	Mean body weight of male and female children aged 1 to 6 years
BW_a	Body weight (adult)	71.8	kg	EPA, 1997	Recommended body weight for male and female adults
ED_c	Exposure duration (child)	6	years	EPA, 1989b	Ages 1 to 6 years
ED_a	Exposure duration (adult)	24	Years	EPA, 1989b	Ages 7 to 30 years
EF_{res}	Residential exposure frequency	350	days/year	EPA, 1989b	Default residential exposure frequency
$IR_{a/c}$	Inhalation rate (child)	8.7	m^3/day	EPA, 1997	Recommended mean long-term inhalation rate for children aged 1 to 12 years
$IR_{a/a}$	Inhalation rate (adult)	13.3	m^3/day	EPA, 1997	Recommended mean long-term inhalation rate for adult males and females
IFA_{res}	Age-adjusted inhalation factor	7.6	m^3-year/ kg-day	Calculated by analogy to RAGS Vol. I Part B (EPA, 1991): $IFA_{res} = \frac{IR_{a/c} \times ED_c}{BW_c} + \frac{IR_{a/a} \times ED_a}{BW_a}$	
$IR_{w/c}$	Residential water ingestion rate (child)	0.87	L/day	EPA, 1997	Mean daily intake by children aged 3 to 5 years
$IR_{w/a}$	Residential water ingestion rate (adult)	1.41	L/day	EPA, 1997	Population-weighted mean daily intake by adult males and females
IFW_{res}	Age-adjusted residential water ingestion factor	0.79	L-year/ kg-day	Calculated by analogy to RAGS Vol. I Part B (EPA, 1991): $\frac{IR_{w/c} \times ED_c}{BW_c} + \frac{IR_{w/a} \times ED_a}{BW_a}$	
K	Volatilization factor	0.5	L/m^3	EPA, 1998	
RISK AND HAZARD CRITERIA					
THQ	Target hazard quotient	1.0	unitless	EPA, 1989	Default
TR	Target cancer risk level	10^{-6}	unitless	EPA, 1989	Default
MCL	Maximum contaminant limit	Chemical-specific	µg/L	See Interim Deliverable No. 1	

Table 14-2. Present and Future Off-Site Water Consumer Scenario: Exposure and Toxicity Parameter Definitions and Values

Parameter Definition		Value	Units	Source	Comment
RfD_i	Chronic inhalation reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
RfD_o	Chronic oral reference dose	Chemical-specific	mg/kg-day	See Interim Deliverable No. 1	
SF_i	Inhalation slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	
SF_o	Oral slope factor	Chemical-specific	$(mg/kg\text{-}day)^{-1}$	See Interim Deliverable No. 1	

15. REFERENCES

American Society for Testing and Materials (ASTM). 1995. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. E 1739-95.

Csanady, G.T. 1970. Dispersal of effluents in the Great Lakes. *Water Res* **4**:79-114.

Dames & Moore. 1993. Phase IIA RFI Report. Draft Final Report, Phased Site Investigation, Bethlehem Steel Corporation, Lackawanna, New York.

___. 1994. Phase IIB RFI Report. Draft Final Report, Phased Site Investigation, Bethlehem Steel Corporation, Lackawanna, New York. Phase IIA RFI Report.

___. 1998. Human Health Risk Assessment for Bethlehem Steel Corporation's Lackawanna, New York Site Revised Interim Deliverable No. 1. Detailed Process for Selection of Chemicals of Potential Concern and Identification of Toxicological Criteria. December 1998.

Farmer, W.J., M.S. Yang, J. Letey, W.F. Spencer, and M.H. Roulier. 1978. In: *Land Disposal of Hazardous Waste.* Proceedings of the Fourth Annual Research Symposium. U.S. Environmental Protection Agency, Report No. 631/9-78-016. U.S. Government Printing Office, Washington, D.C., pp. 182-190.

Farmer, W.J., M.S. Yang, J. Letey, and W.F. Spencer. 1980. In: *Land Disposal of Hexachlorobenzene Wastes*. Office of Research and Development, Washington, D.C. EPA-600/2-80/119.

Groundwater Services, Inc. (GSI). 1995. *Tier 2 Guidance Manual for Risk-Based Corrective Action, Appendix A.*

U.S. Army Corps of Engineers (USACOE). 1991. Niagara River – Nov. & Dec. 1990 Current Direction and Velocity Measurements. Prepared for New York Power Authority.

___. 1989a. *Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models.*

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

___. 1991. *Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals).*

Interim. EPA/540/R-92/003. Office of Research and Development, Washington, D.C.

___. 1994. *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children.* EPA/540/R-93/081. Office of Emergency and Remedial Response, Washington, D.C.

___. 1996a. *Drinking Water Regulations and Health Advisories.* Office of Water. EPA 822-B-96-002.

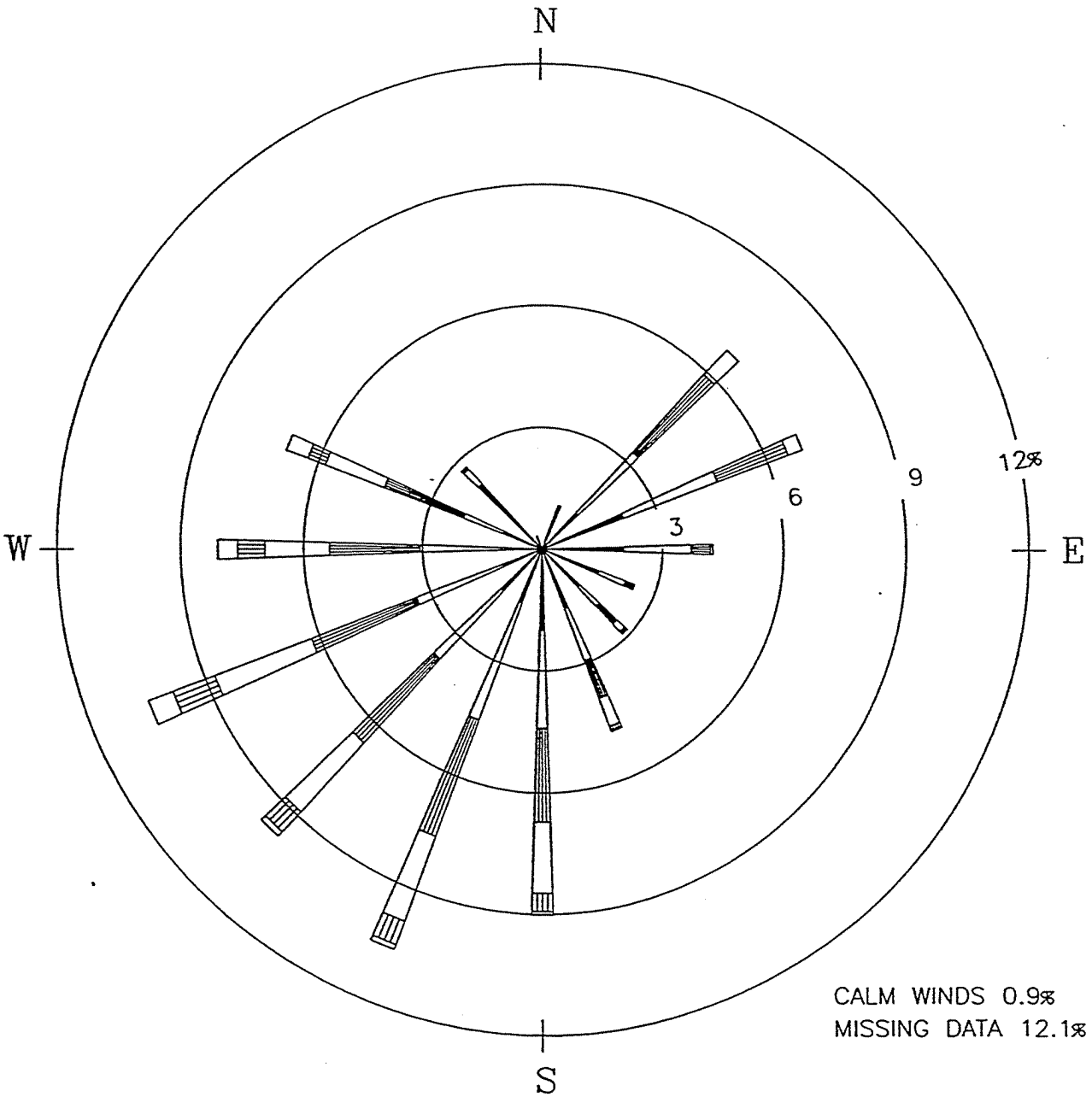
___. 1996b. *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.*

___. 1997. *Exposure Factors Handbook.* EPA/600/P-98/002Fa.

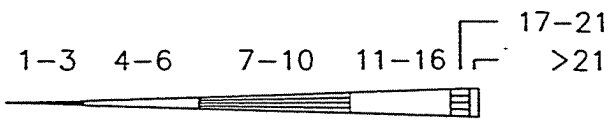
___. 1998. U.S. EPA Region III Risk-Based Concentration Table. October, 1998.

APPENDIX A

METEOROLOGICAL DATA



CALM WINDS 0.9%
MISSING DATA 12.1%



WIND SPEED CLASSES
(KNOTS)

WINDROSE

STATION NO. 99999
LACKAWANNA, NY
PERIOD: 1991

NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURRENCE FOR EACH WIND DIRECTION. WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING. EXAMPLE – WIND IS BLOWING FROM THE SOUTH 9.0 PERCENT OF THE TIME.

Bowman Environmental Engineering

Summary of Meteorological Data
For Year 1991

Percentage Occurrence of Stability Classes

A	B	C	D	E	F
.7	6.1	10.8	58.4	8.4	15.6

Distribution of Wind Direction vs. Stability (Hours)

	Stability Class						
Dir	A	B	C	D	E	F	Totals
N	0.	0.	0.	0.	0.	0.	0.
NNE	0.	0.	3.	66.	21.	11.	101.
NE	0.	12.	57.	356.	69.	96.	590.
ENE	1.	32.	82.	256.	76.	159.	606.
E	4.	29.	34.	106.	50.	150.	373.
ESE	11.	15.	13.	67.	8.	100.	214.
SE	3.	10.	16.	127.	17.	79.	252.
SSE	3.	14.	41.	195.	50.	117.	420.
S	0.	13.	54.	423.	101.	200.	791.
SSW	3.	33.	102.	474.	121.	193.	926.
SW	5.	74.	127.	494.	65.	85.	850.
WSW	10.	122.	169.	538.	44.	36.	919.
W	13.	110.	122.	407.	27.	30.	709.
WNW	6.	49.	64.	392.	50.	39.	600.
NW	0.	9.	18.	147.	35.	33.	242.
NNW	0.	0.	3.	19.	5.	3.	30.
Calm/Mis.	6.	9.	38.	1042.	0.	42.	1137.
Totals	65.	531.	943.	5109.	739.	1373.	8760.

APPENDIX B

SUBCHRONIC TOXICITY DATA

APPENDIX B

Subchronic Toxicity Criteria for Chemicals of Potential Concern
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical of Potential Concern	Subchronic Oral Reference Dose (mg/kg-day)		Subchronic Inhalation Reference Dose (mg/kg-day)	
Volatile Organic Chemicals				
Benzene	NA		1.71E-02	E
Bromodichloromethane	2.00E-02	H	2.00E-02	R
Bromoform	2.00E-01	H	2.00E-01	R
Carbon disulfide	1.00E-01	H	1.00E-01	R
Carbon tetrachloride	2.00E-03	E	2.00E-03	R
Chlorobenzene *	NA		1.71E-01	
Chlorodibromomethane	2.00E-01	H	2.00E-01	R
Chloroform	1.00E-02	H	1.00E-02	R
1,1-Dichloroethane	1.00E+00	H	1.43E+00	A
1,2-Dichloroethane	NA		NA	
1,2-Dichloroethene, Total **	1.00E-01	H	NA	
Ethylbenzene	1.00E-01	E	2.90E-01	E
Methylene chloride	6.00E-02	H	6.00E-02	R
Pyridine	1.00E-02	H	1.00E-02	R
Toluene	2.00E+00	H	1.14E-01	E
1,1,2,2-Tetrachloroethane	NA		NA	
1,1,1-Trichloroethane	NA		NA	
Trichloroethene	NA		NA	
Vinyl chloride	NA		NA	
m-Xylene and p-Xylene	NA		NA	
o-Xylene	NA		NA	
Xylenes, Total	NA		NA	
"Volatile Semivolatile" Organic Chemicals				
Acenaphthene	6.00E-01	H	6.00E-01	R
Acenaphthylene	NA		NA	
Anthracene	3.00E+00	H	3.00E+00	R
Fluorene	4.00E-01	H	4.00E-01	R
Naphthalene	NA		NA	
Phenanthrene	NA		NA	
Semivolatile Organic Chemicals				
Benz(a)anthracene	NA		NA	
Benzo(a)pyrene	NA		NA	
Benzo(b)fluoranthene	NA		NA	
Benzo(g,h,i)perylene	NA		NA	
Benzo(k)fluoranthene	NA		NA	
Bis(2-ethylhexyl)phthalate	NA		NA	
Chrysene	NA		NA	
Cresols, Total ***	5.00E-03	H	NA	
Dibenz(a,h)anthracene	NA		NA	
2,4-Dimethylphenol	2.00E-01	H	NA	
Fluoranthene	4.00E-01	E	NA	
Indeno(1,2,3-c,d)pyrene	NA		NA	
2-Methylphenol	5.00E-01	H	NA	

APPENDIX B

Subchronic Toxicity Criteria for Chemicals of Potential Concern
Human Health Risk Assessment for the Bethlehem Steel Corporation Lackawanna Site
Lackawanna, New York

Chemical of Potential Concern	Subchronic Oral Reference Dose (mg/kg-day)		Subchronic Inhalation Reference Dose (mg/kg-day)	
3-Methylphenol	5.00E-01	H	NA	
3-Methylphenol & 4-Methylphenol ***	5.00E-03	H	NA	
4-Methylphenol	5.00E-03	H	NA	
Phenol	6.00E-01	H	NA	
Pyrene	3.00E-01	H	NA	
Inorganic Chemicals				
Antimony	4.00E-04	H	NA	
Arsenic	3.00E-04	H	NA	
Barium	7.00E-02	H	1.43E-03	A
Cadmium	NA		NA	
Chromium	2.00E-02	H	NA	
Cyanide	2.00E-02	H	NA	
Lead	NA		NA	
Nickel	2.00E-02	H	NA	
Silver	5.00E-03	H	NA	
Thallium	8.00E-04	H	NA	

Notes:

Sources of toxicity criteria: H=HEAST A=HEAST alternate E=EPA-NCEA Regional Support provisional value R=Route-to-route extrapolation

NA = Not available

Chromium is conservatively assumed to be in the toxic and carcinogenic hexavalent form.

"Cyanide" is assumed to be free cyanide.

* The provisional chronic RfC for chlorobenzene, which is based on a subchronic study and includes an uncertainty factor of ten for extrapolation to chronic exposure conditions, was multiplied by ten to derive a subchronic value.

** Toxicity is conservatively assumed to be equivalent to that of the more toxic cis-isomer.

*** Toxicity is conservatively assumed to be equivalent to that of the most toxic isomer (4-methylphenol).

APPENDIX C

Responses to USEPA Comments on ID No. 2

Response to Comments from U.S. EPA
Revised Interim Deliverable No. 2 of
the Human Health Risk Assessment
(Comments Dated April 3, 2003)

The following responses to U.S. EPA's comments on ID No. 2, although not required, are provided in order to document the manner in which the comments have been addressed. The comments have been paraphrased from Attachment 1 to the April 3, 2003 letter from Dale Carpenter (U.S. EPA Region 2) to Leo Kaercher (Bethlehem Steel Corporation).

General Comment No. 1: The exposure of current workers to indoor air vapors migrating from Coke Oven Area groundwater if any occupied buildings are located in, or around the contaminated groundwater plume, will be quantitatively evaluated. Once indoor air vapor concentrations have been quantified, the appropriate OSHA standards to calculate potential risks to the workers will be used. A similar approach should be employed for surface and subsurface soil contamination.

> **Response:** The groundwater to indoor air pathway for industrial/commercial workers at SWMU #26, (the only location in the Coke Oven Area where there is both volatile groundwater contamination and a building) was quantified. Fate and transport modeling was utilized to estimate indoor volatile concentrations resulting from groundwater migration. These concentrations were then compared to the appropriate OSHA PELs, which were used as risk-based levels for comparison purposes.

General Comment No. 2: Separate documentation of the Site OSHA program is not acceptable. The risk assessment will demonstrate how current workers are protected or exposures evaluated quantitatively using the procedure described in General Comment No. 1.

> **Response:** The pathways were quantified as described in General Comment No. 1.

Specific Comment No. 1: It must be stated that the site is deed restricted for industrial use and, as a result, residential development will not occur unless this deed restriction is changed in the future.

> **Response:** This is stated in the individual SWMU reports in Parts V and VI of the RFI report.

Specific Comment No. 2: The exposure of G.T.C. Incorporated workers to vapors from groundwater should be evaluated using data from the Coke Oven Area groundwater, not site-wide groundwater.

> **Response:** Coke Oven Area groundwater data were used to quantify these worker exposures.

Specific Comment No. 3: Revise Table 2-1 to include the following receptors and exposure pathways:

- Dermal exposure to groundwater: current workers, future utility/maintenance workers, future construction workers.
- Dermal contact to sediments: future recreational bathers

Response: These exposure pathways were added to Table 3-1 in Part IV of the RFI Report and were quantified, where appropriate, in the Part V, VI, and VII Reports. As described in Specific Comment #7, the dermal exposure to groundwater pathway was quantified at SWMUs where groundwater is shallow (i.e., less than 15 feet bgs).

Specific Comment No. 4: Expand ID No. 2 and Table 2-2 to include all site SWMUs identified in the draft RFI (i.e., add SWMUs S-12, S-13, S-28, S-29).

Response: These SWMUs were evaluated qualitatively in their respective SWMU reports (Parts V and VI of the RFI). As such, they are not part of the Human Health Risk Assessment Report (Part IV of the RFI). The Revised Final ID No. 2 provides the rationales for their exclusion from the HHRA (Section 2.1).

Specific Comment No. 5: An average depth of groundwater of 35 feet is not an appropriate assumption for receptors in the Coke Oven area. Use an average depth to groundwater of 10 feet to evaluate risks to workers in and adjacent to the Coke Oven Area.

Response: SWMU-specific depths to groundwater were used. In all cases, this was 10 feet or less in the Coke Oven Area.

Specific Comment No. 6: The exposure pathway tables highlight numerous data gaps in site characterization. Consider changing the tables to clarify the information for the general reader. Change the tables to footnote data gaps due to no available data, no toxicity data, or no volatile chemicals detected.

Response: As requested by U.S. EPA in their comment letter, a revised ID No. 2 is not required. The information has been included and/or referenced in the SWMU reports (Parts V, VI, VII) within the RFI Report.

Specific Comment No. 7: Future construction workers and utility/maintenance worker dermal exposures to groundwater must be evaluated where the depth to groundwater is shallow (less than 15 feet).

Response: This was done in each Part V or VI report, for the following SWMUs with shallow groundwater: PA-1, PA-2, PA-3, PA-4 (SWMUs P-11 and P-12), S-8, S-10, S-24, S-26, Tank Farm. Thus, groundwater RBSLs are protective for

both inhalation and dermal contact for construction and utility/maintenance workers.

Specific Comment No. 8: Exposure via direct contact to quench water and soils located in the PA-1 pits, SWMU P-11 and P-18 must be addressed.

Response: This was done (in the PA-1, P-11 and P-18 SWMU reports), where applicable and data are available. Thus, pit water RBSLs are protective for both inhalation and dermal contact for construction and utility/maintenance workers.

Specific Comment No. 9: The risk assessment should be consistent with the approach used in the RFI report, using the same model/flux calculations. In addition to assessing exposure to ship canal maintenance workers, this model is also used to assess exposure to current and future fish consumers.

Response: Revised flux calculations generated for the revised RFI were used in quantifying exposures to ship canal maintenance workers and as input to the modeling for the fish consumption pathway.

Specific Comment No. 10: Future recreational bather dermal exposures to sediments must be addressed for Blasdell Creek, Smokes Creek, and near shore Lake Erie.

Response: These pathways were quantified in the appropriate watercourse reports (Blasdell Creek and Smokes Creek, Part VII) or in Part IV (for Lake Erie) of the RFI report. Thus, sediment RBSLs are protective for both dermal contact and ingestion for the recreational bather population.

Specific Comment No. 11: The averaging time for noncarcinogenic effects should be 2,409 days on Table 6-5.

Response: The assumed exposure duration of 6.6 years on Table 6-5 is incorrect and should be 1 year (utility/maintenance worker). The correct noncancer averaging time is, therefore, 365 days.

Specific Comment No. 12: Based on a review of the integrated findings of all phases of the RFI report, areas of investigative focus may need to be extended and additional data collected. Such actions may impact the risk assessment.

Response: This issue is acknowledged and will be addressed during future activities during the CMS.

Date: October 8, 2004

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D

APPENDIX D

Lake Erie Risk Assessment

APPENDIX D
HUMAN HEALTH RISK ASSESMENT FOR LAKE ERIE EXPOSURES

As described in Part IV of this RFI report and the Human Health Risk Assessment (HHRA) Interim Deliverables (IDs) No. 1 and No. 2 (BSC 1998, 1999) a number of potential exposure scenarios that require quantification for human health involve Lake Erie receptors and media. Since these exposures are not specific to a given SWMU at the Lackawanna Facility, the evaluation of these pathways are summarized in this appendix rather than in a separate watercourse report. Since the methodology for conducting an HHRA was presented in previous Part IV sections, this appendix serves as a summary report much like the other watercourse reports in Part VII of the RFI report.

1.0 DATA EVALUATION

The chemicals of potential concern (COPCs) for Lake Erie were determined by sequentially applying the following criteria, as applicable, to each detected chemical of potential interest on a medium-by-medium basis: 1) the chemical was detected in at least 5% of the samples, 2) the chemical was detected in at least one sample at a level above background (*i.e.*, the maximum sediment concentration was above background), and 3) the chemical was positively detected in at least one sample at levels above applicable screening criteria [*i.e.*, USEPA Region III Risk Based Concentrations (RBCs), NYSDEC Ambient Water Quality Standards and Guidance values].

The sampling data for this HHRA (presented in Part II of the RFI report) were evaluated in order to identify the site-related COPCs for receptor scenarios affiliated with this watercourse. The COPCs were originally determined in ID No. 1, however, as some screening criteria have been revised and because additional samples have been collected since ID No. 1 was submitted, this screening process was updated (Tables 1 through 3).

There are three media of interest: Lake Erie surface water, groundwater in the Lake Erie discharge area and Lake Erie sediment. In Lake Erie surface water, one semivolatile organic COPC (bis(2-ethylhexyl)phthalate was identified (Table 1). Samples in the Lake Erie groundwater discharge area are used for the evaluation of transport of COPCs from groundwater to surface water. In the Lake Erie groundwater discharge area, nine volatile organic COPCs, five volatile semivolatile organic COPCs, nine semivolatile COPCs, and eleven inorganic COPCs were identified (Table 2). In Lake Erie sediment,

two semivolatile organic COPCs (benzo(a)pyrene and dibenz(a,h)anthracene) and one metal COPC (arsenic) were identified (Table 3).

Representative concentrations were determined for each COPC in each medium. For datasets with sample sizes of ten or greater, the 95% upper confidence limit of the mean (95% UCL) was calculated and used as the representative concentration. In cases where the sample size is less than 10 or when the calculated 95% UCL is greater than the maximum concentration, the maximum concentration was used as the representative concentration. The COPCs and their representative concentrations are presented in Table 4. These representative concentrations are used in the risk characterization.

2.0 EXPOSURE ASSESSMENT

Human Health Risk Assessment ID No. 2 (BSC 1999) presented the current and future human receptor scenarios and potentially complete exposure pathways for each SWMU and watercourse identified at the Lackawanna facility. Potential exposure pathways for Lake Erie are presented in Table 5. Subsequent USEPA comments on ID No. 2 identified additional potentially complete exposure pathways (USEPA 2003).

As previously established in ID No. 2, for the Lake Erie HHRA, the potential receptor scenarios include a present and future recreational bather, a present and future fish consumer and a present and future off-site water consumer.

For the present and future recreational bather scenarios, direct contact (*i.e.,* ingestion and dermal contact) with Lake Erie surface water and sediment were considered potentially complete exposure pathways. Direct contact with COPCs transported from the Lake Erie groundwater discharge area to surface water was included in this scenario. For the present and future fish consumer scenarios, ingestion of COPCs in fish that have bioaccumulated via Lake Erie surface water and from the Lake Erie groundwater discharge area were considered potentially complete exposure pathways. For the present and future off-site water consumer scenarios, the potential pathway of ingestion of drinking water from the Niagara River was determined as potentially complete. The COPCs that could be transported into the Niagara River via transport from the Lake Erie groundwater discharge area to Lake Erie are included in this scenario. A more detailed description of the potentially exposed receptor scenarios and pathways for the Lake Erie HHRA are in ID. No. 2 (BSC 1999) and Part IV.

3.0 DEVELOPMENT OF RISK-BASED SCREENING LEVELS

Tier 1 RBSLs were calculated and compared to the respective representative concentrations. The RBSLs are defined as concentrations of COPCs in media that are not expected to produce any adverse health effects under assumed exposure conditions. The equations used to calculate the RBSLs follow basic USEPA risk assessment principles (USEPA 1989; 1996). Conservative exposure parameters, as defined by the ASTM Standard (ASTM, 1995), USEPA guidance (USEPA, 1989; 1991a; 1991b), and USEPA toxicity criteria (USEPA, 2000b) were inputs into these equations.

In addition to standard USEPA equations and as presented in ID. No. 2, additional methodologies were used to arrive at the receptor-specific RBSLs. For the recreational bather and fish consumer scenarios, groundwater RBSLs for contact with surface water in Lake Erie were back-calculated from corresponding surface water RBSLs using a dilution factor, in accordance with ID No. 2 (BSC 1998). The dilution factor of 106 is the ratio of the surface water outflow rate (provided in ID No.2) divided by the total annual groundwater discharge rate (provided in Table J-1 of the RFI).

For the fish consumer scenarios, surface water concentrations corresponding to acceptable fish tissue concentrations were calculated using published bioconcentration factors (BCFs). For the off site water consumer scenarios, groundwater RBSLs for off site water consumers were back-calculated from corresponding 1996 federal Maximum Contaminant Levels (MCLs), or, for chemicals that lack MCLs, Region III risk-based tap water concentrations (USEPA 2000a), using a steady-state mass balance model assuming a well-mixed system. This is discussed in ID No. 2 (BSC 1998). Because the water consumer RBSLs are preferentially based on MCLs, which are of variable derivation, potential human health risks for this scenario were not evaluated in terms of cancer or noncancer effects, but rather as a direct concentration comparison.

Toxicity criteria are current as of 2000 (USEPA 2000b) and are summarized in Table 6. The bioconcentration factors (BCFs) used in the calculation of fish consumer scenario RBSLs are presented in Table 7. When available, BCFs were obtained from the CHEMFATE database (Syracuse Research Corporation 2001). The database, CHEMFATE, is a data value file containing environmental fate and physical/chemical property information for commercially important chemical compounds. When values were not available, they were calculated using USEPA (1988) guidelines.

It should be noted that, in surface water, some of the calculated RBSLs are greater than the chemicals' solubility in water. In such cases, the RBSL was capped at the solubility limit. None of the representative concentrations of chemicals in surface water, however, are greater than their respective solubility limits. The solubility limits of these chemicals are indicated in Table 8.

A comparison of the representative COPC concentrations to the calculated RBSLs for each of the exposure scenarios is presented in Table 8. This comparison provides a preliminary screening of potential risks to the specific receptor populations and exposure pathways identified for this SWMU.

For the fish consumer scenarios, bis(2-ethylhexyl)phthalate in surface water exceeds the fish ingestion RBSL (via biotransport from surface water to fish). For all other chemicals and scenarios, the representative concentrations are below their respective RBSLs. As described in Part IV, those COPCs that do not exceed the Tier 1 RBSLs are not evaluated further. The exceedance of bis(2-ethylhexyl)phthalate surface water Tier 1 RBSLs is evaluated further using a Tier 1 HHRA. Risk Characterization

4.0 RISK CHARACTERIZATION

Risk characterization involves estimating the magnitude of potential adverse health effects of the COPCs and summarizing the nature of the health impact to the defined receptor populations. It combines the results of the toxicity and exposure assessments to provide numerical estimates of health risk.

A Tier 1 HHRA provides an estimate of risk and hazard based on a comparison of the RBSL (*i.e.*, health-protective levels) to the COPC concentrations (*i.e.*, site-specific levels). Specifically, for those COPCs that exceeded an RBSL, a screening-level hazard index (SLHI) was calculated to evaluate noncarcinogenic health effects, and a total screening-level cancer risk ($SLCR_{total}$) was calculated to evaluate carcinogenic effects. The SLHI and $SLCR_{total}$ methodologies are based on USEPA guidance (USEPA 1989) and follow the Part IV of the RFI. Only the $SLCR_{total}$ methodology is discussed below, since only the cancer RBSL for bis(2-ethylhexyl)phthalate was exceeded.

In a human health risk assessment, carcinogenic health risks are defined in terms of the probability of an individual developing cancer over a lifetime as the result of exposure to a given chemical at a given concentration (USEPA 1989). The incremental probability of developing cancer over a lifetime (*i.e.*, the theoretical excess lifetime cancer risk) is the additional risk above and beyond the

cancer risk an individual would face in the absence of the exposures characterized in this risk assessment. In this Tier 1 HHRA, cancer risk was evaluated according to the following equation:

$$SLCR = \frac{\text{Representative concentration}_{COPC/medium}}{RBSL_{COPC/medium/receptor/pathway}} x \text{ Target Risk Level}$$

Cancer risks are summed regardless of the differences in target organ, weight-of-evidence for human carcinogenicity or potential chemical interactions (*e.g.*, antagonistic or synergistic effects). This approach is consistent with USEPA's current approach to carcinogenic effects, which is to assume effects are additive unless adequate information to the contrary is available (USEPA 1989). Based on USEPA methodology (USEPA 1989) and as discussed in the Work Plan (BSC 1997), if the total screening level cancer risk ($SLCR_{total}$) for each receptor/pathway is less than 1×10^{-4}, the risks are considered to be negligible.

The $SLCR_{total}$ for the present and future fish consumer is 3×10^{-5}, attributable to bis(2-ethylhexyl)phthalate in surface water. This SLCR is below the Tier 1 acceptable cancer risk benchmark of 1×10^{-4}.

5.0 CONCLUSIONS

The results of the Tier 1 HHRA indicate that none of the COPCs generate potentially elevated risks or hazards. Based on these results, further evaluation is not warranted during a Corrective Measures Study (CMS). The uncertainties inherent in these conclusions are presented in the Uncertainty Analysis that follows.

6.0 UNCERTAINTY ANALYSIS

Multiple sources of uncertainty can be identified for any risk assessment. These include, among others, uncertainty associated with the toxicity criteria used to derive dose-response factors, uncertainties associated with exposure parameters used in the exposure assessment and uncertainties associated with combining exposure parameters and toxicity criteria to characterize risk.

In the development of any health assessment, some level of uncertainty is introduced each time an assumption is relied upon to describe a dynamic parameter. Some assumptions have a significant

scientific basis while others do not, which could result in the selection and use of conservative default exposure parameters in an exposure assessment. The selection of multiple conservative assumptions in the exposure assessment generally results in an overestimation of potential health risks associated with exposure to specific chemical constituents. The primary areas of uncertainty for this risk assessment are qualitatively discussed below. A more detailed discussion of the uncertainties inherent in the risk assessment process is included in Part IV.

COPC Selection Process:

The COPCs in sediment were identified in the Human Health Risk Assessment Interim Deliverable (ID) No. 1 (BSC 1998). These chemicals were selected in part because of their representative concentrations exceeded Region III RBCs (USEPA 2000a) for residential scenarios. Since no exposure s similar to residential exposures are realistic for any of the scenarios involving sediment, some chemicals which are not likely to pose a potential threat to most of the human receptors, may have been retained as COPCs and subjected to further evaluation. This intentionally overconservative screening process is not likely to have screened out a chemical that is indeed an important contributor to risk.

Toxicity Assessment:

Noncarcinogenic Criteria- Toxicity information for many of the COPCs is limited for humans. Consequently, depending on the quality and extent of toxicity information, varying degrees of uncertainty will be associated with the calculated toxicity values. The USEPA derives reference concentrations (RfC; inhalation exposures) and reference doses (RfDo; oral exposures) for chemicals using an uncertainty factor (UF) approach. The uncertainty factor for DEHP, for instance, is 1000. This was derived by applying a UF of 10 to account for extrapolation of the guinea pig study to humans, another UF of 10 to account for sensitive humans and another UF of 10 to account for use of non-chronic data to represent lifetime exposure. In general, the procedures used to extrapolate from animals to humans in toxicity studies include a conservative use of uncertainty factors so that potential effects on humans are likely overestimated rather than underestimated. It is widely accepted in the scientific community that low doses of toxicants may be detoxified by any one of several processes present in human organ-systems (Ames et al. 1987). As a result, humans may not react to the same degree as the population of genetically homogeneous laboratory animal populations used in standard bioassays.

Carcinogenic Criteria- USEPA cancer SFs are developed using variations of the Linear Multistage Model (LMS) for carcinogenicity. The LMS is highly conservative as it assumes linearity between dose and effect to zero dose assuming no threshold for carcinogenicity. However, the human body has mechanisms to detoxify most chemicals particularly at low doses, and therefore, many scientists believe that most, if not all, carcinogens only cause cancer above a "threshold dose."

The carcinogenic COPC, bis(2-ethylhexyl)phthalate, was evaluated in the risk characterization. The oral slope factor for DEHP is based on evidence of liver carcinomas in both sexes of mice and rats. However, there is no evidence that exposure to DEHP causes cancer in humans (ATSDR 2000), and there appears to be no relevance of the rodent studies to human response. The mechanism of action for carcinogenicity in rodents involves peroxisome proliferation and increased hepatocyte replication. Because this mechanism of action is not operative in humans, it is unlikely that humans will develop liver cancer under expected levels of exposure (ATSDR 2000).

Risk Characterization:

Uncertainties in the risk characterization portion of the risk assessment are a combination of the uncertainties associated with both the dose-response assessment and the exposure assessment. As discussed above, the assumptions and parameters used for both the dose-response and exposure assessments are extremely conservative. In addition, since the toxicity criteria and exposure parameters are combined in the risk characterization, the conservatism is compounded.

This Tier I HHRA includes uncertainties and conservative assumptions that, in general, effectively combine to overestimate the potential current and future exposures. The net effect of the uncertainties of this HHRA is the generation of risk and hazard estimates that probably far exceed any true exposure conditions that currently exist or which could possibly exist in the future.

REFERENCES

Ames, B.N., Magaw, R. and Gold, L.S. (1987). Ranking possible carcinogenic hazards. *Science.* 236:271-273.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. *Toxicological Profile for Di(2-ethylhexyl)phthalate.* U.S. Department of Health and Human Services. September.

American Society for Testing and Materials (ASTM). 1995. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. E 1739-95.

Bethlehem Steel Corporation (BSC). 1997. *Human Health Risk Assessment Work Plan. Bethlehem Steel Corporation, Lackawanna, NY.* Lackawanna, New York. April.

Bethlehem Steel Corporation (BSC). 1998. *Human Health Risk Assessment for Bethlehem Steel Corporation's Lackawanna, New York Site. Revised Final Interim Deliverable Number 1: Detailed Process for Selection of Chemicals of Potential Concern and Identification of Toxicological Criteria. Bethlehem Steel Corporation, Lackawanna, New York.* Lackawanna, New York. December.

Bethlehem Steel Corporation (BSC). 1999. *Human Health Risk Assessment for Bethlehem Steel Corporation's Lackawanna, New York Site. Interim Deliverable Number 2: Exposure Pathway Conceptual Site Model and Tier* I Equations and Parameter Values, Bethlehem Steel Corporation. *Lackawanna, New York.* Lackawanna, New York. January.

New York State Department of Environmental Conservation (NYSDEC). 1998. *Ambient Water Quality Standards and Guidance Values.*

Syracuse Research Corporation. 2001. *CHEMFATE: current on-line database.* http://esc.syrres.com/efdb/Chemfate.htm.

U.S. Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund, Volume 1. Human Health Evaluation Manual (Part A)*, interim final. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.

U.S. Environmental Protection Agency (USEPA). 1991a. *Risk Assessment Guidance for Superfund, Volume 1. Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*, interim. Office of Emergency and Remedial Response, Washington, D.C. PB92-963333.

U.S. Environmental Protection Agency (USEPA). 1991b. *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors."* Directive 9285.6-03. Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch, Washington, D.C.

United States Environmental Protection Agency (USEPA). 1991c. *National Primary Drinking Water Standards. Lead and Copper Rule.* 56 FR 26460, June 7, 1991.

United States Environmental Protection Agency (USEPA). 1994. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.* OSWER Directive No. 9355.4-12. Office of Emergency and Remedial Response, Washington, DC EPA/540F-94/043, PB94-983282.

U.S. Environmental Protection Agency (USEPA). 1996. *Soil Screening Guidance: Technical Background Document.* Office of Solid Waste and Emergency Response. Office of Emergency and Remedial Response; Hazardous Site Control Division. May, EPA/540/R-96/018.

United States Environmental Protection Agency (USEPA). 1997. *Health Effects Assessment Summary Tables (HEAST).* USEPA, Environmental Criteria and Assessment, Office of Research and Development. Cincinnati, Ohio. EPA 540/R-97-036. July

United States Environmental Protection Agency (USEPA). 1999. *Ecological Risk Protocol for Hazardous Waste Combustion Facilities.* EPA 530-D-99-001a,b,c.

U.S. Environmental Protection Agency (USEPA). 2000a. Risk-Based Concentration Table, Region III. October 2000.

US Environmental Protection Agency (USEPA). 2000b. *Integrated Risk Information System* (IRIS). Cincinnati, OH.

United States Environmental Protection Agency (USEPA). 2003. *Comments on Revised Interim Deliverable No. 2 of the Draft Human Health Risk Assessment.* Letter from Dale J. Carpenter, Project Manager, USEPA Region 2 to Leo Kaercher, Director Environmental Engineering, Bethlehem Steel Corporation. April 3, 2003.

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TABLE 1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) SELECTION PROCESS
LAKE ERIE SURFACE WATER
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Concentration (µg/L)	Region III Tap Water RBC[a] (µg/L)	NYSDEC Standard[b] (µg/L)	Human Health COPC?[c]
Volatiles							
Toluene	10	1	10%	0.35	750	5	No
Semivolatiles							
bis(2-Ethylhexyl)phthalate	10	1	10%	21	4.8	5	**Yes**
Metals (Total) [d]							
Lead	10	4	40%	5.7	15[e]	25	No
Miscellaneous							
Cyanide	3	1	33%	20	730[f]	200	No

a USEPA Region III Tapwater Risk Based Concentration (RBC) (USEPA 2000a).

b NYSDEC Ambient Water Quality Standard and Guidance value (NYSDEC 1998).

c Chemical is a COPC if detection frequency exceeds 5.0%, and the maximum detected concentration exceeds the lower of the RBC or NYSDEC Standards.

d Total metal analyses were used in this comparison.

e Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L is used for screening purposes (USEPA 1991c).

f Cyanide is compared to the RBC for free cyanide.

NA Not available.

TABLE 2
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) SELECTION PROCESS
LAKE ERIE DISCHARGE AREA GROUNDWATER
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Concentration (µg/L)	Region III Tap Water RBC[a] (µg/L)	NYSDEC Standard[b] (µg/L)	Human Health COPC?[c]
Volatiles							
1,2-Dichlorobenzene	497	2	0.4%	28	550	3	No
1,1-Dichloroethane	494	128	26%	3,100	800	5	**Yes**
1,2-Dichloroethane	494	17	3%	300	0.16	0.6	No
1,2-Dichloroethene, Total	19	2	11%	7.5	55	5[d]	**Yes**
1,1,1-Trichloroethane	485	8	2%	14	3,200	5	No
1,1,2-Trichloroethane	485	1	0.2%	2.3	0.19	1	No
Acrylonitrile	379	2	0.5%	7.9	0.037	5	No
Benzene	615	478	78%	570,000	0.32	1	**Yes**
Carbon disulfide	37	13	35%	67	1,000	NA	No
Carbon tetrachloride	494	2	0.4%	3.4	0.16	5	No
Chlorobenzene	494	17	3%	54	106	5	No
Chloroform	494	2	0.4%	2.9	0.15	7	No
Ethylbenzene	499	162	32%	1,300	1,300	5	**Yes**
Hexachlorobenzene	497	1	0.2%	12	0.042	0.04	No
Methylene chloride	485	40	8%	3,700	4.1	5	**Yes**
ridine	454	48	11%	200	37	50	**Yes**
etrachloroethene	485	3	0.6%	19	1.1	5	No
Toluene	490	330	67%	70,000	750	5	**Yes**
trans-1,2-Dichloroethene	475	6	1%	16	120	5	No
Trichloroethene	485	89	18%	77	1.6	5	**Yes**
Xylenes, Total	490	336	69%	8,600	12,000	5	**Yes**
Volatile Semivolatiles							
Acenaphthene	45	11	24%	4.4	370	20	No
Acenaphthylene	495	285	58%	130	370[e]	20[e]	**Yes**
Anthracene	497	71	14%	59	1,800	50	**Yes**
Fluorene	497	305	61%	1,700	240	50	**Yes**
Naphthalene	612	481	79%	32,000	6.5	10	**Yes**
Phenanthrene	497	306	62%	330	180[k]	50	**Yes**
Semivolatiles							
2,4,6-Trichlorophenol	490	1	0.2%	1.6	6.1	NA	No
2,4-Dichlorophenol	492	3	0.6%	4.3	110	5	No
2,4-Dimethylphenol	494	170	34%	140	730	50	**Yes**
2-Chloronaphthalene	497	4	0.8%	4.5	490	10	No
2-Methylphenol	467	180	39%	980	1,800	1	**Yes**
3-Methylphenol & 4-Methylphenol	377	183	49%	5,400	180[f]	1[f]	**Yes**
4-Chloro-3-Methylphenol	491	6	1%	20	NA	1	No
4-Methylphenol	91	34	37%	140	180	1	**Yes**
Benzo(a)anthracene	497	6	1%	9.4	0.092	0.002	No
Benzo(a)pyrene	497	3	1%	7.6	0.092	NA	No
Benzo(b)fluoranthene	45	1	2%	4.0	0.092	0.002	No

TABLE 2
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) SELECTION PROCESS
LAKE ERIE DISCHARGE AREA GROUNDWATER
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Concentration (µg/L)	Region III Tap Water RBC[a] (µg/L)	NYSDEC Standard[b] (µg/L)	Human Health COPC?[c]
Benzo(g,h,i)perylene	45	1	2%	2.0	NA	NA	No
bis(2-Ethylhexyl)phthalate	497	111	22%	890	4.8	5	**Yes**
Butyl benzyl phthalate	497	1	0.2%	3.5	7,300	50	No
Chrysene	497	6	1%	10	9.2	0.002	No
Cresols, Total	9	4	44%	39	180[g]	1[g]	**Yes**
Diethyl phthalate	497	1	0.2%	1.3	29,000	50	No
Dimethyl phthalate	497	1	0.2%	3.0	370,000	50	No
Di-n-butyl phthalate	497	1	0.2%	3.0	3,700	50	No
Di-n-octyl phthalate	497	3	0.6%	360	730	50	No
Fluoranthene	497	138	28%	160	1,500	50	**Yes**
Indeno(1,2,3-c,d)pyrene	45	1	2%	2.0	0.092	0.002	No
Pentachlorophenol	485	4	1%	13	0.58	1	No
Phenol	521	250	48%	29,000	21,900	1	**Yes**
Pyrene	497	104	21%	120	180	50	**Yes**
Metals							
Antimony	184	24	13%	11	15	3	**Yes**
Arsenic	300	128	43%	900	0.045	25	**Yes**
Barium	299	213	71%	33,000	2,600	1,000	**Yes**
Cadmium	300	26	9%	63	18	5	**Yes**
Chromium	300	171	57%	1,100	110[h]	50[h]	**Yes**
Lead	301	104	35%	1,400	15[i]	25	**Yes**
Mercury	301	50	17%	3.0	11[l]	0.7	**Yes**
Nickel	183	39	21%	180	730	100	**Yes**
Selenium	283	179	63%	28	180	10	**Yes**
Silver	301	9	3%	68	180	50	No
Thallium	183	15	8%	18	2.6	0.5	**Yes**
Miscellaneous							
Cyanide	448	275	61%	18,000	730[j]	200	**Yes**

a USEPA Region III Tapwater Risk Based Concentration (RBC) (USEPA 2000a).

b NYSDEC Ambient Water Quality Standard and Guidance value (NYSDEC 1998).

c Chemical is a COPC if detection frequency exceeds 5.0%, and the maximum detected concentration exceeds the lower of the RBC or NYSDEC Standard

d 1,2-Dichloroethene, Total is compared to NYSDEC Standard for trans-dichloroethene.

e Screening values for acenaphthene are used as surrogate criteria for acenaphthylene.

f The 3-methylphenol and 4-methylphenol mixture is compared to RBC and NYSDEC Standard for 4-methylphenol.

g Total cresols are compared to RBC and NYSDEC Standard for 4-methylphenol.

h Chromium is compared to the RBC and NYSDEC for hexavalent chromium.

i Lead lacks standard toxicity criteria and RBCs. A value of 15 µg/L is used for screening purposes (USEPA 1991).

j Cyanide is compared to the RBC for free cyanide.

k RBC for pyrene is used as a surrogate for phenanthrene.

l Mercury compared to RBC for mercuric chloride.

NA Not available.

TABLE 3
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) SELECTION PROCESS
LAKE ERIE SEDIMENT
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Concentration (mg/kg)	Maximum Background Concentration (mg/kg)	Region III Residential Soil RBC (mg/kg)[a]	Human Health COPC?[b]
Volatiles							
Chloromethane	10	1	10%	0.013	NA	49	No
1,1,2,2-Tetrachloroethane	10	1	10%	0.0045	NA	3.2	No
Toluene	10	1	10%	0.0041	NA	16,000	No
Semivolatiles							
Acenaphthene	10	1	10%	0.17	NA	4,700	No
Anthracene	10	2	20%	0.35	NA	23,000	No
Benzo(a)anthracene	10	2	20%	0.78	NA	0.87	No
Benzo(a)pyrene	10	3	30%	0.40	0.09	0.087	**Yes**
Benzo(b)fluoranthene	10	7	70%	0.64	NA	0.87	No
Benzo(g,h,i)perylene	10	2	20%	0.30	NA	2,300[c]	No
Benzo(k)fluoranthene	10	2	20%	0.31	NA	8.7	No
Bis(2-ethylhexyl)phthalate	10	5	50%	0.63	NA	46	No
Chrysene	10	6	60%	0.73	0.09	87	No
Dibenz(a,h)anthracene	10	1	10%	0.18	NA	0.087	**Yes**
Di-n-butyl phthalate	10	1	10%	0.12	NA	7,800	No
Fluoranthene	10	8	80%	1.5	0.17	3,100	No
Fluorene	10	1	10%	0.19	NA	3,100	No
Indeno(1,2,3-c,d)pyrene	10	3	30%	0.31	NA	0.87	No
Naphthalene	10	1	10%	0.33	NA	1,600	No
Phenanthrene	10	9	90%	0.91	0.16	2,300[c]	No
Pyrene	10	9	90%	1.2	0.14	2,300	No
Metals							
Antimony	10	5	50%	14	NA	31	No
Arsenic	10	10	100%	6.7	5	0.43	**Yes**
Barium	10	10	100%	47	NA	5,500	No
Chromium	10	10	100%	150	4.6	230[c]	No
Lead	10	10	100%	38	6	400[d]	No
Mercury	10	2	20%	0.33	NA	23[e]	No
Nickel	10	10	100%	36	10	1,600	No
Silver	10	4	40%	5.5	NA	390	No

a USEPA Region III Residential Soil Risk Based Concentration (RBC) (USEPA 2000a).

b Chemicals with a detection frequency greater than 5% and a maximum concentration greater than background and the screening criteria are retained as COPCs.

c Benzo(g,h,i)perylene and phenanthrene are compared to the RBC for pyrene.

d Chromium is compared to the RBC for hexavalent chromium.

e Lead lacks standard toxicity criteria and RBCs. A value of 400 mg/kg (protective of children) is used for screening purposes (USEPA 1994).

f Mercury is compared to the RBC for mercuric chloride.

NA Not available.

TABLE 4
REPRESENTATIVE CONCENTRATIONS[a] OF CHEMICALS OF POTENTIAL CONCERN (COPCs)
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Lake Erie Surface Water COPCs	Representative Concentration (mg/L)	Lake Erie Discharge Area Groundwater COPCs	Representative Concentration (ug/L)	Lake Erie Sediment COPCs	Representative Concentration (mg/kg)
bis(2-Ethylhexyl)phthalate	0.021	1,1-Dichloroethane	7.9	Arsenic	6.4
		1,2-Dichloroethene, Total	7.5	Benzo(a)pyrene	0.30
		2,4-Dimethylphenol	15	Dibenz(a,h)anthracene	0.18
		2-Methylphenol	18		
		3-Methylphenol & 4-Methylphenol	36		
		4-Methylphenol	15		
		Acenaphthylene	19		
		Anthracene	14		
		Antimony	11		
		Arsenic	9.3		
		Barium	180		
		Benzene	200		
		bis(2-Ethylhexyl)phthalate	17		
		Cadmium	2.9		
		Chromium[b]	19		
		Cresols, Total	39		
		Cyanide	110		
		Ethylbenzene	9.0		
		Fluoranthene	15		
		Fluorene	17		
		Lead	6.3		
		Mercury	0.11		
		Methylene chloride	7.8		
		Naphthalene	390		
		Nickel	35		
		Phenanthrene	20		
		Phenol	51		
		Pyrene	14		
		Pyridine	21		
		Selenium	8.1		
		Thallium	6.6		
		Toluene	33		
		Trichloroethene	5.9		
		Xylenes, Total	94		

a For datasets greater than 10, the 95% UCL is used as the representative concentration. For datasets with less than 10 samples, the maximum concentration is used.

b Chromium is assumed to be in the hexavalent form.

TABLE 5
POTENTIAL EXPOSURE SCENARIOS[a]
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Potential Receptor Scenario	Medium of Concern	Transport	Medium of Exposure	Potential Pathway of Exposure
Present and Future Recreational Bather	Lake Erie surface water	--	Lake Erie surface water	ingestion
				dermal contact
	Lake Erie groundwater discharge area	To Lake Erie surface water	Lake Erie surface water	ingestion
				dermal contact
	Lake Erie sediment	--	Lake Erie sediment	ingestion
				dermal contact
Present and Future Fish Consumer	Lake Erie surface water	To Fish	Fish	ingestion
	Lake Erie groundwater discharge area	To Lake Erie surface water, to Fish	Fish	ingestion
Present and Future Off-site Water Consumer	Lake Erie groundwater discharge area	To Lake Erie surface water, to Niagara River	Drinking water from Niagara River	ingestion

a Potential exposure scenarios for Lake Erie are based on those determined in ID No. 2 (BSC 1999), the chemicals of potential concern determined in ID No. 1 (BSC 1998) and this report, and comments from USEPA Region 2 (USEPA 2003).

-- Not applicable

TABLE 6
TOXICITY CRITERIA FOR COPCs
REFERENCE DOSES (RfDs) AND SLOPE FACTORS (SFs)
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Chemical	CAS	Noncarcinogenic Toxicity Criteria		Carcinogenic Toxicity Criteria		
		Oral RfD (mg/kg-d)	Source	Weight of Evidence[a]	Oral SF $(mg/kg\text{-}d)^{-1}$	Source
Inorganics						
Antimony	7440-36-0	4.00E-04	H	--	--	--
Arsenic	7440-38-2	3.00E-04	I	A	1.50E+00	I
Lead[c]	7439-92-1	--	--	--	--	--
Barium	7440-39-3	7.00E-02	I	--	--	--
Cadmium	7440-43-9	5.00E-04	I	B1	--	--
Chromium[b]	18540-29-9	3.00E-03	I	A	--	--
Mercury	7487-94-7	3.00E-04	I	--	--	--
Nickel	7440-02-0	2.00E-02	I	--	--	--
Selenium	7782-49-2	5.00E-03	I	--	--	--
Silver	7440-22-4	5.00E-03	I	--	--	--
Thallium	108-90-7	8.00E-05	I, thallium chloride	--	--	--
Organics						
1,1-Dichloroethane	79-01-6	1.00E-01	H	--	--	--
1,2-Dichloroethene, Total	540-59-0	9.00E-03	H	--	--	--
2,4-Dimethylphenol	105-67-9	2.00E-02	I	--	--	--
2-Methylphenol	95-48-7	5.00E-02	I	--	--	--
3-Methylphenol and 4-Methylphenol[d]	108-39-4/ 106-44-5	5.00E-03	I	--	--	--
4-Methylphenol	106-44-5	5.00E-03	I	--	--	--
Acenaphthylene	83-32-9	6.00E-02	I, acenaphthene surrogate	--	--	--
Anthracene	120-12-7	3.00E-01	I	--	--	--
Benzene	71-43-2	3.00E-03	E	A	5.50E-02	I
Bis(2-ethylhexyl)phthalate	117-81-7	2.00E-02	I	B2	1.40E-02	I
Cresols, Total[e]	1319-77-3	5.00E-03	I	--	--	--
Cyanide	57-12-5	2.00E-02	I	--	--	--
Ethylbenzene	100-41-4	1.00E-01	I	--	--	--
Fluoranthene	206-44-0	4.00E-02	I	--	--	--
Fluorene	86-73-7	4.00E-02	I	--	--	--
Methylene chloride	75-09-2	6.00E-02	I	B2	7.50E-03	I
Naphthalene	91-20-3	2.00E-02	I	--	--	--
Phenanthrene	85-01-8	3.00E-02	I, pyrene surrogate	--	--	--
Phenol	108-95-2	6.00E-01	I	--	--	--
Pyrene	129-00-0	3.00E-02	I	--	--	--
Pyridine	110-86-1	1.00E-03	I	--	--	--
Toluene	108-88-3	2.00E-01	I	--	--	--
Trichloroethene	79-01-6	6.00E-03	E	NC	1.10E-02	E
Xylenes, Total	1130-20-7	2.00E+00	I	--	--	--

-- There is no toxicity criterion for this pathway.

a Weight of Evidence: A - known human carcinogen, B1 -probable human carcinogen, B2 - probable human carcinogen (sufficient animal/inadequate human evidence), NC - no classification at this time (USEPA 2001).

b The toxicity criteria for hexavalent chromium is conservatively used for chromium.

c Lead lacks standard toxicity criteria and was evaluated alternatively.

d The toxicity criteria for 4-Methylphenol is conservatively used for 3-Methylphenol and 4-Methylphenol.

e The toxicity criteria for 4-Methylphenol is conservatively used for Cresols, Total.

E Obtained from the USEPA National Center for Environmental Assessment as obtained from the Region III RBC Tables (USEPA 2000a).

H Health Effects Assessment Summary Tables (HEAST) (USEPA 1997).

I Integrated Risk Information System (IRIS) online database (USEPA 2000b).

TABLE 7
BIOCONCENTRATION FACTORS (BCFs) FOR COPCs
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Volatile Organic Chemicals			*Semivolatile Organic Chemicals*			*Inorganic Chemicals*		
Chemical of Potential Concern	**BCF**	**Ref.**	**Chemical of Potential Concern**	**BCF**	**Ref.**	**Chemical of Potential Concern**	**BCF**	**Ref.**
1,1-Dichloroethane	13	a	Acenaphthylene	575	a	Antimony	0.90	f
1,2-Dichloroethene, Total	19	b	Anthracene	1,349	a	Arsenic	4.0	f
Benzene	4.3	a	bis(2-Ethylhexyl)phthalate	851	a	Barium	93	g
Ethylbenzene	15	a	Fluoranthene	3,981	a	Cadmium	3,800	f
Methylene chloride	5.2	a	Fluorene	1,288	a	Chromium	1.00	f, i
Pyridine	1.8	a	2-Methylphenol	18	a	Lead	45.00	f
Toluene	37	a	3-Methylphenol	20	a	Mercury	85,700	f
Trichloroethene	17	a	4-Methylphenol	17	a	Nickel	0.80	f
Xylenes, Total	19	d	Cresols, Total	18	e	Selenium	5,700	f
			Naphthalene	427	a	Thallium	130	f
			Phenanthrene	1,778	a	Cyanide	0.90	h
			Phenol	20	a			
			Pyrene	2,692	a			
			3-Methylphenol & 4-Methylphenol	19	e			

a Syracuse Research Corporation CHEMFATE database.
b Average of values for *cis*- and *trans*-isomers in Syracuse Research Corporation CHEMFATE database.
c Calculated per USEPA (1988): Log BCF = 0.79*Log Kow - 0.4. Log Kow value from USEPA (1996).
d Average of values for m-, o-, and p-isomers in Syracuse Research Corporation CHEMFATE database.
e Average of values for component isomers in Syracuse Research Corporation CHEMFATE database.
f Superfund Chemical Data Matrix foodchain freshwater BCF.
g Average of two similar values in Syracuse Research Corporation DATALOG database.
h Screening level ecological risk protocol for hazardous waste combustion facilities (USEPA 1999).
i All chromium is conservatively considered to be hexavalent chromium.

TABLE 8
COMPARISON OF CHEMICALS OF POTENTIAL CONCERN (COPCs) TO RISK-BASED SCREENING LEVELS (RBSLs)
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Scenarios and COPCs	Representative Concentration	Cancer RBSL	Non-Cancer RBSL
Present and Future Recreational Bather			
Direct Contact with COPCs in Surface Water (mg/L)			
bis(2-Ethylhexyl)phthalate	0.0089	1.3	150
Direct Contact with COPCs in Surface Water - via Transport from Groundwater (mg/L)			
1,1-Dichloroethane	0.0079	--	> sol (5,060)
1,2-Dichloroethene, Total	0.0075	--	> sol (4,900)
2,4-Dimethylphenol	0.015	--	3,649
2-Methylphenol	0.018	--	> sol (26,000)
3-Methylphenol & 4-Methylphenol	0.036	--	5,120
4-Methylphenol	0.015	--	105
Acenaphthylene	0.019	--	> sol (16)
Anthracene	0.014	--	> sol (0.043)
Antimony	0.011	--	4,767
Arsenic	0.0093	7.3	1,741
Barium	0.18	--	304,704
Benzene	0.20	38	> sol (1,750)
Bis(2-Ethylhexyl)Phthalate	0.017	> sol (0.34)	> sol (0.34)
Cadmium	0.0029	--	2,176
Chromium[a]	0.019	--	13,059
Cresols, Total	0.039	--	5,163
Cyanide	0.11	--	36,840
Ethylbenzene	0.0090	--	> sol (169)
Fluoranthene	0.015	--	> sol (0.21)
Fluorene	0.017	--	> sol (2.0)
Lead	0.0063	--	0.015[b]
Mercury	0.00011	--	1,306
Methylene chloride	0.0078	837	> sol (13,000)
Naphthalene	0.39	--	> sol (31)
Nickel	0.035	--	87,058
Phenanthrene	0.020	--	> sol (1.2)
Phenol	0.051	--	> sol (82,800)
Pyrene	0.014	--	> sol (0.14)
Pyridine	0.021	--	> sol (300)
Selenium	0.0081	--	21,765
Thallium	0.0066	--	348
Toluene	0.033	--	> sol (526)
Trichloroethene	0.0059	239	> sol (1,100)
Xylenes, Total	0.094	--	> sol (175)
Dermal Contact with and Ingestion of COPCs in Sediment (mg/kg)			
Arsenic	6.4	15	2,752
Benzo(a)pyrene	0.30	3	--
Dibenz(a,h)anthracene	0.18	3	--

TABLE 8
COMPARISON OF CHEMICALS OF POTENTIAL CONCERN (COPCs) TO RISK-BASED SCREENING LEVELS (RBSLs)
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Scenarios and COPCs	Representative Concentration	Cancer RBSL	Non-Cancer RBSL
Present and Future Fish Consumer			
Ingestion of COPCs in Fish - via Biotransport from Surface Water (mg/L)			
Bis(2-ethylhexyl)phthalate	0.021	0.00071	0.079
Ingestion of COPCs in Fish - via Transport from Groundwater to Surface Water and Biotransport from Surface Water (mg/L)			
1,1-Dichloroethane	0.0079	--	2,743
1,2-Dichloroethene, Total	0.0075	--	169
2,4-Dimethylphenol	0.015	--	47
2-Methylphenol	0.018	--	991
3-Methylphenol & 4-Methylphenol	0.036	--	94
4-Methylphenol	0.015	--	105
Acenaphthylene	0.019	--	> sol (16)
Anthracene	0.014	--	> sol (0.043)
Antimony	0.011	--	158
Arsenic	0.0093	0.15	27
Barium	0.18	--	268
Benzene	0.20	3.8	249
bis(2-Ethylhexyl)phthalate	0.017	0.070	> sol (0.34)
Cadmium	0.0029	--	0.050
Chromium[a]	0.019	--	1,070
Cresols, Total	0.039	--	99
Cyanide	0.11	--	7,924
Ethylbenzene	0.0090	--	> sol (169)
Fluoranthene	0.015	--	> sol (0.21)
Fluorene	0.017	--	> sol (2.0)
Lead	0.0063	--	0.015[b]
Mercury	0.00011	--	2.3
Methylene chloride	0.0078	23	4,115
Naphthalene	0.39	--	17
Nickel	0.035	--	8,915
Phenanthrene	0.020	--	> sol (1.2)
Phenol	0.051	--	10,698
Pyrene	0.014	--	> sol (0.14)
Pyridine	0.021	--	198
Selenium	0.0081	--	0.31
Thallium	0.0066	--	0.22
Toluene	0.033	--	> sol (526)
Trichloroethene	0.0059	4.8	126
Xylenes, Total	0.094	--	> sol (175)

TABLE 8
COMPARISON OF CHEMICALS OF POTENTIAL CONCERN (COPCs) TO RISK-BASED SCREENING LEVELS (RBSLs)
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

Scenarios and COPCs	Representative Concentration	Groundwater RBSL
Present and Future Off-Site Water Consumer *Ingestion of COPCs in Drinking Water - via Transport from Groundwater to Lake Erie to Niagara River (mg/L)*		
1,1-Dichloroethane	0.0079	180,000
1,2-Dichloroethene, Total	0.0075	14,000
2,4-Dimethylphenol	0.015	160,000
2-Methylphenol	0.018	400,000
3-Methylphenol & 4-Methylphenol	0.036	40,000
4-Methylphenol	0.015	40,000
Acenaphthylene	0.019	82,000
Anthracene	0.014	410,000
Antimony	0.011	1,200
Arsenic	0.009	10,000
Barium	0.18	400,000
Benzene	0.20	1,000
Bis(2-Ethylhexyl)Phthalate	0.017	1,200
Cadmium	0.0029	1,000
Chromium[a]	0.019	20,000
Cresols, Total	0.039	40,000
Cyanide	0.11	40,000
Ethylbenzene	0.0090	140,000
Fluoranthene	0.015	320,000
Fluorene	0.017	55,000
Lead	0.0063	3,000
Mercury	0.00011	400
Methylene chloride	0.0078	1,000
Naphthalene	0.39	1,500
Nickel	0.035	158,000
Phenanthrene	0.020	10,000
Phenol	0.051	40,000
Pyrene	0.014	240,000
Pyridine	0.021	1,400
Selenium	0.0081	10,000
Thallium	0.0066	400
Toluene	0.033	200,000
Trichloroethene	0.0059	1,000
Xylenes, Total	0.094	> 1,000,000

a	All chromium is conservatively considered to be hexavalent chromium; RBSLs are for hexavalent chromium.
b	Value is not a calculated Tier 1 RBSL. Value is primary drinking water standard (USEPA 1991c).
--	Not evaluated as there is no toxicity criteria for this pathway.
	Shaded cell indicates value exceeds the RBSL.
>1,000,000	Calculated RBSL is greater than 1,000,000 parts per million (mg/kg or mg/L).

TABLE 9
TIER I RISK ASSESSMENT RESULTS
LAKE ERIE HHRA
BETHLEHEM STEEL LACKAWANNA FACILITY

	Representative Concentration (mg/L)	Cancer RBSL (mg/L)	Screening Level Cancer Risk (SLCR)	Non-Cancer RBSL (mg/L)	Screening Level Hazard Quotient (SLHQ)	Primary Target Organ
PRESENT AND FUTURE FISH CONSUMER						
Ingestion of COPCs in Fish (via Biotransfer from Surface Water)						
bis(2-Ethylhexyl)phthalate	0.021	0.00071	3.0E-05	NA	NA	NA
		Ambient $SLCR_{total}$ =	**3E-05**		**NA**	

NA Not applicable as chemical does not exceed an RBSL for this effect.
SLCR Screening Level Cancer Risk
SLHI Screening Level Hazard Index

APPENDIX E

Site-Wide Groundwater Risk Assessment

APPENDIX E
HUMAN HEALTH RISK ASSESSMENT FOR SITE-WIDE EXPOSURES TO GROUNDWATER

1.0 INTRODUCTION

As described in Part IV of this RFI report and the Human Health Risk Assessment (HHRA) Interim Deliverables (IDs) No. 1 and 2 (BSC 1998, 1999), an evaluation of potential human health risks to groundwater was evaluated on a site-wide basis for two receptor populations: a current non-BSC commercial/industrial worker and a present/future fenceline resident. Since these exposures are not specific to any one SWMU, the results of this risk assessment in presented in this appendix. Since the methodology for conducting an HHRA was presented in previous Part IV sections, this appendix serves as a summary report much like the SWMU or watercourse reports presented in Parts V, VI, and VII of the RFI Report.

2.0 DATA EVALUATION

The chemicals of potential concern (COPCs) for site-wide groundwater were determined by sequentially applying the following criteria to each detected chemical of potential interest: 1) the chemical was detected in at least 5% of the samples, the chemical was detected in at least one sample at a level above the applicable screening criterion [*i.e.*, the maximum concentration was greater than the lower of the USEPA Region III Risk Based Concentrations (RBCs) for tap water (USEPA 2000a), or NYSDEC Ambient Water Quality Standards and Guidance value (NYSDEC, 1998)]. The screening criteria used are current as of 2000.

The results of the COPC selected process are presented in Table 1. A total of 15 COPCs were identified in site-wide groundwater: nine volatile organic chemicals and six volatile semivolatile organic chemicals.

Representative concentrations were determined for each COPC. All datasets contained more than ten samples, thus a 95% UCL was calculated for each chemical. The COPCs and their

representative concentrations, which are used in the risk characterization within this HHRA, are presented in Table 2.

3.0 EXPOSURE ASSESSMENT

Human Health Risk Assessment ID No. 2 (BSC 1999) presented the current and future human receptor scenarios and potentially complete exposure pathways to be evaluated for each of the SWMUs identified at the Lackawanna site consistent with the Work Plan. Subsequent USEPA Region 2 comments identified additional potentially complete exposure pathways (USEPA, 2003). For the sitewide HHRA, the potential receptor scenarios include a current non-BSC commercial/industrial worker and a present and future fenceline resident (Table 3). For these scenarios, it was determined that the potentially complete exposure pathway is ambient vapor inhalation from COPCs in groundwater. Further descriptions of the potentially exposed receptor scenarios and pathways for site-wide groundwater can be found in ID No. 2 (BSC 1999) summary.

4.0 DEVELOPMENT OF RISK-BASED SCREENING LEVELS

For both receptor scenarios, Tier I risk-based screening levels (RBSLs) were calculated and compared to the representative COPC concentrations in site-wide groundwater. The RBSLs are defined as concentrations of COPCs in relevant media that are not expected to produce any adverse health effects under assumed exposure conditions. The equations used to calculate the RBSLs follow basic USEPA risk assessment principles (USEPA 1989; 1996). Conservative exposure parameters and USEPA toxicity criteria, as described in Part IV, were the inputs to these equations. The RBSL equations are provided in detail in Part IV and in ID No. 2 (BSC 1999). The toxicity criteria are summarized in Table 4.

It should be noted that, in groundwater, most of the RBSLs calculated were greater than the chemicals' solubilities in water. This indicates that, based on the predicted amount of chemical volatilization, pure product in the groundwater would not pose an inhalation health threat from these chemicals.

A comparison of the representative COPC concentrations to RBSLs for each of the exposure scenarios is presented in Table 5. This comparison provides a preliminary estimate of potential risk to the specific receptor populations and exposure pathways identified for this SWMU.

For the future commercial/industrial worker and the present/future fenceline resident scenarios, the representative groundwater concentrations are below the respective RBSLs for all chemicals. In accordance with Part IV of this RFI, those COPCs that do not exceed the Tier 1 RBSLs are not evaluated further.

5.0 RISK CHARACTERIZATION

Risk characterization involves estimating the magnitude of potential adverse health effects of the COPCs and summarizing the nature of the health impact to the defined receptor populations. It combines the results of the toxicity and exposure assessments to provide numerical estimates of health risk. In accordance with Part IV, those COPCs that exceed an RBSL would be further evaluated in a Tier 1 HHRA; however, as none of the COPCs exceed any RBSLs, it was not necessary to perform a Tier 1 HHRA.

6.0 CONCLUSIONS

The results of the Tier 1 HHRA indicate that there are no chemicals in site-wide groundwater that generate elevated noncarcinogenic hazards or cancer risks for the future commercial/industrial worker or the present/future fenceline resident. Based on these results further evaluation is not warranted during the Corrective Measures Study (CMS). The uncertainties inherent in these conclusions are presented in the following Uncertainty Analysis.

7.0 UNCERTAINTY ANALYSIS

There are multiple sources of uncertainty that can be identified for any risk assessment. These include, among others, uncertainty associated with the toxicity criteria used to derive dose-response

factors, uncertainties associated with exposure parameters used in the exposure assessment and uncertainties associated with combining exposure parameters and toxicity criteria to characterize risk.

In the development of any health assessment, some level of uncertainty is introduced each time an assumption is relied upon to describe a dynamic parameter. Some assumptions have a significant scientific basis while others do not, which may result in the selection and use of conservative default exposure parameters in the exposure assessment. The selection of multiple conservative assumptions in the exposure assessment generally results in an overestimation of potential health risks associated with exposure to specific chemical constituents. The primary areas of uncertainty for this risk assessment are qualitatively discussed below and are described in more detail in Part IV.

Exposure Parameters:

Several conservative default exposure parameters including the inhalation rates and the exposure frequency and duration were incorporated into the exposure assessment to define general population behavior. For example, for the current non-BSC industrial/commercial worker scenario, default exposure parameters are intended to be conservative and representative of an individual who is consistently present at the site. In reality, the reasonable maximum daily site exposure probably occurs for a much lower amount of time. In fact, most parameters incorporated into the exposure assessment are highly conservative values to define a worst-case population behavior. The net effect of these conservative exposure assumptions is the overestimation of potential health risks.

Toxicity Assessment:

Reference Doses - Toxicity information for many of the COPCs is limited for humans. Consequently, depending on the quality and extent of toxicity information, varying degrees of uncertainty will be associated with the calculated toxicity values. The USEPA derives RfDs for chemicals using an uncertainty factor approach. The uncertainty factor for naphthalene, for instance, is 3000. This was derived by applying a UF of 10 to account for extrapolation of the mouse study to humans, another UF of 10 to account for sensitive humans, another UF of 10 to account for extrapolation from a LOAEL to a NOAEL and a final UF of 3 to account for lack of an appropriate reproductive study. In general, the procedures used to extrapolate from animals to humans in toxicity studies include a conservative use of uncertainty factors so that potential effects on humans are likely overestimated rather than

underestimated. It is widely accepted in the scientific community that low doses of toxicants may be detoxified by any one of several processes present in human organ systems (Ames et al. 1987). As a result, humans may not react to the same degree as the population of genetically homogeneous laboratory animal populations used in standard bioassays.

Slope Factors (SFs) - USEPA cancer SFs are developed using variations of the Linear Multistage Model (LMS) for carcinogenicity. The LMS is highly conservative as it assumes linearity between dose and effect to zero dose assuming no threshold for carcinogenicity. However, the human body has mechanisms to detoxify most chemicals particularly at low doses, and therefore, many scientists believe that most, if not all, carcinogens only cause cancer above a "threshold dose." The slope factor for some chemicals (for example, benzene) is based on human data, and thus an extrapolation from animal data is not necessary, and the slope factor may be considered more certain than most.

Absence of Inhalation Toxicity Criteria - Although toxicity information is generally available for the most significant chemicals and exposure routes in this HHRA, there were some volatile COPCs in this HHRA for which no inhalation toxicity criteria (RfDs or cancer slope factors) exist. In the absence of data, either the oral RfD or SF was used to evaluate inhalation exposures. This extrapolation assumes that the chemical is equitoxic by both exposure routes (oral and inhalation). The letter "R" in Table 4 notes these extrapolations. It is more conservative to evaluate these chemicals for inhalation exposures than to not evaluate them at all. Thus, this method potentially overestimates inhalation risks for COPCs evaluated as such.

This Tier I HHRA includes uncertainties and conservative assumptions that, in general, effectively combine to overestimate the potential and future exposures. The net effect of the uncertainties of this HHRA is the generation of risk and hazard estimates that probably far exceed any true exposure conditions that currently exist or that could possibly exist in the future.

REFERENCES:

Ames, B.N., Magaw, R. and Gold, L.S. (1987). Ranking possible carcinogenic hazards. *Science.* 236:271-273.

American Society for Testing and Materials (ASTM). 1995. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.* E 1739-95.

Bethlehem Steel Corporation (BSC). 1997. *Human Health Risk Assessment Work Plan. Bethlehem Steel Corporation, Lackawanna, NY.* Lackawanna, New York. April.

Bethlehem Steel Corporation (BSC). 1998. *Human Health Risk Assessment for Bethlehem Steel Corporation's Lackawanna, New York Site. Revised Final Interim Deliverable Number 1: Detailed Process for Selection of Chemicals of Potential Concern and Identification of Toxicological Criteria. Bethlehem Steel Corporation, Lackawanna, New York.* Lackawanna, New York. December.

Bethlehem Steel Corporation (BSC). 1999. *Human Health Risk Assessment for Bethlehem Steel Corporation's Lackawanna, New York Site. Interim Deliverable Number 2: Exposure Pathway Conceptual Site Model and Tier* I Equations and Parameter Values, Bethlehem Steel Corporation. *Lackawanna, New York.* Lackawanna, New York. January.

New York State Department of Environmental Conservation (NYSDEC). 1998. *Ambient Water Quality Standards and Guidance Values.*

U.S. Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund, Volume 1. Human Health Evaluation Manual (Part A)*, interim final. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.

U.S. Environmental Protection Agency (USEPA). 1991a. *Risk Assessment Guidance for Superfund, Volume 1. Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*, interim. Office of Emergency and Remedial Response, Washington, D.C. PB92-963333.

U.S. Environmental Protection Agency (USEPA). 1991b. *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors."* Directive 9285.6-03. Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1996. *Soil Screening Guidance: Technical Background Document.* Office of Solid Waste and Emergency Response. Office of Emergency and Remedial Response; Hazardous Site Control Division. May, EPA/540/R-96/018.

United States Environmental Protection Agency (USEPA). 1997. *Health Effects Assessment Summary Tables (HEAST).* USEPA, Environmental Criteria and Assessment, Office of Research and Development. Cincinnati, Ohio. EPA 540/R-97-036. July

U.S. Environmental Protection Agency (USEPA). 2000a. Risk-Based Concentration Table, Region III. October 2000.

US Environmental Protection Agency (USEPA). 2000b. *Integrated Risk Information System* (IRIS). Cincinnati, OH.

United States Environmental Protection Agency (USEPA). 2003. *Comments on Revised Interim Deliverable No. 2 of the Draft Human Health Risk Assessment.* Letter from Dale J. Carpenter, Project Manager, USEPA Region 2 to Leo Kaercher, Director Environmental Engineering, Bethlehem Steel Corporation. April 3, 2003.

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TABLE 1
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) SELECTION PROCESS
SITE-WIDE GROUNDWATER

Chemical	Number of Samples	Number of Detects	Detection Frequency	Maximum Detected Concentration (µg/L)	Region III Tap Water RBC[a] (µg/L)	NYSDEC Standard[b] (µg/L)	Human Health COPC?[c]
Volatiles							
1,1,1-Trichloroethane	628	8	1%	20	3,200	5	No
1,1,2-Trichloroethane	628	1	0.2%	2.3	0.19	1	No
1,1-Dichloroethane	637	149	23%	3,100	800	5	Yes
1,2-Dichlorobenzene	648	2	0.3%	28	550	3	No
1,2-Dichloroethane	638	20	3%	300	0.16	0.6	No
Acrylonitrile	607	2	0.3%	7.9	0.037	5	No
Benzene	821	697	85%	570,000	0.32	1	Yes
Carbon disulfide	66	15	23%	1,300	1,000	NA	Yes
Chlorobenzene	646	17	3%	54	110	5	No
Chloroform	637	5	0.8%	12	0.15	7	No
Chloromethane	637	1	0.2%	30	2.1	5	No
Ethylbenzene	673	215	32%	25,000	1,300	5	Yes
Hexachlorobenzene	639	2	0.3%	12	0.042	0.04	No
Methylene chloride	628	45	7%	3,700	4.1	5	Yes
Pyridine	602	82	14%	250,000	37	50	Yes
Tetrachloroethene	628	3	0.5%	19	1.1	5	No
Toluene	664	445	67%	77,000	750	5	Yes
trans-1,2-Dichloroethene	607	5	0.8%	16	120	5	No
Trichloroethene	628	94	15%	52	1.6	5	Yes
Vinyl chloride	628	2	0.3%	1,100	0.019	2	No
Xylenes, Total	643	443	69%	390,000	12,000	5	Yes
Volatile Semivolatiles							
2-Chloronaphthalene	639	5	0.8%	4.5	490	10	No
Acenaphthene	69	20	29%	360	370	20	Yes
Acenaphthylene	638	334	52%	150	370[d]	20[d]	Yes
Anthracene	639	91	14%	270	1,800	50	Yes
Fluorene	639	370	58%	1,700	240	50	Yes
Naphthalene	804	622	77%	280,000	6.5	10	Yes
Phenanthrene	639	370	58%	940	180[e]	50	Yes

a USEPA Region III Tapwater Risk Based Concentration (RBC) (USEPA 2000a).
b NYSDEC Ambient Water Quality Standard and Guidance value (NYSDEC 1998).
c Chemical is a COPC if detection frequency exceeds 5.0%, and the maximum detected concentration exceeds the lower of the RBC or NYSDEC Standards.
d Screening values for acenaphthene are used as surrogate criteria for acenaphthylene.
e RBC for pyrene used for phenanthrene.
NA indicates not available.

TABLE 2
REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF POTENTIAL CONCERN (COPCs)
SITE-WIDE GROUNDWATER

Site-wide Groundwater COPCs	Representative Concentration[a] (µg/L)
1,1-Dichloroethane	21
Acenaphthene	34
Acenaphthylene	25
Anthracene	20
Benzene	3,200
Carbon disulfide	1,000
Ethylbenzene	44
Fluorene	24
Methylene chloride	23
Naphthalene	620
Phenanthrene	28
Pyridine	84
Toluene	180
Trichloroethene	17
Xylenes, Total	420

a The 95% UCL is used as the representative concentration.

TABLE 3
POTENTIAL EXPOSURE SCENARIOS
SITE-WIDE GROUNDWATER

Potential Receptor Scenario	Exposure Media	Potential Pathway of Exposure
Current Non-BSC Commercial/Industrial Worker	sitewide groundwater	ambient vapor inhalation
Present/Future Fenceline Resident	sitewide groundwater	ambient vapor inhalation

* Potential exposure scenarios for the sitewide groundwater HHRA are based on those determined in ID No. 2 (BSC 1999), the chemicals of potential concern determined in ID No. 1 (BSC 1998), and comments from USEPA Region 2 (USEPA 2003).

TABLE 4
TOXICITY CRITERIA FOR COPCs
REFERENCE DOSES (RfDs) and SLOPE FACTORS (SFs)
SITE-WIDE GROUNDWATER

		Noncarcinogenic Toxicity Criteria				Carcinogenic Toxicity Criteria				
Chemical	CAS	Oral RfD (mg/kg-d)	Source	Inhalation RfD (mg/kg-d)	Source	Weight of Evidence[a]	Oral SF $(mg/kg-d)^{-1}$	Source	Inhalation SF $(mg/kg-d)^{-1}$	Source
Organics										
1,1-Dichloroethane	79-01-6	1.00E-01	H	1.40E-01	H	--	--	--	--	--
Acenaphthene	208-96-8	6.00E-02	I	6.00E-02	R	--	--	--	--	--
Acenaphthylene	83-32-9	6.00E-02	I, acenaphthene surrogate	6.00E-02	R	--	--	--	--	--
Anthracene	120-12-7	3.00E-01	I	3.00E-01	R	--	--	--	--	--
Benzene	71-43-2	3.00E-03	E	1.70E-03	E	A	5.50E-02	I	2.90E-02	I
Carbon disulfide	75-15-0	1.00E-01	I	2.00E-01	I	--	--	--	--	--
Ethylbenzene	100-41-4	1.00E-01	I	2.90E-01	I	--	--	--	--	--
Fluorene	86-73-7	4.00E-02	I	4.00E-02	R	--	--	--	--	--
Methylene chloride	75-09-2	6.00E-02	I	8.60E-01	H	B2	7.50E-03	I	1.65E-03	I
Naphthalene	91-20-3	2.00E-02	I	9.00E-04	I	--	--	--	--	--
Phenanthrene	85-01-8	3.00E-02	I, pyrene surrogate	3.00E-02	R	--	--	--	--	--
Pyridine	110-86-1	1.00E-03	I	1.00E-03	R	--	--	--	--	--
Toluene	108-88-3	2.00E-01	I	1.14E-01	I	--	--	--	--	--
Trichloroethene	79-01-6	6.00E-03	E	--	--	NC	1.10E-02	E	6.00E-03	E
Xylenes, Total	1130-20-7	2.00E+00	I	2.00E+00	R	--	--	--	--	--

-- There is no toxicity criteria for this pathway.

a Weight of Evidence: A - known human carcinogen, B2 - probable human carcinogen (sufficient animal/inadequate human evidence), NC - no classification at this time (USEPA 2000b).

E Obtained from the USEPA National Center for Environmental Assessment as obtained from the Region III RBC Tables (USEPA 2000a).

H Health Effects Assessment Summary Tables (HEAST) (USEPA 1997).

R Route-to-route extrapolation.

I Integrated Risk Information System (IRIS) online database (USEPA 2000b).

TABLE 5
COMPARISON OF CHEMICALS OF POTENTIAL CONCERN (COPCs) TO RISK-BASED SCREENING LEVELS (RBSLs)
SITE-WIDE GROUNDWATER

Scenarios and COPCs	Representative Concentration	Cancer RBSL	Non-Cancer RBSL
Current Non-BSC Commercial/Industrial Worker			
Inhalation of Ambient Vapors from Groundwater (mg/L)			
1,1-Dichloroethane	0.021	--	3,000
Acenaphthene	0.034	--	> sol (4.24)
Acenaphthylene	0.025	--	> sol (16.1)
Anthracene	0.020	--	> sol (0.043)
Benzene	3.2	7.2	31
Carbon disulfide	1.0	--	570
Ethylbenzene	0.044	--	> sol (169)
Fluorene	0.024	--	> sol (1.98)
Methylene chloride	0.023	278	> sol (13,000)
Naphthalene	0.62	--	> sol (31)
Phenanthrene	0.028	--	> sol (1.15)
Pyridine	0.084	--	14
Toluene	0.18	--	> sol (526)
Trichloroethene	0.017	21	--
Xylenes, Total	0.42	--	> sol (175)
Present/Future Fenceline Resident			
Inhalation of Ambient Vapors from Groundwater (mg/L)			
1,1-Dichloroethane	0.021	--	> sol (5,060)
Acenaphthene	0.034	--	> sol (4.24)
Acenaphthylene	0.025	--	> sol (16.1)
Anthracene	0.020	--	> sol (0.043)
Benzene	3.2	51	1,000
Carbon disulfide	1.0	--	> sol (1,190)
Ethylbenzene	0.044	--	> sol (169)
Fluorene	0.024	--	> sol (1.98)
Methylene chloride	0.023	2,000	> sol (13,000)
Naphthalene	0.62	--	> sol (31)
Phenanthrene	0.028	--	> sol (1.15)
Pyridine	0.084	--	> sol (300)
Toluene	0.18	--	> sol (526)
Trichloroethene	0.017	150	--
Xylenes, Total	0.42	--	> sol (175)

-- Not evaluated as there is no toxicity criteria for this pathway.
> sol The RBSL exceeds the solubility limit in this medium, indicated in parentheses.
Shaded cell indicates value exceeds the RBSL.