CB&I
312 Directors Drive
Knoxville, TN 37923
Tel: +1 865 690 3211
Fax: +1 865 690 3626
Steven.Downey@CBIfederalservices.com

January 16, 2014

U.S. Army Engineer District, Nashville
ATTN: CELRN-EC-E (Ms. Paula Coleman)
110 Ninth Avenue South, Room 682
U.S. Court House Annex
Nashville, Tennessee 37203

Subject: ***Submittal of the Final Unloading Area Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment***
Former Plum Brook Ordnance Works, Sandusky, Ohio
Contract No. W91278-10-D-0094: Shaw Project Number 141427

Dear Ms. Coleman:

In accordance with the requirements of Delivery Order No. DX01 of Contract No. W91278-10-D-0094 awarded to Shaw Environmental & Infrastructure, Inc., a CB&I company, we are pleased to submit the Final Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment for the Garage Maintenance Area (Unloading Area) at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio. This report was prepared consistent with other PBOW risk assessment reports, U.S. Environmental Protection Agency guidance, and the Garage Maintenance Area risk assessment work plan.

Enclosed for your review are four copies of this report. Copies have also been sent to those on the distribution list as indicated for their records. As requested, the document was sent to the Center of Expertise (CX) and the Restoration Advisory Board Co-Chair in electronic format only.

Should you have any questions or require additional information regarding this submittal, please do not hesitate to contact me at (865) 694-7496.

Sincerely,

Steven. T. Downey, PE, PMP
Project Manager

Please Reply To: Steven T. Downey
Phone: 865 694 7496
E-Mail Address: Steven.Downey@CBIfederalservices.com

200-1e
G05OH001825_03.11_0505_a

Control Copy Distribution List

Name	Control Copy
U.S. Army Engineer District, Nashville ATTN: CELRN-EC-E (Ms. Paula Coleman) 110 Ninth Avenue South, Room 682 Annex Nashville, TN 37203	1-4
U.S. Army Engineer District, Huntington ATTN: CELRH-PM-PP-P (Mr. Rick Meadows) 502 Eighth Street Huntington, West Virginia 25701-2070	5-7 (CD provided)
Mr. Paul Jayko Site Coordinator Division of Emergency and Remedial Response (DERR) Ohio Environmental Protection Agency 347 North Dunbridge Road Bowling Green, Ohio 43402-0466	8, 9
Mr. Brian Tucker Ohio Environmental Protection Agency Division of Emergency and Remedial Response (DERR) Central Office Lazarus Government Center 50 W. Town Street, Suite 700 Columbus, OH 43216-1049	10
Mr. Robert Lallier Environmental Coordinator NASA - Plum Brook Station 6100 Columbus Avenue Sandusky, Ohio 44870	11
U.S. Army Corps of Engineers (**electronic only**) HTRW Center of Expertise ATTN: CEHNC-CX-EG (Vern StJohn) 1616 Capitol Avenue Omaha, Nebraska 68144-3869	(CD provided)
Mr. John Blakeman (**electronic only**) PBOW RAB Co-chairman 2412 Scheid Road Huron, Ohio 44839	(CD provided)
Mr. Jeffrey G. Leach US Army Public Health Command ATTN: MCHB-IP-REH, BLDG E1675 Aberdeen Proving Grounds, MD 21010-5403	12

DISCIPLINE SIGN-OFF REVIEW

Shaw Environmental & Infrastructure, Inc.

Client Name: U.S. Army Engineer District, Nashville; CELRN-EC-E

Project Description: Baseline Human Health Risk Assessment for the Garage Maintenance Area (Unloading Area) Former Plum Brook Ordnance Works, Sandusky, Ohio

Contract No. W 9 1 2 7 8 - 1 0 - D - 0 0 9 4

Delivery Order No. D X 0 1

Project No. 1 4 1 4 2 7

Task/Phase Number: 1 2 0 0 0 0 0 0

Document Type	Identify specific section or segment covered by this checkprint	Document Origin
☐ Technical / Cost Proposal		X Originator Developed
☐ RFP		☐ Edited Standard
☐ Contract / Subcontract		☐ Client Furnished
☐ Work Plans		
X Report	BHHRA	**Document Status**
☐ Risk Assessment / Evaluation		☐ Preliminary
☐ Specifications & Plans		☐ Internal Draft
☐ Design Calculations		☐ Draft
☐ Tables		☐ Draft Final
☐ Drawings / Figures		X Final
☐ Other:		☐ Other:

	Required Person	Signature	Date
Originator	Frank Eidson	for AFE.	1-16-14
Editor	Donald Groseclose		1-16-14
Peer Review	Jon Lindberg		1/16/14
Technical Review	Michael Gunderson		1/16/14
Quality Assurance Mgr	Ken Martinez		01-16-14
Project Manager	Steven Downey		1/16/14

NOTICE: By signature above, parties certify that the subject document has been prepared by and/or reviewed by them (as appropriate), that all review comments have been resolved, and that the document is ready for submittal.

Final
Garage Maintenance Area (Unloading Area)
Baseline Human Health Risk Assessment
FUDS Project No. G050H001825

Former Plum Brook Ordnance Works
Sandusky, Ohio

Prepared for:

U.S. Army Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202-1070

Prepared by:

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)
312 Directors Drive
Knoxville, Tennessee 37923

Shaw Project No. 141427

January 2014

Table of Contents

Page

List of Tables iv
List of Figures v
List of Acronyms vi
Executive Summary ES-1
1.0 Introduction 1-1
1.1 Facility Location and Description 1-1
1.2 Facility History and Background 1-1
1.3 Unloading Area Description and History 1-3
1.4 Groundwater Use and Site Use 1-4
1.5 Protocol for the Baseline Human Health Risk Assessment 1-4
1.6 Report Organization 1-6
2.0 Data Evaluation 2-1
2.1 Data Sources 2-1
2.2 Sorting the Analytical Data 2-1
2.3 Evaluation of Data Quality 2-2
2.4 Identification of Chemicals of Potential Concern 2-3
2.4.1 Risk-Based Screening 2-3
2.4.2 Frequency of Detection 2-6
2.4.3 Comparison to Background 2-6
2.4.3.1 Background Screening of Inorganics 2-7
2.4.3.2 Statistical Data Set Testing of Inorganics 2-7
2.4.3.3 Treatment of Organic Compounds 2-8
2.5 Data Evaluation Summary 2-8
3.0 Exposure Assessment 3-1
3.1 Conceptual Site Exposure Model 3-1
3.1.1 Physical Setting 3-2
3.1.1.1 Climate/Meteorology 3-2
3.1.1.2 Geology 3-3
3.1.1.3 Soils 3-3
3.1.1.4 Hydrology 3-3
3.1.1.5 Surface Water 3-4
3.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways 3-5

Table of Contents *(Continued)*

Page

3.1.3 Receptors and Exposure Pathways 3-5
3.1.3.1 Current Groundskeeper 3-7
3.1.3.2 Future Groundskeeper 3-7
3.1.3.3 Indoor Worker 3-8
3.1.3.4 Construction Worker 3-9
3.1.3.5 On-Site Resident 3-10
3.1.3.6 Future Hunter 3-11
3.1.3.7 Future Hunter's Child 3-12
3.1.3.8 Other Receptors Not Considered 3-13
3.2 Quantification of Exposure-Point Concentrations 3-13
3.2.1 Exposure-Point Concentrations in Soil and Groundwater 3-13
3.2.2 Exposure-Point Concentrations in Air 3-15
3.2.2.1 COPC Concentrations from Dust 3-15
3.2.2.2 Concentrations of VOCs in Household Air from Groundwater Use 3-17
3.2.2.3 Concentrations of VOCs in Groundwater: Residential Dermal Uptake 3-17
3.2.2.4 Concentrations of COPCs in Venison 3-17
3.3 Quantification of Chemical Intake 3-19
3.3.1 Inhalation of COPCs in Air 3-19
3.3.2 Incidental Ingestion of COPCs in Soil 3-20
3.3.3 Incidental Ingestion of COPCs in Water 3-20
3.3.4 Dermal Contact with COPCs in Soil or Water 3-20
4.0 Toxicity Evaluation 4-1
4.1 Evaluation of Carcinogenicity 4-1
4.2 Evaluation of Noncarcinogenic Effects 4-3
4.3 Dermal Toxicity Values 4-5
4.4 Target Organ Toxicity 4-5
4.5 Sources of Toxicity Information Used in the Risk Assessment 4-6
5.0 Risk Characterization 5-1
5.1 Cancer Risk 5-1
5.2 Noncancer Effects of Chemicals 5-3

Table of Contents *(Continued)*

Page

5.3 Risk Characterization Results 5-4
5.3.1 Current Groundkeeper 5-4
5.3.2 Future Groundskeeper 5-5
5.3.3 Indoor Worker 5-6
5.3.4 Construction Worker 5-6
5.3.5 Hypothetical Future On-Site Resident 5-6
5.3.6 Adult Hunter 5-7
5.3.7 Hunter's Child 5-8
6.0 Uncertainty Analysis 6-1
6.1 Types of Uncertainty 6-1
6.2 Sources of Uncertainty 6-2
6.2.1 Sample Selection 6-2
6.2.2 Exposure-Point Concentration Estimates 6-2
6.2.3 Land-Use Assumptions/Receptor Selection 6-3
6.2.4 Groundwater Use 6-3
6.2.5 Exposure Assumption Values 6-3
6.2.6 Toxicity Assessment 6-4
6.2.7 Risk Characterization 6-5
6.2.8 Evaluation of Selected COPCs for Site Relatedness 6-5
7.0 Summary and Conclusions 7-1
7.1 Summary 7-1
7.2 Conclusions 7-2
8.0 References 8-1
Tables
Figures
Appendix A – Data Summary of Chemicals Detected in Overburden Groundwater Piezometers
Appendix B – ProUCL Output for Upper Confidence Limits on the Mean
Appendix C – Toxicological Profiles
Appendix D – Risk Characterization Spreadsheets
Appendix E – Analytical Data Used in the Baseline Human Health Risk Assessment

List of Tables

Table	*Title*	*Follows Tab*
2-1	Summary of Samples Evaluated in the Baseline Human Health Risk Assessment	
2-2	Statistical Summary and Selection of Chemicals of Potential Concern in Surface Soil	
2-3	Statistical Summary and Selection of Chemicals of Potential Concern in Subsurface Soil	
2-4	Statistical Summary and Selection of Chemicals of Potential Concern in Overburden Monitoring Well Groundwater	
3-1	Receptor/Exposure Scenarios	
3-2	Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors	
3-3	Physical Properties of Site-Related Chemicals	
4-1	Summary of Toxicity Assessment	
5-1	Summary of Risk for All Receptors	
5-2	Summary of Risk for Receptors Excluding Exposure to Groundwater	
5-3	Summary of Noncancer Hazard to Target Organs for the On-Site Resident Child Potentially Exposed to Groundwater	

List of Figures

Figure	*Title*	*Follows Tab*
1-1	PBOW Vicinity Map	
1-2	Site Location Map	
1-3	General Site Features of the Unloading Area with Site Topography and Sampling Locations	
3-1	Human Health Conceptual Site Exposure Model	

List of Acronyms

ABS	dermal absorption factor
AF	soil-to-skin adherence factor
bgs	below ground surface
BHHRA	baseline human health risk assessment
BSC	background screening concentration
BTEX	benzene, toluene, ethylbenzene, and xylenes
CDI	chronic daily intake
cm/hour	centimeters per hour
cm^2	square centimeter
COPC	chemical of potential concern
CSEM	conceptual site exposure model
°F	degrees Fahrenheit
DA	dose absorbed per unit body surface area per day
D&M	Dames and Moore, Inc.
DM	dry matter
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPC	exposure-point concentration
ES	EnviroScience, Inc.
ET	exposure time
FI	fractional term
GAF	gastrointestinal absorption factor
gpm	gallons per minute
g	gram
g/kg-day	grams per kilogram per day
g/m^3	grams per cubic meter
HQ	hazard quotient
HI	hazard index
ICI	International Consultants Incorporated
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
IT	IT Corporation

List of Acronyms *(Continued)*

kg	kilogram
K_p	permeability coefficient
L/cm^3	liters per cubic centimeter
L/day	liters per day
m^3	cubic meter
m^3/day	cubic meters per day
m^3/hr	cubic meters per hour
m^3/kg	cubic meters per kilogram
MDC	maximum detected concentration
$\mu g/m^3$	micrograms per cubic meter
mg/cm^2	milligrams per square centimeter
mg/cm^2-day	milligrams per square centimeter per day
mg/day	milligrams per day
mg/m^3	milligrams per cubic meter
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
µg/L	micrograms per liter
mg/L	milligrams per liter
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OEPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works
PDT	Project Delivery Team
PEF	particulate emission factor
RBSC	risk-based screening concentration
RfC	reference concentration
RfD	reference dose
RME	reasonable maximum exposure
RSL	regional screening level
SF	cancer slope factor
SVOC	semivolatile organic compound
Shaw	Shaw Environmental & Infrastructure, Inc.
TNT	trinitrotoluene

List of Acronyms *(Continued)*

TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
UCL	95th percent upper confidence limit on the arithmetic mean
UF	uncertainty factor
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
VOC	volatile organic compound
WRS	Wilcoxon Rank Sum

Executive Summary

A baseline human health risk assessment (BHHRA) was conducted to evaluate potential human health risks associated with exposure to soil and groundwater associated with the former Unloading Area at the Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio. The approach used in the BHHRA is consistent with methodologies described in the U.S. Environmental Protection Agency's primary risk assessment guidance documents, the site-specific work plan, and discussions and agreements between the Ohio Environmental Protection Agency, the U.S. Army Corps of Engineers Nashville and Huntington Districts, and Shaw Environmental & Infrastructure, Inc. (a CB&I company).

Site History/Description. The PBOW facility was constructed on property comprising 9,009 acres in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene, 2,4-dinitroluene, and pentolite. Production of explosives at PBOW began in December 1941 and continued until 1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during the 4-year operating period. After plant operations ceased, the manufacturing process lines were decontaminated by the Army in late 1945. After the property was certified as decontaminated, 3,230 acres of the property were initially transferred to the Ordnance Department, then to the War Assets Administration. In 1949, PBOW was transferred to the General Services Administration. The Department of the Army reacquired the 3,230 acres in 1954 and performed cleanup efforts from the mid-1950s until 1963.

Accountability and custody for the entire portion of the former PBOW property that had been under the accountability and custody of the Department of the Army were transferred to the National Aeronautics and Space Administration (NASA) on March 15, 1963. NASA performed further decontamination efforts during 1964. NASA has operated and maintained the former PBOW property since 1963, and the facility is currently the NASA Glenn Research Center, Plum Brook Station. NASA operates the property as a space research facility in support of the John H. Glenn Research Center at Lewis Field, Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the site are currently on standby or inactive status.

The Unloading Area is located within the property controlled by NASA on the north side of Maintenance Road, between Ransom Road and Taylor Road, and was used principally for unloading of toluene and possibly other chemicals from railcars. The Unloading Area is estimated to have been approximately 2.2 acres in size. The area consists primarily of a former rail line with open areas to the north and south of the former rail bed. The site is bounded to the

west by a drainage ditch and the Former Sellite Area and to the east by NASA maintenance buildings. The Unloading Area included underground storage tanks (UST) that contained gasoline, solvents, and waste oil. These USTs were removed in 1989 and 1990. The locations of these former USTs are downgradient and/or crossgradient of the Unloading Area relative to the overburden groundwater flow direction.

Approach. The BHHRA evaluated exposure to chemicals in overburden groundwater, surface soil, and subsurface soil for cancer risks and noncancer hazards. Validated analytical data used for this BHHRA were obtained from samples collected during 2011 and 2012, as reported in the site characterization report.

A screening for chemicals of potential concern (COPC) was used to focus the evaluation on those chemicals most likely to present a risk to potentially exposed individuals. This screening included a risk-based screening and, for inorganic chemicals in soil, a background screening. The background screening protocol used for the Unloading Area is based on PBOW Project Delivery Team agreements and differs somewhat from the current Ohio Environmental Protection Agency guidance. Use of this PBOW Project Delivery Team method for the development of background screening concentrations and as part of the COPC screening process ensures consistency between all of the PBOW Formerly Used Defense Sites project sites.

Each COPC in each medium was evaluated for exposure via the relevant exposure pathways and the resultant risk and hazards were estimated. One COPC was identified in surface soil; no COPCs were identified in subsurface soil. Because no COPCs were identified in subsurface soil, total soil exposure routes were conservatively evaluated using COPCs and exposure-point concentrations developed for surface soil. Six metals were identified as COPCs in overburden groundwater.

The following receptors were evaluated for exposure to the COPCs and their associated hazards and risks:

- Current groundskeeper (surface soil)
- Future groundskeeper (overburden groundwater and total soil [surface soil])
- Indoor worker (overburden groundwater and total soil [surface soil])
- Construction worker (overburden groundwater and total soil [surface soil])

- On-site resident (overburden groundwater; noncancer hazards evaluated separately for the young child [ages 1 through 6 years] and adult, total soil [surface soil])
- Hunter (surface soil)
- Hunter's child (surface soil).

Should on-site groundwater be developed as a potable water supply, future on-site residents and workers could plausibly become exposed to COPCs in overburden groundwater. The future on-site resident would have longer and more frequent groundwater exposure than other plausible receptors. Therefore, potential exposures of future groundskeepers, indoor workers, or construction workers are not assessed quantitatively in this BHHRA.

Results. Risks were characterized for each COPC identified in groundwater for the relevant receptors. Noncancer hazards were evaluated against a target hazard index (HI) criterion of 1 and the PBOW team target incremental lifetime cancer risk (ILCR) goal of 1E-5 (i.e., 1 additional incidence of cancer per 100,000 individuals exposed). Cancer risk results are also compared to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) acceptable cancer risk range of 1E-6 to 1E-4 (i.e., a rate of 1 additional incidence of cancer per 1,000,000 to 1 in 10,000 individuals exposed), which is referred to herein as the "NCP risk management range."

The overall HI and ILCR values are summarized for each receptor in the following bullets. Exceedances of PBOW cancer risk goal (ILCR greater than 1E-5) are shown in bold type and exceedances of the noncancer hazard goal (HI greater than 1) or the NCP risk management range (1E-6 to 1E-4) are shown as bold italics:

- Current groundskeeper: ILCR = 1E-7; HI = 0 (the COPC in soil is not associated with noncancer health effects). Thus, adverse health effects from exposure to soil are of no further concern at the site.
- Future groundskeeper: **ILCR = 2E-5** (1E-7 excluding background-related arsenic in groundwater); HI = 0.3.
- Future indoor worker: **ILCR = 2E-5** (3E-6 excluding background-related arsenic in groundwater); HI = 0.3. (Estimated risks above PBOW criteria are associated only with potential groundwater use.)
- Construction worker: ILCR = 6E-9; HI = 0 (the COPC in soil is not associated with noncancer health effects). Thus, adverse health effects from exposure to soil are of no further concern at the site.

- Resident: **ILCR = 1E-4** (4E-7 excluding groundwater-related arsenic); adult HI = 1; child HI calculated for target organs = 0.4 (heart), 0.9 (skin), 0.4 (thryroid), 0.2 (gastrointestinal tract), 0.4 (central nervous system). (The COPC in soil is not associated with noncancer health effects. Estimated risks and hazards are associated with potential groundwater use.)

- Hunter: ILCR = 8E-9; HI = 0 (the COPC in soil is not associated with noncancer health effects). Thus, adverse health effects from exposure to soil are of no further concern at the site.

- Hunter's child: ILCR = 0; HI = 0 (the COPC in soil is not associated with noncancer health effects and does not accumulate in venison). Thus, adverse health effects from exposure to soil are of no further concern at the site.

Conclusions. The receptor scenarios evaluated cover a wide range of human activities that are representative of future land use at the Unloading Area. The ILCR and HI values for the current groundskeeper, current construction worker, hunter, and future hunter's child exposure scenarios meet the PBOW cancer risk goal (ILCR less than or equal to 1E-5) and the noncancer hazard criterion (HI less than or equal to 1).

The ILCR values for the future groundskeeper, future indoor worker, and potential on-site resident exceed the PBOW cancer risk criterion. These estimated cancer risks that exceed the criterion are entirely attributable to arsenic in groundwater. The estimated cancer risks for exposure to soil are below the PBOW cancer risk criterion for all scenarios.

The noncancer hazard estimates for future groundskeeper, future indoor worker, and potential on-site resident are below the PBOW noncancer HI criterion with the exception of the HI estimate for the hypothetical on-site resident child. However, the target organ HI values for this receptor are each below the target HI criterion. Thus, the estimated noncancer hazard estimates are below the PBOW criterion for all scenarios.

Use of the overburden groundwater is regarded as unlikely. Even though the monitoring wells appear to produce sufficient yield for potable use, this groundwater unit is seasonally dependent and areally limited under most of PBOW, and the readily available municipal water supply obviates the need for use of groundwater as a potential source of tap water in the general vicinity of PBOW. Also, NASA has recently expressed intentions of placing institutional controls on the Plum Brook Station property that would prohibit the use of on-site groundwater in perpetuity.

Even if this groundwater unit were used as a source of potable water, the presence of arsenic, which drives the cancer risks associated with the groundwater pathways, appears to be unrelated

to former PBOW operations. Also, the maximum detected concentration of arsenic (5.8 micrograms per liter [µg/L]) in Unloading Area groundwater is less than the promulgated Safe Drinking Water Act Maximum Contaminant Level (10 µg/L) that is permissible for municipal tap water.

If the contributions of exposure to groundwater are appropriately excluded, no ILCR estimated for any scenario exceeds the PBOW risk goal of 1E-05. No receptor had HI values that exceed the noncancer hazard criterion (HI greater than 1). These results indicate that exposures to the environmental media at the Unloading Area are unlikely to pose an unacceptable cancer risk or noncancer health effects to receptors.

1.0 Introduction

This baseline human health risk assessment (BHHRA) evaluates potential human health risks associated with exposure to soil and groundwater associated with the Unloading Area at the former Plum Brook Ordnance Works (PBOW), Sandusky, Erie County, Ohio. The Unloading Area is administratively considered a sub-area of the Garage Maintenance Area. This work is being conducted by Shaw Environmental and Infrastructure, Inc. (a CB&I company) for the U.S. Army Corps of Engineers (USACE) under the Defense Environmental Restoration Program-Formerly Used Defense Sites, managed by the USACE Huntington District, and technically overseen by the USACE Nashville District.

This BHHRA is consistent with U.S. Environmental Protection Agency (EPA) guidance and with the Garage Maintenance Area (Sellite Area and Unloading Area) work plan (Shaw, 2013a).

In this BHHRA, the term “facility” refers to the entire former PBOW property, and the term “site” refers to an area within PBOW under investigation.

1.1 Facility Location and Description

PBOW is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland (Figure 1-1). Although located primarily in Perkins and Oxford Townships, the eastern edge of the facility extends into Huron and Milan Townships. PBOW is bounded on the north by Bogart Road, on the south by Mason Road, on the west by Patten Tract Road, and on the east by U.S. Highway 250. The areas surrounding PBOW are mostly agricultural and residential. The facility is currently surrounded by a chain-link fence, and the perimeter is regularly patrolled. Access by authorized personnel is limited to established checkpoints. Public access is restricted. Hunting is allowed by permit on portions of PBOW during the annual deer hunting season.

1.2 Facility History and Background

The PBOW facility was constructed on property comprising 9,009 acres in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), 2,4-dinitroluene, and pentolite (International Consultants Incorporated [ICI], 1995). Production of explosives at PBOW began in December 1941 and continued until 1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during the 4-year operating period. The three explosives manufacturing areas were designated TNT Area A (TNTA), TNT Area B (TNTB), and TNT

Area C (TNTC). Twelve process lines were used in the manufacture of TNT: four lines at TNTA, three lines at TNTB, and five lines at TNTC.

After plant operations ceased, the manufacturing process lines were decontaminated by the Army in late 1945. During decontamination, all chemical material was removed, and many of the structures and much equipment and manufacturing debris were either removed and salvaged or removed and burned from late 1945 through the early 1960s. After the property was certified as decontaminated, 3,230 acres of the property were initially transferred to the Ordnance Department, then to the War Assets Administration. In 1949, PBOW was transferred to the General Services Administration. This transfer did not include the Plum Brook Depot area, also known as the Magazine Area, which consists of 2,800 acres. The Department of the Army reacquired the 3,230 acres in 1954. In 1955, the Army completed further decontamination of the manufacturing process lines. This effort included removal of contaminated surface and subsurface soil around the buildings and wooden and ceramic waste disposal lines containing TNT. Thousands of pounds of TNT were discovered in catch basins; this TNT was removed and burned at the burning grounds. The Army continued cleanup efforts until 1963.

Two property use agreements were entered into by the Army and the National Advisory Committee of Aeronautics, the predecessor of the National Aeronautics and Space Administration (NASA), in 1956 and 1958, respectively. Accountability and custody for the entire portion of the former PBOW property (6,030 acres) that had been under the accountability and custody of the Department of the Army were transferred to NASA on March 15, 1963. NASA performed further decontamination efforts during 1964. The NASA decontamination process included removing contaminated surface soil above the drain tiles, flumes, etc.; destruction of all buildings by fire; and removal of all soil, debris, sumps, and above-grade portions of concrete foundations. Portions of the concrete foundations located below grade were left buried, and some that had been previously slightly above grade were covered with fill material. All materials, including the soil in those areas, were flashed; the area was then rough-graded. The decontamination process was also to have included the burning of excavated nitroaromatic-filled flumes (Dames & Moore, Inc. [D&M], 1997).

NASA has operated and maintained the former PBOW property since 1963, and the facility is currently the NASA Glenn Research Center, Plum Brook Station. NASA operates the property as a space research facility in support of their John H. Glenn Research Center at Lewis Field, Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the site are currently on standby or inactive status. On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. This excess included former buffer areas that had not been used by the

Army and were thus not subject to decontamination efforts. The Perkins Township Board of Education acquired 46 acres of the excess acreage and uses this area as a bus transportation area. The General Services Administration retains ownership of the remaining excess acreage and currently has a use agreement with the Ohio National Guard for 604 acres of this land. The details of land transactions are listed in the site management plan (ICI, 1995).

1.3 Unloading Area Description and History

The Unloading Area is located on the north side of Maintenance Road, between Ransom Road and Taylor Road, and was used principally for unloading of toluene and possibly other chemicals from railcars. It is estimated that more than 400 million pounds of toluene may have been unloaded at this site during the PBOW operational period (ICI, 1995). The Unloading Area is estimated to have been approximately 550 feet wide by 175 feet in length (approximately 2.2 acres). The area consists primarily of a former rail line with open areas to the north and south of the former bed. The site is bounded to the west by a drainage ditch and the Former Sellite Area and to the east by NASA maintenance buildings (Figure 1-2). In an area approximately 300 feet northeast of the Unloading Area, five underground storage tanks (UST) (#28, #32, #33, #34, and #35) were installed in the Garage Maintenance Area in 1942 to support maintenance work (Tetra Tech, Inc., 2001). The USTs contained gasoline, solvents, and waste oil. The locations of Tanks #33, #34, and #35 are shown on Figure 1-3. Tank #32 was located north of NASA Building No. 7131 (Ebasco Environmental, 1991). Tank #28 was located east of NASA Building No. 7121 and on the east side of Garage Road. In 1964, NASA installed three USTs (#29, #30, and #31) at the Garage Maintenance Area for the storage of solvents (acetone, trichloroethene, and 1,1,1-trichloroethane) (Tetra Tech, Inc., 2001). Tanks #28, #29, #30, #31, #33, #34, and #35 were removed in 1989. Tank #32 was removed in 1990 (Tetra Tech., Inc., 2001). The locations of these former USTs are downgradient and/or crossgradient of the Unloading Area relative to the overburden/shale groundwater flow direction (Shaw, 2013b).

The site is currently covered with a mixture of shrub thicket and upland old fields. No buildings or other structures are present on the site, other than the railroad line, which curves from southwest to northeast before forming an east-west line that roughly bisects the site. A mowed border approximately 30 feet wide is adjacent to Maintenance Road. A wetland delineation effort recently performed at PBOW identified several wetlands at the Unloading Area, including two small unconnected wetlands between Maintenance Road and the line of soil borings south of the former railroad, and some wetlands associated with the drainage ditch that forms the western border of the site (EnviroScience, Inc., [ES], 2012). These wetlands are depicted on Figure 1-3. It is noted that these areas are currently not considered jurisdictional wetlands because USACE verification of the wetlands identified by ES (2012) is still pending.

1.4 Groundwater Use and Site Use

Two groundwater aquifer systems are utilized for drinking water in the region: a carbonate aquifer to the west and a shale aquifer to the east (Shaw, 2005). PBOW is located within the transition of the two systems. Approximately 170 private drinking water wells permitted by the Erie County Health Department are located within 4 miles of PBOW. Groundwater is not used on the PBOW facility. Permits are not required for agricultural wells. The Erie County Health Department does not permit using surface water as private drinking water. A shallow discontinuous and variably saturated groundwater system exists within the unconsolidated material atop the bedrock under much of the site.

Current use of the PBOW facility is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the BHHRA. D&M (1997) describes potential future uses of all or portions of the facility as follows:

- Industrial use (NASA activities and programs) may continue.
- Portions of the site may be used for recreation by hunters and fishermen.
- Portions of the site may be sold to state or local government or private individuals (no land-use restrictions were mentioned).
- Parts of the facility may be used in the future for residential or agricultural purposes.
- Parts of the facility may be used for training by the Ohio National Guard.
- Construction activities may be performed during development of any of the sites.

In summary, future site uses of property that includes the Unloading Area are considered to be industrial or residential for the purpose of developing receptor and exposure scenarios. There are no current NASA activities at the Unloading Area, but because PBOW is under NASA control, the potential for NASA activities exists. Even though hunting is not currently permitted on the Unloading Area property, hunting is permitted in other areas within PBOW; therefore, future use of the Unloading Area for hunting is evaluated in this BHHRA. It is conservatively assumed for purposes of this BHHRA that groundwater may be developed as a source of potable water in the future. Please refer to Section 3.1.3 for a discussion of receptors and exposure scenarios.

1.5 Protocol for the Baseline Human Health Risk Assessment

The BHHRA was performed in accordance with the Garage Maintenance Area BHHRA work plan (Shaw, 2013a). The BHHRA work plan was developed consistent with previous PBOW

BHHRAs and is based on EPA, USACE, and Ohio Environmental Protection Agency (OEPA) guidance, including, but not limited to, the following:

- Ohio Environmental Protection Agency (OEPA), 2009a***, Use of U.S. EPA's Regional Screening Levels as Screening Values in Human Health Risk Assessments***, Technical Decision Compendium, Division of Emergency and Remedial Response, August.

- Ohio Environmental Protection Agency (OEPA), 2009b***, Human Health Cumulative Carcinogenic Risk and Non-carcinogenic Hazard Goals for the DERR Remedial Response Program***, Technical Decision Compendium, Division of Emergency and Remedial Response, August.

- U.S. Army Corps of Engineers (USACE), 1999, ***Risk Assessment Handbook, Volume I: Human Health Evaluation***, Engineer Manual EM 200-1-4.

- U.S. Environmental Protection Agency (EPA), 1989a, ***Risk Assessment Guidance for Superfund, Volume I, 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 (EPA), 1991, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors***, Interim Final, Office of Solid Waste and Emergency Response, OSWER Directive: 9285.6-03.

- U.S. Environmental Protection Agency (EPA), 1992, ***Guidance on Risk Characterization for Risk Managers and Risk Assessors***, Memorandum from F. Henry Habicht II, Deputy Administrator, to Assistant Administrators, Regional Administrators, February.

- U.S. Environmental Protection Agency (EPA), 1997a, ***Exposure Factors Handbook***, Office of Research and Development, National Center for Environmental Assessment, Washington, D.C., EPA/600/P-95/002Fa, August.

- U.S. Environmental Protection Agency (EPA), 2002, ***Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites***, Office of Solid Waste and Emergency Response, Washington, D.C., 9355.4-24, December.

- U.S. Environmental Protection Agency (EPA), 2004a, ***Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part E - Supplemental Guidance for Dermal Risk Assessment)***, Final, Office of Superfund Remediation and Technology Innovation, Washington, D.C., EPA/540/R-99/005, July.

- U.S. Environmental Protection Agency (EPA), 2010a, ***ProUCL Version 4.1 Technical Guide***, Draft, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, EPA/600/R-07/041, May.

- U.S. Environmental Protection Agency (EPA), 2010b, ***ProUCL Version 4.1 User Guide***, Draft, Office of Research and Development, Technology Support Center

Characterization and Monitoring Branch, Las Vegas, Nevada, EPA/600/R-07/038, May.

- U.S. Environmental Protection Agency (EPA), 2011, ***ProUCL Version 4.1***, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, February, on line at http://www.epa.gov/esd/tsc/form.htm.

1.6 Report Organization

The remainder of this document is organized as follows:

- ***Chapter 2.0, Data Evaluation.*** Identifies data sources, evaluates data quality, identifies chemicals of potential concern (COPC), and provides a background screening and evaluation protocol. It is noted that the background screening protocol differs from the current OEPA (2009c) guidance, as explained in Section 2.4.3.

- ***Chapter 3.0, Exposure Assessment.*** Presents a conceptual site exposure model (CSEM), including contaminant sources, contaminant release mechanisms, receptors, and exposure pathways; describes exposure-point concentrations (EPC); and presents methods for calculating chemical intake and contact rates.

- ***Chapter 4.0, Toxicity Evaluation.*** Describes the potential for cancer and/or noncancer human health effects, provides an estimate of the quantitative relationship between the magnitude of dose or contact rate and the probability and/or severity of adverse effects, identifies the toxicity values that are used in the BHHRA, and describes the development of dermal toxicity values.

- ***Chapter 5.0, Risk Characterization.*** Combines the output of the exposure assessment and toxicity assessment to quantify the risk to each receptor at each site. Risks associated with exposure to all appropriate media for each site are evaluated.

- ***Chapter 6.0, Uncertainty Analysis.*** Identifies uncertainties in all phases of the BHHRA and discusses their individual effects on the risk assessment results, focusing on those issues that are most likely to have the greatest effect on risk estimates and/or risk management decisions.

- ***Chapter 7.0, Summary and Conclusions.*** Provides a brief summary of the BHHRA, including quantitative results, uncertainties, and pertinent site information. Summary and discussion is focused on those results and issues that are most directly relevant to the risk assessment conclusions for the Unloading Area.

- ***Chapter 8.0, References.*** Presents the references used in the preparation of this document.

2.0 Data Evaluation

Data evaluation consists of a description of the appropriate data sources for each environmental medium sampled for each site, a discussion of data quality, a description of the methodology used for identification of the COPCs, and a summary of the COPCs for each Unloading Area environmental medium.

2.1 Data Sources

All soil and groundwater samples from which the validated analytical data used in the BHHRA were derived are presented in Table 2-1. These data include surface soil, subsurface soil, and overburden groundwater well samples documented in the site characterization report (Shaw, 2013b). The sample summary table identifies each sample used in the BHHRA and the associated analytical suite. All Unloading Area sampling locations are shown on Figure 1-3.

2.2 Sorting the Analytical Data

Prior to initiation of BHHRA calculations, a database of chemicals present in site samples was compiled for each environmental medium. This database includes all chemicals detected, as described in the characterization report (Shaw, 2013b). The surface soil and subsurface soil are considered separate media. Surface soil is defined as samples collected from within the interval of 0 to 1 foot below ground surface (bgs), and subsurface soil is defined as samples collected from depths greater than 1 foot bgs (Shaw, 2013b). Surface soil data are used to assess exposures under the current groundskeeper, indoor worker, and hunter scenarios. Surface and subsurface soil data are typically combined to assess exposures under the construction worker, future groundskeeper, and residential site-use scenarios that would likely occur after surface and subsurface soil had been excavated and/or mixed. Combined surface and subsurface soil data are termed “total soil” in the BHHRA. However, it is understood that a reference to the evaluation of exposure to total soil is actually an evaluation of exposure to both surface soil and subsurface soil. The total soil COPC list is created by combining the list of COPCs identified in surface and subsurface soil. If a chemical is identified as either a surface soil COPC or a subsurface soil COPC, then that chemical is identified as a total soil COPC. The EPCs for total soil are typically generated from the combined data sets. Because no subsurface soil COPCs were identified in this BHHRA, total soil was not evaluated, and surface soil replaced total soil as the exposure medium for those receptors that would ordinarily be exposed to total soil.

Direct-push drilling was used to collect soil samples at the Unloading Area. Twelve borings (SB-01 through SB-12) were drilled to 10 feet and soil samples were collected from specified

depth intervals (0 to 1, 3 to 5, and 8 to 10 feet bgs). Surface soil samples collected from the 0 to 1 foot bgs interval were used to assess surface soil exposures in the BHHRA. Subsurface samples collected at the 3 to 5 and 8 to 10 feet intervals were used in the assessment of total soil exposures in the BHHRA.

Boreholes in which a piezometer was installed were advanced beyond the initial 10 feet required for subsurface soil sampling until probe refusal (Shaw, 2013b). Soil samples were analyzed for nitroaromatics (explosives), metals, volatile organic compounds (VOC), polychlorinated biphenyls (PCB), semivolatile organic compounds (SVOC), and general chemistry parameters. Groundwater samples were analyzed for nitroaromatics, VOCs, SVOCs, metals (unfiltered and filtered), and several water quality parameters.

Three overburden/shale monitoring wells were installed at the Unloading Area (Figure 1-3). Monitoring wells were installed in upgradient (ULA-MW01) and downgradient (ULA-MW03) locations and in a suspected source area location (ULA-MW02). Groundwater samples from the monitoring wells were analyzed for nitroaromatics, VOCs, SVOCs, metals (unfiltered and filtered), and several water quality parameters.

2.3 Evaluation of Data Quality

The quality of analytical data was evaluated to select data for inclusion in the BHHRA. Data quality is expressed by the assignment of qualifier codes during the analytical laboratory quality control process or during third-party data evaluation. Some of the more common qualifiers and their meanings are as follows (EPA, 1989a):

- U - Chemical was analyzed for but not detected; the associated value is the sample quantitation limit.
- J - Value is estimated, usually below the reporting limit.
- N - The analysis indicates an analyte for which there is presumptive evidence to make a tentative identification.
- NJ - The analysis indicates a “tentatively identified analyte,” and the reported value represents its approximate concentration.
- UJ - The analyte was not detected above the reporting limit. However, the reporting limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R - Quality control indicates that the data are unusable (chemical may or may not be present).

B - The concentration in the sample is not sufficiently higher than concentration in the blank, using the 5-times, 10-times rule, which states that a chemical is considered a nondetect unless its concentration exceeds 5 times the blank concentration. For common laboratory contaminants (acetone, 2-butanone [methyl ethyl ketone], methylene chloride, toluene, and the phthalate esters), the sample concentration must exceed 10 times the blank concentration to be considered a detection.

"J," "N," and "NJ" qualified data are treated in the BHHRA as detected concentrations; "R" data and "B" qualified chemical data are not used. "U" and "UJ" qualified data are treated in the BHHRA as nondetections. The use of data with other, less common qualifiers is evaluated on a case-by-case basis. Generally, data for which the identity of the chemical is unclear are not used in the BHHRA. If confidence that the chemical is present is reasonably high but the actual concentration is somewhat in question, the data generally are used in the BHHRA.

Some chemicals may be analyzed under two different analytical programs. For example, the dinitrotoluene isomers are analyzed by EPA Method 8330 for nitroaromatics and by EPA Method 8270C for SVOCs. Risks associated with the reported values from both analyses are considered in the risk characterization (Chapter 5.0) and discussed as appropriate in the uncertainty analysis (Chapter 6.0), together with potential issues such as the relative sensitivities (i.e., differences in respective reporting limits) of the methods.

2.4 Identification of Chemicals of Potential Concern

A screening process is used to identify COPCs, which are the detected chemical analytes carried through the full risk assessment process. The objectives of COPC screening are to focus the risk assessment on those chemicals that may contribute significantly to overall risk and to remove from quantification those chemicals whose contribution is clearly inconsequential. COPC screening includes a risk-based screen that also considers status as a human nutrient (Section 2.4.1), a frequency-of-detection evaluation (Section 2.4.2), and a background concentration screen (Section 2.4.3).

2.4.1 Risk-Based Screening

In the risk-based screen, the maximum detected concentration (MDC) of a chemical in a given medium is compared to the appropriate risk-based screening concentration (RBSC) for that chemical and medium. This comparison is performed for each chemical in each medium. The units of the MDC and RBSC are the same for each chemical in a given medium.

If the MDC of a chemical is less than or equal to its RBSC, then the chemical is not considered further in the BHHRA for this medium because it is very unlikely that chemical concentrations at or below the RBSC would contribute substantially to risk. An analyte may be identified as a COPC if its MDC exceeds its RBSC. As indicated in Section 2.4, actual status as a COPC also depends on a chemical's frequency of detection (Section 2.4.2), concentration with respect to background (Section 2.4.3), and potential status as a nutrient. Groundwater RBSCs used in the BHHRA are derived from the EPA (2013a) regional screening level (RSL) table "tap water" values, and RBSCs for soil are derived from "residential soil" RSL values.

This source of RBSCs represents a change from PBOW BHHRA work plans begun prior to March 2009 based on discussions between USACE and OEPA (2009c), and is consistent with recent OEPA (2009a) guidelines. Previously, the groundwater and soil RBSCs were derived from the corresponding EPA (2004b) Region 9 preliminary remediation goals. The soil RBSCs are applied to both surface and subsurface soil.

The RSL values are based on a concentration equal to either an incremental lifetime cancer risk (ILCR) of 1E-6 or a noncancer hazard quotient (HQ) of 1, the threshold at (or below) which adverse noncancer effects are regarded as unlikely to occur. For the BHHRA, the noncancer values listed in the RSL tables are multiplied by a factor of 0.1 to provide additional protection for simultaneous exposure to multiple chemicals (OEPA, 2009a; EPA, 2013a). Multiplication by this factor results in RBSC values associated with an HQ of 0.1. For cancer risk, the RSL values based on an ILCR of 1E-6 were used directly as RBSCs in the BHHRA. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) identifies acceptable exposure levels that are generally associated with concentration levels that represent an excess upper bound lifetime cancer risk to an individual of 1E-6 to 1E-4 (EPA, 1990). This range is hereinafter referred to as the NCP risk management range. Cancer risks associated with RSL values represent the lower end of this range. OEPA recognizes an overall cancer risk of 1E-5, which represents the logarithmic midpoint of the EPA risk management range, as a remedial goal (OEPA, 2009b). The RBSC for a chemical that elicits both cancer and noncancer health effects is selected based on either a cancer risk of 1E-6 or an HQ of 0.1, whichever associated concentration is lower.

The screening of lead in soil and groundwater is a special case. The EPA (2012a) Office of Water treatment technique action level of 15 micrograms per liter (µg/L) for lead is listed in the RSL table, and the RSL user's guide (EPA, 2012b) recommends this level for use as an RSL.

Lead exposure and risk are evaluated separately from other chemicals using the EPA (2009) Integrated Exposure Uptake Biokinetic (IEUBK) model. The selection of the action level as the drinking water RSL is based partly on IEUBK model. Section 5.2 of the RSL user's guide states that if the average tap water concentration exceeds 15 µg/L and the average soil concentration exceeds a value of 250 milligrams per kilogram (mg/kg), then more than the IEUBK target (EPA, 2009) of 5 percent of the population of exposed children would exceed 10 micrograms per deciliter of lead in blood. Because an RSL of 15 µg/L sufficiently screens for a potential average concentration of 15 µg/L, the RSL of 15 µg/L is used as the RBSC. Note that this RSL value equals the maximum contaminant level for lead established in the Safe Drinking Water Act. However, it is possible that the residential soil RSL of 400 mg/kg, which is selected as the soil RBSC, may not screen for an average soil concentration of 250 mg/kg within a given data set. Therefore, the following conditions were placed on the screening of lead:

1. If either the soil RBSC or groundwater RBSC is exceeded, then the IEUBK blood-lead model is run using both average soil and groundwater concentrations.

2. If the average soil concentration exceeds 250 mg/kg, then the IEUBK model is run, even if neither RBSC is exceeded, using average concentrations of lead in both soil and groundwater.

There are no RSLs for sulfate in tap water, but the drinking water outside-of-the-mixing-zone average value of 250 milligrams per liter (mg/L) for the Lake Erie Basin is used as the RBSC. This value is the same as the secondary drinking water regulation of 250 mg/L (EPA, 2012a). Secondary drinking water regulations are nonpromulgated values, based on aesthetic characteristics, which are used as guidelines for public water systems. A health-based advisory level of 500 mg/L also exists for sulfate (EPA, 2012a).

The evaluation of essential nutrients is a special form of risk-based screening applied to certain ubiquitous elements that are generally considered to be required human nutrients. Essential nutrients such as calcium, chloride, iodine, magnesium, phosphorous, potassium, and sodium are generally considered innocuous at levels found in environmental media. No RSLs are listed for these nutrients. Should any of these chemicals be identified as site related, an exposure analysis is performed whereby a daily dose of chemical from ingestion of the medium in question is calculated. The dose is compared with levels known or expected to be safe or toxic, and/or with recommended daily allowances, depending on the availability of data.

2.4.2 Frequency of Detection

When confidence that a given chemical is present is high, the data generally are used in the BHHRA. For most chemicals, their detection is presumptive evidence of their presence. As suggested by EPA (1989a), chemicals that are reported infrequently may be artifacts in the data that do not reflect the actual presence of the chemical in question. For the BHHRA, chemicals that are reported only at low concentrations in less than 5 percent of the samples from a given medium are excluded from further consideration, unless the presence of a given chemical is expected based on historical information about the site. Chemicals detected infrequently at high concentrations may identify the existence of contaminant plumes or limited "hot spots" and are retained as COPCs.

2.4.3 Comparison to Background

A number of the chemicals detected in PBOW environmental media may have MDCs that exceed RBSCs but are part of normal background concentrations. Such chemicals may include inorganics and polycyclic aromatic hydrocarbons (PAH), a class of organic compounds which form from natural or anthropogenic combustion of organic matter, including fossil fuels, and are generally ubiquitous in the environment. Airborne PAHs associated with non-U.S. Department of Defense sources may be deposited on soil and leach to groundwater. Benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds, as well as PAHs, may also be associated with background concentrations due to the presence of natural petroleum-derived compounds present in the vicinity of PBOW (Section 3.1.1).

Concentrations of inorganic chemicals in site environmental media may be compared to those of PBOW background using a two-step approach: 1) background screening and 2) statistical data set testing. This second step (Section 2.4.3.2) is initiated only in cases where the concentration used for background screening is exceeded (Section 2.4.3.1) and is performed after the risk characterization (Chapter 5.0). The results of the statistical data testing are discussed in the uncertainty analysis (Chapter 6.0).

Inorganics and organics are treated similarly from a quantitative perspective. However, all organics not eliminated on the basis of RBSC exceedence (Section 2.4.1) or infrequent detection (Section 2.4.2) are carried through the risk calculation process (exposure assessment, toxicity assessment, and risk characterization). As presented in Section 2.4.3.3, organic compounds are quantitatively eliminated as background related only through the uncertainty analysis if applicable.

2.4.3.1 Background Screening of Inorganics

Background screening is applied to each inorganic whose MDC in soil or limestone bedrock groundwater exceeds the RBSC and that cannot be characterized as an infrequently detected analyte. In background screening, the MDC is compared to the PBOW chemical-specific background screening concentration (BSC). The background data set and derivation of soil BSCs for all PBOW soil investigations are described in the site investigation of the acid areas (IT Corporation [IT], 1998), and the background data set and derivation of BSCs for PBOW bedrock groundwater are described in the 2004 groundwater report (Shaw, 2005). The background screening protocol used for the Unloading Area is based on PBOW Project Delivery Team (PDT) agreements (PBOW PDT, 2000), and differs somewhat from the current OEPA (2009c) guidance. Use of this PBOW PDT method for the development of background screening concentrations and as part of the COPC screening process ensures consistency between all of the PBOW Formerly Used Defense Sites project sites.

The background screening consists of comparing the MDC of the site data set to the BSC. The chemical may be regarded as a COPC if its MDC exceeds the BSC for that chemical or if no BSC can be determined due to a lack of detections in the background data set. COPCs are fully evaluated in the exposure assessment, toxicity assessment, and risk characterization. An inorganic analyte is not regarded as a COPC if its MDC is equal to or less than the BSC.

2.4.3.2 Statistical Data Set Testing of Inorganics

Statistical testing is performed to compare data sets of site inorganics data against the appropriate PBOW background data sets. As described in Section 2.4.3.1, the background data set for groundwater is presented in the 2004 groundwater report (Shaw, 2005), and the background data set for soil is presented in the site investigation for the acid areas (IT, 1998). Because background data sets do not exist for overburden groundwater, statistical background evaluation for COPCs in these media cannot be performed. The method for statistical comparison of the site data sets to the background data sets, described in Appendix M of Shaw (2005), is the Wilcoxon Rank Sum (WRS) statistical test (also known as the Mann-Whitney U test).

All COPCs identified based on RBSC comparison (Section 2.4.1) and frequency of detection (Section 2.4.2) criteria are carried through the risk characterization process; thus, statistical testing results are not used to screen out any chemicals. WRS testing is performed for inorganics that may potentially warrant corrective action.

Site data sets are interpreted as being significantly different from PBOW background if the associated p-level is less than 0.05. WRS statistical output and box-and-whisker plots of the

various inorganic COPC data sets are appended to the BHHRA for each inorganic data set evaluated against the appropriate site background data set; the WRS results are discussed as part of the uncertainties. Analytes shown by the WRS results to exceed background (or for which the WRS testing was not run) are assumed to be site related, unless a qualitative chemical-specific explanation is presented in the uncertainties analysis as to why the analyte should not be regarded as site related. The WRS is not run if the COPC was not detected in the PBOW background data set. Data sets for which the WRS results do not suggest site relatedness (i.e., site data and background data are not statistically different) are still evaluated for risks and hazards in the risk characterization (Chapter 5.0).

2.4.3.3 Treatment of Organic Compounds

As mentioned in Section 2.4.3, certain organic compounds (e.g., BTEX and PAHs) in site media may be attributable to background conditions. However, no organic compounds are summarily screened out by this method. Instead, all detected organic compounds are carried through the risk assessment process (i.e., exposure assessment, toxicity assessment, and risk characterization) unless screened out on the basis of comparison to RBSCs (Section 2.4.1) or characterized as infrequently detected (Section 2.4.2). Background contributions of organics are discussed in the uncertainties analysis, as applicable.

2.5 Data Evaluation Summary

Data summary tables are provided for the following Unloading Area media: surface soil (Table 2-2), subsurface soil (Table 2-3), and overburden groundwater (wells) (Table 2-4). These tables provide the following information for each detected chemical in each environmental medium:

- Chemical name
- Frequency of detection
- Range of detected concentrations
- Range of detection limits
- Arithmetic mean of site concentrations
- 95th percent upper confidence limit on the arithmetic mean (UCL) (for COPCs only)
- Appropriate RBSC
- Appropriate BSC
- Selection/exclusion of chemical as a COPC
- EPC (for COPCs only).

The estimation of the UCL values for COPCs is discussed in Section 3.2.1. For duplicate samples, the associated regular and field duplicate values are averaged in the data summary if both samples are detects or if both are nondetects; if only one of the duplicates is a detect, then the detected value is used in the data summary.

An analogous summary table for the overburden groundwater piezometer samples is appended (Appendix A). Note that these direct-push groundwater piezometer samples are collected for nature-and-extent purposes to determine groundwater flow direction and the placement of monitoring wells. These data are not sufficiently representative of groundwater conditions for use in risk assessment. Therefore, they are not used to identify COPCs and are not quantitatively evaluated in the BHHRA. This piezometer groundwater summary table is appended only to provide ancillary information.

The COPCs for each of the Unloading Area media are identified as follows:

- ***Surface Soil*** – Benzo(a)pyrene.
- ***Subsurface Soil*** – No COPCs are identified.
- ***Overburden Groundwater*** – Antimony, arsenic, chromium, cobalt, iron, and manganese.

As discussed in Section 2.2, the total soils COPCs include all surface soil and subsurface soil COPCs. Because no COPCs are identified in subsurface soil at the Unloading Area, exposures assumed in scenarios involving total soil are conservatively evaluated using COPCs and EPCs developed for surface soil.

3.0 Exposure Assessment

Exposure is the contact of a receptor with a chemical or physical agent. An exposure assessment estimates the type and magnitude of potential exposure of a receptor to COPCs found at or migrating from a site (EPA, 1989a). An exposure assessment includes the following steps:

- Characterize the physical setting.
- Identify the contaminant sources, release mechanisms, and migration pathways.
- Identify the potentially exposed receptors.
- Identify the potential exposure pathways.
- Estimate exposure concentrations.
- Estimate chemical intakes or contact rates.

The BHHRA characterizes potential exposures to COPCs in the Unloading Area environmental media as portrayed by the CSEM in Section 3.1.

3.1 Conceptual Site Exposure Model

The CSEM provides the basis for identifying and evaluating the potential risks to human health in the BHHRA. The CSEM, graphically depicted on Figure 3-1, includes the receptors appropriate to all plausible site-use scenarios and the potential exposure pathways. This presentation of all plausible pathways by which a potential receptor may be exposed, including all sources, release and transport pathways, and exposure routes, facilitates consistent and comprehensive evaluation of risk to human health and helps to ensure that potential pathways are not overlooked. The elements of a CSEM include the following:

- Source
- Source media (i.e., initially contaminated environmental media)
- Contaminant release mechanisms
- Contaminant transport pathways
- Intermediate or transport media
- Exposure media
- Receptors
- Routes of exposure.

Contaminant release mechanisms and transport pathways are not relevant for direct receptor contact with a contaminated source medium (e.g., ingestion or dermal contact).

The receptors and pathways on Figure 3-1 reflect scenarios developed from information regarding site background and history, topography, climate, and demographics as presented by D&M (1997) and the sitewide groundwater investigation (IT, 1997). On Figure 3-1, asterisks

identify exposure pathways that are complete and addressed in this BHHRA. Justification for exclusion of other pathways is provided in the Figure 3-1 footnotes, and the exclusion of other potential receptors is discussed in Section 3.1.3.7. No current or future exposure by off-site residents is evaluated. Most of the off-site residents are serviced by municipal water from surface water sources. Although there are numerous private groundwater wells in the vicinity, including eight within 1 mile of the facility boundary, none of these is used as a potable source. Based on the investigations of other PBOW sites, natural hydrocarbons and hydrogen sulfide are known to be present within the bedrock limestone, and shale formation groundwater generally provides low yields and is of low quality water (Shaw, 2008); however, the groundwater underlying the Unloading Area was not summarily excluded for consideration as a tap water source based on natural water quality parameters or assumed yield. Therefore, given the presence of numerous off-site wells and the assumption of unrestricted future land use on site, the development of groundwater for on-site residential (or on-site worker) use as tap water is initially regarded as plausible for purposes of this BHHRA. Groundwater quality and potential use is discussed further in the uncertainty analysis (Chapter 6.0).

3.1.1 Physical Setting

The topography at the Unloading Area is essentially flat (Figure 1-3). Ground surface elevations at the Unloading Area range from approximately 633.2 feet above mean sea level at ULA/MW-01 along the southern portion of the site to 637.2 feet above mean sea level at ULA/SB-12 near the southeastern portion of the site.

The following subsections further describe the physical setting of the Unloading Area, including the climate and meteorology of the Sandusky region (Section 3.1.1.1), and geology (Section 3.1.1.2), soil (3.1.1.3), hydrology (Section 3.1.1.4), and surface water characteristics (Section 3.1.1.5) of the area and of the Unloading Area in particular. A general description of the Unloading Area is provided in Section 1.2.

3.1.1.1 Climate/Meteorology

The climate in the Sandusky area is continental and strongly affected by Lake Erie. July is generally the warmest month (average high and low temperatures of 82 and 65 degrees Fahrenheit [°F], respectively), and January is generally the coldest month (average high and low temperatures of 32 and 19°F, respectively) (The Weather Channel, 2004). On average, the first freezing day (low of 32°F or less) occurs in late October (average of three per month), and the last freezing day falls in early May (average of one per month) (National Oceanic and Atmospheric Administration, 1990). The average annual precipitation for Sandusky is 34.5 inches per year, with a monthly average of more than 3 inches per month falling in April through

September and less than 3 inches in each of the other seven months (The Weather Channel, 2004). Precipitation is fairly evenly distributed throughout the year, with the fewest precipitation days (10 days per month with 0.01 inch or greater) occurring during July, August, September, and October, and the most (15 days) occurring in December and January (City-Data.com, 2004). The mean annual wind speed is 10.3 miles per hour (City-Data.com, 2004), with winds predominantly from the southwest (Science Applications International Corporation, 1991). Sandusky area winters are cloudy, with 33 percent sunshine during November through February, as compared with up to 65 percent sunshine during the summer months (City-Data.com, 2004).

3.1.1.2 Geology

At PBOW, three bedrock units are present beneath unconsolidated overburden: from deepest to most shallow, these are the Delaware Limestone, Olentangy Shale, and Ohio Shale. Each of these formations has been encountered in the upper 100 feet of bedrock at PBOW (Shaw, 2005).

Based upon regional bedrock geology and review of borelogs from nearby bedrock monitoring wells, the Unloading Area is located above the Plum Brook Shale, which in turn is located above the Delaware Limestone. Information from nearby wells indicate that shale would probably be encountered at an approximate depth of 25 feet bgs followed by the Delaware Limestone encountered at an approximate depth of 37.5 feet bgs. Based upon these depths, shale thickness should be 12.5 feet (Shaw, 2013b).

3.1.1.3 Soils

The overburden in Erie County is predominantly glacial till, glacial outwash, or glacial lacustrine (lake) deposits. In the vicinity of PBOW, the soil has been interpreted to be lacustrine. In many PBOW areas, the overburden also consists of highly weathered bedrock. The thickness of the overburden ranges from less than 1 foot to more than 25 feet.

3.1.1.4 Hydrology

The two main water-bearing zones at PBOW are located in the overburden/shale unit and the limestone bedrock and are thus called the overburden/shale and bedrock water-bearing zones. The overburden and shale groundwater units show similar water levels in these two units, suggesting substantial vertical communication. Therefore, these two geologic units are combined for purposes of the PBOW groundwater evaluation. Data collected during various investigations (Shaw, 2003, 2005; IT, 1997, 1999, 2000a,b) indicate that groundwater in the overburden is in discontinuous pockets during dry time periods. The shallow overburden generally has low yields over most of PBOW due to the high percentage of silt and clay. Groundwater flow in the limestone bedrock is primarily through fractures. The limestone bedrock water-bearing zone

yields groundwater year round, although specific locations may not produce water because of limited fractures in some areas. During periods of low precipitation, only limited migration of contaminants would occur in the overburden due to less infiltration.

Regional groundwater flow in both the overburden/shale and the limestone bedrock is to the north-northeast towards Lake Erie, although local flow may vary due to local topography. A hydrogeological study by the U.S. Geological Survey (1992) conducted in the glacial deposits of Sandusky in 1990 reported a horizontal hydraulic conductivity of 0.046 feet per day and a vertical hydraulic conductivity of 1.2 feet per day.

Water in the limestone bedrock typically occurs in joints and along bedding planes or in solutionally enlarged openings. The conceptual model interprets that bedrock groundwater flow in the Delaware Limestone water-bearing zone is influenced by the frequency, orientation, density, and connectivity of the bedrock fractures.

Based on locations and yields of domestic groundwater wells outside of the PBOW facility boundary, the Ohio Department of Natural Resources divided the bedrock groundwater in the vicinity of PBOW into three zones (D&M, 1997). Zone 1 occurs in the north and northwestern portion of PBOW. It has been characterized as yielding from 100 to 500 gallons per minute (gpm) from karstic limestone approximately 100 feet below grade. Zone 2 is in the northern portion of PBOW and has yields of 15 gpm or less from limestone approximately 300 feet below grade. Zone 3 is located in the eastern and southern portion of the site in predominantly shale bedrock. In addition to being found in the shale, groundwater is located in thin sand and gravel horizons interbedded with silt and clay deposits. Most Zone 3 wells are poor yielding, many of them providing less than 3 gpm (D&M, 1997). The Unloading Area lies within Zone 3.

3.1.1.5 Surface Water

Surface water for the Unloading Area specifically drains into an unnamed ditch west of the site that eventually drains into Ransom Brook. Note that this unnamed ditch west of the site marks the boundary between the Former Sellite Area and Unloading Area. This ditch was evaluated for human health impacts in the Former Sellite Area BHHRA (Shaw, 2013c). Two drainages at the site, Kuebler Ditch and Plum Brook, are monitored by NASA Plum Brook Station under a National Pollutant Discharge Elimination System outfall permit (OEPA, 2012). These permitted outfalls are monitored for metals (nickel, zinc, lead, chromium, and copper) as well as water quality parameters (chemical oxygen demand, total suspended solids, pH, hardness, and chlorine) and oil and grease. These outfalls are approximately 15,380 and 4,750 feet from the site, respectively, and effluent from these outfalls is not expected to affect the Unloading Area.

A wetland delineation effort recently performed at PBOW identified several wetlands at the Unloading Area, including two small unconnected wetlands between Maintenance Road and the line of soil borings south of the former railroad, and some wetlands associated with the drainage ditch that forms the western border of the site (ES, 2012). It is noted that these areas are currently not considered jurisdictional wetlands because the USACE verification of the wetlands identified in the ES (2012) report is still pending.

3.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways

Contaminant sources, release mechanisms, and migration pathways are summarized on Figure 3-1. Briefly, TNT is made by nitrating toluene in a three-step process that uses nitric and sulfuric acids (D&M, 1997). The Unloading Area was used principally for unloading of toluene and possibly other chemicals from railcars. Five USTs that contained gasoline, solvents, and waste oil were located in an area approximately 300 feet northeast of the Unloading Area. Three additional USTs contained solvents (acetone, trichloroethene, and 1,1,1-trichloroethane). These USTs have been removed and were formerly located downgradient and/or crossgradient of the Unloading Area relative to the overburden/shale groundwater flow direction (Shaw, 2013b).

Contamination may have resulted from the inadvertent release of stored chemicals from the storage tanks. Releases may have occurred to the surface soil during unloading and to subsurface soil from vertical migration. Infiltration and leaching may have carried contaminants into the subsurface soil or groundwater. Runoff and erosion may have spread contamination over the surrounding surface soil.

3.1.3 Receptors and Exposure Pathways

Receptors selected from all plausible groups of people to represent the upper bound on exposure to chemicals associated with the Unloading Area are depicted on Figure 3-1 and summarized in Table 3-1. Figure 3-1 and Table 3-1 also include the pathways by which these receptors may be exposed. The exposure variable values used in the contaminant intake models are compiled in Table 3-2. The receptors evaluated in the BHHRA are listed below.

- Current groundskeeper
- Future groundskeeper
- Indoor worker (future)
- Construction worker (current/future)
- On-site resident (future)
- Hunter (future)
- Hunter’s child (future).

The COPCs identified in overburden groundwater include nonvolatile metals (antimony, arsenic, chromium, cobalt, and manganese).

Note that the current (Section 3.1.3.1) and future (Section 3.1.3.2) groundskeeper scenarios include different environmental media and are, thus, listed separately. The construction worker scenario may be viable under current or future land use, but the evaluation for this receptor is exactly the same under both current and future scenarios.

Most BHHRAs are based on a reasonable maximum exposure (RME) assumption. The intent of the RME assumption is to estimate the highest exposure level that could reasonably be expected to occur, but not necessarily the worst possible case (EPA, 1989a; 1991). It is interpreted as reflecting the upper 90 to 95th percentile on exposure. In keeping with EPA (1989a; 1991) guidance, variables chosen for a baseline RME scenario for ingestion rate, exposure frequency, and exposure duration are generally upper bounds. Other variables, such as body weight and exposed skin surface area, are generally central or average values. In the case of contact rates consisting of multiple components (e.g., dermal contact with soil or water, which consists of a dermal absorption factor [ABS] and soil-to-skin adherence factor [AF] for soil, and permeability coefficient [K_p] and exposure time [ET] for water), only one variable, ABS or K_p, needs to be an upper bound. The conservativeness built into the individual variables ensures that the entire estimate for contact rate is sufficiently conservative.

The averaging time for noncancer evaluation is computed as the product of the exposure duration (years) multiplied by 365 days per year. The resultant noncancer averaging time is used to estimate an average daily dose over the entire exposure period (EPA, 1989a). For cancer evaluation, the averaging time is computed as the product of 70 years, the assumed human lifetime, times 365 days/year. This cancer-based averaging time is used to estimate an average daily dose prorated over a lifetime, regardless of the frequency or duration of exposure. The methodology used in deriving the averaging time for cancer risks assumes that the risk from short-term exposure to a high dose of a given carcinogen is equivalent to long-term exposure to a correspondingly lower dose, provided that the total lifetime doses are equivalent. This approach is generally consistent with the EPA (2005) policy of carcinogen evaluation, although it introduces considerable uncertainty into the BHHRA cancer risk estimates.

A fractional term (FI) is introduced into the chemical intake equations to account for scenarios in which exposure to a potentially contaminated medium associated with the site is less than total daily exposure to that medium. For example, if the site of interest is small or has unusual dimensions so that a groundskeeper would be unlikely to spend all (or nearly all) of his working

time at the site, an FI value of less than 1 might be applied to the soil ingestion and dermal intake equations.

Receptors and the associated exposure pathways are presented in Sections 3.1.3.1 through 3.1.3.8. Please note that some of the pathways considered for the receptors (e.g., VOCs in soil) were not quantitatively evaluated because pertinent chemicals associated with these pathways were not identified as COPCs in soil or groundwater at this site.

3.1.3.1 Current Groundskeeper

The groundskeeper scenario is designed to evaluate the upper bound for long-term site worker exposure to surface soil in the current site-use scenario and total soil in the future site-use scenario. It is noted that other than some mowing in portions of the Unloading Area (particularly along the southern edge of the Unloading Area adjacent to Maintenance Road), no groundskeeper is currently working at the site, but current land use does not prohibit a site worker from performing regular groundskeeping activities at the site. Use of groundwater that could theoretically be developed as a source of drinking water is also evaluated for the groundskeeper in the future site-use scenario, as discussed in Section 3.1.3.2.

One semivolatile COPC (benzo[a]pyrene) was identified in surface soil, and no COPCs were identified in subsurface soil. Because no volatile COPCs were identified in surface soil, subsurface soil, or groundwater, all inhalation exposure pathways are based on exposure to airborne dust and all potential vapor inhalation pathways are incomplete.

The groundskeeper is assumed to be a 70-kilogram (kg) adult who works 8 hours per day, approximately 5 days per week year-round on site for a total of 250 days/year for 25 years (EPA, 2004a). The respiratory rate for the groundskeeper is assumed to be 20 cubic meters (m^3) per 8-hour workday or 2.5 cubic meters per hour (m^3/hr) (EPA, 1991), and the soil incidental ingestion rate is assumed to be 100 milligrams per day (mg/day) (EPA, 2002). The groundskeeper is assumed to be exposed dermally to soil. An exposed skin surface area of 3,300 square centimeters (cm^2) and a soil AF of 0.2 milligrams per square centimeter (mg/cm^2) are assumed (EPA, 2004a).

3.1.3.2 Future Groundskeeper

A hypothetical future groundskeeper is assumed to be exposed to groundwater that could theoretically be developed as a source of drinking water in the future. The groundskeeper is assumed to be a 70-kg adult who works 8 hours per day, approximately 5 days per week year-round on site for a total of 250 days/year for 25 years (EPA, 2004a).

The future groundskeeper scenario usually assumes exposure to a combination of surface soil and subsurface soil to account for the likelihood that construction has taken place and that some of the soil currently in the subsurface has been brought to the surface during earthmoving activities. This exposure to total soil for the future groundskeeper is not evaluated in this BHHRA because no COPCs were identified in subsurface soil. Therefore, the future groundskeeper is assumed to be conservatively exposed only to surface soil in this evaluation.

His drinking water ingestion rate is assumed to be 1 liter per day (L/day) (EPA, 1991). He may also experience dermal contact with groundwater used to clean equipment and to rinse dust or perspiration from his body. For this evaluation, it is assumed that the head, forearms, and hands, approximately 3,300 cm^2 of his body (EPA, 2004a), would be exposed intermittently for up to 1 hour/day. Because exposure is assumed to be intermittent rather than continuous, organic chemical uptake across the dermis would not reach steady state, which guides the selection of the EPA (2004a) model used to quantify this pathway (Section 3.3).

Exposure pathways involving exposure of a future groundskeeper to COPCs in soil (incidental ingestion, dermal contact, inhalation of dust) are evaluated. Because no volatile COPCs were identified in surface soil, subsurface soil, or groundwater, all potential vapor inhalation exposure pathways are incomplete.

3.1.3.3 Indoor Worker

A hypothetical future indoor worker is assumed to be exposed to groundwater that could theoretically be developed as a source of drinking water in the future. Because there are no volatile COPCs identified in soil or groundwater that could infiltrate into the indoor work space, the exposure pathways for the future indoor worker to soil COPCs are the same as those evaluated for the future groundskeeper. The higher exposure values applied in the future groundskeeper evaluation (Table 3-2) always result in higher exposure estimates than for the indoor worker exposed by the same pathways.

The indoor worker is assumed to be a 70-kg adult who works 8 hours/day, approximately 5 days/week year-round on the site for a total of 250 days/year for 25 years (EPA, 2002). His incidental soil ingestion rate is assumed to be 50 mg/day (EPA, 2002), and his inhalation rate is assumed to be 20 m^3/8-hour workday (EPA, 1991).

His drinking water ingestion rate is assumed to be 1 L/day (EPA, 1991). Some indoor worker positions may require relatively frequent dermal contact with groundwater as well, e.g., a food

preparer/cafeteria worker who would wash his hands, produce, equipment, etc. For this evaluation, it is assumed that the head, forearms, and hands, approximately 3,300 cm^2 of his body (EPA, 2004a), would be exposed intermittently for up to 1 hour per day. Because exposure is assumed to be intermittent rather than continuous, organic chemical uptake across the dermis would not reach steady state, which guides the selection of the EPA (2004a) model used to quantify this pathway (Section 3.3.3).

3.1.3.4 Construction Worker

The construction worker scenario is used to evaluate short-term exposure to surface and subsurface soil (total soil) in either the current or future land-use scenario. Although construction activities would typically result in a mixture of surface and subsurface soils, for the reasons described for the future groundskeeper (Section 3.1.3.2), the construction worker is only evaluated for exposure to surface soil at this site. The construction worker is also typically used to evaluate exposure to surface water and sediment that may occur during projects such as installation of underground utilities or rerouting of surface flow. Because construction worker exposure to surface water and sediment in the ditch abutting the western boundary of the Unloading Area was previously evaluated for the Former Sellite Area BHHRA (Shaw, 2013c), the construction worker is only evaluated for exposure to soil in this BHHRA.

No construction projects are anticipated in this area, but this property is currently under NASA control and a construction project may be possible under current land use or in the future. The evaluation for this receptor is exactly the same under both current and future land uses. Construction projects are expected to be infrequent. It is assumed that the construction worker participates in only one construction project at the Unloading Area.

The construction worker is assumed to be a 70-kg adult who works 8 hours/day, 5 days/week. This represents an annual exposure frequency rate of about 250 days per year, which is the same as described for the groundskeeper (Section 3.1.3.1) and indoor worker (Section 3.1.3.3). Construction projects involving soil exposure are assumed to last 6 months. The respiratory rate for the construction worker is assumed to be 20 m^3/8-hour workday (2.5 m^3/hr) (EPA, 1991). A soil ingestion rate of 330 mg/day is assumed for the construction worker (EPA, 2002). A dermal soil AF for the construction worker of 0.3 mg/cm^2 and an exposed body surface area of 3,300 cm^2, which represents the head, hands, and forearms, are assumed (EPA, 2002; 2004a).

Exposure to groundwater by the construction worker is also possible; however, if on-site groundwater were developed as a tap water source, other potential future groundwater receptors

such as the future on-site resident would have longer and/or more frequent groundwater exposure. Therefore, groundwater exposure is not evaluated for the construction worker.

3.1.3.5 On-Site Resident

The hypothetical future on-site residential scenario is used to evaluate the upper bound for long-term exposure to site soil, surface water, sediment, and groundwater under the future land-use scenario. Because residential exposure to surface water and sediment in the ditch abutting the western boundary of the Unloading Area was previously evaluated for the Former Sellite Area BHHRA (Shaw, 2013c), the resident is only evaluated for exposure to soil and groundwater in this BHHRA. Although the construction and landscaping activities needed to create a residential property are typically assumed to result in a mixing of the surface and subsurface soils (total soil), for the reasons described for the future groundskeeper (Section 3.1.3.2), the on-site resident is only evaluated for exposure to surface soil at this site. Residential land use is plausible because property surrounding the PBOW facility includes rural residential use. This type of land use is also consistent with assumed future land use of other PBOW sites (IT, 2001).

Noncancer hazard estimates are derived separately for the child and adult life stages. Cancer risk is estimated as the sum of the risks calculated for the adult (24 years) and the child (6 years) (EPA, 2002; 2013a). The on-site resident is assumed to occupy the site approximately year-round for a total of 350 days/year (EPA, 2004a).

The resident is assumed to be exposed directly to soil. Relevant pathways for soil exposure include incidental ingestion, dermal contact, and inhalation of dust. For evaluating inhalation of airborne dust, it is assumed that 80 percent of the soil surface is covered with pavement or vegetation.

The adult resident is assumed to be a 70-kg person with an incidental soil ingestion rate of 100 mg/day and an inhalation rate of 20 cubic meters per day (m^3/day) or 0.83 m^3/hr (EPA, 1991). A body surface area of 5,700 cm^2, representing the hands, forearms, head, and lower legs, is assumed to be available for dermal exposure to soil (EPA, 2004a). A soil AF of 0.07 mg/cm^2 is used as the default RME value for the adult resident (EPA, 2004a). The adult resident is assumed to be exposed for 350 days/year for 24 years (EPA, 1991; 2002).

The child resident is assumed to be a 1- through 6-year-old child with an average body weight of 15 kg, a soil ingestion rate of 200 mg/day, and an average inhalation rate of 10 m^3/day or 0.417 m^3/hr (EPA, 2004c). An average body surface area of 2,800 cm^2 throughout the 6-year childhood exposure period, representing the head, hands, forearms, lower legs, and feet, is assumed for

dermal contact with soil (EPA, 2004a). A soil AF of 0.2 mg/cm^2 is used as the default RME value for the child resident (EPA, 2004a). The child resident is assumed to be exposed for 350 days/year for 6 years (EPA, 1991; 2002).

For the purpose of the BHHRA, it was assumed that, under future residential land use, the overburden water unit will be developed as a source of potable water. The resident is assumed to use groundwater underlying the site as the sole source of household tap water. Exposure to COPCs in groundwater would occur via ingestion or dermal contact during bathing/washing.

It is assumed that an adult resident ingests 2 L/day of tap water (EPA, 1991) and that the young child drinks 1 L/day (EPA, 2013a). The total body surface areas of the adult and of the young child resident are assumed to be exposed to tap water while bathing/showering. The total surface area for an adult is assumed to be 20,000 cm^2 and the total surface area for the young child is assumed to be 6,600 cm^2 (EPA, 1997a). Both the child and adult resident are assumed to be dermally exposed to COPCs in groundwater while bathing/showering. The child is assumed to bathe for 20 minutes per day (0.33 hour/day) (EPA, 1997a), and the adult is assumed to shower for 12 minutes per day (0.2 hour/day) (EPA, 1997a).

Because EPA (1997a) lists a 90th percentile for time spent in a residence as over 23 hours per day, it is conservatively assumed that the resident spends 24 hours per day in the house.

3.1.3.6 Future Hunter

This scenario is created to evaluate the potential for contaminants in soil to affect food chain pathways. The Unloading Area property provides habitat for deer and other wildlife. Even though hunting is not currently permitted in this area, deer hunting is permitted in other areas within PBOW; therefore, future use of the Unloading Area property for hunting is addressed in this BHHRA.

Many kinds of game animals may be hunted and consumed (e.g., squirrel, pheasant and other upland birds, turkey, deer); however, the deer is the species most likely to contribute meaningfully to the diet. Therefore, this evaluation is limited to a deer hunter. Potential exposure pathways include incidental surface soil ingestion, dermal contact with surface soil, and ingestion of venison from deer that browse plants growing on contaminated surface soil, all of which are evaluated quantitatively. Inhalation of airborne dust from wind currents is a potentially complete exposure pathway; however, vegetation reduces dust emissions to insignificant levels (EPA, 1996), and it is assumed that the deer hunter would spend virtually all of his time on vegetated rather than bare soil. Therefore, it is assumed that inhalation exposure would

contribute much less than incidental ingestion and the inhalation exposure pathway is not quantified separately from ingestion. Ingestion and dermal exposure to surface water and sediment are expected to be negligible for this receptor, as contact with these media would generally be avoided during hunting activities.

The deer hunter is assumed to be a 70-kg adult who harvests deer and consumes venison over a 30-year period. It is assumed that he spends 14 days per year hunting on PBOW. His incidental soil ingestion rate is assumed to be 100 mg/day (EPA, 1991). Hunting at PBOW occurs in the fall and winter. Given the temperate climate of northern Ohio during hunting season, a hunter would dress appropriately, with typically only the hands and head exposed, at most. The default industrial RME exposed skin surface area of 3,300 cm^2, which represents the hands, forearms, and head (EPA, 2004a), is conservatively assumed for the hunter. The default industrial RME soil AF of 0.2 mg/cm^2 (EPA, 2004a) is also assumed.

Data regarding the rate of venison ingestion were not located; therefore, a hypothetical scenario is adapted from the assumptions applied to a similar site in West Virginia (IT, 2000c) and subsequently applied to the Unloading Area. A highly conservative but plausible scenario consists of a hunter who kills one deer from the Unloading Area property each year. It is assumed that the hunter eats 10 pounds (4.5 kg) of venison per year (Sharp, 1995). This consumption rate corresponds to 0.013 kg per day (0.186 grams per kilogram of body weight per day [g/kg-day]) of venison for each of the 350 days per year (EPA, 1991) that the hunter spends at his residence.

3.1.3.7 Future Hunter's Child

It is likely that a successful hunter, described in Section 3.1.3.6, would share his venison with the rest of the family, which may include small children. Small children, however, would be unlikely to accompany the hunter afield. Therefore, the direct exposure pathways evaluated for the hunter (i.e., incidental ingestion and dermal contact with soil) are not evaluated for the small child.

Data regarding the rate of venison ingestion by small children were not located. However, if it is assumed that venison may replace beef in the diet, the differences in beef consumption between adults and children can be used to estimate a venison ingestion rate for children. EPA (1997a) provides per capita beef intake data for under 1- to 5-year-old children ranging from 0.941 to 1.46 g/kg-day (time-weighted average of 1.296 g/kg-day). EPA (1997a) provides per capita beef intake data for 12- to 70-plus-year-old adults ranging from 0.568 to 0.83 g/kg-day (time-weighted average of 0.727 g/kg-day). From these data, it can be estimated that the rate of beef consumption for small children, expressed on a body weight basis, is approximately 1.8 times

that of an adult. Therefore, a venison ingestion rate of 0.335 g/kg-day is estimated for a young child from the venison ingestion rate of 0.186 g/kg-day for the adult. Assuming that the child is 1 through 6 years old with an average body weight of 15 kg (EPA, 1991; 2002), the child's venison ingestion rate may be expressed as 0.005 kg per day.

3.1.3.8 Other Receptors Not Considered

Other plausible receptor groups that could visit the Unloading Area include delivery personnel or personnel at National Guard training activities. These receptors, however, would be less intensively exposed to soil than the groundskeeper; therefore, their exposures are not evaluated.

The Unloading Area could become part of the area used for National Guard training activities. National Guard trainees, however, may be less exposed to any of the potentially contaminated media than the receptors identified previously. Because they would likely not represent an upper bound for nonresidential exposure, these receptors are not evaluated.

As discussed in Section 3.1, off-site use of groundwater is not evaluated because nearby residents use municipal water from surface water sources as a potable source, and potential on-site users would be exposed to higher concentrations of contaminants in groundwater. Also, because the overburden groundwater is spatially discontinuous, it is understood that lateral migration within the overburden unit to off-site locations does not occur.

3.2 Quantification of Exposure-Point Concentrations

The EPC is an estimate of the concentration of a COPC in a given medium to which a receptor may be exposed over the duration of the exposure. An EPC may be based on chemical concentrations in media that have been directly measured using laboratory analysis, or it may be derived based on environmental medium-to-medium transport modeling. The EPCs of COPCs in soil and groundwater are derived based on measured analytical data. Concentrations of COPCs in air and venison are not measured (and in some cases cannot reasonably be measured) but are based on models that use the EPCs of COPCs in the appropriate directly measured media (i.e., soil and groundwater) as input values. Section 3.2.1 describes the approach used to derive EPCs for direct exposure to soil and groundwater based on analytical measurements of these media. Section 3.2.2 describes the estimation of vapor concentrations in air associated with soil.

3.2.1 Exposure-Point Concentrations in Soil and Groundwater

Exposure to an environmental medium is generally assumed to be random, and the EPC should be the arithmetic average encountered over the duration of exposure (EPA, 1989a). Therefore, the population mean concentration, if known, would be the ideal value selected as the EPC. The

sample mean is an obvious estimate of the population mean. However, uncertainties exist as to how well the sample mean represents the population mean. Therefore, EPA (1989a) has recommended the inclusion of a UCL for RME evaluation as a conservative estimate of the true mean exposure concentration.

The EPA (2010a,b; 2011) ProUCL (Version 4.1) software was used to estimate UCLs for the groundwater data sets of COPCs represented by at least five samples. If the data set consists of fewer than five data points, the MDC was selected as the EPC. Analytical data from field duplicates are averaged with originals to yield one result for use in the statistical manipulations (Section 2.5). The method detection limit is used as the ProUCL input concentration for nondetects. Nondetect sample results with aberrantly high detection limits due to matrix interferences or other sample-specific causes are included in the initial ProUCL calculations. This is a conservative approach, as EPA (1989a) recommends that nondetect results with aberrantly high detection limits be removed from the data set so that calculation of the UCL is not unduly skewed by a nondetect.

Because the current version of ProUCL (EPA, 2011) includes mathematical manipulations under the default “with NDs” mode that are more robust than earlier versions, single elevated detection limits are less likely to skew the UCL estimates than in the past. If it is observed during the risk characterization that an elevated nondetect value skews a UCL estimate such that this value substantially affects the result of the risk estimate, the ProUCL model is rerun without the elevated nondetect value and the risks are recalculated. If this recalculation is performed on a data set, data eliminated for the recalculation are identified in the risk characterization and discussed in the uncertainty analysis.

ProUCL generates a variety of UCL estimates for each data set. The ProUCL output for each COPC is included in Appendix B. Generally, the results of one or two (sometimes more) of the UCL estimates are recommended. This recommendation is based on a variety of factors, including the distribution (i.e., normal, lognormal, gamma, or not discernible) that provides the best fit, the number of nondetects, the size of the data set, and skewness. If the recommended value(s) under the default mode equal or exceed the MDC, ProUCL is rerun using the full data set mode under the assumption that the COPC is present in nondetects at the method detection limit. Occasionally, ProUCL recommends the 97.5 or 99 percent upper confidence limit on the arithmetic mean estimated by the Chebyshev method. In these cases, the UCL estimated by the Chebyshev method (95th percent) is selected as the EPC because this is more consistent with the intent of the RME paradigm as defined by EPA (1989a; 1991).

The UCL generated by the ProUCL protocol described in the preceding paragraphs or the MDC, whichever is smaller, is selected as the EPC and understood to represent a conservative estimate of average for use in the risk assessment. Note that EPA (1989a) guidance states that an estimate of average rather than the MDC should be used to represent the EPC under chronic exposure and that use of the maximum is typically not reasonable. Therefore, data sets which use the MDC as the EPC are generally biased high. Unusually high detected values are included in the calculation of the UCL concentration. Inclusion of these high values increases the statistical variability and the overall conservativeness of the risk estimate.

ProUCL is a software tool that provides estimates of the UCL using a variety of mathematical approaches and recommends use of one or more of the values. Depending on the data set, some of the estimates generated by the various calculation methods included in ProUCL may vary by an order of magnitude. ProUCL and the decision tree on which its recommendations are based have been developed using multitudes of simulated data sets with a variety of distributions and other characteristics. There are uncertainties as to how well this decision tree derives a recommended UCL for a given data set. This uncertainty tends to increase with variability and skewness and where a large proportion of the samples are nondetects. For example, with respect to distribution testing, ProUCL bases the determination of distribution type only on the detected samples. The true concentrations of the nondetected values are unknown, and this lack of information can affect the distribution determination and consequently affect the ProUCL recommendation. The general uncertainties associated with the EPC values and the uses of ProUCL are discussed in the uncertainty analysis (Chapter 6.0). Specific uncertainties associated with the EPC values of specific data sets may be discussed in the uncertainty analysis as appropriate.

3.2.2 Exposure-Point Concentrations in Air

The model shown in this section for estimating COPC concentrations in air includes only those relevant and used specifically for the Unloading Area COPCs and media.

3.2.2.1 COPC Concentrations from Dust

Inhalation exposure to particulate (dust) emissions from soils for the groundskeeper and construction worker evaluations arises from activities that raise dust. Therefore, the most appropriate approach for estimating chemical concentrations in ambient air is the use an activity-based dust loading equation (U.S. Department of Energy [DOE], 1989):

$$C_a = (D)(C_s)(CF_1) \qquad \text{Eq. 3.1}$$

where:

C_a	=	contaminant concentration in air (milligrams per cubic meter [mg/m^3], calculated)
D	=	dust loading factor (grams [g] of soil/m^3 of air)
Cs	=	contaminant concentration in soil (mg/kg)
CF1	=	conversion factor (1E-3 kg per g).

Plausible values for D include 2E-4 grams per cubic meter (g/m^3) for agricultural activity (DOE, 1989), 6E-4 g/m^3 for construction work (DOE, 1983), and 1E-4 g/m^3 for other activity (National Council on Radiation Protection and Measurements, 1984). The value for D of 1E-4 g/m^3 for other activity is used for the groundskeeper. It is assumed that construction activities requiring intensive contact with soil, for which D = 6E-4 g/m^3 is appropriate, may last for one-half of a construction period. The remaining one-half of the time is more realistically characterized by D = 1E-4 g/m^3. Therefore, a time-weighted average dust loading factor for construction work of 3.5E-4 g/m^3 is estimated for the construction worker.

The resident is more likely to be exposed to dust arising from wind erosion than from dust-raising activities on the site. EPA (1996) derived a model for estimating a dust particulate emission factor (PEF) based on an "unlimited reservoir" model and the assumption that the source area is square:

$$PEF = Q/C \times \frac{3600}{0.036 \times (1 - V) \times (U_m / U_t)^3 \times F(x)} \qquad \text{Eq. 3.2}$$

where:

PEF	=	particulate emission factor (cubic meters per kilogram [m^3/kg], calculated)
Q/C	=	inverse of the mean concentration at center of square source (55.99 grams per square meter-second per kg/m^3, site-specific value from Table 3 in EPA [1996] [Zone 7, Cleveland, 5-acre site])
3600	=	seconds/hour
V	=	fraction of surface covered with vegetation (0.8, unitless, assumed)
U_m	=	mean annual wind speed (default, 4.60 meters per second [m/second] equals mean annual wind speed of 10.3 miles per hour [Section 3.1.1.1])
U_t	=	equivalent threshold value of wind speed at 7 meters (default, 11.32 m/second)
F(x)	=	function dependent on U_m/U_t (default, 0.194).

The concentration of a COPC in air is calculated as follows:

$$C_a = \frac{C_s}{PEF} \qquad \text{Eq. 3.3}$$

where:

C_a = contaminant concentration in air (mg/m^3, calculated)
C_s = contaminant concentration in soil (mg/kg)
PEF = particulate emission factor (m^3/kg).

3.2.2.2 Concentrations of VOCs in Household Air from Groundwater Use

No VOCs were identified in groundwater (Section 2.5). Therefore, this pathway is incomplete in this BHHRA.

3.2.2.3 Concentrations of VOCs in Groundwater: Residential Dermal Uptake

No VOCs were identified in groundwater (Section 2.5). Therefore, this pathway is incomplete in this BHHRA.

3.2.2.4 Concentrations of COPCs in Venison

The hunter is assumed to harvest and consume game and share it with family members, including small children. The game is assumed to be venison, because the white-tailed deer is the species hunted most widely and most likely to provide a regular contribution to the diet. Data do not exist to reliably estimate contaminant concentrations in venison, but the following simplifying assumptions permit estimates sufficient for a BHHRA.

- Deer are small ruminants and, as such, are not unlike cattle; thus, it is reasonable to assume they may have similar physiological processes that could yield similar biotransfer factors. Unlike beef, however, deer meat does not undergo marbling with fat, and deer fat is quite unpalatable and is likely to be trimmed rather than consumed. Therefore, the biotransfer factors for edible venison are derived by adjusting biotransfer factors for beef to account for differences in the fat content of table-ready beef (cooked choice retail cuts trimmed to 0 inches of fat: average 14.4 percent fat) and venison (cooked boneless muscle meats: average 2.9 percent fat) (Nutrient Database, 1997).

- Deer are expected to browse a much larger area than that encompassed in the Unloading Area; therefore, the fraction of total browse consumed from the Unloading Area is expected to be relatively small.

- Indirect food chain pathways may be significant for some metals and for those SVOCs that persist in the environment and have the tendency to bioaccumulate. VOCs are generally mobile in the environment and labile in biological systems and do not tend to bioaccumulate.

To reflect the assumptions previously noted, venison biotransfer factors are estimated by multiplying beef biotransfer factors by 2.9/14.4 (or 0.20), and by a fraction, FI_r. This fraction

reflects the areal portion of the site compared to a deer's home range area. These assumptions are captured in the following equation:

$$B_v = 0.20(B_b)(FI_r) \qquad \text{Eq. 3.4}$$

where:

B_v	=	biotransfer factor for venison (days/kg tissue, calculated)
0.20	=	factor to reflect differences in fat content between beef and venison (0.20, unitless, see above)
FI_r	=	areal portion of site compared to a deer's home range (0.02, unitless, see below)
B_b	=	biotransfer factor for beef (days/kg tissue).

Values for B_b for metals are provided in the toxicity profiles prepared for each of the COPCs (Appendix C). The toxicity profiles briefly describe the uses of the chemical, its physical properties, behavior in environmental media, biotransfer capability, and toxicity values.

The Unloading Area is relatively small in comparison to the home range of a white-tailed deer. The total acreage of the Unloading Area study area is approximately 2.2 acres. The home range of the white-tailed deer is between 150 and 1,280 acres (Sample and Suter, 1994). Even if the low end of this range (150 acres) is assumed for deer in northern Ohio, the area represented by the Unloading Area is approximately 2 percent of this land area. Therefore, an FI_r value of 0.02 is used for the Unloading Area.

Deer are assumed to be exposed to contaminants by ingesting browse growing on contaminated soil. It is estimated that deer consume approximately 1.74 kg of browse per day (Sample et al., 1996), which is approximately 50 percent dry matter (DM), or 0.87 kg browse DM per day (Mautz et al., 1976). The contaminant concentration in browse is estimated from the following equation, which was originally developed for estimating the contaminant concentration in forage to which cattle may be exposed (EPA, 1994):

$$C_p = (CF)(C_s)(B_p) \qquad \text{Eq. 3.5}$$

where:

C_p	=	concentration of contaminant in (plant) forage DM (mg/kg, calculated)
CF	=	conversion factor to adjust for soil containing 20 percent moisture (1.25, unitless).
C_s	=	concentration of contaminant in soil (mg/kg)
B_p	=	soil-to-forage biotransfer factor (mg of chemical per kg of dry plant/mg of chemical per kg of dry soil).

Values for B_p are taken from the toxicity profiles in Appendix C. B_p values for the vegetative parts of plants, rather than the reproductive parts of plants, are selected, as possible, because deer browse year-round, and the vegetative parts are more available for the greater part of the year.

The concentration of a COPC in venison can be estimated from the following equation (adapted from EPA [1994]):

$$C_v = (Q_p)(C_p)(B_v) \qquad \text{Eq. 3.6}$$

where:

C_v	=	contaminant concentration in venison (mg/kg tissue, calculated)
Q_p	=	browse ingestion rate (0.87 kg DM/day)
C_p	=	contaminant concentration in browse DM (mg/kg)
B_v	=	biotransfer factor for venison (days/kg tissue).

3.3 Quantification of Chemical Intake

This section describes the models used to quantify doses or intakes of the COPCs by the exposure pathways identified previously.

3.3.1 Inhalation of COPCs in Air

The inhaled dose of a COPC in dust in ambient air from soil for the groundskeeper, construction worker, and future on-site resident is estimated as follows:

$$I_a = \frac{(C_a)(FI_a)(IR_a)(EF)(ED)}{(BW)(AT)} \qquad \text{Eq. 3.7}$$

where:

I_a	=	inhaled dose of COPC (milligrams per kilograms per day [mg/kg-day], calculated)
C_a	=	concentration of COPC in air (mg/m^3)
FI_a	=	fraction of exposure attributed to site media (unitless)
IR_a	=	inhalation rate (m^3/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days).

3.3.2 Incidental Ingestion of COPCs in Soil

The ingested dose of a COPC in soil (groundskeeper, construction worker, future resident, future indoor worker, and hunter) is estimated from the following equation:

$$I = \frac{(C)(FI)(IR)(EF)(ED)(CF)}{(BW)(AT)} \qquad \text{Eq. 3.8}$$

where:

I	=	ingested dose of COPC (mg/kg-day, calculated)
C	=	concentration of COPC (mg/kg)
FI	=	fraction of exposure attributed to site medium (unitless)
IR	=	ingestion rate of medium (mg/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
CF	=	conversion factor (1E-6 kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days).

3.3.3 Incidental Ingestion of COPCs in Water

The ingested dose of a COPC in groundwater (future groundskeeper, and resident) is estimated from the following equation:

$$I_w = \frac{(C_w)(IR_w)(FI_w)(EF_w)(ED_w)}{(BW)(AT)} \qquad \text{Eq. 3.9}$$

where:

I_w	=	ingested dose of COPC in water (mg/kg-day, calculated)
C_w	=	concentration of COPC in water (mg/L)
IR_w	=	water ingestion rate (L/day)
FI_w	=	fraction of exposure attributed to site water (unitless)
EF_w	=	fraction of exposure attributed to site water exposure frequency (days/year)
ED_w	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days).

3.3.4 Dermal Contact with COPCs in Soil or Water

Unlike the methodologies for estimating inhaled or ingested doses of a COPC, which quantify the dose presented to the barrier membrane (the pulmonary or gastrointestinal mucosa, respectively), dermal dose is estimated as the dose that crosses the skin and is systemically absorbed. For this reason, dermal toxicity values are also based on absorbed dose. The absorbed dose of a COPC is estimated from the following equation (EPA, 2004a):

$$DAD = \frac{(DA)(SA)(EF)(ED)}{(BW)(AT)} \qquad \text{Eq. 3.10}$$

where:

DAD	=	average dermally absorbed dose of COPC (mg/kg-day, calculated)
DA	=	dose absorbed per unit body surface area per day (milligrams per square centimeter per day [mg/cm^2-day])
SA	=	surface area of the skin exposed (cm^2)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days).

Dose absorbed per unit body surface area per day (DA) is calculated differently for dermal uptake from soil and from water. Dermal uptake of constituents from soil (groundskeeper, construction worker, future on-site resident, and hunter) assumes that absorption is a function of the fraction of a dermally applied dose that is absorbed. DA is calculated from the following equation (EPA, 2004a):

$$DA = (C_s)(FI)(CF)(AF)(ABS) \qquad \text{Eq. 3.11}$$

where:

DA	=	dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C	=	concentration of COPC in medium (mg/kg)
FI	=	fraction of exposure attributed to site soil (unitless)
CF	=	conversion factor (1E-6 kg/mg)
AF	=	AF for soil-to-skin adherence factor (mg/cm^2-day)
ABS	=	absorption fraction (unitless, chemical-specific).

ABS values are provided in the toxicity profiles for each COPC (Appendix C).

Quantification of dermal uptake of constituents from groundwater (future groundskeeper, indoor worker, resident) depends on a K_p, which describes the rate of movement of a constituent from water across the dermal barrier to the systemic circulation (EPA, 2004a). The equation for dermal uptake of chemicals from water is shown in Eq. 3.10. DA is calculated differently for inorganic and organic chemicals in water. For inorganic chemicals, DA is calculated from the following equation:

$$DA = (C_w)(FI)(K_p)(ET_w)(CF) \qquad \text{Eq. 3.12}$$

where:

DA	=	dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C_w	=	concentration of COPC in water (mg/L)
FI	=	fraction of exposure attributed to site medium (unitless)
K_p	=	permeability coefficient (centimeters per hour [cm/hour])
ET_w	=	time of exposure (hours/day)
CF	=	conversion factor (1E-3 liters per cubic centimeter [L/cm^3]).

The K_p for organic chemicals varies by several orders of magnitude and is highly dependent on lipophilicity, expressed as a function of the octanol/water partition coefficient (EPA, 2004a). Because the stratum corneum (the outer skin layer) is rich in lipid content, it may act as a sink, initially reducing the transport of chemical to the systemic circulation. With continued exposure and the attainment of steady-state conditions, the rate of dermal uptake increases. The time per event for a chemical to reach steady state absorption across the skin (referred to as "t*") is a chemical-specific estimate expressed in hours. Therefore, different equations are used to estimate DA, depending on whether the ET is less than or greater than the estimated time to reach steady state. Non-steady-state exposures occur either when the ET is relatively brief (e.g., showering, for most chemicals) or when intermittent exposure occurs throughout the day (e.g., washing of hands). For exposure scenarios under which steady state is not reached for a given organic chemical (ET_w<t*, see below), the following equation is used to calculate DA (EPA, 2004a):

$$DA = 2(FA)(K_p)(C_w)(CF)\sqrt{\left(\frac{6\tau(ET_w)}{\pi}\right)} \qquad \text{Eq. 3.13}$$

where:

DA	=	dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C_w	=	C_{gw} for groundwater, = concentration of COPC in water (mg/L)
FA	=	fraction absorbed from the water (unitless)
K_p	=	permeability coefficient (cm/hour)
CF	=	conversion factor (1E-3 L/cm^3)
τ	=	lag time per event (hours), a function of time required for the chemical to permeate the skin
ET_w	=	time of contact (hour(s)/day).

In cases where steady state is reached (ET_w>t*), such as where the duration of a bath exceeds the time to reach steady state for a given organic compound, the following equation is used to calculate DA (EPA, 2004a):

$$DA = (FA)(K_p)(C_w)(CF)\left[\frac{ET_w}{1+B} + 2\tau\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right] \quad \text{Eq. 3.14}$$

where:

DA	=	dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C_w	=	concentration of COPC in water (mg/L)
FA	=	fraction absorbed from the water (unitless)
K_p	=	permeability coefficient (cm/hour)
CF	=	conversion factor (1E-3 L/cm^3)
τ	=	lag time per event (hours), a function of time required for the chemical to permeate the skin
ET_w	=	time of contact (hour[s]/day)
B	=	Ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (unitless).

Assuming one exposure event/day allows expressing ET_w as hour(s)/day, which preserves the dimensional integrity of the equation.

When available, values for K_p and τ are taken from EPA (2004a). For organics that have no K_p values listed, the values are calculated using the following equation (EPA, 2004a):

$$\text{Log}(K_p) = -2.80 + 0.66(\log K_{ow}) - 0.0056(MW) \quad \text{Eq. 3.15}$$

where:

K_p	=	permeability coefficient (cm/hour, calculated)
log K_{ow}	=	log of the octanol/water partition coefficient (unitless)
MW	=	molecular weight.

Where values for τ are not available, they were calculated using the following equation (EPA, 2004a).

$$\tau = 0.105 \times 10^{(0.0056 \times MW)} \quad \text{Eq. 3.16}$$

where:

τ	=	lag time per event (hours), a function of time required for the chemical to permeate the skin
MW	=	molecular weight.

Values of K_p and τ used in the BHHRA are summarized in Table 3-3 and documented in Appendix C.

4.0 Toxicity Evaluation

Toxicity is defined as the ability of a chemical to induce adverse effects in biological systems. The purpose of the toxicity assessment is two-fold:

- Identify the cancer and noncancer effects that may arise from exposure of humans to the COPC (hazard assessment).
- Provide an estimate of the quantitative relationship between the magnitude and duration of exposure and the probability or severity of adverse effects (dose-response assessment).

The latter is accomplished by the derivation of cancer and noncancer toxicity values, as described in the following sections.

4.1 Evaluation of Carcinogenicity

A few chemicals are known, and many more are suspected, to be human carcinogens. The evaluation of the potential carcinogenicity of a chemical includes both a qualitative and a quantitative aspect (EPA, 2005). The qualitative aspect is a weight-of-evidence evaluation of the likelihood that a chemical might induce cancer in humans. EPA (2005) recognizes five weight-of-evidence group classifications for carcinogenicity. Formerly, EPA (1986) used a letter-based system to describe the weight of evidence for carcinogenicity. Reference to this former system is included because many of the carcinogenicity assessments listed on the Integrated Risk Information System (IRIS) use the former letter-based system (EPA, 2013b). The five EPA weight-of-evidence classifications are as follows:

- ***Carcinogenic to Humans*** (corresponds to the former Group A – Human Carcinogen)
- ***Likely to be Carcinogenic to Humans*** (includes both the former Group B1 and Group B2 – Probable Human Carcinogens)
- ***Suggestive Evidence of Carcinogenic Potential*** (corresponds to the former Group C – Possible Human Carcinogen)
- ***Inadequate Information to Assess Carcinogenic Potential*** (corresponds to the former Group D – Not Classifiable as to Human Carcinogenicity)
- ***Not Likely to be Carcinogenic to Humans*** (corresponds to the former Group E – Evidence of Noncarcinogenicity to Humans).

The toxicity value for carcinogenicity, called a cancer slope factor (SF), is an estimate of potency. SFs are developed only for chemicals in the first three groups and only if the data are sufficient. The SFs are statistically derived from the dose-response curve from the best human or animal study or studies of the chemical. Although human data are often considered to be more reliable than animal data because there is no need to extrapolate the results obtained in one species to another, most human studies have one or more of the following limitations:

- The duration of exposure is usually considerably less than lifetime.
- The concentration or dose of chemical to which the humans were exposed can be approximated only crudely, usually from historical data.
- Concurrent exposure to other chemicals frequently confounds interpretation.
- Data regarding other factors (tobacco, alcohol, illicit or medicinal drug use, nutritional factors and dietary habits, and heredity) are usually insufficient to eliminate or quantify confounding effects on the results.
- Most epidemiologic studies are occupational investigations of workers, which may not accurately reflect the range of sensitivities of the general population.
- Most epidemiologic studies lack the statistical power (i.e., sample size) to detect a low, but chemical-related increased incidence of tumors.

Most potency estimates are derived from animal data, which present different limitations:

- It is necessary to extrapolate from results in animals to predict results in humans, usually by estimating an equivalent human dose from the animal dose.
- The range of sensitivities arising from genotypic and phenotypic diversity in the human population is not reflected in the animal models ordinarily used in cancer studies.
- Usually, very high doses of chemical are used, which may alter normal biology, creating a physiologically artificial state and introducing substantial uncertainty regarding the extrapolation to the low-dose range expected with environmental exposure.
- Individual studies vary in quality (e.g., duration of exposure, group size, scope of evaluation, adequacy of control groups, appropriateness of dose range, absence of concurrent disease, and sufficient long-term survival to detect tumors with long induction or latency periods).

The SF is usually expressed as "extra risk" per unit dose, that is, the additional risk above that in a background population not exposed to the chemicals in the assessment, and it is expressed as

risk per mg/kg-day, shown mathematically as $(mg/kg\text{-}day)^{-1}$. To be appropriately conservative, the SF is usually the 95 percent upper bound on the slope of the dose-response curve extrapolated from high (experimental) doses to the low-dose range expected in environmental exposure scenarios. EPA (2005) assumes that there are no thresholds for carcinogenic expression; therefore, any exposure represents some quantifiable risk, however miniscule it may be.

The oral SF is usually derived directly from the experimental dose data, because oral dose is usually expressed as mg/kg-day. When the test chemical was administered in the diet or drinking water, oral dose first must be estimated from data for the concentration of the test chemical in the food or water, food or water intake data, and body weight data.

The IRIS (EPA, 2013b) expresses inhalation cancer potency as a unit risk based on concentration, or risk per microgram of chemical per m^3 of ambient air, shown mathematically as (micrograms per cubic meter $[\mu g/m^3])^{-1}$. Because cancer risk characterization requires an SF expressed as risk per mg/kg-day, the unit risk must be converted to the mathematical equivalent of an inhalation cancer SF, or risk per unit dose as $(mg/kg\text{-}day)^{-1}$. Because the inhalation unit risk is based on continuous lifetime exposure of an adult human (assumed to inhale 20 m^3 of air per day and to weigh 70 kg), the mathematical conversion consists of multiplying the unit risk (per $\mu g/m^3$) by 70 kg and by 1,000 micrograms per milligram, and dividing the result by 20 m^3/day.

4.2 Evaluation of Noncarcinogenic Effects

Many chemicals, whether or not associated with carcinogenicity, are associated with adverse noncarcinogenic effects. The evaluation of noncancer effects (EPA, 1989b) involves the following:

- Qualitative identification of the adverse effect(s) associated with the chemical; these may differ depending on the duration (acute or chronic) or route (oral or inhalation) of exposure.
- Identification of the critical effect for each duration of exposure (i.e., the first adverse effect that occurs as dose is increased).
- Estimation of the threshold dose for the critical effect for each duration of exposure.
- Development of an uncertainty factor (UF); i.e., quantification of the uncertainty associated with interspecies extrapolation, intraspecies variation in sensitivity, severity of the critical effect, slope of the dose-response curve, and deficiencies in the database, in regard to developing a reference dose (RfD) for human exposure.
- Identification of the target organ(s) for the critical effect for each route of exposure.

These information points are used to derive an exposure route- and duration-specific toxicity value called an RfD, expressed as mg/kg-day, which is considered to be the dose for humans, with uncertainty of an order of magnitude or greater, at which adverse effects are not expected to occur. Mathematically, it is estimated as the ratio of the threshold dose to the UF. For purposes of risk assessment, chronic exposure is typically defined as equal to or greater than 7 years, i.e., at least 10 percent of expected life span; subchronic exposure is typically defined as 2 weeks to 7 years. However, professional judgment may be used where exposure durations approach 10 percent of the expected life span. Also, exposure during a critical stage of development, such as a portion of early childhood, may be treated as chronic even if the anticipated exposure duration is considerably less than 10 percent of the expected life span.

The IRIS (EPA, 2013b) expresses the inhalation noncancer reference value as a reference concentration (RfC) in units of mg/m^3. Because noncancer risk characterization requires a reference value expressed as mg/kg-day, the RfC must be converted to an inhalation RfD. Because the inhalation RfC is based on continuous exposure of an adult human (assumed to inhale 20 m^3 of air per day and to weigh 70 kg), the mathematical conversion consists of multiplying the RfC (mg/m^3) by 20 m^3/day and dividing the result by 70 kg.

The RfD and RfC values are derived for both chronic and subchronic exposure. Under the assumption of monotonicity (incidence, intensity, or severity of effects can increase, but cannot decrease, with increasing magnitude or duration of exposure), a chronic RfD may be considered sufficiently protective for subchronic exposure, but a subchronic RfD may not be protective for chronic exposure. Currently, subchronic RfD values exist for few chemicals. Subchronic RfD values can be derived from chronic RfD values as follows:

- If the UF applied in the derivation of the chronic RfD (or RfC) does not provide for expansion from subchronic to chronic exposure (e.g., if the chronic RfD was derived from a chronic study), the chronic RfD is adopted as being sufficiently protective for subchronic exposure.

- If the UF applied in the derivation of the chronic RfD (or RfC) contains a component to expand from subchronic to chronic exposure, the subchronic RfD is derived by multiplying the chronic RfD by the factor used to expand from subchronic to chronic exposure (e.g., if a factor of 10 was used to expand from subchronic to chronic exposure, the subchronic RfD would be 10 times larger than the chronic RfD).

Only chronic RfDs and RfCs are used in the risk characterization of this BHHRA.

4.3 Dermal Toxicity Values

Dermal RfDs and SFs are derived from the corresponding oral values, provided there is no evidence to suggest that dermal exposure induces exposure route-specific effects that are not appropriately modeled by oral exposure data. In the derivation of a dermal RfD, the oral RfD is multiplied by the gastrointestinal absorption factor (GAF), expressed as a decimal fraction. The resulting dermal RfD, therefore, is based on absorbed dose. The RfD based on absorbed dose is the appropriate value with which to compare a dermal dose, because dermal doses are expressed as absorbed doses rather than exposure doses. The dermal SF is derived by dividing the oral SF by the GAF. The oral SF is divided, rather than multiplied, by the GAF because the SF is expressed as a reciprocal dose.

4.4 Target Organ Toxicity

As a matter of science policy, EPA assumes dose and effect to be additive for noncarcinogenic effects (EPA, 1989a). This assumption provides the justification for adding the HQ or hazard index (HI) values in the risk characterization for noncancer effects (Section 5.2) resulting from exposure to multiple chemicals, pathways, or media. However, EPA (1989a) acknowledges that adding all HQ or HI values may overestimate hazard, because the assumption of additivity is probably appropriate only for those chemicals that exert their toxicity by the same mechanism.

Mechanisms of toxicity data sufficient for predicting additivity with a high level of confidence are available for very few chemicals. In the absence of such data, EPA (1989a) assumes that chemicals that act on the same target organ may do so by the same mechanism of toxicity; that is, the target organ serves as a surrogate for mechanism of toxicity. When total HI for all media for a receptor exceeds 1 due to the contributions of several chemicals, it is appropriate to segregate the chemicals by route of exposure and mechanism of toxicity (i.e., target organ) and estimate separate HI values for each target organ.

As a practical matter, because human environmental exposures are likely to involve near- or sub-threshold doses, the target organ chosen for a given chemical is the one associated with the critical effect. If more than one organ is affected by a given chemical at the threshold, then all affected target organs are selected for this chemical. The target organ is also selected on the basis of duration of exposure (i.e., the target organ for chronic or subchronic exposure to low or moderate doses is selected rather than the target organ for acute exposure to high doses) and route of exposure. Because dermal RfD values are derived from oral RfD values, the oral target organ is adopted as the dermal target organ. For some chemicals, no target organ is identified. This occurs when no adverse effects are observed or when adverse effects such as reduced

longevity or growth rate are not accompanied by recognized organ- or system-specific functional or morphologic alteration.

4.5 Sources of Toxicity Information Used in the Risk Assessment

Toxicity values were selected for use in the BHHRA based on EPA Office of Solid Waste and Emergency Response Directive 9285.7-53 (EPA, 2003), which prescribes the following hierarchy:

- **Tier 1** values: IRIS (EPA, 2013b) database.
- **Tier 2** values: These are EPA's provisional peer-reviewed toxicity values. The provisional peer-reviewed toxicity values are developed by the Office of Research and Development, the National Center for Environmental Assessment, and the Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by the Superfund program.
- **Tier 3** values: These are other toxicity values from additional EPA and non-EPA sources of toxicity information. As stated in the EPA Office of Solid Waste and Emergency Response directive, "priority should be given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed." Two common examples of Tier 3 values are EPA's Health Effects Assessment Summary Tables (EPA, 1997b) and the California Environmental Protection Agency (2011) Office of Environmental Health Hazard Assessment Toxicity Criteria Database.

The Environmental Council of the States-U.S. Department of Defense (2007) has issued a toxicity value hierarchy that basically supports the EPA (2003) hierarchy presented previously but places higher emphasis on the necessity for external peer review.

GAFs used to derive dermal RfD values and SFs from the corresponding oral toxicity values are obtained from the following sources, in order of hierarchy:

- Oral absorption efficiency data compiled by the National Center for Environmental Assessment for the Superfund Health Risk Technical Support Center of EPA, such as listed in EPA (2004a)
- Federal agency reviews of the empirical data, such as Agency for Toxic Substances and Disease Registry toxicological profiles and various EPA criteria documents
- Other published reviews of the empirical data
- The primary literature.

GAFs obtained from reviews are compared to empirical (especially more recent) data, when possible, and are evaluated for suitability for use in deriving dermal toxicity values from oral toxicity values. Some of the GAF values are also listed in the RSL Web site support tables (EPA, 2013a). The suitability of the GAF increases when the following similarities are present in the oral pharmacokinetic study from which the GAF is derived and in the key toxicity study from which the oral toxicity value is derived:

- The same strain, sex, age, and species of test animal were used.
- The same chemical form (e.g., the same salt or complex of an inorganic element or organic compound) was used.
- The same mode of administration (e.g., diet, drinking water, or gavage vehicle) was used.
- Similar dose rates were used.

Individual COPC-specific toxicity profiles, including sources of the toxicity and GAF values, are included in Appendix C for all of the COPCs evaluated in the BHHRA. Summary toxicity information sufficient to support the risk calculations, including toxicity values, GAFs, and target organs are provided in Table 4-1.

5.0 Risk Characterization

Risk characterization is the process of applying numerical methods and professional judgment to determine the potential for adverse human health effects to result from the presence of site-specific contaminants. This is done by combining the intake rates estimated during the exposure assessment with the appropriate toxicity information identified during the toxicity assessment. Noncancer hazards and cancer risks are characterized separately, including COPCs that induce both types of effects.

Quantitative expressions are calculated during risk characterization that describe the probability of developing cancer (i.e., ILCRs), or the nonprobabilistic comparison of estimated dose with an RfD for noncancer effects (i.e., HQs and HIs). Quantitative estimates are developed for individual chemicals, exposure pathways, and exposure media for each receptor. These quantitative risk characterization expressions, in combination with qualitative information, are used to guide risk management decisions. Risk characterization, as described in this section, is applied only to COPCs.

Generally, the risk characterization follows the methodology prescribed by EPA (1989a), as modified by more recent information and guidance. EPA methods are appropriately designed to be health protective and tend to overestimate rather than underestimate risk. The risk results, however, may be overly conservative because risk characterization involves multiplication of the conservative assumptions built into the estimation of the EPCs, exposure (intake) estimates, and toxicity dose-response assessments.

5.1 Cancer Risk

The risk from exposure to potential chemical carcinogens is estimated as the probability of an individual developing cancer over a lifetime and is called the ILCR. In the low-dose range, which would be expected for most environmental exposures, cancer risk is estimated from the following linear equation (EPA, 1989a):

$$ILCR = (CDI)(SF) \qquad \text{Eq. 5.1}$$

where:

ILCR = incremental lifetime cancer risk, a unitless expression of the probability of developing cancer, adjusted for background incidence, calculated
CDI = chronic daily intake, averaged over 70 years (mg/kg-day)
SF = cancer slope factor (risk per mg/kg-day).

The chronic daily intake (CDI) term in Equation 5.1 is equivalent to the "I" or "DAD" terms (intake or dose) in Equations 3.7 through 3.10 when these equations are evaluated for cancer intakes.

The use of Equation 5.1 assumes that chemical carcinogenesis does not exhibit a threshold and that the dose-response relationship is linear in the low-dose range. Because this equation could generate theoretical cancer risks greater than 1 for high-dose levels, it is considered to be inaccurate at cancer risks greater than 1E-2. In these cases, cancer risk is estimated by the following one-hit model (EPA, 1989a):

$$ILCR = 1 - e^{[-(CDI)(SF)]} \qquad \text{Eq. 5.2}$$

where:

ILCR	=	incremental lifetime cancer risk, a unitless expression of the probability of developing cancer, adjusted for background incidence, calculated
$-e^{(CDI)(SF)}$	=	the exponential of the negative of the risk calculated using Equation 5.1.

Because none of the COPCs had an ILCR greater than 1E-2 using Equation 5.1, it was not necessary to use Equation 5.2 for any of the Unloading Area COPCs. As a matter of policy, EPA (1986) considers the carcinogenic potency of simultaneous exposure to low doses of carcinogenic chemicals to be additive, regardless of the chemicals' mechanisms of toxicity or sites of action (organs of the body). Cancer risk arising from exposure to multiple chemicals in a given exposure medium and pathway is estimated from the following equation (EPA, 1989a):

$$ILCR_p = ILCR_{(chem1)} + ILCR_{(chem2)} + \cdots ILCR_{(chemi)} \qquad \text{Eq. 5.3}$$

where:

$ILCR_p$	=	total pathway risk of cancer incidence, calculated
$ILCR_{(chem\ i)}$	=	individual chemical cancer risk for the pathway.

The sum of the ILCRs summed across pathways is the total ILCR as shown in the following equation:

$$Total\ ILCR = ILCR_{(p\ 1)} + ILCR_{(p\ 2)} + \cdots ILCR_{(p\ i)} \qquad \text{Eq. 5.4}$$

where:

Total ILCR	=	total incremental lifetime cancer risk across all pathways
$ILCR_{pi}$	=	incremental lifetime cancer risks associate with pathway "*i*."

The total ILCR represents all additional cancer risks posed to a given receptor by contact with contaminants in site environmental media.

Total ILCRs in the range of 1E-6 to 1E-4 are regarded as acceptable (EPA, 1990). As mentioned in Section 2.4.1, this range is referred to as the NCP risk management range. Risks less than this range are regarded as negligible. A target cancer risk goal of 1E-5 is used by OEPA and was selected by the PBOW Project Delivery Team as a basis to consider remedial action. Use of this 1E-5 goal represents a departure from the Army's practice of generally using a cancer risk exceeding a value of 1E-4 (the upper end of the NCP risk management range) to trigger remedial action considerations.

5.2 Noncancer Effects of Chemicals

The hazards associated with noncancer effects of chemicals are evaluated by comparing an exposure level or intake with an RfD. The HQ, defined as the ratio of intake to RfD, is estimated as follows (EPA, 1989a):

$$HQ = I / RfD \qquad \text{Eq. 5.5}$$

where:

HQ = hazard quotient (unitless, calculated)
I = intake of chemical averaged over subchronic or chronic exposure period (mg/kg-day)
RfD = reference dose (mg/kg-day).

The "I" term in Equation 5.5 is equivalent to the "I" or "DAD" terms (intake or dose) in Equations 3.7 through 3.10 when these equations are evaluated for noncancer intakes.

Chemical noncancer hazards are evaluated using chronic RfD values. This approach is different from the probabilistic approach used to evaluate cancer risks. An HQ of 0.01 does not imply a 1-in-100 chance of an adverse effect, but indicates only that the estimated intake is 100 times lower than the RfD. An HQ of unity indicates that the estimated intake equals the RfD. If the HQ is greater than unity, there may be concern for potential adverse health effects.

In the case of simultaneous exposure of a receptor to multiple chemicals, or to a given chemical by multiple pathways, an HI is calculated as the sum of the HQs by the following equation:

$$HI = HQ_1 + HQ_2 + \ldots HQ_i \qquad \text{Eq. 5.6}$$

where:

HI = hazard index (unitless, calculated)
HQ_i = hazard quotient for the ith chemical, or for the ith pathway.

A total HI is calculated as the sum of all HI values, including all media and all COPCs, for a given receptor. Calculating a total HI as the sum of HQ values is based on the assumption that the potential for noncancer effects is additive. EPA (1989a), however, acknowledges that the assumption of additivity is probably appropriate only for chemicals that induce adverse effects by the same mechanism (Section 4.4). Therefore, if the total HI for a receptor exceeds 1, individual HI values may be calculated for each target organ.

A total target organ HI is calculated by summing the HI values (associated by target organ[s]), across exposure pathways as follows:

$$Total\ Target\ Organ\ HI_a = HI_{p1-a} + HI_{p2-a} + ...HI_{pi-a} \qquad \text{Eq. 5.7}$$

where:

Total target organ HI_a = total hazard index for target organ "*a*" (unitless, calculated)
HI_{pi-a} = hazard index for target organ "*a*" via pathway "*i*."

HI values of 1 or less indicate that adverse noncancer health effects associated with that target organ of any individual under the exposure assumptions for that receptor are unlikely. If the total target organ HI exceeds a value of 1, then adverse noncancer health effects concerning that target organ and receptor cannot be regarded as unlikely.

5.3 Risk Characterization Results

Cancer and noncancer risk characterization results were evaluated for each receptor and each environmental medium using the methods described in Sections 5.1 and 5.2. Sections 5.3.1 through 5.3.7 describe the risk characterization results for each receptor associated with the Unloading Area. Risk summary tables are shown for each receptor as referenced. The detailed quantitative evaluation tables include the exposure equations presented in Chapter 3.0, and the risk characterization equations presented in Chapter 5.0 are provided in Appendix D. Analytical results used as input in the BHHRA are included in Appendix E.

5.3.1 Current Groundkeeper

The ILCR for the current groundskeeper (Table 5-1) exposed to surface soil both through direct contact and via inhalation of suspended particulates is estimated as 1E-7. This value is below the NCP risk management range of 1E-6 to 1E-4 and the PBOW cancer risk goal of 1E-5.

Benzo(a)pyrene is the only COPC identified in soil at the Unloading Area. Because noncancer health effects are not associated with exposure to benzo(a)pyrene (Table 4-1), no HQ or HI values are calculated for this COPC (Table 5-1).

5.3.2 Future Groundskeeper

The exposure assumptions for the future groundskeeper differ from those of the current groundskeeper (Section 5.3.1) in that the future groundskeeper is assumed to be exposed to groundwater via direct contact (ingestion and dermal exposure) (Table 5-1).

The total ILCR for the future groundskeeper, assuming hypothetical exposure to overburden groundwater, is 2E-5 (Table 5-1). This value is within the NCP risk management range but exceeds the PBOW target cancer risk goal of 1E-5. This value is predominantly associated with ingestion exposure to arsenic in groundwater (2.3E-5) (Appendix D, Table D-10).

Arsenic was detected in two of the six overburden groundwater samples collected in December 2011 and April 2012. Arsenic in overburden groundwater at the Unloading Area is not regarded as resultant from former site operations for the following reasons:

- Arsenic has not been identified as being part of any production processes or waste streams at PBOW.
- Arsenic was not found to be present in the overlying soils at concentrations greater than PBOW background in surface soil or subsurface soil (Tables 2-2 and 2-3).

Although there are no data for PBOW overburden background groundwater, the MDC for arsenic in overburden groundwater (5.8 µg/L) is less than the PBOW BSC (7.4 µg/L) used for arsenic in limestone bedrock groundwater. The MDC is also less than the Safe Drinking Water Act maximum contaminant level for arsenic (10 µg/L).

If the potential cancer effects associated with arsenic in groundwater are excluded because of non-site relatedness, the resulting total ILCR is 1E-7 (Table 5-2). This value is below the NCP risk management range of 1E-6 to 1E-4 and the PBOW cancer risk goal of 1E-5.

The total HI for the future groundskeeper, assuming hypothetical exposure to overburden groundwater, is 0.3 (Table 5-1). This value is below the target HI criterion of 1, indicating that noncancer health effects are regarded as unlikely to occur under this scenario.

5.3.3 Indoor Worker

The exposure assumptions for the future indoor worker include incidental ingestion of surface soil and exposure to overburden groundwater via direct contact (ingestion and dermal exposure). Groundwater exposure assumes hypothetical use of the overburden unit underlying the Unloading Area as a potable source (Section 5.3.2).

The total ILCR for the future indoor worker is 2E-5 (Table 5-1). This value is within the NCP risk management range but exceeds the PBOW target cancer risk goal of 1E-5. This value is predominantly associated with ingestion of arsenic in groundwater (2.3E-5) (Appendix D, Table D-11).

If the potential cancer effects associated with arsenic in groundwater are excluded because of non-site relatedness, the resulting total ILCR is 3E-8 (Table 5-2), which is below the 1E-6 to 1E-4 NCP risk management range and the PBOW cancer risk goal of 1E-5.

The total HI for the future indoor worker is 0.3 (Table 5-1). This value is below the target HI criterion of 1, indicating that noncancer health effects are regarded as unlikely to occur under this scenario.

5.3.4 Construction Worker

The ILCR for the construction worker (Table 5-1) exposed to soil both through direct contact and via inhalation of suspended particulates is estimated as 6E-9. This value is below the NCP risk management range of 1E-6 to 1E-4 and the PBOW cancer risk goal of 1E-5. Benzo(a)pyrene is the only COPC identified in soil at the Unloading Area. Because noncancer health effects are not associated with exposure to benzo(a)pyrene (Table 4-1), no HQ or HI values are calculated for this COPC (Table 5-1).

5.3.5 Hypothetical Future On-Site Resident

The exposure assumptions for the hypothetical future resident include direct contact with soil, inhalation of particulates from soil, and direct exposure with groundwater via direct contact (ingestion and dermal exposure). Groundwater exposure assumes hypothetical use of the overburden unit underlying the Unloading Area as a potable source (Section 5.3.2).

The ILCR for the resident was calculated assuming exposure during a combined 30-year child/adult exposure duration, whereas separate noncancer HI values were calculated for the young child and adult life stages (Section 3.1.3.5). The results of each are described below.

The total ILCR for the future resident is 1E-4 (Table 5-1). This value equals the upper value of the NCP risk management range and exceeds the PBOW target cancer risk goal of 1E-5. This value is predominantly associated with ingestion of arsenic in groundwater (9.6E-5) (Appendix D, Table D-12).

The total HI for the adult resident is 1 (Table 5-1). This value equals the target HI value of 1, indicating that noncancer health effects to the adult are regarded as unlikely to occur under this scenario.

The total HI for the future child resident is 2 (Table 5-1). This value is above the target HI criterion of 1. The value for the future child resident is associated primarily with ingestion of arsenic (0.92), cobalt (0.41), manganese (0.36), antimony (0.35), and iron (0.21) in groundwater (Appendix D, Table D-14).

Because the total HI for the future child resident is above the target HI criterion of 1, individual HI values were calculated for each target organ as described in Section 5.2. The target organs for oral exposure to COPCs in groundwater are the heart, skin, thyroid, gastrointestinal tract, and central nervous system (Table 4-1).

The Target Organ HI values for each target organ were calculated according to Eq. 5.7 (Appendix D, Table D-15) and the results are summarized in Table 5-3. The HI values for each target organ are below the target HI criterion of 1, indicating that adverse noncancer health effects concerning that target organs or a future resident child can be regarded as unlikely.

If the potential cancer effects associated with metals in groundwater are excluded because of non-site relatedness, the resulting total ILCR is 4E-7 (Table 5-2), which is below the NCP risk management range of 1E-6 to 1E-4 and the PBOW cancer risk goal of 1E-5.

Because noncancer health effects are not associated with exposure to benzo(a)pyrene in soil (Table 4-1), no HQ or HI values are calculated for exposures that exclude groundwater use (Table 5-2).

5.3.6 Adult Hunter

The ILCR for the future adult hunter (Table 5-1) exposed to surface soil both through direct contact and via the ingestion of venison is estimated as 8E-9. This is below the NCP risk management range of 1E-6 to 1E-4 and is less than the PBOW cancer risk goal of 1E-5. Because

noncancer health effects are not associated with exposure to benzo(a)pyrene (Table 4-1), no HQ or HI values are calculated for this COPC (Table 5-1).

5.3.7 Hunter's Child

The ILCR for the hunter's child (Table 5-1) exposed to surface soil via the ingestion of venison from deer which grazed on site cannot be quantified because benzo(a)pyrene in surface soil does not bioaccumulate in food. Cancer risks associated with PBOW to this receptor are regarded as de minimis and less than the NCP risk management range of 1E-6 to 1E-4 and the PBOW cancer risk goal of 1E-5. Because noncancer health effects are not associated with exposure to benzo(a)pyrene (Table 4-1), no HQ or HI values are calculated for this COPC (Table 5-1).

6.0 Uncertainty Analysis

The primary objective of the BHHRA is to characterize and quantify potential human health risks. However, these risks are estimated using incomplete and imperfect information that introduces uncertainties at various stages of the risk assessment process. Uncertainties associated with earlier stages of the risk assessment become magnified when they are linked with other uncertainties in the latter stages. Reliance on a simplified numerical presentation of dose rate and risk without consideration of uncertainties, limitations, and assumptions inherent in their derivation can be misleading. For example, the calculated ILCR for a given scenario "A" may be 1E-5 (meets the PBOW risk goal) and that of scenario "B" may be 5E-5 (exceeds the PBOW risk goal). However, if the uncertainties associated with scenario "B," for instance, span orders of magnitude and the ILCR is regarded as biased high, it is not unlikely that scenario "A" actually presents a higher risk of developing cancer.

The chief goal of this analysis is to evaluate uncertainties and present them in context of their potential impact on the interpretation of the risk assessment results and the types of environmental management decisions that may be based on these results. The uncertainty analysis does not exhaustively describe all potential uncertainties but presents those that have the largest implications for the interpretation of the risk assessment results. This analysis also summarizes the types and, as applicable, the magnitude of the uncertainties at each stage of the risk assessment. Although the discussion in the following sections includes generic uncertainties that are common to the state of human health risk assessment practice overall (e.g., additivity of health effects in the risk characterization), the uncertainty analysis focuses on the sets of uncertainties that are specific to the Unloading Area.

6.1 Types of Uncertainty

Uncertainties in risk assessment are categorized into two general types: 1) variability inherent in the (true) heterogeneity of the data set, measurement precision, and measurement accuracy; and 2) uncertainty that arises from data gaps. Estimates of the degree of variability tend to decrease as the sample size increases. This is because larger data sets are less impacted by individual samples/measurements and can allow for greater accuracy. Uncertainty that arises from data gaps is addressed by applying models and assumptions. Models are applied because they represent a level of understanding to address certain exposure parameters that are impractical or impossible to measure (e.g., COPC concentrations in air that would result from groundwater use that has not yet occurred, or may never occur, at a site). Assumptions represent an educated estimate to address information that is not available (e.g., additivity of carcinogens).

6.2 Sources of Uncertainty

The discussion in the following sections provides an overview of uncertainty, with a focus on those sources that are most likely to affect interpretation of the risk assessment results.

6.2.1 Sample Selection

Soil samples were collected from the Unloading Area where chemicals used in TNT production were unloaded from railcars. Samples were collected at various depths, ranging from surface to 10 feet bgs where handling took place. These locations were expected to have the highest concentrations of chemicals potentially released during handling. The locations for well installation were selected from areas adjacent to the Unloading Area that were expected to have the highest concentrations of contaminants in groundwater if the Unloading Area had been a source of contamination.

6.2.2 Exposure-Point Concentration Estimates

Uncertainty is introduced in the statistical approach used to calculate the EPCs. As stated in the human health evaluation manual (EPA, 1989a), the average concentration of the site should be used as the concentration term. Generally, a UCL is used to account for the uncertainty of using a sample data set to estimate the true population mean concentration for the site. ProUCL Version 4.1 software (EPA, 2011) was used to calculate the EPCs for those media with five or more samples. However, as is readily observed by reviewing the ProUCL output (Appendix B), the calculation of the UCL can vary with methodology. It is unclear whether the UCL value of a specific EPC would result in an underestimate or overestimate of the true population mean. However, the general use of a UCL on all the data sets, even given the uncertainty as to whether a given method provides full coverage at 95 percent confidence, would result in general overestimation of the population mean and associated risks. Therefore, as intended by the guidance (EPA, 1989a), this practice of using the UCL as the EPC (note that the MDC is used as the EPC if the UCL exceeds the MDC) introduces bias that tends to overestimate the population mean and the resultant risk values.

Because no COPCs were identified in subsurface soil (Table 2-3), EPCs of COPCs identified in surface soil were applied to the assessment of receptors expected to be exposed to “total soil” (the future groundskeeper, the construction worker, and the hypothetical future site resident), which represents a conservative overestimation of exposures of these receptors (Section 2.5).

6.2.3 Land-Use Assumptions/Receptor Selection

The current groundskeeper is intended to represent an on-site worker under the current land use as NASA-controlled property. Because there is currently no identified NASA activity other than mowing at the Unloading Area, the use of this receptor likely overestimates risks and hazards to a current site worker. The assumed future use of the hunter and the hunter's child is reasonable, as other areas within PBOW may currently be legally hunted by permit.

Unrestricted land use, including residential use, is a reasonable assumption for the future use of property at the Unloading Area, given the rural residential use of property adjacent to the PBOW facility. The assumption that the overburden groundwater will be used as a potable water source in the future is regarded as unlikely for reasons described in Section 6.2.4.

6.2.4 Groundwater Use

The overburden groundwater is of low yield regionally, and the overburden groundwater is regionally and seasonally discontinuous throughout much of PBOW (Shaw, 2006). However, it appears that the overburden groundwater unit produces enough water for tap water use. This conclusion is based largely on the observation that each of the groundwater wells could be sampled using low-flow methodology. Regardless, use of the overburden groundwater as a potable source is considered unlikely for the following reasons: 1) the seasonal and areal limitations of the overburden groundwater underlying most of PBOW suggest that the shallow unit under the Unloading Area may not be a reliable source of groundwater during drought conditions; 2) municipal tap water is readily available and universally used in the area; 3) limestone bedrock groundwater in the vicinity of PBOW has naturally poor quality and thus would not represent a suitable source to supplement the overburden groundwater (by screening through both units) such that a reliable volume of groundwater would be present during drought conditions; and 4) NASA has recently expressed intentions of placing institutional controls on the Plum Brook Station property that would prohibit the use of on-site groundwater in perpetuity (PBOW Project Delivery Team, 2013). Because potable use of the groundwater underlying the Unloading Area is unlikely, inclusion of groundwater pathways in the BHHRA introduces a conservative bias to risk estimates.

6.2.5 Exposure Assumption Values

The exposure assumption values used in the exposure assessment (Table 3-1) are selected to represent either an upper bound (e.g., 95th percentile) or mid-range value, depending on the particular parameter. Mathematically combining these terms in exposure equations is generally thought to result in decidedly conservative exposure estimations (Cogliano, 1997; Burmaster and Harris, 1993). In general, this conservatism is associated with the state of risk assessment

practice, which attempts to focus on the upper end of exposure possibilities rather than more realistic levels of exposure, and not on assumptions made specifically for the Unloading Area.

6.2.6 Toxicity Assessment

Uncertainties associated with the toxicity assessment include those regarding development of the health effects criteria values, the classification of potential carcinogenicity, the extrapolation of exposure route-specific toxicity values to other routes of exposure, and the extrapolation of toxic effects observed in animal studies to potential adverse effects in humans.

The development of health effects criteria for noncancer effects involves considerable professional judgment. An uncertainty factor of up to 10 may be applied to a toxicologically identified benchmark dose or concentration to address the unknown regarding each of the following (EPA, 1989b): lowest-observed-adverse-effects level to no-observed-adverse-effects level, subchronic-to-chronic extrapolation, route-to-route extrapolation, and species-to-species extrapolation. A “modifying factor” of 10 or less is likewise applied in the development of RfDs and RfCs, using professional judgment. This modifying factor is intended to address gaps in the database and the steepness of the dose-response curve. In practice, the overall UF, derived by multiplying the individual uncertainty factors by the modifying factor, associated with RfD and RfC values may span up to four orders of magnitude.

The EPA weight-of-evidence classification system for carcinogens is used to examine and classify chemical agents with respect to their carcinogenic potential. Most EPA potential carcinogens are classified based on animal data, without sufficient human data to support a causal association (i.e., former Group B2; refer to Section 4.1). Also, the linearized multistage mathematical model was used to extrapolate values from relatively high-dose rodent studies to relatively low-dose human exposures in the development of SFs for these compounds. The linearized multistage approach used to develop SFs, combined with other assumptions, tends to overestimate potential risks and is the subject of much controversy.

Overall, the toxicity values, assuming similar effects between humans and test species, tend to result in overestimates of noncancer hazards or cancer risks. However, it is possible that a given chemical can elicit a toxic response in humans that is not observed in the laboratory species studied or that humans may be more sensitive to a given chemical. In this instance, it is possible for the use of the toxicity values to result in underestimates of risks/hazards to humans.

6.2.7 Risk Characterization

It is assumed that the effects of simultaneous exposures to multiple carcinogens at a site are additive. Likewise, it is assumed that noncancer effects of contaminants are additive if they have a similar mechanism of toxicity. In risk assessment practice, it is assumed that the effects of chemicals that affect the same target organ are additive unless chemical-specific information would indicate otherwise. However, chemicals in combination may act additively, synergistically, or antagonistically or may not influence one another at all. Therefore, depending on the interactive effects (if any), the risk characterization approach to multiple contaminants may lead to either underestimates or overestimates of potential risk/hazard.

6.2.8 Evaluation of Selected COPCs for Site Relatedness

Benzo(a)pyrene is the only COPC identified in soil (Table 2-2) and is one of the PAH compounds that form from natural or anthropogenic combustion of organic matter, including fossil fuels, and are generally ubiquitous in the environment (Section 2.4.3). All of the COPCs identified in overburden groundwater (Table 2-4) are naturally occurring metals found in PBOW overlying soils (IT, 1998). Because these COPCs identified in soil and groundwater at the Unloading Area are likely naturally occurring or are not associated with former PBOW activities, the cancer risks and noncancer hazard estimates developed in the BHHRA represent a conservative overestimation of risks from exposures to chemicals from PBOW-related chemicals formerly handled at the site.

7.0 Summary and Conclusions

7.1 Summary

The BHHRA was conducted to evaluate cancer risk and noncancer hazards associated with surface soil, subsurface soil, and overburden groundwater at the Unloading Area. A risk-based screening approach was used to identify COPCs and focus the risk assessment on those chemicals detected in media at the Unloading Area that may contribute appreciably to risk or hazard. The sampled media were screened against the respective RBSCs, and inorganics in bedrock groundwater and soil were also screened against BSCs. COPCs for the various media were identified based on this screening. Exposure and risk/hazard associated with the COPCs were evaluated using the following receptors (media evaluated in parentheses):

- Current groundskeeper (surface soil)
- Future groundskeeper (total soil and overburden groundwater)
- Future indoor worker (surface soil and overburden groundwater)
- Current/future construction worker (total soil)
- Hypothetical future resident (total soil and overburden groundwater)
- Future adult hunter (surface soil, including venison pathway)
- Future hunter's child (surface soil [venison pathway only]).

The resident was evaluated for noncancer hazards separately for the young child (ages 1 through 6 years) and adult life stages.

The overall HI and ILCR values are summarized for these receptors in the following bullets. Exceedances of PBOW cancer risk goal (ILCR greater than 1E-5) are shown in bold type and exceedances of the noncancer hazard goal (HI greater than 1) or the NCP risk management range (1E-6 to 1E-4) are shown as bold italics:

- Current groundskeeper: ILCR = 1E-7; HI = 0 (Benzo[a]pyrene identified in soil is not associated with noncancer health effects.) Thus, adverse health effects from exposure to soil are of no further concern at the site.

- Future groundskeeper: **ILCR = 2E-5** (1E-7 excluding background-related arsenic in groundwater); HI = 0.3. (Estimated risks above PBOW criteria are associated with only with potential groundwater use.)

- Future indoor worker: **ILCR = 2E-5** (3E-8 excluding background-related arsenic in groundwater); HI = 0.3. (Estimated risks above PBOW criteria are associated with only with potential groundwater use.)

- Construction worker: ILCR = 6E-9; HI = 0 (Benzo[a]pyrene identified in soil is not associated with noncancer health effects.) Thus, adverse health effects from exposure to soil are of no further concern at the site.

- Resident: **ILCR = 1E-4** (4E-7 excluding background-related arsenic in groundwater); adult HI = 1; child HI calculated for target organs = 0.4 (heart), 0.9 (skin), 0.4 (thryroid), 0.2 (gastrointestinal tract), 0.4 (central nervous system). (Benzo[a]pyrene identified in soil is not associated with noncancer health effects. Estimated risks and hazards are associated with potential groundwater use.)

- Hunter: ILCR = 8E-9; HI = 0 (Benzo[a]pyrene identified in soil is not associated with noncancer health effects). Thus, adverse health effects from exposure to soil are of no further concern at the site.

- Hunter's child: ILCR = 0; HI = 0 (Benzo[a]pyrene identified in soil is not associated with noncancer health effects and does not accumulate in venison.) Thus, adverse health effects from exposure to soil are of no further concern at the site.

7.2 Conclusions

These receptor scenarios cover a wide range of human activities that are representative of future land use at the Unloading Area. The ILCR and HI values for the current groundskeeper, current construction worker, hunter, and future hunter's child exposure scenarios meet the PBOW cancer risk goal (ILCR less than or equal to 1E-5) and the noncancer hazard criterion (HI less than or equal to 1). Note that no groundskeeping appears to have occurred at the Unloading Area in recent years, except occasional mowing, and no construction is currently planned at the Unloading Area.

The cancer risks associated with the following future receptors assumed to use overburden groundwater as a hypothetical source of tap water exceed the PBOW cancer risk goal: future groundskeeper, future indoor worker, and future resident. These estimated cancer risks that exceed the criterion are entirely attributable to arsenic in groundwater. The estimated cancer risks for exposure to soil are below the PBOW cancer risk criterion for all scenarios.

The noncancer hazard estimates for future groundskeeper, future indoor worker, and potential on-site resident are equal to or below the PBOW noncancer HI criterion with the exception of the HI estimate for the hypothetical on-site resident child. However, the target organ HI values are each below the target HI criterion. The estimated noncancer hazard estimates for exposure to soil are below the PBOW criterion for all scenarios.

Because use of the underlying groundwater as a potable source is unlikely, the exposure scenarios evaluated in the BHHRA for potable use of groundwater represent overestimates of human health risks and hazards.

If the contributions of exposure to groundwater are appropriately excluded, no ILCR estimated for any scenario exceeds the PBOW risk goal of 1E-5 and no receptor had HI values that exceed the noncancer hazard criterion (HI greater than 1).

This result indicates that the associated environmental media at the Unloading Area are unlikely to pose an unacceptable cancer risk or noncancer hazard to any receptor and that exposure to these media is unlikely to result in adverse noncancer health effects for any human receptor.

8.0 References

Burmaster, D.E., and R.H. Harris, 1993, "The Magnitude of Compounding Conservatisms in Superfund Risk Assessment," ***Risk Analysis, 13(2): 131-134***.

California Environmental Protection Agency, 2011, ***Toxicity Criteria Database***, Office of Environmental Health Hazard Assessment, Sacramento, California, http://www.oehha.ca.gov/risk/ChemicalDB/index.asp.

City-Data.com, 2004, on-line data search for Sandusky, Ohio, performed November 11, 2004, http://www.city-data.com/city/Sandusky-South-Ohio.html.

Cogliano, V.J., 1997, "Plausible Upper Bounds: Are Their Sums Plausible?" ***Risk Analysis***, 17(1): 77-84.

Dames and Moore, Inc. (D&M), 1997, ***TNT Areas Site Investigation Final Report for Plum Brook Ordnance Works, Plum Brook Station/NASA, Sandusky, Ohio***, prepared for U.S. Army Corps of Engineers, Nashville District/Huntington District, April.

Ebasco Environmental, 1991, ***Underground Storage Tank Corrective Actions Remedial Investigation/Feasibility Study, NASA Plum Brook Station***, November.

Environmental Council of States-U.S. Department of Defense, 2007, ***Identification and Selection of Toxicity Values/Criteria for CERCLA and Hazardous Waste Site Risk Assessments in the Absence of IRIS Values,*** ECO-DOD Sustainability Work Group, Emerging Contaminants Task Group, Risk Assessment Provisional Values Subgroup Issue Paper, 23 April.

EnviroScience, Inc. (ES), 2012, ***Wetland and Other Waters Delineation Report, 6,431 Acres at NASA Plum Brook Station, Sandusky, Erie County, Ohio***, August 10, revised November.

International Consultants Incorporated (ICI), 1995, ***Site Management Plan, Plum Brook Ordnance Works, Sandusky, Ohio, Part B, Areas of Concern***, September.

IT Corporation (IT), 2001, ***TNT Areas A and C Remedial Investigation, Volume II – Human Health Risk Assessment, Final, Former Plum Book Ordnance Works, Sandusky, Ohio,*** November.

IT Corporation (IT), 2000a, ***TNT Areas A and C Remedial Investigation, Volume 1, Part 2 Report of Findings, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** November.

IT Corporation (IT), 2000b, ***TNT Areas A and C Remedial Investigation, Volume 1, Part 3 Report of Findings, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** November.

IT Corporation (IT), 2000c, ***Draft Baseline Human Health Risk Assessment Work Plan for the Former TNT Manufacturing Area, West Virginia Ordnance Works, Mason Count, West Virginia***, January.

IT Corporation (IT), 1999, ***Final - Summary Report, Site-Wide Groundwater Monitoring (1997-1998), Former Plum Brook Ordnance Works, Sandusky, Ohio,*** June.

IT Corporation (IT), 1998, ***Site Investigation of the Acid Areas, Former Plum Brook Ordnance Works, Sandusky, Ohio***, August.

IT Corporation (IT), 1997, ***Site-Wide Groundwater Investigation, Former Plum Brook Ordnance Works, Sandusky, Ohio***, September.

Mautz, W.W., H. Silver, and J.B. Holter, 1976, "Digestibility and Related Nutritional Data for Seven Northern Deer Browse Species," ***Journal of Wildlife Management***, 40(4): 630-638.

National Council on Radiation Protection and Measurements, 1984, ***Radiological Assessment: Predicting the Transport, Bioaccumulation, and Uptake by Man of Radionuclides Released to the Environment***, NCRP Report No. 76.

National Oceanic and Atmospheric Administration, 1990, ***Comparative Climatic Data for the United States through 1989***, National Climatic Data Center, Asheville, North Carolina.

Nutrient Database, 1997, Data compiled from U.S. Department of Agriculture releases, and published nutrient information from 71 chain references, on line, http://www.nutribase.com.

Ohio Environmental Protection Agency (OEPA), 2012, ***Authorization to Discharge Under the National Pollutant Discharge Elimination System,*** (issue date June 29, 2012, effective date August 1, 2012), on line at http://wwwapp.epa.ohio.gov/dsw/permits/doc/2IO00002.pdf.

Ohio Environmental Protection Agency (OEPA), 2009a***, Use of U.S. EPA's Regional Screening Levels as Screening Values in Human Health Risk Assessments***, Technical Decision Compendium, Division of Emergency and Remedial Response, August.

Ohio Environmental Protection Agency (OEPA), 2009b***, Human Health Cumulative Carcinogenic Risk and Non-carcinogenic Hazard Goals for the DERR Remedial Response Program***, Technical Decision Compendium, Division of Emergency and Remedial Response, August.

Ohio Environmental Protection Agency (OEPA), 2009c, Email Correspondence from B. Buthker, OEPA Risk Assessor, to L. Long, USACE Risk Assessor, March 18.

Plum Brook Ordnance Works (PBOW) Project Delivery Team, 2013, teleconference discussion between legal counsel and technical team member representing NASA, USACE, and the Ohio EPA, October 31.

Plum Brook Ordnance Works (PBOW) Project Delivery Team (PDT), 2000, ***Meeting with USACE and OEPA, Quarterly Background Groundwater Investigation***, meeting minutes, NASA Plum Brook Station, Sandusky, Ohio, May 10.

Sample, B.E. and Suter II, G.W., 1994, ***Estimating Exposure of Terrestrial Wildlife Contaminants***, Environmental Sciences Division, Oak Ridge National Laboratory, ES/ER/TM-125.

Sample, B.E., D.M. Opresko, and G.W. Suter II, 1996, ***Toxicological Benchmarks for Wildlife: 1996 Revision***, prepared for the U.S. Department of Energy by Health Sciences Research Division, Oak Ridge National Laboratory.

Science Applications International Corporation, 1991, ***Plum Brook Station Preliminary Assessment,*** June.

Sharp, G., 1995, Personal Communication: Telephone conversation between P. Goetchius, IT Corp. and Gary Sharp, Wildlife Biologist, West Virginia Division of Natural Resources, Point Pleasant, West Virginia, 17 February.

Shaw Environmental, Inc. (Shaw), 2013a, ***Baseline Human Health Risk Assessment Work Plan, Garage Maintenance Area (Former Sellite Area and Unloading Area), Final, Former Plum Brook Ordnance Works, Sandusky, Ohio***, May.

Shaw Environmental, Inc. (Shaw), 2013b, ***Garage Maintenance Area (Unloading Area) Site Characterization Report, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio***, May.

Shaw Environmental, Inc. (Shaw), 2013c, ***Baseline Human Health Risk Assessment, Draft, Former Plum Brook Ordnance Works, Sandusky, Ohio***, August.

Shaw Environmental, Inc. (Shaw), 2008, ***Feasibility Study for Groundwater, TNT and Red Water Pond Areas, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** December.

Shaw Environmental, Inc. (Shaw), 2006, ***Baseline Human Health Risk Assessment of Groundwater, Former Plum Brook Ordnance Works, Sandusky, Ohio***, September.

Shaw Environmental, Inc. (Shaw), 2005, ***2004 Groundwater Data Summary and Evaluation Report, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio***, April.

Shaw Environmental, Inc. (Shaw), 2003, ***2002 Groundwater Data Summary and Evaluation Report, Former Plum Brook Ordnance Works, Sandusky, Ohio***, June.

Tetra Tech, Inc., 2001, ***Environmental Baseline Survey Report for the Plum Brook Reactor Facility Decommissioning Project***, February.

The Weather Channel, 2004, on-line data search for weather averages and records for Sandusky, Ohio, performed November 11, 2004, http://www.weather.com.

U.S. Army Corps of Engineers (USACE), 1999, ***Risk Assessment Handbook, Volume I: Human Health Evaluation***, Engineer Manual EM 200-1-4.

U.S. Department of Energy (DOE), 1989, ***A Manual for Implementing Residual Radioactive Material Guidelines***, Argonne National Laboratory, Argonne, Illinois, ANL/ES-160, DOE/CH/8901.

U.S. Department of Energy (DOE), 1983, ***Pathway Analysis and Radiation Dose Estimates for Radioactive Residues at Formerly Utilized MED/AEC Sites***, U.S. Dept. of Energy, Oak Ridge Operations Office, Oak Ridge, Tennessee, DOE ORO-832.

U.S. Environmental Protection Agency (EPA), 2013a, ***Regional Screening Level Table***, May, on line at www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm.

U.S. Environmental Protection Agency (EPA), 2013b, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, Ohio, on line.

U.S. Environmental Protection Agency (EPA), 2012a, ***2012 Edition of the Drinking Water Standards and Health Advisories***, Office of Water, April, EPA 822-S-12-001.

U.S. Environmental Protection Agency (EPA), 2012b, ***Regional Screening Level Table, User's Guide (November 2012)***, on line at www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm.

U.S. Environmental Protection Agency (EPA), 2011, ***ProUCL Version 4.1.01***, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, February, on line at http://www.epa.gov/esd/tsc/form.htm.

U.S. Environmental Protection Agency (EPA), 2010a, ***ProUCL Version 4.1 Technical Guide***, Draft, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, EPA/600/R-07/041, May.

U.S. Environmental Protection Agency (EPA), 2010b, ***ProUCL Version 4.1 User Guide***, Draft, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, EPA/600/R-07/038, May.

U.S. Environmental Protection Agency (EPA), 2009, ***Overview of Changes From IEUBKwin version 1 build 264 to IEUBKwin version 1.1***, June, on line at http://www.epa.gov/superfund/health/contaminants/lead/products.htm

U.S. Environmental Protection Agency (EPA), 2005, ***Guidelines for Carcinogen Risk Assessment***, Risk Assessment Forum, Washington, D.C., March, EPA/630/P-03/001B.

U.S. Environmental Protection Agency (EPA), 2004a, ***Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part E - Supplemental Guidance for Dermal Risk Assessment)***, Final, Office of Superfund Remediation and Technology Innovation, Washington, D.C., EPA/540/R-99/005, July.

U.S. Environmental Protection Agency (EPA), 2004b, ***Region 9 Preliminary Remediation Goals (PRG) Table***, San Francisco, California, October.

U.S. Environmental Protection Agency (EPA), 2004c, ***User's Guide and Background Technical Document for Region 9 Preliminary Remediation Goals (PRG) Table***, Region 9, San Francisco, California, October, <http://www.epa.gov/region09/waste/sfund /prg/files/04usersguide.pdf>.

U.S. Environmental Protection Agency (EPA), 2003, ***Human Health Toxicity Values in Superfund Risk Assessments***, Office of Solid Waste and Emergency Response, Washington, D.C., OSWER Directive 9285.7-53, December.

U.S. Environmental Protection Agency (EPA), 2002, ***Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites***, Office of Solid Waste and Emergency Response, Washington, D.C., 9355.4-24, December.

U.S. Environmental Protection Agency (EPA), 1997a, ***Exposure Factors Handbook***, Office of Research and Development, National Center for Environmental Assessment, Washington, D.C., EPA/600/P-95/002Fa, August.

U.S. Environmental Protection Agency (EPA), 1997b, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, 9200.6-303 (97-1), EPA-540-R-97-036, NTIS No. PB97-921199.

U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Technical Background Document***, Office of Solid Waste and Emergency Response, EPA/540/R-95/128, NTIS No. PB96-963502.

U.S. Environmental Protection Agency (EPA), 1994, ***Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities,*** Office of Solid Waste and Emergency Response, Draft, April, EPA530-R-94-021, including Errata, "Guidance for Performing Screening Level Risk Analyses at Combustion Facilities Burning Hazardous Wastes," October, and "Modification of Screening Guidance Fate and Transport Equations, November.

U.S. Environmental Protection Agency (EPA), 1992, ***Guidance on Risk Characterization for Risk Managers and Risk Assessors,*** Memorandum from F. Henry Habicht II, Deputy Administrator, to Assistant Administrators, Regional Administrators, February.

U.S. Environmental Protection Agency (EPA), 1991, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors***, Interim Final, Office of Solid Waste and Emergency Response, OSWER Directive: 9285.6-03.

U.S. Environmental Protection Agency (EPA), 1990, "National Oil and Hazardous Substances Pollution Contingency Plan," ***Federal Register*** 55(46): 8666-8865.

U.S. Environmental Protection Agency (EPA), 1989a, ***Risk Assessment Guidance for Superfund***, ***Volume I, 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 (EPA), 1989b, ***General Quantitative Risk Assessment Guidelines for Noncancer Health Effects***, prepared by the Office of Health and Environmental Assessment, Cincinnati, Ohio, for the Risk Assessment Forum, ECAO-CIN-538.

U.S. Environmental Protection Agency (EPA), 1986, "Guidelines for Carcinogen Risk Assessment," ***Federal Register***, 51(185): 33992-34003.

U.S. Geological Survey, 1992, ***Hydraulic Properties of Three Types of Glacial Deposits in Ohio***, Water-Resources Investigation Report 92-4135.

TABLES

Table 2-1

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
Surface Soil					
ULA-SB01	ULA0001	REG	18-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB02	ULA0002	REG	19-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB02	ULA0003	FD	19-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB03	ULA0005	REG	19-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB04	ULA0006	REG	18-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB05	ULA0007	REG	19-May-11	0 - 1	Explosives, Gen Chem, Metals, SVOC, VOC
ULA-SB06	ULA0008	REG	18-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB07	ULA0009	REG	18-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB08	ULA0010	REG	19-May-11	0 - 1	Explosives, Gen Chem, Metals, SVOC, VOC
ULA-SB09	ULA0011	REG	18-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB10	ULA0012	REG	19-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB11	ULA0013	REG	19-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB12	ULA0014	REG	19-May-11	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
Subsurface Soil					
ULA-SB01	ULA0015	REG	18-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB01	ULA0029	REG	18-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB02	ULA0016	REG	19-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB02	ULA0017	FD	19-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB02	ULA0030	REG	19-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB03	ULA0019	REG	19-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB03	ULA0031	REG	19-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB03	ULA0032	FD	19-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB04	ULA0020	REG	18-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB04	ULA0034	REG	18-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB05	ULA0021	REG	19-May-11	3 - 5	Explosives, Gen Chem, Metals, SVOC, VOC
ULA-SB05	ULA0035	REG	19-May-11	8 - 10	Explosives, Gen Chem, Metals, SVOC, VOC
ULA-SB06	ULA0022	REG	18-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB06	ULA0036	REG	18-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB07	ULA0023	REG	18-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB07	ULA0037	REG	18-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB08	ULA0024	REG	19-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB08	ULA0038	REG	19-May-11	8 - 10	Explosives, Gen Chem, Metals, SVOC, VOC
ULA-SB09	ULA0025	REG	18-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB09	ULA0039	REG	18-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB10	ULA0026	REG	19-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB10	ULA0040	REG	19-May-11	8 - 10	Explosives, Gen Chem, Metals, SVOC, VOC
ULA-SB10	ULA0041	FD	19-May-11	8 - 10	Explosives, Gen Chem, Metals, SVOC, VOC
ULA-SB11	ULA0027	REG	19-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB11	ULA0043	REG	19-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB12	ULA0028	REG	19-May-11	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC, VOC
ULA-SB12	ULA0044	REG	19-May-11	8 - 10	Explosives, Gen Chem, Metals, PCB, SVOC, VOC

Table 2-1

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
Groundwater Samples					
Overburden Well Samples					
ULA-MW01	ULA3010	REG	9-Dec-11	NA	Explosives, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-MW01	ULA3011	FD	9-Dec-11	NA	Explosives, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-MW01	ULA3015	REG	1-May-12	NA	Explosives, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-MW01	ULA3016	FD	1-May-12	NA	Explosives, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-MW02	ULA3013	REG	13-Dec-11	NA	Explosives, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-MW02	ULA3018	REG	30-Apr-12	NA	Explosives, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-MW03	ULA3014	REG	12-Dec-11	NA	Explosives, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-MW03	ULA3019	REG	25-Apr-12	NA	Explosives, Field Tests, Gen Chem, Metals, SVOC, VOC
Piezometer [a]					
ULA-PZ01	ULA3000	REG	16-Jun-11	NA	Field Tests, SVOC, VOC
ULA-PZ01	ULA3001	FD	16-Jun-11	NA	VOC
ULA-PZ02	ULA3003	REG	17-Jun-11	NA	Field Tests, SVOC, VOC
ULA-PZ03	ULA3004	REG	17-Jun-11	NA	Explosives, Field Tests, SVOC, VOC
ULA-PZ04	ULA3005	REG	20-Jun-11	NA	Explosives, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-PZ05	ULA3006	REG	17-Jun-11	NA	Field Tests, Gen Chem, Metals (f & uf), SVOCs, VOCs
ULA-PZ06	ULA3007	REG	16-Jun-11	NA	Field Tests, SVOC, VOC
ULA-PZ07	ULA3008	REG	16-Jun-11	NA	Explosives, Field Tests, SVOC, VOC
ULA-PZ08	ULA3009	REG	17-Jun-11	NA	Explosives, Field Tests, SVOC, VOC

[a] These samples are summarized and screened, but no exposure calculations are presented.
FD - Field duplicate.
Metals - Analyzed as unfiltered unless indicated; (f & uf) - filtered and unfiltered
PCB - Polychlorinated biphenyls.
REG - Regular sample.
SVOC - Semivolatile organic compounds.
VOC - Volatile organic compounds.

Table 2-2

Statistical Summary and Selection of Chemicals of Potential Concern in Surface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Reporting Limits Minimum	Maximum	Mean mg/kg	BSC [a] mg/kg	RBSC [b] mg/kg	COPC? [c,d]	95% UCL [e] mg/kg	EPC [f] mg/kg
Inorganics														
Aluminum	12 / 12	100	3.76E+03		1.19E+04		1.20E+00	1.10E+01	8.24E+03	1.55E+04	7700	N (b)		
Arsenic	12 / 12	100	2.65E+00		9.50E+00		5.20E-02	4.60E-01	5.49E+00	3.65E+01	0.61	N (b)		
Barium	12 / 12	100	1.23E+01	J	8.25E+01		2.10E-01	1.90E+00	4.62E+01	8.26E+02	1500	N (b)		
Beryllium	12 / 12	100	1.70E-01	J	7.10E-01	J	5.20E-03	4.60E-02	4.53E-01	1.00E+00	16	N (b)		
Cadmium	4 / 12	33	1.80E-01	J	9.50E-01	J	5.20E-03	4.60E-02	1.50E-01	NA	7	N (a)		
Calcium	12 / 12	100	4.27E+02	J	2.99E+03		2.60E+00	2.30E+01	1.78E+03	5.23E+04	Nutrient	N (c)		
Chromium	12 / 12	100	4.70E+00		1.74E+01		5.20E-02	4.60E-01	1.16E+01	2.90E+01	0.29	N (b)		
Cobalt	12 / 12	100	1.50E+00	J	1.78E+01	J	5.20E-02	4.60E-01	6.37E+00	1.16E+02	2.3	N (b)		
Copper	12 / 12	100	4.70E+00	J	3.84E+01		5.20E-02	4.60E-01	1.28E+01	5.62E+01	310	N (b)		
Iron	12 / 12	100	5.54E+03		2.26E+04		1.20E+00	1.10E+01	1.40E+04	2.34E+05	5500	N (b)		
Lead	12 / 12	100	3.85E+00		1.27E+01		4.40E-02	6.60E-02	9.06E+00	4.86E+01	400	N (b)		
Magnesium	12 / 12	100	4.80E+02		2.52E+03		2.60E+00	2.30E+01	1.55E+03	1.04E+04	Nutrient	N (c)		
Manganese	12 / 12	100	4.31E+01		5.25E+02		5.20E-02	4.60E-01	2.38E+02	3.51E+03	180	N (b)		
Mercury	12 / 12	100	1.20E-02	J	7.60E-02	J	5.80E-03	9.20E-03	3.36E-02	8.50E-02	2.3	N (b)		
Nickel	12 / 12	100	5.25E+00	J	3.26E+01		5.20E-02	4.60E-01	1.39E+01	5.51E+01	150	N (b)		
Potassium	12 / 12	100	2.09E+02	JJ	9.49E+02	J	2.60E+00	2.30E+01	5.12E+02	3.39E+03	Nutrient	N (c)		
Selenium	2 / 12	17	2.30E-01	J	5.40E-01	J	1.00E-01	9.30E-01	4.39E-01	2.00E+00	39	N (b)		
Vanadium	12 / 12	100	8.30E+00		2.58E+01		5.20E-02	4.60E-01	2.01E+01	4.09E+01	39	N (b)		
Zinc	12 / 12	100	1.50E+01	J	1.70E+02		5.20E-02	4.60E-01	4.50E+01	3.22E+02	2300	N (b)		

Table 2-2

Statistical Summary and Selection of Chemicals of Potential Concern in Surface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Reporting Limits Minimum	Maximum	Mean mg/kg	BSC [a] mg/kg	RBSC [b] mg/kg	COPC? [c,d]	95% UCL [e] mg/kg	EPC [f] mg/kg
Polychlorinated biphenyls (PCB)														
Aroclor 1254	1 / 10	10	1.29E-02	J	1.29E-02	J	7.10E-03	1.10E-02	8.89E-03		0.11	N (a)		
Semivolatile Organic Compounds														
Benzo(a)anthracene	2 / 12	17	2.86E-02	J	3.29E-02	J	1.80E-02	2.80E-02	2.27E-02		0.15	N (a)		
Benzo(a)pyrene	3 / 12	25	2.39E-02	J	3.08E-02	J	1.80E-02	2.80E-02	2.24E-02		0.015	Y	2.57E-02	2.57E-02
Benzo(b)fluoranthene	2 / 12	17	3.83E-02	J	4.44E-02	J	1.80E-02	2.80E-02	2.44E-02		0.15	N (a)		
Chrysene	3 / 12	25	2.72E-02	J	3.43E-02	J	1.80E-02	2.80E-02	2.38E-02		15	N (a)		
Fluoranthene	4 / 12	33	2.96E-02	J	8.11E-02	J	1.80E-02	2.80E-02	3.13E-02		230	N (a)		
Methylnaphthalene, 2-	1 / 12	8	3.01E-02	J	3.01E-02	J	1.80E-02	2.80E-02	2.17E-02		23	N (a)		
Phenanthrene	2 / 12	17	4.21E-02	J	4.33E-02	J	1.80E-02	2.80E-02	2.47E-02		170 [g]	N (a)		
Pyrene	4 / 12	33	2.94E-02	J	5.55E-02	J	1.80E-02	2.80E-02	2.77E-02		170	N (a)		
Volatile Organic Compounds														
Acetone	11 / 12	92	2.10E-02	J	2.51E-01	J	1.20E-02	2.30E-02	5.86E-02		6100	N (a)		
Butanone, 2-	4 / 12	33	6.00E-03	J	2.38E-02	J	3.60E-03	7.00E-03	6.89E-03		2800	N (a)		
Methyl-2-pentanone, 4-	1 / 12	8	6.70E-03	J	6.70E-03	J	3.20E-03	6.30E-03	4.39E-03		530	N (a)		
Methylene chloride	9 / 12	75	3.60E-03	J	9.70E-03	J	2.70E-03	5.30E-03	5.78E-03		36	N (a)		

BSC - Background screening criterion.
COPC - Chemical of potential concern.
EPC - Exposure point concentration.
J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed.
mg/kg - Milligrams per kilogram.
RBSC - Risk-based screening concentration.
VQ - Validation qualifier.

[a] IT Corporation (IT), 1998, ***Site Investigation of Acid Areas*** , Plum Brook Ordnance Works, Sandusky, Ohio, August.
[b] Risk-Based Screening Concentrations based on USEPA Regional Screening Level Table (May 2013) residential soil values and are based on a risk level of 1.0E-06 and a hazard index of 0.1.
[c] N - Chemical is not chosen as a COPC:
(a) = maximum detected concentration is less than the RBSC.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
[d] Y - Chemical is chosen as COPC.
[e] 95% UCL determined using ProUCL Version 4.1 (EPA, 2011, *ProUCL Version 4.1.01* , Technical Support Center, Office of Science Policy, Atlanta, Georgia, July, http://www.epa.gov/osp/hstl/tsc/software.htm). Calculated only for COPCs.
[f] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.
[g] RBSC based on pyrene.

Table 2-3

Statistical Summary and Selection of Chemicals of Potential Concern in Subsurface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Reporting Limits Minimum	Maximum	Mean mg/kg	BSC [a] mg/kg	RBSC [b] mg/kg	COPC? [c,d]
Inorganics												
Aluminum	24 / 24	100	3.89E+03		1.24E+04		1.10E+00	7.00E+00	6.93E+03	1.55E+04	7700	N (b)
Antimony	8 / 24	33	1.10E-01	J	4.40E-01	J	4.60E-02	2.90E-01	1.91E-01	9.30E+00	3.1	N (b)
Arsenic	24 / 24	100	3.00E+00	J	2.04E+01		4.40E-02	2.90E-01	7.89E+00	3.65E+01	0.61	N (b)
Barium	24 / 24	100	2.87E+01		1.24E+02		1.80E-01	1.20E+00	5.14E+01	8.26E+02	1500	N (b)
Beryllium	24 / 24	100	2.50E-01		7.80E-01	J	4.60E-03	2.90E-02	3.89E-01	1.00E+00	16	N (b)
Cadmium	18 / 24	75	8.60E-02	J	4.80E-01	J	4.40E-03	2.90E-02	1.68E-01	NA	7	N (a)
Calcium	24 / 24	100	6.19E+02	J	8.07E+04	J	3.10E+00	1.50E+01	3.66E+04	5.23E+04	Nutrient	N (c)
Chromium	24 / 24	100	6.60E+00		1.87E+01		4.60E-02	2.90E-01	1.18E+01	2.90E+01	0.29	N (b)
Cobalt	24 / 24	100	3.00E+00		1.48E+01	J	4.40E-02	2.90E-01	7.25E+00	1.16E+02	2.3	N (b)
Copper	24 / 24	100	1.22E+01	J	5.84E+01		4.60E-02	2.90E-01	1.88E+01	5.62E+01	310	N (a)
Iron	24 / 24	100	7.67E+03		2.80E+04		1.00E+00	6.70E+00	1.55E+04	2.34E+05	5500	N (b)
Lead	24 / 24	100	7.70E+00		6.90E+01		4.60E-02	2.20E-01	1.28E+01	4.86E+01	400	N (a)
Magnesium	24 / 24	100	1.24E+03		1.98E+04		2.60E+00	1.50E+01	1.17E+04	1.04E+04	Nutrient	N (c)
Manganese	24 / 24	100	1.30E+02		1.68E+03		5.70E-02	5.30E-01	4.92E+02	3.51E+03	180	N (b)
Mercury	20 / 24	83	1.00E-02	J	6.20E-02	J	6.40E-03	7.60E-03	2.01E-02	8.50E-02	2.3	N (b)
Nickel	24 / 24	100	9.90E+00		3.35E+01		4.40E-02	2.90E-01	1.84E+01	5.51E+01	150	N (b)
Potassium	24 / 24	100	4.23E+02	J	1.36E+03	J	2.30E+00	1.50E+01	9.44E+02	3.39E+03	Nutrient	N (c)
Selenium	7 / 24	29	2.20E-01	J	9.90E-01	J	9.10E-02	5.80E-01	3.94E-01	2.00E+00	39	N (b)
Sodium	11 / 24	46	8.07E+01	J	4.00E+02	J	3.90E+01	2.50E+02	1.49E+02	NA	Nutrient	N (c)
Thallium	6 / 24	25	2.75E-01	J	4.30E-01	J	6.80E-02	8.50E-01	2.29E-01	1.30E+00	0.078	N (b)
Vanadium	24 / 24	100	1.05E+01	J	2.91E+01		4.40E-02	2.90E-01	1.67E+01	4.09E+01	39	N (b)
Zinc	24 / 24	100	2.56E+01		7.62E+01		4.60E-02	2.90E-01	4.30E+01	3.22E+02	2300	N (b)
Volatile Organic Compounds												
Acetone	8 / 24	33	1.20E-02	J	5.85E-02	J	1.20E-02	9.90E-01	6.31E-02		6100	N (a)
Benzene	8 / 24	33	1.00E-03	J	2.90E-03	J	9.30E-04	7.40E-02	4.51E-03		1.1	N (a)
Butanone, 2-	1 / 24	4	5.30E-03	J	5.30E-03	J	3.80E-03	3.00E-01	1.78E-02		2800	N (a)
Ethylbenzene	2 / 24	8	1.30E-03	J	3.41E-03	J	6.20E-04	4.90E-02	3.03E-03		5.4	N (a)
Methylene chloride	13 / 24	54	4.10E-03	J	2.03E-01	J	2.80E-03	2.30E-01	3.05E-02		36	N (a)
Toluene	11 / 24	46	1.50E-03	J	6.80E-03		7.40E-04	5.90E-02	4.17E-03		500	N (a)
Trichloroethane, 1,1,1-	1 / 24	4	1.95E-03	J	1.95E-03	J	6.80E-04	5.40E-02	3.24E-03		870	N (a)
Xylenes, total	1 / 24	4	3.70E-03	J	3.70E-03	J	2.00E-03	1.60E-01	9.48E-03		63	N (a)

Table 2-3

Statistical Summary and Selection of Chemicals of Potential Concern in Subsurface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

BSC - Background screening criterion.
COPC - Chemical of potential concern.
J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed.
mg/kg - Milligrams per kilogram.
RBSC - Risk based screening concentration.
VQ - Validation qualifier.

[a] IT Corporation (IT), 1998, *Site Investigation of Acid Areas,Plum Brook Ordnance Works, Sandusky, Ohio* , August.
[b] Risk-Based Screening Concentrations based on USEPA Regional Screening Level Table (May 2013) residential soil values and based on a risk level of 1.0E-06 and a hazard index of 0.1.
[c] N = Chemical is not chosen as a COPC:
(a) = maximum detected concentration is less than the RBSC.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
[d] Y = Chemical is chosen as COPC.

Table 2-4

Statistical Summary and Selection of Chemicals of Potential Concern in Overburden Monitoring Well Groundwater
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Chemical	Detection Frequency	Percent hits	Range of values, µg/L: Detected Concentrations Minimum	VQ	Maximum	VQ	Method Detection Limits Minimum	Maximum	Arithmetic Mean µg/L	RBSC [a] µg/L	COPC? [b,c]	95% UCL [d] µg/L	EPC [e] µg/L	EPC mg/L
Inorganics - Unfiltered														
Aluminum	6 / 6	100	2.58E+01	J	1.07E+02	J	2.00E+01	2.00E+01	5.78E+01	1600	N (a)		---	
Antimony	2 / 6	33	2.00E+00	J	2.30E+00	J	1.00E+00	1.00E+00	1.38E+00	0.6	Y	2.18E+00	2.18E+00	2.18E-03
Arsenic	2 / 6	33	2.10E+00	J	5.80E+00	J	1.00E+00	1.00E+00	1.98E+00	0.045	Y	4.32E+00	4.32E+00	4.32E-03
Barium	6 / 6	100	7.94E+01	J	2.42E+02		1.00E+00	1.00E+00	1.68E+02	290	N (a)		---	
Calcium	6 / 6	100	8.76E+04		1.41E+05		5.00E+01	5.00E+01	1.09E+05	Nutrient	N (b)		---	
Chromium	1 / 6	17	1.00E+00	J	1.00E+00	J	1.00E+00	1.00E+00	1.00E+00	0.031	Y	NA	1.00E+00	1.00E-03
Cobalt	2 / 6	33	1.80E+00	J	2.00E+00	J	1.00E+00	1.00E+00	1.30E+00	0.47	Y	1.92E+00	1.92E+00	1.92E-03
Copper	1 / 6	17	2.30E+00	J	2.30E+00	J	1.00E+00	1.00E+00	1.22E+00	62	N (a)		---	
Iron	6 / 6	100	1.56E+02	J	3.64E+03		3.40E+01	3.40E+01	1.22E+03	1100	Y	2.32E+03	2.32E+03	2.32E+00
Lead	1 / 6	17	1.10E+00	J	1.10E+00	J	1.00E+00	1.00E+00	1.02E+00	15 [f]	N (a)		---	
Magnesium	6 / 6	100	3.48E+04		4.02E+04		5.00E+01	5.00E+01	3.84E+04	Nutrient	N (b)		---	
Manganese	6 / 6	100	3.73E+01		2.81E+02		1.00E+00	1.00E+00	1.73E+02	32	Y	2.51E+02	2.51E+02	2.51E-01
Nickel	1 / 6	17	1.50E+00	J	1.50E+00	J	1.00E+00	1.00E+00	1.08E+00	30	N (a)		---	
Potassium	6 / 6	100	1.85E+03	J	6.36E+03	J	5.00E+01	5.00E+01	3.61E+03	Nutrient	N (b)		---	
Selenium	2 / 6	33	3.00E+00	J	3.20E+00	J	2.00E+00	2.00E+00	2.37E+00	7.8	N (a)		---	
Sodium	6 / 6	100	2.13E+04		7.82E+04		7.50E+02	7.50E+02	3.97E+04	Nutrient	N (b)		---	
Zinc	2 / 6	33	5.00E+00	J	5.30E+00	J	1.00E+00	1.00E+00	2.38E+00	470	N (a)		---	
Semivolatile Organics														
Di-n-butyl phthalate	1 6	17	1.22E+00	J	1.22E+00	J	8.35E-01	8.50E-01	9.03E-01	67	N (a)		---	
General Chemistry														
Chloride	6 / 6	100	7.50E+03		1.18E+04		1.00E+03	2.00E+03	1.00E+04	Nutrient	N (b)		---	
Nitrate-Nitrite	1 / 6	17	2.80E+02		2.80E+02		5.00E+01	2.50E+04	2.80E+02	1000 [g]	N (a)		---	
Sulfate	6 / 6	100	7.07E+04		1.29E+05		1.00E+03	2.00E+03	9.49E+04	250,000 [h]	N (a)		---	

Table 2-4

Statistical Summary and Selection of Chemicals of Potential Concern in Overburden Monitoring Well Groundwater
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC - Chemical of potential concern.
EPC - Exposure-point concentration.
J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed.
MCL - Maximum contaminant level established in the Safe Drinking Water Act.
µg/L - Micrograms per liter.
mg/L - Milligrams per liter.
RBSC - Risk-based screening concentration.
VQ - Validation qualifier.

[a] Risk-Based Screening Concentrations based on EPA Regional Screening Level Table (May 2013) tap water values and are based on a risk level of 1.0E-06 and a hazard index of 0.1.
[b] N = Chemical is not chosen as a COPC:
(a) = Maximum detected concentration is less than the RBSC.
(b) = Essential nutrient.
[c] Y = Chemical is chosen as COPC.
[d] 95% UCL (Upper confidence limit) determined using ProUCL Version 4.1.01 (U.S. Environmental Protection Agency [EPA], 2011, Office of Research and Development, Las Vegas, Nevada, and Technology Support Center, Atlanta, GA, May, on line at http://www.epa.gov/esd/tsc/TSC_form.htm. Calculated only for COPCs.
[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.
[f] Screening criteria for lead based on the action level of 15 µg/L (U.S. Environmental Protection Agency [EPA], 2012 Edition of the Drinking Water Standards and Health Advisories, Office of Water, October, EPA 822-S-12-001).
[g] Because no Regional Screening Level exists for nitrate-nitrite, 0.1X the nitrate-nitrite MCL is used for screening.
[h] Source: EPA, 2012.

Table 3-1

Receptor/Exposure Scenarios
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Source Medium	Model	Exposure Medium	Exposure Route
Groundskeeper – Current			
Surface Soil	None	Soil	Incidental Ingestion
			Dermal Contact
	Dust Emissions Based on Activity	Ambient Air	Inhalation
	Volatilization from Soil	Ambient Air	Not Quantified[a]
Subsurface Soil	Not Quantified[b]		
Groundwater	Not Quantified[c]		
Groundskeeper – Future			
Total Soil[d]	NoneP	Soil	Incidental Ingestion
			Dermal Contact
	Dust Emissions Based on Activity	Ambient Air	Inhalation
	Volatilization from Soil	Ambient Air	Not Quantified[a]
Groundwater	None	Tap Water	Ingestion
			Dermal Contact
Indoor Worker – Future			
Surface Soil	None	Soil	Incidental Ingestion
			Dermal Contact[e]
	Dust Emissions; Volatilization	Indoor Air	Not Quantified[a]
Subsurface Soil	Not Quantified[a]		
Groundwater	None	Tap Water	Ingestion
			Dermal Contact
Construction Worker – Current/Future			
Total Soil[d]	None	Soil	Incidental Ingestion
			Dermal Contact
	Dust Emissions Based on Activity	Ambient Air	Inhalation
	Volatilization from Soil	Ambient Air	Not Quantified[a]
Groundwater	Not Quantified[e]		

Table 3-1

Receptor/Exposure Scenarios
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Source Medium	Model	Exposure Medium	Exposure Route
On-Site Resident – Future			
Total Soil[d]	None	Soil	Incidental Ingestion
			Dermal Contact
	Dust Emissions Based on Wind Erosion	Ambient Air	Inhalation
	Volatilization from Soil	Ambient Air	Not Quantified[a]
Subsurface Soil	Not Quantified[a]		
Groundwater	None	Tap Water	Ingestion
			Dermal Contact
	Volatilization from Water	Indoor Air	Not Quantified[a]
Hunter – Future			
Surface Soil	None	Soil	Incidental Ingestion
			Dermal Contact
	Dust Emissions, Volatilization	Ambient Air	Not Quantified[a,e]
	Biouptake	Venison	Venison Consumption
Subsurface Soil	Not Quantified[c]		
Hunter's Child – Future			
Surface Soil	Not Quantified[c]		
	Not Quantified[c]		
	Biouptake	Venison	Venison Consumption
Subsurface Soil	Not Quantified[c]		

COPC – Chemical of potential concern.

[a] No volatile COPCs were identified in soil or groundwater, as explained in the text.

[b] No COPCs were identified in subsurface soil, as explained in the text.

[c] There is no plausible pathway for exposure.

[d] Total soil represents a mixture of surface and subsurface soil and is evaluated for future scenarios where excavation and regrading is assumed to take place. Because no COPCs were identified in subsurface soil, exposures in these future scenarios are evaluated using surface soil COPC concentrations.

[e] Although contact with this medium may be possible, exposure would be sporadic, rather than continuous or predictable. Such exposures cannot be adequately evaluated under the chronic toxicity paradigm used in a baseline risk assessment.

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Groundskeeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter and Hunter's Child
General Variables Used in All Intake Models					
Body weight (BW), kg	70[a]	70[a]	Child: 15[a] Adult: 70[a]	70[a]	Child: 15[a] Adult: 70[a]
Averaging time, noncancer (AT), days[b]	9125	183	Child: 2190 Adult: 8760	9125	Child: 2190 Adult: 10950
Averaging time, cancer (AT), days[b]	25550	25550	25550	25550	25550
Inhalation of COPCs and Resuspended Dust from Surface Soil, Total Soil or Subsurface Soil					
Fraction exposed to contaminated medium (FI_a), unitless	1[c]	1[c]	0.8[c]	NA	NA
Inhalation rate (IR_a), m^3/day	20[d]	20[d]	Child: 10[e] Adult: 20[d]	NA	NA
Exposure frequency (EF), days/year	250[d]	250[f]	350[a]	NA	NA
Exposure duration (ED), years	25[a]	0.5[f]	Child: 6[a] Adult: 24[a]	NA	NA
Inhalation of VOCs in Indoor Air from Subsurface Soil – No VOCs are identified as COPCs in soil at the site					
Incidental Ingestion of Soil					
Fraction exposed to contaminated medium (FI_{so}), unitless	1[c]	1[c]	1[c]	1[c]	1[c]
Soil incidental ingestion rate (IR_{so}), mg/day	100[a]	330[a]	Child: 200[a] Adult: 100[a]	50[a]	Child: NA Adult: 100[a]
Exposure frequency (EF), days/year	250[d]	250[a]	350[a]	250[a]	14[d]
Exposure duration (ED), years	25[a]	0.5[f]	Child: 6[a] Adult: 24[a]	25[a]	30[a]

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Groundskeeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter and Hunter's Child
Dermal Contact with Soil					
Fraction exposed to contaminated medium (FI_{so}), unitless	1[c]	1[c]	1[c]	NA	1[c]
Body surface area exposed to soil (SA_{so}), cm^2	3,300[g]	3,300[g]	Child: 2,800[g] Adult: 5,700[g]	NA	Child: NA Adult: 3,300[g,h]
Soil-to-skin adherence factor (AF_{so}), mg/cm^2	0.2[g]	0.3[g]	Child: 0.2[g] Adult: 0.07[g]	NA	0.2[g,h]
Dermal absorption factor (ABS), unitless	csv	csv	csv	NA	csv
Exposure frequency (EF), days/year	250[d]	250[a]	350[a]	NA	14[h]
Exposure duration (ED), years	25[a]	0.5[f]	Child: 6[a] Adult: 24[a]	NA	30[a]
Inhalation of VOCs from Groundwater – No VOCs are identified as COPCs in groundwater at the site					
Drinking Water Ingestion of Groundwater					
Fraction exposed to contaminated medium (FI_{gw}), unitless	1[c]	NA	1[c]	1[c]	NA
Drinking water ingestion rate (IR_{gw}), L/day	1[d]	NA	Child: 1[e] Adult: 2[d]	1[d]	NA
Exposure frequency (EF), days/year	250[a]	NA	350[a]	250[a]	NA

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Groundskeeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter and Hunter's Child
Dermal Contact with Groundwater					
Fraction exposed to contaminated medium (Fl_{gw}), unitless	1[c]	NA	1[c]	1[c]	NA
Body surface area exposed to water (SA_{gw}), cm^2	3,300[j]	NA	Child: 6,600[i] Adult: 20,000[i]	3,300[j]	NA
Permeability coefficient (PC), cm/hour	csv	NA	csv	csv	NA
Exposure time (ET_{gw}), hours/day	1[c]	NA	Child: 0.33[i] Adult: 0.2[i]	1[c]	NA
Exposure frequency (EF), days/year	250[a]	NA	350[d]	250[a]	NA
Venison Consumption					
Venison ingestion rate (IR_v), kg/day	NA	NA	NA	NA	Child: 0.005[k] Adult: 0.013[h]
Exposure frequency (EF), days/year	NA	NA	NA	NA	350[a]
Exposure duration (ED), years	NA	NA	NA	NA	Child: 6[a] Adult: 30[l]

Note: No volatile COPCs are identified in soil or groundwater pathways at the site. All volatilization exposure pathways are incomplete.

[a] U.S. Environmental Protection Agency (EPA), 2002, *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, Office of Solid Waste and Emergency Response, Washington, DC, 9355.4-24, December.

[b] For noncancer evaluation, calculated as the product of ED (years) x 365 days/year; for cancer evaluation, calculated as the product of 70 years (assumed human lifetime) x 365 days/year. Source: U.S. Environmental Protection Agency (EPA), 1989a, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*, Interim Final, Office of Emergency and Remedial Response, Washington, D.C., EPA/540/1-89/002.

[c] Default value which assumes 100 percent of exposure is to contaminated medium. For the evaluation of airborne dust in the on-site residential scenario, it is assumed that 80 percent of the soil is covered with pavement or vegetation.

[d] U.S. Environmental Protection Agency (EPA), 1991a, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors*, Interim Final, Office of Solid Waste and Emergency Response, OSWER Directive: 9285.603.

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

[e] U.S. Environmental Protection Agency (EPA), 2004b, *User's Guide and Background Technical Document for Region 9 Preliminary Remediation Goals (PRG) Table*, Region 9, San Francisco, California, October, <http://www.epa.gov/region09/waste/sfund /prg/files/04usersguide.pdf>.
[f] Assumed; see Section 3.1.3.4 of text for explanation.
[g] U.S. Environmental Protection Agency (EPA), 2004a, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part E - Supplemental Guidance for Dermal Risk Assessment)*, Final, Office of Superfund Remediation and Technology Innovation, Washington, D.C., EPA/540/R-99/005, July.
[h] Please see Section 3.1.3.6 of text for detailed explanation.
[i] U.S. Environmental Protection Agency (EPA), 1997a, *Exposure Factors Handbook*, Final, National Center for Environmental Assessment, Washington, D.C., EPA/600/P-95/002Fa, August.
[j] Please see Section 3.1.3.3 of the text for detailed explanation.
[k] Please see Section 3.1.3.7 of text for detailed explanation.
[l] Assumes deer are hunted for 30-year duration.
csv – Chemical-specific value.
NA – Pathway not applicable for receptor.

Table 3-3

Physical Properties of Site-Related Chemicals[a]
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical of Potential Concern	Soil-to-forage Biotransfer Factor B_p (unitless)	Biotransfer Factor for Beef B_b (days/kg)	Biotransfer Factor for Venison B_v (unitless)	Diffusivity In Air (D_i) (cm^2/second)	Soil Organic Carbon-Water Partition Coefficient K_{oc} (cm^3/g)	log K_{ow}	Absorption Fraction ABS (unitless)	Permeability Coefficient K_p (cm/hour)	*tau* (hour/event)	*t** (hour)	Fraction Absorbed from Water FA (unitless)	B (unitless)	Molecular Weight (g/mole)	Henry's Law Constant (atm-m^3/mole)
Metals														
Antimony														
Arsenic	NA	NA	NA	NA	2.90E+01	NA	0.03	1.00E-03	NA	NA	NA	NA	74.92	NA
Chromium, Total	NA	NA	NA	NA	NA	NA	NA	1.00E-03	NA	NA	NA	NA	52	NA
Cobalt	NA	NA	NA	NA	4.50E+01	NA	NA	4.00E-04	NA	NA	NA	NA	58.93	NA
Iron	NA	NA	NA	NA	2.50E+01	NA	NA	1.00E-03	NA	NA	NA	NA	55.845	NA
Manganese	NA	NA	NA	NA	6.50E+01	NA	NA	1.00E-03	NA	NA	NA	NA	54.94	NA
Semivolatile Organic Compounds														
Benzo(a)pyrene	NA	NA	NA	4.30E-02	1.02E+06	6.10E+00	0.13	7.00E-01	2.69	11.67	1	4.3	252.3	4.57E-07
General Chemistry														
Nitrate-Nitrite	3.00E+01	NA	NA	NA	NA	NA	NA	1.00E-03	NA	NA	NA	NA	NA	NA

tau - Lag time associated with rate at which chemical crosses stratum corneum per event.
t* - Time for absorption across the stratum corneum to reach steady state ; equals 2.4 times tau.
atm-m^3 - Atmospheres per cubic meter.
B - Ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis.
cm - Centimeter.
g - Gram.
kg - Kilogram.

[a] See Appendix C, which provides references for these values.

Table 4-1

Summary of Toxicity Assessment [a]
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical of Potential Concern	GAF	Weight of Evidence	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight of Evidence	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$
Metals							
Antimony	0.15	D	NA	NA	NA	NA	NA
Arsenic	1	A	1.50E+00	1.50E+00	A	4.30E-03	1.50E+01
Chromium, Total	0.013	D	NA	NA	A	1.20E-02	4.20E+01
Cobalt	1	ND	NA	NA	B	9.00E-03	3.20E+01
Iron	1	ND	NA	NA	ND	NA	NA
Manganese	0.04	D	NA	NA	D	NA	NA
Semivolatile Organic Compounds							
Benzo(a)pyrene	1	B2	7.30E+00	7.30E+00	B2	8.80E-04	3.10E+00
General Chemistry							
Nitrate-Nitrite	NA	ND	NA	NA	NA	NA	NA

mg/kg-day - Milligrams per kilogram-day.
$\mu g/m^3$ - Milligrams per cubic meter.
GAF - Gastrointestinal absorption factor.
IRIS - Integrated Risk Information System evaluation (EPA, 2013).
NA - Not available or not applicable.
ND - No data or not determined.
[a] See Appendix C which provides references for these values.

Weight of Evidence (WOE) EPA Group:
A - Carcinogenic to humans
B - Likely to be carcinogenic to humans (includes both the former B1 and B2 probable human carcinogens as classified on IRIS)
C - Suggested evidence of carcinogenic potential
D - Inadequate evidence to assess carcinogenic potential

Table 4-1

Summary of Toxicity Assessment [a]
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Oral		Dermal	Reference	Inhalation	
		Reference Dose	Target	Reference Dose	Concentration	Reference Dose	Target
Chemical of Potential Concern	GAF	mg/kg-day	Organs	mg/kg-day	mg/m^3	mg/kg-day	Organs
Metals							
Antimony	0.15	4.00E-04	Heart	6.00E-05	NA	NA	NA
Arsenic	1	3.00E-04	S	3.00E-04	NA	NA	NA
Chromium, Total	0.013	2.10E-02	ND	2.70E-04	7.00E-04	2.03E-04	Lung
Cobalt	1	3.00E-04	Thyroid	3.00E-04	6.00E-06	1.70E-06	RT
Iron	1	7.00E-01	GI	NA	ND	NA	NA
Manganese	0.04	4.70E-02	CNS	1.90E-03	5.00E-05	1.40E-05	CNS
Semivolatile Organic Compounds							
Benzo(a)pyrene	1	ND	NA	NA	ND	NA	NA
General Chemistry							
Nitrate-Nitrite	NA	1.00E-01	E	1.00E-01	NA	NA	NA

mg/kg-day - Milligrams per kilogram-day.
$\mu g/m^3$ - Milligrams per cubic meter.
GAF - Gastrointestinal absorption factor.
IRIS - Integrated Risk Information System evaluation (EPA, 2013).
NA - Not available or not applicable.
ND - No data or not determined.
[a] See Appendix C which provides references for these values.

Target Organs: E - Erythrocytes; S - Skin; GI - Gastrointestinal; CNS - Central nervous system; RT - Respiratory tract.

Table 5-1

Summary of Risk for All Receptors
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Groundskeeper [a]		Construction Worker		Indoor Worker		Resident			Hunter		Hunter's Child	
	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR	Total Adult - HI	Total Child - HI	Total ILCR	Total HI	Total ILCR	Total HI
Exposure Media													
Surface Soil	1.22E-07	NA	NE	NE	3.28E-08	NA	NE	NE	NE	8.19E-09	NA	NA	NA
Total Soil	1.22E-07	NA	6.05E-09	NA	NE	NE	3.85E-07	NA	NA	NE	NE	NE	NE
Overburden Groundwater	2.27E-05	0.348	NE	NE	2.27E-05	0.348	9.66E-05	0.968	2.26	NE	NE	NE	NE
Total ILCR or HI	**2.E-05**	**0.3**	**6.E-09**	**NA**	**2.E-05**	**0.3**	**1.E-04**	**1**	**2**	**8.E-09**	**NA**	**NA**	**NA**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - Not applicable.
NE - Pathway not evaluated for this receptor.

Note:
[a]Total ILCR and total HI values for the groundskeeper reflect the respective totals for the future groundskeeper assumed to use overburden groundwater. The total ILCR and HI values for the current groundskeeper are simply those shown for surface soil. The rounded current groundskeeper ILCR is 1E-7.

Table 5-2

Summary of Risk for Receptors Excluding Exposure to Groundwater
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Future Groundskeeper		Indoor Worker		Resident		
	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR	Total Adult - HI	Total Child - HI
Exposure Media							
Surface Soil	NE	NE	3.28E-08	NA	NE	NE	NE
Total Soil	1.22E-07	NA	NE	NE	3.85E-07	NA	NA
Total ILCR or HI	**1.E-07**	**NA**	**3.E-08**	**NA**	**4.E-07**	**NA**	**NA**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - Not applicable.
NE - Pathway not evaluated for this receptor.

Notes:
1. The above receptors are those that were evaluated for groundwater exposure as shown in Table 5-1. The above total ILCR and HI estimates exclude the groundwater component of the total ILCR and HI values shown in Table 5-1 .
2. Groundwater use is not regarded as unlikely because of low yield in the area and readily available municipal water supply. Also, NASA legal counsel expressed the intention of adding explicit restrictions against groundwater use to the Plum Brook Station (PBS) Master Plan

Table 5-3

Summary of Noncancer Hazard to Target Organs for the On-Site Resident Child Potentially Exposed to Groundwater Unloading Area Former Plum Brook Ordnance Works, Sandusky, Ohio

Target Organ	Target Organ HI
Heart	**0.4**
Skin	**0.9**
Thyroid	**0.4**
Gastrointestinal Tract	**0.2**
Central Nervous System	**0.4**

Notes:
1. Target organs for toxicity by groundwater COPCs are described in Table 4-1.
2. Calculation of Target Organ Hazard values is described in Appendix D, Table D-15
COPC - Chemical of potential concern.
HI - Hazard index.

FIGURES

FIGURE 1-1
PBOW VICINITY MAP

UNLOADING AREA BASELINE HUMAN HEALTH RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

gma_ula_bhhra_001.dgn cbentley 8/22/2013 2:11:23 PM pdf_with_levels.plt SEI_TEXTSUB_ONLY.TBL

NOTES:

1. SNAKE ROAD BURNING GROUND AREA WAS ALSO REFERRED TO AS "SNAKE ROAD BURN PIT", "SCHEID ROAD BURNING GROUNDS", AND "DISPOSAL AREA THREE".
2. FORMER REACTOR FACILITY CONSTRUCTED BY NASA POST WWII AND IS IDENTIFIED FOR LOCATION PURPOSES ONLY. DEMOLITION OF THE REACTOR WAS COMPLETED BY NASA IN 2012.

LEGEND:

- AREA OF CONCERN
- APPROXIMATE LOCATION OF SEWER LINES
- POND
- CREEK, DITCH, CONVEYANCE
- FORMER RAILROAD
- ROAD
- FENCE
- FACILITY BOUNDARY

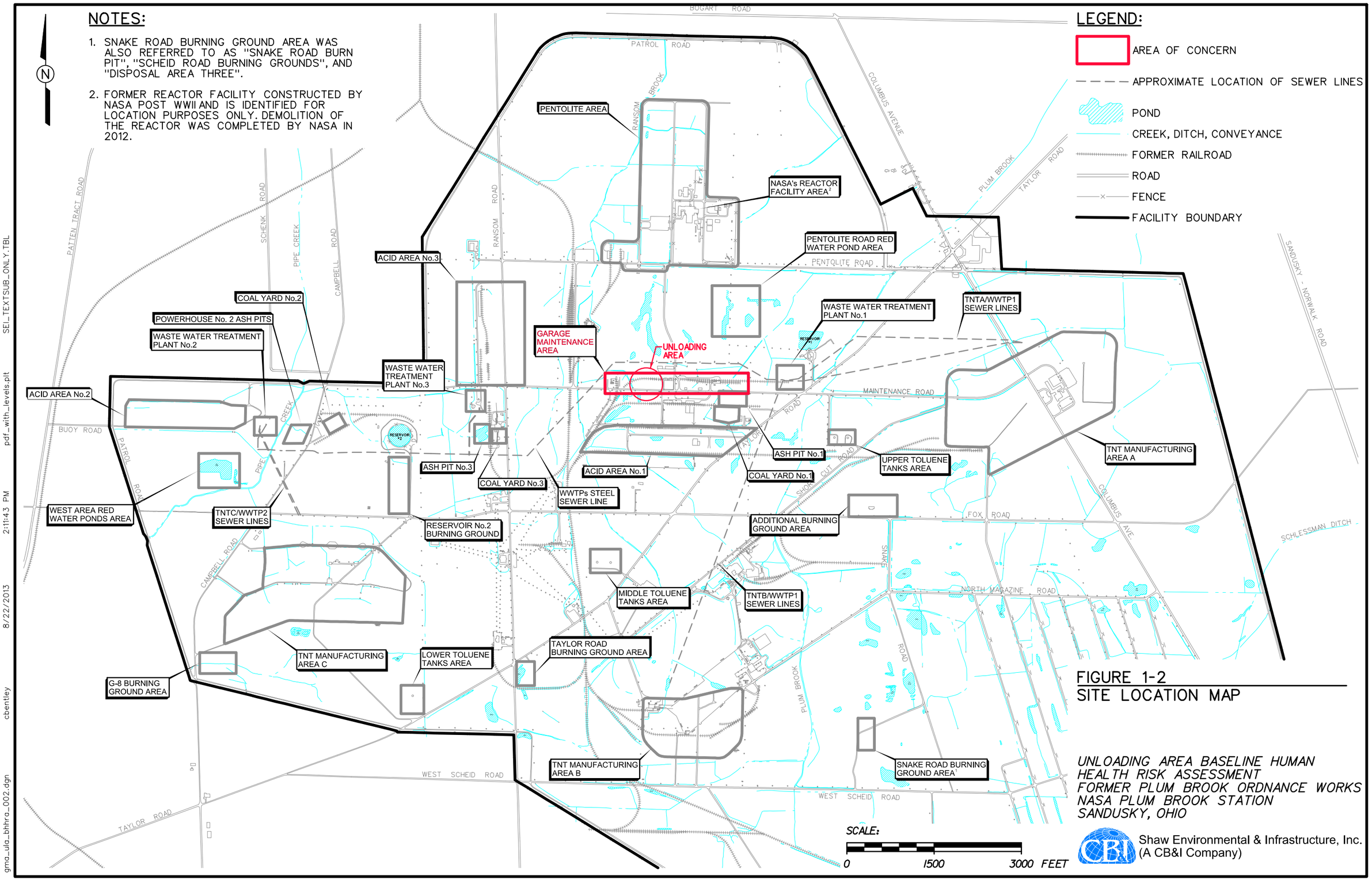
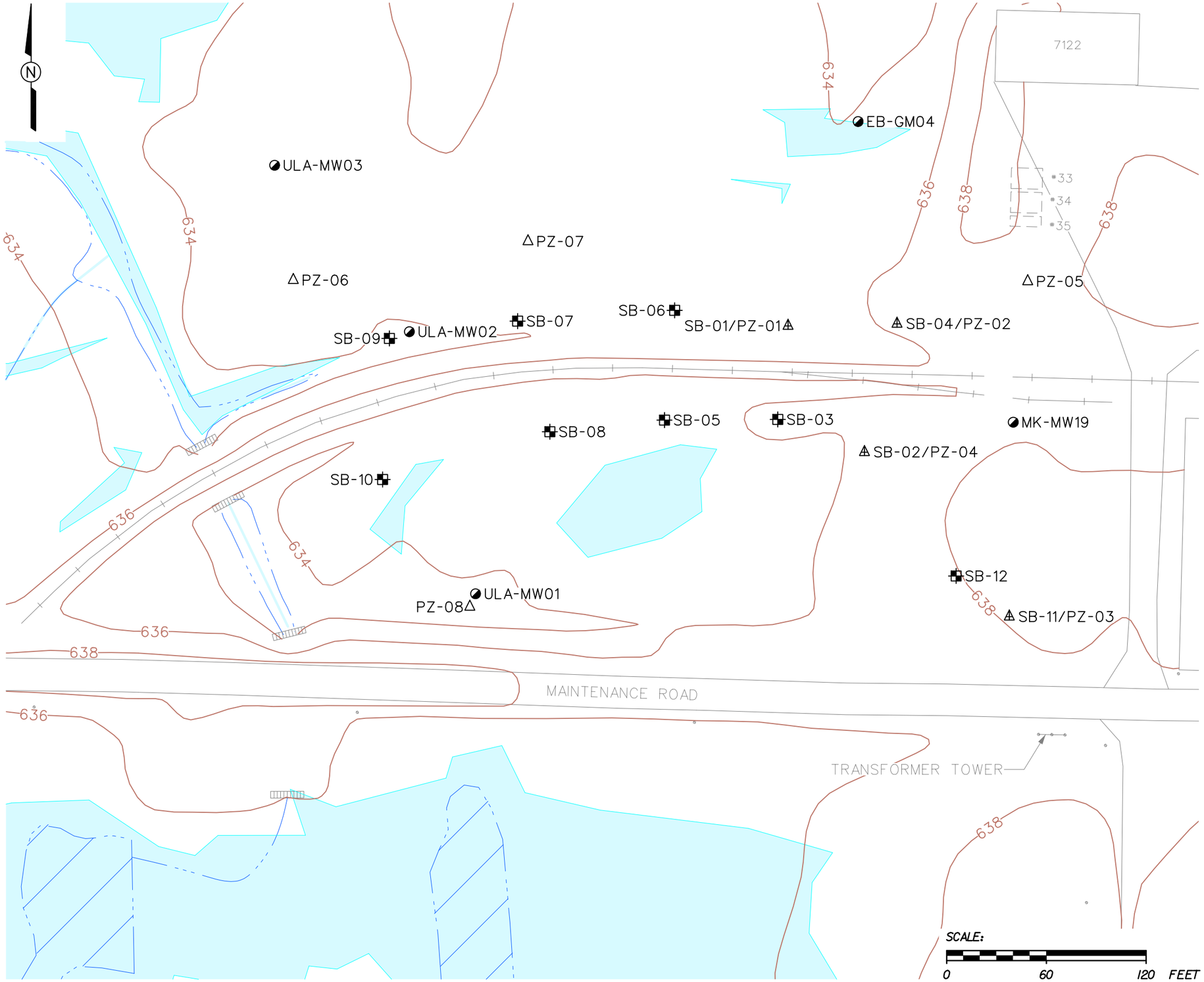


FIGURE 1-2
SITE LOCATION MAP

UNLOADING AREA BASELINE HUMAN HEALTH RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

gma_ula_bhhra_002.dgn cbentley 8/22/2013 2:11:43 PM pdf_with_levels.plt SEL_TEXTSUB_ONLY.TBL



LEGEND:

- POND
- CREEK, DITCH, CONVEYANCE
- LINEAR WATERWAY (ENVIROSCIENCE, 2012) (NOTE 1)
- WETLAND AREA (ENVIROSCIENCE, 2012) (NOTE 1)
- FORMER RAILROAD
- ROAD
- FORMER UNDERGROUND STORAGE TANK (NOTE 2)
- OVERBURDEN MONITORING WELL
- SOIL BORING
- SOIL BORING / PIEZOMETER
- PIEZOMETER
- 634 TOPOGRAPHIC CONTOUR (2 FT. INTERVAL)

NOTES:

1. THE LINEAR WATERWAYS AND WETLAND AREAS ARE PRELIMINARY IN NATURE, AND ARE PENDING APPROVAL BY THE UNITED STATES ARMY CORPS OF ENGINEERS. THEREFORE, THEY DO NOT REPRESENT JURISDICTIONAL WETLANDS, AND ARE PRESENTED FOR INFORMATIONAL PURPOSES ONLY.
2. UNDERGROUND STORAGE TANKS #33, #34, AND #35 REMOVED IN 1989.

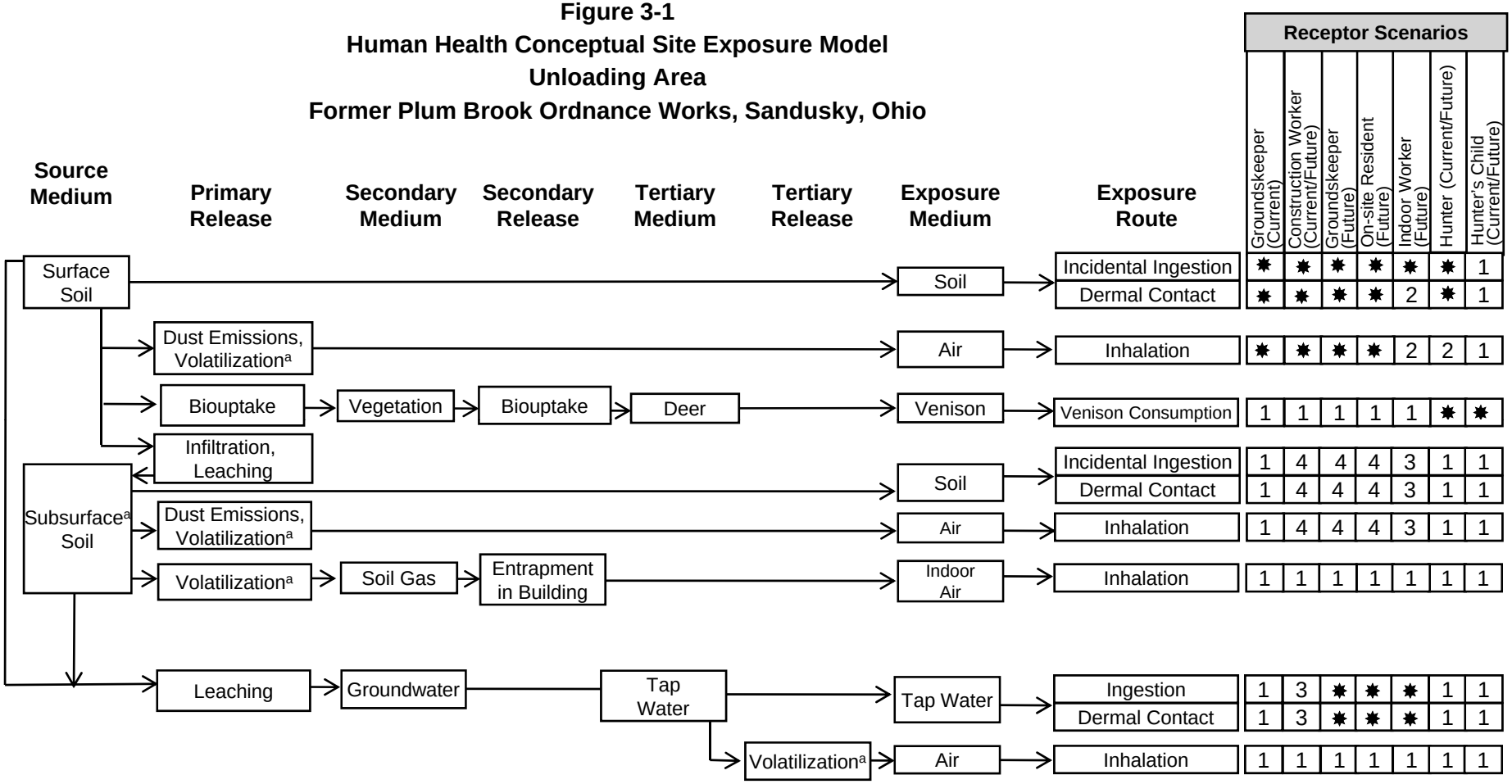
FIGURE 1-3
GENERAL SITE FEATURES OF THE UNLOADING AREA WITH SITE TOPOGRAPHY AND SAMPLING LOCATIONS

UNLOADING AREA BASELINE HUMAN HEALTH RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

gma_ula_bhhra_003.dgn cbentley 1/6/2014 5:31:01 PM pdf_with_levels.plt SEL_TEXTSUB_ONLY.TBL

Figure 3-1
Human Health Conceptual Site Exposure Model
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio



Exposure Route	Groundskeeper (Current)	Construction Worker (Current/Future)	Groundskeeper (Future)	On-site Resident (Future)	Indoor Worker (Future)	Hunter (Current/Future)	Hunter's Child (Current/Future)
Incidental Ingestion	✸	✸	✸	✸	✸	✸	1
Dermal Contact	✸	✸	✸	✸	2	✸	1
Inhalation	✸	✸	✸	✸	2	2	1
Venison Consumption	1	1	1	1	1	✸	✸
Incidental Ingestion	1	4	4	4	3	1	1
Dermal Contact	1	4	4	4	3	1	1
Inhalation	1	4	4	4	3	1	1
Inhalation	1	1	1	1	1	1	1
Ingestion	1	3	✸	✸	✸	1	1
Dermal Contact	1	3	✸	✸	✸	1	1
Inhalation	1	1	1	1	1	1	1

[a] No volatile COPCs were identified in soil or groundwater at the site and no COPCs were identified in subsurface soil.
✸ = Complete exposure route quantified in the risk assessment.
1 = There is no plausible pathway for exposure to this medium.
2 = Although theoretically complete, this pathway is not quantified as explained in text.
3 = For current use there is no plausible exposure pathway. For future use, the pathway is potentially complete, but is not quantified as explained in the text.
4 = No COPCs were identified in subsurface soil. Exposures to combined surface and subsurface soil (total soil) are evaluated using surface soil concentrations as explained in the text.

APPENDIX A

DATA SUMMARY OF CHEMICALS DETECTED IN OVERBURDEN GROUNDWATER PIEZOMETERS

Table A-1

Summary of Piezometer Groundwater Samples for Risk Screening
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Analyses
Piezometer [a]				
ULA-PZ01	ULA3000	REG	16-Jun-11	Field Tests, SVOC, VOC
ULA-PZ01	ULA3001	FD	16-Jun-11	VOC
ULA-PZ02	ULA3003	REG	17-Jun-11	Field Tests, SVOC, VOC
ULA-PZ03	ULA3004	REG	17-Jun-11	Explosives, Field Tests, SVOC, VOC
ULA-PZ04	ULA3005	REG	20-Jun-11	Explosives, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
ULA-PZ05	ULA3006	REG	17-Jun-11	Field Tests, Gen Chem, Metals (f & uf), SVOCs, VOCs
ULA-PZ06	ULA3007	REG	16-Jun-11	Field Tests, SVOC, VOC
ULA-PZ07	ULA3008	REG	16-Jun-11	Explosives, Field Tests, SVOC, VOC
ULA-PZ08	ULA3009	REG	17-Jun-11	Explosives, Field Tests, SVOC, VOC

[a] These samples are summarized and screened, but no exposure calculations are presented.

f & uf - Filtered and unfiltered.
FD - Field duplicate; averaged with the regular (REG) sample at the same location to create one result.
Gen Chem - General chemistry.
REG - Regular sample.
SVOC - Semivolatile organic compounds.
VOC - Volatile organic compounds.

Table A-2

Summary and Screening of Chemicals Detected in Overburden Groundwater Piezometers
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent hits	Range of values, µg/L: Detected Concentrations Minimum	VQ	Maximum	VQ	Reporting Limits Minimum	Maximum	Arithmetic Mean µg/L	BSC [a] µg/L	RBSC [b] µg/L		Exceeds BSC? [c,d]	Exceeds RBSC? [c,d]
Inorganics														
Aluminum	2 / 2	100	2.03E+03		7.82E+03	J	2.00E+01	2.40E+01	4.93E+03	3.09E+02	1.60E+03		Y	Y
Arsenic	2 / 2	100	9.80E+00	J	2.59E+01		1.00E+00	1.00E+00	1.79E+01	7.40E+00	4.50E-02		Y	Y
Barium	2 / 2	100	1.94E+02	J	2.76E+02		1.00E+00	4.00E+00	2.35E+02	1.18E+04	2.90E+02		N	N
Calcium	2 / 2	100	9.07E+04		2.21E+05	J	5.00E+01	5.00E+01	1.56E+05	3.16E+05	Nutrient		N	N
Chromium	2 / 2	100	4.10E+00	J	1.33E+01		1.00E+00	1.00E+00	8.70E+00	NA	3.10E-02		NA	Y
Cobalt	2 / 2	100	1.90E+00	J	1.00E+01	J	1.00E+00	1.00E+00	5.95E+00	1.21E+01	4.70E-01		N	Y
Copper	2 / 2	100	6.70E+00	J	2.76E+01		1.00E+00	1.00E+00	1.72E+01	1.98E+01	6.20E+01		Y	N
Iron	2 / 2	100	4.22E+03		2.89E+04	J	2.30E+01	3.40E+01	1.66E+04	1.55E+03	1.10E+03		Y	Y
Lead	2 / 2	100	2.20E+00	J	1.65E+01		1.00E+00	1.00E+00	9.35E+00	NA	1.50E+01	e	NA	Y
Magnesium	2 / 2	100	3.43E+04		7.10E+04	J	5.00E+01	5.00E+01	5.27E+04	2.17E+05	Nutrient		N	N
Manganese	2 / 2	100	8.58E+02		9.47E+02	J	1.00E+00	1.00E+00	9.03E+02	6.36E+02	3.20E+01		Y	Y
Mercury	1 / 2	50	1.40E-01	J	1.40E-01	J	7.10E-02	7.10E-02	1.06E-01	NA	6.30E-02		NA	Y
Nickel	2 / 2	100	5.80E+00	J	2.58E+01	J	1.00E+00	1.00E+00	1.58E+01	8.60E+00	3.00E+01		Y	N
Potassium	2 / 2	100	3.81E+03	J	7.57E+03	J	5.00E+01	5.00E+01	5.69E+03	1.16E+05	Nutrient		N	N
Selenium	1 / 2	50	2.10E+00	J	2.10E+00	J	2.00E+00	2.00E+00	2.05E+00	NA	7.80E+00		NA	N
Sodium	2 / 2	100	1.49E+04		4.27E+04		7.50E+02	8.50E+02	2.88E+04	1.39E+06	Nutrient		N	N
Vanadium	2 / 2	100	5.30E+00	J	2.06E+01	J	1.00E+00	1.00E+00	1.30E+01	NA	6.30E+00		NA	Y
Zinc	2 / 2	100	2.99E+01		7.19E+01	J	1.00E+00	1.00E+00	5.09E+01	5.01E+02	4.70E+02		N	N
Volatile Organics														
Trichloroethane, 1,1,1-	1 / 8	13	7.90E+00		7.90E+00		2.00E-01	2.00E-01	1.16E+00		7.50E+02		NA	N
General Chemistry														
Chloride	1 / 1	100	7.10E+03		7.10E+03		1.00E+03	1.00E+03	7.10E+03		Nutrient		NA	N
Sulfate	1 / 1	100	9.48E+04	J	9.48E+04	J	1.00E+03	1.00E+03	9.48E+04		2.50E+05	f	NA	N

µg/L - Micrograms per liter.
BSC - Background screening concentration.
RBSC - Risk-based screening concentration.
VQ - Validation qualifier.
J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed.

[a] Shaw Environmental, Inc. (Shaw), 2005, *2004 Groundwater Data Summary and Evaluation Report, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio* , April.
[b] Risk-Based Screening Concentrations based on EPA Regional Screening Level Table (May 2013) tap water values and are based on a risk level of 1.0E-06 and a hazard index of 0.1.
[c] N - Chemical concentration does not exceed the criterion, or is an essential nutrient.
[d] Y - Chemical concentration exceeds the criterion.
[e] Screening criteria for lead based on the action level of 15 µg/L (EPA, 2009, *Drinking Water Regulations and Health Advisories* , Office of Water, Washington, D.C., October).
[f] U.S. Environmental Protection Agency (EPA), 2009, *2009 Edition of the Drinking Water Standards and Health Advisories* , Office of Water, October.

APPENDIX B

ProUCL OUTPUT FOR UPPER CONFIDENCE LIMITS ON THE MEAN

Table B-1

Input Data for Chemical of Potential Concern Concentrations in Surface Soil Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

SAMPLE LOCATION	SAMPLE NUMBER	Benzo(a)pyrene	D_Benzo(a)pyrene
ULA-SB01	ULA0001	0.021	0
ULA-SB03	ULA0005	0.028	0
ULA-SB04	ULA0006	0.02	0
ULA-SB05	ULA0007	0.0239	1
ULA-SB06	ULA0008	0.022	0
ULA-SB07	ULA0009	0.021	0
ULA-SB08	ULA0010	0.02	0
ULA-SB09	ULA0011	0.02	0
ULA-SB10	ULA0012	0.018	0
ULA-SB11	ULA0013	0.0241	1
ULA-SB12	ULA0014	0.0308	1
ULA-SB02	ULA0002/ULA0003 [b]	0.0205	0

D - Indicates code identifying detected concentration (1) or undetected concentration (0). Value of undetected concentration equated to the reporting limit for the chemical in the sample.

[a] All concentrations reported in units of milligrams per kilogram.

[b] Average of regular (REG) and field duplicate (FD) sample concentrations.

Table B-2

General Upper Confidence Limit Statistics for Data Sets with Nondetects for Surface Soil Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(a)pyrene

General Statistics

Number of Valid Data	12	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	9
		Percent Non-Detects	75.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0239	Minimum Detected	-3.734
Maximum Detected	0.0308	Maximum Detected	-3.48
Mean of Detected	0.0263	Mean of Detected	-3.647
SD of Detected	0.00393	SD of Detected	0.144
Minimum Non-Detect	0.018	Minimum Non-Detect	-4.017
Maximum Non-Detect	0.028	Maximum Non-Detect	-3.576

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	11
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	1
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	91.67%

Warning: There are only 3 Distinct Detected Values in this data set

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

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

Table B-2

General Upper Confidence Limit Statistics for Data Sets with Nondetects for Surface Soil Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Benzo(a)pyrene

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.772	Shapiro Wilk Test Statistic	0.775
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0145	Mean	-4.328
SD	0.00738	SD	0.428
95% DL/2 (t) UCL	0.0183	95% H-Stat (DL/2) UCL	0.0189
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.989
		SD in Log Scale	0.23
		Mean in Original Scale	0.019
		SD in Original Scale	0.00487
		95% t UCL	0.0215
		95% Percentile Bootstrap UCL	0.0213
		95% BCA Bootstrap UCL	0.0218
		95% H-UCL	0.0216
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	N/A	**Data appear Normal at 5% Significance Level**	
Theta Star	N/A		
nu star	N/A		

Table B-2

General Upper Confidence Limit Statistics for Data Sets with Nondetects for Surface Soil Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL (Use when n >= 40)	N/A
95% Adjusted Gamma UCL (Use when n < 40)	N/A

Note: DL/2 is not a recommended method.

Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	0.0245
SD	0.0019
SE of Mean	0.0006726
95% KM (t) UCL	0.0257
95% KM (z) UCL	0.0256
95% KM (jackknife) UCL	0.0254
95% KM (bootstrap t) UCL	0.0421
95% KM (BCA) UCL	0.0308
95% KM (Percentile Bootstrap) UCL	N/A
95% KM (Chebyshev) UCL	0.0274
97.5% KM (Chebyshev) UCL	0.0287
99% KM (Chebyshev) UCL	0.0312
Potential UCLs to Use	
95% KM (t) UCL	0.0257
95% KM (Percentile Bootstrap) UCL	N/A

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table B-3

Input Data for Chemical of Potential Concern Concentrations in Overburden Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

SAMPLE LOCATION	SAMPLE NUMBER	Antimony	D_Antimony	Arsenic	D_Arsenic	Chromium	D_Chromium	Cobalt	D_Cobalt	Iron	D_Iron	Manganese	D_Manganese
ULA-MW01	ULA3010/ULA3011 [b]	1	0	1	0	1	1	1	0	404	1	123.5	1
ULA-MW02	ULA3013	2.3	1	2.1	1	1	0	1.8	1	1710	1	281	1
ULA-MW03	ULA3014	1	0	1	0	1	0	1	0	228	1	37.3	1
ULA-MW01	ULA3015/ULA3016 [b]	1	0	1	0	1	0	1	0	1200	1	186	1
ULA-MW02	ULA3018	1	0	5.8	1	1	0	2	1	3640	1	275	1
ULA-MW03	ULA3019	2	1	1	0	1	0	1	0	156	1	138	1

D - indicates code identifying detected concentration (1) or undetected concentration (0). Value of undetected concentration equated to the reporting limit for the chemical in the sample.

[a] All concentrations reported in units of micrograms per liter.

[b] Average of regular (REG) and field duplicate (FD) sample concentrations.

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

User Selected Options

From File	ProUCL GW COPCs input.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	6	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	4
		Percent Non-Detects	66.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2	Minimum Detected	0.693
Maximum Detected	2.3	Maximum Detected	0.833
Mean of Detected	2.15	Mean of Detected	0.763
SD of Detected	0.212	SD of Detected	0.0988
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Antimony

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.05	Mean	-0.208
SD	0.857	SD	0.753
95% DL/2 (t) UCL	1.755	95% H-Stat (DL/2) UCL	3.314
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% t UCL	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
		95% H-UCL	N/A
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	N/A	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	2.05
5% K-S Critical Value	N/A	SD	0.112
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0645
		95% KM (t) UCL	2.18
Assuming Gamma Distribution		95% KM (z) UCL	2.156
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	N/A
Minimum	N/A	95% KM (bootstrap t) UCL	N/A
Maximum	N/A	95% KM (BCA) UCL	N/A
Mean	N/A	95% KM (Percentile Bootstrap) UCL	N/A
Median	N/A	95% KM (Chebyshev) UCL	2.331
SD	N/A	97.5% KM (Chebyshev) UCL	2.453
k star	N/A	99% KM (Chebyshev) UCL	2.692
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	95% KM (t) UCL	2.18
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Arsenic

General Statistics

Number of Valid Data	6	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	4
		Percent Non-Detects	66.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2.1	Minimum Detected	0.742
Maximum Detected	5.8	Maximum Detected	1.758
Mean of Detected	3.95	Mean of Detected	1.25
SD of Detected	2.616	SD of Detected	0.718
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Arsenic

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.65	Mean	-0.0455
SD	2.131	SD	1.054
95% DL/2 (t) UCL	3.403	95% H-Stat (DL/2) UCL	12.72
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% t UCL	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
		95% H-UCL	N/A

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A
Data not Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Data Distribution Test with Detected Values Only
Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	2.717
SD	1.379
SE of Mean	0.796
95% KM (t) UCL	4.321
95% KM (z) UCL	4.026
95% KM (jackknife) UCL	N/A
95% KM (bootstrap t) UCL	N/A
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	N/A
95% KM (Chebyshev) UCL	6.187
97.5% KM (Chebyshev) UCL	7.688
99% KM (Chebyshev) UCL	10.64
Potential UCLs to Use	
95% KM (t) UCL	4.321
95% KM (% Bootstrap) UCL	N/A

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Chromium

General Statistics

Number of Valid Data	6	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	5
		Percent Non-Detects	83.33%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Chromium was not processed!

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Cobalt

General Statistics

Number of Valid Data	6	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	4
		Percent Non-Detects	66.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.8	Minimum Detected	0.588
Maximum Detected	2	Maximum Detected	0.693
Mean of Detected	1.9	Mean of Detected	0.64
SD of Detected	0.141	SD of Detected	0.0745
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Cobalt

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.967	Mean	-0.249
SD	0.726	SD	0.689
95% DL/2 (t) UCL	1.564	95% H-Stat (DL/2) UCL	2.606
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% t UCL	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
		95% H-UCL	N/A

Gamma Distribution Test with Detected Values Only

Data Distribution Test with Detected Values Only

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)
Theta Star	N/A	
nu star	N/A	
A-D Test Statistic	N/A	Nonparametric Statistics
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method
K-S Test Statistic	N/A	Mean 1.833
5% K-S Critical Value	N/A	SD 0.0745
Data not Gamma Distributed at 5% Significance Level		SE of Mean 0.043
		95% KM (t) UCL 1.92
Assuming Gamma Distribution		95% KM (z) UCL 1.904
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL N/A
Minimum	N/A	95% KM (bootstrap t) UCL N/A
Maximum	N/A	95% KM (BCA) UCL N/A
Mean	N/A	95% KM (Percentile Bootstrap) UCL N/A
Median	N/A	95% KM (Chebyshev) UCL 2.021
SD	N/A	97.5% KM (Chebyshev) UCL 2.102
k star	N/A	99% KM (Chebyshev) UCL 2.262
Theta star	N/A	
Nu star	N/A	Potential UCLs to Use
AppChi2	N/A	95% KM (t) UCL 1.92
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL N/A
95% Adjusted Gamma UCL	N/A	

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Iron

General Statistics

Number of Valid Observations	6	Number of Distinct Observations	6

Raw Statistics		Log-transformed Statistics	
Minimum	156	Minimum of Log Data	5.05
Maximum	3640	Maximum of Log Data	8.2
Mean	1223	Mean of log Data	6.536
Median	802	SD of log Data	1.234
SD	1333		
Std. Error of Mean	544		
Coefficient of Variation	1.09		
Skewness	1.456		

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Iron

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.837	Shapiro Wilk Test Statistic	0.947
Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2319	95% H-UCL	22550
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3871
95% Adjusted-CLT UCL (Chen-1995)	2463	97.5% Chebyshev (MVUE) UCL	5010
95% Modified-t UCL (Johnson-1978)	2373	99% Chebyshev (MVUE) UCL	7247

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Gamma Distribution Test

k star (bias corrected)	0.614
Theta Star	1991
MLE of Mean	1223
MLE of Standard Deviation	1561
nu star	7.37
Approximate Chi Square Value (.05)	2.376
Adjusted Level of Significance	0.0122
Adjusted Chi Square Value	1.484
Anderson-Darling Test Statistic	0.28
Anderson-Darling 5% Critical Value	0.715
Kolmogorov-Smirnov Test Statistic	0.22
Kolmogorov-Smirnov 5% Critical Value	0.341

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	3794
95% Adjusted Gamma UCL	6076

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	2118
95% Jackknife UCL	2319
95% Standard Bootstrap UCL	2035
95% Bootstrap-t UCL	2992
95% Hall's Bootstrap UCL	5832
95% Percentile Bootstrap UCL	2136
95% BCA Bootstrap UCL	2287
95% Chebyshev(Mean, Sd) UCL	3594
97.5% Chebyshev(Mean, Sd) UCL	4620
99% Chebyshev(Mean, Sd) UCL	6636

Potential UCL to Use

Use 95% Student's-t UCL 2319

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Manganese

General Statistics

Number of Valid Observations 6

Number of Distinct Observations 6

Raw Statistics

Minimum	37.3
Maximum	281
Mean	173.5
Median	162
SD	94.15
Std. Error of Mean	38.44
Coefficient of Variation	0.543
Skewness	-0.144

Log-transformed Statistics

Minimum of Log Data	3.619
Maximum of Log Data	5.638
Mean of log Data	4.974
SD of log Data	0.746

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Table B-4

General Upper Confident Limit Statistics for Data Sets with Nondetects for Groundwater Samples
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Manganese

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.934
Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	250.9

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	234.3
95% Modified-t UCL (Johnson-1978)	250.5

Gamma Distribution Test

k star (bias corrected)	1.562
Theta Star	111.1
MLE of Mean	173.5
MLE of Standard Deviation	138.8
nu star	18.74
Approximate Chi Square Value (.05)	9.931
Adjusted Level of Significance	0.0122
Adjusted Chi Square Value	7.725
Anderson-Darling Test Statistic	0.346
Anderson-Darling 5% Critical Value	0.702
Kolmogorov-Smirnov Test Statistic	0.198
Kolmogorov-Smirnov 5% Critical Value	0.335

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	327.4
95% Adjusted Gamma UCL	420.9

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.863
Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL	575.6
95% Chebyshev (MVUE) UCL	419.8
97.5% Chebyshev (MVUE) UCL	523.1
99% Chebyshev (MVUE) UCL	726

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	236.7
95% Jackknife UCL	250.9
95% Standard Bootstrap UCL	231.4
95% Bootstrap-t UCL	255.1
95% Hall's Bootstrap UCL	257
95% Percentile Bootstrap UCL	235.9
95% BCA Bootstrap UCL	229.9
95% Chebyshev(Mean, Sd) UCL	341
97.5% Chebyshev(Mean, Sd) UCL	413.5
99% Chebyshev(Mean, Sd) UCL	555.9

Potential UCL to Use

Use 95% Student's-t UCL	250.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

APPENDIX C

TOXICOLOGICAL PROFILES

Introduction to the Toxicological Profiles

1.0 Purpose and Use of the Toxicological Profiles

Human health toxicological profiles are presented for each chemical of potential concern (COPC), each chemical for which documentation of chemical-specific values is required or about which there are chemical-specific issues that require resolution. The toxicological profiles provide documentation of the chemical-specific physical properties and toxicity values used in the risk assessment (RA). They also discuss the identity, classification and uses of the chemical, the common sources of release to the environment and the fate of the chemical in the environment, including the relevance of aquatic and terrestrial food-chain pathways to human health. A brief review of toxicokinetics discusses absorption, distribution, metabolism or biotransformation, excretion of the parent compound and metabolites, and mechanism of toxicity including identifying the ultimate toxicant – i.e., the moiety (parent chemical or metabolite) identified as most likely responsible for the adverse effects associated with the chemical. This information may be helpful to determine whether laboratory animals may serve as appropriate models for toxicity to humans, and to clarify the nature of toxicological interactions with other chemicals. A discussion of dermal exposure provides perspective on the significance of dermal uptake, and documents the development of dermal toxicity values and the extent or rate of dermal uptake from soil or water according to U.S. Environmental Protection Agency (EPA) (2004) guidance.

The noncancer effects evaluation and carcinogenicity evaluation provide an overall perspective on the nature of the adverse effects associated with the chemical, as well as documentation of the toxicity values. Chemical-specific issues or controversies that may influence the interpretation or application of the results of the RA are also discussed herein. The toxicity values used in the RA are summarized in a table.

The overall purpose of the toxicological profiles is to provide perspective on characteristics of each of the chemicals included in the RA so that the numerical risk estimates can be interpreted and applied wisely in the management of the site.

2.0 Chemical Identity

The identity of the chemical or chemical class is given in the title of each profile; additional information or clarification is provided in the *Introduction and Physical Properties* Section as required. The hyphenated number in parentheses following the chemical name is its unique Chemical Abstract Service (CAS) registration number. The CAS number may be located in the profile title, text, or in the case of multiple isomers or members of a chemical class, in the table that provides the physical properties.

3.0 Physical Properties

The toxicological profiles also provide documentation for the physical properties or constants that are important for chemical transport modeling, such as molecular weight (MW) in grams per mole (g/mole), the log of the octanol/water partition coefficient (log K_{ow}), Henry's Law constant (H) in atmosphere-cubic meters per mole (atm-m^3/mole), the soil/water partition coefficient (K_d) in liters per kilogram (L/kg) for metals, the log of the soil/organic carbon partition coefficient (log K_{oc}) (unitless) for organic chemicals, diffusivity in air (D_a) in square centimeters per second

(cm^2/s), diffusivity in water (D_w) in cm^2/s, vapor pressure (VP) in atmospheres (atm), solubility in water (S) in milligrams per liter (mg/L), and, for volatile organic compounds (VOC), boiling point of pure compound (T_b) in degrees Kelvin (°K), critical temperature (T_c) in °K, and enthalpy of vaporization at the boiling point ($\Delta H_{v,b}$) in calories per mole (cal/mol). Organic chemicals are designated as VOCs or semivolatile organic compounds (SVOC) based on their propensity to volatilize from environmental media. Chemicals designated as VOCs generally have an H greater than 1E-5 atm-m^3/mole (EPA, 2002).

The physical constants generally are taken from the most reliable source (i.e., the source that provides the highest level of documentation). Values for interrelated properties are usually taken from the same source (e.g., H is often estimated from VP and S; therefore, the same source is generally used for all three property values). When one source provides several values for a given property, professional judgment is used to select the most appropriate. Obvious outliers may be dropped from consideration. The average or the midpoint of a range of values may be selected. K_d values for metals and K_{oc} values for ionizing organic compound are based on a default pH of 6.8 (EPA, 2002) if the data are available. VP, S and H values are limited to those provided for normal ambient temperatures (0 to 30 °C) and the reference temperature is provided.

When values for H are not located, they are calculated as follows, provided the requisite information is available (EPA, 1998):

$$H = \frac{VP \bullet MW}{S}$$

where:

H	=	Henry's law constant (atm-m^3/mole, calculated)
VP	=	vapor pressure (atm)
MW	=	molecular weight (g/mole)
S	=	solubility in water (mg/L).

When values for K_{oc} are not located, they are calculated as follows for phthalates and polyaromatic aromatic hydrocarbons (PAH) provided log K_{ow} is available (EPA, 1998):

$$\log K_{oc} = 0.97 \log K_{ow} - 0.094$$

where:

K_{oc}	=	soil/organic carbon partition coefficient (unitless, calculated)
K_{ow}	=	octanol/water partition coefficient (unitless).

K_{oc} for other organic chemicals is calculated as follows provided log K_{ow} is available (EPA, 1998):

$$\log K_{oc} = 0.78 \log K_{ow} + 0.151$$

where:

K_{oc} = soil/organic carbon partition coefficient (unitless, calculated)
K_{ow} = octanol/water partition coefficient (unitless).

When values for D_a are not located, they are calculated as follows (EPA, 1998):

$$D_a = \frac{1.9}{MW^{2/3}}$$

where:

D_a = diffusivity in air (cm^2/s, calculated)
MW = molecular weight (g/mole).

When values for D_w are not located, they are calculated as follows (EPA, 1998):

$$D_w = \frac{22E{-}5}{MW^{2/3}}$$

where:

D_w = diffusivity in water (cm^2/s, calculated)
MW = molecular weight (g/mole).

Values for T_b, T_c and $\Delta H_{v,b}$ for VOCs are preferentially taken from EPA (2004), unless there is evidence that values provided by other sources (HSDB, 2013; NIST, 2013) are more reliable. If values are not located for these variables, they may be estimated by the most appropriate technique for the specific chemical or class to which it belongs as recommended by Lyman et al. (1990). The estimation method used is identified by footnote in the table of physical properties.

4.0 Environmental Release, Fate and Transport

The toxicological profiles also present the predominant sources of release to the environment as well as a qualitative or semi-quantitative description of the fate and transport of the chemical in air, water, sediment, and soil. No attempt is made to present detailed quantitative data because environmental fate is usually highly dependent on climatic conditions and the characteristics of the medium of interest, both of which may differ from location to location and change from time to time. The source and fate information may provide perspective regarding the likelihood that the chemical's presence is related to site activities, that the chemical will migrate across media, or that the chemical will persist at toxicologically significant levels.

Biotransfer factors are provided for chemicals for which food-chain pathways may be significant, which includes a few inorganic chemicals and those organic chemicals that are highly lipophilic, persist in the environment, and are resistant to metabolism by lower trophic organisms in the food chain. High lipophilicity is indicated by a log K_{ow} greater than 3 (Lyman et al., 1990). Lipophilicity enhances partitioning to biomedia and passage across biological

membranes. Persistence in the environment is evidence that the chemical might resist biotransformation and, therefore, remain in edible tissues at toxicologically significant concentrations. Toxicokinetic data, when available, clarify the potential for biotransfer. Biotransformation products may be more toxic than the parent compound, but they tend to be short-lived or more quickly removed from the body, reducing the likelihood of significant bioaccumulation. Similarly, VOCs tend to be mobile and labile (i.e., subject to rapid and extensive biotransformation and excretion), and generally do not participate significantly in food-chain pathways. Therefore, biotransfer factors are not estimated for VOCs, with few exceptions. Some SVOCs, however, are highly lipophilic and may persist. Biotransfer factors generally are not estimated unless empirical data suggest that participation in food-chain pathways is likely to be significant.

The biotransfer factors of interest are water-to-fish bioconcentration factors (BCF) or bioaccumulation factors (BAF), or biota-sediment accumulation factors (BSAF), soil-to-plant biotransfer factors (Bp), cattle ingestion-to-beef factors (Bb) and cattle ingestion-to-milk factors (Bm). Separate soil-to-plant biotransfer factors are available for the reproductive parts of plants (e.g., fruits, seeds) and the vegetative parts of plants (e.g., stems, leaves) for inorganic and some organic chemicals. Soil-to-plant factors for the reproductive parts of plants are designated Bpr; soil-to-plant factors for the vegetative parts of plants are designated Bpv.

Most chemicals in surface water bodies remain predominantly in the dissolved phase in the water column or partition to sediment, which generally settles to the bottom. The difference in concentration between surface water and sediment is usually upwards of an order of magnitude. Theoretically it is appropriate to evaluate biotransfer from both media, using BCF to quantify uptake from water and BSAF to quantify uptake from sediment. Quantification of biotransfer, however, is accompanied by considerable uncertainty and variability because field conditions cannot be readily duplicated in the laboratory where BCF values are generally measured. Therefore, the biotransfer models for either medium are intentionally designed to be very conservative to ensure protection of human health. Consequently, evaluating biotransfer from both water and sediment captures the conservatism of both models and is likely to grossly overestimate total biotransfer. Therefore, most chemicals with the potential to participate significantly in aquatic food chain pathways are evaluated for bioconcentration from surface water *or* bioaccumulation from sediment, depending on which pathway is expected to predominate, but not both.

BCF values are adopted from empirical data when the data are clearly the best choice (i.e., similar results in multiple species of fin fish). When the empirical data are few or inconsistent, BCFs for inorganic chemicals are taken from various sources. BCF values for organic chemicals are generally estimated from the Bintein and Devillers model (Devillers et al., 1996):

$$\log BCF = 0.910 \log K_{ow} - 1.975 \log(6.8E{-}7 K_{ow} + 1) - 0.786$$

where:

BCF = bioconcentration factor (L/kg, calculated)
K_{ow} = octanol/water partition coefficient (unitless).

The Bintein and Devillers model is selected over simpler models adopted by the EPA largely because the Bintein and Devillers approach has undergone scrutiny since first published (Bintein and Devillers, 1993), and considerable effort was expended to validate the model; i.e., to compare modeled and empirical results. The Bintein and Devillers model is probably more realistic than simpler models, particularly for chemicals with higher log K_{ow} values. BSAF values are chosen instead of BCFs for those very highly lipophilic chemicals such as the polychlorinated biphenyls (PCB), polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF) and selected organochlorine pesticides expected to partition almost entirely to benthic sediment.

Soil-to-plant biotransfer factors (Bp) for SVOCs are estimated by a simple model by Travis and Arms (1988), which is based only on log K_{ow}:

$$\log Bp = 1.588 - 0.578 \log K_{ow}$$

where:

Bp = soil-to-plant biotransfer factor (unitless, calculated)
K_{ow} = octanol/water partition coefficient (unitless).

Separate biotransfer factors are not estimated for the reproductive parts of plants (Bpr) and the vegetative parts of plants (Bpv) by the Travis and Arms model.

Cattle ingestion-to-beef factors (Bb) for SVOCs are estimated by a simple model by Travis and Arms (1988), which is based only on log K_{ow}:

$$\log Bb = -7.6 + \log K_{ow}$$

where:

Bb = cattle ingestion-to-beef biotransfer factor (days/kg, calculated)
K_{ow} = octanol/water partition coefficient (unitless).

Cattle ingestion-to-milk factors (Bm) for SVOCs are estimated by a simple model by Travis and Arms (1988), which is based only on log K_{ow}:

$$\log Bm = -8.10 + \log K_{ow}$$

where:

Bm = cattle ingestion-to-milk biotransfer factor (days/kg, calculated)
K_{ow} = octanol/water partition coefficient (unitless).

It should be understood that the biotransfer models described above depend only on one or two physical property values that are related largely to the propensity for transfer across biological membranes. Many compounds have relatively large log K_{ow} values, indicating ready passage across membranes; however, they are sufficiently volatile, or are otherwise mobile or labile so

they are unable to persist in biological tissues. For example, many constituents with high log K_{ow} values are efficiently metabolized by lower trophic organisms in the food chain so that significant human exposure does not occur. Such is the case for practically all VOCs and most SVOCs; relatively few compounds participate significantly in food-chain pathways. Therefore, biotransfer is evaluated as a potential pathway only for those chemicals with empirical data that indicate food-chain exposure could be significant.

5.0 Toxicokinetics

Toxicokinetics describes the uptake or absorption of the chemical from contact media, the distribution of the chemical (or its metabolites) within the body following absorption, the metabolism or biotransformation of the chemical, and the mechanisms of excretion of the parent compound and its biotransformation products from the body. The toxicokinetics section documents the gastrointestinal (GI) absorption factor (GAF) required to develop toxicity factors for dermal exposure, because dermal risk characterization depends on an absorbed dose rather than an exposure dose. The toxicokinetics section also identifies the compounds that are rapidly metabolized or eliminated, which justifies excluding their evaluation in food-chain pathways even though they may have a large K_{ow} that indicates ready passage across cell membranes. This section also tries to identify the ultimate toxicant and elucidate the most important mechanism(s) of toxicity.

6.0 Dermal Exposure

The toxicological profiles provide the documentation for the GAF, which is used to develop the dermal toxicity values. The toxicological profiles also provide documentation for the dermal absorption factor (ABS), which describes the extent of dermal uptake from soil, and the time for dermal uptake to reach steady state (t*), the permeability coefficient (K_p), the lag time for chemical to cross the stratum corneum (τ), the fraction absorbed (FA), and the ratio of the permeability coefficient for passage across the stratum corneum to the permeability coefficient for passage across the viable epidermis (B), all which are used to estimate the rate of dermal uptake from water. These values are taken from listings in EPA (2004) if available. Otherwise, they are estimated by the EPA (2004) methods.

7.0 Toxicity Evaluation

The toxicological profile contains a brief description of the nature of the adverse effects associated with the chemical. It is important to note that a discussion of adverse effects without a discussion of dose is incomplete and potentially misleading, because virtually any chemical may be toxic at some dose, and many chemicals (e.g., nutritionally required minerals, vitamins, amino acids, etc.) enhance human health at some low dose. An ever growing and compelling body of evidence suggests that many environmental contaminants also enhance health at low doses (Hart and Frame, 1996).

7.1 Noncancer Evaluation

The toxicity values for noncancer effects include a reference dose (RfD) expressed in milligrams per kilogram per day (mg/kg-day) for chronic or subchronic oral exposure, and a reference concentration (RfC), in milligrams per cubic meter (mg/m^3), for chronic or subchronic inhalation exposure. The inhalation RfC in units of mg/m^3 may be converted to an equivalent inhalation RfD by assuming continuous chronic exposure of humans with a body weight of 70 kg and an

inhalation rate of 20 m^3/day (EPA, 1989, 1991). In other words, the RfC expressed as mg/m^3 is multiplied by the inhalation rate of 20 m^3/day, and the result is divided by the assumed adult body weight of 70 kg to yield an inhalation RfD expressed as mg/kg-day.

RfD and RfC values are usually derived from empirical benchmark doses (BMD) or concentrations called no-observed-effect levels (NOEL) or no-observed-adverse-effect levels (NOAEL) from animal toxicity or human epidemiology studies. If the data do not permit identifying a NOEL or NOAEL, a lowest-observed-adverse-effect level (LOAEL) or lowest-effect level (LEL) may be used. A frank-effect level (FEL), e.g., mortality, shortened life span or serious physiologic, neurologic or behavioral disturbances, is generally considered an inappropriate benchmark from which to develop an RfD or RfC. Some RfD and RfC derivations employ a BMD that is a statistically estimated dose for humans at which some low proportion of the population may experience some minimally adverse effect. A BMD at which 10 percent of the population may be expected to experience such an effect is expressed as BMD_{10}. The RfD or RfC is derived by dividing the benchmark level (e.g., NOAEL or BMD_{10}) by a series of uncertainty and modifying factors, which collectively are designated the uncertainty factor (UF).

RfD and RfC values are not currently available for acute toxicity and acute exposure is not evaluated in the RA. Nonetheless, the levels associated with acute lethality and data regarding the effects of acute exposure to levels higher than ordinarily observed in chronic environmental exposure provide additional perspective regarding the toxicity of the chemical. Therefore, information regarding acute toxicity, when available, is included in the profiles. Lethality data for laboratory animals are generally expressed as the oral dose associated with lethality of 50 percent of an exposed population (LD_{50}) or the concentration in air associated with lethality of 50 percent of an exposed population (LC_{50}). Occasionally the dose associated with lethality in a low percentage of an exposed population (LD_{LO}) is presented.

RfD and RfC values are derived for both chronic and subchronic exposure. For purposes of the RA, chronic exposure is defined as equal to or greater than 7 years, i.e., at least 10 percent of expected life span; subchronic exposure is defined as 2 weeks to 7 years.

Under the assumption of monotonicity (i.e., incidence, intensity, or severity of effects can increase, but cannot decrease, with increasing magnitude or duration of exposure), a chronic RfD may be considered sufficiently protective for subchronic exposure, but a subchronic RfD may not be protective for chronic exposure. Currently, verified subchronic RfD values are unavailable. Provisional subchronic RfDs exist for few chemicals and are compiled in the Health Effects Assessment Summary Tables (HEAST) (EPA, 1997) and some National Center for Environmental Assessment (NCEA) or Provisional Peer Reviewed Toxicity Value (PPRTV) derivations. Although once updated semi-annually, the HEAST is no longer updated, because the EPA (2005) Integrated Risk Information System (IRIS) is generally considered the source of the highest quality toxicity values. For some chemicals the PPRTV derivations are more recent and it is known that summaries on IRIS will be replaced with the PPRTV derivations. In these cases the PPRTV values will be selected preferentially to those on IRIS. Subchronic RfD and RfC values are generally obtained from EPA (1997) or more recent NCEA or PPRTV evaluations, or they may be derived *de novo* from the toxicological data set or from chronic RfD values as follows:

- If the UF applied in the derivation of the chronic RfD does not provide for expansion from subchronic to chronic exposure (e.g., if the chronic RfD was derived from a chronic study), the chronic RfD is adopted as being sufficiently protective for subchronic exposure.

- If the UF applied in the derivation of the chronic RfD contains a component to expand from subchronic to chronic exposure, the subchronic RfD is derived by multiplying the chronic RfD by the component of the UF used to expand from subchronic to chronic exposure (e.g., if a factor of 10 was used to expand from subchronic to chronic exposure, the subchronic RfD will be 10 times larger than the chronic RfD).

7.2 Carcinogenicity Evaluation

The evaluation of the potential carcinogenicity of a chemical includes both a qualitative and a quantitative aspect (EPA, 1986, 2005). EPA (2005) recognizes five weight-of-evidence group classifications for carcinogenicity. Formerly, EPA (1986) used a letter-based system to describe the weight of evidence for carcinogenicity. Reference to this former system is included because many of the carcinogenicity assessments listed on the Integrated Risk Information System (IRIS) use the former letter-based system (EPA, 2013). The five EPA weight-of-evidence classifications are as follows:

- ***Carcinogenic to Humans*** (corresponds to the former Group A - Human Carcinogen).

- ***Likely to be Carcinogenic to Humans*** (includes both the former Group B1 and Group B2-Probable Human Carcinogens)

- ***Suggestive Evidence of Carcinogenic Potential*** (corresponds to the former Group C - Possible Human Carcinogen)

- ***Inadequate Information to Assess Carcinogenic Potential*** (corresponds to the former Group D - Not Classifiable as to Human Carcinogenicity)

- ***Not Likely to be Carcinogenic to Humans*** (corresponds to the former Group E - Evidence of Noncarcinogenicity to Humans).

Toxicity values for cancer risk include a slope factor (SF) for oral exposure, expressed as the risk per mg/kg-day ingested dose, and a unit risk factor (URF) for inhalation exposure, expressed as the risk per microgram per cubic meter ($\mu g/m^3$) in ambient air. These quantitative estimates are generally provided for chemicals in EPA weight-of-evidence Groups A, B and C if the data are adequate. The SF or URF is usually estimated as an upper bound on the slope of the dose- or concentration-response curve from animal toxicity or human epidemiology studies. The inhalation URF in units of risk per $\mu g/m^3$ may be converted to an equivalent inhalation SF in units of risk per mg/kg-day by assuming continuous lifetime exposure of humans with a body weight to 70 kg and an inhalation rate of 20 m^3/day. In other words, the URF expressed as risk per $\mu g/m^3$ is divided by the inhalation rate of 20 m^3/day, and multiplied by the assumed body weight of 70 kg and a conversion factor of 1000 μg/mg.

EPA (1986, 2005) generally assumes that there are no thresholds for carcinogenic expression; therefore, any exposure represents some quantifiable risk. A few potential carcinogens are understood to require a threshold for carcinogenic expression. Such chemicals are more appropriately evaluated with an RfD developed as described above.

7.3 Hierarchy for Selecting Toxicity Data

Toxicity values generally are chosen using the following hierarchy:

- The EPA's (2013) on-line IRIS database containing toxicity values that have undergone the most rigorous Agency review.
- PPRTV derivations for the Superfund Technical Support Center (STSC); there may be individual chemicals for which the PPRTV derivations supersede those on IRIS.
- Older NCEA derivations for the STSC, HEAST (EPA, 1997), or other EPA documents or memoranda.

When EPA-derived toxicity values are not located in any of the above sources, Minimal Risk Levels (MRL) from the Agency for Toxic Substances Disease Registry (ATSDR) toxicological profiles may be adopted or adapted for use in the RA. MRLs are derived by a methodology similar to the EPA methodology for RfD derivation. ATSDR toxicological profiles generally identify levels significant to human health with particular emphasis on target organ and mechanism of toxicity. Also, the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) has derived toxicity values for certain chemicals (and their degradation products) associated with military use. Finally, the primary literature may be surveyed to determine whether sufficient data exist to derive a toxicity value using the EPA methodology. The use of surrogate chemicals is also considered if the chemical structure, adverse effects, and toxic potency of the surrogate and chemical of interest are judged to be sufficiently similar.

GAFs, used to derive dermal RfD values and SFs from the corresponding oral toxicity values, are obtained from the following hierarchy:

- EPA (2004)
- Empirical data
- PPRTV summaries or NCEA position papers
- Federal agency reviews of the empirical data, such as ATSDR toxicological profiles and various EPA criteria documents
- Other published reviews of the empirical data.

8.0 References

Bintein, S. and J. Devillers, 1993, "Nonlinear Dependence of Fish Bioconcentration on n-Octanol/Water Partition Coefficient," ***SAR and QSAR in Environmental Research***, 1: 29-39.

Devillers, J., S. Bintein and D. Domine, 1996, "Comparison of BCF Models Based on Log P," ***Chemosphere***, 33(6): 1047-1065.

Hart, R.W. and L.T. Frame, 1996, "Toxicological Defense Mechanisms and How They May Affect the Nature of Dose-Response Relationships," ***Biological Effects of Low Level Exposure (BELLE) Newsletter***, 5(1): 1-16.

Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

Lyman, W. J., W. F. Reehl and D. H. Rosenblatt, 1990, ***Handbook of Chemical Property Estimation Methods, Environmental Behavior of Organic Compounds***, American Chemical Society, Washington, DC.

National Institute of Standards and Technology (NIST), 2013, ***NIST Chemistry WebBook***, on line.

Travis, C.C. and A.D. Arms, 1988, "Bioconcentration of Organics in Beef, Milk and Vegetation," ***Environmental Science and Technology***, 22(3): 271-274.

U.S. Environmental Protection Agency (EPA), 1986, "Guidelines for Carcinogen Risk Assessment," ***Federal Register***, 51(185): 33992-34003.

U.S. Environmental Protection Agency (EPA), 1989, ***Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)***, Interim Final, Office of Emergency and Remedial Response, Washington, DC, EPA/540/1-89/002, December.

U.S. Environmental Protection Agency (EPA), 1991, ***Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors***, Interim Final, Office of Solid Waste and Emergency Response, OSWER Directive: 9285.6-03, 25 March.

U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, Washington, DC, 9200.6-303(97-1), EPA 540/R-97-036, PB97-921199.

U.S. Environmental Protection Agency (EPA), 1998, ***Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume Two***, Peer Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, EPA530-D-98-001B, July.

U.S. Environmental Protection Agency (EPA), 2002, ***Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites***, Office of Solid Waste and Emergency Response, Washington, DC, 9355.4-24, December.

U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final***, Office of Superfund Remediation and Technology Innovation, Washington, DC, EPA/540/R/99/005, OSWER 9285.7-02EP July.

U.S. Environmental Protection Agency (EPA), 2005, ***Guidelines for Carcinogen Risk Assessment***, Risk Assessment Forum, Washington, D.C., March, EPA/630/P-03/001B.

U.S. Environmental Protection Agency (EPA), 2013, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

METALS

ANTIMONY (7440-36-0)

1.0 Introduction and Physical Properties

Antimony is a naturally occurring brittle **metal** that is not readily fabricated (ATSDR, 1992). It is alloyed with lead and other metals, imparting hardness, mechanical strength, corrosion resistance, electrochemical stability, and decreased coefficient of friction. Major applications include its use in grid metal in acid storage batteries, solder, sheet metal and pipe, bearing metal, castings, ammunition and type metal. Antimony trioxide is used as a fire retardant in plastics and textiles. Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
121.75[a] (Element)	NA	NA	45[b]	NA	NA	NA	Note[c]

MW = molecular weight (g/mole); log K_{ow} = base 10 logarithm of the octanol/water partition coefficient (unitless); H = Henry's Law constant (atm-m^3/mole) at the reference temperature; K_d = soil/water partition coefficient (L/kg); D_a = diffusivity in air (cm^2/second); D_w = diffusivity in water (cm^2/second); VP = vapor pressure (atm) at the reference temperature; S = solubility in water (mg/L) at the reference temperature; NA = not applicable.
[a]Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.
[b]Baes, C.F., R.D. Sharp, A.L. Sjoreen, R.W. Shor, 1984, ***A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture***, Health and Safety Division, Oak Ridge National Laboratory, ORNL-5786, September.
[c]Agency for Toxic Substances and Disease Registry (ATSDR), 1992, ***Toxicological Profile for Antimony***, U.S. Department of Health and Human Services, Atlanta, Georgia, December.
Note 1: Solubility of antimony compounds varies from essentially insoluble to slightly soluble in water. The exception is antimony trichloride (6.0E+6 mg/L at 0°C).

2.0 Environmental Fate and Transport

Antimony is naturally present in the earth's crust and is released to the environment in windblown dust, from volcanic eruptions, sea spray, forest fires, and biogenic sources (HSDB, 2013). The majority of antimony released to the environment arises from anthropogenic sources, including nonferrous metal mining, smelting and refining, and the production, use and disposal of antimony alloys and compounds. Coal combustion and refuse and sludge combustion are other major anthropogenic sources of antimony.

The sorption and mobility of antimony released to soil is determined by the nature of the soil, the form of antimony deposited on the soil, and the pH (ATSDR, 1992; HSDB, 2013). Antimony is strongly sorbed to most soils. After prolonged leaching, the residual antimony appears to convert to a less mobile form, thereby reducing the potential for future leaching. This is reflected in the concentration versus depth profiles in contaminated soil; the concentration of antimony is highest in the surface layer of soil. Adsorption to soil correlates with the iron, manganese, and aluminum content of the soil with which it coprecipitates as hydroxylated oxides. Adsorption of antimony in soil is not correlated with organic carbon content, although this might be expected because of antimony's occurrence in anionic species. Leaching increases markedly at pH excursions above or below neutrality. There is little information on the forms of

antimony in soil and the transformations that may occur in soil. During weathering, sulfitic minerals may be converted to oxides. Results of a sequential extraction study of soil at a smelter site showed that three-quarters of the antimony was in a residual form (extractable with aqua regia) and the rest of the antimony was equally distributed among five more labile forms. At the control site, all of the antimony was in the five more labile forms.

Antimony released into waterways from natural weathering of soils and anthropogenic sources will be transported in streams and rivers and settle out in areas of active sedimentation; e.g., where a river empties into a bay (HSDB, 2013). Antimony appears to be strongly bound to sediment in association with iron, manganese, and aluminum hydroxyoxides. Antimony in the dissolved state in both fresh water and seawater is largely in the +5 oxidation state; the primary species is the anion $[Sb(OH)_6]^-$. A much smaller amount, predominantly in anaerobic waters, occurs in the +3 oxidation state, probably as the neutral species $Sb(OH)_3$. Thiocomplexes of Sb(III) may also occur in the anaerobic zone. Antimony can be reduced and methylated by microorganism in anaerobic sediment, releasing volatile methylated antimony compounds, which are both soluble and readily oxidized. Methylstibonic acid and dimethylstibonic acid have been found in seawater and estuarine water. In a study in the Baltic Sea these species constituted about 10 percent of dissolved antimony in the water column.

Antimony in the ambient air will exist entirely in particulate form or adsorbed to particulate matter (HSDB, 2013). It will be dispersed by the wind and removed from the atmosphere by gravitational settling, dry deposition, washout by rain (attachment to water droplets occurring within a cloud), and rainout (attachment to water droplets occurring below a cloud). The removal rate and distance traveled from the source will depend on source characteristics (e.g., stack height), particle size and density, and meteorological conditions. Gravitational settling governs the removal of large particles (>5 um), such as that associated with windblown dust, whereas dry and wet deposition govern the removal of small particles. Large particles may have atmospheric half-lives of the order of hours, whereas very small particles may have atmospheric half-lives as long as 30 days.

Most anthropogenic emissions of antimony are from combustion processes. These emissions are primarily associated with small (submicron) particles, because antimony volatilizes during the combustion process and recondenses in the stack. A model that relates particle size to volatility estimates a mean atmospheric half-life for antimony of 1.9 days; for the more volatile antimony trioxide, the half-life is 3.2 days. The ratio of wet-to-dry deposition generally increases with decreasing particle size; therefore, a larger proportion of antimony will be found in rain compared with most other metals. A study of wet and dry deposition on an island in the German Bight far from anthropogenic sources found 87 percent of antimony dissolved in rain, 11 percent as particulate matter in rain, and only 2 percent as dry deposition.

Bioconcentration studies and field studies suggest that antimony does not bioconcentrate significantly in fish and aquatic organisms, and does not participate significantly in food-chain pathways (HSDB, 2013, EPA, 1995). Therefore, biotransfer factors are not developed for antimony.

3.0 Data for Evaluating Dermal Exposure

Estimates of the GI absorption of antimony tartrate and antimony trichloride by animals range from two to seven percent (ATSDR, 1992); ten percent is recommended as a reference value for

humans for GI absorption of antimony tartrate. Although empirical data are lacking, one percent is recommend for other forms of antimony. The key study for development of the chronic oral RfD used potassium antimony tartrate administered to rats and mice (EPA, 2013), for which EPA (2004) estimated a GI absorption efficiency of 15 percent. Therefore, the GAF of 15 percent (0.15) is chosen for this evaluation.

Data were not located regarding the extent of dermal uptake of antimony from soil. EPA (2004) recommends that dermal uptake from soil should not be quantified for chemicals without ABS recommendations, but that these chemicals should be discussed qualitatively as a source of uncertainty. Empirical data regarding the uptake of soluble forms of antimony from water were not located. The EPA (2004) default K_p for inorganic chemicals of 1E-3 cm/hour is selected for antimony.

4.0 Noncancer Effects Evaluation

Acute intoxication from ingestion of large doses of antimony induces GI disturbances, dehydration and cardiac effects in humans (Iffland, 1988). Chronic oral exposure studies in laboratory animals include two briefly reported lifetime drinking water studies in rats and mice (EPA, 2013). The only dose tested, 5 parts per million (ppm) potassium antimony tartrate, resulted in reduced longevity in both species, altered blood chemistry and reduced mean heart weight in the rats. EPA (2013) verified an RfD of 4E-4 mg/kg-day for chronic oral exposure to antimony from the LOAEL of 5 ppm potassium antimony tartrate (0.35 mg antimony/kg body weight-day) in the lifetime study in rats. An uncertainty factor of 1000 was applied; factors of 10 each for inter- and intraspecies variation and to estimate a no-observed-adverse-effect level (NOAEL) from a LOAEL. Confidence in the oral RfD is low. The heart is considered a likely target organ for chronic oral exposure of humans.

EPA (1997) adopted the verified chronic oral RfD of 4E-4 mg/kg-day as sufficiently protective for subchronic oral exposure.

EPA (2013) has not identified an RfC for antimony. EPA (2013) verified an RfC for antimony trioxide of 2E-4 mg/m^3.

5.0 Carcinogenicity Evaluation

Empirical data were not located regarding the carcinogenicity of antimony to humans. Antimony has not undergone a complete EPA (2013) evaluation for human carcinogenic potential.

6.0 Toxicity Summary

Toxicity values for antimony are summarized below. In addition to the EPA (2013) evaluation of oral exposure to antimony and inhalation exposure to antimony trioxide, EPA (1997) previously derived provisional chronic and subchronic oral RfDs for several specific antimony compounds. These RfDs were derived by analogy to antimony (i.e., the EPA [2013] evaluation) by assuming that toxicity was limited to the antimony moiety alone, and by correcting for differences in molecular weight. Ordinarily, antimony is not speciated when analyzed in environmental media, in which case the RfDs for antimony rather than the specific antimony compounds should be used. Nonetheless, the RfDs for the specific antimony compounds are included in the following table:

Noncancer Effects						Carcinogenicity				
Oral Exposure[a]			Inhalation Exposure			Oral Exposure		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
Antimony (not otherwise specified)										
4E-4	4E-4	H	ND	ND	NA	D	NA	D	NA	NA
Antimony Pentoxide										
5E-4	5E-4	H	ND	ND	NA	D	NA	D	NA	NA
Antimony Potassium Tartrate										
9E-4	9E-4	H	ND	ND	NA	D	NA	D	NA	NA
Antimony Tetroxide										
4E-4	4E-4	H	ND	ND	NA	D	NA	D	NA	NA
Antimony Trioxide										
4E-4	4E-4	H	ND	2E-4/ 5.7E-5[b]	Lu[b]	D	NA	D	NA	NA

sRfDo = subchronic oral reference dose (milligrams per kilogram-day); cRfDo = chronic oral reference dose (milligrams per kilogram-day); TO = target organ(s) or critical effect(s); sRfC = subchronic inhalation reference concentration (milligrams per cubic meter); sRfDi = subchronic inhalation reference dose (milligrams per kilogram-day); cRfC = chronic inhalation reference concentration (milligrams per cubic meter); cRfDi = chronic inhalation reference dose (milligrams per kilogram-day); WOE = cancer weight-of-evidence evaluation; SFo = oral cancer slope factor (risk per milligram per kilogram-day); URFi = inhalation unit risk factor (risk per microgram per cubic meter); SFi = inhalation cancer slope factor (risk per milligram per kilogram-day); ND = no data; NA = not applicable.
Target organ abbreviations: H = heart; Lu = lung.
[a]sRfDo and cRfDo should be adjusted by the GAF of 0.15 when used for dermal exposure.
[b]Applicable to antimony and all its compounds if it is assumed that all have similar effects following inhalation exposure.

7.0 References

Agency for Toxic Substances and Disease Registry (ATSDR), 1992, ***Toxicological Profile for Antimony***, U.S. Department of Health and Human Services, Atlanta, Georgia, December.

Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

Iffland, R., 1988, "Antimony, In: Seiler, H.G., H. Sigel and A. Sigel, Eds., ***Handbook on Toxicity of Inorganic Compounds***, New York: Marcel Dekker, Inc., pp. 67-76.

U.S. Environmental Protection Agency (EPA), 1995, “40 CFR 9, 122, 123, 131, and 132 Final Water Quality Guidance for the Great Lakes System; Final Rule,” ***Federal Register***, 60(56); 15366-15425.

U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, Washington, DC, 9200.6-303(97-1), EPA 540/R-97-036, PB97-921199.

U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final***, Office of Emergency and Remedial Response, EPA/540/R/99/005, OSWER 9285.7-02EP, July.

U.S. Environmental Protection Agency (EPA), 2013, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

ARSENIC (7440-38-2)

1.0 Introduction and Physical Properties

Arsenic is a natural **metalloid**, the 20th most abundant element in the earth's crust that occurs in both inorganic and organic forms (ATSDR, 2007; HSDB, 2013). Elemental arsenic is a steel-grey material that may occur naturally. However, arsenic is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur. Most inorganic and organic arsenic compounds are non-volatile, odorless and tasteless white or colorless powders. Inorganic arsenic occurs naturally in soil and in many kinds of rock, especially in minerals and ores that contain copper or lead. Inorganic arsenic is more toxic than organic forms. Major uses of arsenic in the U.S. include its incorporation into wood preservatives and other agricultural chemicals. It is also used as a metal in various electrical devices and is alloyed with lead and copper in the manufacture of lead bullets or shot (Lewis, 1997). Arsenic is also a component of the chemical warfare agent Lewisite (Opresko et al., 1998). Lewisite is manufactured by the condensation of arsenic trichloride with acetylene in the presence of aluminum, copper or mercuric chloride (Lewis, 1997). Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
74.92[a]	NA	NA	2.9E+1[b]	NA	NA	Note 1[c]	Note 2[c]

MW = molecular weight (g/mole); log K_{ow} = base 10 logarithm of the octanol/water partition coefficient (unitless); H = Henry's Law constant (atm-m^3/mole) at the reference temperature; K_d = soil/water partition coefficient (L/kg); D_a = diffusivity in air (cm^2/second); D_w = diffusivity in water (cm^2/second); VP = vapor pressure (atm) at the reference temperature; S = solubility in water (mg/L) at the reference temperature; NA = not applicable.
Note 1: Variable: inorganic arsenic compounds are not likely to volatilize; some organic arsenic compounds are low-boiling liquids or gases at normal temperatures.
Note 2: Variable: inorganic arsenic compounds range from practically insoluble to freely miscible in water; most organic arsenic compounds are not readily soluble, most arsenic acid compounds are soluble to freely miscible.
[a] Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.
[b]U.S. Environmental Protection Agency (EPA), 2002, ***Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites***,, Office of Solid Waste and Emergency Response, OSWER 9355.4-24, December.
[c]Agency for Toxic Substances and Disease Registry, (ATSDR), 2007, ***Toxicological Profile for Arsenic***, U.S. Public Health Service, Atlanta, Georgia, August.

2.0 Environmental Fate and Transport

The production of arsenic and its use in nonferrous alloys and in the manufacture of semiconductors may result in its release to the environment through various waste streams HSDB, 2013). Other important anthropogenic releases are metal smelting, coal burning, and other industrial activities. Arsenic may be present at military sites as a result of training with or demilitarization or disposal of Lewisite. Most (approximately 80 percent) of anthropogenic releases are initially to soil (ATSDR, 2007).

Arsenic occurs in the air as a combination of trivalent and pentavalent forms almost entirely adsorbed to small particles that permit dispersion over long distances (ATSDR, 2007). Residence time in the atmosphere averages approximately nine days. Removal is largely by wet and dry deposition. Arsenic in surface water can undergo a variety of reactions and exist as several different soluble compounds. Sorption to sediment is often an important removal process, but biotransformation in sediment may return soluble forms to the water. Arsenic in soil generally exists as insoluble forms sorbed to clay or organic matter or complexed with calcium or iron.

Mobility is low and leaching is not generally significant, except that increasing soil pH can dramatically increase solubility and mobility.

Arsenic has been shown to bioconcentrate in aquatic organisms, mainly at the water-algae interface (ATSDR, 2007). There is no evidence for biomagnification through the various trophic levels, nor do there appear to be significant differences between bottom-feeders and predatory fish. Arsenic is among the metals listed as being of no concern for bioaccumulation in fish (EPA, 1995). Empirical data suggest that bioconcentration through terrestrial food chain pathways is unlikely to be significant (ATSDR, 2007). Therefore, biotransfer factors are not developed for arsenic.

3.0 Toxicokinetics

All forms of inorganic arsenic are readily absorbed by the lungs and GI tract; the extent of absorption is greater for more soluble compounds than for more insoluble compounds (ATSDR, 2007). Dermal absorption has not been well characterized but is significantly less than inhalation or oral absorption. GI and dermal absorption of arsenic from soil is much lower than from aqueous solution. Distribution is generally widespread throughout the body following absorption.

Metabolism of inorganic arsenic involves reduction of As^{+5} to As^{+3}, and oxidation of As^{+3} to As^{+5} so that arsenic is present systemically as a mixture of arsenate and arsenite (ATSDR, 2007). Arsenite is readily oxidized and methylated primarily in the liver to form the organic compounds monomethyl arsonic acid and dimethyl arsinic acid, which are rapidly excreted in the urine.

4.0 Dermal Exposure

EPA (2004) concluded that a GAF should not be estimated for the purpose of adjusting oral toxicity values for dermal exposure. Therefore, the oral toxicity values described below are used directly without adjustment for evaluating dermal exposure.

EPA (2004) cites empirical data indicating that dermal uptake of arsenic from soil approximates 3 percent. The ABS of 0.03 recommended by EPA (2004) is used herein. Empirical data regarding the uptake of soluble forms of arsenic from water were not located. The EPA (2004) default K_p for inorganic chemicals of 1E-3 cm/hour is selected for arsenic.

5.0 Noncancer Effects Evaluation

Inorganic arsenic may be an essential nutrient, at least for food-producing domestic animals, exerting beneficial effects on growth, health and feed conversion efficiency (Underwood, 1977). A lethal dose of arsenic trioxide in humans is 70-180 mg, approximately 50 to 140 mg arsenic (Ishinishi et al., 1986). Acute oral exposure of humans to high doses of arsenic produces liver swelling, skin lesions, disturbed heart function and neurological effects. The only noncancer effects in humans clearly attributable to chronic oral exposure to arsenic are dermal hyper pigmentation and keratosis, as revealed by studies of several hundred Chinese exposed to naturally occurring arsenic in well water (EPA, 2013). Similar effects were observed in persons exposed to high levels of arsenic in water in Utah and the northern part of Mexico. EPA (2013) verified an RfD of 3E-4 mg/kg-day for chronic oral exposure, based on a NOAEL of 8E-4 mg/kg-day for hyper pigmentation and kertatosis of the skin from the Chinese data. An uncertainty factor of 3 was applied. An increased incidence of Blackfoot disease was also observed, which may not be related to arsenic alone. Goyer (1991) describes black-foot disease

as a peripheral vascular disorder manifested as acrocyanosis and Raynaud's disease, which may progress to gangrene. EPA (2013) notes that the skin is the more sensitive target organ. Nonetheless, in keeping with EPA (1989) guidance regarding selection of target organ, both the skin and peripheral vascular system are selected as target organs for prolonged oral exposure to arsenic. Confidence in the RfD is medium.

The available data do not suggest a significant difference between chronic and subchronic exposure regarding the threshold for noncancer effects. Therefore, EPA (1997) adopted the chronic oral RfD as the provisional subchronic oral RfD for arsenic.

Occupational (predominantly inhalation) exposure is also associated with neurological deficits, anemia, and vascular effects (Ishinishi et al., 1986). However, concomitant exposure to other chemicals cannot be ruled out in the occupational studies. Therefore, the data are not sufficient for estimation of an inhalation RfC.

6.0 Carcinogenicity Evaluation

Inorganic arsenic is clearly a carcinogen in humans. Inhalation exposure is associated with increased risk of lung cancer in persons employed as smelter workers, in arsenical pesticide applicators, and in a population residing near a pesticide manufacturing plant (EPA, 2013). Oral exposure to high levels in well water is associated with increased risk of skin cancer and several forms of internal cancer, although the role of other chemicals in the internal cancers is unclear. Extensive animal testing with various forms of arsenic given by many routes of exposure to several species, however, has not demonstrated the carcinogenicity of arsenic, indicating that the common laboratory animals are not good models for carcinogenicity to humans. EPA (2013) classified inorganic arsenic in cancer weight-of-evidence Group A (human carcinogen), and recommended an oral SF of 1.5E+0 per mg/kg-day, based on the incidence of skin cancer in the Chinese study. EPA (2007) noted that arsenic probably functions via several different mechanisms of toxicity not including direct interaction with DNA. These appear to obey thresholds or to generate a non-linear slope that approaches 0 in the low-dose range. The SF probably exaggerates cancer risk in the low dose range associated with most environmental exposures, although the extent is unclear.

An inhalation URF of 4.3E-3 per $\mu g/m^3$, equivalent to an inhalation SF of 1.5E+1 per mg/kg-day, was derived for inorganic arsenic from the incidence of lung cancer in occupationally exposed men (EPA, 2013).

7.0 Toxicity Summary

Noncancer Effects						Carcinogenicity				
Oral Exposure[a]			Inhalation Exposure			Oral Exposure[a]		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
3E-4	3E-4	S, PVS	ND	ND	NA	A	1.5E+0	A	4.3E-3	1.5E+1

sRfDo = subchronic oral reference dose (milligrams per kilogram-day); cRfDo = chronic oral reference dose (milligrams per kilogram-day); TO = target organ(s) or critical effect(s); sRfC = subchronic inhalation reference concentration (milligrams per cubic meter); sRfDi = subchronic inhalation reference dose (milligrams per kilogram-day); cRfC = chronic inhalation reference concentration (milligrams per cubic meter); cRfDi = chronic inhalation reference dose (milligrams per kilogram-day); WOE = cancer weight-of-evidence evaluation; SFo = oral cancer slope factor (risk per milligram per kilogram-day); URFi = inhalation unit risk factor (risk per microgram per cubic meter); SFi = inhalation cancer slope factor (risk per milligram per kilogram-day); ND = no

Noncancer Effects						Carcinogenicity				
Oral Exposure[a]			Inhalation Exposure			Oral Exposure[a]		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
data; NA = not applicable. Target organ or critical effect abbreviations: S = skin; PVS = peripheral vascular system. [a]sRfDo, cRfDo and SFo should be used for dermal exposure without adjustment for GI absorption.										

8.0 References

Agency for Toxic Substances and Disease Registry, (ATSDR), 2007, ***Toxicological Profile for Arsenic***, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia, August.

Goyer, R.A., 1991, "Toxic Effects of Metals," in ***Casarett and Doull's Toxicology, The Basic Science of Poisons***, Fourth Edition, Amdur, M.O., J. Doull and C.D. Klaassen, Eds., Pergamon Press, New York, pp. 623-680.

Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

Ishinishi, N., K. Tsuchiya, M. Vahter and B.A. Fowler, 1986, "Arsenic," In: Friberg, L., G.F. Nordberg and V.B. Vouk, Eds., ***Handbook on the Toxicology of Metals***, Volume II, Second Edition, New York: Elsevier Science Publishers B.V., pp. 43-83.

Lewis, R.J., Sr., 1997, ***Hawley's Condensed Chemical Dictionary***, Thirteenth Edition, John Wiley & Sons, Inc., New York, pp. 92-93.

Opresko, D.M., R.A. Young, R.A. Faust, et al., 1998, "Chemical Warfare Agents: Estimating Oral Reference Doses," ***Reviews in Environmental Contamination and Toxicology***, 156: 1-183.

Underwood, E.J., 1977, ***Trace Elements in Human and Animal Nutrition***, Fourth Edition, New York: Academic Press, pp. 424-429.

U.S. Environmental Protection Agency (EPA), 1989, ***Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A)***, Interim Final, Office of Emergency and Remedial Response, Washington, DC, EPA/540/1-89/002, December.

U.S. Environmental Protection Agency (EPA), 1995, "40 CFR 9, 122, 123, 131, and 132 Final Water Quality Guidance for the Great Lakes System; Final Rule," ***Federal Register***, 60(56); 15366-15425.

U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, Washington, DC, 9200.6-303(97-1), EPA 540/R-97-036, PB97-921199.

U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final***, Office of Superfund Remediation and Technology Innovation, Washington, DC, EPA/540/R/99/005, OSWER 9285.7-02EP July.

U.S. Environmental Protection Agency (EPA), 2013, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

CHROMIUM (7440-47-3)

1.0 Introduction and Physical Properties

Chromium is a naturally occurring **metal** (ATSDR, 2012). It occurs in several valence states; chromium (III) (16065-83-1) and chromium (VI) (18540-29-9) are the forms most commonly encountered in environmental media. Chromium is used largely in the metallurgical, refractory and chemical industries. The largest amount is used in the metallurgical industry in various steels and nonferrous alloys. The second largest use is by the chemical industry in pigments, metal finishing, leather tanning and wood treatment. Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
52.00[a] (element)	NA	NA	1.8E+6 (CrIII) 1.9E+1 (CrVI)[b]	NA	NA	ND	Note 1[a]

MW = molecular weight (g/mole); log K_{ow} = base 10 logarithm of the octanol/water partition coefficient (unitless); H = Henry's Law constant (atm-m^3/mole) at the reference temperature; K_d = soil/water partition coefficient (L/kg); D_a = diffusivity in air (cm^2/second); D_w = diffusivity in water (cm^2/second); VP = vapor pressure (atm) at the reference temperature; S = solubility in water (mg/L) at the reference temperature; NA = not applicable; ND = no data.
Note 1: Chromium compounds vary from insoluble to highly soluble.
[a]Agency for Toxic Substances and Disease Registry, (ATSDR), 2012, ***Toxicological Profile for Chromium***, U.S. Public Health Service, Atlanta, Georgia.
U.S. Environmental Protection Agency (EPA), 2002, ***Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites***, Office of Solid Waste and Emergency Response, Washington, D.C., 9355.4-24, December.

2.0 Environmental Fate and Transport

Chromium is released into the atmosphere from natural gas, oil and coal combustion, and from use by the industries mentioned above (ATSDR, 2012). Other sources include wind transport from road dust, cement producing plants, the wearing down of asbestos brake linings from automobiles, incineration of municipal refuse and sewage sludge, exhaust emission from automotive catalytic converters, and emissions from cooling towers that use chromium compounds as rust inhibitors. Significant quantities of chromium are released to surface water from industrial use. Land disposal of chromium-containing commercial products, solid waste and slag from chromate manufacture, and coal ash, primarily from electric utilities and other operations that burn coal, are the major releases to soil.

Chromium releases from combustion processes and ore processing are generally in the form of chromium (III) oxide; however, chromium (VI) has been identified in fly ash from coal combustion at chromate manufacturing and user sites (ATSDR, 2012). Airborne chromium exists in particulate form that may travel great distances from the point of emissions; wet and dry deposition account for the majority of removal from air.

Most chromium released to surface water eventually adsorbs to particles and becomes deposited in bottom sediment, but small quantities may remain in the water in both soluble and insoluble forms (ATSDR, 2012). The soluble forms are usually chromium (VI) salts and soluble chromium (III) compounds. Chromium (VI) may be found in water, but eventually organic matter and other reducing agents will reduce chromium (VI) to chromium (III). Chromium in soil is present

mainly as insoluble chromium (III) carbonates and oxides that are unlikely to be mobile to any significant extent. However, soluble forms may also be present, depending on the form of the chemical released, that may be quite mobile in soil. Also, lower pH facilitates complexation with organic matter and increases mobility.

Empirical evidence suggests that chromium is unlikely to participate significantly in food chain pathways (ATSDR, 2012; EPA, 1995); therefore, biotransfer factors are not compiled.

3.0 Toxicokinetics

Identification of chromium in urine, serum and tissues of occupationally exposed humans confirms that soluble chromium (III) and chromium (VI) compounds are absorbed from the lung (ATSDR, 2012). The rate of absorption, however, depends largely on the physical and chemical characteristics of the chromium compound involved, as shown in numerous animal inhalation studies. Chromium (VI) compounds are more readily absorbed because the chromate anion participates in facilitated diffusion mechanisms not available to chromium (III).

Absorption of dietary sources of chromium from the GI tract in humans ranges from approximately 0.5 to 2 percent, as inferred from urinary excretion data (ATSDR, 2012). The extent of absorption appears to be inversely related to dietary chromium content. A review of several studies suggests that 0.4 to 14.5 percent of orally administered chromium not related to dietary sources is absorbed by the GI tract of humans, but valence and chemical form and nutritional status (fed vs. fasting) appear to influence efficiency of absorption (ATSDR, 2012). Chromium (VI) sources are more efficiently absorbed than chromium (III) sources as described above for inhalation exposure. Experiments with laboratory animals showed that the stomach has the ability to reduce chromium (VI) to chromium (III), reducing the extent of absorption when chromium (VI) compounds were administered *per os* compared with injection directly into the jejunum.

Both chromium (III) and chromium (VI) can penetrate intact human skin, and dermal uptake is increased if the skin is damaged (ATSDR, 2012). In some cases, dermal uptake was sufficient to result in signs of toxicity. The form and the vehicle greatly influence the rate of dermal uptake.

Inhaled particles of chromium compounds can remain in the lungs for years (ATSDR, 2012). Chromium absorbed into the blood is distributed throughout the body with highest levels frequently located in the kidneys. Chromium has been shown to cross the placenta and to be excreted via lactation. Autopsy studies in the US show that highest concentrations in newborns occur in the kidney, liver, aorta, heart, pancreas and spleen, and that tissue levels decline with age.

The main feature of the metabolism of chromium involves reduction of chromium (VI) to chromium (III) via the formation of chromium (V) and chromium (IV) intermediates (ATSDR, 2012). Reduction of chromium (VI) to chromium (III) occurs in the acid milieu of the stomach, primarily by reaction with ascorbate. Ascorbate, glutathione and other substrates effectively reduce absorbed chromium (VI) to chromium (III). Chromium (III) is considered a nutritionally essential element required for the proper metabolism of glucose, proteins and lipids. It acts as part of a complex known as GTF, which facilitates the action of insulin. Although chromium (III) complexes are generally thought to be inert, there is recent evidence that chromium (III)

may be reduced to chromium (II), which could catalyze the Haber-Weiss reaction resulting in the production of genotoxic hydroxyl radicals.

Absorbed chromium is excreted primarily in the urine (ATSDR, 2012).

4.0 Dermal Exposure

EPA (2004a) recommends GAFs of 0.013 for chromium (III) and 0.025 for chromium (VI), generally consistent with the toxicokinetic data reviewed above, which are used in this evaluation. The GAF of 0.013 for chromium (III) should be used for total chromium, which is assumed to consist of 6 parts of chromium (III) to 1 part of chromium (VI) (EPA, 2004b, 2013).

Data were not located regarding the extent of dermal uptake of chromium from soil, and EPA (2004a) provides no estimate of the extent of dermal absorption (ABS). EPA (2004a) recommends that dermal uptake from soil should not be quantified for chemicals without ABS recommendations, but that these chemicals should be discussed qualitatively as a source of uncertainty. EPA (2004a) compiled *in vivo* and *in vitro* data from human experiments of dermal uptake of chromium from water. Average K_p values of 1E-4 cm/hour and 1E-3 cm/hour are estimated for chromium (III) and chromium (VI), respectively. The K_p of 1E-4 cm/hour for chromium (III) should be used for total chromium as explained above.

5.0 Noncancer Effects Evaluation

As mentioned above, chromium (III) is an essential nutrient involved in maintenance of normal metabolism (ATSDR, 2012). EPA (2013) verified an RfD of 1.5E+0 mg/kg-day for chronic oral exposure to chromium (III) by applying an uncertainty factor of 1000 to a NOEL of 1800 g/kg (1.468 mg/kg body weight/day) as an average total ingested dose in a dietary study in which rats were given 600 feedings of chromic oxide baked into bread. No other dose levels were tested. Confidence in the RfD is low. No target organ or critical effect was identified for the toxicity of oral exposure to chromium (III).

The available data do not suggest a significant difference between chronic and subchronic exposure regarding the threshold for the noncancer effects of chromium (III). Therefore, EPA (1997) adopted the verified chronic oral RfD, which at the time was listed on IRIS as 1E+0 mg/kg-day, as the provisional subchronic oral RfD for chromium (III). Subsequently, EPA (2013) recalculated the average daily dose, which led to revising the chronic oral RfD from 1E+0 to 1.5E+0 mg/kg-day. Since the only change between the earlier and the present verified oral RfD reflects a recalculation, it is recommended that the current verified chronic oral RfD of 1.5E+0 mg/kg-day should also be used for subchronic exposure.

EPA (20113) verified an RfD for chronic oral exposure to chromium (VI) of 3E-3 mg/kg-day based on a NOAEL of 25 mg/L (2.5 mg/kg-day) in the drinking water of rats exposed for one year. An overall uncertainty factor of 900 was applied. The uncertainty factor consists of factors of 10 each for inter- and intra-species variation, a factor of 3 to expand from subchronic to chronic exposure, and a modifying factor of 3 to address concerns that relatively low levels may induce GI effects and possibly some forms of cancer in humans. Inclusion of the modifying factor of 3 was a (EPA, 1998a) revision to a previously verified derivation. EPA (2013) notes that confidence in the chronic oral RfD is low.

EPA (1997) presented a provisional subchronic oral RfD of 2E-2 mg/kg-day for chromium (VI) based on the same drinking water study and an uncertainty factor of 200 (not otherwise explained). Presumably, this derivation reflects the earlier IRIS evaluation before inclusion of the modifying factor of 3. However, the concern for GI effects that gave rise to the modifying factor could apply to subchronic as well as chronic exposure. Therefore, it is recommended that a new preliminary subchronic oral RfD should be calculated for chromium (VI). This is done by applying an overall uncertainty factor of 300 to the NOAEL of 2.5 mg/kg-day from the drinking water study. The uncertainty factor of 300 reflects the overall uncertainty factor of 900 used for the chronic RfD without the factor of 3 to expand from subchronic to chronic exposure. The preliminary subchronic oral RfD for chromium (VI) so calculated is 8E-3 mg/kg-day.

Inhalation (occupational) exposure to chromium may induce respiratory symptoms, changes in lung function and irritation, erosion or perforation of the nasal septum, depending in part on the exposure level (EPA, 2013). No adverse effects were observed in workers exposed to 1E-3 mg/m^3 for 0.2 to 23.6 years (average 2.5 years). EPA (1998b, 2013) reviewed several human and animal studies, and determined that effects observed from inhalation exposure to chromium (VI) are not relevant to exposure to chromium (III). EPA (1998c) concluded that chromium (VI) is the only form of chromium of concern for inhalation exposure.

EPA (2013) developed separate chronic inhalation RfC values for human exposure to chromic acid mists and dissolved chromium (VI) aerosols, and for exposure to chromium (VI) particulates. A verified chronic inhalation RfC of 8E-6 mg/m^3 for chromic acid mists and dissolved chromium (VI) aerosols is based on an adjusted LOAEL of 7.14E-4 mg/m^3 associated with atrophy of the nasal septum in subchronically occupationally exposed humans. An overall uncertainty factor of 90 was used, consisting of factors of 10 for intraspecies variation, 3 to estimate a NOAEL from a LOAEL, and 3 to expand from subchronic to chronic exposure. Confidence in the inhalation RfC is low. The upper respiratory tract is considered the target organ for inhalation exposure to chromic acid mists and dissolved chromium (VI) aerosols. The chronic inhalation RfC is equivalent to a chronic inhalation RfD of 2.3E-6 mg/kg-day.

Inhalation exposure to chromium (VI) particulates is associated with pneumocyte toxicity; i.e., with effects on the lungs themselves. EPA (2013) derived an RfC of 1E-4 mg/m^3 for chronic inhalation exposure to chromium (VI) particulates from an adjusted benchmark concentration of 3.4E-2 mg/m^3 associated with altered enzyme activity in bronchioalveolar lavage fluid from rats exposed to sodium dichromate dust intermittently for up to 90 days. An uncertainty factor of 300 was used, consisting of a factor of 10 to provide additional protection to unusually sensitive individuals, and factors of 3 each to cover for physiologic differences between rats and humans, and to expand from subchronic to chronic exposure. Confidence in the RfC is medium. The RfC is equivalent to a chronic inhalation RfD of 2.9E-5 mg/kg-day. The lung is considered to be the target organ for chronic inhalation exposure to chromium (VI) particulates.

No current EPA-derived subchronic inhalation evaluation exists for chromic acid mists and dissolved chromium (VI) aerosols. However, a preliminary subchronic inhalation RfC can be derived by excluding the uncertainty factor of 3 for expanding from subchronic to chronic exposure. Application of the remaining overall uncertainty factor of 30 to the adjusted LOAEL of 7.14E-4 mg/m^3 yields a preliminary subchronic inhalation RfC of 2E-5 mg/m^3 for chromic acid mists and dissolved chromium (VI) aerosols. The preliminary subchronic inhalation RfC is equivalent to a subchronic inhalation RfD of 6.8E-6 mg/kg-day.

No current EPA-derived subchronic inhalation evaluation exists for chromium (VI) particulates. However, a preliminary subchronic inhalation RfC can be derived by excluding the uncertainty factor of 3 for expanding from subchronic to chronic exposure. Application of the remaining overall uncertainty factor of 100 to the adjusted LOAEL benchmark concentration of 3.4E-2 mg/m^3 yields a preliminary subchronic inhalation RfC of 3E-4 mg/m^3 for chromium (VI) particulates. The preliminary subchronic inhalation RfC is equivalent to a subchronic inhalation RfD of 9.7E-5 mg/kg-day.

EPA (1998c) noted that exposure to chromic acid mists and dissolved chromium (VI) aerosols is likely to be restricted to occupational settings and that most environmental exposures would involve exposure to chromium (VI) particulates. Therefore, the chronic inhalation RfC and RfD for chromium particulates will be used in this evaluation.

6.0 Carcinogenicity Evaluation

EPA (2013) classified chromium (III) in cancer weight-of-evidence group D – not classified as to carcinogenicity to humans – because of inadequate data. Chromium (VI) is classified in cancer weight-of-evidence group A – known human carcinogen – based on the consistent finding of lung cancer in epidemiologic studies of occupationally exposed workers in chromate production and the chrome pigment industry (EPA, 2013). Conclusions regarding the human data are corroborated by data from animal experiments. There is no evidence that oral exposure to chromium (VI) induces cancer, and EPA (2013) assigned chromium (VI) to Group D for oral exposure.

An inhalation URF of 1.2E-2 per ug/m^3, equivalent to an inhalation SF of 4.2E+1 per mg/kg-day, was based on increased risk of lung cancer deaths in chromate production workers (EPA, 2013). It should be noted that the quantitative assessment is based on the concentration of total chromium to which the workers were exposed, including insoluble (trivalent) and soluble (hexavalent) forms. It was assumed that chromium (VI) constituted not less than one-seventh of the total chromium; i.e., a ratio of 1 part of chromium (VI) to 6 parts of chromium (III). However, the forms of chromium in the air were not identified, and chromium (VI) may have constituted a significantly much greater portion of total airborne chromium. EPA (2013) presented the URF of 1.2E-2 per ug/m^3 as a verified potency estimate for chromium (VI), but noted that this estimate may underestimate the potency of exposure to pure chromium (VI) by as much as seven-fold.

7.0 Toxicity Summary

Toxicity values for chromium (III) and chromium (VI) are summarized below. Theoretical noncancer toxicity values are calculated for total chromium assuming a chromium (III)/chromium (VI) ratio of 6 to 1. Note that the URF is based on a mixture of chromium (III) and chromium (VI).

Noncancer Effects						Carcinogenicity				
Oral Exposure[a]			Inhalation Exposure			Oral Exposure		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
Chromium (III)										
1.5E+0	1.5E+0	ND	ND	ND	NA	D	ND	D	ND	ND

Noncancer Effects						Carcinogenicity				
Oral Exposure[a]			Inhalation Exposure			Oral Exposure		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
Chromium (VI)[b]										
8E-3	3E-3	ND	3E-4/ 9.7E-5	1E-4/ 2.9E-5	Lu	D	ND	A	1.2E-2	4.2E+1
Total Chromium[c]										
NA	2.1E-2	ND	NA	7E-4/ 2.0E-4	Lu	D	ND	A	1.2E-2	4.2E+1

sRfDo = subchronic oral reference dose (milligrams per kilogram-day); cRfDo = chronic oral reference dose (milligrams per kilogram-day); TO = target organ(s) or critical effect(s); sRfC = subchronic inhalation reference concentration (milligrams per cubic meter); sRfDi = subchronic inhalation reference dose (milligrams per kilogram-day); cRfC = chronic inhalation reference concentration (milligrams per cubic meter); cRfDi = chronic inhalation reference dose (milligrams per kilogram-day); WOE = cancer weight-of-evidence evaluation; SFo = oral cancer slope factor (risk per milligram per kilogram-day); URFi = inhalation unit risk factor (risk per microgram per cubic meter); SFi = inhalation cancer slope factor (risk per milligram per kilogram-day); ND = no data; NA = not applicable.
Target organ or critical effect abbreviations: Lu = lung.
[a]sRfDo and cRfDo should be adjusted by the appropriate GAF values described above when used for dermal exposure.
[b]Inhalation RfC/RfD values listed are those for chromium (VI) particulates. Values for chromic acid mists and dissolved chromium (VI) aerosols are not relevant to environmental exposures.
[c]For noncancer effects is based on the assumption that total chromium consists of 1 part of chromium (VI) and 6 parts of chromium (III); note that the URF assumed a mixture of chromium (III) to chromium (VI) at a ratio of approximately 6:1 (EPA 2013; EPA, 2004b).

8.0 References

Agency for Toxic Substances and Disease Registry, (ATSDR), 2012, ***Toxicological Profile for Chromium***, U.S. Public Health Service, Atlanta, Georgia, September.

U.S. Environmental Protection Agency (EPA), 1995, "40 CFR 9, 122, 123, 131, and 132 Final Water Quality Guidance for the Great Lakes System; Final Rule," ***Federal Register***, 60(56); 15366-15425.

U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, Washington, DC, 9200.6-303(97-1), EPA 540/R-97-036, PB97-921199.

U.S. Environmental Protection Agency (EPA), 1998a, ***Toxicological Review of Hexavalent Chromium (CAS No. 18540-29-9) In Support of Summary Information on the Integrated Risk Information System (IRIS)***, August, on line.

U.S. Environmental Protection Agency (EPA), 1998b, ***Combustion Technical Assistance Center (CTAC) Request No. 70: Chromium Values***, National Center for Environmental Assessment, Cincinnati, OH, 22 September.

U.S. Environmental Protection Agency (EPA), 1998c, ***Combustion Technical Assistance Center (CTAC) Request No. 77: Information Regarding Chromium (III) and (VI) for Site-Specific Risk Assessment***, National Center for Environmental Assessment, Cincinnati, OH, 5 October.

U.S. Environmental Protection Agency (EPA), 2004a, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for***

Dermal Risk Assessment) Final, Office of Superfund Remediation and Technology Innovation, Washington, DC, EPA/540/R/99/005, OSWER 9285.7-02EP July.

U.S. Environmental Protection Agency (EPA), 2004b, ***Preliminary Remediation Goals Users Guide,*** Region 9, San Francisco.

U.S. Environmental Protection Agency (EPA), 2013, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

COBALT (7440-48-4)

1.0 Introduction and Physical Properties

Cobalt is a relatively scarce **metal**, constituting about 0.001 percent of the earth's crust (Elinder and Friberg, 1986). It often occurs in association with nickel, silver, lead, copper and iron ores. Cobalt is used in forming special metal alloys with unusual and useful properties (ATSDR, 2004; HSDB, 2013). It is also used in cutting materials, lacquers, varnishes, paint driers, enamels, inks, glazes, glass manufacture, as a catalyst in petroleum refining, and as a supplement in animal and human nutrition. Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
58.93[a]	NA	NA	45[b]	NA	NA	ND	Note 1[c]

MW = molecular weight (g/mole); log K_{ow} = base 10 logarithm of the octanol/water partition coefficient (unitless); H = Henry's Law constant (atm-m^3/mole) at the reference temperature; K_d = soil/water partition coefficient (L/kg); D_a = diffusivity in air (cm^2/second); D_w = diffusivity in water (cm^2/second); VP = vapor pressure (atm) at the reference temperature; S = solubility in water (mg/L) at the reference temperature; NA = not applicable; ND = no data.
Note 1: Cobaltous chloride as a typical cobalt salt: soluble.
[a]Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.
[b]Baes, C.F., R.D. Sharp, H. Sjoreen, and R.W. Shor, ***A Review and Analysis for Assessing Transport of Environmentally Released Radionuclides through Agriculture, ORNL-5786, Oak Ridge National Laboratory*** .
[c]Budavari, S, Ed., 1989, ***The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals***, Eleventh Edition, Merck & Co., Rahway, NJ.

2.0 Environmental Fate and Transport

Cobalt is released to the environment, particularly to the air, largely from industrial processes that involve grinding or polishing hard metal devices that contain cobalt (HSDB, 2013). Other anthropogenic sources include fossil fuel burning, vehicular and aircraft exhaust, production and use of cobalt-containing alloys and chemicals, copper and nickel smelting and refining, disposal of sewage sludge, and application of fertilizers derived from phosphate rock (ATSDR, 2004). Natural sources include soil and soil dust, seawater spray, and volcanic eruptions. Natural releases to the atmosphere slightly exceed anthropogenic releases.

Ionic cobalt compounds exist in the particulate phase in air and these compounds may be removed from the air by wet and dry deposition (HSDB, 2013).

HSDB (2013) reports that K_d values for cobalt range from 0.2 to 3,800 L/kg. The value of 45 L/kg presented above appears to be a reasonable intermediate point. Soils with higher pH and content of clay, natural organics, and hydrous manganese and iron oxides, bind cobalt to a greater degree; as these factors decrease, the mobility of cobalt increases. Microbial activity may increase the solubility of cobalt in soil. Chelating agents increase the solubility of cobalt and enhance its mobility in soil. Cobalt compounds do not volatilize from moist or dry soil surfaces due to their ionic character.

The transport and speciation of cobalt in natural waters and sediments is complicated by many factors (HSDB, 2013). The presence of sewage-derived organics appears to enhance the solubility of cobalt in freshwater by forming soluble complexes. Cobalt exists in the +2 or +3 oxidation state for the majority of its compounds and complexes. Volatilization from water surfaces is not expected, due to the ionic nature of dissolved cobalt compounds.

A few plant species are known to accumulate cobalt; however, translocation to aerial parts is generally insignificant (ATSDR, 2004; HSDB, 2013). Cobalt is bioaccumulated by aquatic organisms, particularly at the lower trophic levels. Biomagnification, however, does not occur and cobalt localizes in the viscera and on the skin, rather than in edible tissues. Therefore, cobalt is not expected to impact human health through the food-chain pathways and biotransfer factors are not provided.

3.0 Toxicokinetics

Inhaled cobalt particles deposit in the upper or lower respiratory tract, depending largely on particulate size (ATSDR, 2004). Uptake may occur by dissolution or phagocytosis; larger particles are removed by ciliary clearance. The extent of pulmonary uptake depends largely on particle size distribution.

GI absorption of ingested cobalt in humans ranges from 18 to 97 percent, depending on the form and dose, and on the nutritional status of the subjects (ATSDR, 2004). Cobalt is absorbed more efficiently in cases of iron deficiency. Animal studies show that soluble forms such as cobalt chloride are absorbed to a much greater extent (13 to 34 percent) than insoluble cobalt oxide (1 to 3 percent).

Experiments with humans indicate that cobalt in hard metal dust can be absorbed through the skin, although the rate or extent of uptake were not quantified (ATSDR, 2004). Experiments in animals indicate that cobalt is absorbed much more efficiently through abraded than intact skin.

Distribution of cobalt within body tissues depends in large measure on the route of exposure (ATSDR, 2004). Cobalt as a component of cyanocobalamin (vitamin B12) is generally distributed among the body tissues. Highest levels following inhalation exposure are found in the tissues and lymph nodes of the respiratory tract. Lesser but elevated levels are found in liver, spleen and kidney. Highest levels are found in the liver following ingestion exposure.

Elimination also depends on route of exposure (ATSDR, 2004). Inhaled particulates are cleared by mucociliary elevation, phagocytosis and dissolution. Elevated particles are swallowed and subjected to GI absorption or throughput in the feces. Absorbed cobalt is excreted primarily through the urine.

4.0 Dermal Exposure

The provisional chronic oral RfD of 3E-4 for cobalt was derived from a study in which humans were treated orally with cobalt (EPA, 2008). A GAF of 1, as recommended by EPA (2004) is selected for cobalt.

Data were not located regarding the extent of dermal uptake of cobalt from soil, and EPA (2004) provides no estimate of the extent of dermal absorption (ABS). EPA (2004) recommends that

dermal uptake from soil should not be quantified for chemicals without ABS recommendations, but that these chemicals should be discussed qualitatively as a source of uncertainty. The EPA (2004) K_p for cobalt of 4E-4 cm/hour is selected for cobalt.

5.0 Noncancer Effects Evaluation

Human health effects following oral exposure to cobalt include decreased iodine uptake by the thyroid, dermatitis in sensitized individuals, increased erythrocyte production and hemoglobin levels, and cardiomyopthy. Related effects to each of these, except dermatitis, are supported by animal studies. Other effects observed in animal studies include neurobehavioral and testicular; these effects were observed only at relatively high doses. Thyroid toxicity was selected as the critical effect for the derivation of provisional oral reference doses.
Cobalt is nutritionally essential as a cofactor in cyanocobalamin ATSDR, 2004). The element is ubiquitous and universally present in the diet. Data from a dietary survey performed in the 1980s indicate that daily U.S. dietary intakes of cobalt are in the range of 3E-3 to 1.1E-2 mg/day (4E-5 to 2E-4 mg/kg-day, assuming an average body weight of 70 kg). Chronic ingestion from the consumption of beer containing high concentrations of cobalt is associated with "beer-cobalt cardiomyopathy," which includes polycythemia and goiter, as well as marked myocardial degeneration and mortality. However, confounding variables were identified and a dose-response could not be derived from the associated studies (EPA, 2008).

A consistently produced effect of exogenously administered cobalt in humans is the erythropoietic effect of stimulating erythrocyte production resulting in increased blood hemoglobin concentration (EPA, 2002). Cobalt chloride has been used therapeutically at dose rates of 1.6E-1 to 3.2E-1 mg cobalt/kg-day in anemic, anephric dialysis patients for 12 to 32 weeks to induce a significant, but reversible, rise in blood hemoglobin concentration. Clinical studies demonstrating this effect identified an effect level of 1.8E-1 mg/kg-day, which EPA (2002) had previously designated a LOAEL. However, EPA (2008) has since identified confounding variables, and has judged the effects of cobalt in some of the patients in pertinent studies as beneficial rather than adverse. A LOAEL of 1 mg/kg-day for subchronic thyroid toxicity as the critical oral effect was identified by EPA (2008) from a subchronic study by Roche and Layrisse (1956). A provisional subchronic RfD of 3E-3 mg/kg-day was derived assuming a composite UF of 300. This assumes a UF of 10 for LOAEL to NOAEL conversion, and a UF of 10 for inter-individual variability. An additional UF of 3 was added due to a lack of multigenerational studies, since testicular degeneration and sperm function were noted in some animal studies.

The provisional chronic oral RfD of 3E-4 mg/kg-day was derived as described for the subchronic RfD, with an additional UF of 10 added to extrapolate from subchronic to chronic exposure for a composite UF of 3,000 (EPA, 2008). Confidence in the principal study is described as low-to-medium.

The human and animal database indicate that symptoms of inhaled cobalt include respiratory tract irritation and altered pulmonary function. There were identified as the critical effects for exposure to inhaled cobalt for the derivation of RfDs. A NOAEL adjusted for continuous exposure of 1.9 $\mu g/m^3$ was identified by EPA (2008). A subchronic RfC of 2E-5 mg/m^3 was derived by EPA (2008) assuming a composite UF of 100, assuming a UF of 10 for database

insufficiencies and a UF of 10 for inter-individual variability. The preliminary subchronic inhalation RfC is equivalent to a preliminary subchronic inhalation RfD of 5.7E-5 mg/kg-day.

A provisional chronic RfC of 6E-6 mg/m3 was derived as described above for the subchronic RfC, but with an additional UF of 3 for the extrapolation from subchronic to chronic exposure (EPA, 2008). Thus, the composite UF is 300. This provisional RfC equals an inhalation RfD of 1.7E-6 mg/kg-day.

6.0 Carcinogenicity Evaluation

Human or animal studies examining the carcinogenicity of cobalt associated with oral exposure were not located. Therefore, cobalt is classified as having "inadequate information to assess carcinogenic potential" via the oral pathway, thus no cancer slope factor was derived (EPA, 2008).

Cobalt is described as "likely to be carcinogenic to humans by the inhalation route," based on limited evidence of carcinogenicity in humans (occupational studies) and sufficient evidence of carcinogenicity in animals (EPA, 2008). Respiratory tract tumors have been suggested in occupational studies as the result of inhaled cobalt. Statistically increased incidence of respiratory tract tumors have been observed in animal studies. Limited evidence supports genotoxicity and cytotoxicity, followed by cellular regeneration as potential modes of cobalt tumorigenicity. A mutagenic effect may be plausible for inhaled cobalt, but has not been clearly established (EPA, 2008).

Human inhalation studies were not sufficiently detailed to use in the derivation of a URF. Rats and mice exposed via inhalation to cobalt sulfate heptahydrate for 2 years developed alveolar and bronchial lung tumors (neoplasms and adenomas). EPA (2008) identified a benchmark dose level of In the absence of an identified mode of action, EPA developed a provisional URF by linear extrapolation of benchmark dose level of 0.011 mg/m^3. Using a benchmark response of 10 percent in extra risk, a provisional URF of 9E-3$(\mu g/m^3)^{-1}$ was derived for cobalt sulfate. This equals an inhalation SF of 3.2E+1 $(mg/kg\text{-}day)^{-1}$.

7.0 Toxicity Summary

Toxicity values for cobalt are summarized as follows:

Noncancer Effects						Carcinogenicity				
Oral Exposure			Inhalation Exposure			Oral Exposure		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
3E-3	3E-4	Thyroid	2E-5/5.7E-5	6E-6/ 1.7E-6	RT	ND	ND	B	9E-3	3.2E+1

sRfDo = subchronic oral reference dose (milligrams per kilogram-day); cRfDo = chronic oral reference dose (milligrams per kilogram-day); TO = target organ(s) or critical effect(s); sRfC = subchronic inhalation reference concentration (milligrams per cubic meter); sRfDi = subchronic inhalation reference dose (milligrams per kilogram-day); cRfC = chronic inhalation reference concentration (milligrams per cubic meter); cRfDi = chronic inhalation reference dose (milligrams per kilogram-day); WOE = cancer weight-of-evidence evaluation; SFo = oral cancer slope factor (risk per milligram per kilogram-day); URFi = inhalation unit risk factor (risk per microgram per cubic meter); SFi = inhalation cancer slope factor (risk per milligram per kilogram-day); ND = no data; NA = not applicable.
Target organ or critical effect abbreviations: RT = respiratory tract.

8.0 References

Agency for Toxic Substances and Disease Registry (ATSDR), 2004, ***Toxicological Profile for Cobalt***, Draft for Public Comment, U.S. Department of Health and Human Services, Atlanta, Georgia, April.

Elinder, C.-G and L. Friberg, 1986, "Cobalt," In: Friberg, L., G.F. Nordberg and V.B. Vouk, Eds., ***Handbook on the Toxicology of Metals,*** Second Edition, Volume II: Specific Metals, Elsevier Science Publishers, New York, NY, pp. 211-232.

Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

Roche, M., and M. Layrisse, 1956, "The Effect of Cobalt on Thyroidal Uptake of I^{131}", ***Journal of Clinical Endocrinology and Metabolism***, Volume 16, pp. 831-833.

U.S. Environmental Protection Agency (EPA), 2002, ***Risk Assessment Issue Paper for: Derivation of a Provisional RfD for Cobalt and Compounds (CASRN 7440-48-4)***, National Center for Environmental Assessment, Cincinnati, OH, 15 January.

U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final***, Office of Emergency and Remedial Response, EPA/540/R/99/005, OSWER 9285.7-02EP, July.

U.S. Environmental Protection Agency (EPA), 2008, ***Provisional Peer-Reviewed Toxicity Values for Cobalt (CASRN 7440-48-4)***, National Center for Environmental Assessment, Cincinnati, OH, 25 August.

IRON (7439-89-6)

1.0 Introduction and Physical Properties

Iron is a very abundant, ubiquitous, naturally occurring **metal** that constitutes approximately 5 percent of the earth's crust (Spivey Fox and Rader, 1988). It is the second most prevalent metal in the earth's crust following aluminum (HSDB, 2013). Its primary use is in making steels and other metals that have a wide range of application. Less than one percent of iron is used to make iron compounds that have application in dyes and pigments, water treatment, organic chemical synthesis, and medicinal preparations. Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
55.85[a] (Element)	NA	NA	25[b]	NA	NA	ND	Note 1[a]

MW = molecular weight (g/mole); log K_{ow} = base 10 logarithm of the octanol/water partition coefficient (unitless); H = Henry's Law constant (atm-m^3/mole) at the reference temperature; K_d = soil/water partition coefficient (L/kg); D_a = diffusivity in air (cm^2/second); D_w = diffusivity in water (cm^2/second); VP = vapor pressure (atm) at the reference temperature; S = solubility in water (mg/L) at the reference temperature; NA = not applicable; ND = no data.
Note 1: Ferrous sulfate as a typical iron salt: soluble.
[a]Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.
[b] Baes, C.F., R.D. Sharp, H. Sjoreen, and R.W. Shor, ***A Review and Analysis for Assessing Transport of Environmentally Released Radionuclides through Agriculture, ORNL-5786, Oak Ridge National Laboratory*** .

2.0 Environmental Fate and Transport

There is little information available regarding the anthropogenic release of iron and its fate in the environmental, probably because of its prevalence in nature. Clearly, however, mining and handling of iron ores releases dust containing iron oxides (HSDB, 2013). Presumably the manufacture and use of iron compounds may result in release to the environment, but data were not located.

Insoluble iron compounds are most likely to occur in air as particulates, and are expected to deposit to soil and surface water (HSDB, 2013). Although data are unavailable, soluble compounds are expected to leach to groundwater, and to remain in solution in both groundwater and surface water. The extent of partitioning to sediment is expected to depend on water pH, organic matter and reduction-oxidation potential of the water system.

Biouptake of iron is known to occur, because the element is a nutritionally required trace element that is a structural component of heme proteins and some enzymes, which are common to mammals and several other orders of living organisms (Spivey Fox and Rader, 1988). However, there is no evidence that iron bioconcentrates in either aquatic or terrestrial food chain pathways. Therefore, biotransfer factors for iron are not presented.

3.0 Toxicokinetics

The GI absorption of iron is regulated by homeostatic mechanisms sited largely in the intestinal mucosa (Goyer, 1991; EPA, 2006). Approximately 2 to 15 percent of dietary iron is ordinarily absorbed; however, several dietary factors may increase or decrease absorption (HSDB, 2013). Dietary iron from animal sources is absorbed more readily (10 to 25 percent) than iron from

vegetables and grains (1 to 10 percent) (Elinder, 1986). Absorption is greatly increased at times of unusual need (rapid growth of childhood, pregnancy, blood loss). Divalent (ferrous) iron is absorbed into the intestinal mucosal cells and released to the blood plasma where it is oxidized to the trivalent (ferric) form, which binds with a specific protein, transferrin, for transport to storage sites.

Approximately 67 percent of iron in the body is associated with hemoglobin in the erythrocytes, 10 percent is associated with myoglobin and various iron-containing enzymes, and the remainder is bound to ferritin or hemosiderin, which are intracellular storage forms (Goyer, 1991). Ferritin and hemosiderin bind iron in a manner that renders it inactive for beneficial use (e.g., hemoglobin synthesis) and inactive as a toxicant. Some of the iron taken up by the cells of the reticuloendothelial system remains stored and some enters a labile pool that is available for erythropoiesis.

Excess iron is generally excreted, in part in shed intestinal epithelial cells, or in the bile or urine (Goyer, 1991). In cases of very high iron intake, excretion may be unable to remove iron as quickly as it is absorbed. Iron overload results, which stimulates increased synthesis of ferritin and increased iron storage, particularly in the liver, pancreas, spleen, various endocrine organs and the heart.

4.0 Dermal Exposure

As noted above, the GI absorption of iron appears to be under homeostatic control in normal humans (EPA, 2006), which suggests that GI absorption could vary widely between individuals depending on nutritional status. Given the uncertainty about the GI absorption of iron, a default GAF of 1 (EPA, 2004) is chosen for this evaluation.

Data were not located regarding the extent of dermal uptake of iron from soil, and EPA (2004) provides no estimate of the extent of dermal absorption (ABS). EPA (2004) recommends that dermal uptake from soil should not be quantified for chemicals without ABS recommendations, but that these chemicals should be discussed qualitatively as a source of uncertainty. Empirical data regarding the uptake of soluble forms of iron from water were not located. The EPA (2004) default K_p for inorganic chemicals of 1E-3 cm/hour is selected for iron.

5.0 Noncancer Effects Evaluation

Iron is a nutritionally required trace element that forms an integral part of hemoglobin, myoglobin and several enzymes (Spivey Fox and Rader, 1988). The NAS (1989) Recommended Daily Allowance (RDA) for iron is 10 mg/day (0.13 mg/kg-day) for adult males; 15 mg/day (0.24 to 0.33 mg/kg-day) for females aged 11 to 50 years; 30 mg/day (0.443 mg/kg-day) for pregnant females; and 10 mg/day (0.36 to 1.11 mg/kg-day) for children aged 6 months to 10 years.

Both acute and chronic toxicity syndromes are associated with ingestion exposure to iron. Acute toxicity generally involves children (Goyer, 1991). Acute ingestion of large quantities (e.g., children may ingest several ferrous sulfate tablets with candy-like coating) results in severe GI irritation and, in some cases, liver damage. Liver cirrhosis and blood coagulation defects (indicative of reduced circulating levels of blood clotting factors produced by the liver) are observed as sequellae to severe acute toxicity.

Three chronic toxicity syndromes that result in iron overload have been observed in humans (Goyer et al., 1991). The first chronic syndrome is idiopathic hemochromotosis, which arises from a genetic derangement of the homeostatic mechanisms that control iron absorption. This syndrome involves greatly increased GI absorption of iron, regardless of the level of iron in the diet, which results in massive iron overload.

The second chronic syndrome is iron overload resulting from high dietary intake (Goyer, 1991). Although high dietary intake seldom results in iron overload in humans with normal homeostatic control of iron absorption, rare exceptions occur (EPA, 2006). One such exception is the occurrence of iron overload in Bantus who regularly consumed Kaffir beer, an acid beer brewed in iron vessels. This syndrome is not entirely understood; however, the iron in Kaffir beer appears to have exceptionally high bioavailability – equivalent to that of nutritional iron supplements especially formulated for bioavailability – which may account for the increased absorption and iron overload. Other exceptions include persons who take large amounts of tonics or nutritional supplements containing iron.

The third chronic syndrome involves persons requiring multiple blood transfusions over a period of time (Goyer, 1991). This results in the parenteral administration of large quantities of iron that are released as the transfused erythrocytes expire and are removed from the circulation by the reticuloendothelial system. As noted above, excretion cannot keep up with unusually high circulating levels of iron, such as results from multiple blood transfusions. Clearly, the third syndrome has no relevance to environmental exposure.

Regardless of the chronic syndrome that produces it, the effects of iron overload involve the same pathogenesis (Goyer, 1991). Iron stores in the body increase from the normal level of 3 to 5 g, to levels of 20 to 40 g. The cells are induced to increase production of ferritin, which binds the iron cation inactivating its toxicity. Increasingly larger proportions of iron are located in hemosiderin than in ferritin. Hemosiderin is a larger storage protein, probably formed primarily from ferritin. The iron in hemosiderin is essentially completely unavailable and nontoxic. Hemosiderosis is the term given to large accumulations of hemosiderin that do not result in adverse effects because the iron is unavailable. Extremely large accumulations of hemosiderin that result in impaired cellular function is termed hemochromotosis. Hemochromotosis of the liver, endocrine glands and heart is associated with reduced liver function, eventually liver cirrhosis, pancreatic fibrosis, diabetes mellitus, other endocrine disruption and cardiovascular effects.

Goyer (1991) and EPA (2006) reviewed the available data regarding the toxicity of iron. Neither source located any data clearly associating *environmental* exposure with toxicity. EPA (1996) reviewed a study associating high circulating ferritin levels and high dietary iron intakes with myocardial infarction in Finnish men, but association with other factors (e.g., high levels of red meat consumption) confounds interpretation of this study. Furthermore, attempts to produce an animal model of chronic iron toxicity have failed, presumably because of the efficacy of the homeostatic mechanisms that regulate iron absorption from the GI tract.

EPA (1996) reasoned previously that a NOEL for chronic iron overload could be inferred from the estimates of dietary intake and iron status (circulating ferritin levels) established by the second National Health and Nutrition Examination Survey (NHANES II) data base. The

NHANES II study determined that average dietary iron intakes, which ranged from 0.15 to 0.27 mg/kg-day, were associated with normal iron status. More recently, EPA (2006) has concluded that the assignment of a LOAEL based on iron overload for normal individuals cannot be determined based on existing data because of confounding factors in the studies.

EPA (2006) has determined that gastrointestinal toxicity, commonly associated with therapeutic use of iron supplements, is the critical effect. A provisional subchronic and chronic oral RfD of 0.7 mg/kg-day was derived, based on a LOAEL of 1 mg/kg-day and a UF of 1.5 (EPA, 2006). The same value was derived for both subchronic and chronic exposures because clinical experience with iron supplements indicates that the gastrointestinal irritation is associated with treatment and does not intensify with duration. Further, the effect is reversible once treatment is discontinued. A higher UF was not selected because of the reversibility and the effect is not regarded as serious (EPA, 2006).

Inhalation (occupational) exposure to iron oxide fumes may lead to radiographic densities in the lungs without demonstrable clinical effects (ACGIH, 1991). Inhalation of dusts or mists of ferric salts may irritate the respiratory tract. Inhalation data are insufficient for derivation of an inhalation RfC or RfD (EPA, 2005a).

6.0 Carcinogenicity Evaluation

Data regarding the potential carcinogenicity of iron were not located. Neither a cancer weight-of-evidence classification nor cancer potency factors are available (EPA, 2005b).

7.0 Toxicity Summary

Toxicity values for iron are summarized below:

Noncancer Effects						Carcinogenicity				
Oral Exposure[a]			Inhalation Exposure			Oral Exposure		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
7E-1	7E-1	GI	ND	ND	NA	ND	ND	ND	ND	ND

sRfDo = subchronic oral reference dose (milligrams per kilogram-day); cRfDo = chronic oral reference dose (milligrams per kilogram-day); TO = target organ(s) or critical effect(s); sRfC = subchronic inhalation reference concentration (milligrams per cubic meter); sRfDi = subchronic inhalation reference dose (milligrams per kilogram-day); cRfC = chronic inhalation reference concentration (milligrams per cubic meter); cRfDi = chronic inhalation reference dose (milligrams per kilogram-day); WOE = cancer weight-of-evidence evaluation; SFo = oral cancer slope factor (risk per milligram per kilogram-day); URFi = inhalation unit risk factor (risk per microgram per cubic meter); SFi = inhalation cancer slope factor (risk per milligram per kilogram-day); ND = no data; NA = not applicable.
Target organ or critical effect abbreviations: GI = gastrointestinal.
[a]sRfDo and cRfDo should be used for dermal exposure without adjustment for GI absorption.

In most cases, it is inappropriate to apply the toxicity values summarized above to environmental exposure.

8.0 References

American Conference of Governmental Industrial Hygienists (ACGIH), 1991, ***Documentation of the Threshold Limit Values and Biological Exposure Indices***, Sixth Edition, ACGIH, Cincinnati, OH, pp. 803-809.

Elinder, C.-G., 1986, "Iron," in Friberg, L., G.F. Nordberg and V.B. Vouk, eds., ***Handbook on the Toxicology of Metals,*** Second Edition, Volume II: Specific Metals, Elsevier Science Publishers, New York, NY, pp. 276-297.

Goyer, R.A., 1991, "Toxic Effects of Metals," in ***Casarett and Doull's Toxicology, The Basic Science of Poisons, Fourth Edition***, M.O. Amdur, J. Doull and C.D. Klaassen, eds., Pergamon Press, New York, pp 623-680.

Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

National Academy of Sciences (NAS), 1989, ***Recommended Daily Allowances, 10th Edition***, National Academy Press, Washington, DC. (Cited in EPA, 1996).

Spivey Fox, M.R. and J.I. Rader, 1988, "Iron," in Seiler, H.G. and H. Sigel, eds., ***Handbook on Toxicity of Inorganic Compounds***, Marcel Dekker, Inc., New York, pp. 345-354.

U.S. Environmental Protection Agency (EPA), 1996, ***Risk Assessment Issue Paper for: Derivation of a Provisional RfD for Iron (CASRN 7439-89-6)***, National Center for Environmental Assessment, Cincinnati, OH, 23 July. 2008

U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final***, Office of Emergency and Remedial Response, EPA/540/R/99/005, OSWER 9285.7-02EP, July.

U.S. Environmental Protection Agency (EPA), 2005a, ***Provisional Peer-Reviewed Toxicity Values for Iron and Compounds (CASRN 7439-89-6), Derivation of a Carcinogenicity Assessment***, National Center for Environmental Assessment, Cincinnati, OH, 29 July.

U.S. Environmental Protection Agency (EPA), 2005b, ***Provisional Peer-Reviewed Toxicity Values for Iron and Compounds (CASRN 7439-89-6), Derivation of n Inhalation RfC***, National Center for Environmental Assessment, Cincinnati, OH, 16 June.

U.S. Environmental Protection Agency (EPA), 2006, ***Provisional Peer-Reviewed Toxicity Values for Iron and Compounds (CASRN 7439-89-6), Derivation of Chronic and Subchronic Oral RfDs***, National Center for Environmental Assessment, Cincinnati, OH, 29 July.

INORGANIC MANGANESE (7439-96-5)

1.0 Introduction and Physical Properties

Manganese is a naturally occurring **metal** found in the earth's crust in the form of numerous minerals such as pyrolusite, romanechite, manganite and hausmannite (ATSDR, 2012; HSDB, 2013; Keen and Leach, 1988). It occurs ubiquitously in the environment, constituting approximately 0.085 percent of the earth's crust, commonly in valence states of +2, +4 and +7; valences of +1, +3, +5 and +6 are rare. Manganese is used in the manufacture of steel, and in other metallurgical processes, batteries, and various manganese-containing chemicals including matches, glass and porcelain, fireworks, varnishes, ceramics, diagnostic contrast media and fungicides. Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
54.938[a] (Elemental)	NA	NA	65[b]	NA	NA	NA	Note 1[c]

MW = molecular weight (g/mole); log K_{ow} = base 10 logarithm of the octanol/water partition coefficient (unitless); H = Henry's Law constant (atm-m^3/mole) at the reference temperature; K_d = soil/water partition coefficient (L/kg); D_a = diffusivity in air (cm^2/second); D_w = diffusivity in water (cm^2/second); VP = vapor pressure (atm) at the reference temperature; S = solubility in water (mg/L) at the reference temperature; NA = not applicable.
Note 1: Metallic manganese decomposes in the presence of water. Manganous chloride as a typical manganese salt: 7.23E+5 mg/L (25° C).
[a]Hazardous Substance Data Bank (HSDB), 2010, National Library of Medicine, on line.
[b]Baes, C.F., R.D. Sharp, A.L. Sjoreen, R.W. Shor, 1984, ***A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture***, Health and Safety Division, Oak Ridge National Laboratory, ORNL-5786, September.
[c]Agency for Toxic Substances and Disease Registry, (ATSDR), 2000, ***Update Toxicological Profile for Manganese***, U.S. Public Health Service, Atlanta, Georgia, September.

2.0 Environmental Fate and Transport

Inorganic manganese compounds enter the atmosphere and other environmental compartments from the weathering of rocks and windblown soil (HSDB, 2013). Anthropogenic sources of atmospheric manganese include metal processing, disposal and use of manganese-containing materials (antiseptics, catalysts, dietary supplements, dry cells, feed additives, fertilizers, pesticides and pigments), resuspension of manganese-containing soil dust, and fly ash emissions from incinerators (ATSDR, 2012; HSDB, 2013). Another source of atmospheric manganese is the combustion of gasoline containing organic manganese anti-knock ingredients such as methylcyclopentadienyl manganese tricarbonyl (MMT). It is unclear whether manganese from this source remains as an organic form or is converted to an inorganic form. The use of MMT in gasoline has been discontinued because of deleterious effects on catalytic converters. Manganese may be released to water by discharge from industrial facilities or in leachate from landfills and soil. Landfill disposal of manganese-containing wastes is the predominant source of manganese release to soil.

Manganese exists in the air bound to particles; dry deposition is the primary removal mechanism, although wet deposition may also be significant (ATSDR, 2012). Manganese in fly ash exists as chlorides and oxides that are relatively soluble and mobile in the environment.

Manganese in water exists as any of several sparingly soluble salts that attach to suspended sediment (ATSDR, 2000). Sedimentation is the primary removal process. Soluble forms also exist, depending on pH of the water, and may be released from sediment. The extent of

absorption to constituents of soil is highly variable. Low concentrations may irreversibly bind to clay, but higher concentrations often manifest considerable mobility.

Manganese may accumulate in various kinds of plants such as legumes, nuts, heather, and tea, and in the lower aquatic trophic levels, but not significantly in the higher aquatic trophic levels or most terrestrial animals (ATSDR, 2012; HSDB, 2013). This indicates that food-chain pathways are unlikely to be significant for human health; therefore, biotransfer factors are not compiled or estimated.

3.0 Toxicokinetics

Manganese is nutritionally essential for humans (ATSDR, 2012). Stable tissue levels are maintained by homeostatic regulation of GI absorption and biliary excretion.

Manganese is absorbed by the respiratory tract (ATSDR, 2012), although data quantifying the extent of absorption were not located. Smaller particles are probably retained in the lung eventually to be absorbed; larger particles are probably removed by mucocilliary elevation and swallowed so that they become available for GI absorption. The more soluble compounds are more readily absorbed by the respiratory tract. Studies in rats given radiolabeled manganese by intranasal administration suggest that olfactory uptake and direct transmission to the brain may occur.

GI absorption of manganese in humans averages 3 to 5 percent, but homeostatic mechanisms reduce the extent of absorption at higher doses (ATSDR, 2012). The more soluble compounds are more readily absorbed. Iron deficiency enhances manganese uptake. Absorption appears to be more efficient and resulting tissue levels appear to be higher in infants than adults.

Quantitative data regarding dermal uptake of manganese were not located.

Normal tissue levels of manganese in humans range from 0.1 to 1 mg/kg wet weight with highest levels in liver, pancreas and kidney, and lowest levels in bone and fat (ATSDR, 2012). Animal studies (inhalation, intranasal, intratracheal and oral administration) confirm that many tissues including the brain, and in some instances specific regions of the brain, show significant increases in manganese levels after treatment. Tissue levels recede toward normal after treatment ceases.

Metabolism of manganese appears to be limited to oxidation-reduction changes in valence state (ATSDR, 2000). The evidence suggests that manganese (+2) is oxidized to manganese (+3), which alters its tissue distribution and slows excretion. Manganese is removed from the blood in the liver and is excreted principally through the bile. Urine, sweat and milk represent minor excretory routes. Animal studies show that the young are less efficient than adults in excreting manganese, although the young do not appear to be more sensitive to its effects.

4.0 Dermal Exposure

Data were not located regarding the extent of dermal uptake of manganese from soil, and EPA (2004) provides no estimate of the extent of dermal absorption (ABS). EPA (2004) recommends that dermal uptake from soil should not be quantified for chemicals without ABS recommendations, but that these chemicals should be discussed qualitatively as a source of

uncertainty. Empirical data regarding the uptake of soluble forms of manganese from water were not located. ATSDR (2012), however, notes that the uptake of manganese across intact skin is insignificant with respect to exposure, suggesting that uptake of toxicologically significant amounts is unlikely. EPA (2004) provides no chemical-specific estimate of K_p for manganese; therefore, the default K_p value of 1E-3 cm/hr is used to estimate dermal uptake of manganese from water.

5.0 Noncancer Effects Evaluation

Manganese is nutritionally required by humans for normal growth and health (EPA, 2010). Humans exposed to approximately 0.8 mg manganese/kg-day in drinking water (28 mg/L) exhibited lethargy, increased muscle tonus, tremor and mental disturbances. The elderly appeared to be more sensitive than children. Oral treatment of laboratory rodents induces biochemical changes in the brain, but rodents do not exhibit the neurological signs exhibited by humans.

EPA (2013) verified a chronic oral RfD for manganese of 1.4E-1 mg/kg-day from a NOAEL of 1.4E-1 mg/kg-day for neurologic effects from human dietary studies and an uncertainty factor of 1. Confidence in the RfD is medium. The oral RfD of 1.4E-1 mg/kg-day will be used for dietary items other than drinking water. EPA (2013) recommends that the contribution of background diet should be subtracted and that a modifying factor of 3 should be used to adjust for use when oral exposure involves drinking water and non-dietary ingestion. The oral RfD resulting from these manipulations is 4.7E-2 mg/kg-day, which is used for drinking water and incidental ingestion of non-dietary items. The CNS is the target organ for chronic oral exposure to manganese. EPA (1997) effectually adopts the chronic oral RfD as sufficiently protective for subchronic oral exposure.

The NOAEL described above is associated with a dose rate of approximately 10 mg/day for an adult. However, EPA (2002) notes that normal intake levels may well exceed 10 mg/day, especially with diets containing substantial amounts of whole-grain cereals, nuts, green leafy vegetables, and tea. Adverse effects have not been reported at dietary levels of 10 mg/day. It is likely that larger dose rates are innocuous as well.

Occupational exposure to high concentrations in air induces a generally typical spectrum of neurological effects, and increased incidence of pneumonia (ACGIH, 1991). EPA (2013) presents a verified chronic inhalation RfC of 5E-5 mg/m^3 (equivalent to an inhalation RfD of 1.4E-5 mg/kg-day) based on a LOAEL for neurological effects in occupationally exposed humans and an uncertainty factor of 1000. The uncertainty factor consists of three factors of 10 each to provide additional protection for unusually sensitive individuals, to extrapolate a NOAEL from a LOAEL, and to address database limitations including the less-than-chronic periods of exposure, the lack of developmental toxicity data, and uncertainty regarding potential but unquantified differences in the toxicity of different forms of manganese. Confidence in the RfC is medium. The CNS is the target organ for inhalation exposure to manganese. The chronic inhalation RfC is adopted as sufficiently protective for subchronic inhalation exposure.

6.0 Carcinogenicity Evaluation

EPA (2013) classified manganese in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans). Quantitative cancer risk estimates are not derived for Group D chemicals.

7.0 Toxicity Summary

Noncancer Effects						Carcinogenicity				
Oral Exposure			Inhalation Exposure			Oral Exposure		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
1.4E-1[a]/ 4.7E-2[b]	1.4E-1[a]/ 4.7-2[b]	CNS	5E-5/ 1.4E-4	5E-5/ 1.4E-5	CNS	D	ND	D	ND	ND

sRfDo = subchronic oral reference dose (milligrams per kilogram-day); cRfDo = chronic oral reference dose (milligrams per kilogram-day); TO = target organ(s) or critical effect(s); sRfC = subchronic inhalation reference concentration (milligrams per cubic meter); sRfDi = subchronic inhalation reference dose (milligrams per kilogram-day); cRfC = chronic inhalation reference concentration (milligrams per cubic meter); cRfDi = chronic inhalation reference dose (milligrams per kilogram-day); WOE = cancer weight-of-evidence evaluation; SFo = oral cancer slope factor (risk per milligram per kilogram-day); URFi = inhalation unit risk factor (risk per microgram per cubic meter); SFi = inhalation cancer slope factor (risk per milligram per kilogram-day); ND = no data.
Target organ or critical effect abbreviations: CNS = central nervous system.
[a]Dietary items other than drinking water.
[b]Ingestion of environmental media and drinking water.

8.0 References

Agency for Toxic Substances and Disease Registry, (ATSDR), 2012, ***Toxicological Profile for Manganese***, U.S. Public Health Service, Atlanta, Georgia, September.

American Conference of Governmental Industrial Hygienists (ACGIH), 1991, ***Documentation of the Threshold Limit Values and Biological Exposure Indices***, Sixth Edition, ACGIH, Cincinnati, OH, pp. 876-878.

Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

Keen and Leach, 1988, "Manganese," in Seiler, H.G. and H. Sigel, eds., ***Handbook on Toxicity of Inorganic Compounds***, Marcel Dekker, Inc., New York, pp. 405-415.

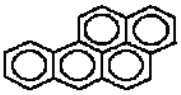
U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, Washington, DC, 9200.6-303(97-1), EPA 540/R-97-036, PB97-921199.

U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final***, Office of Superfund Remediation and Technology Innovation, Washington, DC, EPA/540/R/99/005, OSWER 9285.7-02EP July.

U.S. Environmental Protection Agency (EPA), 2013, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

Semivolatile Organic Compounds

POLYNUCLEAR AROMATIC HYDROCARBONS a.k.a. POLYCYCLIC AROMATIC HYDROCARBONS a.k.a. POLYAROMATIC HYDROCARBONS (PAH) (130498-29-2)



Benzo(a)Pyrene
(A representative and the most studied member of this class of compounds.)

1.0 Introduction and Physical Properties

The PAHs regularly observed in environmental media and addressed in this profile include acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene and pyrene. All exist as solids at room temperature. Classification as **SVOC** or **VOC** is made in the following table. PAHs are the products of incomplete combustion of fossil fuels or other organic matter, hence include both natural and anthropogenic sources (ATSDR, 1995; HSDB, 2013). Several are also components of crude oil. Naphthalene is used in the synthesis of phthalic anhydride, the insecticide carbaryl, leather tanning agents and surface active agents, and is a component of diesel and other fuels (ATSDR, 2005). Relevant physical properties are compiled below:

MW	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$
Acenaphthene (83-32-9) **(VOC)**										
154.21[a]	3.92[a]	1.55E-4[b] (25°C)	3.85[b]	4.21E-2[b] (25°C)	7.69E-6[b] (25°C)	3.29E-6[a] (25°C)	4.24E+0[b] (20-25°C)	550.54[c]	803.15[c]	1.22E+4[c]
Acenaphthylene (208-96-8) **(VOC)**										
152.20[a]	4.07[a]	1.13E-5[a] (25°C)	3.42[a]	6.67E-2[d] (25°C)[e]	7.72E-6[d] (25°C)[e]	1.20E-6[a] (25°C)	3.93E+0[a] (25°C)	543.2[a]	797[f]	1.1E+4[g]
Anthracene (120-12-7) **VOC)**										
178.23[a]	4.45[a]	6.51E-5[b] (25°C)	4.47[b]	3.24E-2[b] (25°C)	7.74E-6[b] (25°C)	3.51E-9[a] (25°C)	4.34E-2[b] (20-25°C)	615.18[c]	873.00[c]	1.31E+4[c]
Benzo(a)anthracene (56-55-3) **(SVOC)**										
228.3[h]	5.66[h]	3.34E-6[b] (25°C)	5.60[b]	5.10E-2[b] (25°C)	9.00E-6[b] (25°C)	2.50E-9[a] (25°C)	9.40E-3[b] (20-25°C)	708.15[c]	1004.8[c]	1.60E+4[c]
Benzo(a)pyrene (50-32-8) **(SVOC)**										
252.3[a]	6.10[h]	4.57E-7[i] (25°C)	6.01[b]	4.30E-2[b] (25°C)	9.00E-6[b] (25°C)	7.22E-12[a] (25°C)	1.62E-3[b] (20-25°C)	715.90[c]	969.27[c]	1.90+4[c]
Benzo(b)fluoranthene (205-99-2) **(VOC)**										
252.3[h]	6.12[h]	6.57E-7[i] (25°C)	6.09[b]	2.26E-2[b] (25°C)	5.56E-6[b] (25°C)	6.58E-10[a] (20°C)	1.50E-3[b] (20-25°C)	715.90[c]	969.27[c]	1.70+4[c]
Benzo(k)fluoranthene (207-08-9) **(SVOC)**										
252.32[a]	6.84[a]	8.29E-7[b] (25°C)	6.09[b]	2.26E-2[b] (25°C)	5.56E-6[b] (25°C)	1.28E-12[a] (25°C)	8.00E-4[b] (20-25°C)	753.15[c]	1019.7[c]	1.80E+4[c]
Benzo(g,h,i)perylene (191-24-2) **(SVOC)**										
276.34[a]	6.63[a]	2.66E-7[a] (20°C)	4.98[a]	4.48E-2[d] (25°C)[e]	5.19E-6[d] (25°C)[e]	1.3E-13[a] (25°C)	2.6E-4[a] (25°C)	823[a]	1097[f]	1.96E+4[g]
Chrysene (218-01-9) **(VOC)**										
228.3[h]	5.66[h]	9.46E-5[b] (25°C)	5.60[b]	2.48E-2[b] (25°C)	6.21E-6[b] (25°C)	8.20E-12[a] (25°C)	1.60E-3[b] (20-25°C)	714.15[c]	979.0[c]	1.65E+4[c]
Dibenz(a,h)anthracene (53-70-3) **(SVOC)**										
278.4[h]	6.84[h]	1.47E-8[b] (25°C)	6.58[b]	2.02E-2[b] (25°C)	5.18E-6[b] (25°C)	1.32E-13[a] (20°C)	2.49E-3[b] (20-25°C)	743.24[c]	990.41[c]	3.00E+4[c]
Fluoranthene (206-44-0) **(VOC)**										
202.3[h]	4.95[h]	1.61E-5[b] (25°C)	5.03[b]	3.02E-2[b] (25°C)	6.35E-6[b] (25°C)	1.21E-8[a] (25°C)	2.06E-1[b] (20-25°C)	655.95[c]	905.0[c]	1.38E+4[c]

MW	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$
Fluorene (86-73-7) **(VOC)**										
166.21[a]	4.18[i]	6.37E-5[b] (25°C)	4.14[b]	3.63E-2[b] (25°C)	7.88E-6[b] (25°C)	4.21E-7[a] (20°C)	1.98E+0[b] (20-25°C)	570.44[c]	870.0[c]	1.27E+4[c]
Indeno(1,2,3-cd)pyrene (193-39-5) **(SVOC)**										
276.3[h]	6.58[h]	1.60E-6[b] (25°C)	6.54[b]	1.90E-2[b] (25°C)	5.66E-6[b] (25°C)	1.71E-13[a] (25°C)	2.20E-5[b] (20-25°C)	809.15[c]	1078.2[c]	1.90E+4[c]
Naphthalene (91-20-3) **(VOC)**										
128.2[h]	3.30[h]	4.40E-4[k] (25°C)	3.30[b]	5.90E-2[b] (25°C)	7.50E-6[b] (25°C)	1.12E-4[a] (25°C)	3.10E+1[b] (20-25°C)	491.14[c]	748.40[c]	1.04E+4[c]
Phenanthrene (85-01-8) **(VOC)**										
178.2[h]	4.46[h]	1.24E-4[a] (25°C)	4.36[a]	6.00E-2[d] (25°C)[e]	6.95E-6[d] (25°C)[e]	8.95E-7[a] (25°C)	1.29E+0[a] (25°C)	613.2[a]	869.2[j]	1.42E+4[a]
Pyrene (129-00-0) **(VOC)**										
202.26[a]	4.88[a]	1.1E-5[b] (25°C)	5.02[b]	2.72E-2[b] (25°C)	7.24E-6[b] (25°C)	1.17E-7[a] (25°C)	1.35E-1[b] (20-25°C)	667.95[c]	936.0[c]	1.44E+4[c]

MW = molecular weight (g/mole); log K_{ow} = base 10 logarithm of the octanol/water partition coefficient (unitless); H = Henry's Law constant (atm-m^3/mole) at the reference temperature; log K_{oc} = base 10 logarithm of the soil/organic carbon partition coefficient (L/kg); D_a = diffusivity in air (cm^2/second); D_w = diffusivity in water (cm^2/second); VP = vapor pressure (atm) at the reference temperature; S = solubility in water (mg/L) at the reference temperature; T_b = normal boiling point (at 1 atm) of pure liquid compound (°K); T_c = critical temperature (°K);.$H_{v,b}$ = enthalpy of vaporization at the boiling point (cal/mole); ND = no data.

[a]Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

[b]U.S. Environmental Protection Agency (EPA), 2002, ***Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites***, Office of Solid Waste and Emergency Response, Washington, D.C., 9355.4-24, December.

[c]U.S. Environmental Protection Agency (EPA), 2000, ***User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings, Revised***, Office of Emergency and Remedial Response, Washington, DC, December.

[d]Calculated as described in Introduction to Toxicological profiles.

[e]Assumed.

[f]Estimated from Equation 12-4 in Lyman, W.J., W.F. Reehl and D.H. Rosenblatt, 1990, ***Handbook of Chemical Property Estimation Methods***, American Chemical Society, Washington, DC.

[g]Estimated from Equation 13-5 in Lyman, W.J., W.F. Reehl and D.H. Rosenblatt, 1990, ***Handbook of Chemical Property Estimation Methods***, American Chemical Society, Washington, DC.

[h]U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part E - Supplemental Guidance for Dermal Risk Assessment)***, Final, Office of Superfund Remediation and Technology Innovation, Washington, D.C., EPA/540/R-99/005, July.

[k]U.S. Environmental Protection Agency (EPA), 2012, *EPISuite electronic database*

.[j]National Institute of Standards and Technology (NIST), 2004, Standard Reference Data Program, Online Data Bases.

2.0 Environmental Fate and Transport

The PAHs are ubiquitous products of incomplete combustion; natural sources include volcanoes and forest fires (ATSDR, 1995, 2005; HSDB, 2013). There is some evidence for biosynthesis by plants, bacteria and algae. Some of the PAHs occur naturally in fossil fuels. Anthropogenic releases to the environment, primarily to the atmosphere, greatly outweigh the natural sources and include any processes that involve incomplete combustion of fossil fuels and organic matter, including wood-burning for home heat (the predominant source), cigarette smoke, internal combustion engine exhaust, and fuel oil emissions. Industrial sources include coal mining, processing and storing, wood treatment (creosote), manufactured gas plants (coal tar), power generation, production of coal tar, coke and asphalt, petroleum cracking and industrial and municipal incineration. Other sources include various crude oils, fresh and used motor oils, gasolines, charcoal-broiled foods, processed foods, various oils, margarine, butter and fats, fruits, vegetables, and cereals, roasted coffee and tea. Indoor sources include unvented kerosene heaters and gas cooking and heating appliances. Naphthalene is released during its manufacture and processes that involve its use (e.g., vaporization from moth balls).

Although PAHs generally occur in mixtures, certain chemicals tend to predominate in different sources so that the PAH pattern observed in a given medium may provide a clue to the source. The following compilation relates individual PAHs and sources:

Source[a]	Individual PAHs
Residential wood burning	Acenaphthylene
Auto emissions	Benzo(g,h,i)perylene, pyrene
Diesel exhaust particulates	Fluoranthene, phenanthrene, pyrene
Diesel exhaust vapors	Phenanthrene, anthracene

Source[a]	Individual PAHs
Diesel total emissions	Acenaphthene, fluorene, phenanthrene
Fly ash & bottom ash from U.S. municipal waste incinerators	Phenanthrene
Fly ash from U.K. municipal waste incinerators	Benzo(g,h,i)perylene
Particulate emissions from municipal waste incinerator	Benzo(a)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene
Municipal/medical waste incinerator	Benzo(a)anthracene, benzo(g,h,i)perylene
Rotary kiln incinerator charged with polyethylene, no afterburner	Fluoranthene, phenanthrene, pyrene (see next entry)
Rotary kiln incinerator charged with polyethylene with afterburner	Benzo(a)anthracene, phenanthrene (total PAH emissions reduced 100-fold compared with no afterburner)
Coal tar pitch emissions	Phenanthrene and pyrene 20 to 80 X > benzo(a)pyrene, benzo(g,h,i)perylene
Natural gas home appliances – fine particulate emissions	Chrysene, fluoranthene, pyrene, triphenylene
Groundwater near coal & oil gasification plant	Acenaphthylene, acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene, chrysene
Groundwater near wood treatment facilities	Benzo(a)pyrene, phenanthrene
[a]Agency for Toxic Substances and Disease Registry, (ATSDR), 1995, ***Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)***, U.S. Public Health Service, Atlanta, Georgia, August.	

Data compiled for soils are not included in the table above because the lists are long and the variation from one site to another is great, so that the information is not useful for identifying sources. Similarly, sediment is a sink for PAHs from all sources including atmospheric deposition from far distant locations, and the patterns observed in sediment do not necessarily reflect a nearby source (ATSDR, 1995). Generally, PAHs associated with combustion exhibit highly condensed ring structures and little alkylation (i.e., benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, benzo(e)pyrene, chrysene, fluoranthene, pyrene).

Crude petroleum and products made from crude petroleum (e.g., asphalts, fuels, oils) contain PAHs, but the patterns observed depend on the location of the source (ATSDR, 1995; Potter and Simmons, 1998). Phenanthrene and alkylated forms of PAHs, particularly the methylnaphthalenes, often predominate in petroleum products.

The partitioning and fate of the PAHs in environmental media depend largely on VP (tendency to exist in air as a vapor), H (indicator of partitioning between air and water) and K_{oc} (indicator of affinity to bind to organic matter in soil and sediment). ATSDR (1995) noted that H and K_{oc} are roughly directly related to MW, and that VP is roughly inversely related to MW. Therefore, they grouped the PAHs into the following categories to facilitate understanding their behavior in the environment:

- Low MW (152 to 178 g/mole) – acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene

- Medium MW (approximately 202 g/mole) – fluoranthene, pyrene

- High MW (228 to 278 g/mole) – benzo(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.

PAHs exist in the atmosphere as vapors or adsorbed to particulates, the proportion depending on the vapor pressure of the individual chemical and atmospheric conditions such as temperature and humidity (ATSDR, 1995; HSDB, 2013). Generally, the two- and three-ring compounds (low and medium MW except pyrene) exist predominantly as vapors; the four-ring compounds exist in both the vapor and particulate phase, and compounds with 5 or more rings (benzo[a]pyrene, benzo[g,h,i]perylene exist predominantly as particulates. Increasing atmospheric temperature and relative humidity favors existence in the vapor phase. PAHs may travel short or long distances before removal from the air. Vapor forms are subject to chemical oxidation processes in the air, which reduces the distance they may travel. Residence time and transport distance is inversely related to the size of the particles on which the PAHs are adsorbed. Small particles may have residence times of weeks, permitting transport for hundreds or upwards of a thousand miles. Wet and dry deposition accounts for removal of the particulates.

The predominant sources of PAHs in surface water are deposition from the atmosphere, industrial and sewage effluent and oil spills (ATSDR, 1995; 2005). Runoff and erosion can also contribute PAHs to surface water bodies. Volatilization is a significant fate process for PAHs with H values of 1E-5 atm-m^3/mole or greater (generally the low and medium MW compounds). Volatilization is a very limited removal process for most of the high MW compounds. Volatilization is enhanced by high temperature, turbulence and high wind. Sorption to benthic or suspended sediment and biodegradation are competing removal processes. Generally, volatilization and biodegradation are the predominant removal processes for the low MW compounds, and volatilization and sorption are the predominant removal processes for medium and high MW compounds. Naphthalene is relatively water soluble and may remain largely in solution. PAHs in sediment may biodegrade, recycle back to the water column (lower MW compounds) or accumulate in the lower trophic levels of living organisms.

Deposition from the atmosphere is the principal source of PAHs in soil (ATSDR, 1995; 2005). Other sources include industrial activities, disposal of sewage sludge, and leaching from coal storage sites. Most PAHs sorb to soil constituents because of their low solubility and high affinity for organic matter. Volatilization is an important removal process for the low molecular weight compounds. Some of the low molecular weight compounds, particularly naphthalene, may leach fairly rapidly to groundwater.

The high lipophilicity of many PAHs evidenced by high log K_{ow} values suggest that the PAHs might cross biologic membranes and participate significantly in food-chain pathways involving fish, fruit and vegetable, and meat and milk consumption. This, however, is not the case. For example, the PAHs are efficiently metabolized and excreted by fin fish, greatly reducing the likelihood of bioconcentration from water or bioaccumulation from sediment (ATSDR, 1995). Consequently, there are often great discrepancies between modeled BCF values and empirical BCF values, where care was taken to identify the parent compound rather than PAH metabolites in fish tissue. This distinction is necessary because aromatic fragments from PAH metabolism are readily assimilated as normal endogenous components of biological tissue. PAH concentrations in aquatic food-chain systems usually decrease with increasing trophic level, reflecting the generally greater efficiency of metabolism in the higher trophic organisms.

Approximate tissue-to-sediment PAH concentration ratios were reported to be 0.6 to 1.2 for amphipods, 0.1 for clams, and 0.05 for fin fish and shrimp.

It has been reported that terrestrial plants can accumulate PAHs from soil by uptake through the roots (ATSDR, 1995). More careful investigation, however, reveals that root uptake is quite low, and there is no evidence of bioconcentration or biomagnification. For example, PAH ratios in vegetation to soil in one survey ranged from 0.001 to 0.18 for total PAHs, and from 0.002 to 0.33 for benzo(a)pyrene. It is likely that most of the PAH contamination on the vegetation resulted from atmospheric deposition. Increased concentrations in vegetation have not been observed when soil PAH concentrations were greatly increased by amendment with sewage sludge. Data from carrots (*Daucus carotu*) showed that PAHs adhere to the outer skin of the root but show little tendency to penetrate to deeper layers, and even less tendency to translocate to aerial parts.

The inability of plants to bioconcentrate PAHs from soil reduces concern for bioconcentration in agricultural products such as meat and milk. It should be noted, however, that measurable concentrations of PAHs may accumulate on the aerial parts of plants because of deposition from the atmosphere (ATSDR, 1995). Also, food-producing animals ingest a substantial amount of soil while grazing or consuming mechanically harvested forage crops. Mammals, however, efficiently metabolize the PAHs to polar compounds that are readily excreted, reducing concern for bioconcentration.

In summary, the PAHs are highly lipophilic, which implies significance in food-chain exposure pathways. Empirical data, however, show that fish and mammals efficiently metabolize and eliminate these compounds. Furthermore, bioconcentration in plants because of uptake from soil is not significant. Therefore, it is unlikely that the PAHs would participate significantly in food-chain pathways, and biotransfer factors are not estimated.

3.0 Toxicokinetics

The PAHs are absorbed by all routes of exposure, but the rate and extent depends on the compound, the species of animal and the vehicle (or nature of the particulates) (ATSDR, 1995). PAHs are readily absorbed during inhalation exposure; however, intratracheal instillation studies indicate that particle size is the most important determiner of the extent of pulmonary uptake.

Toxicokinetic studies of several PAHs summarized by ATSDR (1995) provide limited quantitative information regarding the extent of GI absorption. Limitations arise largely because biliary excretion complicates quantification of uptake from the GI tract. A study of benzo(a)pyrene in rats suggests that GI absorption ranges from 38 to 58 percent. A study in rats reported absorption efficiency for anthracene ranging from 53 to 74 percent. GI absorption of pyrene, chrysene and dibenzo(a,h)anthracene is described as high. Administration of the test compound in oil or in a high-fat diet appears to increase the extent of GI absorption.

Empirical data with pure compound dissolved or suspended in various vehicles suggest that dermal uptake of benzo(a)pyrene is extensive (ATSDR, 1995). One occupational study reported that approximately 75 percent of systemically absorbed pyrene entered the body through dermal uptake rather than through inhalation exposure. Combining PAHs with soil appears to significantly reduce the extent of dermal uptake compared with oleaginous or acetone vehicles.

Anecdotal evidence from using cloth diapers stored in contact with naphthalene indicates that naphthalene is absorbed by the skin, but quantitative data are not available (ATSDR, 2005).

Distribution of absorbed PAHs is generally widespread, with highest levels located initially in lipid-rich tissues (ATSDR, 1995). Highest levels of metabolites (radioactivity following administration of radiolabeled compounds) are located in the liver and GI tract, even after inhalation exposure, probably reflecting extensive metabolism in the liver followed by biliary excretion. Ciliary clearance and deglutition probably contribute to levels associated with the GI tract. Concentrations of radioactivity following administration of radiolabeled compound reveal fetal levels approximately 2- to 10-fold lower than maternal levels, although this depends on the specific compound administered.

Metabolism of the PAHs, particularly benzo(a)pyrene, has been extensively studied (ATSDR, 1995). Metabolism proceeds rapidly, yielding products that are more water soluble and readily excreted than the parent compound. All tissues have the ability to metabolize the PAHs, potentially to carcinogenic intermediates, which probably accounts for the observation that cancers occur at the point of contact. There is considerable variability in tissue metabolic activity; however, the liver is probably the most active in most cases.

ATSDR (1995) distinguishes between “alternant” and “nonalternant” PAHs, based on the nature of the electron density associated with the molecule, which influences how that compound is metabolized to its ultimate carcinogen. Alternant PAHs (e.g., benzo[a]pyrene, benzo[a]anthracene, chrysene, dibenz[a,h]anthracene) exhibit a uniformly distributed electron density. Nonalternant PAHs (e.g., fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-cd]pyrene) behave more like two separate molecules because of uneven electron distribution.

Alternant PAHs (based on data for benzo[a]pyrene) are initially metabolized by the microsomal cytochrome P-450 system to several arene oxides (ATSDR, 1995). These may re-arrange spontaneously to phenols or undergo hydration to form the corresponding trans-dihydrodiols. Further oxidation of the dihydrodiols results in formation of quinones, phenol diols and dihydrodiol epoxides. Phenols may be formed by direct insertion of oxygen into a ring. Many of the metabolites resulting from the reactions described above are subject to conjugation with various substrates followed rapidly by excretion. The dihydrodiol epoxides that form in the “bay” region (the three-sided concave region formed by the fusion of three benzene rings) are most likely the ultimate carcinogens that covalently bind to macromolecules such as DNA, resulting in alkylation or other adducts that yield genetic errors.

Metabolism of the nonalternant PAHs differs from the alternant PAHs in that more extensive oxidation to hydroxy-epoxy-diols may be important to achieve genotoxicity (ATSDR, 1995). Dihydrodiol epoxide formation in the bay region is associated with carcinogenicity of the PAHs generally; however, some of the nonalternant PAHs yield reactive metabolites that deviate from the classical bay region model.

PAH metabolites are readily excreted, largely through the bile, although some metabolites are excreted by the kidney (ATSDR, 1995). The extent of elimination is species specific. In one inhalation study rats excreted metabolites much more efficiently than dogs or monkeys.

4.0 Dermal Exposure

EPA (2004) recommends that oral toxicity values for the PAHs should not be adjusted when applied to dermal exposure because GI absorption probably exceeds 50 percent. Therefore, no GAF is estimated and the oral toxicity values described below should be used for dermal exposure without adjustment.

Empirical data with pure compound dissolved or suspended in various vehicles suggest that dermal uptake of benzo(a)pyrene is extensive (ATSDR, 1995). Anecdotal evidence from using cloth diapers stored in contact with naphthalene indicates that naphthalene is absorbed by the skin, but quantitative data are not available (ATSDR, 2005). EPA (2004) reviewed empirical data regarding dermal uptake of benzo(a)pyrene and recommended an ABS of 0.13 for the PAHs. However, EPA (2004) also notes that VOCs tend to volatilize from soil when applied to the skin, reducing dermal uptake to toxicologically insignificant levels. Therefore, the ABS of 0.13 is applied to all the PAHs identified above as SVOCs. Dermal uptake of the PAHs identified as VOCs is not quantified.

Values for t*, K_p, τ, FA and B are provided or estimated as follows:

Chemical	t*	K_p	τ	FA	B
Acenaphthene[a]	1.84	8.39E-2	7.67E-1	1	0.4
Acenaphthylene[a]	1.79	1.08E-1	7.47E-1	1	0.5
Anthracene[a]	4.06	1.38E-1	1.05E+0	1	0.7
Benzo(a)anthracene[b]	8.53	4.7E-1	2.03E+0	1.0	2.8
Benzo(a)pyrene[b]	11.67	7.0E-1	2.69E+0	1.0	4.3
Benzo(b)fluoranthene[b]	12.03	7.0E-1	2.77E+0	1.0	4.3
Benzo(k)fluoranthene[a]	12.40	2.00E+0	2.72E+0	0.4	12
Benzo(g,h,i)perylene[a]	8.89	1.07E+0	3.70E+0	0.7	6.8
Chrysene[b]	8.53	4.7E-1	2.03E+0	1.0	2.8
Dibenz(a,h)anthracene[b]	17.57	1.5E+0	3.88E+0	0.6	9.7
Fluoranthene[b]	5.68	2.2E-1	1.45E+0	1.0	1.2
Fluorene[a]	2.15	1.07E-1	8.95E-1	1	0.5
Indeno(1,2,3-cd)pyrene[b]	16.83	1.0E+0	3.78E+0	0.6	6.7
Naphthalene[b]	1.34	4.7E-2	5.6E-1	1	0.2
Phenanthrene[b]	4.11	1.4E-1	1.06E+0	1	0.7
Pyrene[a]	3.42	1.94E-1	1.43E+0	1	1.1

t* = time for dermal uptake to reach steady state (hours); K_p = permeability coefficient (cm/hour); τ = lag time for chemical to cross stratum corneum (hours); FA = fraction absorbed (unitless); B = ratio of the permeability coefficient for passage across the stratum corneum relative to the permeability coefficient for passage across the viable epidermis (unitless).
[a]Estimated as described in Introduction to Toxicological profiles.
[b]Provided by U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part E - Supplemental Guidance for Dermal Risk Assessment)***, Final, Office of Superfund Remediation and Technology Innovation, Washington, D.C., EPA/540/R-99/005, July.

5.0 Noncancer Effects Evaluation

The PAHs are generally divided into two EPA cancer weight-of-evidence groups: Group D – not classifiable as to carcinogenicity to humans, and Group B2 – probable human carcinogens. The Group D PAHs have not been evaluated for carcinogenicity by toxicity testing; therefore, cancer SFs or URFs cannot be estimated for these compounds (EPA, 1986, 2010). Risk evaluation of these compounds is limited to noncancer effects. It is theoretically possible that cancer risk could be the “driver” for some of these compounds. However, the mechanism of carcinogenicity of the PAHs is fairly well understood to be correlated with molecular morphology and the propensity to

form certain active metabolites (ATSDR, 1995). The Group D PAHs either do not fit the morphologic mold or have been shown empirically to be unlikely to cause cancer, reducing greatly the uncertainty that significant cancer risk is being overlooked.

Cancer SFs and URFs are available for the Group B2 compounds, but noncancer RfDs or RfCs are not. Therefore, risk evaluation of these compounds is limited to cancer risk. These compounds have the morphologic requirements for carcinogenicity; therefore, it has been thought that cancer risk is the driver, and that noncancer effects are relatively insignificant, although empirical data were lacking until recently.

Recent data support this assumption. De Jong et al. (2008) reported a study in which male rats were treated by gavage with benzo(a)pyrene 5 days per week for 35 days at dose rates of 0 (control), 3, 10, 30 or 90 mg/kg. Significantly reduced rate of body weight gain and altered organ weights were observed in the 90 mg/kg group. Fore stomach lesions were found in the 30 and 90 mg/kg groups. Decreased thymus weights and hematological evidence of erythrocyte toxicity were observed in a dose-related manner in rats treated with 10 mg/kg and above. Subtle alterations in measures of immune function were also observed in these groups, establishing 10 mg/kg as the LOAEL and 3 mg/kg as the NOAEL for this study. The 3 mg/kg dose is equivalent to a NOAEL of 2.1 mg/kg-day when adjusted for continuous exposure. Application of an uncertainty factor of 1000 (factor of 10 to expand from subchronic to chronic exposure, and factors of 10 each to provide additional protection for intra- and interspecies variation) allows development of a preliminary oral RfD of 2E-3 mg/kg-day. Uncertainty surrounding the preliminary oral RfD is very high because the data base for the noncancer effects of benzo(a)pyrene is essentially limited to one study and several toxicological endpoints (e.g., developmental, reproductive, neurological) were not investigated.

The sole purpose for developing this oral RfD is to evaluate the potential for noncancer effects to be the driver for the Group B2 PAHs. The RfD was not developed with sufficient rigor to be used in the risk assessment of the noncancer effects of benzo(a)pyrene. The oral SF for benzo(a)pyrene is 7.3 per mg/kg-day (please see below), from which it is estimated that the oral RfD is equivalent to a cancer risk of 1.5E-2. This cancer risk is orders of magnitude above the EPA (1990) risk management range of 1E-6 to 1E-4, strengthening the position that noncancer effects are unlikely to be the driver for the Group B2 PAHs.

Data regarding the toxicity of acute oral exposure to the PAHs are generally scarce. Prolonged oral exposure to the Group D PAHs is associated with a number of renal, hematologic and other effects, depending on the compound.

Subchronic (90 day) gavage treatment of mice with acenaphthene is associated with histopathologic evidence of liver hypertrophy. A verified RfD of 6E-2 mg/kg-day for chronic oral exposure was derived from the NOAEL of 175 mg/kg-day and an uncertainty factor of 3000 (EPA, 2010). The LOAEL in this study was 350 mg/kg-day. Confidence in the RfD is low. The liver is considered the target organ for prolonged oral exposure to acenaphthene. EPA (1997) derived a provisional subchronic oral RfD for acenaphthene of 6E-1 mg/kg-day from the same mouse study using an uncertainty factor of 300.

A verified RfD of 3E-1 mg/kg-day for chronic oral exposure to anthracene was derived from a NOEL of 1000 mg/kg-day, the highest dose tested, in a 90-day gavage study in mice (EPA,

2010). An uncertainty factor of 3000 was applied. Confidence in the RfD is low. The data are inadequate to identify a target organ for prolonged oral exposure to anthracene. EPA (1997) derived a provisional subchronic oral RfD for anthracene of 3E+0 mg/kg-day from the same mouse study using an uncertainty factor of 300.

Subchronic exposure to fluoranthene induces liver and kidney effects and hematologic alterations in orally treated mice (EPA, 2010). A verified RfD of 4E-2 mg/kg-day for chronic oral exposure was derived from a NOAEL of 125 mg/kg-day in a 13-week gavage study. The LOAEL was 250 mg/kg-day in this study. An uncertainty factor of 3000 was applied. Confidence in the oral RfD is low. The kidney, liver and blood cells are chosen as the target organs for prolonged oral exposure to fluoranthene. EPA (1997) derived a provisional subchronic oral RfD for fluoranthene of 4E-1 mg/kg-day from the same mouse study using an uncertainty factor of 300.

Subchronic exposure to fluorene induces hemolytic anemia in orally treated mice (EPA, 2010). A verified RfD of 4E-2 mg/kg-day for chronic oral exposure was derived from a NOAEL of 125 mg/kg-day in a 13-week gavage study. The LOAEL was 250 mg/kg-day in this study. An uncertainty factor of 3000 was applied. Confidence in the oral RfD is low. The erythrocyte is the target organ for prolonged oral exposure to fluorene. EPA (1997) derived a provisional subchronic oral RfD for fluorene of 4E-1 mg/kg-day from the same mouse study using an uncertainty factor of 300.

Single-dose LD_{50} values for naphthalene include 533 to 710 mg/kg for mice and 2200 to 2400 mg/kg for rats, establishing the mouse as more sensitive to the lethal effects of acute oral exposure (ATSDR, 2005). Decreased terminal body weights, accompanied by a remarkable absence of hematological and histopathological effects, were observed in rats treated by gavage for 13 weeks (EPA, 2010). The LOAEL in this study was 142 mg/kg-day associated with greater than 10 percent reduction in terminal body weights. The NOAEL was 71 mg/kg-day. The high dose rate, 286 mg/kg-day was a FEL associated with increased mortality. Application of an uncertainty factor of 3000 (10 to extrapolate from rats to humans, 10 to protect sensitive humans, 10 to extrapolate from subchronic to chronic exposure, and 3 for database deficiencies) to the NOAEL of 71 mg/kg-day yields the verified chronic oral RfD of 2E-2 mg/kg-day. Confidence in the RfD is low. A preliminary subchronic oral RfD can be derived for naphthalene by applying an uncertainty factor of 300 to the NOAEL of 71 mg/kg-day described above. The uncertainty factor of 300 reflects the chronic uncertainty factor of 3000 without the factor of 10 to expand from subchronic to chronic exposure. The preliminary subchronic oral RfD so derived is 2E-1 mg/kg-day.

The key study described above is not sufficient to identify target organs for prolonged oral exposure to naphthalene. Adults, children and neonates exposed to moth balls exhibit hemolytic anemia, evidence of liver disease and neurological deficits (EPA, 1993a, 1998). The liver effects and neurological deficits may be secondary to hemolytic anemia and reduced oxygen-carrying capacity of the blood. Hemolytic anemia and cataract formation have been seen also in orally exposed humans (EPA, 1998). The data suggest that the erythrocyte may be the most sensitive tissue in humans. Among common species of laboratory mammals, hemolytic anemia is seen only in dogs (EPA, 1998). Cataracts are seen in several laboratory mammals, but only at relatively high doses. The key study identifies reduced body weight as the critical effect in rats. Rats, however, do not exhibit hemolytic anemia, and exhibit cataracts only at very high doses,

suggesting that rats may not be a totally acceptable model for the toxicity of naphthalene to humans. Therefore, based on the effects observed in humans, the erythrocyte and eye are selected as target organs for prolonged oral exposure to naphthalene. Reduced body weight is also included as a critical effect because this was the only endpoint observed in rats in the key study.

EPA (1993a, 2010) reported a 2-year study in which mice were exposed to naphthalene vapors for 6 hours/day on 5 days/week. Inflammation of the nasal and olfactory epithelium was the most consistently observed sign; granulomatous lesions in the lungs were also observed. There was equivocal evidence of hematologic involvement. The lowest exposure concentration, 10 ppm, was a LOAEL for the nasal effects, which are considered the critical effects of inhalation exposure. The LOAEL is equivalent to a human equivalent concentration of 9.3 mg/m^3 (EPA, 2010). Application of an uncertainty factor of 3000 yields a verified chronic inhalation RfC of 3E-3 mg/m^3, which is equivalent to a chronic inhalation RfD of 8.6E-4 mg/kg-day. The nasal and olfactory epithelia are the target organs for inhalation exposure to naphthalene. Confidence in the RfC is medium. The chronic inhalation RfC of 3E-3 mg/m^3, equivalent to an inhalation RfD of 8.6E-4 mg/kg-day, is adopted as sufficiently protective for subchronic inhalation exposure as well.

Subchronic exposure to pyrene induces mild renal tubular degeneration and reduced kidney weight in orally treated mice (EPA, 2010). A verified RfD of 3E-2 mg/kg-day for chronic oral exposure was derived from a NOAEL of 75 mg/kg-day in a 13-week gavage study. The LOAEL was 125 mg/kg-day in this study. An uncertainty factor of 3000 was applied. Confidence in the oral RfD is low. The kidney tubule is chosen as the target organ for chronic oral exposure to pyrene. EPA (1997) derived a provisional subchronic oral RfD for pyrene of 3E-1 mg/kg-day from the same mouse study using an uncertainty factor of 300.

Data regarding prolonged oral exposure are not available for several of the Group D PAHs, which hinders estimation of an RfD or RfC and compromises evaluation of the potential for noncancer effects. Therefore, surrogates are used to develop toxicity values for the noncancer effects.

Generally surrogates are chosen on the basis of the following hierarchy:

- Toxicological similarity (effects and dose-response relationship).
- Toxicokinetic similarity, assuming that likeness in absorption, distribution and especially products of biotransformation suggests toxicological similarity.
- Structural similarity, assuming that likeness in structure suggests similarity in toxicokinetics.

Selection of defensible surrogates for the PAHs is compromised because toxicological and toxicokinetic data are virtually non-existent (except for benzo[a]pyrene), and the structural similarities often are not very convincing, which imparts a great deal of uncertainty to the effort. Therefore, the most defensible approach for some of the PAHs is to select the most conservative surrogate; i.e., the PAH with the smallest verified oral RfD, which happens to be pyrene.

Data regarding the effects of chronic or subchronic exposure to acenaphthylene were not located in the available literature. Acenaphthene is adopted as a reasonable surrogate for acenaphthylene based on structural similarity, since the surrogate differs from the principal chemical only in the presence of two hydrogen atoms and the absence of a double bond. Therefore, the verified chronic oral RfD of 6E-2 mg/kg-day for acenaphthene is adopted as the RfD for chronic oral exposure to acenaphthylene. The liver, which is the target organ for acenaphthene, is adopted for oral exposure to acenaphthylene. Similarly, the provisional subchronic oral RfD of 6E-1 mg/kg-day for acenaphthene is adopted as the RfD for subchronic oral exposure to acenaphthylene.

Data regarding the effects of chronic or subchronic exposure to benzo(g,h,i)perylene were not located in the available literature. Pyrene is adopted as a reasonable surrogate for benzo(g,h,i)perylene based somewhat on structural similarity, but more on the selection of a conservative approach as justified above. Therefore, the verified oral RfD of 3E-2 mg/kg-day for pyrene is adopted as the oral RfD for chronic exposure to benzo(g,h,i)perylene. Similarly, the provisional subchronic oral RfD of 3E-1 mg/kg-day for pyrene is adopted as the RfD for subchronic oral exposure to benzo(g,h,i)perylene. The kidney tubule, which is the target organ for pyrene, is adopted for oral exposure to benzo(g,h,i)perylene.

Relevant data regarding chronic or subchronic exposure to phenanthrene were not located. Potential surrogates based on similarity in chemical structure include anthracene and pyrene. Pyrene is selected as the surrogate only because it is the more conservative choice. Therefore, the verified oral RfD of 3E-2 mg/kg-day for pyrene is adopted as the oral RfD for chronic exposure to phenanthrene. Similarly, the provisional subchronic oral RfD of 3E-1 mg/kg-day for pyrene is adopted as the RfD for subchronic oral exposure to phenanthrene. The kidney tubule, which is the target organ for pyrene, is adopted for oral exposure to phenanthrene.

Data regarding inhalation exposure sufficient for development of inhalation RfCs were not located for any of the PAHs with the exception of naphthalene as noted above.

6.0 Carcinogenicity Evaluation

Acenaphthylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene and pyrene are classified in EPA cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) because of a lack of human data and inadequate animal data (EPA, 2013). Data regarding the carcinogenicity of acenaphthene were not located. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, , chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene are classified in EPA weight-of-evidence Group B2 (probable human carcinogens) (EPA, 1997, 2013). Benzo(a)pyrene is the most extensively studied member of the class, inducing tumors in tissues at the point of contact of practically all laboratory species tested by all routes of exposure.

Although epidemiology studies suggested that complex mixtures that contain PAHs (coal tar, soots, coke oven emissions, cigarette smoke) are carcinogenic to humans, the carcinogenicity cannot be attributed to PAHs alone because of the presence of other potentially carcinogenic substances in these mixtures (ATSDR, 1995). In addition, recent investigations showed that the PAH fraction of roofing tar, cigarette smoke and coke oven emissions accounted for only 0.1-8% of the total mutagenic activity in *Salmonella* of the unfractionated complex mixture (Lewtas, 1988). Aromatic amines, nitrogen heterocyclic compounds, highly oxygenated quinones, diones,

and nitrooxygenated compounds, none of which would be expected to arise from in vivo metabolism of PAHs, probably accounts for the majority of the mutagenicity of coke oven emissions and cigarette smoke. Furthermore, coal tar, which contains a mixture of many PAHs, has a long history of use in the clinical treatment of a variety of skin disorders in humans (ATSDR, 1995).

Because of the lack of human cancer data, assignment of individual PAHs to EPA cancer weight-of-evidence groups is based largely on the results of animal studies with large doses of purified compound (EPA, 2013). Frequently, unnatural routes of exposure, including implants of the test chemical in beeswax and trioctanoin in the lungs of female rats, intratracheal instillation, and subcutaneous or intraperitoneal injection, were used. Although the carcinogenicity of benzo(a)pyrene in animals managed in an unnatural manner in laboratory conditions has been well established, the potential for carcinogenicity to humans in environmental settings involving exposure to low concentrations remains unclear.

EPA (2013) verified a SF for oral exposure to benzo(a)pyrene of 7.3E+0 per mg/kg-day, based on several dietary studies in mice and rats. Recent reevaluations of the carcinogenicity and mutagenicity of the Group B2 PAHs suggest that there are large differences between individual PAHs in cancer potency (Krewski et al., 1989). Based on the available cancer and mutagenicity data, and assuming that there is a constant relative potency between different potential carcinogens across different bioassay systems and that the PAHs under consideration have similar dose-response curves, EPA (1993b) adopted relative potency values for several PAHs. These values and the corresponding oral SFs, based on a relative potency for benzo(a)pyrene of 1.0, are presented below:

Relative Potency Estimates for PAHs				
			Inhalation	
PAH	Relative Potency	Oral Slope Factor (per mg/kg-day)	Unit Risk Factor (per µg/m^3)	Slope Factor (per mg/kg-day)
Benzo(a)pyrene	1.0	7.3E+0	8.8E-4	3.1E+0
Benzo(a)anthracene	0.1	7.3E-1	8.8E-5	3.1E-1
Benzo(b)fluoranthene	0.1	7.3E-1	8.8E-5	3.1E-1
Benzo(k)fluoranthene	0.01	7.3E-2	8.8E-6	3.1E-2
Chrysene	0.001	7.3E-3	8.8E-7	3.1E-3
Dibenz(a,h)anthracene	1.0	7.3E+0	8.8E-4	3.1E+0
Indeno(1,2,3-cd)pyrene	0.1	7.3E-1	8.8E-5	3.1E-1

Although the EPA has not verified SFs for Group B2 PAHs other than benzo(a)pyrene, the SFs above represent reasonable estimates based on the data available. The relative potency approach employed here meets criteria considered to be desirable for this type of analysis (Lewtas, 1988). For example, the chemicals compared have similar chemical structures and would be expected to have similar toxicokinetic fate in mammalian systems. In addition, the available data suggest that the Group B2 PAHs have a similar mechanism of action, inducing frameshift mutations in *Salmonella* and tumor initiation in the mouse skin painting assay. Similar noncancer effects (minor changes in the blood, liver, kidneys) of the Group D PAHs support the hypothesis of a common mechanism of toxicity. Finally, the same endpoints of toxicity, i.e., potency in various cancer assays, and related data, were used to derive the relative potency values (Krewski et al., 1989). The oral SF for benzo(a)pyrene of 7.3E+0 per mg/kg-day, and the SFs presented above for the other Group B2 PAHs are adopted for the purposes of this evaluation.

An EPA (1994) evaluation of the inhalation cancer data suggests adoption of an inhalation SF for benzo(a)pyrene of 3.1E+0 per mg/kg-day, based on the incidence of upper respiratory and digestive tract tumors in hamsters. Applying the relative potency estimates presented above yield the inhalation URFs and SFs for the other Group B2 PAHs presented above.

EPA (2013) classified naphthalene in EPA cancer weight-of-evidence group C – possible human carcinogen – based on benign respiratory tumors and one carcinoma in female mice exposed to naphthalene by inhalation. Cancer potency factors are not available because the data are not sufficient.

7.0 Toxicity Summary

Toxicity values for the PAHs are summarized below:

Noncancer Effects						Carcinogenicity				
Oral Exposure[a]			Inhalation Exposure			Oral Exposure[a]		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
Acenaphthene										
6E-1	6E-2	L	ND	ND	NA	ND	NA	ND	NA	NA
Acenaphthylene										
6E-1	6E-2	L	ND	ND	NA	D	NA	D	NA	NA
Anthracene										
3E+0	3E-1	ND	ND	ND	NA	D	NA	D	NA	NA
Benzo(a)anthracene										
ND	ND	NA	ND	ND	NA	B2	7.3E-1	B2	8.8E-5	3.1E-1
Benzo(a)pyrene										
ND	ND	NA	ND	ND	NA	B2	7.3E+0	B2	8.8E-4	3.1E+0
Benzo(b)fluoranthene										
ND	ND	NA	ND	ND	NA	B2	7.3E-1	B2	8.8E-5	3.1E-1
Benzo(k)fluoranthene										
ND	ND	NA	ND	ND	NA	B2	7.3E-2	B2	8.8E-6	3.1E-2
Benzo(g,h,i)perylene										
3E-1	3E-2	K	ND	ND	NA	D	NA	D	NA	NA
Chrysene										
ND	ND	NA	ND	ND	NA	B2	7.3E-3	B2	8.8E-7	3.1E-3
Dibenz(a,h)anthracene										
ND	ND	NA	ND	ND	NA	B2	7.3E+0	B2	8.8E-4	3.1E+0
Fluoranthene										
4E-1	4E-2	L,K,B	ND	ND	NA	D	NA	D	NA	NA
Fluorene										
4E-1	4E-2	E	ND	ND	NA	D	NA	D	NA	NA
Indeno(1,2,3-cd)pyrene										
ND	ND	NA	ND	ND	NA	B2	7.3E-1	B2	8.8E-5	3.1E-1
Naphthalene										
2E-1	2E-2	E, Ey, BW	3E-3/ 8.6E-4	3E-3/ 8.6E-4	Ne, Oe	C	ND	C	ND	ND
Phenanthrene										
3E-1	3E-2	K	ND	ND	NA	D	NA	D	NA	NA
Pyrene										
3E-1	3E-2	K	ND	ND	NA	D	NA	D	NA	NA

Noncancer Effects						Carcinogenicity				
Oral Exposure[a]			Inhalation Exposure			Oral Exposure[a]		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi

sRfDo = subchronic oral reference dose (milligrams per kilogram-day); cRfDo = chronic oral reference dose (milligrams per kilogram-day); TO = target organ(s) or critical effect(s); sRfC = subchronic inhalation reference concentration (milligrams per cubic meter); sRfDi = subchronic inhalation reference dose (milligrams per kilogram-day); cRfC = chronic inhalation reference concentration (milligrams per cubic meter); cRfDi = chronic inhalation reference dose (milligrams per kilogram-day); WOE = cancer weight-of-evidence evaluation; SFo = oral cancer slope factor (risk per milligram per kilogram-day); URFi = inhalation unit risk factor (risk per microgram per cubic meter); SFi = inhalation cancer slope factor (risk per milligram per kilogram-day); ND = no data; NA = not applicable.
Target organ or critical effect abbreviations: B = blood cells; BW = reduced body weight; E = erythrocyte; Ey = eye; L = liver; K = kidney; Ne = nasal epithelium; Oe = olfactory epithelium.
[a]sRfDo, cRfDo and SFo should be used for dermal exposure without adjustment for GI absorption.

8.0 References

Agency for Toxic Substances and Disease Registry, (ATSDR), 1995, ***Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)***, U.S. Public Health Service, Atlanta, Georgia, August.

Agency for Toxic Substances and Disease Registry, (ATSDR), 2005, ***Toxicological Profile for Naphthalene, 1-Methylnaphthalene, 2-Methylnaphthalene***, U.S. Public Health Service, Atlanta, Georgia, August.

De Jong, W.H., E.D. Kroes, J.G. Vos and H. Van Loveren, 1999, “Detection of Immunotoxicity of Benzo[a]pyrene in a Subacute Toxicity Study after Oral Exposure in Rats,” ***Toxicological Sciences*** 50: 214-220.

Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

Krewski, D., T. Thorslund and J. Withey, 1989, "Carcinogenic Risk Assessment of Complex Mixtures," ***Toxicology and Industrial Health***, 5: 851-867.

Lewtas, J., 1988, "Genotoxicity of Complex Mixtures: Strategies for the Identification and Comparative Assessment of Airborne Mutagens and Carcinogens from Combustion Sources," ***Fundamental and Applied Toxicology***, 10: 571-589.

Potter, T.L. and K.E. Simmons, 1998, ***Composition of Petroleum Mixtures***, Volume 2, Total Petroleum Hydrocarbon Criteria Working Group Series, University of Massachusetts, Amherst, May.

U.S. Environmental Protection Agency (EPA), 1986, “Guidelines for Carcinogen Risk Assessment,” ***Federal Register*** 51(185): 33992-34003.

U.S. Environmental Protection Agency (EPA), 1990, “National Oil and Hazardous Substances Pollution Contingency Plan,” ***Federal Register*** 55(46): 8666-8865.

U.S. Environmental Protection Agency (EPA), 1993a, ***Risk Assessment Issue Paper for: Derivation of a Subchronic RfC for Naphthalene (CASRN 91-20-3)***, National Center for Environmental Assessment, Cincinnati, Ohio, March 12.

U.S. Environmental Protection Agency (EPA), 1993b, ***Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons***, Office of Health and Environmental Assessment, Cincinnati, OH, EPA/600/R-93/089, March.

U.S. Environmental Protection Agency (EPA), 1994, ***Risk Assessment Issue Paper: Status of Inhalation Cancer Unit Risk for Benzo(a)Pyrene (CAS No. 50-32-8)***, National Center for Environmental Assessment, Cincinnati, OH, November 18.

U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, Washington, DC, 9200.6-303(97-1), EPA 540/R-97-036, PB97-921199.

U.S. Environmental Protection Agency (EPA), 1998, ***Toxicological Review of Naphthalene (CAS No. 91-20-3) In Support of Summary Information on the Integrated Risk Information System (IRIS)***, August.

U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part E - Supplemental Guidance for Dermal Risk Assessment)***, Final, Office of Superfund Remediation and Technology Innovation, Washington, D.C., EPA/540/R-99/005, July.

U.S. Environmental Protection Agency (EPA), 2013, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

Miscellaneous

NITRATE (14797-55-8) and NITRITE (14797-65-0)

Nitrate is a naturally occurring member of the nitrogen cycle, being formed and released by nitrogen-fixing bacteria (EPA, 1989; Kettrup and Huppe, 1988). Nitrates are used largely as fertilizers. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	K_d (L/kg)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
Nitrate							
62.00 (anion)	NA	NA	NA	NA	NA	NA	Note 1[a]
Nitrite							
46.01 (anion)	NA	NA	NA	NA	NA	NA	Note 1[a]

NA = not applicable.
Note 1: Variable; many nitrate and nitrate salts are very soluble.
[a]Budavari, S, Ed., 1989, ***The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals***, Eleventh Edition, Merck & Co., Rahway, NJ.

Agricultural application of synthetic fertilizer and animal waste is a major mechanism by which nitrates are released to the environment (EPA, 1989; HSDB, 2013). It is also possible that the degradation of nitroaromatic compounds could contribute nitrate to the environment. Data were not located regarding the fate of nitrate or nitrite in the atmosphere, but the high solubility of many nitrate/nitrite compounds suggests that wet deposition may be a major removal process. Nitrate and nitrite in soil and water will exist largely as the soluble anions (EPA, 1989). Chemical interconversion and microbial transformation to other nitrogenous species will occur in soil and water. Biotransfer factors for nitrogen are compiled below:

BCF (L/kg)	Bpr (unitless)	Bpv (unitless)	Bb (unitless)	Bm (unitless)
ND	3.0E+1[a]	3.0E+1[a]	NA (see below)	NA (see below)

ND = no data; NA = not applicable.
[a]Baes, C.F., R.D. Sharp, A.L. Sjoreen, R.W. Shor, 1984, ***A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture***, Health and Safety Division, Oak Ridge National Laboratory, ORNL-5786, September.

It is well established that certain plants grown in soil containing high levels of nitrates (e.g., highly fertilized) may accumulate high levels of nitrate (Menzer, 1991). This is of particular concern to the welfare of domestic ruminant species, which consume large quantities of heavily fertilized forages. Animals, however, do not tend to bioaccumulate nitrate or nitrate. Therefore, human ingestion of food products from animals that consumed feedstuffs obtained from soils with high levels of nitrate is not likely to be a matter for concern.

Data regarding the GI absorption of nitrate/nitrite nitrogen are of limited usefulness. Several competing processes may occur in the acidic and reducing milieu of the GI tract, including conversion of nitrite to N_2O_2, which is probably readily absorbed (EPA, 1989). *In vivo* and *in vitro* studies indicate that GI absorption of nitrite (the first reduction product of nitrate) may approach 50 to 80 percent. A GAF is of 1 is used per the recommendation of EPA (2004) for chemicals that are absorbed from the GI tract at 50 percent or greater.

Data regarding the dermal absorption of nitrate/nitrite nitrogen were not located; therefore, no ABS value is selected, consistent with EPA (2004) guidance for the evaluation of inorganic constituents. Data were not located regarding the dermal uptake of nitrate/nitrite nitrogen from water. However, as noted above, most nitrate and nitrite salts are very soluble in water. Therefore, it is assumed that the nitrate and nitrite anion may be absorbed by the skin at the same rate as water. The PC for water of 1E-3 cm/hour (EPA, 1992) is adopted for nitrate/nitrite nitrogen.

The oral toxicity of nitrate is mediated by its reduction to nitrite by the microflora of the GI tract (EPA, 2002). Nitrite oxidizes hemoglobin to methemoglobin, which is incapable of transporting oxygen from the lungs to the tissues. Human toxicity is generally associated with high levels of nitrate or nitrite in drinking water. Infants are the most sensitive members of the population. EPA (2013) presents a verified chronic oral RfD for nitrate of 1.6E+0 mg nitrate nitrogen/kg-day, based on a NOAEL of 1.6 mg/kg-day for methemoglobinemia in infants and an uncertainty factor of 1. Confidence in the oral RfD is high. EPA (2013) also presents a verified chronic oral RfD for nitrite of 1E-1 mg nitrite nitrogen/kg-day, based on the same NOAEL and an uncertainty factor of 10. Confidence in the oral RfD is high. The target tissue for the toxicity of nitrate or nitrite is the erythrocyte. The chronic oral RfD of 1E-1 for nitrite nitrogen is adopted as the conservative estimate of a chronic oral RfD for nitrate/nitrite nitrogen.

Data regarding the toxicity of inhalation exposure to nitrate/nitrite nitrogen were not located; an inhalation RfC cannot be developed.

Data regarding the carcinogenicity of uncombined nitrate or nitrite were not located. Nitrite can combine with secondary amines in food or other nitrogenous compounds to form nitrosamines or other N-nitroso compounds, many of which are important animal carcinogens (Menzer, 1991).

References for Nitrate/Nitrite

Hazardous Substance Data Bank (HSDB), 2013, National Library of Medicine, on line.

Kettrup, A and U. Huppe, 1988, "Nitrogen," in Seiler, H.G. and H. Sigel, eds., ***Handbook on Toxicity of Inorganic Compounds***, Marcel Dekker, Inc., New York, pp. 475-489.

Menzer, R.E., 1991, "Water and Soil Pollutants." In: M.O. Amdur, J. Doull and C.D. Klaassen, eds., ***Casarett and Doull's Toxicology, the Basic Science of Poisons***, Fourth Edition, New York: Pergamon Press, p. 872-902.

U.S. Environmental Protection Agency (EPA), 1989, ***Health and Environmental Effects Document for Nitrite***, Final Draft, Prepared by the Environmental Criteria and Assessment Office, Cincinnati, OH, for the Office of Solid Waste, Washington, DC., ECAO-CIN-GO59.

U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 2004, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final***, Office of Superfund Remediation and Technology Innovation, Washington, DC, EPA/540/R/99/005, OSWER 9285.7-02EP July.

U.S. Environmental Protection Agency (EPA), 2013, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

APPENDIX D

RISK CHARACTERIZATION SPREADSHEETS

Table D-1

Groundskeeper, Current Scenarios, Exposure to Surface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

		Incidental Ingestion				Dermal Contact				
Chemicals of Potential Concern	EPC mg/kg	Cancer Dose mg/kg-day	Noncancer Dose mg/kg-day	ILCR	HQ	Dose Absorbed mg/cm^2-day	Cancer Dose mg/kg-day	Noncancer Dose mg/kg-day	ILCR	HQ
Semivolatile Organic Compounds										
Benzo(a)pyrene	2.57E-02	8.98E-09	2.51E-08	6.56E-08	NA	6.68E-10	7.71E-09	2.16E-08	5.63E-08	NA
Total ILCR or HI				**6.56E-08**	**NA**				**5.63E-08**	**NA**

Table D-1

Groundskeeper, Current Scenarios, Exposure to Surface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemicals of Potential Concern	Concentration in Air C_a mg/m^3	Inhalation Cancer Dose mg/kg-day	Inhalation Noncancer Dose mg/kg-day	Inhalation ILCR	Inhalation HQ	**All Pathways Total ILCR**	**All Pathways Total HI**
Semivolatile Organic Compounds							
Benzo(a)pyrene	2.57E-09	1.80E-10	5.03E-10	5.57E-10	NA	**1.22E-07**	**NA**
Total ILCR or HI				**5.57E-10**	**NA**	**1.22E-07**	**NA**

EPC - Exposure-point concentration.
ILCR - Incremental lifetime cancer risk.
HQ - Hazard quotient; HI - Hazard index.
mg/kg - Milligrams per kilogram.
mg/cm^2 - Milligrams per square centimeter.
mg/m^3 - Milligrams per cubic meter.
NA - Not applicable.

Table D-2

Indoor Worker, Future Scenario, Exposure to Surface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					
Chemicals of Potential Concern	EPC mg/kg	Cancer Dose mg/kg-day	Noncancer Dose mg/kg-day	ILCR	HQ	**Total ILCR**	**Total HI**
Semivolatile Organic Compounds							
Benzo(a)pyrene	2.57E-02	4.49E-09	1.26E-08	3.28E-08	NA	**3.28E-08**	**NA**
Total ILCR or HI						**3.28E-08**	**NA**

EPC - Exposure-point concentration.
ILCR - Incremental lifetime cancer risk.
HQ - Hazard quotient; HI - Hazard index.
mg/kg - Milligrams per kilogram.
NA - Not applicable.

Table D-3

Adult Hunter, Future Scenario, Exposure to Surface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion				Dermal Contact				
	EPC	Cancer Dose	Noncancer Dose	Adult Hunter	Adult Hunter	Dose Absorbed	Cancer Dose	Noncancer Dose	Adult Hunter	Adult Hunter
Chemicals of Potential Concern	mg/kg	mg/kg-day	mg/kg-day	ILCR	HQ	mg/cm^2-day	mg/kg-day	mg/kg-day	ILCR	HQ
Semivolatile Organic Compounds										
Benzo(a)pyrene	2.57E-02	6.04E-10	1.41E-09	4.41E-09	NA	6.68E-10	5.18E-10	1.21E-09	3.78E-09	NA
Total ILCR and HI				**4.41E-09**	**NA**				**3.78E-09**	**NA**

Table D-3

Adult Hunter, Future Scenario, Exposure to Surface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Concentration in Forage C_p	Concentration in Venison C_v	Consumption of Venison				**All Pathways**	
			Cancer Dose	Noncancer Dose			**Total**	**Total**
Chemicals of Potential Concern	mg/kg	mg/kg	mg/kg-day	mg/kg-day	ILCR	HQ	**ILCR**	**HI**
Semivolatile Organic Compounds								
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	**8.19E-09**	**NA**
Total ILCR and HI					**NA**	**NA**	**8.19E-09**	**NA**

EPC - Exposure-point concentration.
HQ - Hazard quotient; HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
mg/kg - Milligrams per kilogram.
mg/cm^2 - Milligrams per square centimeter.
NA - Not applicable.

Table D-4

Hunter's Child, Future Scenario, Exposure to Surface Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Concentration	Concentration	Consumption of Venison					
	EPC	in Forage C_p	in Venison C_v	Cancer Dose	Noncancer Dose			**Total**	**Total**
Chemicals of Potential Concern	mg/kg	mg/kg	mg/kg	mg/kg-day	mg/kg-day	ILCR	HQ	**ILCR**	**HI**
Semivolatile Organic Compounds									
Benzo(a)pyrene	2.57E-02	NA	NA	NA	NA	NA	NA	**NA**	**NA**
Total ILCR and HI						**NA**	**NA**	**NA**	**NA**

EPC - Exposure-point concentration.
HQ - Hazard quotient; HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
mg/kg - Milligrams per kilogram.
NA - Not applicable.

Table D-5

Groundskeeper, Future Scenario, Exposure to Total Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

		Incidental Ingestion				Dermal Contact				
Chemicals of Potential Concern	EPC [a] mg/kg	Cancer Dose mg/kg-day	Noncancer Dose mg/kg-day	ILCR	HQ	Dose Absorbed mg/cm^2-day	Cancer Dose mg/kg-day	Noncancer Dose mg/kg-day	ILCR	HQ
Semivolatile Organic Compounds										
Benzo(a)pyrene	2.57E-02	8.98E-09	2.51E-08	6.56E-08	NA	6.68E-10	7.71E-09	2.16E-08	5.63E-08	NA
Total ILCR or HI				**6.56E-08**	**NA**				**5.63E-08**	**NA**

Table D-5

Groundskeeper, Future Scenario, Exposure to Total Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemicals of Potential Concern	Concentration in Air [a] C_a mg/m^3	Inhalation Cancer Dose mg/kg-day	Inhalation Noncancer Dose mg/kg-day	Inhalation ILCR	Inhalation HQ	**All Pathways Total ILCR**	**All Pathways Total HI**
Semivolatile Organic Compounds							
Benzo(a)pyrene	2.57E-09	1.80E-10	5.03E-10	5.57E-10	NA	**1.22E-07**	**NA**
Total ILCR or HI				**5.57E-10**	**NA**	**1.22E-07**	**NA**

[a] No Chemicals of Potential Concern were identfied in subsurface soil. EPC values developed from surface soil data were used in the assessment of this receptor.
EPC - Exposure-point concentration.
ILCR - Incremental lifetime cancer risk.
HQ - Hazard quotient; HI - Hazard index.
mg/kg - Milligrams per kilogram.
mg/cm^2 - Milligrams per square centimeter.
mg/m^3 - Milligrams per cubic meter.
NA - Not applicable.

Table D-6

Construction Worker, Current and Future Scenarios, Exposure to Total Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

		Incidental Ingestion				Dermal Contact				
Chemicals of Potential Concern	EPC [a] mg/kg	Cancer Dose mg/kg-day	Noncancer Dose mg/kg-day	ILCR	HQ	Dose Absorbed mg/cm^2-day	Cancer Dose mg/kg-day	Noncancer Dose mg/kg-day	ILCR	HQ
Semivolatile Organic Compounds										
Benzo(a)pyrene	2.57E-02	5.93E-10	8.28E-08	4.33E-09	NA	1.00E-09	2.31E-10	3.23E-08	1.69E-09	NA
Total ILCR or HI				**4.33E-09**	**NA**				**1.69E-09**	**NA**

Table D-6

Construction Worker, Current and Future Scenarios, Exposure to Total Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemicals of Potential Concern	Concentration in Air [a] C_a mg/m^3	Inhalation Cancer Dose mg/kg-day	Inhalation Noncancer Dose mg/kg-day	Inhalation ILCR	Inhalation HQ	**All Pathways Total ILCR**	**All Pathways Total HI**
Semivolatile Organic Compounds							
Benzo(a)pyrene	9.00E-09	1.26E-11	1.76E-09	3.90E-11	NA	**6.05E-09**	**NA**
Total ILCR or HI				**3.90E-11**	**NA**	**6.05E-09**	**NA**

[a] No Chemicals of potential concern were identified in subsurface soil. EPC values developed from surface soil data were used in the assessment of this receptor.
EPC - Exposure-point concentration.
ILCR - Incremental lifetime cancer risk.
HQ - Hazard quotient; HI - Hazard index.
mg/kg - Milligrams per kilogram.
mg/cm^2 - Milligrams per square centimeter.
mg/m^3 - Milligrams per cubic meter.
NA - Not applicable.

Table D-7

On-Site Resident, Cancer Risk, Future Scenario, Exposure to Total Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

		Incidental Ingestion			Dermal Contact				
Chemicals of Potential Concern	EPC [a] mg/kg	Adult Dose mg/kg-day	Child Dose mg/kg-day	Resident ILCR	Adult Dose Absorbed mg/cm^2-day	Adult Dose mg/kg-day	Child Dose Absorbed mg/cm^2-day	Child Dose mg/kg-day	Resident ILCR
Semivolatile Organic Compounds									
Benzo(a)pyrene	2.57E-02	1.09E-08	2.53E-08	2.64E-07	2.34E-10	6.26E-09	6.68E-10	1.03E-08	1.21E-07
Total ILCR				**2.64E-07**					**1.21E-07**

Table D-7

On-Site Resident, Cancer Risk, Future Scenario, Exposure to Total Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemicals of Potential Concern	Concentration in Air [a] C_a mg/m^3	Inhalation Adult Dose mg/kg-day	Inhalation Child Dose mg/kg-day	Inhalation Resident ILCR	**All Pathways Total ILCR**
Semivolatile Organic Compounds					
Benzo(a)pyrene	5.06E-11	4.76E-12	2.77E-12	2.33E-11	**3.85E-07**
Total ILCR				**2.33E-11**	**3.85E-07**

[a] No chemicals of potential concern were identified in subsurface soil. EPC values developed from surface soil data were used in the assessment of this receptor.

EPC - Exposure-point concentration.
ILCR - Incremental lifetime cancer risk.
mg/kg - Milligrams per kilogram.
mg/cm^2 - Milligrams per square centimeter.
mg/m^3 - Milligrams per cubic meter.
NA - Not applicable.

Table D-8

On-Site Adult Resident, Noncancer Risk, Future Scenario, Exposure to Total Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			Concentration	Inhalation		**All**
	EPC [a]	Adult Dose	Adult Resident	Dose Absorbed	Adult Dose	Adult Resident	in Air [a] C_a	Adult Dose	Adult Resident	**Pathways Total**
Chemicals of Potential Concern	mg/kg	mg/kg-day	HQ	mg/cm^2-day	mg/kg-day	HQ	mg/m^3	mg/kg-day	HQ	**HI**
Semivolatile Organic Compounds										
Benzo(a)pyrene	2.57E-02	3.17E-08	NA	2.34E-10	1.83E-08	NA	5.06E-11	1.39E-11	NA	**NA**
Total HI			**NA**			**NA**			**NA**	**NA**

[a] No chemicals of potential concern were identified in subsurface soil. EPC values developed from surface soil data were used in the assessment of this receptor.
EPC - Exposure-point concentration
HQ - Hazard quotient; HI - Hazard index.
mg/kg - Milligrams per kilogram.
mg/cm^2 - Milligrams per square centimeter.
mg/m^3 - Milligrams per cubic meter.
NA - Not applicable.

Table D-9

On-Site Child Resident, Noncancer Risk, Future Scenario, Exposure to Total Soil
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			Concentration	Inhalation		**All**
	EPC [a]	Child Dose	Child Resident	Dose Absorbed	Child Dose	Child Resident	in Air [a] C_a	Child Dose	Child Resident	**Pathways Total**
Chemicals of Potential Concern	mg/kg	mg/kg-day	HQ	mg/cm^2-day	mg/kg-day	HQ	mg/m^3	mg/kg-day	HQ	**HI**
Semivolatile Organic Compounds										
Benzo(a)pyrene	2.57E-02	2.96E-07	NA	6.68E-10	1.20E-07	NA	5.06E-11	3.24E-11	NA	**NA**
Total HI			**NA**			**NA**			**NA**	**NA**

[a] No chemicals of potential concern were identified in subsurface soil. EPC values developed from surface soil data were used in the assessment of this receptor.
EPC - Exposure-point concentration.
HQ - Hazard quotient; HI - Hazard index.
mg/kg - Milligrams per kilogram.
mg/cm^2 - Milligrams per square centimeter.
mg/m^3 - Milligrams per cubic meter.
NA - Not applicable.

Table D-10

Groundskeeper, Future Scenario, Exposure to Overburden Groundwater
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion				Dermal Contact					All Pathways	
		Cancer	Noncancer			Dose	Cancer	Noncancer				
	EPC	Dose	Dose			Absorbed	Dose	Dose			**Total**	**Total**
Chemicals of Potential Concern	mg/L	mg/kg-day	mg/kg-day	ILCR	HQ	mg/cm^2-day	mg/kg-day	mg/kg-day	ILCR	HQ	**ILCR**	**HI**
Inorganics												
Antimony	2.18E-03	7.62E-06	2.13E-05	NA	5.33E-02	2.18E-09	2.51E-08	7.04E-08	NA	1.17E-03	**NA**	**5.45E-02**
Arsenic	4.32E-03	1.51E-05	4.23E-05	2.26E-05	1.41E-01	4.32E-09	4.98E-08	1.40E-07	7.47E-08	4.65E-04	**2.27E-05**	**1.41E-01**
Chromium, Total	1.00E-03	3.49E-06	9.78E-06	NA	4.66E-04	1.00E-09	1.15E-08	3.23E-08	NA	1.20E-04	**NA**	**5.86E-04**
Cobalt	1.92E-03	6.71E-06	1.88E-05	NA	6.26E-02	7.68E-10	8.86E-09	2.48E-08	NA	8.27E-05	**NA**	**6.27E-02**
Iron	2.32E+00	8.10E-03	2.27E-02	NA	3.24E-02	2.32E-06	2.67E-05	7.49E-05	NA	NA	**NA**	**3.24E-02**
Manganese	2.51E-01	8.77E-04	2.45E-03	NA	5.22E-02	2.51E-07	2.89E-06	8.10E-06	NA	4.26E-03	**NA**	**5.65E-02**
Total ILCR or HI				**2.26E-05**	**3.42E-01**				**7.47E-08**	**6.10E-03**	**2.27E-05**	**3.48E-01**

EPC - Exposure-point concentration.
ILCR - Incremental lifetime cancer risk.
HQ - Hazard quotient; HI - Hazard index.
mg/L - Milligrams per liter.
mg/kg - Milligrams per kilogram.
mg/cm^2 - Milligrams per square centimeter.
NA - Not applicable.

Table D-11

Indoor Worker, Future Scenario, Exposure to Overburden Groundwater
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion				Dermal Contact					All Pathways	
		Cancer	Noncancer			Dose	Cancer	Noncancer				
	EPC	Dose	Dose			Absorbed	Dose	Dose			Total	Total
Chemicals of Potential Concern	mg/L	mg/kg-day	mg/kg-day	ILCR	HQ	mg/cm^2-day	mg/kg-day	mg/kg-day	ILCR	HQ	ILCR	HI
Inorganics												
Antimony	2.18E-03	7.62E-06	2.13E-05	NA	5.33E-02	2.18E-09	2.51E-08	7.04E-08	NA	1.17E-03	**NA**	**5.45E-02**
Arsenic	4.32E-03	1.51E-05	4.23E-05	2.26E-05	1.41E-01	4.32E-09	4.98E-08	1.40E-07	7.47E-08	4.65E-04	**2.27E-05**	**1.41E-01**
Chromium, Total	1.00E-03	3.49E-06	9.78E-06	NA	4.66E-04	1.00E-09	1.15E-08	3.23E-08	NA	1.20E-04	**NA**	**5.86E-04**
Cobalt	1.92E-03	6.71E-06	1.88E-05	NA	6.26E-02	7.68E-10	8.86E-09	2.48E-08	NA	8.27E-05	**NA**	**6.27E-02**
Iron	2.32E+00	8.10E-03	2.27E-02	NA	3.24E-02	2.32E-06	2.67E-05	7.49E-05	NA	NA	**NA**	**3.24E-02**
Manganese	2.51E-01	8.77E-04	2.45E-03	NA	5.22E-02	2.51E-07	2.89E-06	8.10E-06	NA	4.26E-03	**NA**	**5.65E-02**
Total ILCR or HI				**2.26E-05**	**3.42E-01**				**7.47E-08**	**6.10E-03**	**2.27E-05**	**3.48E-01**

EPC - Exposure-point concentration.

ILCR - Incremental lifetime cancer risk.

HQ - Hazard quotient; HI - Hazard index.

mg/L - Milligrams per liter.

mg/kg - Milligrams per kilogram.

mg/cm^2 - Milligrams per square centimeter.
NA - Not applicable.

Table D-12

Adult On-Site Resident, Future Scenario, Cancer Risk from Exposure to Overburden Groundwater
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion			Dermal Contact					Inhalation of VOCs				**All**
		Adult	Child		Dose	Adult	Dose	Child		Concentration	Adult	Child		**Pathways**
	EPC	Dose	Dose		Absorbed	Dose	Absorbed	Dose		in Air	Dose	Dose		**Total**
Chemicals of Potential Concern	mg/L	mg/kg-day	mg/kg-day	ILCR	mg/cm^2-day	mg/kg-day	mg/cm^2-day	mg/kg-day	ILCR	mg/m^3	mg/kg-day	mg/kg-day	ILCR	**ILCR**
Inorganics														
Antimony	2.18E-03	2.05E-05	1.19E-05	NA	4.36E-10	4.10E-08	7.26E-10	2.63E-08	NA	NA	NA	NA	NA	**NA**
Arsenic	4.32E-03	4.06E-05	2.37E-05	9.64E-05	8.64E-10	8.12E-08	1.44E-09	5.20E-08	2.00E-07	NA	NA	NA	NA	**9.66E-05**
Chromium, Total	1.00E-03	9.39E-06	5.48E-06	NA	2.00E-10	1.88E-08	3.33E-10	1.20E-08	NA	NA	NA	NA	NA	**NA**
Cobalt	1.92E-03	1.80E-05	1.05E-05	NA	1.54E-10	1.44E-08	2.56E-10	9.25E-09	NA	NA	NA	NA	NA	**NA**
Iron	2.32E+00	2.18E-02	1.27E-02	NA	4.64E-07	4.36E-05	7.72E-07	2.79E-05	NA	NA	NA	NA	NA	**NA**
Manganese	2.51E-01	2.36E-03	1.37E-03	NA	5.02E-08	4.71E-06	8.35E-08	3.02E-06	NA	NA	NA	NA	NA	**NA**
Total ILCR				**9.64E-05**					**2.00E-07**				**NA**	**9.66E-05**

EPC - Exposure-point concentration.
ILCR - Incremental lifetime cancer risk.
mg/L - Milligrams per liter.
mg/cm^2 - Milligrams per square meter.
mg/kg - Milligrams per kilogram.
mg/m^3- Milligrams per cubic meter.
NA - Not applicable.

Table D-13

Adult On-Site Resident, Future Scenario, Noncancer Hazard from Exposure to Overburden Groundwater
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			Inhalation of VOCs			**All**
		Noncancer		Dose	Adult		Concentration	Adult		**Pathways**
	EPC	Dose		Absorbed	Dose		in Air	Dose		**Total**
Chemicals of Potential Concern	mg/L	mg/kg-day	HQ	mg/cm^2-day	mg/kg-day	HQ	mg/m^3	mg/kg-day	HQ	**HI**
Inorganics										
Antimony	2.18E-03	5.97E-05	1.49E-01	4.36E-10	1.19E-07	1.99E-03	NA	NA	NA	**1.51E-01**
Arsenic	4.32E-03	1.18E-04	3.95E-01	8.64E-10	2.37E-07	7.89E-04	NA	NA	NA	**3.95E-01**
Chromium, Total	1.00E-03	2.74E-05	1.30E-03	2.00E-10	5.48E-08	2.03E-04	NA	NA	NA	**1.51E-03**
Cobalt	1.92E-03	5.26E-05	1.75E-01	1.54E-10	4.21E-08	1.40E-04	NA	NA	NA	**1.75E-01**
Iron	2.32E+00	6.35E-02	9.08E-02	4.64E-07	1.27E-04	NA	NA	NA	NA	**9.08E-02**
Manganese	2.51E-01	6.87E-03	1.46E-01	5.02E-08	1.37E-05	7.24E-03	NA	NA	NA	**1.53E-01**
Total HI			**9.58E-01**			**1.04E-02**			**NA**	**9.68E-01**

EPC - Exposure-point concentration.

HQ - Hazard quotient; HI - Hazard index.

mg/L - Milligrams per liter.

mg/cm^2 - Milligrams per square meter.

mg/kg - Milligrams per kilogram.

mg/m^3- Milligrams per cubic meter.
NA - Not applicable.

Table D-14

Child On-Site Resident, Future Scenario, Noncancer Hazard from Exposure to Overburden Groundwater
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			Inhalation of VOCs			**All**
		Child		Dose	Child		Concentration	Child		**Pathways**
	EPC	Dose		Absorbed	Dose		in Air	Dose		**Total**
Chemicals of Potential Concern	mg/L	mg/kg-day	HQ	mg/cm^2-day	mg/kg-day	HQ	mg/m^3	mg/kg-day	HQ	**HI**
Inorganics										
Antimony	2.18E-03	1.39E-04	3.48E-01	7.26E-10	3.06E-07	5.10E-03	NA	NA	NA	**3.54E-01**
Arsenic	4.32E-03	2.76E-04	9.21E-01	1.44E-09	6.07E-07	2.02E-03	NA	NA	NA	**9.23E-01**
Chromium, Total	1.00E-03	6.39E-05	3.04E-03	3.33E-10	1.40E-07	5.20E-04	NA	NA	NA	**3.56E-03**
Cobalt	1.92E-03	1.23E-04	4.09E-01	2.56E-10	1.08E-07	3.60E-04	NA	NA	NA	**4.09E-01**
Iron	2.32E+00	1.48E-01	2.12E-01	7.72E-07	3.26E-04	NA	NA	NA	NA	**2.12E-01**
Manganese	2.51E-01	1.60E-02	3.41E-01	8.35E-08	3.53E-05	1.86E-02	NA	NA	NA	**3.60E-01**
Total HI			**2.23E+00**			**2.66E-02**			**NA**	**2.26E+00**

EPC - Exposure-point concentration.

HQ - Hazard quotient; HI - Hazard index.

mg/L - Milligrams per liter.

mg/cm^2 - Milligrams per square meter.

mg/kg - Milligrams per kilogram.

mg/m^3- Milligrams per cubic meter.
NA - Not applicable.

Table D-15

Separation of Noncancer Hazard by Target Organ for the On-Site Resident Child
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Target Organ Hazard [a]				
Chemicals of Potential Concern	Heart	Skin	Thyroid	Gastrointestinal Tract	Central Nervous System
Groundwater					
Inorganics					
Antimony	3.54E-01	ND	ND	ND	ND
Arsenic	ND	9.23E-01	ND	ND	ND
Cobalt	ND	ND	4.09E-01	ND	ND
Iron	ND	ND	ND	2.12E-01	ND
Manganese	ND	ND	ND	ND	3.60E-01
Target Organ HI :	**0.4**	**0.9**	**0.4**	**0.2**	**0.4**

[a] See Table 4-1 for data regarding selection of target organs and Table D-14 for Total HI values for all pathways.
HI - Hazard index.
NA - Not applicable.
ND - No data or not determined.

APPENDIX E

ANALYTICAL DATA USED IN THE BASELINE HUMAN HEALTH RISK ASSESSMENT

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB01					ULA-SB02					ULA-SB02					ULA-SB02				
SAMPLE NO		ULA0001					ULA0002					ULA0003					ULA0004				
SAMPLE DATE		18-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					FD					FS				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.02	U	UJ
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.29	0.29	0.098	U	UJ
Dinitrobenzene, 1,3-	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.049	U	UJ
Dinitrotoluene, 2,4-	mg/kg	0.16	0.16	0.078	U	U	0.15	0.15	0.075	U	U	0.17	0.17	0.083	U	U	0.24	0.24	0.02	U	UJ
Dinitrotoluene, 2,6-	mg/kg	0.16	0.16	0.07	U	U	0.15	0.15	0.067	U	U	0.17	0.17	0.075	U	U	0.24	0.24	0.029	U	UJ
HMX	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.029	U	UJ
Nitrobenzene	mg/kg	0.16	0.16	0.074	U	U	0.15	0.15	0.072	U	U	0.17	0.17	0.08	U	U	0.24	0.24	0.049	U	UJ
Nitrotoluene, 2-	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.078	U	UJ
Nitrotoluene, 3-	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.069	U	UJ
Nitrotoluene, 4-	mg/kg	0.16	0.16	0.081	U	U	0.15	0.15	0.078	U	U	0.17	0.17	0.087	U	U	0.49	0.49	0.078	U	UJ
RDX	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.039	U	UJ
Tetryl	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.049	U	UJ
Trinitrobenzene, 1,3,5-	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.02	U	UJ
Trinitrotoluene, 2,4,6-	mg/kg	0.16	0.16	0.064	U	U	0.15	0.15	0.062	U	U	0.17	0.17	0.069	U	U	0.24	0.24	0.02	U	UJ
General Chemistry																					
% Solids	Percent	80.1	0				79.6	0				81.1	0								
Metals																					
Aluminum	mg/kg	6620	44	5.3			4580	11	1.4		J	4730	10	1.2			4900	24	11		
Antimony	mg/kg	4.4	4.4	0.22	U	U	1.1	1.1	0.057	U	UJ	1	1	0.051	U	U	1.2	1.2	0.46	U	U
Arsenic	mg/kg	4.3	2.2	0.22			2.8	0.57	0.057			2.5	0.51	0.051			3.4	1.2	0.35		
Barium	mg/kg	18.2	44	0.89	B	J	9.7	11	0.23	B	J	14.8	10	0.2			24	24	0.084	U	U
Beryllium	mg/kg	0.32	1.1	0.022	B	J	0.22	0.28	0.0057	B	J	0.23	0.25	0.0051	B	J	0.59	0.59	0.051	U	U
Cadmium	mg/kg	0.89	0.89	0.022	U	U	0.23	0.23	0.0057	U	U	0.2	0.2	0.0051	U	U	0.24	0.24	0.043	U	U
Calcium	mg/kg	1420	1100	11			544	280	2.8		J	550	250	2.5		J	850	590	19		
Chromium	mg/kg	9.7	2.2	0.22			6.9	0.57	0.057		J	6.2	0.51	0.051			7.8	0.59	0.24		
Cobalt	mg/kg	5.5	11	0.22	B	J	3.2	2.8	0.057		J	2.5	2.5	0.051			5.9	5.9	0.19	U	U
Copper	mg/kg	5.8	5.5	0.22			4.9	1.4	0.057		J	4.5	1.3	0.051			5.2	3	0.87		
Iron	mg/kg	12400	66	5.1			7650	17	1.3		J	6630	15	1.2			10000	12	5.8		
Lead	mg/kg	5.8	0.89	0.044			3.5	1.1	0.057			4.2	1	0.051			4.5	0.35	0.22		
Magnesium	mg/kg	1050	1100	11	B	J	705	280	2.8		J	664	250	2.5			790	590	6		
Manganese	mg/kg	296	3.3	0.22			135	0.85	0.057		J	93.1	0.76	0.051			190	1.8	0.087		
Mercury	mg/kg	0.038	0.1	0.0071	B	J	0.015	0.1	0.0074	B	J	0.013	0.091	0.0064	B	J	0.11	0.11	0.016	U	U
Nickel	mg/kg	9.4	8.9	0.22			5.4	2.3	0.057		J	5.1	2	0.051			6.4	4.7	0.32		
Potassium	mg/kg	315	2200	11	B	J	215	570	2.8	B	J	202	510	2.5	B	J	590	590	7.3	U	U
Selenium	mg/kg	4.4	4.4	0.44	U	U	1.1	1.1	0.11	U	UJ	1	1	0.1	U	U	0.59	0.59	0.53	U	U
Silver	mg/kg	2.2	2.2	0.22	U	U	0.57	0.57	0.057	U	UJ	0.51	0.51	0.051	U	U	0.59	0.59	0.12	U	U
Sodium	mg/kg	2200	2200	190	U	U	570	570	48	U	U	510	510	43	U	U	590	590	78	U	U
Thallium	mg/kg	0.44	0.44	0.066	U	U	0.57	0.57	0.085	U	U	0.51	0.51	0.076	U	U	1.2	1.2	0.65	U	U
Vanadium	mg/kg	20.1	11	0.22			15.5	2.8	0.057		J	12.7	2.5	0.051			16	5.9	0.14		
Zinc	mg/kg	22.2	4.4	0.22			13.8	1.1	0.057		J	16.1	1	0.051			18	2.4	1.2		
Pesticides/PCBs																					
Aroclor 1016	mg/kg	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U	0.021	0.021	0.0082	U	U	0.041	0.041	0.026	U H	UJ
Aroclor 1221	mg/kg	0.021	0.021	0.01	U	U	0.021	0.021	0.01	U	U	0.021	0.021	0.01	U	U	0.041	0.041	0.02	U H	UJ
Aroclor 1232	mg/kg	0.021	0.021	0.01	U	U	0.021	0.021	0.01	U	U	0.021	0.021	0.01	U	U	0.041	0.041	0.017	U H	UJ
Aroclor 1242	mg/kg	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U	0.021	0.021	0.0082	U	U	0.041	0.041	0.016	U	UJ
Aroclor 1248	mg/kg	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U	0.021	0.021	0.0082	U	U	0.041	0.041	0.021	U H	UJ
Aroclor 1254	mg/kg	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U	0.021	0.021	0.0082	U	U	0.041	0.041	0.021	U H	UJ
Aroclor 1260	mg/kg	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U	0.021	0.021	0.0082	U	U	0.041	0.041	0.021	U H	UJ
Aroclor 1268	mg/kg	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U	0.021	0.021	0.0082	U	U					

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB01					ULA-SB02					ULA-SB02					ULA-SB02				
SAMPLE NO		ULA0001					ULA0002					ULA0003					ULA0004				
SAMPLE DATE		18-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					FD					FS				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.21	0.21	0.03	U	U	0.21	0.21	0.03	U	U	0.2	0.2	0.029	U	U	0.49	0.49	0.025	U	U
Acenaphthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Acenaphthylene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Acetophenone	mg/kg																0.12	0.12	0.011	U	U
Anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Atrazine	mg/kg																0.25	0.25	0.011	U	U
Benzaldehyde	mg/kg																0.12	0.12	0.015	U	UJ
Benzo(a)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Benzo(a)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Benzo(b)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Benzo(ghi)perylene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Benzo(k)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Benzoic acid	mg/kg	1	1	0.36	U	U	1	1	0.37	U	U	1	1	0.36	U	U					
Benzyl alcohol	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U					
Bibenzene	mg/kg																0.062	0.062	0.033	U	U
Bis(2-chloroethoxy)methane	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.12	0.12	0.027	U	U
Bis(2-chloroethyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.12	0.12	0.0025	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	UJ	0.2	0.2	0.02	U	UJ	0.12	0.12	0.012	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.41	0.41	0.083	U	U	0.42	0.42	0.083	U	UJ	0.41	0.41	0.081	U	UJ	0.062	0.062	0.023	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.016	U	U
Butyl benzyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	UJ	0.2	0.2	0.041	U	UJ	0.062	0.062	0.012	U	U
Caprolactam	mg/kg																0.41	0.41	0.046	U	U
Carbazole	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.033	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.19	0.19	0.026	U	U
Chloroaniline, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.19	0.19	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.062	0.062	0.0041	U	U
Chlorophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.033	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.016	U	U
Chrysene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0014	U	U
Dibenz(a,h)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Dibenzofuran	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.0041	U	U
Dichlorobenzene, 1,2-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U					
Dichlorobenzene, 1,3-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U					
Dichlorobenzene, 1,4-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U					
Dichlorobenzidine, 3,3'-	mg/kg	0.41	0.41	0.041	U	U	0.42	0.42	0.042	U	U	0.41	0.41	0.041	U	U	0.12	0.12	0.022	U	U
Dichlorophenol, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.19	0.19	0.025	U	U
Diethyl phthalate	mg/kg	0.41	0.41	0.083	U	U	0.42	0.42	0.083	U	U	0.41	0.41	0.081	U	U	0.062	0.062	0.02	U	U
Dimethyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.062	0.062	0.021	U	U
Dimethylphenol, 2,4-	mg/kg	0.21	0.21	0.026	U	U	0.21	0.21	0.026	U	U	0.2	0.2	0.026	U	U	0.19	0.19	0.025	U	U
Di-n-butyl phthalate	mg/kg	0.41	0.41	0.083	U	U	0.42	0.42	0.083	U	U	0.41	0.41	0.081	U	U	0.062	0.062	0.019	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.41	0.41	0.083	U	U	0.42	0.42	0.083	U	U	0.41	0.41	0.081	U	U	0.19	0.19	0.099	U	U
Dinitrophenol, 2,4-	mg/kg	1	1	0.41	U	U	1	1	0.42	U	U	1	1	0.41	U	U	0.41	0.41	0.099	U	U
Dinitrotoluene, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.25	0.25	0.033	U	U
Dinitrotoluene, 2,6-	mg/kg	0.21	0.21	0.024	U	U	0.21	0.21	0.025	U	U	0.2	0.2	0.024	U	U	0.25	0.25	0.026	U	U
Di-n-octyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	UJ	0.2	0.2	0.041	U	UJ	0.062	0.062	0.033	U	U
Fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Fluorene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Hexachlorobenzene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0026	U	U
Hexachlorobutadiene	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.062	0.062	0.033	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB01					ULA-SB02					ULA-SB02					ULA-SB02				
SAMPLE NO		ULA0001					ULA0002					ULA0003					ULA0004				
SAMPLE DATE		18-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					FD					FS				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachlorocyclopentadiene	mg/kg	0.21	0.21	0.091	U	U	0.21	0.21	0.092	U	U	0.2	0.2	0.089	U	U	0.41	0.41	0.033	U	U
Hexachloroethane	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.062	0.062	0.011	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Isophorone	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.016	U	U
Methylnaphthalene, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Methylphenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.25	0.25	0.099	U	U
Naphthalene	mg/kg	0.21	0.21	0.033	U	U	0.21	0.21	0.033	U	U	0.2	0.2	0.032	U	U	0.0082	0.0082	0.0041	U	U
Nitroaniline, 2-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.25	0.25	0.011	U	U
Nitroaniline, 3-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.25	0.25	0.02	U	U
Nitroaniline, 4-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.25	0.25	0.032	U	U
Nitrobenzene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.12	0.12	0.0027	U	U
Nitrophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.033	U	U
Nitrophenol, 4-	mg/kg	1	1	0.17	U	U	1	1	0.17	U	U	1	1	0.16	U	U	0.41	0.41	0.099	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.033	U	U
n-Nitrosodiphenylamine	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.026	U	U
Pentachlorophenol	mg/kg	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.24	U	U	0.19	0.19	0.099	U	U
Phenanthrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Phenol	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.062	0.062	0.033	U	U
Pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U					
Trichlorophenol, 2,4,5-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.19	0.19	0.031	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.19	0.19	0.099	U	U
Volatile Organics																					
Acetone	mg/kg	0.0393	0.038	0.015		J	0.0441	0.037	0.015	J	J	0.035	0.035	0.014	U	U	0.24	0.025	0.002		
Benzene	mg/kg	0.0038	0.0038	0.0011	U	U	0.0037	0.0037	0.0011	U	U	0.0035	0.0035	0.001	U	U	0.0062	0.0062	0.00017	U	U
Bromodichloromethane	mg/kg	0.0038	0.0038	0.00084	U	U	0.0037	0.0037	0.00081	U	U	0.0035	0.0035	0.00077	U	U	0.0062	0.0062	0.00019	U	U
Bromoform	mg/kg	0.0038	0.0038	0.0011	U	UJ	0.0037	0.0037	0.0011	U	U	0.0035	0.0035	0.001	U	U	0.0062	0.0062	0.00052	U	U
Bromomethane	mg/kg	0.0038	0.0038	0.0015	U	UJ	0.0037	0.0037	0.0015	U	U	0.0035	0.0035	0.0014	U	U	0.0062	0.0062	0.0004	U *	U
Butanone, 2-	mg/kg	0.019	0.019	0.0047	U	UJ	0.018	0.018	0.0045	U	U	0.017	0.017	0.0043	U	U	0.025	0.025	0.0011	U	U
Carbon disulfide	mg/kg	0.0038	0.0038	0.0015	U	U	0.0037	0.0037	0.0015	U	U	0.0035	0.0035	0.0014	U	U	0.0062	0.0062	0.00045	U	U
Carbon tetrachloride	mg/kg	0.0038	0.0038	0.0014	U	U	0.0037	0.0037	0.0013	U	U	0.0035	0.0035	0.0013	U	U	0.0062	0.0062	0.00038	U	U
Chlorobenzene	mg/kg	0.0038	0.0038	0.00077	U	UJ	0.0037	0.0037	0.00073	U	U	0.0035	0.0035	0.0007	U	U	0.0062	0.0062	0.00041	U	U
Chloroethane	mg/kg	0.0038	0.0038	0.0015	U	UJ	0.0037	0.0037	0.0015	U	U	0.0035	0.0035	0.0014	U	U	0.0062	0.0062	0.00043	U	U
Chloroform	mg/kg	0.0038	0.0038	0.00092	U	U	0.0037	0.0037	0.00088	U	U	0.0035	0.0035	0.00084	U	U	0.0062	0.0062	0.00035	U	U
Chloromethane	mg/kg	0.0038	0.0038	0.0015	U	U	0.0037	0.0037	0.0015	U	U	0.0035	0.0035	0.0014	U	U	0.0062	0.0062	0.00027	U	UJ
Cyclohexane	mg/kg																0.012	0.012	0.00027	U	U
Dibromo-3-chloropropane, 1,2-	mg/kg																0.012	0.012	0.0012	U	U
Dibromochloromethane	mg/kg	0.0038	0.0038	0.00077	U	UJ	0.0037	0.0037	0.00073	U	U	0.0035	0.0035	0.0007	U	U	0.0062	0.0062	0.00038	U	U
Dibromoethane, 1,2-	mg/kg																0.0062	0.0062	0.00051	U	U
Dichlorobenzene, 1,2-	mg/kg																0.0062	0.0062	0.00051	U	U
Dichlorobenzene, 1,3-	mg/kg																0.0062	0.0062	0.00036	U	U
Dichlorobenzene, 1,4-	mg/kg																0.0062	0.0062	0.00058	U	U
Dichlorodifluoromethane	mg/kg																0.0062	0.0062	0.00043	U	UJ
Dichloroethane, 1,1-	mg/kg	0.0038	0.0038	0.00084	U	U	0.0037	0.0037	0.00081	U	U	0.0035	0.0035	0.00077	U	U	0.0062	0.0062	0.00031	U	U
Dichloroethane, 1,2-	mg/kg	0.0038	0.0038	0.00077	U	U	0.0037	0.0037	0.00073	U	U	0.0035	0.0035	0.0007	U	U	0.0062	0.0062	0.00035	U	U
Dichloroethene, 1,1-	mg/kg	0.0038	0.0038	0.0011	U	U	0.0037	0.0037	0.001	U	U	0.0035	0.0035	0.00098	U	U	0.0062	0.0062	0.00046	U	U
Dichloroethene, cis-1,2-	mg/kg	0.0038	0.0038	0.0011	U	U	0.0037	0.0037	0.0011	U	U	0.0035	0.0035	0.001	U	U	0.0062	0.0062	0.00027	U	U
Dichloroethene, trans-1,2-	mg/kg	0.0038	0.0038	0.0011	U	U	0.0037	0.0037	0.0011	U	U	0.0035	0.0035	0.001	U	U	0.0062	0.0062	0.00043	U	U
Dichloropropane, 1,2-	mg/kg	0.0038	0.0038	0.00092	U	U	0.0037	0.0037	0.00088	U	U	0.0035	0.0035	0.00084	U	U	0.0062	0.0062	0.00061	U	U
Dichloropropene, cis-1,3-	mg/kg	0.0038	0.0038	0.00077	U	UJ	0.0037	0.0037	0.00073	U	U	0.0035	0.0035	0.0007	U	U	0.0062	0.0062	0.00022	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB01					ULA-SB02					ULA-SB02					ULA-SB02				
SAMPLE NO		ULA0001					ULA0002					ULA0003					ULA0004				
SAMPLE DATE		18-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					FD					FS				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Dichloropropene, trans-1,3-	mg/kg	0.0038	0.0038	0.00084	U	UJ	0.0037	0.0037	0.00081	U	U	0.0035	0.0035	0.00077	U	U	0.0062	0.0062	0.0004	U	U
Ethylbenzene	mg/kg	0.0038	0.0038	0.00077	U	UJ	0.0037	0.0037	0.00073	U	U	0.0035	0.0035	0.0007	U	U	0.0062	0.0062	0.00052	U	U
Hexanone, 2-	mg/kg	0.019	0.019	0.0041	U	UJ	0.018	0.018	0.004	U	U	0.017	0.017	0.0038	U	U	0.025	0.025	0.00074	U	U
Isopropylbenzene	mg/kg																0.0062	0.0062	0.00046	U	U
METHYL ACETATE	mg/kg																0.012	0.012	0.00079	U	U
Methyl Tertiary Butyl Ether	mg/kg																0.025	0.025	0.00031	U	U
Methyl-2-pentanone, 4-	mg/kg	0.019	0.019	0.0042	U	UJ	0.018	0.018	0.004	U	U	0.017	0.017	0.0038	U	U	0.025	0.025	0.00084	U	U
Methylcyclohexane	mg/kg																0.012	0.012	0.0003	U	U
Methylene chloride	mg/kg	0.0097	0.0077	0.0035		J	0.0057	0.0073	0.0034	J	J	0.007	0.007	0.0032	U	U	0.015	0.0062	0.0012		
Styrene	mg/kg	0.0038	0.0038	0.002	U	UJ	0.0037	0.0037	0.0019	U	U	0.0035	0.0035	0.0018	U	U	0.0062	0.0062	0.00033	U	U
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0038	0.0038	0.00092	U	UJ	0.0037	0.0037	0.00088	U	U	0.0035	0.0035	0.00084	U	U	0.0062	0.0062	0.00029	U	U
Tetrachloroethene	mg/kg	0.0038	0.0038	0.00077	U	U	0.0037	0.0037	0.00073	U	U	0.0035	0.0035	0.0007	U	U	0.0062	0.0062	0.00051	U	U
Toluene	mg/kg	0.0038	0.0038	0.00092	U	U	0.0037	0.0037	0.00088	U	U	0.0035	0.0035	0.00084	U	U	0.0062	0.0062	0.0004	U	U
Trichlorobenzene, 1,2,4-	mg/kg																0.0062	0.0062	0.00072	U	U
Trichloroethane, 1,1,1-	mg/kg	0.0038	0.0038	0.00084	U	U	0.0037	0.0037	0.00081	U	U	0.0035	0.0035	0.00077	U	U	0.0062	0.0062	0.00032	U	U
Trichloroethane, 1,1,2-	mg/kg	0.0038	0.0038	0.00084	U	UJ	0.0037	0.0037	0.00081	U	U	0.0035	0.0035	0.00077	U	U	0.0062	0.0062	0.00078	U	U
Trichloroethene	mg/kg	0.0038	0.0038	0.00092	U	U	0.0037	0.0037	0.00088	U	U	0.0035	0.0035	0.00084	U	U	0.0062	0.0062	0.00036	U	U
Trichlorofluoromethane	mg/kg																0.0062	0.0062	0.00031	U	U
Trichlorotrifluoroethane	mg/kg																0.0062	0.0062	0.00055	U	U
Vinyl chloride	mg/kg	0.0038	0.0038	0.0011	U	U	0.0037	0.0037	0.0011	U	U	0.0035	0.0035	0.001	U	U	0.0062	0.0062	0.00033	U	U
Xylenes, total	mg/kg	0.011	0.011	0.0025	U	UJ	0.011	0.011	0.0024	U	U	0.01	0.01	0.0022	U	U	0.012	0.012	0.001	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB03					ULA-SB04					ULA-SB05					ULA-SB06				
SAMPLE NO		ULA0005					ULA0006					ULA0007					ULA0008				
SAMPLE DATE		19-May-11					18-May-11					19-May-11					18-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Dinitrobenzene, 1,3-	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Dinitrotoluene, 2,4-	mg/kg	0.19	0.19	0.092	U	U	0.16	0.16	0.076	U	U	0.18	0.18	0.086	U	U	0.15	0.15	0.071	U	U
Dinitrotoluene, 2,6-	mg/kg	0.19	0.19	0.082	U	U	0.16	0.16	0.068	U	U	0.18	0.18	0.077	U	U	0.15	0.15	0.064	U	U
HMX	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Nitrobenzene	mg/kg	0.19	0.19	0.088	U	U	0.16	0.16	0.073	U	U	0.18	0.18	0.082	U	U	0.15	0.15	0.068	U	U
Nitrotoluene, 2-	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Nitrotoluene, 3-	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Nitrotoluene, 4-	mg/kg	0.19	0.19	0.096	U	U	0.16	0.16	0.079	U	U	0.18	0.18	0.089	U	U	0.15	0.15	0.074	U	U
RDX	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Tetryl	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.19	0.19	0.076	U	U	0.16	0.16	0.063	U	U	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
General Chemistry																					
% Solids	Percent	58.7	0				80.9	0				81.8	0				75.8	0			
Metals																					
Aluminum	mg/kg	6740	13	1.6			10400	47	5.7			8360	52	6.2			10400	47	5.6		
Antimony	mg/kg	1.3	1.3	0.066	U	U	4.7	4.7	0.24	U	U	5.2	5.2	0.26	U	U	4.7	4.7	0.23	U	U
Arsenic	mg/kg	3.6	0.66	0.066			9.5	2.4	0.24			6.4	2.6	0.26			6.1	2.3	0.23		
Barium	mg/kg	20.2	13	0.26			46	47	0.94	B	J	61.6	52	1			82.5	47	0.93		
Beryllium	mg/kg	0.29	0.33	0.0066	B	J	0.57	1.2	0.024	B	J	0.47	1.3	0.026	B	J	0.69	1.2	0.023	B	J
Cadmium	mg/kg	0.26	0.26	0.0066	U	U	0.94	0.94	0.024	U	U	1	1	0.026	U	U	0.33	0.93	0.023	B	J
Calcium	mg/kg	930	330	3.3		J	2990	1200	12			1990	1300	13			2840	1200	12		
Chromium	mg/kg	9.1	0.66	0.066			17.4	2.4	0.24			11	2.6	0.26			12.9	2.3	0.23		
Cobalt	mg/kg	3.7	3.3	0.066			7.8	12	0.24	B	J	5.7	13	0.26	B	J	6.1	12	0.23	B	J
Copper	mg/kg	5.9	1.6	0.066			19.1	5.9	0.24			10.1	6.5	0.26			10.1	5.8	0.23		
Iron	mg/kg	9670	20	1.5			21000	71	5.4			15700	78	6			15300	70	5.4		
Lead	mg/kg	8.4	1.3	0.066			10.7	0.94	0.047			12.5	1	0.052			12.7	1.2	0.058		
Magnesium	mg/kg	987	330	3.3			2520	1200	12			1610	1300	13			1720	1200	12		
Manganese	mg/kg	118	0.98	0.066			385	3.5	0.24			360	3.9	0.26			525	3.5	0.23		
Mercury	mg/kg	0.032	0.13	0.0092	B	J	0.03	0.1	0.0072	B	J	0.033	0.09	0.0064	B	J	0.039	0.1	0.0073	B	J
Nickel	mg/kg	7.4	2.6	0.066			23.3	9.4	0.24			11	10	0.26			12.6	9.3	0.23		
Potassium	mg/kg	316	660	3.3	B	J	949	2400	12	B	J	627	2600	13	B	J	596	2300	12	B	J
Selenium	mg/kg	1.3	1.3	0.13	U	U	4.7	4.7	0.47	U	U	5.2	5.2	0.52	U	U	4.7	4.7	0.47	U	U
Silver	mg/kg	0.66	0.66	0.066	U	U	2.4	2.4	0.24	U	U	2.6	2.6	0.26	U	U	2.3	2.3	0.23	U	U
Sodium	mg/kg	660	660	56	U	U	2400	2400	200	U	U	2600	2600	220	U	U	2300	2300	200	U	U
Thallium	mg/kg	0.66	0.66	0.098	U	U	0.47	0.47	0.071	U	U	0.52	0.52	0.078	U	U	0.58	0.58	0.088	U	U
Vanadium	mg/kg	19.7	3.3	0.066			25.8	12	0.24			20.7	13	0.26			22.7	12	0.23		
Zinc	mg/kg	21.5	1.3	0.066			52.7	4.7	0.24			34.1	5.2	0.26			40.7	4.7	0.23		
Pesticides/PCBs																					
Aroclor 1016	mg/kg	0.028	0.028	0.011	U	U	0.021	0.021	0.0082	U	U						0.022	0.022	0.0088	U	U
Aroclor 1221	mg/kg	0.028	0.028	0.014	U	U	0.021	0.021	0.01	U	U						0.022	0.022	0.011	U	U
Aroclor 1232	mg/kg	0.028	0.028	0.014	U	U	0.021	0.021	0.01	U	U						0.022	0.022	0.011	U	U
Aroclor 1242	mg/kg	0.028	0.028	0.011	U	U	0.021	0.021	0.0082	U	U						0.022	0.022	0.0088	U	U
Aroclor 1248	mg/kg	0.028	0.028	0.011	U	U	0.021	0.021	0.0082	U	U						0.022	0.022	0.0088	U	U
Aroclor 1254	mg/kg	0.028	0.028	0.011	U	U	0.021	0.021	0.0082	U	U						0.022	0.022	0.0088	U	U
Aroclor 1260	mg/kg	0.028	0.028	0.011	U	U	0.021	0.021	0.0082	U	U						0.022	0.022	0.0088	U	U
Aroclor 1268	mg/kg	0.028	0.028	0.011	U	U	0.021	0.021	0.0082	U	U						0.022	0.022	0.0088	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB03					ULA-SB04					ULA-SB05					ULA-SB06				
SAMPLE NO		ULA0005					ULA0006					ULA0007					ULA0008				
SAMPLE DATE		19-May-11					18-May-11					19-May-11					18-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.28	0.28	0.041	U	U	0.2	0.2	0.029	U	U	0.2	0.2	0.029	U	U	0.22	0.22	0.031	U	U
Acenaphthene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Acenaphthylene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Acetophenone	mg/kg																				
Anthracene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Atrazine	mg/kg																				
Benzaldehyde	mg/kg																				
Benzo(a)anthracene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Benzo(a)pyrene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.0239	0.2	0.02	J	J	0.22	0.22	0.022	U	U
Benzo(b)fluoranthene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Benzo(ghi)perylene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Benzo(k)fluoranthene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Benzoic acid	mg/kg	1.4	1.4	0.5	U	U	1	1	0.36	U	U	1	1	0.36	U	U	1.1	1.1	0.38	U	U
Benzyl alcohol	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Bibenzene	mg/kg																				
Bis(2-chloroethoxy)methane	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Bis(2-chloroethyl)ether	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.28	0.28	0.028	U	UJ	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	UJ	0.22	0.22	0.022	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.57	0.57	0.11	U	UJ	0.41	0.41	0.081	U	U	0.4	0.4	0.081	U	UJ	0.44	0.44	0.087	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Butyl benzyl phthalate	mg/kg	0.28	0.28	0.057	U	UJ	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	UJ	0.22	0.22	0.044	U	U
Caprolactam	mg/kg																				
Carbazole	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Chloroaniline, 4-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Chloronaphthalene, 2-	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Chlorophenol, 2-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Chrysene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.0272	0.2	0.02	J	J	0.22	0.22	0.022	U	U
Dibenz(a,h)anthracene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Dibenzofuran	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Dichlorobenzene, 1,2-	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Dichlorobenzene, 1,3-	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Dichlorobenzene, 1,4-	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.57	0.57	0.057	U	U	0.41	0.41	0.041	U	U	0.4	0.4	0.04	U	U	0.44	0.44	0.044	U	U
Dichlorophenol, 2,4-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Diethyl phthalate	mg/kg	0.57	0.57	0.11	U	U	0.41	0.41	0.081	U	U	0.4	0.4	0.081	U	U	0.44	0.44	0.087	U	U
Dimethyl phthalate	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Dimethylphenol, 2,4-	mg/kg	0.28	0.28	0.036	U	U	0.2	0.2	0.026	U	U	0.2	0.2	0.026	U	U	0.22	0.22	0.028	U	U
Di-n-butyl phthalate	mg/kg	0.57	0.57	0.11	U	U	0.41	0.41	0.081	U	U	0.4	0.4	0.081	U	U	0.44	0.44	0.087	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.57	0.57	0.11	U	U	0.41	0.41	0.081	U	U	0.4	0.4	0.081	U	U	0.44	0.44	0.087	U	U
Dinitrophenol, 2,4-	mg/kg	1.4	1.4	0.57	U	U	1	1	0.41	U	U	1	1	0.4	U	U	1.1	1.1	0.44	U	U
Dinitrotoluene, 2,4-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Dinitrotoluene, 2,6-	mg/kg	0.28	0.28	0.033	U	U	0.2	0.2	0.024	U	U	0.2	0.2	0.024	U	U	0.22	0.22	0.026	U	U
Di-n-octyl phthalate	mg/kg	0.28	0.28	0.057	U	UJ	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	UJ	0.22	0.22	0.044	U	U
Fluoranthene	mg/kg	0.0412	0.28	0.028	J	J	0.2	0.2	0.02	U	U	0.0296	0.2	0.02	J	J	0.22	0.22	0.022	U	U
Fluorene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Hexachlorobenzene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Hexachlorobutadiene	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB03					ULA-SB04					ULA-SB05					ULA-SB06				
SAMPLE NO		ULA0005					ULA0006					ULA0007					ULA0008				
SAMPLE DATE		19-May-11					18-May-11					19-May-11					18-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachlorocyclopentadiene	mg/kg	0.28	0.28	0.12	U	U	0.2	0.2	0.089	U	U	0.2	0.2	0.089	U	U	0.22	0.22	0.096	U	U
Hexachloroethane	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Isophorone	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Methylnaphthalene, 2-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Methylphenol, 2-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Naphthalene	mg/kg	0.28	0.28	0.045	U	U	0.2	0.2	0.033	U	U	0.2	0.2	0.032	U	U	0.22	0.22	0.035	U	U
Nitroaniline, 2-	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Nitroaniline, 3-	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Nitroaniline, 4-	mg/kg	0.28	0.28	0.057	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.22	0.22	0.044	U	U
Nitrobenzene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Nitrophenol, 2-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Nitrophenol, 4-	mg/kg	1.4	1.4	0.23	U	U	1	1	0.16	U	U	1	1	0.16	U	U	1.1	1.1	0.17	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
n-Nitrosodiphenylamine	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Pentachlorophenol	mg/kg	1.4	1.4	0.34	U	U	1	1	0.24	U	U	1	1	0.24	U	U	1.1	1.1	0.26	U	U
Phenanthrene	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Phenol	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Pyrene	mg/kg	0.0381	0.28	0.028	J	J	0.2	0.2	0.02	U	U	0.0294	0.2	0.02	J	J	0.22	0.22	0.022	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.28	0.28	0.028	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.22	0.022	U	U
Volatile Organics																					
Acetone	mg/kg	0.251	0.058	0.023	J	J	0.0288	0.043	0.017	J	J	0.0466	0.042	0.017	J	J	0.0457	0.037	0.015		
Benzene	mg/kg	0.0058	0.0058	0.0017	U	U	0.0043	0.0043	0.0013	U	U	0.0042	0.0042	0.0013	U	U	0.0037	0.0037	0.0011	U	U
Bromodichloromethane	mg/kg	0.0058	0.0058	0.0013	U	U	0.0043	0.0043	0.00095	U	U	0.0042	0.0042	0.00093	U	U	0.0037	0.0037	0.00081	U	U
Bromoform	mg/kg	0.0058	0.0058	0.0017	U	U	0.0043	0.0043	0.0013	U	U	0.0042	0.0042	0.0013	U	U	0.0037	0.0037	0.0011	U	U
Bromomethane	mg/kg	0.0058	0.0058	0.0023	U	U	0.0043	0.0043	0.0017	U	U	0.0042	0.0042	0.0017	U	U	0.0037	0.0037	0.0015	U	U
Butanone, 2-	mg/kg	0.0238	0.029	0.007	J	J	0.021	0.021	0.0052	U	U	0.006	0.021	0.0051	J	J	0.018	0.018	0.0045	U	U
Carbon disulfide	mg/kg	0.0058	0.0058	0.0023	U	U	0.0043	0.0043	0.0017	U	U	0.0042	0.0042	0.0017	U	U	0.0037	0.0037	0.0015	U	U
Carbon tetrachloride	mg/kg	0.0058	0.0058	0.0021	U	U	0.0043	0.0043	0.0015	U	U	0.0042	0.0042	0.0015	U	U	0.0037	0.0037	0.0013	U	U
Chlorobenzene	mg/kg	0.0058	0.0058	0.0012	U	U	0.0043	0.0043	0.00086	U	U	0.0042	0.0042	0.00084	U	UJ	0.0037	0.0037	0.00074	U	U
Chloroethane	mg/kg	0.0058	0.0058	0.0023	U	U	0.0043	0.0043	0.0017	U	UJ	0.0042	0.0042	0.0017	U	U	0.0037	0.0037	0.0015	U	UJ
Chloroform	mg/kg	0.0058	0.0058	0.0014	U	U	0.0043	0.0043	0.001	U	U	0.0042	0.0042	0.001	U	U	0.0037	0.0037	0.00088	U	U
Chloromethane	mg/kg	0.0058	0.0058	0.0023	U	U	0.0043	0.0043	0.0017	U	U	0.0042	0.0042	0.0017	U	U	0.0037	0.0037	0.0015	U	U
Cyclohexane	mg/kg																				
Dibromo-3-chloropropane, 1,2-	mg/kg																				
Dibromochloromethane	mg/kg	0.0058	0.0058	0.0012	U	U	0.0043	0.0043	0.00086	U	U	0.0042	0.0042	0.00084	U	U	0.0037	0.0037	0.00074	U	U
Dibromoethane, 1,2-	mg/kg																				
Dichlorobenzene, 1,2-	mg/kg																				
Dichlorobenzene, 1,3-	mg/kg																				
Dichlorobenzene, 1,4-	mg/kg																				
Dichlorodifluoromethane	mg/kg																				
Dichloroethane, 1,1-	mg/kg	0.0058	0.0058	0.0013	U	U	0.0043	0.0043	0.00095	U	U	0.0042	0.0042	0.00093	U	U	0.0037	0.0037	0.00081	U	U
Dichloroethane, 1,2-	mg/kg	0.0058	0.0058	0.0012	U	U	0.0043	0.0043	0.00086	U	U	0.0042	0.0042	0.00084	U	U	0.0037	0.0037	0.00074	U	U
Dichloroethene, 1,1-	mg/kg	0.0058	0.0058	0.0016	U	U	0.0043	0.0043	0.0012	U	U	0.0042	0.0042	0.0012	U	U	0.0037	0.0037	0.001	U	U
Dichloroethene, cis-1,2-	mg/kg	0.0058	0.0058	0.0017	U	U	0.0043	0.0043	0.0013	U	U	0.0042	0.0042	0.0013	U	U	0.0037	0.0037	0.0011	U	U
Dichloroethene, trans-1,2-	mg/kg	0.0058	0.0058	0.0017	U	U	0.0043	0.0043	0.0013	U	U	0.0042	0.0042	0.0013	U	U	0.0037	0.0037	0.0011	U	U
Dichloropropane, 1,2-	mg/kg	0.0058	0.0058	0.0014	U	U	0.0043	0.0043	0.001	U	U	0.0042	0.0042	0.001	U	U	0.0037	0.0037	0.00088	U	U
Dichloropropene, cis-1,3-	mg/kg	0.0058	0.0058	0.0012	U	U	0.0043	0.0043	0.00086	U	U	0.0042	0.0042	0.00084	U	U	0.0037	0.0037	0.00074	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB03					ULA-SB04					ULA-SB05					ULA-SB06				
SAMPLE NO		ULA0005					ULA0006					ULA0007					ULA0008				
SAMPLE DATE		19-May-11					18-May-11					19-May-11					18-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Dichloropropene, trans-1,3-	mg/kg	0.0058	0.0058	0.0013	U	U	0.0043	0.0043	0.00095	U	U	0.0042	0.0042	0.00093	U	U	0.0037	0.0037	0.00081	U	U
Ethylbenzene	mg/kg	0.0058	0.0058	0.0012	U	U	0.0043	0.0043	0.00086	U	U	0.0042	0.0042	0.00084	U	U	0.0037	0.0037	0.00074	U	U
Hexanone, 2-	mg/kg	0.029	0.029	0.0062	U	U	0.021	0.021	0.0046	U	U	0.021	0.021	0.0046	U	U	0.018	0.018	0.004	U	U
Isopropylbenzene	mg/kg																				
METHYL ACETATE	mg/kg																				
Methyl Tertiary Butyl Ether	mg/kg																				
Methyl-2-pentanone, 4-	mg/kg	0.0067	0.029	0.0063	J	J	0.021	0.021	0.0047	U	U	0.021	0.021	0.0046	U	U	0.018	0.018	0.004	U	U
Methylcyclohexane	mg/kg																				
Methylene chloride	mg/kg	0.0097	0.012	0.0053	J	J	0.0088	0.0086	0.004			0.0046	0.0084	0.0039	J	J	0.0037	0.0074	0.0034	J	J
Styrene	mg/kg	0.0058	0.0058	0.003	U	U	0.0043	0.0043	0.0022	U	U	0.0042	0.0042	0.0022	U	UJ	0.0037	0.0037	0.0019	U	U
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0058	0.0058	0.0014	U	U	0.0043	0.0043	0.001	U	U	0.0042	0.0042	0.001	U	U	0.0037	0.0037	0.00088	U	U
Tetrachloroethene	mg/kg	0.0058	0.0058	0.0012	U	U	0.0043	0.0043	0.00086	U	U	0.0042	0.0042	0.00084	U	U	0.0037	0.0037	0.00074	U	U
Toluene	mg/kg	0.0058	0.0058	0.0014	U	U	0.0043	0.0043	0.001	U	U	0.0042	0.0042	0.001	U	U	0.0037	0.0037	0.00088	U	U
Trichlorobenzene, 1,2,4-	mg/kg																				
Trichloroethane, 1,1,1-	mg/kg	0.0058	0.0058	0.0013	U	U	0.0043	0.0043	0.00095	U	U	0.0042	0.0042	0.00093	U	U	0.0037	0.0037	0.00081	U	U
Trichloroethane, 1,1,2-	mg/kg	0.0058	0.0058	0.0013	U	U	0.0043	0.0043	0.00095	U	U	0.0042	0.0042	0.00093	U	U	0.0037	0.0037	0.00081	U	U
Trichloroethene	mg/kg	0.0058	0.0058	0.0014	U	U	0.0043	0.0043	0.001	U	U	0.0042	0.0042	0.001	U	U	0.0037	0.0037	0.00088	U	U
Trichlorofluoromethane	mg/kg																				
Trichlorotrifluoroethane	mg/kg																				
Vinyl chloride	mg/kg	0.0058	0.0058	0.0017	U	U	0.0043	0.0043	0.0013	U	U	0.0042	0.0042	0.0013	U	U	0.0037	0.0037	0.0011	U	U
Xylenes, total	mg/kg	0.017	0.017	0.0037	U	U	0.013	0.013	0.0028	U	U	0.013	0.013	0.0027	U	UJ	0.011	0.011	0.0024	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB07					ULA-SB08					ULA-SB09					ULA-SB10				
SAMPLE NO		ULA0009					ULA0010					ULA0011					ULA0012				
SAMPLE DATE		18-May-11					19-May-11					18-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Dinitrobenzene, 1,3-	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Dinitrotoluene, 2,4-	mg/kg	0.17	0.17	0.081	U	U	0.16	0.16	0.076	U	U	0.19	0.19	0.092	U	U	0.17	0.17	0.083	U	U
Dinitrotoluene, 2,6-	mg/kg	0.17	0.17	0.073	U	U	0.16	0.16	0.069	U	U	0.19	0.19	0.083	U	U	0.17	0.17	0.075	U	U
HMX	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Nitrobenzene	mg/kg	0.17	0.17	0.078	U	U	0.16	0.16	0.073	U	U	0.19	0.19	0.089	U	U	0.17	0.17	0.08	U	U
Nitrotoluene, 2-	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Nitrotoluene, 3-	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Nitrotoluene, 4-	mg/kg	0.17	0.17	0.085	U	U	0.16	0.16	0.08	U	U	0.19	0.19	0.096	U	U	0.17	0.17	0.087	U	U
RDX	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Tetryl	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.17	0.17	0.067	U	U	0.16	0.16	0.063	U	U	0.19	0.19	0.076	U	U	0.17	0.17	0.069	U	U
General Chemistry																					
% Solids	Percent	77.3	0				82.1	0				81.7	0				93.9	0			
Metals																					
Aluminum	mg/kg	11900	63	7.5			10200	23	2.7			10500	57	6.9			6310	19	2.3		
Antimony	mg/kg	6.3	6.3	0.31	U	U	2.3	2.3	0.11	U	U	5.7	5.7	0.29	U	U	1.9	1.9	0.094	U	U
Arsenic	mg/kg	6.3	3.1	0.31			7.8	1.1	0.11			4.4	2.9	0.29			3.2	0.94	0.094		
Barium	mg/kg	60.4	63	1.3	B	J	62.1	23	0.46			57.4	57	1.1			47.6	19	0.38		
Beryllium	mg/kg	0.52	1.6	0.031	B	J	0.53	0.57	0.011	B	J	0.59	1.4	0.029	B	J	0.35	0.47	0.0094	B	J
Cadmium	mg/kg	1.3	1.3	0.031	U	U	0.46	0.46	0.011	U	U	1.1	1.1	0.029	U	U	0.18	0.38	0.0094	B	J
Calcium	mg/kg	1840	1600	16			2290	570	5.7			2520	1400	14			2310	470	4.7		
Chromium	mg/kg	15.6	3.1	0.31			14.3	1.1	0.11			14.2	2.9	0.29			8.4	0.94	0.094		
Cobalt	mg/kg	5.3	16	0.31	B	J	9.9	5.7	0.11			7	14	0.29	B	J	3.3	4.7	0.094	B	J
Copper	mg/kg	10.8	7.8	0.31			18.1	2.8	0.11			8.6	7.1	0.29			9.4	2.4	0.094		
Iron	mg/kg	16800	94	7.2			19900	34	2.6			13200	86	6.6			9230	28	2.2		
Lead	mg/kg	8.6	1.3	0.063			11.4	1.1	0.057			10.4	1.1	0.057			9.1	0.94	0.047		
Magnesium	mg/kg	2120	1600	16			2450	570	5.7			2070	1400	14			1300	470	4.7		
Manganese	mg/kg	109	4.7	0.31			434	1.7	0.11			168	4.3	0.29			148	1.4	0.094		
Mercury	mg/kg	0.029	0.097	0.0069	B	J	0.076	0.091	0.0065	B	J	0.04	0.1	0.0072	B	J	0.044	0.082	0.0058	B	J
Nickel	mg/kg	16	13	0.31			18.1	4.6	0.11			13.7	11	0.29			8.3	3.8	0.094		
Potassium	mg/kg	580	3100	16	B	J	701	1100	5.7	B	J	586	2900	14	B	J	516	940	4.7	B	J
Selenium	mg/kg	6.3	6.3	0.63	U	U	2.3	2.3	0.23	U	U	5.7	5.7	0.57	U	U	0.54	1.9	0.19	B	J
Silver	mg/kg	3.1	3.1	0.31	U	U	1.1	1.1	0.11	U	U	2.9	2.9	0.29	U	U	0.94	0.94	0.094	U	U
Sodium	mg/kg	3100	3100	270	U	U	1100	1100	97	U	U	2900	2900	240	U	U	940	940	80	U	U
Thallium	mg/kg	0.63	0.63	0.094	U	U	0.57	0.57	0.085	U	U	0.57	0.57	0.086	U	U	0.47	0.47	0.071	U	U
Vanadium	mg/kg	23.6	16	0.31			24.3	5.7	0.11			22.9	14	0.29			13.3	4.7	0.094		
Zinc	mg/kg	35.3	6.3	0.31			35.3	2.3	0.11			36.5	5.7	0.29			28.5	1.9	0.094		
Pesticides/PCBs																					
Aroclor 1016	mg/kg	0.022	0.022	0.0086	U	U						0.02	0.02	0.008	U	U	0.018	0.018	0.0071	U	U
Aroclor 1221	mg/kg	0.022	0.022	0.011	U	U						0.02	0.02	0.01	U	U	0.018	0.018	0.0088	U	U
Aroclor 1232	mg/kg	0.022	0.022	0.011	U	U						0.02	0.02	0.01	U	U	0.018	0.018	0.0088	U	U
Aroclor 1242	mg/kg	0.022	0.022	0.0086	U	U						0.02	0.02	0.008	U	U	0.018	0.018	0.0071	U	U
Aroclor 1248	mg/kg	0.022	0.022	0.0086	U	U						0.02	0.02	0.008	U	U	0.018	0.018	0.0071	U	U
Aroclor 1254	mg/kg	0.022	0.022	0.0086	U	U						0.02	0.02	0.008	U	U	0.018	0.018	0.0071	U	U
Aroclor 1260	mg/kg	0.022	0.022	0.0086	U	U						0.02	0.02	0.008	U	U	0.018	0.018	0.0071	U	U
Aroclor 1268	mg/kg	0.022	0.022	0.0086	U	U						0.02	0.02	0.008	U	U	0.018	0.018	0.0071	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB07					ULA-SB08					ULA-SB09					ULA-SB10				
SAMPLE NO		ULA0009					ULA0010					ULA0011					ULA0012				
SAMPLE DATE		18-May-11					19-May-11					18-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.21	0.21	0.031	U	U	0.2	0.2	0.029	U	U	0.2	0.2	0.029	U	U	0.18	0.18	0.025	U	U
Acenaphthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Acenaphthylene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Acetophenone	mg/kg																				
Anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Atrazine	mg/kg																				
Benzaldehyde	mg/kg																				
Benzo(a)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Benzo(a)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Benzo(b)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Benzo(ghi)perylene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Benzo(k)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Benzoic acid	mg/kg	1.1	1.1	0.37	U	U	1	1	0.36	U	U	1	1	0.35	U	U	0.88	0.88	0.31	U	U
Benzyl alcohol	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Bibenzene	mg/kg																				
Bis(2-chloroethoxy)methane	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Bis(2-chloroethyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	UJ	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	UJ
Bis(2-ethylhexyl)phthalate	mg/kg	0.42	0.42	0.085	U	U	0.4	0.4	0.081	U	UJ	0.4	0.4	0.08	U	U	0.35	0.35	0.071	U	UJ
Bromophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Butyl benzyl phthalate	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	UJ	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	UJ
Caprolactam	mg/kg																				
Carbazole	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Chloroaniline, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Chloronaphthalene, 2-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Chlorophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Chrysene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Dibenz(a,h)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Dibenzofuran	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Dichlorobenzene, 1,2-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Dichlorobenzene, 1,3-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Dichlorobenzene, 1,4-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.42	0.42	0.042	U	U	0.4	0.4	0.04	U	U	0.4	0.4	0.04	U	U	0.35	0.35	0.035	U	U
Dichlorophenol, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Diethyl phthalate	mg/kg	0.42	0.42	0.085	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U	0.35	0.35	0.071	U	U
Dimethyl phthalate	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Dimethylphenol, 2,4-	mg/kg	0.21	0.21	0.027	U	U	0.2	0.2	0.025	U	U	0.2	0.2	0.025	U	U	0.18	0.18	0.022	U	U
Di-n-butyl phthalate	mg/kg	0.42	0.42	0.085	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U	0.35	0.35	0.071	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.42	0.42	0.085	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U	0.35	0.35	0.071	U	U
Dinitrophenol, 2,4-	mg/kg	1.1	1.1	0.42	U	U	1	1	0.4	U	U	1	1	0.4	U	U	0.88	0.88	0.35	U	U
Dinitrotoluene, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Dinitrotoluene, 2,6-	mg/kg	0.21	0.21	0.025	U	U	0.2	0.2	0.024	U	U	0.2	0.2	0.024	U	U	0.18	0.18	0.021	U	U
Di-n-octyl phthalate	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	UJ	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	UJ
Fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Fluorene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Hexachlorobenzene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Hexachlorobutadiene	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB07					ULA-SB08					ULA-SB09					ULA-SB10				
SAMPLE NO		ULA0009					ULA0010					ULA0011					ULA0012				
SAMPLE DATE		18-May-11					19-May-11					18-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachlorocyclopentadiene	mg/kg	0.21	0.21	0.093	U	U	0.2	0.2	0.089	U	U	0.2	0.2	0.088	U	U	0.18	0.18	0.078	U	U
Hexachloroethane	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Isophorone	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Methylnaphthalene, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Methylphenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Naphthalene	mg/kg	0.21	0.21	0.034	U	U	0.2	0.2	0.032	U	U	0.2	0.2	0.032	U	U	0.18	0.18	0.028	U	U
Nitroaniline, 2-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Nitroaniline, 3-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Nitroaniline, 4-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.18	0.18	0.035	U	U
Nitrobenzene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Nitrophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Nitrophenol, 4-	mg/kg	1.1	1.1	0.17	U	U	1	1	0.16	U	U	1	1	0.16	U	U	0.88	0.88	0.14	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
n-Nitrosodiphenylamine	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Pentachlorophenol	mg/kg	1.1	1.1	0.25	U	U	1	1	0.24	U	U	1	1	0.24	U	U	0.88	0.88	0.21	U	U
Phenanthrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Phenol	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.018	U	U
Volatile Organics																					
Acetone	mg/kg	0.021	0.046	0.018	J	J	0.0732	0.034	0.013	J	J	0.0406	0.037	0.015			0.0773	0.029	0.012	J	J
Benzene	mg/kg	0.0046	0.0046	0.0014	U	U	0.0034	0.0034	0.001	U	U	0.0037	0.0037	0.0011	U	U	0.0029	0.0029	0.00088	U	U
Bromodichloromethane	mg/kg	0.0046	0.0046	0.001	U	U	0.0034	0.0034	0.00074	U	U	0.0037	0.0037	0.00082	U	U	0.0029	0.0029	0.00064	U	U
Bromoform	mg/kg	0.0046	0.0046	0.0014	U	U	0.0034	0.0034	0.001	U	U	0.0037	0.0037	0.0011	U	U	0.0029	0.0029	0.00088	U	U
Bromomethane	mg/kg	0.0046	0.0046	0.0018	U	U	0.0034	0.0034	0.0013	U	U	0.0037	0.0037	0.0015	U	U	0.0029	0.0029	0.0012	U	U
Butanone, 2-	mg/kg	0.023	0.023	0.0056	U	U	0.0069	0.017	0.0041	J	J	0.019	0.019	0.0045	U	U	0.0076	0.015	0.0036	J	J
Carbon disulfide	mg/kg	0.0046	0.0046	0.0018	U	U	0.0034	0.0034	0.0013	U	U	0.0037	0.0037	0.0015	U	U	0.0029	0.0029	0.0012	U	U
Carbon tetrachloride	mg/kg	0.0046	0.0046	0.0017	U	U	0.0034	0.0034	0.0012	U	U	0.0037	0.0037	0.0013	U	U	0.0029	0.0029	0.0011	U	U
Chlorobenzene	mg/kg	0.0046	0.0046	0.00092	U	U	0.0034	0.0034	0.00067	U	U	0.0037	0.0037	0.00074	U	U	0.0029	0.0029	0.00059	U	U
Chloroethane	mg/kg	0.0046	0.0046	0.0018	U	U	0.0034	0.0034	0.0013	U	U	0.0037	0.0037	0.0015	U	UJ	0.0029	0.0029	0.0012	U	U
Chloroform	mg/kg	0.0046	0.0046	0.0011	U	U	0.0034	0.0034	0.00081	U	U	0.0037	0.0037	0.00089	U	U	0.0029	0.0029	0.0007	U	U
Chloromethane	mg/kg	0.0046	0.0046	0.0018	U	U	0.0034	0.0034	0.0013	U	U	0.0037	0.0037	0.0015	U	U	0.0029	0.0029	0.0012	U	U
Cyclohexane	mg/kg																				
Dibromo-3-chloropropane, 1,2-	mg/kg																				
Dibromochloromethane	mg/kg	0.0046	0.0046	0.00092	U	U	0.0034	0.0034	0.00067	U	U	0.0037	0.0037	0.00074	U	U	0.0029	0.0029	0.00059	U	U
Dibromoethane, 1,2-	mg/kg																				
Dichlorobenzene, 1,2-	mg/kg																				
Dichlorobenzene, 1,3-	mg/kg																				
Dichlorobenzene, 1,4-	mg/kg																				
Dichlorodifluoromethane	mg/kg																				
Dichloroethane, 1,1-	mg/kg	0.0046	0.0046	0.001	U	U	0.0034	0.0034	0.00074	U	U	0.0037	0.0037	0.00082	U	U	0.0029	0.0029	0.00064	U	U
Dichloroethane, 1,2-	mg/kg	0.0046	0.0046	0.00092	U	U	0.0034	0.0034	0.00067	U	U	0.0037	0.0037	0.00074	U	U	0.0029	0.0029	0.00059	U	U
Dichloroethene, 1,1-	mg/kg	0.0046	0.0046	0.0013	U	U	0.0034	0.0034	0.00094	U	U	0.0037	0.0037	0.001	U	U	0.0029	0.0029	0.00082	U	U
Dichloroethene, cis-1,2-	mg/kg	0.0046	0.0046	0.0014	U	U	0.0034	0.0034	0.001	U	U	0.0037	0.0037	0.0011	U	U	0.0029	0.0029	0.00088	U	U
Dichloroethene, trans-1,2-	mg/kg	0.0046	0.0046	0.0014	U	U	0.0034	0.0034	0.001	U	U	0.0037	0.0037	0.0011	U	U	0.0029	0.0029	0.00088	U	U
Dichloropropane, 1,2-	mg/kg	0.0046	0.0046	0.0011	U	U	0.0034	0.0034	0.00081	U	U	0.0037	0.0037	0.00089	U	U	0.0029	0.0029	0.0007	U	U
Dichloropropene, cis-1,3-	mg/kg	0.0046	0.0046	0.00092	U	U	0.0034	0.0034	0.00067	U	U	0.0037	0.0037	0.00074	U	U	0.0029	0.0029	0.00059	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB07					ULA-SB08					ULA-SB09					ULA-SB10				
SAMPLE NO		ULA0009					ULA0010					ULA0011					ULA0012				
SAMPLE DATE		18-May-11					19-May-11					18-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft					0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Dichloropropene, trans-1,3-	mg/kg	0.0046	0.0046	0.001	U	U	0.0034	0.0034	0.00074	U	U	0.0037	0.0037	0.00082	U	U	0.0029	0.0029	0.00064	U	U
Ethylbenzene	mg/kg	0.0046	0.0046	0.00092	U	U	0.0034	0.0034	0.00067	U	U	0.0037	0.0037	0.00074	U	U	0.0029	0.0029	0.00059	U	U
Hexanone, 2-	mg/kg	0.023	0.023	0.005	U	U	0.017	0.017	0.0036	U	U	0.019	0.019	0.004	U	U	0.015	0.015	0.0032	U	U
Isopropylbenzene	mg/kg																				
METHYL ACETATE	mg/kg																				
Methyl Tertiary Butyl Ether	mg/kg																				
Methyl-2-pentanone, 4-	mg/kg	0.023	0.023	0.005	U	U	0.017	0.017	0.0037	U	U	0.019	0.019	0.0041	U	U	0.015	0.015	0.0032	U	U
Methylcyclohexane	mg/kg																				
Methylene chloride	mg/kg	0.0081	0.0092	0.0042	J	J	0.0067	0.0067	0.0031	U	U	0.0036	0.0074	0.0034	J	J	0.0059	0.0059	0.0027	U	U
Styrene	mg/kg	0.0046	0.0046	0.0024	U	U	0.0034	0.0034	0.0018	U	U	0.0037	0.0037	0.0019	U	U	0.0029	0.0029	0.0015	U	U
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0046	0.0046	0.0011	U	U	0.0034	0.0034	0.00081	U	U	0.0037	0.0037	0.00089	U	U	0.0029	0.0029	0.0007	U	U
Tetrachloroethene	mg/kg	0.0046	0.0046	0.00092	U	U	0.0034	0.0034	0.00067	U	U	0.0037	0.0037	0.00074	U	U	0.0029	0.0029	0.00059	U	U
Toluene	mg/kg	0.0046	0.0046	0.0011	U	U	0.0034	0.0034	0.00081	U	U	0.0037	0.0037	0.00089	U	U	0.0029	0.0029	0.0007	U	U
Trichlorobenzene, 1,2,4-	mg/kg																				
Trichloroethane, 1,1,1-	mg/kg	0.0046	0.0046	0.001	U	U	0.0034	0.0034	0.00074	U	U	0.0037	0.0037	0.00082	U	U	0.0029	0.0029	0.00064	U	U
Trichloroethane, 1,1,2-	mg/kg	0.0046	0.0046	0.001	U	U	0.0034	0.0034	0.00074	U	U	0.0037	0.0037	0.00082	U	U	0.0029	0.0029	0.00064	U	U
Trichloroethene	mg/kg	0.0046	0.0046	0.0011	U	U	0.0034	0.0034	0.00081	U	U	0.0037	0.0037	0.00089	U	U	0.0029	0.0029	0.0007	U	U
Trichlorofluoromethane	mg/kg																				
Trichlorotrifluoroethane	mg/kg																				
Vinyl chloride	mg/kg	0.0046	0.0046	0.0014	U	U	0.0034	0.0034	0.001	U	U	0.0037	0.0037	0.0011	U	U	0.0029	0.0029	0.00088	U	U
Xylenes, total	mg/kg	0.014	0.014	0.0029	U	U	0.01	0.01	0.0022	U	U	0.011	0.011	0.0024	U	U	0.0088	0.0088	0.0019	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB11					ULA-SB12				
SAMPLE NO		ULA0013					ULA0014				
SAMPLE DATE		19-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives											
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Dinitrobenzene, 1,3-	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Dinitrotoluene, 2,4-	mg/kg	0.18	0.18	0.086	U	U	0.15	0.15	0.071	U	U
Dinitrotoluene, 2,6-	mg/kg	0.18	0.18	0.077	U	U	0.15	0.15	0.064	U	U
HMX	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Nitrobenzene	mg/kg	0.18	0.18	0.083	U	U	0.15	0.15	0.068	U	U
Nitrotoluene, 2-	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Nitrotoluene, 3-	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Nitrotoluene, 4-	mg/kg	0.18	0.18	0.09	U	U	0.15	0.15	0.074	U	U
RDX	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Tetryl	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.18	0.18	0.071	U	U	0.15	0.15	0.059	U	U
General Chemistry											
% Solids	Percent	84.8	0				83.7	0			
Metals											
Aluminum	mg/kg	9010	93	11			3760	10	1.2		
Antimony	mg/kg	9.3	9.3	0.46	U	U	1	1	0.052	U	U
Arsenic	mg/kg	8.6	4.6	0.46			3	0.52	0.052		
Barium	mg/kg	67.3	93	1.9	B	J	19.2	10	0.21		
Beryllium	mg/kg	0.71	2.3	0.046	B	J	0.17	0.26	0.0052	B	J
Cadmium	mg/kg	0.95	1.9	0.046	B	J	0.18	0.21	0.0052	B	J
Calcium	mg/kg	1280	2300	23	B	J	427	260	2.6		J
Chromium	mg/kg	15.1	4.6	0.46			4.7	0.52	0.052		
Cobalt	mg/kg	17.8	23	0.46	B	J	1.5	2.6	0.052	B	J
Copper	mg/kg	12.4	12	0.46			38.4	1.3	0.052		
Iron	mg/kg	22600	140	11			5540	16	1.2		
Lead	mg/kg	7.9	0.93	0.046			7.4	1	0.052		
Magnesium	mg/kg	1620	2300	23	B	J	480	260	2.6		
Manganese	mg/kg	157	7	0.46			43.1	0.78	0.052		
Mercury	mg/kg	0.012	0.091	0.0064	B	J	0.016	0.095	0.0067	B	J
Nickel	mg/kg	32.6	19	0.46			9.7	2.1	0.052		
Potassium	mg/kg	516	4600	23	B	J	235	520	2.6	B	J
Selenium	mg/kg	9.3	9.3	0.93	U	U	0.23	1	0.1	B	J
Silver	mg/kg	4.6	4.6	0.46	U	U	0.52	0.52	0.052	U	U
Sodium	mg/kg	4600	4600	390	U	U	520	520	44	U	U
Thallium	mg/kg	2.3	2.3	0.7	U	U	0.52	0.52	0.078	U	U
Vanadium	mg/kg	25.8	23	0.46			8.3	2.6	0.052		
Zinc	mg/kg	170	9.3	0.46			48.3	1	0.052		
Pesticides/PCBs											
Aroclor 1016	mg/kg	0.02	0.02	0.0078	U	U	0.02	0.02	0.0079	U	U
Aroclor 1221	mg/kg	0.02	0.02	0.0098	U	U	0.02	0.02	0.0098	U	U
Aroclor 1232	mg/kg	0.02	0.02	0.0098	U	U	0.02	0.02	0.0098	U	U
Aroclor 1242	mg/kg	0.02	0.02	0.0078	U	U	0.02	0.02	0.0079	U	U
Aroclor 1248	mg/kg	0.02	0.02	0.0078	U	U	0.02	0.02	0.0079	U	U
Aroclor 1254	mg/kg	0.02	0.02	0.0078	U	U	0.0129	0.02	0.0079	J	J
Aroclor 1260	mg/kg	0.02	0.02	0.0078	U	U	0.02	0.02	0.0079	U	U
Aroclor 1268	mg/kg	0.02	0.02	0.0078	U	U	0.02	0.02	0.0079	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB11					ULA-SB12				
SAMPLE NO		ULA0013					ULA0014				
SAMPLE DATE		19-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics											
3-Methylphenol and 4-Methylphenol	mg/kg	0.19	0.19	0.028	U	U	0.2	0.2	0.028	U	U
Acenaphthene	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Acenaphthylene	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Acetophenone	mg/kg										
Anthracene	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Atrazine	mg/kg										
Benzaldehyde	mg/kg										
Benzo(a)anthracene	mg/kg	0.0286	0.19	0.019	J	J	0.0329	0.2	0.02	J	J
Benzo(a)pyrene	mg/kg	0.0241	0.19	0.019	J	J	0.0308	0.2	0.02	J	J
Benzo(b)fluoranthene	mg/kg	0.0383	0.19	0.019	J	J	0.0444	0.2	0.02	J	J
Benzo(ghi)perylene	mg/kg	0.19	0.19	0.019	U	UJ	0.2	0.2	0.02	U	UJ
Benzo(k)fluoranthene	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Benzoic acid	mg/kg	0.97	0.97	0.34	U	U	0.99	0.99	0.35	U	U
Benzyl alcohol	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Bibenzene	mg/kg										
Bis(2-chloroethoxy)methane	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Bis(2-chloroethyl)ether	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.39	0.39	0.078	U	U	0.39	0.39	0.079	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Butyl benzyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Caprolactam	mg/kg										
Carbazole	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Chloroaniline, 4-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Chloronaphthalene, 2-	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Chlorophenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Chrysene	mg/kg	0.0338	0.19	0.019	J	J	0.0343	0.2	0.02	J	J
Dibenz(a,h)anthracene	mg/kg	0.19	0.19	0.019	U	UJ	0.2	0.2	0.02	U	UJ
Dibenzofuran	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Dichlorobenzene, 1,2-	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Dichlorobenzene, 1,3-	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Dichlorobenzene, 1,4-	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.39	0.39	0.039	U	U	0.39	0.39	0.039	U	U
Dichlorophenol, 2,4-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Diethyl phthalate	mg/kg	0.39	0.39	0.078	U	U	0.39	0.39	0.079	U	U
Dimethyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Dimethylphenol, 2,4-	mg/kg	0.19	0.19	0.024	U	U	0.2	0.2	0.025	U	U
Di-n-butyl phthalate	mg/kg	0.39	0.39	0.078	U	U	0.39	0.39	0.079	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.39	0.39	0.078	U	U	0.39	0.39	0.079	U	U
Dinitrophenol, 2,4-	mg/kg	0.97	0.97	0.39	U	U	0.99	0.99	0.39	U	U
Dinitrotoluene, 2,4-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Dinitrotoluene, 2,6-	mg/kg	0.19	0.19	0.023	U	U	0.2	0.2	0.023	U	U
Di-n-octyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Fluoranthene	mg/kg	0.0616	0.19	0.019	J	J	0.0811	0.2	0.02	J	J
Fluorene	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Hexachlorobenzene	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Hexachlorobutadiene	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB11					ULA-SB12				
SAMPLE NO		ULA0013					ULA0014				
SAMPLE DATE		19-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachlorocyclopentadiene	mg/kg	0.19	0.19	0.085	U	U	0.2	0.2	0.087	U	U
Hexachloroethane	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.19	0.19	0.019	U	UJ	0.2	0.2	0.02	U	UJ
Isophorone	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Methylnaphthalene, 2-	mg/kg	0.0301	0.19	0.019	J	J	0.2	0.2	0.02	U	U
Methylphenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Naphthalene	mg/kg	0.19	0.19	0.031	U	U	0.2	0.2	0.032	U	U
Nitroaniline, 2-	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Nitroaniline, 3-	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Nitroaniline, 4-	mg/kg	0.19	0.19	0.039	U	U	0.2	0.2	0.039	U	U
Nitrobenzene	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Nitrophenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Nitrophenol, 4-	mg/kg	0.97	0.97	0.16	U	U	0.99	0.99	0.16	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
n-Nitrosodiphenylamine	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Pentachlorophenol	mg/kg	0.97	0.97	0.23	U	U	0.99	0.99	0.24	U	U
Phenanthrene	mg/kg	0.0433	0.19	0.019	J	J	0.0421	0.2	0.02	J	J
Phenol	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Pyrene	mg/kg	0.0465	0.19	0.019	J	J	0.0555	0.2	0.02	J	J
Trichlorobenzene, 1,2,4-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.19	0.19	0.019	U	U	0.2	0.2	0.02	U	U
Volatile Organics											
Acetone	mg/kg	0.0362	0.041	0.016	J	J	0.037	0.037	0.015	U	U
Benzene	mg/kg	0.0041	0.0041	0.0012	U	U	0.0037	0.0037	0.0011	U	U
Bromodichloromethane	mg/kg	0.0041	0.0041	0.0009	U	U	0.0037	0.0037	0.00082	U	U
Bromoform	mg/kg	0.0041	0.0041	0.0012	U	U	0.0037	0.0037	0.0011	U	U
Bromomethane	mg/kg	0.0041	0.0041	0.0016	U	U	0.0037	0.0037	0.0015	U	U
Butanone, 2-	mg/kg	0.02	0.02	0.005	U	U	0.019	0.019	0.0045	U	U
Carbon disulfide	mg/kg	0.0041	0.0041	0.0016	U	U	0.0037	0.0037	0.0015	U	U
Carbon tetrachloride	mg/kg	0.0041	0.0041	0.0015	U	U	0.0037	0.0037	0.0013	U	U
Chlorobenzene	mg/kg	0.0041	0.0041	0.00082	U	U	0.0037	0.0037	0.00074	U	U
Chloroethane	mg/kg	0.0041	0.0041	0.0016	U	U	0.0037	0.0037	0.0015	U	U
Chloroform	mg/kg	0.0041	0.0041	0.00098	U	U	0.0037	0.0037	0.00089	U	U
Chloromethane	mg/kg	0.0041	0.0041	0.0016	U	U	0.0037	0.0037	0.0015	U	U
Cyclohexane	mg/kg										
Dibromo-3-chloropropane, 1,2-	mg/kg										
Dibromochloromethane	mg/kg	0.0041	0.0041	0.00082	U	U	0.0037	0.0037	0.00074	U	U
Dibromoethane, 1,2-	mg/kg										
Dichlorobenzene, 1,2-	mg/kg										
Dichlorobenzene, 1,3-	mg/kg										
Dichlorobenzene, 1,4-	mg/kg										
Dichlorodifluoromethane	mg/kg										
Dichloroethane, 1,1-	mg/kg	0.0041	0.0041	0.0009	U	U	0.0037	0.0037	0.00082	U	U
Dichloroethane, 1,2-	mg/kg	0.0041	0.0041	0.00082	U	U	0.0037	0.0037	0.00074	U	U
Dichloroethene, 1,1-	mg/kg	0.0041	0.0041	0.0011	U	U	0.0037	0.0037	0.001	U	U
Dichloroethene, cis-1,2-	mg/kg	0.0041	0.0041	0.0012	U	U	0.0037	0.0037	0.0011	U	U
Dichloroethene, trans-1,2-	mg/kg	0.0041	0.0041	0.0012	U	U	0.0037	0.0037	0.0011	U	U
Dichloropropane, 1,2-	mg/kg	0.0041	0.0041	0.00098	U	U	0.0037	0.0037	0.00089	U	U
Dichloropropene, cis-1,3-	mg/kg	0.0041	0.0041	0.00082	U	U	0.0037	0.0037	0.00074	U	U

Table E-1

Surface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB11					ULA-SB12				
SAMPLE NO		ULA0013					ULA0014				
SAMPLE DATE		19-May-11					19-May-11				
DEPTH		0 - 1 Ft					0 - 1 Ft				
SAMPLE PURPOSE		REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Dichloropropene, trans-1,3-	mg/kg	0.0041	0.0041	0.0009	U	U	0.0037	0.0037	0.00082	U	U
Ethylbenzene	mg/kg	0.0041	0.0041	0.00082	U	U	0.0037	0.0037	0.00074	U	U
Hexanone, 2-	mg/kg	0.02	0.02	0.0044	U	U	0.019	0.019	0.004	U	U
Isopropylbenzene	mg/kg										
METHYL ACETATE	mg/kg										
Methyl Tertiary Butyl Ether	mg/kg										
Methyl-2-pentanone, 4-	mg/kg	0.02	0.02	0.0045	U	U	0.019	0.019	0.0041	U	U
Methylcyclohexane	mg/kg										
Methylene chloride	mg/kg	0.0082	0.0082	0.0038	U	U	0.0071	0.0074	0.0034	J	J
Styrene	mg/kg	0.0041	0.0041	0.0021	U	U	0.0037	0.0037	0.0019	U	U
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0041	0.0041	0.00098	U	U	0.0037	0.0037	0.00089	U	U
Tetrachloroethene	mg/kg	0.0041	0.0041	0.00082	U	U	0.0037	0.0037	0.00074	U	U
Toluene	mg/kg	0.0041	0.0041	0.00098	U	U	0.0037	0.0037	0.00089	U	U
Trichlorobenzene, 1,2,4-	mg/kg										
Trichloroethane, 1,1,1-	mg/kg	0.0041	0.0041	0.0009	U	U	0.0037	0.0037	0.00082	U	U
Trichloroethane, 1,1,2-	mg/kg	0.0041	0.0041	0.0009	U	U	0.0037	0.0037	0.00082	U	U
Trichloroethene	mg/kg	0.0041	0.0041	0.00098	U	U	0.0037	0.0037	0.00089	U	U
Trichlorofluoromethane	mg/kg										
Trichlorotrifluoroethane	mg/kg										
Vinyl chloride	mg/kg	0.0041	0.0041	0.0012	U	U	0.0037	0.0037	0.0011	U	U
Xylenes, total	mg/kg	0.012	0.012	0.0026	U	U	0.011	0.011	0.0024	U	U

FD - Field duplicate.
LQ - Laboratory qualifier.
MDL - Method detection limit.
mg/kg - Milligrams per kilogram.
REG - Regular sample.
RL - Reporting limit.
VQ - Validation qualifier.

VQ Definitions: U = Parameter not detected; J = Parameter detected, but below the reporting limit. Concentration is considered estimated. "B" LQ = Parameter concentration is estimated (for metals) or associated with the sample blank (organics).

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB01					ULA-SB01					ULA-SB02					ULA-SB02				
SAMPLE NO		ULA0015					ULA0029					ULA0016					ULA0017				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					3 - 5 Ft				
SAMPLE PURPOSE		REG					REG					REG					FD				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Dinitrobenzene, 1,3-	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Dinitrotoluene, 2,4-	mg/kg	0.18	0.18	0.087	U	U	0.19	0.19	0.094	U	U	0.18	0.18	0.085	U	U	0.17	0.17	0.081	U	U
Dinitrotoluene, 2,6-	mg/kg	0.18	0.18	0.078	U	U	0.19	0.19	0.084	U	U	0.18	0.18	0.077	U	U	0.17	0.17	0.072	U	U
HMX	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Nitrobenzene	mg/kg	0.18	0.18	0.083	U	U	0.19	0.19	0.09	U	U	0.18	0.18	0.082	U	U	0.17	0.17	0.077	U	U
Nitrotoluene, 2-	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Nitrotoluene, 3-	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Nitrotoluene, 4-	mg/kg	0.18	0.18	0.09	U	U	0.19	0.19	0.098	U	U	0.18	0.18	0.089	U	U	0.17	0.17	0.084	U	U
RDX	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Tetryl	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.18	0.18	0.071	U	U	0.19	0.19	0.078	U	U	0.18	0.18	0.07	U	U	0.17	0.17	0.067	U	U
General Chemistry																					
% Solids	Percent	81.6	0				79.6	0				81.8	0				83.4	0			
Metals																					
Aluminum	mg/kg	5530	21	2.6			4510	11	1.3			7080	20	2.4			4500	11	1.3		
Antimony	mg/kg	2.1	2.1	0.11	U	U	0.18	1.1	0.053	B	J	2	2	0.1	U	U	0.13	1.1	0.053	B	J
Arsenic	mg/kg	6.5	1.1	0.11			7	0.53	0.053			5	1	0.1			3.4	0.53	0.053		
Barium	mg/kg	28.9	21	0.43			36	11	0.21			51.1	20	0.4			30.8	11	0.21		
Beryllium	mg/kg	0.33	0.54	0.011	B	J	0.27	0.27	0.0053			0.38	0.51	0.01	B	J	0.24	0.27	0.0053	B	J
Cadmium	mg/kg	0.15	0.43	0.011	B	J	0.25	0.21	0.0053			0.21	0.4	0.01	B	J	0.17	0.21	0.0053	B	J
Calcium	mg/kg	28000	540	5.4			58300	1100	11			35200	510	5.1			48300	530	5.3		
Chromium	mg/kg	10.3	1.1	0.11			7.7	0.53	0.053			11.6	1	0.1			7.4	0.53	0.053		
Cobalt	mg/kg	5.1	5.4	0.11	B	J	6.2	2.7	0.053			6.4	5.1	0.1			4.8	2.7	0.053		
Copper	mg/kg	14.8	2.7	0.11			16.7	1.3	0.053			15	2.5	0.1			10.4	1.3	0.053		
Iron	mg/kg	12000	32	2.5			10800	16	1.2			13100	30	2.3		J	7710	16	1.2		J
Lead	mg/kg	7.7	1.1	0.054			10.9	1.1	0.053			9.5	1	0.051			6.7	1.1	0.053		
Magnesium	mg/kg	8350	540	5.4			18100	1100	11			12900	510	5.1			14500	530	5.3		
Manganese	mg/kg	259	1.6	0.11			564	3.2	0.21			332	1.5	0.1			339	1.6	0.11		
Mercury	mg/kg	0.021	0.09	0.0064	B	J	0.1	0.1	0.0074	U	U	0.089	0.089	0.0063	U	U	0.1	0.1	0.0071	U	U
Nickel	mg/kg	13.6	4.3	0.11			15.5	2.1	0.053			16	4	0.1			11.7	2.1	0.053		
Potassium	mg/kg	736	1100	5.4	B	J	899	530	2.7			909	1000	5.1	B	J	667	530	2.7		
Selenium	mg/kg	2.1	2.1	0.21	U	U	0.38	1.1	0.11	B	J	2	2	0.2	U	U	1.1	1.1	0.11	U	U
Silver	mg/kg	1.1	1.1	0.11	U	U	0.53	0.53	0.053	U	U	1	1	0.1	U	U	0.53	0.53	0.053	U	U
Sodium	mg/kg	1100	1100	91	U	U	109	530	45	B	J	1000	1000	86	U	U	83.9	530	45	B	J
Thallium	mg/kg	0.54	0.54	0.081	U	U	0.41	0.53	0.08	B	J	0.51	0.51	0.076	U	U	0.14	0.53	0.08	B	J
Vanadium	mg/kg	14.3	5.4	0.11			12.3	2.7	0.053			16	5.1	0.1			11.3	2.7	0.053		
Zinc	mg/kg	32.8	2.1	0.11			34.6	1.1	0.053			36	2	0.1			24.7	1.1	0.053		
Pesticides/PCBs																					
Aroclor 1016	mg/kg	0.02	0.02	0.0082	U	U	0.021	0.021	0.0083	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.008	U	U
Aroclor 1221	mg/kg	0.02	0.02	0.01	U	U	0.021	0.021	0.01	U	U	0.02	0.02	0.01	U	U	0.02	0.02	0.01	U	U
Aroclor 1232	mg/kg	0.02	0.02	0.01	U	U	0.021	0.021	0.01	U	U	0.02	0.02	0.01	U	U	0.02	0.02	0.01	U	U
Aroclor 1242	mg/kg	0.02	0.02	0.0082	U	U	0.021	0.021	0.0083	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.008	U	U
Aroclor 1248	mg/kg	0.02	0.02	0.0082	U	U	0.021	0.021	0.0083	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.008	U	U
Aroclor 1254	mg/kg	0.02	0.02	0.0082	U	U	0.021	0.021	0.0083	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.008	U	U
Aroclor 1260	mg/kg	0.02	0.02	0.0082	U	U	0.021	0.021	0.0083	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.008	U	U
Aroclor 1268	mg/kg	0.02	0.02	0.0082	U	U	0.021	0.021	0.0083	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.008	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB01					ULA-SB01					ULA-SB02					ULA-SB02				
SAMPLE NO		ULA0015					ULA0029					ULA0016					ULA0017				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					3 - 5 Ft				
SAMPLE PURPOSE		REG					REG					REG					FD				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.2	0.2	0.029	U	U	0.21	0.21	0.03	U	U	0.2	0.2	0.029	U	U	0.2	0.2	0.029	U	U
Acenaphthene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Acenaphthylene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Acetophenone	mg/kg																				
Anthracene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Atrazine	mg/kg																				
Benzaldehyde	mg/kg																				
Benzo(a)anthracene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Benzo(a)pyrene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Benzo(b)fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Benzo(ghi)perylene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Benzo(k)fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Benzoic acid	mg/kg	1	1	0.35	U	U	1	1	0.37	U	U	1	1	0.36	U	U	1	1	0.35	U	U
Benzyl alcohol	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Bibenzene	mg/kg																				
Bis(2-chloroethoxy)methane	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Bis(2-chloroethyl)ether	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	UJ	0.2	0.2	0.02	U	UJ
Bis(2-ethylhexyl)phthalate	mg/kg	0.4	0.4	0.08	U	U	0.42	0.42	0.083	U	U	0.4	0.4	0.081	U	UJ	0.4	0.4	0.08	U	UJ
Bromophenyl phenyl ether, 4-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Butyl benzyl phthalate	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	UJ	0.2	0.2	0.04	U	UJ
Caprolactam	mg/kg																				
Carbazole	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Chloroaniline, 4-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Chloronaphthalene, 2-	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Chlorophenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Chrysene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Dibenz(a,h)anthracene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Dibenzofuran	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Dichlorobenzene, 1,2-	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Dichlorobenzene, 1,3-	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Dichlorobenzene, 1,4-	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.4	0.4	0.04	U	U	0.42	0.42	0.042	U	U	0.4	0.4	0.04	U	U	0.4	0.4	0.04	U	U
Dichlorophenol, 2,4-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Diethyl phthalate	mg/kg	0.4	0.4	0.08	U	U	0.42	0.42	0.083	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U
Dimethyl phthalate	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Dimethylphenol, 2,4-	mg/kg	0.2	0.2	0.025	U	U	0.21	0.21	0.026	U	U	0.2	0.2	0.026	U	U	0.2	0.2	0.025	U	U
Di-n-butyl phthalate	mg/kg	0.4	0.4	0.08	U	U	0.42	0.42	0.083	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.4	0.4	0.08	U	U	0.42	0.42	0.083	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U
Dinitrophenol, 2,4-	mg/kg	1	1	0.4	U	U	1	1	0.42	U	U	1	1	0.4	U	U	1	1	0.4	U	U
Dinitrotoluene, 2,4-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Dinitrotoluene, 2,6-	mg/kg	0.2	0.2	0.024	U	U	0.21	0.21	0.025	U	U	0.2	0.2	0.024	U	U	0.2	0.2	0.024	U	U
Di-n-octyl phthalate	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	UJ	0.2	0.2	0.04	U	UJ
Fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Fluorene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Hexachlorobenzene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Hexachlorobutadiene	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Hexachlorocyclopentadiene	mg/kg	0.2	0.2	0.088	U	U	0.21	0.21	0.092	U	U	0.2	0.2	0.089	U	U	0.2	0.2	0.088	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB01					ULA-SB01					ULA-SB02					ULA-SB02				
SAMPLE NO		ULA0015					ULA0029					ULA0016					ULA0017				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					3 - 5 Ft				
SAMPLE PURPOSE		REG					REG					REG					FD				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachloroethane	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Isophorone	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Methylnaphthalene, 2-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Methylphenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Naphthalene	mg/kg	0.2	0.2	0.032	U	U	0.21	0.21	0.033	U	U	0.2	0.2	0.032	U	U	0.2	0.2	0.032	U	U
Nitroaniline, 2-	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Nitroaniline, 3-	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Nitroaniline, 4-	mg/kg	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U
Nitrobenzene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Nitrophenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Nitrophenol, 4-	mg/kg	1	1	0.16	U	U	1	1	0.17	U	U	1	1	0.16	U	U	1	1	0.16	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
n-Nitrosodiphenylamine	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Pentachlorophenol	mg/kg	1	1	0.24	U	U	1	1	0.25	U	U	1	1	0.24	U	U	1	1	0.24	U	U
Phenanthrene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Phenol	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Pyrene	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U
Volatile Organics																					
Acetone	mg/kg	0.039	0.039	0.015	U	U	0.041	0.067	0.027	J	J	0.035	0.035	0.014	U	U	0.06	0.06	0.024	U	UJ
Benzene	mg/kg	0.0016	0.0039	0.0012	J	J	0.0067	0.0067	0.002	U	UJ	0.002	0.0035	0.001	J	J	0.006	0.006	0.0018	U	UJ
Bromodichloromethane	mg/kg	0.0039	0.0039	0.00085	U	U	0.0067	0.0067	0.0015	U	UJ	0.0035	0.0035	0.00077	U	U	0.006	0.006	0.0013	U	UJ
Bromoform	mg/kg	0.0039	0.0039	0.0012	U	U	0.0067	0.0067	0.002	U	UJ	0.0035	0.0035	0.001	U	U	0.006	0.006	0.0018	U	UJ
Bromomethane	mg/kg	0.0039	0.0039	0.0015	U	U	0.0067	0.0067	0.0027	U	UJ	0.0035	0.0035	0.0014	U	U	0.006	0.006	0.0024	U	UJ
Butanone, 2-	mg/kg	0.019	0.019	0.0047	U	U	0.034	0.034	0.0082	U	UJ	0.017	0.017	0.0043	U	U	0.03	0.03	0.0073	U	UJ
Carbon disulfide	mg/kg	0.0039	0.0039	0.0015	U	U	0.0067	0.0067	0.0027	U	UJ	0.0035	0.0035	0.0014	U	U	0.006	0.006	0.0024	U	UJ
Carbon tetrachloride	mg/kg	0.0039	0.0039	0.0014	U	U	0.0067	0.0067	0.0024	U	UJ	0.0035	0.0035	0.0013	U	U	0.006	0.006	0.0022	U	UJ
Chlorobenzene	mg/kg	0.0039	0.0039	0.00077	U	U	0.0067	0.0067	0.0013	U	UJ	0.0035	0.0035	0.0007	U	U	0.006	0.006	0.0012	U	UJ
Chloroethane	mg/kg	0.0039	0.0039	0.0015	U	U	0.0067	0.0067	0.0027	U	UJ	0.0035	0.0035	0.0014	U	U	0.006	0.006	0.0024	U	UJ
Chloroform	mg/kg	0.0039	0.0039	0.00092	U	U	0.0067	0.0067	0.0016	U	UJ	0.0035	0.0035	0.00084	U	U	0.006	0.006	0.0014	U	UJ
Chloromethane	mg/kg	0.0039	0.0039	0.0015	U	U	0.0067	0.0067	0.0027	U	UJ	0.0035	0.0035	0.0014	U	U	0.006	0.006	0.0024	U	UJ
Cyclohexane	mg/kg																				
Dibromo-3-chloropropane, 1,2-	mg/kg																				
Dibromochloromethane	mg/kg	0.0039	0.0039	0.00077	U	U	0.0067	0.0067	0.0013	U	UJ	0.0035	0.0035	0.0007	U	U	0.006	0.006	0.0012	U	UJ
Dibromoethane, 1,2-	mg/kg																				
Dichlorobenzene, 1,2-	mg/kg																				
Dichlorobenzene, 1,3-	mg/kg																				
Dichlorobenzene, 1,4-	mg/kg																				
Dichlorodifluoromethane	mg/kg																				
Dichloroethane, 1,1-	mg/kg	0.0039	0.0039	0.00085	U	U	0.0067	0.0067	0.0015	U	UJ	0.0035	0.0035	0.00077	U	U	0.006	0.006	0.0013	U	UJ
Dichloroethane, 1,2-	mg/kg	0.0039	0.0039	0.00077	U	U	0.0067	0.0067	0.0013	U	UJ	0.0035	0.0035	0.0007	U	U	0.006	0.006	0.0012	U	UJ
Dichloroethene, 1,1-	mg/kg	0.0039	0.0039	0.0011	U	U	0.0067	0.0067	0.0019	U	UJ	0.0035	0.0035	0.00098	U	U	0.006	0.006	0.0017	U	UJ
Dichloroethene, cis-1,2-	mg/kg	0.0039	0.0039	0.0012	U	U	0.0067	0.0067	0.002	U	UJ	0.0035	0.0035	0.001	U	U	0.006	0.006	0.0018	U	UJ
Dichloroethene, trans-1,2-	mg/kg	0.0039	0.0039	0.0012	U	U	0.0067	0.0067	0.002	U	UJ	0.0035	0.0035	0.001	U	U	0.006	0.006	0.0018	U	UJ
Dichloropropane, 1,2-	mg/kg	0.0039	0.0039	0.00092	U	U	0.0067	0.0067	0.0016	U	UJ	0.0035	0.0035	0.00084	U	U	0.006	0.006	0.0014	U	UJ
Dichloropropene, cis-1,3-	mg/kg	0.0039	0.0039	0.00077	U	U	0.0067	0.0067	0.0013	U	UJ	0.0035	0.0035	0.0007	U	U	0.006	0.006	0.0012	U	UJ
Dichloropropene, trans-1,3-	mg/kg	0.0039	0.0039	0.00085	U	U	0.0067	0.0067	0.0015	U	UJ	0.0035	0.0035	0.00077	U	U	0.006	0.006	0.0013	U	UJ
Ethylbenzene	mg/kg	0.0039	0.0039	0.00077	U	U	0.0067	0.0067	0.0013	U	UJ	0.00081	0.0035	0.0007	J	J	0.006	0.006	0.0012	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB01					ULA-SB01					ULA-SB02					ULA-SB02				
SAMPLE NO		ULA0015					ULA0029					ULA0016					ULA0017				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					3 - 5 Ft				
SAMPLE PURPOSE		REG					REG					REG					FD				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexanone, 2-	mg/kg	0.019	0.019	0.0042	U	UJ	0.034	0.034	0.0073	U	UJ	0.017	0.017	0.0038	U	U	0.03	0.03	0.0065	U	UJ
Isopropylbenzene	mg/kg																				
METHYL ACETATE	mg/kg																				
Methyl Tertiary Butyl Ether	mg/kg																				
Methyl-2-pentanone, 4-	mg/kg	0.019	0.019	0.0042	U	UJ	0.034	0.034	0.0074	U	UJ	0.017	0.017	0.0038	U	U	0.03	0.03	0.0066	U	UJ
Methylcyclohexane	mg/kg																				
Methylene chloride	mg/kg	0.005	0.0077	0.0035	J	J	0.203	0.013	0.0062		J	0.007	0.007	0.0032	U	U	0.0116	0.012	0.0055	J	J
Styrene	mg/kg	0.0039	0.0039	0.002	U	U	0.0067	0.0067	0.0035	U	UJ	0.0035	0.0035	0.0018	U	U	0.006	0.006	0.0031	U	UJ
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0039	0.0039	0.00092	U	UJ	0.0067	0.0067	0.0016	U	UJ	0.0035	0.0035	0.00084	U	U	0.006	0.006	0.0014	U	UJ
Tetrachloroethene	mg/kg	0.0039	0.0039	0.00077	U	U	0.0067	0.0067	0.0013	U	UJ	0.0035	0.0035	0.0007	U	U	0.006	0.006	0.0012	U	UJ
Toluene	mg/kg	0.0018	0.0039	0.00092	J	J	0.0018	0.0067	0.0016	J	J	0.0036	0.0035	0.00084			0.006	0.006	0.0014	U	UJ
Trichlorobenzene, 1,2,4-	mg/kg																				
Trichloroethane, 1,1,1-	mg/kg	0.0039	0.0039	0.00085	U	U	0.0067	0.0067	0.0015	U	UJ	0.0026	0.0035	0.00077	J	J	0.006	0.006	0.0013	U	UJ
Trichloroethane, 1,1,2-	mg/kg	0.0039	0.0039	0.00085	U	U	0.0067	0.0067	0.0015	U	UJ	0.0035	0.0035	0.00077	U	U	0.006	0.006	0.0013	U	UJ
Trichloroethene	mg/kg	0.0039	0.0039	0.00092	U	U	0.0067	0.0067	0.0016	U	UJ	0.0035	0.0035	0.00084	U	U	0.006	0.006	0.0014	U	UJ
Trichlorofluoromethane	mg/kg																				
Trichlorotrifluoroethane	mg/kg																				
Vinyl chloride	mg/kg	0.0039	0.0039	0.0012	U	U	0.0067	0.0067	0.002	U	UJ	0.0035	0.0035	0.001	U	U	0.006	0.006	0.0018	U	UJ
Xylenes, total	mg/kg	0.012	0.012	0.0025	U	U	0.02	0.02	0.0043	U	UJ	0.01	0.01	0.0022	U	U	0.018	0.018	0.0038	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB02					ULA-SB02					ULA-SB03					ULA-SB03				
SAMPLE NO		ULA0018					ULA0030					ULA0019					ULA0031				
SAMPLE DATE		19-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FS					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.24	0.24	0.02	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.29	0.29	0.098	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Dinitrobenzene, 1,3-	mg/kg	0.24	0.24	0.049	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Dinitrotoluene, 2,4-	mg/kg	0.24	0.24	0.02	U	UJ	0.17	0.17	0.083	U	U	0.17	0.17	0.082	U	U	0.17	0.17	0.082	U	U
Dinitrotoluene, 2,6-	mg/kg	0.24	0.24	0.029	U	UJ	0.17	0.17	0.075	U	U	0.17	0.17	0.073	U	U	0.17	0.17	0.073	U	U
HMX	mg/kg	0.24	0.24	0.029	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Nitrobenzene	mg/kg	0.24	0.24	0.049	U	UJ	0.17	0.17	0.08	U	U	0.17	0.17	0.078	U	U	0.17	0.17	0.078	U	U
Nitrotoluene, 2-	mg/kg	0.24	0.24	0.078	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Nitrotoluene, 3-	mg/kg	0.24	0.24	0.069	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Nitrotoluene, 4-	mg/kg	0.49	0.49	0.078	U	UJ	0.17	0.17	0.087	U	U	0.17	0.17	0.085	U	U	0.17	0.17	0.085	U	U
RDX	mg/kg	0.24	0.24	0.039	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Tetryl	mg/kg	0.24	0.24	0.049	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.24	0.24	0.02	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.24	0.24	0.02	U	UJ	0.17	0.17	0.069	U	U	0.17	0.17	0.068	U	U	0.17	0.17	0.067	U	U
General Chemistry																					
% Solids	Percent						82	0				80.9	0				79.7	0			
Metals																					
Aluminum	mg/kg	6800	23	11			5600	10	1.2			5380	23	2.7			8810	36	4.4		
Antimony	mg/kg	1.1	1.1	0.44	U	U	4.1	4.1	0.2	U	U	1.1	1.1	0.057	U	U	3.6	3.6	0.18	U	U
Arsenic	mg/kg	10	1.1	0.34			3.6	0.51	0.051			8.4	0.57	0.057			6.8	1.8	0.18		J
Barium	mg/kg	39	23	0.081			35.2	10	0.2			28.7	23	0.46			66	36	0.73		
Beryllium	mg/kg	0.57	0.57	0.049	U	U	0.32	0.26	0.0051			0.31	0.57	0.011	B	J	0.46	0.91	0.018	B	J
Cadmium	mg/kg	0.23	0.23	0.041	U	U	0.18	0.2	0.0051	B	J	0.086	0.23	0.0057	B	J	0.73	0.73	0.018	U	U
Calcium	mg/kg	45000	570	18			47100	1000	10			32800	570	5.7			49200	910	9.1		
Chromium	mg/kg	12	0.57	0.23			12.1	2	0.2			8.5	0.57	0.057			14	1.8	0.18		
Cobalt	mg/kg	7.4	5.7	0.18			6.2	2.6	0.051			3.9	2.9	0.057			13.2	9.1	0.18		J
Copper	mg/kg	18	2.9	0.84			18.8	5.1	0.2			13.4	1.4	0.057			20.9	4.5	0.18		
Iron	mg/kg	18000	11	5.6			10200	15	1.2			14500	34	2.6			20700	55	4.2		
Lead	mg/kg	8.4	0.34	0.22			11.3	4.1	0.2			9.2	1.1	0.057			11.8	0.91	0.045		
Magnesium	mg/kg	14000	570	5.8			15700	260	2.6			11600	570	5.7			15600	910	9.1		
Manganese	mg/kg	410	1.7	0.084			429	3.1	0.2			187	0.86	0.057			725	2.7	0.18		
Mercury	mg/kg	0.096	0.096	0.014	U	U	0.026	0.1	0.0072	B	J	0.024	0.098	0.007	B	J	0.026	0.1	0.0071	B	J
Nickel	mg/kg	20	4.6	0.31			16.7	2	0.051			11.2	2.3	0.057			32.4	7.3	0.18		J
Potassium	mg/kg	940	570	7.1			1090	510	2.6			694	1100	5.7	B	J	1410	1800	9.1	B	J
Selenium	mg/kg	0.57	0.57	0.51	U	U	4.1	4.1	0.41	U	U	1.1	1.1	0.11	U	U	3.6	3.6	0.36	U	U
Silver	mg/kg	0.57	0.57	0.11	U	U	0.51	0.51	0.051	U	U	0.57	0.57	0.057	U	U	1.8	1.8	0.18	U	U
Sodium	mg/kg	570	570	75	U	U	115	510	44	B	J	1100	1100	97	U	U	1800	1800	150	U	U
Thallium	mg/kg	1.1	1.1	0.63	U	U	2	2	0.31	U	U	0.57	0.57	0.086	U	U	0.27	0.45	0.068	B	J
Vanadium	mg/kg	19	5.7	0.14			13.9	2.6	0.051			13.8	2.9	0.057			20.1	9.1	0.18		
Zinc	mg/kg	45	2.3	1.1			45.1	4.1	0.2			30.9	1.1	0.057			51.3	3.6	0.18		
Pesticides/PCBs																					
Aroclor 1016	mg/kg	0.041	0.041	0.026	U H	UJ	0.02	0.02	0.0081	U	U	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U
Aroclor 1221	mg/kg	0.041	0.041	0.02	U H	UJ	0.02	0.02	0.01	U	U	0.021	0.021	0.01	U	U	0.021	0.021	0.01	U	U
Aroclor 1232	mg/kg	0.041	0.041	0.018	U H	UJ	0.02	0.02	0.01	U	U	0.021	0.021	0.01	U	U	0.021	0.021	0.01	U	U
Aroclor 1242	mg/kg	0.041	0.041	0.016	U H	UJ	0.02	0.02	0.0081	U	U	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U
Aroclor 1248	mg/kg	0.041	0.041	0.021	U H	UJ	0.02	0.02	0.0081	U	U	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U
Aroclor 1254	mg/kg	0.041	0.041	0.021	U H	UJ	0.02	0.02	0.0081	U	U	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U
Aroclor 1260	mg/kg	0.041	0.041	0.021	U H	UJ	0.02	0.02	0.0081	U	U	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U
Aroclor 1268	mg/kg						0.02	0.02	0.0081	U	U	0.021	0.021	0.0082	U	U	0.021	0.021	0.0083	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB02					ULA-SB02					ULA-SB03					ULA-SB03				
SAMPLE NO		ULA0018					ULA0030					ULA0019					ULA0031				
SAMPLE DATE		19-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FS					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.5	0.5	0.025	U	U	0.2	0.2	0.029	U	U	0.21	0.21	0.03	U	U	0.21	0.21	0.03	U	U
Acenaphthene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Acenaphthylene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Acetophenone	mg/kg	0.12	0.12	0.011	U	U															
Anthracene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Atrazine	mg/kg	0.25	0.25	0.011	U	U															
Benzaldehyde	mg/kg	0.12	0.12	0.015	U	U															
Benzo(a)anthracene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzo(a)pyrene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzo(b)fluoranthene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzo(ghi)perylene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzo(k)fluoranthene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzoic acid	mg/kg						1	1	0.36	U	U	1	1	0.36	U	U	1	1	0.37	U	U
Benzyl alcohol	mg/kg						0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Bibenzene	mg/kg	0.062	0.062	0.033	U	U															
Bis(2-chloroethoxy)methane	mg/kg	0.12	0.12	0.027	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroethyl)ether	mg/kg	0.12	0.12	0.0025	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.12	0.12	0.012	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	UJ	0.21	0.21	0.021	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.062	0.062	0.024	U	U	0.4	0.4	0.081	U	U	0.41	0.41	0.082	U	UJ	0.42	0.42	0.083	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.062	0.062	0.016	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Butyl benzyl phthalate	mg/kg	0.062	0.062	0.012	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	UJ	0.21	0.21	0.042	U	U
Caprolactam	mg/kg	0.41	0.41	0.046	U	U															
Carbazole	mg/kg	0.062	0.062	0.033	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.19	0.19	0.026	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chloroaniline, 4-	mg/kg	0.19	0.19	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.062	0.062	0.0041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Chlorophenol, 2-	mg/kg	0.062	0.062	0.033	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.062	0.062	0.016	U *	UJ	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chrysene	mg/kg	0.0083	0.0083	0.0014	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Dibenz(a,h)anthracene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Dibenzofuran	mg/kg	0.062	0.062	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Dichlorobenzene, 1,2-	mg/kg						0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,3-	mg/kg						0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,4-	mg/kg						0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.12	0.12	0.022	U	U	0.4	0.4	0.04	U	U	0.41	0.41	0.041	U	U	0.42	0.42	0.042	U	U
Dichlorophenol, 2,4-	mg/kg	0.19	0.19	0.025	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Diethyl phthalate	mg/kg	0.062	0.062	0.02	U	U	0.4	0.4	0.081	U	U	0.41	0.41	0.082	U	U	0.42	0.42	0.083	U	U
Dimethyl phthalate	mg/kg	0.062	0.062	0.021	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Dimethylphenol, 2,4-	mg/kg	0.19	0.19	0.025	U	U	0.2	0.2	0.025	U	U	0.21	0.21	0.026	U	U	0.21	0.21	0.026	U	U
Di-n-butyl phthalate	mg/kg	0.062	0.062	0.019	U	U	0.4	0.4	0.081	U	U	0.41	0.41	0.082	U	U	0.42	0.42	0.083	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.19	0.19	0.099	U	U	0.4	0.4	0.081	U	U	0.41	0.41	0.082	U	U	0.42	0.42	0.083	U	U
Dinitrophenol, 2,4-	mg/kg	0.41	0.41	0.099	U	U	1	1	0.4	U	U	1	1	0.41	U	U	1	1	0.42	U	U
Dinitrotoluene, 2,4-	mg/kg	0.25	0.25	0.033	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Dinitrotoluene, 2,6-	mg/kg	0.25	0.25	0.026	U	U	0.2	0.2	0.024	U	U	0.21	0.21	0.024	U	U	0.21	0.21	0.025	U	U
Di-n-octyl phthalate	mg/kg	0.062	0.062	0.033	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	UJ	0.21	0.21	0.042	U	U
Fluoranthene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Fluorene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Hexachlorobenzene	mg/kg	0.0083	0.0083	0.0026	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Hexachlorobutadiene	mg/kg	0.062	0.062	0.033	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Hexachlorocyclopentadiene	mg/kg	0.41	0.41	0.033	U	U	0.2	0.2	0.089	U	U	0.21	0.21	0.09	U	U	0.21	0.21	0.092	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB02					ULA-SB02					ULA-SB03					ULA-SB03				
SAMPLE NO		ULA0018					ULA0030					ULA0019					ULA0031				
SAMPLE DATE		19-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FS					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachloroethane	mg/kg	0.062	0.062	0.011	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Isophorone	mg/kg	0.062	0.062	0.016	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Methylnaphthalene, 2-	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Methylphenol, 2-	mg/kg	0.25	0.25	0.099	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Naphthalene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.032	U	U	0.21	0.21	0.033	U	U	0.21	0.21	0.033	U	U
Nitroaniline, 2-	mg/kg	0.25	0.25	0.011	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 3-	mg/kg	0.25	0.25	0.02	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 4-	mg/kg	0.25	0.25	0.032	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U	0.21	0.21	0.042	U	U
Nitrobenzene	mg/kg	0.12	0.12	0.0027	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 2-	mg/kg	0.062	0.062	0.033	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 4-	mg/kg	0.41	0.41	0.099	U	U	1	1	0.16	U	U	1	1	0.16	U	U	1	1	0.17	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.062	0.062	0.033	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
n-Nitrosodiphenylamine	mg/kg	0.062	0.062	0.026	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Pentachlorophenol	mg/kg	0.19	0.19	0.099	U	U	1	1	0.24	U	U	1	1	0.25	U	U	1	1	0.25	U	U
Phenanthrene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Phenol	mg/kg	0.062	0.062	0.033	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Pyrene	mg/kg	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Trichlorobenzene, 1,2,4-	mg/kg						0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.19	0.19	0.031	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.19	0.19	0.099	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Volatile Organics																					
Acetone	mg/kg	0.025	0.025	0.002	U	U	0.06	0.06	0.024	U	UJ	0.032	0.032	0.013	U	U	0.06	0.06	0.024	U	R
Benzene	mg/kg	0.0062	0.0062	0.00017	U	U	0.006	0.006	0.0018	U	UJ	0.0011	0.0032	0.00096	J	J	0.006	0.006	0.0018	U	UJ
Bromodichloromethane	mg/kg	0.0062	0.0062	0.00019	U	U	0.006	0.006	0.0013	U	UJ	0.0032	0.0032	0.0007	U	U	0.006	0.006	0.0013	U	UJ
Bromoform	mg/kg	0.0062	0.0062	0.00052	U	U	0.006	0.006	0.0018	U	UJ	0.0032	0.0032	0.00096	U	U	0.006	0.006	0.0018	U	UJ
Bromomethane	mg/kg	0.0062	0.0062	0.0004	U *	UJ	0.006	0.006	0.0024	U	UJ	0.0032	0.0032	0.0013	U	U	0.006	0.006	0.0024	U	UJ
Butanone, 2-	mg/kg	0.025	0.025	0.0011	U	U	0.03	0.03	0.0073	U	UJ	0.016	0.016	0.0039	U	U	0.03	0.03	0.0073	U	UJ
Carbon disulfide	mg/kg	0.0062	0.0062	0.00045	U	U	0.006	0.006	0.0024	U	UJ	0.0032	0.0032	0.0013	U	U	0.006	0.006	0.0024	U	UJ
Carbon tetrachloride	mg/kg	0.0062	0.0062	0.00039	U	U	0.006	0.006	0.0021	U	UJ	0.0032	0.0032	0.0012	U	U	0.006	0.006	0.0021	U	UJ
Chlorobenzene	mg/kg	0.0062	0.0062	0.00041	U	U	0.006	0.006	0.0012	U	UJ	0.0032	0.0032	0.00064	U	U	0.006	0.006	0.0012	U	UJ
Chloroethane	mg/kg	0.0062	0.0062	0.00044	U	U	0.006	0.006	0.0024	U	UJ	0.0032	0.0032	0.0013	U	U	0.006	0.006	0.0024	U	UJ
Chloroform	mg/kg	0.0062	0.0062	0.00035	U	U	0.006	0.006	0.0014	U	UJ	0.0032	0.0032	0.00077	U	U	0.006	0.006	0.0014	U	UJ
Chloromethane	mg/kg	0.0062	0.0062	0.00027	U	UJ	0.006	0.006	0.0024	U	UJ	0.0032	0.0032	0.0013	U	U	0.006	0.006	0.0024	U	UJ
Cyclohexane	mg/kg	0.012	0.012	0.00027	U	U															
Dibromo-3-chloropropane, 1,2-	mg/kg	0.012	0.012	0.0012	U *	UJ															
Dibromochloromethane	mg/kg	0.0062	0.0062	0.00039	U	U	0.006	0.006	0.0012	U	UJ	0.0032	0.0032	0.00064	U	U	0.006	0.006	0.0012	U	UJ
Dibromoethane, 1,2-	mg/kg	0.0062	0.0062	0.00051	U	U															
Dichlorobenzene, 1,2-	mg/kg	0.0062	0.0062	0.00051	U *	UJ															
Dichlorobenzene, 1,3-	mg/kg	0.0062	0.0062	0.00036	U *	UJ															
Dichlorobenzene, 1,4-	mg/kg	0.0062	0.0062	0.00058	U *	UJ															
Dichlorodifluoromethane	mg/kg	0.0062	0.0062	0.00044	U	UJ															
Dichloroethane, 1,1-	mg/kg	0.0062	0.0062	0.00031	U	U	0.006	0.006	0.0013	U	UJ	0.0032	0.0032	0.0007	U	U	0.006	0.006	0.0013	U	UJ
Dichloroethane, 1,2-	mg/kg	0.0062	0.0062	0.00035	U	U	0.006	0.006	0.0012	U	UJ	0.0032	0.0032	0.00064	U	U	0.006	0.006	0.0012	U	UJ
Dichloroethene, 1,1-	mg/kg	0.0062	0.0062	0.00046	U	U	0.006	0.006	0.0017	U	UJ	0.0032	0.0032	0.00089	U	U	0.006	0.006	0.0017	U	UJ
Dichloroethene, cis-1,2-	mg/kg	0.0062	0.0062	0.00027	U	U	0.006	0.006	0.0018	U	UJ	0.0032	0.0032	0.00096	U	U	0.006	0.006	0.0018	U	UJ
Dichloroethene, trans-1,2-	mg/kg	0.0062	0.0062	0.00044	U	U	0.006	0.006	0.0018	U	UJ	0.0032	0.0032	0.00096	U	U	0.006	0.006	0.0018	U	UJ
Dichloropropane, 1,2-	mg/kg	0.0062	0.0062	0.00061	U	U	0.006	0.006	0.0014	U	UJ	0.0032	0.0032	0.00077	U	U	0.006	0.006	0.0014	U	UJ
Dichloropropene, cis-1,3-	mg/kg	0.0062	0.0062	0.00022	U	U	0.006	0.006	0.0012	U	UJ	0.0032	0.0032	0.00064	U	U	0.006	0.006	0.0012	U	UJ
Dichloropropene, trans-1,3-	mg/kg	0.0062	0.0062	0.0004	U	U	0.006	0.006	0.0013	U	UJ	0.0032	0.0032	0.0007	U	U	0.006	0.006	0.0013	U	UJ
Ethylbenzene	mg/kg	0.0062	0.0062	0.00052	U	U	0.006	0.006	0.0012	U	UJ	0.0032	0.0032	0.00064	U	U	0.006	0.006	0.0012	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB02					ULA-SB02					ULA-SB03					ULA-SB03				
SAMPLE NO		ULA0018					ULA0030					ULA0019					ULA0031				
SAMPLE DATE		19-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FS					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexanone, 2-	mg/kg	0.025	0.025	0.00075	U	U	0.03	0.03	0.0064	U	UJ	0.016	0.016	0.0035	U	U	0.03	0.03	0.0064	U	UJ
Isopropylbenzene	mg/kg	0.0062	0.0062	0.00046	U	U															
METHYL ACETATE	mg/kg	0.012	0.012	0.0008	U	U															
Methyl Tertiary Butyl Ether	mg/kg	0.025	0.025	0.00031	U	U															
Methyl-2-pentanone, 4-	mg/kg	0.025	0.025	0.00085	U	U	0.03	0.03	0.0066	U	UJ	0.016	0.016	0.0035	U	U	0.03	0.03	0.0066	U	UJ
Methylcyclohexane	mg/kg	0.012	0.012	0.0003	U	U															
Methylene chloride	mg/kg	0.013	0.0062	0.0012			0.0342	0.012	0.0055		J	0.0064	0.0064	0.0029	U	U	0.0175	0.012	0.0055	B	B
Styrene	mg/kg	0.0062	0.0062	0.00034	U	U	0.006	0.006	0.0031	U	UJ	0.0032	0.0032	0.0017	U	U	0.006	0.006	0.0031	U	UJ
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0062	0.0062	0.00029	U *	UJ	0.006	0.006	0.0014	U	UJ	0.0032	0.0032	0.00077	U	U	0.006	0.006	0.0014	U	UJ
Tetrachloroethene	mg/kg	0.0062	0.0062	0.00051	U	U	0.006	0.006	0.0012	U	UJ	0.0032	0.0032	0.00064	U	U	0.006	0.006	0.0012	U	UJ
Toluene	mg/kg	0.0063	0.0062	0.0004			0.0017	0.006	0.0014	J	J	0.0017	0.0032	0.00077	J	J	0.006	0.006	0.0014	U	UJ
Trichlorobenzene, 1,2,4-	mg/kg	0.0062	0.0062	0.00072	U *	UJ															
Trichloroethane, 1,1,1-	mg/kg	0.0062	0.0062	0.00032	U	U	0.006	0.006	0.0013	U	UJ	0.0032	0.0032	0.0007	U	U	0.006	0.006	0.0013	U	UJ
Trichloroethane, 1,1,2-	mg/kg	0.0062	0.0062	0.00078	U	U	0.006	0.006	0.0013	U	UJ	0.0032	0.0032	0.0007	U	U	0.006	0.006	0.0013	U	UJ
Trichloroethene	mg/kg	0.0062	0.0062	0.00036	U	U	0.006	0.006	0.0014	U	UJ	0.0032	0.0032	0.00077	U	U	0.006	0.006	0.0014	U	UJ
Trichlorofluoromethane	mg/kg	0.0062	0.0062	0.00031	U	U															
Trichlorotrifluoroethane	mg/kg	0.0062	0.0062	0.00055	U	U															
Vinyl chloride	mg/kg	0.0062	0.0062	0.00034	U	U	0.006	0.006	0.0018	U	UJ	0.0032	0.0032	0.00096	U	U	0.006	0.006	0.0018	U	UJ
Xylenes, total	mg/kg	0.012	0.012	0.001	U	U	0.018	0.018	0.0038	U	UJ	0.0096	0.0096	0.002	U	U	0.018	0.018	0.0038	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB03					ULA-SB03					ULA-SB04					ULA-SB04				
SAMPLE NO		ULA0032					ULA0033					ULA0020					ULA0034				
SAMPLE DATE		19-May-11					19-May-11					18-May-11					18-May-11				
DEPTH		8 - 10 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FD					FS					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.02	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.17	0.17	0.069	U	U	0.29	0.29	0.098	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Dinitrobenzene, 1,3-	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.049	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Dinitrotoluene, 2,4-	mg/kg	0.17	0.17	0.084	U	U	0.24	0.24	0.02	U	UJ	0.14	0.14	0.07	U	U	0.16	0.16	0.078	U	U
Dinitrotoluene, 2,6-	mg/kg	0.17	0.17	0.075	U	U	0.24	0.24	0.029	U	UJ	0.14	0.14	0.063	U	U	0.16	0.16	0.07	U	U
HMX	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.029	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Nitrobenzene	mg/kg	0.17	0.17	0.081	U	U	0.24	0.24	0.049	U	UJ	0.14	0.14	0.067	U	U	0.16	0.16	0.075	U	U
Nitrotoluene, 2-	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.078	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Nitrotoluene, 3-	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.069	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Nitrotoluene, 4-	mg/kg	0.17	0.17	0.087	U	U	0.49	0.49	0.078	U	UJ	0.14	0.14	0.073	U	U	0.16	0.16	0.081	U	U
RDX	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.039	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Tetryl	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.049	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.02	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.17	0.17	0.069	U	U	0.24	0.24	0.02	U	UJ	0.14	0.14	0.058	U	U	0.16	0.16	0.065	U	U
General Chemistry																					
% Solids	Percent	81.6	0									82.3	0				79.6	0			
Metals																					
Aluminum	mg/kg	7430	37	4.4			8200	23	11			6530	24	2.9			6030	11	1.3		
Antimony	mg/kg	3.7	3.7	0.18	U	U	1.1	1.1	0.44	U	U	2.4	2.4	0.12	U	U	0.16	1.1	0.056	B	J
Arsenic	mg/kg	3.5	0.46	0.046		J	8.1	1.1	0.34			8.2	1.2	0.12			6.6	0.56	0.056		
Barium	mg/kg	40.5	37	0.74			55	23	0.08			43	24	0.48			44.9	11	0.22		
Beryllium	mg/kg	0.41	0.92	0.018	B	J	0.56	0.56	0.049	U	U	0.38	0.6	0.012	B	J	0.33	0.28	0.0056		
Cadmium	mg/kg	0.088	0.18	0.0046	B	J	0.23	0.23	0.041	U	U	0.2	0.48	0.012	B	J	0.22	0.22	0.0056		
Calcium	mg/kg	48800	920	9.2			48000	560	18			30000	600	6			49000	1100	11		
Chromium	mg/kg	12.7	1.8	0.18			14	0.56	0.23			10.9	1.2	0.12			10	0.56	0.056		
Cobalt	mg/kg	7.3	2.3	0.046		J	12	5.6	0.18			6.2	6	0.12			7.5	2.8	0.056		
Copper	mg/kg	21.8	4.6	0.18			22	2.8	0.84			16.6	3	0.12			17.2	1.4	0.056		
Iron	mg/kg	19600	55	4.2			22000	11	5.5			15000	36	2.8			11600	17	1.3		
Lead	mg/kg	11.9	3.7	0.18			11	0.34	0.21			8.6	1.2	0.06			11.4	1.1	0.056		
Magnesium	mg/kg	15500	920	9.2			16000	560	5.8			8390	600	6			19800	1100	11		
Manganese	mg/kg	465	2.8	0.18			600	1.7	0.084			316	1.8	0.12			536	3.3	0.22		
Mercury	mg/kg	0.016	0.099	0.007	B	J	0.13	0.13	0.019	U	U	0.1	0.1	0.0072	U	U	0.014	0.092	0.0066	B	J
Nickel	mg/kg	17.7	1.8	0.046		J	29	4.5	0.3			17.3	4.8	0.12			17.7	2.2	0.056		
Potassium	mg/kg	1300	1800	9.2	B	J	1700	560	7			917	1200	6	B	J	1150	560	2.8		
Selenium	mg/kg	1	3.7	0.37	B	J	0.56	0.56	0.51	U	U	2.4	2.4	0.24	U	U	0.38	1.1	0.11	B	J
Silver	mg/kg	0.46	0.46	0.046	U	U	0.56	0.56	0.11	U	U	1.2	1.2	0.12	U	U	0.56	0.56	0.056	U	U
Sodium	mg/kg	1800	1800	160	U	U	560	560	75	U	U	1200	1200	100	U	U	116	560	47	B	J
Thallium	mg/kg	1.8	1.8	0.28	U	U	1.1	1.1	0.62	U	U	0.6	0.6	0.09	U	U	0.31	0.56	0.083	B	J
Vanadium	mg/kg	12.3	2.3	0.046			19	5.6	0.14			17.8	6	0.12			15.5	2.8	0.056		
Zinc	mg/kg	54.4	3.7	0.18			61	2.3	1.1			38.7	2.4	0.12			36.2	1.1	0.056		
Pesticides/PCBs																					
Aroclor 1016	mg/kg	0.02	0.02	0.008	U	U						0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1221	mg/kg	0.02	0.02	0.01	U	U						0.02	0.02	0.01	U	U	0.021	0.021	0.01	U	U
Aroclor 1232	mg/kg	0.02	0.02	0.01	U	U						0.02	0.02	0.01	U	U	0.021	0.021	0.01	U	U
Aroclor 1242	mg/kg	0.02	0.02	0.008	U	U						0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1248	mg/kg	0.02	0.02	0.008	U	U						0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1254	mg/kg	0.02	0.02	0.008	U	U						0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1260	mg/kg	0.02	0.02	0.008	U	U						0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1268	mg/kg	0.02	0.02	0.008	U	U						0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB03					ULA-SB03					ULA-SB04					ULA-SB04				
SAMPLE NO		ULA0032					ULA0033					ULA0020					ULA0034				
SAMPLE DATE		19-May-11					19-May-11					18-May-11					18-May-11				
DEPTH		8 - 10 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FD					FS					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.2	0.2	0.029	U	U	0.5	0.5	0.025	U	U	0.2	0.2	0.029	U	U	0.21	0.21	0.03	U	U
Acenaphthene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acenaphthylene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acetophenone	mg/kg						0.12	0.12	0.011	U	U										
Anthracene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Atrazine	mg/kg						0.25	0.25	0.011	U	U										
Benzaldehyde	mg/kg						0.12	0.12	0.015	U	U										
Benzo(a)anthracene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(a)pyrene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(b)fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(ghi)perylene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(k)fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzoic acid	mg/kg	1	1	0.35	U	U						1	1	0.35	U	U	1	1	0.37	U	U
Benzyl alcohol	mg/kg	0.2	0.2	0.04	U	U						0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Bibenzene	mg/kg						0.062	0.062	0.034	U	U										
Bis(2-chloroethoxy)methane	mg/kg	0.2	0.2	0.02	U	U	0.12	0.12	0.027	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroethyl)ether	mg/kg	0.2	0.2	0.02	U	U	0.12	0.12	0.0025	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.2	0.2	0.02	U	U	0.12	0.12	0.012	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.4	0.4	0.081	U	U	0.062	0.062	0.024	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.084	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.016	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Butyl benzyl phthalate	mg/kg	0.2	0.2	0.04	U	U	0.062	0.062	0.012	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Caprolactam	mg/kg						0.41	0.41	0.046	U	U										
Carbazole	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.034	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.2	0.2	0.02	U	U	0.19	0.19	0.026	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloroaniline, 4-	mg/kg	0.2	0.2	0.02	U	U	0.19	0.19	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.2	0.2	0.04	U	U	0.062	0.062	0.0041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Chlorophenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.034	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.016	U *	UJ	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chrysene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0014	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenz(a,h)anthracene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenzofuran	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dichlorobenzene, 1,2-	mg/kg	0.2	0.2	0.04	U	U						0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,3-	mg/kg	0.2	0.2	0.04	U	U						0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,4-	mg/kg	0.2	0.2	0.04	U	U						0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.4	0.4	0.04	U	U	0.12	0.12	0.022	U	U	0.4	0.4	0.04	U	U	0.42	0.42	0.042	U	U
Dichlorophenol, 2,4-	mg/kg	0.2	0.2	0.02	U	U	0.19	0.19	0.025	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Diethyl phthalate	mg/kg	0.4	0.4	0.081	U	U	0.062	0.062	0.02	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.084	U	U
Dimethyl phthalate	mg/kg	0.2	0.2	0.04	U	U	0.062	0.062	0.021	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dimethylphenol, 2,4-	mg/kg	0.2	0.2	0.025	U	U	0.19	0.19	0.025	U	U	0.2	0.2	0.025	U	U	0.21	0.21	0.026	U	U
Di-n-butyl phthalate	mg/kg	0.4	0.4	0.081	U	U	0.062	0.062	0.019	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.084	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.4	0.4	0.081	U	U	0.19	0.19	0.1	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.084	U	U
Dinitrophenol, 2,4-	mg/kg	1	1	0.4	U	U	0.41	0.41	0.1	U	U	1	1	0.4	U	U	1	1	0.42	U	U
Dinitrotoluene, 2,4-	mg/kg	0.2	0.2	0.02	U	U	0.25	0.25	0.034	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dinitrotoluene, 2,6-	mg/kg	0.2	0.2	0.024	U	U	0.25	0.25	0.026	U	U	0.2	0.2	0.024	U	U	0.21	0.21	0.025	U	U
Di-n-octyl phthalate	mg/kg	0.2	0.2	0.04	U	U	0.062	0.062	0.034	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Fluorene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobenzene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0026	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobutadiene	mg/kg	0.2	0.2	0.04	U	U	0.062	0.062	0.034	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Hexachlorocyclopentadiene	mg/kg	0.2	0.2	0.089	U	U	0.41	0.41	0.034	U	U	0.2	0.2	0.088	U	U	0.21	0.21	0.092	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB03					ULA-SB03					ULA-SB04					ULA-SB04				
SAMPLE NO		ULA0032					ULA0033					ULA0020					ULA0034				
SAMPLE DATE		19-May-11					19-May-11					18-May-11					18-May-11				
DEPTH		8 - 10 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FD					FS					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachloroethane	mg/kg	0.2	0.2	0.04	U	U	0.062	0.062	0.011	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Isophorone	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.016	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylnaphthalene, 2-	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylphenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.25	0.25	0.1	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Naphthalene	mg/kg	0.2	0.2	0.032	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.032	U	U	0.21	0.21	0.034	U	U
Nitroaniline, 2-	mg/kg	0.2	0.2	0.04	U	U	0.25	0.25	0.011	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 3-	mg/kg	0.2	0.2	0.04	U	U	0.25	0.25	0.02	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 4-	mg/kg	0.2	0.2	0.04	U	U	0.25	0.25	0.032	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitrobenzene	mg/kg	0.2	0.2	0.02	U	U	0.12	0.12	0.0027	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.034	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 4-	mg/kg	1	1	0.16	U	U	0.41	0.41	0.1	U	U	1	1	0.16	U	U	1	1	0.17	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.034	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
n-Nitrosodiphenylamine	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.026	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pentachlorophenol	mg/kg	1	1	0.24	U	U	0.19	0.19	0.1	U	U	1	1	0.24	U	U	1	1	0.25	U	U
Phenanthrene	mg/kg	0.2	0.2	0.02	U	U	0.0083	0.0083	0.0041	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Phenol	mg/kg	0.2	0.2	0.02	U	U	0.062	0.062	0.034	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pyrene	mg/kg	0.2	0.2	0.02	U	U	0.013	0.0083	0.0041			0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.2	0.2	0.02	U	U						0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.2	0.2	0.02	U	U	0.19	0.19	0.031	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.2	0.2	0.02	U	U	0.19	0.19	0.1	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Volatile Organics																					
Acetone	mg/kg	0.061	0.061	0.024	U	UJ	0.031	0.025	0.002			0.034	0.034	0.014	U	U	0.063	0.063	0.025	U	UJ
Benzene	mg/kg	0.0061	0.0061	0.0018	U	UJ	0.0063	0.0063	0.00018	U	U	0.001	0.0034	0.001	J	J	0.0063	0.0063	0.0019	U	UJ
Bromodichloromethane	mg/kg	0.0061	0.0061	0.0013	U	UJ	0.0063	0.0063	0.00019	U	U	0.0034	0.0034	0.00076	U	U	0.0063	0.0063	0.0014	U	UJ
Bromoform	mg/kg	0.0061	0.0061	0.0018	U	UJ	0.0063	0.0063	0.00053	U	U	0.0034	0.0034	0.001	U	U	0.0063	0.0063	0.0019	U	UJ
Bromomethane	mg/kg	0.0061	0.0061	0.0024	U	UJ	0.0063	0.0063	0.0004	U *	UJ	0.0034	0.0034	0.0014	U	U	0.0063	0.0063	0.0025	U	UJ
Butanone, 2-	mg/kg	0.031	0.031	0.0075	U	UJ	0.025	0.025	0.0011	U	U	0.017	0.017	0.0042	U	U	0.031	0.031	0.0077	U	UJ
Carbon disulfide	mg/kg	0.0061	0.0061	0.0024	U	UJ	0.0063	0.0063	0.00045	U	U	0.0034	0.0034	0.0014	U	U	0.0063	0.0063	0.0025	U	UJ
Carbon tetrachloride	mg/kg	0.0061	0.0061	0.0022	U	UJ	0.0063	0.0063	0.00039	U	U	0.0034	0.0034	0.0012	U	U	0.0063	0.0063	0.0023	U	UJ
Chlorobenzene	mg/kg	0.0061	0.0061	0.0012	U	UJ	0.0063	0.0063	0.00041	U	U	0.0034	0.0034	0.00069	U	U	0.0063	0.0063	0.0013	U	UJ
Chloroethane	mg/kg	0.0061	0.0061	0.0024	U	UJ	0.0063	0.0063	0.00044	U	U	0.0034	0.0034	0.0014	U	UJ	0.0063	0.0063	0.0025	U	UJ
Chloroform	mg/kg	0.0061	0.0061	0.0015	U	UJ	0.0063	0.0063	0.00035	U	U	0.0034	0.0034	0.00083	U	U	0.0063	0.0063	0.0015	U	UJ
Chloromethane	mg/kg	0.0061	0.0061	0.0024	U	UJ	0.0063	0.0063	0.00028	U	UJ	0.0034	0.0034	0.0014	U	U	0.0063	0.0063	0.0025	U	UJ
Cyclohexane	mg/kg						0.013	0.013	0.00028	U	U										
Dibromo-3-chloropropane, 1,2-	mg/kg						0.013	0.013	0.0012	U *	UJ										
Dibromochloromethane	mg/kg	0.0061	0.0061	0.0012	U	UJ	0.0063	0.0063	0.00039	U	U	0.0034	0.0034	0.00069	U	U	0.0063	0.0063	0.0013	U	UJ
Dibromoethane, 1,2-	mg/kg						0.0063	0.0063	0.00051	U	U										
Dichlorobenzene, 1,2-	mg/kg						0.0063	0.0063	0.00051	U *	UJ										
Dichlorobenzene, 1,3-	mg/kg						0.0063	0.0063	0.00036	U *	UJ										
Dichlorobenzene, 1,4-	mg/kg						0.0063	0.0063	0.00059	U *	UJ										
Dichlorodifluoromethane	mg/kg						0.0063	0.0063	0.00044	U	UJ										
Dichloroethane, 1,1-	mg/kg	0.0061	0.0061	0.0013	U	UJ	0.0063	0.0063	0.00031	U	U	0.0034	0.0034	0.00076	U	U	0.0063	0.0063	0.0014	U	UJ
Dichloroethane, 1,2-	mg/kg	0.0061	0.0061	0.0012	U	UJ	0.0063	0.0063	0.00035	U	U	0.0034	0.0034	0.00069	U	U	0.0063	0.0063	0.0013	U	UJ
Dichloroethene, 1,1-	mg/kg	0.0061	0.0061	0.0017	U	UJ	0.0063	0.0063	0.00046	U	U	0.0034	0.0034	0.00097	U	U	0.0063	0.0063	0.0018	U	UJ
Dichloroethene, cis-1,2-	mg/kg	0.0061	0.0061	0.0018	U	UJ	0.0063	0.0063	0.00028	U	U	0.0034	0.0034	0.001	U	U	0.0063	0.0063	0.0019	U	UJ
Dichloroethene, trans-1,2-	mg/kg	0.0061	0.0061	0.0018	U	UJ	0.0063	0.0063	0.00044	U	U	0.0034	0.0034	0.001	U	U	0.0063	0.0063	0.0019	U	UJ
Dichloropropane, 1,2-	mg/kg	0.0061	0.0061	0.0015	U	UJ	0.0063	0.0063	0.00061	U	U	0.0034	0.0034	0.00083	U	U	0.0063	0.0063	0.0015	U	UJ
Dichloropropene, cis-1,3-	mg/kg	0.0061	0.0061	0.0012	U	UJ	0.0063	0.0063	0.00023	U	U	0.0034	0.0034	0.00069	U	U	0.0063	0.0063	0.0013	U	UJ
Dichloropropene, trans-1,3-	mg/kg	0.0061	0.0061	0.0013	U	UJ	0.0063	0.0063	0.0004	U	U	0.0034	0.0034	0.00076	U	U	0.0063	0.0063	0.0014	U	UJ
Ethylbenzene	mg/kg	0.0061	0.0061	0.0012	U	UJ	0.0063	0.0063	0.00053	U	U	0.0034	0.0034	0.00069	U	U	0.0063	0.0063	0.0013	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB03					ULA-SB03					ULA-SB04					ULA-SB04				
SAMPLE NO		ULA0032					ULA0033					ULA0020					ULA0034				
SAMPLE DATE		19-May-11					19-May-11					18-May-11					18-May-11				
DEPTH		8 - 10 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FD					FS					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexanone, 2-	mg/kg	0.031	0.031	0.0066	U	UJ	0.025	0.025	0.00075	U	U	0.017	0.017	0.0037	U	U	0.031	0.031	0.0068	U	UJ
Isopropylbenzene	mg/kg						0.0063	0.0063	0.00046	U	U										
METHYL ACETATE	mg/kg						0.013	0.013	0.0008	U	U										
Methyl Tertiary Butyl Ether	mg/kg						0.025	0.025	0.00031	U	U										
Methyl-2-pentanone, 4-	mg/kg	0.031	0.031	0.0067	U	UJ	0.025	0.025	0.00085	U	U	0.017	0.017	0.0038	U	U	0.031	0.031	0.0069	U	UJ
Methylcyclohexane	mg/kg						0.013	0.013	0.0003	U	U										
Methylene chloride	mg/kg	0.0187	0.012	0.0056		J	0.0063	0.0063	0.0013	U	U	0.0069	0.0069	0.0032	U	U	0.135	0.013	0.0058		J
Styrene	mg/kg	0.0061	0.0061	0.0032	U	UJ	0.0063	0.0063	0.00034	U	U	0.0034	0.0034	0.0018	U	U	0.0063	0.0063	0.0033	U	UJ
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0061	0.0061	0.0015	U	UJ	0.0063	0.0063	0.00029	U *	UJ	0.0034	0.0034	0.00083	U	U	0.0063	0.0063	0.0015	U	UJ
Tetrachloroethene	mg/kg	0.0061	0.0061	0.0012	U	UJ	0.0063	0.0063	0.00051	U	U	0.0034	0.0034	0.00069	U	U	0.0063	0.0063	0.0013	U	UJ
Toluene	mg/kg	0.0061	0.0061	0.0015	U	UJ	0.0063	0.0063	0.0004	U	U	0.0015	0.0034	0.00083	J	J	0.0063	0.0063	0.0015	U	UJ
Trichlorobenzene, 1,2,4-	mg/kg						0.0063	0.0063	0.00073	U *	UJ										
Trichloroethane, 1,1,1-	mg/kg	0.0061	0.0061	0.0013	U	UJ	0.0063	0.0063	0.00033	U	U	0.0034	0.0034	0.00076	U	U	0.0063	0.0063	0.0014	U	UJ
Trichloroethane, 1,1,2-	mg/kg	0.0061	0.0061	0.0013	U	UJ	0.0063	0.0063	0.00079	U	U	0.0034	0.0034	0.00076	U	U	0.0063	0.0063	0.0014	U	UJ
Trichloroethene	mg/kg	0.0061	0.0061	0.0015	U	UJ	0.0063	0.0063	0.00036	U	U	0.0034	0.0034	0.00083	U	U	0.0063	0.0063	0.0015	U	UJ
Trichlorofluoromethane	mg/kg						0.0063	0.0063	0.00031	U	U										
Trichlorotrifluoroethane	mg/kg						0.0063	0.0063	0.00055	U	U										
Vinyl chloride	mg/kg	0.0061	0.0061	0.0018	U	UJ	0.0063	0.0063	0.00034	U	U	0.0034	0.0034	0.001	U	U	0.0063	0.0063	0.0019	U	UJ
Xylenes, total	mg/kg	0.018	0.018	0.0039	U	UJ	0.013	0.013	0.001	U	U	0.01	0.01	0.0022	U	U	0.019	0.019	0.004	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB05					ULA-SB05					ULA-SB06					ULA-SB06				
SAMPLE NO		ULA0021					ULA0035					ULA0022					ULA0036				
SAMPLE DATE		19-May-11					19-May-11					18-May-11					18-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Dinitrobenzene, 1,3-	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Dinitrotoluene, 2,4-	mg/kg	0.15	0.15	0.074	U	U	0.18	0.18	0.086	U	U	0.16	0.16	0.076	U	U	0.15	0.15	0.074	U	U
Dinitrotoluene, 2,6-	mg/kg	0.15	0.15	0.066	U	U	0.18	0.18	0.077	U	U	0.16	0.16	0.068	U	U	0.15	0.15	0.067	U	U
HMX	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Nitrobenzene	mg/kg	0.15	0.15	0.071	U	U	0.18	0.18	0.083	U	U	0.16	0.16	0.073	U	U	0.15	0.15	0.071	U	U
Nitrotoluene, 2-	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Nitrotoluene, 3-	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Nitrotoluene, 4-	mg/kg	0.15	0.15	0.077	U	U	0.18	0.18	0.09	U	U	0.16	0.16	0.079	U	U	0.15	0.15	0.077	U	U
RDX	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Tetryl	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.15	0.15	0.061	U	U	0.18	0.18	0.071	U	U	0.16	0.16	0.063	U	U	0.15	0.15	0.061	U	U
General Chemistry																					
% Solids	Percent	78	0				81.3	0				81.7	0				80	0			
Metals																					
Aluminum	mg/kg	12400	58	7			8180	42	5.1			9330	56	6.7			6270	11	1.4		
Antimony	mg/kg	5.8	5.8	0.29	U	U	0.44	4.2	0.21	B	J	5.6	5.6	0.28	U	U	0.11	1.1	0.056	B	J
Arsenic	mg/kg	7.8	2.9	0.29			17.7	0.53	0.053			5.7	2.8	0.28			6.9	0.56	0.056		
Barium	mg/kg	124	58	1.2			91.5	42	0.85			54.6	56	1.1	B	J	44	11	0.23		
Beryllium	mg/kg	0.78	1.5	0.029	B	J	0.51	1.1	0.021	B	J	0.49	1.4	0.028	B	J	0.36	0.28	0.0056		
Cadmium	mg/kg	1.2	1.2	0.029	U	U	0.48	0.85	0.021	B	J	1.1	1.1	0.028	U	U	0.26	0.23	0.0056		
Calcium	mg/kg	6400	1500	15			40400	1100	11			2990	1400	14			50100	1100	11		
Chromium	mg/kg	15.3	2.9	0.29			14.1	2.1	0.21			16	2.8	0.28			10.5	0.56	0.056		
Cobalt	mg/kg	10.5	15	0.29	B	J	9.7	2.7	0.053			5.9	14	0.28	B	J	7.8	2.8	0.056		
Copper	mg/kg	15.7	7.3	0.29			21.9	5.3	0.21			18.5	7	0.28			18	1.4	0.056		
Iron	mg/kg	22000	87	6.7			28000	64	4.9			17700	84	6.5			14100	17	1.3		
Lead	mg/kg	12.2	1.2	0.058			12.5	4.2	0.21			8.5	1.1	0.056			10.9	1.1	0.056		
Magnesium	mg/kg	2490	1500	15			13600	1100	11			2780	1400	14			15800	1100	11		
Manganese	mg/kg	848	4.4	0.29			1680	8	0.53			146	4.2	0.28			443	3.4	0.23		
Mercury	mg/kg	0.062	0.11	0.0076	B	J	0.018	0.1	0.0073	B	J	0.033	0.1	0.0072	B	J	0.02	0.1	0.0073	B	J
Nickel	mg/kg	18.8	12	0.29			30.2	2.1	0.053			19.2	11	0.28			19.8	2.3	0.056		
Potassium	mg/kg	841	2900	15	B	J	1050	2100	11	B	J	928	2800	14	B	J	1090	560	2.8		
Selenium	mg/kg	5.8	5.8	0.58	U	U	4.2	4.2	0.42	U	U	5.6	5.6	0.56	U	U	0.99	1.1	0.11	B	J
Silver	mg/kg	2.9	2.9	0.29	U	U	0.53	0.53	0.053	U	U	2.8	2.8	0.28	U	U	0.56	0.56	0.056	U	U
Sodium	mg/kg	2900	2900	250	U	U	2100	2100	180	U	U	2800	2800	240	U	U	94.7	560	48	B	J
Thallium	mg/kg	0.58	0.58	0.087	U	U	2.1	2.1	0.32	U	U	0.56	0.56	0.084	U	U	0.56	0.56	0.084	U	U
Vanadium	mg/kg	29.1	15	0.29			14.7	2.7	0.053			20.4	14	0.28			16.1	2.8	0.056		
Zinc	mg/kg	44	5.8	0.29			53.2	4.2	0.21			53.4	5.6	0.28			41.8	1.1	0.056		
Pesticides/PCBs																					
Aroclor 1016	mg/kg											0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1221	mg/kg											0.02	0.02	0.01	U	U	0.021	0.021	0.01	U	U
Aroclor 1232	mg/kg											0.02	0.02	0.01	U	U	0.021	0.021	0.01	U	U
Aroclor 1242	mg/kg											0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1248	mg/kg											0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1254	mg/kg											0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1260	mg/kg											0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U
Aroclor 1268	mg/kg											0.02	0.02	0.008	U	U	0.021	0.021	0.0082	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB05					ULA-SB05					ULA-SB06					ULA-SB06				
SAMPLE NO		ULA0021					ULA0035					ULA0022					ULA0036				
SAMPLE DATE		19-May-11					19-May-11					18-May-11					18-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.21	0.21	0.031	U	U	0.2	0.2	0.029	U	U	0.2	0.2	0.029	U	U	0.21	0.21	0.03	U	U
Acenaphthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acenaphthylene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acetophenone	mg/kg																				
Anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Atrazine	mg/kg																				
Benzaldehyde	mg/kg																				
Benzo(a)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(a)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(b)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(ghi)perylene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(k)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzoic acid	mg/kg	1.1	1.1	0.37	U	U	1	1	0.36	U	U	1	1	0.35	U	U	1	1	0.36	U	U
Benzyl alcohol	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Bibenzene	mg/kg																				
Bis(2-chloroethoxy)methane	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroethyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.21	0.21	0.021	U	UJ	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.42	0.42	0.085	U	UJ	0.41	0.41	0.081	U	U	0.4	0.4	0.08	U	U	0.41	0.41	0.083	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Butyl benzyl phthalate	mg/kg	0.21	0.21	0.042	U	UJ	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Caprolactam	mg/kg																				
Carbazole	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloroaniline, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Chlorophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chrysene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenz(a,h)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenzofuran	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dichlorobenzene, 1,2-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Dichlorobenzene, 1,3-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Dichlorobenzene, 1,4-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.42	0.42	0.042	U	U	0.41	0.41	0.041	U	U	0.4	0.4	0.04	U	U	0.41	0.41	0.041	U	U
Dichlorophenol, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Diethyl phthalate	mg/kg	0.42	0.42	0.085	U	U	0.41	0.41	0.081	U	U	0.4	0.4	0.08	U	U	0.41	0.41	0.083	U	U
Dimethyl phthalate	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Dimethylphenol, 2,4-	mg/kg	0.21	0.21	0.027	U	U	0.2	0.2	0.026	U	U	0.2	0.2	0.025	U	U	0.21	0.21	0.026	U	U
Di-n-butyl phthalate	mg/kg	0.42	0.42	0.085	U	U	0.41	0.41	0.081	U	U	0.4	0.4	0.08	U	U	0.41	0.41	0.083	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.42	0.42	0.085	U	U	0.41	0.41	0.081	U	U	0.4	0.4	0.08	U	U	0.41	0.41	0.083	U	U
Dinitrophenol, 2,4-	mg/kg	1.1	1.1	0.42	U	U	1	1	0.41	U	U	1	1	0.4	U	U	1	1	0.41	U	U
Dinitrotoluene, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dinitrotoluene, 2,6-	mg/kg	0.21	0.21	0.025	U	U	0.2	0.2	0.024	U	U	0.2	0.2	0.024	U	U	0.21	0.21	0.024	U	U
Di-n-octyl phthalate	mg/kg	0.21	0.21	0.042	U	UJ	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Fluorene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobenzene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobutadiene	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Hexachlorocyclopentadiene	mg/kg	0.21	0.21	0.093	U	U	0.2	0.2	0.09	U	U	0.2	0.2	0.088	U	U	0.21	0.21	0.091	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB05					ULA-SB05					ULA-SB06					ULA-SB06				
SAMPLE NO		ULA0021					ULA0035					ULA0022					ULA0036				
SAMPLE DATE		19-May-11					19-May-11					18-May-11					18-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachloroethane	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Isophorone	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylnaphthalene, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylphenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Naphthalene	mg/kg	0.21	0.21	0.034	U	U	0.2	0.2	0.033	U	U	0.2	0.2	0.032	U	U	0.21	0.21	0.033	U	U
Nitroaniline, 2-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Nitroaniline, 3-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Nitroaniline, 4-	mg/kg	0.21	0.21	0.042	U	U	0.2	0.2	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.041	U	U
Nitrobenzene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 4-	mg/kg	1.1	1.1	0.17	U	U	1	1	0.16	U	U	1	1	0.16	U	U	1	1	0.17	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
n-Nitrosodiphenylamine	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pentachlorophenol	mg/kg	1.1	1.1	0.25	U	U	1	1	0.24	U	U	1	1	0.24	U	U	1	1	0.25	U	U
Phenanthrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Phenol	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Volatile Organics																					
Acetone	mg/kg	0.0439	0.038	0.015	J	J	0.06	0.06	0.024	U	UJ	0.0207	0.038	0.015	J	J	0.064	0.064	0.026	U	UJ
Benzene	mg/kg	0.0038	0.0038	0.0011	U	U	0.006	0.006	0.0018	U	UJ	0.0038	0.0038	0.0012	U	U	0.0064	0.0064	0.0019	U	UJ
Bromodichloromethane	mg/kg	0.0038	0.0038	0.00084	U	U	0.006	0.006	0.0013	U	UJ	0.0038	0.0038	0.00084	U	U	0.0064	0.0064	0.0014	U	UJ
Bromoform	mg/kg	0.0038	0.0038	0.0011	U	U	0.006	0.006	0.0018	U	UJ	0.0038	0.0038	0.0012	U	U	0.0064	0.0064	0.0019	U	UJ
Bromomethane	mg/kg	0.0038	0.0038	0.0015	U	U	0.006	0.006	0.0024	U	UJ	0.0038	0.0038	0.0015	U	U	0.0064	0.0064	0.0026	U	UJ
Butanone, 2-	mg/kg	0.019	0.019	0.0047	U	U	0.03	0.03	0.0073	U	UJ	0.019	0.019	0.0047	U	U	0.032	0.032	0.0078	U	UJ
Carbon disulfide	mg/kg	0.0038	0.0038	0.0015	U	U	0.006	0.006	0.0024	U	UJ	0.0038	0.0038	0.0015	U	U	0.0064	0.0064	0.0026	U	UJ
Carbon tetrachloride	mg/kg	0.0038	0.0038	0.0014	U	U	0.006	0.006	0.0021	U	UJ	0.0038	0.0038	0.0014	U	U	0.0064	0.0064	0.0023	U	UJ
Chlorobenzene	mg/kg	0.0038	0.0038	0.00076	U	U	0.006	0.006	0.0012	U	UJ	0.0038	0.0038	0.00077	U	U	0.0064	0.0064	0.0013	U	UJ
Chloroethane	mg/kg	0.0038	0.0038	0.0015	U	U	0.006	0.006	0.0024	U	UJ	0.0038	0.0038	0.0015	U	UJ	0.0064	0.0064	0.0026	U	UJ
Chloroform	mg/kg	0.0038	0.0038	0.00092	U	U	0.006	0.006	0.0014	U	UJ	0.0038	0.0038	0.00092	U	U	0.0064	0.0064	0.0015	U	UJ
Chloromethane	mg/kg	0.0038	0.0038	0.0015	U	U	0.006	0.006	0.0024	U	UJ	0.0038	0.0038	0.0015	U	U	0.0064	0.0064	0.0026	U	UJ
Cyclohexane	mg/kg																				
Dibromo-3-chloropropane, 1,2-	mg/kg																				
Dibromochloromethane	mg/kg	0.0038	0.0038	0.00076	U	U	0.006	0.006	0.0012	U	UJ	0.0038	0.0038	0.00077	U	U	0.0064	0.0064	0.0013	U	UJ
Dibromoethane, 1,2-	mg/kg																				
Dichlorobenzene, 1,2-	mg/kg																				
Dichlorobenzene, 1,3-	mg/kg																				
Dichlorobenzene, 1,4-	mg/kg																				
Dichlorodifluoromethane	mg/kg																				
Dichloroethane, 1,1-	mg/kg	0.0038	0.0038	0.00084	U	U	0.006	0.006	0.0013	U	UJ	0.0038	0.0038	0.00084	U	U	0.0064	0.0064	0.0014	U	UJ
Dichloroethane, 1,2-	mg/kg	0.0038	0.0038	0.00076	U	U	0.006	0.006	0.0012	U	UJ	0.0038	0.0038	0.00077	U	U	0.0064	0.0064	0.0013	U	UJ
Dichloroethene, 1,1-	mg/kg	0.0038	0.0038	0.0011	U	U	0.006	0.006	0.0017	U	UJ	0.0038	0.0038	0.0011	U	U	0.0064	0.0064	0.0018	U	UJ
Dichloroethene, cis-1,2-	mg/kg	0.0038	0.0038	0.0011	U	U	0.006	0.006	0.0018	U	UJ	0.0038	0.0038	0.0012	U	U	0.0064	0.0064	0.0019	U	UJ
Dichloroethene, trans-1,2-	mg/kg	0.0038	0.0038	0.0011	U	U	0.006	0.006	0.0018	U	UJ	0.0038	0.0038	0.0012	U	U	0.0064	0.0064	0.0019	U	UJ
Dichloropropane, 1,2-	mg/kg	0.0038	0.0038	0.00092	U	U	0.006	0.006	0.0014	U	UJ	0.0038	0.0038	0.00092	U	U	0.0064	0.0064	0.0015	U	UJ
Dichloropropene, cis-1,3-	mg/kg	0.0038	0.0038	0.00076	U	U	0.006	0.006	0.0012	U	UJ	0.0038	0.0038	0.00077	U	U	0.0064	0.0064	0.0013	U	UJ
Dichloropropene, trans-1,3-	mg/kg	0.0038	0.0038	0.00084	U	U	0.006	0.006	0.0013	U	UJ	0.0038	0.0038	0.00084	U	U	0.0064	0.0064	0.0014	U	UJ
Ethylbenzene	mg/kg	0.0038	0.0038	0.00076	U	U	0.006	0.006	0.0012	U	UJ	0.0038	0.0038	0.00077	U	U	0.0064	0.0064	0.0013	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB05					ULA-SB05					ULA-SB06					ULA-SB06				
SAMPLE NO		ULA0021					ULA0035					ULA0022					ULA0036				
SAMPLE DATE		19-May-11					19-May-11					18-May-11					18-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexanone, 2-	mg/kg	0.019	0.019	0.0041	U	U	0.03	0.03	0.0064	U	UJ	0.019	0.019	0.0041	U	U	0.032	0.032	0.0069	U	UJ
Isopropylbenzene	mg/kg																				
METHYL ACETATE	mg/kg																				
Methyl Tertiary Butyl Ether	mg/kg																				
Methyl-2-pentanone, 4-	mg/kg	0.019	0.019	0.0042	U	U	0.03	0.03	0.0066	U	UJ	0.019	0.019	0.0042	U	U	0.032	0.032	0.007	U	UJ
Methylcyclohexane	mg/kg																				
Methylene chloride	mg/kg	0.0076	0.0076	0.0035	U	U	0.0147	0.012	0.0055		J	0.0061	0.0077	0.0035	J	J	0.0093	0.013	0.0059	J	J
Styrene	mg/kg	0.0038	0.0038	0.002	U	U	0.006	0.006	0.0031	U	UJ	0.0038	0.0038	0.002	U	U	0.0064	0.0064	0.0033	U	UJ
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0038	0.0038	0.00092	U	U	0.006	0.006	0.0014	U	UJ	0.0038	0.0038	0.00092	U	U	0.0064	0.0064	0.0015	U	UJ
Tetrachloroethene	mg/kg	0.0038	0.0038	0.00076	U	U	0.006	0.006	0.0012	U	UJ	0.0038	0.0038	0.00077	U	U	0.0064	0.0064	0.0013	U	UJ
Toluene	mg/kg	0.0038	0.0038	0.00092	U	U	0.006	0.006	0.0014	U	UJ	0.0038	0.0038	0.00092	U	U	0.0064	0.0064	0.0015	U	UJ
Trichlorobenzene, 1,2,4-	mg/kg																				
Trichloroethane, 1,1,1-	mg/kg	0.0038	0.0038	0.00084	U	U	0.006	0.006	0.0013	U	UJ	0.0038	0.0038	0.00084	U	U	0.0064	0.0064	0.0014	U	UJ
Trichloroethane, 1,1,2-	mg/kg	0.0038	0.0038	0.00084	U	U	0.006	0.006	0.0013	U	UJ	0.0038	0.0038	0.00084	U	U	0.0064	0.0064	0.0014	U	UJ
Trichloroethene	mg/kg	0.0038	0.0038	0.00092	U	U	0.006	0.006	0.0014	U	UJ	0.0038	0.0038	0.00092	U	U	0.0064	0.0064	0.0015	U	UJ
Trichlorofluoromethane	mg/kg																				
Trichlorotrifluoroethane	mg/kg																				
Vinyl chloride	mg/kg	0.0038	0.0038	0.0011	U	U	0.006	0.006	0.0018	U	UJ	0.0038	0.0038	0.0012	U	U	0.0064	0.0064	0.0019	U	UJ
Xylenes, total	mg/kg	0.011	0.011	0.0024	U	U	0.018	0.018	0.0038	U	UJ	0.012	0.012	0.0025	U	U	0.019	0.019	0.0041	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB07					ULA-SB07					ULA-SB08					ULA-SB08				
SAMPLE NO		ULA0023					ULA0037					ULA0024					ULA0038				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Dinitrobenzene, 1,3-	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Dinitrotoluene, 2,4-	mg/kg	0.18	0.18	0.088	U	U	0.15	0.15	0.074	U	U	0.15	0.15	0.071	U	U	0.16	0.16	0.08	U	U
Dinitrotoluene, 2,6-	mg/kg	0.18	0.18	0.079	U	U	0.15	0.15	0.066	U	U	0.15	0.15	0.064	U	U	0.16	0.16	0.071	U	U
HMX	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Nitrobenzene	mg/kg	0.18	0.18	0.084	U	U	0.15	0.15	0.071	U	U	0.15	0.15	0.068	U	U	0.16	0.16	0.076	U	U
Nitrotoluene, 2-	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Nitrotoluene, 3-	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Nitrotoluene, 4-	mg/kg	0.18	0.18	0.091	U	U	0.15	0.15	0.077	U	U	0.15	0.15	0.074	U	U	0.16	0.16	0.083	U	U
RDX	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Tetryl	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.18	0.18	0.072	U	U	0.15	0.15	0.061	U	U	0.15	0.15	0.059	U	U	0.16	0.16	0.066	U	U
General Chemistry																					
% Solids	Percent	80	0				82.5	0				83.1	0				78.8	0			
Metals																					
Aluminum	mg/kg	3890	11	1.4			4090	9.1	1.1			7020	35	4.2		J	6360	12	1.5		
Antimony	mg/kg	0.14	1.1	0.056	B	J	0.18	0.91	0.046	B	J	3.5	3.5	0.18	U	UJ	1.2	1.2	0.062	U	U
Arsenic	mg/kg	20.4	0.56	0.056			4	0.46	0.046			3	0.44	0.044		J	7.9	0.62	0.062		
Barium	mg/kg	41.6	11	0.23			36.2	9.1	0.18			59.1	35	0.71			35.8	12	0.25		
Beryllium	mg/kg	0.26	0.28	0.0056	B	J	0.25	0.23	0.0046			0.34	0.88	0.018	B	J	0.35	0.31	0.0062		
Cadmium	mg/kg	0.22	0.23	0.0056	B	J	0.12	0.18	0.0046	B	J	0.14	0.18	0.0044	B	J	0.25	0.25	0.0062	U	U
Calcium	mg/kg	49700	1100	11			49900	910	9.1			80700	880	8.8		J	29900	310	3.1		
Chromium	mg/kg	7.4	0.56	0.056			7.4	0.46	0.046			11.5	1.8	0.18		J	10.5	0.62	0.062		
Cobalt	mg/kg	8.1	2.8	0.056			3	2.3	0.046			4	2.2	0.044		J	6.2	3.1	0.062		
Copper	mg/kg	15.3	1.4	0.056			12.4	1.1	0.046			12.2	4.4	0.18		J	16	1.5	0.062		
Iron	mg/kg	13400	17	1.3			7670	14	1			12400	53	4.1		J	13800	18	1.4		
Lead	mg/kg	8.4	1.1	0.056			9.3	0.91	0.046			8.5	3.5	0.18		J	11.2	1.2	0.062		
Magnesium	mg/kg	14900	1100	11			17400	910	9.1			15200	880	8.8		J	12700	310	3.1		
Manganese	mg/kg	587	3.4	0.23			256	2.7	0.18			329	2.7	0.18		J	206	0.92	0.062		
Mercury	mg/kg	0.013	0.1	0.0072	B	J	0.016	0.096	0.0068	B	J	0.035	0.094	0.0067	B	J	0.018	0.099	0.007	B	J
Nickel	mg/kg	15.1	2.3	0.056			9.9	1.8	0.046			10.9	1.8	0.044		J	16.4	2.5	0.062		
Potassium	mg/kg	614	560	2.8			730	460	2.3			930	1800	8.8	B	J	1080	620	3.1		
Selenium	mg/kg	0.33	1.1	0.11	B	J	0.22	0.91	0.091	B	J	3.5	3.5	0.35	U	U	0.39	1.2	0.12	B	J
Silver	mg/kg	0.56	0.56	0.056	U	U	0.46	0.46	0.046	U	U	0.44	0.44	0.044	U	UJ	0.62	0.62	0.062	U	U
Sodium	mg/kg	81.3	560	48	B	J	85.3	460	39	B	J	1800	1800	150	U	U	96.4	620	52	B	J
Thallium	mg/kg	0.33	0.56	0.084	B	J	0.46	0.46	0.068	U	U	1.8	1.8	0.27	U	U	0.62	0.62	0.092	U	U
Vanadium	mg/kg	13.6	2.8	0.056			13	2.3	0.046			10.5	2.2	0.044		J	15.6	3.1	0.062		
Zinc	mg/kg	34.7	1.1	0.056			25.6	0.91	0.046			35.3	3.5	0.18		J	38.1	1.2	0.062		
Pesticides/PCBs																					
Aroclor 1016	mg/kg	0.021	0.021	0.0083	U	U	0.02	0.02	0.0079	U	U	0.02	0.02	0.008	U	U					
Aroclor 1221	mg/kg	0.021	0.021	0.01	U	U	0.02	0.02	0.0099	U	U	0.02	0.02	0.01	U	U					
Aroclor 1232	mg/kg	0.021	0.021	0.01	U	U	0.02	0.02	0.0099	U	U	0.02	0.02	0.01	U	U					
Aroclor 1242	mg/kg	0.021	0.021	0.0083	U	U	0.02	0.02	0.0079	U	U	0.02	0.02	0.008	U	U					
Aroclor 1248	mg/kg	0.021	0.021	0.0083	U	U	0.02	0.02	0.0079	U	U	0.02	0.02	0.008	U	U					
Aroclor 1254	mg/kg	0.021	0.021	0.0083	U	U	0.02	0.02	0.0079	U	U	0.02	0.02	0.008	U	U					
Aroclor 1260	mg/kg	0.021	0.021	0.0083	U	U	0.02	0.02	0.0079	U	U	0.02	0.02	0.008	U	U					
Aroclor 1268	mg/kg	0.021	0.021	0.0083	U	U	0.02	0.02	0.0079	U	U	0.02	0.02	0.008	U	U					

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB07					ULA-SB07					ULA-SB08					ULA-SB08				
SAMPLE NO		ULA0023					ULA0037					ULA0024					ULA0038				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.21	0.21	0.03	U	U	0.2	0.2	0.029	U	U	0.2	0.2	0.029	U	U	0.21	0.21	0.03	U	U
Acenaphthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acenaphthylene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acetophenone	mg/kg																				
Anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Atrazine	mg/kg																				
Benzaldehyde	mg/kg																				
Benzo(a)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(a)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(b)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(ghi)perylene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(k)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzoic acid	mg/kg	1	1	0.36	U	U	1	1	0.36	U	U	1	1	0.35	U	U	1.1	1.1	0.37	U	U
Benzyl alcohol	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Bibenzene	mg/kg																				
Bis(2-chloroethoxy)methane	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroethyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	UJ	0.21	0.21	0.021	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.41	0.41	0.083	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	UJ	0.42	0.42	0.084	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Butyl benzyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	UJ	0.21	0.21	0.042	U	U
Caprolactam	mg/kg																				
Carbazole	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloroaniline, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Chlorophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chrysene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenz(a,h)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenzofuran	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dichlorobenzene, 1,2-	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,3-	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,4-	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.41	0.41	0.041	U	U	0.4	0.4	0.04	U	U	0.4	0.4	0.04	U	U	0.42	0.42	0.042	U	U
Dichlorophenol, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Diethyl phthalate	mg/kg	0.41	0.41	0.083	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.084	U	U
Dimethyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dimethylphenol, 2,4-	mg/kg	0.21	0.21	0.026	U	U	0.2	0.2	0.025	U	U	0.2	0.2	0.025	U	U	0.21	0.21	0.026	U	U
Di-n-butyl phthalate	mg/kg	0.41	0.41	0.083	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.084	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.41	0.41	0.083	U	U	0.4	0.4	0.081	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.084	U	U
Dinitrophenol, 2,4-	mg/kg	1	1	0.41	U	U	1	1	0.4	U	U	1	1	0.4	U	U	1.1	1.1	0.42	U	U
Dinitrotoluene, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dinitrotoluene, 2,6-	mg/kg	0.21	0.21	0.024	U	U	0.2	0.2	0.024	U	U	0.2	0.2	0.024	U	U	0.21	0.21	0.025	U	U
Di-n-octyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	UJ	0.21	0.21	0.042	U	U
Fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Fluorene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobenzene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobutadiene	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Hexachlorocyclopentadiene	mg/kg	0.21	0.21	0.091	U	U	0.2	0.2	0.089	U	U	0.2	0.2	0.088	U	U	0.21	0.21	0.092	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB07					ULA-SB07					ULA-SB08					ULA-SB08				
SAMPLE NO		ULA0023					ULA0037					ULA0024					ULA0038				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachloroethane	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Isophorone	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylnaphthalene, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylphenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Naphthalene	mg/kg	0.21	0.21	0.033	U	U	0.2	0.2	0.032	U	U	0.2	0.2	0.032	U	U	0.21	0.21	0.034	U	U
Nitroaniline, 2-	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 3-	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 4-	mg/kg	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitrobenzene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 4-	mg/kg	1	1	0.17	U	U	1	1	0.16	U	U	1	1	0.16	U	U	1.1	1.1	0.17	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
n-Nitrosodiphenylamine	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pentachlorophenol	mg/kg	1	1	0.25	U	U	1	1	0.24	U	U	1	1	0.24	U	U	1.1	1.1	0.25	U	U
Phenanthrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Phenol	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pyrene	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Volatile Organics																					
Acetone	mg/kg	0.04	0.04	0.016	U	U	0.0211	0.034	0.014	J	J	0.057	0.057	0.023	U	UJ	0.06	0.06	0.024	U	UJ
Benzene	mg/kg	0.0029	0.004	0.0012	J	J	0.0034	0.0034	0.001	U	U	0.0057	0.0057	0.0017	U	UJ	0.006	0.006	0.0018	U	UJ
Bromodichloromethane	mg/kg	0.004	0.004	0.00087	U	U	0.0034	0.0034	0.00075	U	U	0.0057	0.0057	0.0013	U	UJ	0.006	0.006	0.0013	U	UJ
Bromoform	mg/kg	0.004	0.004	0.0012	U	U	0.0034	0.0034	0.001	U	U	0.0057	0.0057	0.0017	U	UJ	0.006	0.006	0.0018	U	UJ
Bromomethane	mg/kg	0.004	0.004	0.0016	U	U	0.0034	0.0034	0.0014	U	U	0.0057	0.0057	0.0023	U	UJ	0.006	0.006	0.0024	U	UJ
Butanone, 2-	mg/kg	0.02	0.02	0.0048	U	U	0.0053	0.017	0.0041	J	J	0.029	0.029	0.007	U	UJ	0.03	0.03	0.0073	U	UJ
Carbon disulfide	mg/kg	0.004	0.004	0.0016	U	U	0.0034	0.0034	0.0014	U	U	0.0057	0.0057	0.0023	U	UJ	0.006	0.006	0.0024	U	UJ
Carbon tetrachloride	mg/kg	0.004	0.004	0.0014	U	U	0.0034	0.0034	0.0012	U	U	0.0057	0.0057	0.0021	U	UJ	0.006	0.006	0.0022	U	UJ
Chlorobenzene	mg/kg	0.004	0.004	0.00079	U	U	0.0034	0.0034	0.00068	U	U	0.0057	0.0057	0.0011	U	UJ	0.006	0.006	0.0012	U	UJ
Chloroethane	mg/kg	0.004	0.004	0.0016	U	UJ	0.0034	0.0034	0.0014	U	U	0.0057	0.0057	0.0023	U	UJ	0.006	0.006	0.0024	U	UJ
Chloroform	mg/kg	0.004	0.004	0.00095	U	U	0.0034	0.0034	0.00082	U	U	0.0057	0.0057	0.0014	U	UJ	0.006	0.006	0.0014	U	UJ
Chloromethane	mg/kg	0.004	0.004	0.0016	U	U	0.0034	0.0034	0.0014	U	U	0.0057	0.0057	0.0023	U	UJ	0.006	0.006	0.0024	U	UJ
Cyclohexane	mg/kg																				
Dibromo-3-chloropropane, 1,2-	mg/kg																				
Dibromochloromethane	mg/kg	0.004	0.004	0.00079	U	U	0.0034	0.0034	0.00068	U	U	0.0057	0.0057	0.0011	U	UJ	0.006	0.006	0.0012	U	UJ
Dibromoethane, 1,2-	mg/kg																				
Dichlorobenzene, 1,2-	mg/kg																				
Dichlorobenzene, 1,3-	mg/kg																				
Dichlorobenzene, 1,4-	mg/kg																				
Dichlorodifluoromethane	mg/kg																				
Dichloroethane, 1,1-	mg/kg	0.004	0.004	0.00087	U	U	0.0034	0.0034	0.00075	U	U	0.0057	0.0057	0.0013	U	UJ	0.006	0.006	0.0013	U	UJ
Dichloroethane, 1,2-	mg/kg	0.004	0.004	0.00079	U	U	0.0034	0.0034	0.00068	U	U	0.0057	0.0057	0.0011	U	UJ	0.006	0.006	0.0012	U	UJ
Dichloroethene, 1,1-	mg/kg	0.004	0.004	0.0011	U	U	0.0034	0.0034	0.00095	U	U	0.0057	0.0057	0.0016	U	UJ	0.006	0.006	0.0017	U	UJ
Dichloroethene, cis-1,2-	mg/kg	0.004	0.004	0.0012	U	U	0.0034	0.0034	0.001	U	U	0.0057	0.0057	0.0017	U	UJ	0.006	0.006	0.0018	U	UJ
Dichloroethene, trans-1,2-	mg/kg	0.004	0.004	0.0012	U	U	0.0034	0.0034	0.001	U	U	0.0057	0.0057	0.0017	U	UJ	0.006	0.006	0.0018	U	UJ
Dichloropropane, 1,2-	mg/kg	0.004	0.004	0.00095	U	U	0.0034	0.0034	0.00082	U	U	0.0057	0.0057	0.0014	U	UJ	0.006	0.006	0.0014	U	UJ
Dichloropropene, cis-1,3-	mg/kg	0.004	0.004	0.00079	U	U	0.0034	0.0034	0.00068	U	U	0.0057	0.0057	0.0011	U	UJ	0.006	0.006	0.0012	U	UJ
Dichloropropene, trans-1,3-	mg/kg	0.004	0.004	0.00087	U	U	0.0034	0.0034	0.00075	U	U	0.0057	0.0057	0.0013	U	UJ	0.006	0.006	0.0013	U	UJ
Ethylbenzene	mg/kg	0.0013	0.004	0.00079	J	J	0.0034	0.0034	0.00068	U	U	0.0057	0.0057	0.0011	U	UJ	0.006	0.006	0.0012	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB07					ULA-SB07					ULA-SB08					ULA-SB08				
SAMPLE NO		ULA0023					ULA0037					ULA0024					ULA0038				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexanone, 2-	mg/kg	0.02	0.02	0.0043	U	U	0.017	0.017	0.0037	U	U	0.029	0.029	0.0062	U	UJ	0.03	0.03	0.0065	U	UJ
Isopropylbenzene	mg/kg																				
METHYL ACETATE	mg/kg																				
Methyl Tertiary Butyl Ether	mg/kg																				
Methyl-2-pentanone, 4-	mg/kg	0.02	0.02	0.0044	U	U	0.017	0.017	0.0037	U	U	0.029	0.029	0.0063	U	UJ	0.03	0.03	0.0066	U	UJ
Methylcyclohexane	mg/kg																				
Methylene chloride	mg/kg	0.0056	0.0079	0.0036	J	J	0.0041	0.0068	0.0031	J	J	0.0113	0.011	0.0053		J	0.0151	0.012	0.0055		J
Styrene	mg/kg	0.004	0.004	0.0021	U	U	0.0034	0.0034	0.0018	U	U	0.0057	0.0057	0.003	U	UJ	0.006	0.006	0.0031	U	UJ
Tetrachloroethane, 1,1,2,2-	mg/kg	0.004	0.004	0.00095	U	UJ	0.0034	0.0034	0.00082	U	U	0.0057	0.0057	0.0014	U	UJ	0.006	0.006	0.0014	U	UJ
Tetrachloroethene	mg/kg	0.004	0.004	0.00079	U	U	0.0034	0.0034	0.00068	U	U	0.0057	0.0057	0.0011	U	UJ	0.006	0.006	0.0012	U	UJ
Toluene	mg/kg	0.0068	0.004	0.00095			0.0034	0.0034	0.00082	U	U	0.0057	0.0057	0.0014	U	UJ	0.006	0.006	0.0014	U	UJ
Trichlorobenzene, 1,2,4-	mg/kg																				
Trichloroethane, 1,1,1-	mg/kg	0.004	0.004	0.00087	U	U	0.0034	0.0034	0.00075	U	U	0.0057	0.0057	0.0013	U	UJ	0.006	0.006	0.0013	U	UJ
Trichloroethane, 1,1,2-	mg/kg	0.004	0.004	0.00087	U	U	0.0034	0.0034	0.00075	U	U	0.0057	0.0057	0.0013	U	UJ	0.006	0.006	0.0013	U	UJ
Trichloroethene	mg/kg	0.004	0.004	0.00095	U	U	0.0034	0.0034	0.00082	U	U	0.0057	0.0057	0.0014	U	UJ	0.006	0.006	0.0014	U	UJ
Trichlorofluoromethane	mg/kg																				
Trichlorotrifluoroethane	mg/kg																				
Vinyl chloride	mg/kg	0.004	0.004	0.0012	U	U	0.0034	0.0034	0.001	U	U	0.0057	0.0057	0.0017	U	UJ	0.006	0.006	0.0018	U	UJ
Xylenes, total	mg/kg	0.0037	0.012	0.0025	J	J	0.01	0.01	0.0022	U	U	0.017	0.017	0.0037	U	UJ	0.018	0.018	0.0038	U	UJ

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB09					ULA-SB09					ULA-SB10					ULA-SB10				
SAMPLE NO		ULA0025					ULA0039					ULA0026					ULA0040				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**		**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Dinitrobenzene, 1,3-	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Dinitrotoluene, 2,4-	mg/kg	0.18	0.18	0.086	U	U	0.18	0.18	0.086	U	U	0.18	0.18	0.085	U	U	0.16	0.16	0.076	U	U
Dinitrotoluene, 2,6-	mg/kg	0.18	0.18	0.077	U	U	0.18	0.18	0.077	U	U	0.18	0.18	0.076	U	U	0.16	0.16	0.069	U	U
HMX	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Nitrobenzene	mg/kg	0.18	0.18	0.082	U	U	0.18	0.18	0.082	U	U	0.18	0.18	0.082	U	U	0.16	0.16	0.073	U	U
Nitrotoluene, 2-	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Nitrotoluene, 3-	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Nitrotoluene, 4-	mg/kg	0.18	0.18	0.089	U	U	0.18	0.18	0.089	U	U	0.18	0.18	0.089	U	U	0.16	0.16	0.08	U	U
RDX	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Tetryl	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.18	0.18	0.071	U	U	0.18	0.18	0.071	U	U	0.18	0.18	0.07	U	U	0.16	0.16	0.063	U	U
General Chemistry																					
% Solids	Percent	81	0				81	0				82.8	0				79.2	0			
Metals																					
Aluminum	mg/kg	4020	12	1.4			5760	11	1.4			10100	47	5.7			10000	45	5.5		
Antimony	mg/kg	0.21	1.2	0.058	B	J	0.19	1.1	0.057	B	J	4.7	4.7	0.24	U	U	4.5	4.5	0.23	U	U
Arsenic	mg/kg	14.7	0.58	0.058			9.2	0.57	0.057			8.1	2.4	0.24			13.8	2.3	0.23		
Barium	mg/kg	29.4	12	0.23			44.3	11	0.23			71.2	47	0.95			94.3	45	0.91		
Beryllium	mg/kg	0.26	0.29	0.0058	B	J	0.33	0.28	0.0057			0.5	1.2	0.024	B	J	0.56	1.1	0.023	B	J
Cadmium	mg/kg	0.27	0.23	0.0058			0.21	0.23	0.0057	B	J	0.95	0.95	0.024	U	U	0.41	0.91	0.023	B	J
Calcium	mg/kg	53400	1200	12			49800	1100	11			3070	1200	12			3160	1100	11		
Chromium	mg/kg	6.6	0.58	0.058			9.9	0.57	0.057			16.4	2.4	0.24			17.4	2.3	0.23		
Cobalt	mg/kg	5.3	2.9	0.058			7.7	2.8	0.057			9	12	0.24	B	J	16	11	0.23		
Copper	mg/kg	14.4	1.5	0.058			16.9	1.4	0.057			16.9	5.9	0.24			26.9	5.7	0.23		
Iron	mg/kg	11400	17	1.3			12000	17	1.3			22800	71	5.4			28600	68	5.2		
Lead	mg/kg	9	1.2	0.058			10.9	1.1	0.057			9.2	1.2	0.059			15.9	0.91	0.045		
Magnesium	mg/kg	15600	1200	12			17300	1100	11			3200	1200	12			3470	1100	11		
Manganese	mg/kg	692	3.5	0.23			523	3.4	0.23			478	3.6	0.24			870	3.4	0.23		
Mercury	mg/kg	0.098	0.098	0.007	U	U	0.01	0.1	0.0073	B	J	0.02	0.094	0.0067	B	J	0.03	0.11	0.0075	B	J
Nickel	mg/kg	16.3	2.3	0.058			18.5	2.3	0.057			25.3	9.5	0.24			34.5	9.1	0.23		
Potassium	mg/kg	604	580	2.9			1120	570	2.8			1140	2400	12	B	J	1080	2300	11	B	J
Selenium	mg/kg	1.2	1.2	0.12	U	U	0.42	1.1	0.11	B	J	4.7	4.7	0.47	U	U	4.5	4.5	0.45	U	U
Silver	mg/kg	0.58	0.58	0.058	U	U	0.57	0.57	0.057	U	U	2.4	2.4	0.24	U	U	2.3	2.3	0.23	U	U
Sodium	mg/kg	80.7	580	49	B	J	125	570	48	B	J	2400	2400	200	U	U	2300	2300	190	U	U
Thallium	mg/kg	0.43	0.58	0.087	B	J	0.32	0.57	0.085	B	J	0.59	0.59	0.089	U	U	0.45	0.45	0.068	U	U
Vanadium	mg/kg	12.2	2.9	0.058			14.7	2.8	0.057			24.3	12	0.24			27	11	0.23		
Zinc	mg/kg	31.7	1.2	0.058			39.1	1.1	0.057			47.1	4.7	0.24			63.3	4.5	0.23		
Pesticides/PCBs																					
Aroclor 1016	mg/kg	0.02	0.02	0.0081	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.0079	U	U					
Aroclor 1221	mg/kg	0.02	0.02	0.01	U	U	0.02	0.02	0.01	U	U	0.02	0.02	0.0099	U	U					
Aroclor 1232	mg/kg	0.02	0.02	0.01	U	U	0.02	0.02	0.01	U	U	0.02	0.02	0.0099	U	U					
Aroclor 1242	mg/kg	0.02	0.02	0.0081	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.0079	U	U					
Aroclor 1248	mg/kg	0.02	0.02	0.0081	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.0079	U	U					
Aroclor 1254	mg/kg	0.02	0.02	0.0081	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.0079	U	U					
Aroclor 1260	mg/kg	0.02	0.02	0.0081	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.0079	U	U					
Aroclor 1268	mg/kg	0.02	0.02	0.0081	U	U	0.02	0.02	0.0081	U	U	0.02	0.02	0.0079	U	U					

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB09					ULA-SB09					ULA-SB10					ULA-SB10				
SAMPLE NO		ULA0025					ULA0039					ULA0026					ULA0040				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**		**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.21	0.21	0.03	U	U	0.21	0.21	0.03	U	U	0.2	0.2	0.029	U	U	0.21	0.21	0.03	U	U
Acenaphthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acenaphthylene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acetophenone	mg/kg																				
Anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Atrazine	mg/kg																				
Benzaldehyde	mg/kg																				
Benzo(a)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(a)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(b)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(ghi)perylene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(k)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzoic acid	mg/kg	1	1	0.36	U	U	1	1	0.36	U	U	1	1	0.35	U	U	1	1	0.37	U	U
Benzyl alcohol	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Bibenzene	mg/kg																				
Bis(2-chloroethoxy)methane	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroethyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	UJ	0.21	0.21	0.021	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.41	0.41	0.082	U	U	0.41	0.41	0.083	U	U	0.4	0.4	0.08	U	UJ	0.42	0.42	0.083	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Butyl benzyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	UJ	0.21	0.21	0.042	U	U
Caprolactam	mg/kg																				
Carbazole	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloroaniline, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Chlorophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chrysene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenz(a,h)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenzofuran	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dichlorobenzene, 1,2-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,3-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,4-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.41	0.41	0.041	U	U	0.41	0.41	0.041	U	U	0.4	0.4	0.04	U	U	0.42	0.42	0.042	U	U
Dichlorophenol, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Diethyl phthalate	mg/kg	0.41	0.41	0.082	U	U	0.41	0.41	0.083	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.083	U	U
Dimethyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Dimethylphenol, 2,4-	mg/kg	0.21	0.21	0.026	U	U	0.21	0.21	0.026	U	U	0.2	0.2	0.025	U	U	0.21	0.21	0.026	U	U
Di-n-butyl phthalate	mg/kg	0.41	0.41	0.082	U	U	0.41	0.41	0.083	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.083	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.41	0.41	0.082	U	U	0.41	0.41	0.083	U	U	0.4	0.4	0.08	U	U	0.42	0.42	0.083	U	U
Dinitrophenol, 2,4-	mg/kg	1	1	0.41	U	U	1	1	0.41	U	U	1	1	0.4	U	U	1	1	0.42	U	U
Dinitrotoluene, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dinitrotoluene, 2,6-	mg/kg	0.21	0.21	0.024	U	U	0.21	0.21	0.024	U	U	0.2	0.2	0.024	U	U	0.21	0.21	0.025	U	U
Di-n-octyl phthalate	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	UJ	0.21	0.21	0.042	U	U
Fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Fluorene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobenzene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobutadiene	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Hexachlorocyclopentadiene	mg/kg	0.21	0.21	0.091	U	U	0.21	0.21	0.091	U	U	0.2	0.2	0.088	U	U	0.21	0.21	0.092	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB09					ULA-SB09					ULA-SB10					ULA-SB10				
SAMPLE NO		ULA0025					ULA0039					ULA0026					ULA0040				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**		**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachloroethane	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Isophorone	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylnaphthalene, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylphenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Naphthalene	mg/kg	0.21	0.21	0.033	U	U	0.21	0.21	0.033	U	U	0.2	0.2	0.032	U	U	0.21	0.21	0.033	U	U
Nitroaniline, 2-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 3-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 4-	mg/kg	0.21	0.21	0.041	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.042	U	U
Nitrobenzene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 4-	mg/kg	1	1	0.16	U	U	1	1	0.17	U	U	1	1	0.16	U	U	1	1	0.17	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
n-Nitrosodiphenylamine	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pentachlorophenol	mg/kg	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.24	U	U	1	1	0.25	U	U
Phenanthrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Phenol	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Volatile Organics																					
Acetone	mg/kg	0.012	0.031	0.012	J	J	2.5	2.5	0.99	U	U	0.035	0.035	0.014	U	U	0.042	0.042	0.017	U	UJ
Benzene	mg/kg	0.0031	0.0031	0.00093	U	UJ	0.25	0.25	0.074	U	U	0.0035	0.0035	0.001	U	U	0.0018	0.0042	0.0013	J	J
Bromodichloromethane	mg/kg	0.0031	0.0031	0.00068	U	UJ	0.25	0.25	0.054	U	U	0.0035	0.0035	0.00076	U	U	0.0042	0.0042	0.00093	U	U
Bromoform	mg/kg	0.0031	0.0031	0.00093	U	UJ	0.25	0.25	0.074	U	U	0.0035	0.0035	0.001	U	U	0.0042	0.0042	0.0013	U	U
Bromomethane	mg/kg	0.0031	0.0031	0.0012	U	UJ	0.25	0.25	0.099	U	U	0.0035	0.0035	0.0014	U	U	0.0042	0.0042	0.0017	U	U
Butanone, 2-	mg/kg	0.015	0.015	0.0038	U	UJ	1.2	1.2	0.3	U	U	0.017	0.017	0.0042	U	U	0.021	0.021	0.0052	U	U
Carbon disulfide	mg/kg	0.0031	0.0031	0.0012	U	UJ	0.25	0.25	0.099	U	U	0.0035	0.0035	0.0014	U	U	0.0042	0.0042	0.0017	U	U
Carbon tetrachloride	mg/kg	0.0031	0.0031	0.0011	U	UJ	0.25	0.25	0.089	U	U	0.0035	0.0035	0.0012	U	U	0.0042	0.0042	0.0015	U	U
Chlorobenzene	mg/kg	0.0031	0.0031	0.00062	U	UJ	0.25	0.25	0.049	U	U	0.0035	0.0035	0.00069	U	U	0.0042	0.0042	0.00085	U	U
Chloroethane	mg/kg	0.0031	0.0031	0.0012	U	UJ	0.25	0.25	0.099	U	U	0.0035	0.0035	0.0014	U	U	0.0042	0.0042	0.0017	U	U
Chloroform	mg/kg	0.0031	0.0031	0.00074	U	UJ	0.25	0.25	0.059	U	U	0.0035	0.0035	0.00083	U	U	0.0042	0.0042	0.001	U	U
Chloromethane	mg/kg	0.0031	0.0031	0.0012	U	UJ	0.25	0.25	0.099	U	U	0.0035	0.0035	0.0014	U	U	0.0042	0.0042	0.0017	U	U
Cyclohexane	mg/kg																				
Dibromo-3-chloropropane, 1,2-	mg/kg																				
Dibromochloromethane	mg/kg	0.0031	0.0031	0.00062	U	UJ	0.25	0.25	0.049	U	U	0.0035	0.0035	0.00069	U	U	0.0042	0.0042	0.00085	U	U
Dibromoethane, 1,2-	mg/kg																				
Dichlorobenzene, 1,2-	mg/kg																				
Dichlorobenzene, 1,3-	mg/kg																				
Dichlorobenzene, 1,4-	mg/kg																				
Dichlorodifluoromethane	mg/kg																				
Dichloroethane, 1,1-	mg/kg	0.0031	0.0031	0.00068	U	UJ	0.25	0.25	0.054	U	U	0.0035	0.0035	0.00076	U	U	0.0042	0.0042	0.00093	U	U
Dichloroethane, 1,2-	mg/kg	0.0031	0.0031	0.00062	U	UJ	0.25	0.25	0.049	U	U	0.0035	0.0035	0.00069	U	U	0.0042	0.0042	0.00085	U	U
Dichloroethene, 1,1-	mg/kg	0.0031	0.0031	0.00086	U	UJ	0.25	0.25	0.069	U	U	0.0035	0.0035	0.00097	U	U	0.0042	0.0042	0.0012	U	U
Dichloroethene, cis-1,2-	mg/kg	0.0031	0.0031	0.00093	U	UJ	0.25	0.25	0.074	U	U	0.0035	0.0035	0.001	U	U	0.0042	0.0042	0.0013	U	U
Dichloroethene, trans-1,2-	mg/kg	0.0031	0.0031	0.00093	U	UJ	0.25	0.25	0.074	U	U	0.0035	0.0035	0.001	U	U	0.0042	0.0042	0.0013	U	U
Dichloropropane, 1,2-	mg/kg	0.0031	0.0031	0.00074	U	UJ	0.25	0.25	0.059	U	U	0.0035	0.0035	0.00083	U	U	0.0042	0.0042	0.001	U	U
Dichloropropene, cis-1,3-	mg/kg	0.0031	0.0031	0.00062	U	UJ	0.25	0.25	0.049	U	U	0.0035	0.0035	0.00069	U	U	0.0042	0.0042	0.00085	U	U
Dichloropropene, trans-1,3-	mg/kg	0.0031	0.0031	0.00068	U	UJ	0.25	0.25	0.054	U	U	0.0035	0.0035	0.00076	U	U	0.0042	0.0042	0.00093	U	U
Ethylbenzene	mg/kg	0.0031	0.0031	0.00062	U	UJ	0.25	0.25	0.049	U	U	0.0035	0.0035	0.00069	U	U	0.0042	0.0042	0.00085	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB09					ULA-SB09					ULA-SB10					ULA-SB10				
SAMPLE NO		ULA0025					ULA0039					ULA0026					ULA0040				
SAMPLE DATE		18-May-11					18-May-11					19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**		**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexanone, 2-	mg/kg	0.015	0.015	0.0033	U	UJ	1.2	1.2	0.27	U	U	0.017	0.017	0.0037	U	U	0.021	0.021	0.0046	U	UJ
Isopropylbenzene	mg/kg																				
METHYL ACETATE	mg/kg																				
Methyl Tertiary Butyl Ether	mg/kg																				
Methyl-2-pentanone, 4-	mg/kg	0.015	0.015	0.0034	U	UJ	1.2	1.2	0.27	U	U	0.017	0.017	0.0038	U	U	0.021	0.021	0.0046	U	U
Methylcyclohexane	mg/kg																				
Methylene chloride	mg/kg	0.0062	0.0062	0.0028	U	UJ	0.49	0.49	0.23	U	U	0.0075	0.0069	0.0032			0.0085	0.0085	0.0039	U	U
Styrene	mg/kg	0.0031	0.0031	0.0016	U	UJ	0.25	0.25	0.13	U	U	0.0035	0.0035	0.0018	U	U	0.0042	0.0042	0.0022	U	UJ
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0031	0.0031	0.00074	U	UJ	0.25	0.25	0.059	U	U	0.0035	0.0035	0.00083	U	U	0.0042	0.0042	0.001	U	UJ
Tetrachloroethene	mg/kg	0.0031	0.0031	0.00062	U	UJ	0.25	0.25	0.049	U	U	0.0035	0.0035	0.00069	U	U	0.0042	0.0042	0.00085	U	U
Toluene	mg/kg	0.0019	0.0031	0.00074	J	J	0.25	0.25	0.059	U	U	0.0035	0.0035	0.00083	U	U	0.0024	0.0042	0.001	J	J
Trichlorobenzene, 1,2,4-	mg/kg																				
Trichloroethane, 1,1,1-	mg/kg	0.0031	0.0031	0.00068	U	UJ	0.25	0.25	0.054	U	U	0.0035	0.0035	0.00076	U	U	0.0042	0.0042	0.00093	U	U
Trichloroethane, 1,1,2-	mg/kg	0.0031	0.0031	0.00068	U	UJ	0.25	0.25	0.054	U	U	0.0035	0.0035	0.00076	U	U	0.0042	0.0042	0.00093	U	U
Trichloroethene	mg/kg	0.0031	0.0031	0.00074	U	UJ	0.25	0.25	0.059	U	U	0.0035	0.0035	0.00083	U	U	0.0042	0.0042	0.001	U	U
Trichlorofluoromethane	mg/kg																				
Trichlorotrifluoroethane	mg/kg																				
Vinyl chloride	mg/kg	0.0031	0.0031	0.00093	U	UJ	0.25	0.25	0.074	U	U	0.0035	0.0035	0.001	U	U	0.0042	0.0042	0.0013	U	U
Xylenes, total	mg/kg	0.0093	0.0093	0.002	U	UJ	0.74	0.74	0.16	U	U	0.01	0.01	0.0022	U	U	0.013	0.013	0.0027	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB10					ULA-SB10					ULA-SB11					ULA-SB11				
SAMPLE NO		ULA0041					ULA0042					ULA0027					ULA0043				
SAMPLE DATE		19-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		8 - 10 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FD					FS					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																					
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.02	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.15	0.15	0.062	U	U	0.3	0.3	0.099	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Dinitrobenzene, 1,3-	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.05	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Dinitrotoluene, 2,4-	mg/kg	0.15	0.15	0.075	U	U	0.25	0.25	0.02	U	UJ	0.16	0.16	0.076	U	U	0.18	0.18	0.089	U	U
Dinitrotoluene, 2,6-	mg/kg	0.15	0.15	0.067	U	U	0.25	0.25	0.03	U	UJ	0.16	0.16	0.068	U	U	0.18	0.18	0.08	U	U
HMX	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.03	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Nitrobenzene	mg/kg	0.15	0.15	0.072	U	U	0.25	0.25	0.05	U	UJ	0.16	0.16	0.073	U	U	0.18	0.18	0.085	U	U
Nitrotoluene, 2-	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.079	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Nitrotoluene, 3-	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.069	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Nitrotoluene, 4-	mg/kg	0.15	0.15	0.078	U	U	0.5	0.5	0.079	U	UJ	0.16	0.16	0.079	U	U	0.18	0.18	0.093	U	U
RDX	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.04	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Tetryl	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.05	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.02	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.15	0.15	0.062	U	U	0.25	0.25	0.02	U	UJ	0.16	0.16	0.063	U	U	0.18	0.18	0.073	U	U
General Chemistry																					
% Solids	Percent	79.8	0									80.1	0				81.8	0			
Metals																					
Aluminum	mg/kg	11900	57	6.9			11000	25	12			9810	50	6			6350	11	1.3		
Antimony	mg/kg	5.7	5.7	0.29	U	U	1.3	1.3	0.5	U	U	5	5	0.25	U	U	4.5	4.5	0.22	U	U
Arsenic	mg/kg	10.6	2.9	0.29			16	1.3	0.38			5.7	2.5	0.25			5.9	0.56	0.056		
Barium	mg/kg	74.4	57	1.1			71	25	0.09			56.6	50	1			64.7	11	0.22		
Beryllium	mg/kg	0.62	1.4	0.029	B	J	0.7	0.64	0.055			0.56	1.3	0.025	B	J	0.35	0.28	0.0056		
Cadmium	mg/kg	1.1	1.1	0.029	U	U	0.25	0.25	0.046	U	U	0.39	1	0.025	B	J	0.19	0.22	0.0056	B	J
Calcium	mg/kg	3350	1400	14			3600	640	20			20400	1300	13			51500	1100	11		
Chromium	mg/kg	19.9	2.9	0.29			20	0.64	0.25			16.4	2.5	0.25			13.5	2.2	0.22		
Cobalt	mg/kg	13.5	14	0.29	B	J	15	6.4	0.2			12	13	0.25	B	J	6.8	2.8	0.056		
Copper	mg/kg	25.9	7.2	0.29			30	3.2	0.94			17.6	6.3	0.25			20.6	5.6	0.22		
Iron	mg/kg	26000	86	6.6			29000	13	6.2			20300	76	5.8			13400	17	1.3		
Lead	mg/kg	14.5	1.1	0.057			20	0.38	0.24			10.1	1	0.05			12	4.5	0.22		
Magnesium	mg/kg	4140	1400	14			4600	640	6.5			9100	1300	13			14400	280	2.8		
Manganese	mg/kg	530	4.3	0.29			370	1.9	0.094			547	3.8	0.25			436	3.4	0.22		
Mercury	mg/kg	0.026	0.092	0.0065	B	J	0.087	0.087	0.013	U	U	0.014	0.096	0.0068	B	J	0.015	0.097	0.0069	B	J
Nickel	mg/kg	32.4	11	0.29			29	5.1	0.34			28	10	0.25			18.6	2.2	0.056		
Potassium	mg/kg	1370	2900	14	B	J	1400	640	7.9			1010	2500	13	B	J	1240	560	2.8		
Selenium	mg/kg	5.7	5.7	0.57	U	U	0.64	0.64	0.57	U	U	5	5	0.5	U	U	4.5	4.5	0.45	U	U
Silver	mg/kg	2.9	2.9	0.29	U	U	0.64	0.64	0.13	U	U	2.5	2.5	0.25	U	U	0.56	0.56	0.056	U	U
Sodium	mg/kg	2900	2900	240	U	U	640	640	84	U	U	2500	2500	210	U	U	122	560	48	B	J
Thallium	mg/kg	0.57	0.57	0.086	U	U	1.3	1.3	0.7	U	U	0.5	0.5	0.076	U	U	2.2	2.2	0.34	U	U
Vanadium	mg/kg	27	14	0.29			31	6.4	0.15			19.2	13	0.25			15.1	2.8	0.056		
Zinc	mg/kg	66.5	5.7	0.29			73	2.5	1.3			76.2	5	0.25			48.1	4.5	0.22		
Pesticides/PCBs																					
Aroclor 1016	mg/kg											0.02	0.02	0.0082	U	U	0.02	0.02	0.0081	U	U
Aroclor 1221	mg/kg											0.02	0.02	0.01	U	U	0.02	0.02	0.01	U	U
Aroclor 1232	mg/kg											0.02	0.02	0.01	U	U	0.02	0.02	0.01	U	U
Aroclor 1242	mg/kg											0.02	0.02	0.0082	U	U	0.02	0.02	0.0081	U	U
Aroclor 1248	mg/kg											0.02	0.02	0.0082	U	U	0.02	0.02	0.0081	U	U
Aroclor 1254	mg/kg											0.02	0.02	0.0082	U	U	0.02	0.02	0.0081	U	U
Aroclor 1260	mg/kg											0.02	0.02	0.0082	U	U	0.02	0.02	0.0081	U	U
Aroclor 1268	mg/kg											0.02	0.02	0.0082	U	U	0.02	0.02	0.0081	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB10					ULA-SB10					ULA-SB11					ULA-SB11				
SAMPLE NO		ULA0041					ULA0042					ULA0027					ULA0043				
SAMPLE DATE		19-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		8 - 10 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FD					FS					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics																					
3-Methylphenol and 4-Methylphenol	mg/kg	0.21	0.21	0.03	U	U	0.53	0.53	0.026	U	U	0.21	0.21	0.03	U	U	0.2	0.2	0.029	U	U
Acenaphthene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Acenaphthylene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Acetophenone	mg/kg						0.13	0.13	0.012	U	U										
Anthracene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Atrazine	mg/kg						0.26	0.26	0.012	U	U										
Benzaldehyde	mg/kg						0.13	0.13	0.016	U	U										
Benzo(a)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Benzo(a)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Benzo(b)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Benzo(ghi)perylene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	UJ	0.2	0.2	0.02	U	U
Benzo(k)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Benzoic acid	mg/kg	1	1	0.37	U	U						1	1	0.36	U	U	1	1	0.36	U	U
Benzyl alcohol	mg/kg	0.21	0.21	0.042	U	U						0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Bibenzene	mg/kg						0.066	0.066	0.036	U	U										
Bis(2-chloroethoxy)methane	mg/kg	0.21	0.21	0.021	U	U	0.13	0.13	0.029	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Bis(2-chloroethyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.13	0.13	0.0026	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.13	0.13	0.013	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.42	0.42	0.084	U	U	0.066	0.066	0.025	U	U	0.41	0.41	0.082	U	U	0.4	0.4	0.081	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.017	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Butyl benzyl phthalate	mg/kg	0.21	0.21	0.042	U	U	0.066	0.066	0.013	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Caprolactam	mg/kg						0.43	0.43	0.049	U	U										
Carbazole	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.036	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.028	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Chloroaniline, 4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.022	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Chloronaphthalene, 2-	mg/kg	0.21	0.21	0.042	U	U	0.066	0.066	0.0043	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Chlorophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.036	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.017	U *	UJ	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Chrysene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0014	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Dibenz(a,h)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	UJ	0.2	0.2	0.02	U	U
Dibenzofuran	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Dichlorobenzene, 1,2-	mg/kg	0.21	0.21	0.042	U	U						0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Dichlorobenzene, 1,3-	mg/kg	0.21	0.21	0.042	U	U						0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Dichlorobenzene, 1,4-	mg/kg	0.21	0.21	0.042	U	U						0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.42	0.42	0.042	U	U	0.13	0.13	0.024	U	U	0.41	0.41	0.041	U	U	0.4	0.4	0.04	U	U
Dichlorophenol, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.026	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Diethyl phthalate	mg/kg	0.42	0.42	0.084	U	U	0.066	0.066	0.021	U	U	0.41	0.41	0.082	U	U	0.4	0.4	0.081	U	U
Dimethyl phthalate	mg/kg	0.21	0.21	0.042	U	U	0.066	0.066	0.022	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Dimethylphenol, 2,4-	mg/kg	0.21	0.21	0.026	U	U	0.2	0.2	0.026	U	U	0.21	0.21	0.026	U	U	0.2	0.2	0.025	U	U
Di-n-butyl phthalate	mg/kg	0.42	0.42	0.084	U	U	0.066	0.066	0.02	U	U	0.41	0.41	0.082	U	U	0.4	0.4	0.081	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.42	0.42	0.084	U	U	0.2	0.2	0.11	U	U	0.41	0.41	0.082	U	U	0.4	0.4	0.081	U	U
Dinitrophenol, 2,4-	mg/kg	1	1	0.42	U	U	0.43	0.43	0.11	U	U	1	1	0.41	U	U	1	1	0.4	U	U
Dinitrotoluene, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.26	0.26	0.036	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Dinitrotoluene, 2,6-	mg/kg	0.21	0.21	0.025	U	U	0.26	0.26	0.028	U	U	0.21	0.21	0.024	U	U	0.2	0.2	0.024	U	U
Di-n-octyl phthalate	mg/kg	0.21	0.21	0.042	U	U	0.066	0.066	0.036	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Fluorene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Hexachlorobenzene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0028	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Hexachlorobutadiene	mg/kg	0.21	0.21	0.042	U	U	0.066	0.066	0.036	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Hexachlorocyclopentadiene	mg/kg	0.21	0.21	0.092	U	U	0.43	0.43	0.036	U	U	0.21	0.21	0.091	U	U	0.2	0.2	0.089	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB10					ULA-SB10					ULA-SB11					ULA-SB11				
SAMPLE NO		ULA0041					ULA0042					ULA0027					ULA0043				
SAMPLE DATE		19-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		8 - 10 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FD					FS					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachloroethane	mg/kg	0.21	0.21	0.042	U	U	0.066	0.066	0.012	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	UJ	0.2	0.2	0.02	U	U
Isophorone	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.017	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Methylnaphthalene, 2-	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Methylphenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.26	0.26	0.11	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Naphthalene	mg/kg	0.21	0.21	0.033	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.033	U	U	0.2	0.2	0.032	U	U
Nitroaniline, 2-	mg/kg	0.21	0.21	0.042	U	U	0.26	0.26	0.012	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Nitroaniline, 3-	mg/kg	0.21	0.21	0.042	U	U	0.26	0.26	0.021	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Nitroaniline, 4-	mg/kg	0.21	0.21	0.042	U	U	0.26	0.26	0.034	U	U	0.21	0.21	0.041	U	U	0.2	0.2	0.04	U	U
Nitrobenzene	mg/kg	0.21	0.21	0.021	U	U	0.13	0.13	0.0029	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Nitrophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.036	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Nitrophenol, 4-	mg/kg	1	1	0.17	U	U	0.43	0.43	0.11	U	U	1	1	0.16	U	U	1	1	0.16	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.036	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
n-Nitrosodiphenylamine	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.028	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Pentachlorophenol	mg/kg	1	1	0.25	U	U	0.2	0.2	0.11	U	U	1	1	0.25	U	U	1	1	0.24	U	U
Phenanthrene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Phenol	mg/kg	0.21	0.21	0.021	U	U	0.066	0.066	0.036	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Pyrene	mg/kg	0.21	0.21	0.021	U	U	0.0088	0.0088	0.0043	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.21	0.21	0.021	U	U						0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.033	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.21	0.21	0.021	U	U	0.2	0.2	0.11	U	U	0.21	0.21	0.021	U	U	0.2	0.2	0.02	U	U
Volatile Organics																					
Acetone	mg/kg	0.0146	0.034	0.013	J	J	0.047	0.026	0.0021		U	0.035	0.035	0.014	U	U	0.0208	0.033	0.013	J	J
Benzene	mg/kg	0.0034	0.0034	0.001	U	U	0.0066	0.0066	0.00018	U	U	0.001	0.0035	0.001	J	J	0.0033	0.0033	0.00099	U	U
Bromodichloromethane	mg/kg	0.0034	0.0034	0.00074	U	U	0.0066	0.0066	0.0002	U	U	0.0035	0.0035	0.00077	U	U	0.0033	0.0033	0.00073	U	U
Bromoform	mg/kg	0.0034	0.0034	0.001	U	U	0.0066	0.0066	0.00055	U	U	0.0035	0.0035	0.001	U	U	0.0033	0.0033	0.00099	U	U
Bromomethane	mg/kg	0.0034	0.0034	0.0013	U	U	0.0066	0.0066	0.00042	U *	U	0.0035	0.0035	0.0014	U	U	0.0033	0.0033	0.0013	U	U
Butanone, 2-	mg/kg	0.017	0.017	0.0041	U	U	0.026	0.026	0.0011	U	U	0.017	0.017	0.0043	U	U	0.017	0.017	0.004	U	U
Carbon disulfide	mg/kg	0.0034	0.0034	0.0013	U	U	0.0066	0.0066	0.00047	U	U	0.0035	0.0035	0.0014	U	U	0.0033	0.0033	0.0013	U	U
Carbon tetrachloride	mg/kg	0.0034	0.0034	0.0012	U	U	0.0066	0.0066	0.00041	U	U	0.0035	0.0035	0.0013	U	U	0.0033	0.0033	0.0012	U	U
Chlorobenzene	mg/kg	0.0034	0.0034	0.00067	U	U	0.0066	0.0066	0.00043	U	U	0.0035	0.0035	0.0007	U	U	0.0033	0.0033	0.00066	U	U
Chloroethane	mg/kg	0.0034	0.0034	0.0013	U	U	0.0066	0.0066	0.00046	U	U	0.0035	0.0035	0.0014	U	U	0.0033	0.0033	0.0013	U	U
Chloroform	mg/kg	0.0034	0.0034	0.00081	U	U	0.0066	0.0066	0.00037	U	U	0.0035	0.0035	0.00084	U	U	0.0033	0.0033	0.00079	U	U
Chloromethane	mg/kg	0.0034	0.0034	0.0013	U	U	0.0066	0.0066	0.00029	U	UJ	0.0035	0.0035	0.0014	U	U	0.0033	0.0033	0.0013	U	U
Cyclohexane	mg/kg						0.013	0.013	0.00029	U	U										
Dibromo-3-chloropropane, 1,2-	mg/kg						0.013	0.013	0.0013	U	U										
Dibromochloromethane	mg/kg	0.0034	0.0034	0.00067	U	U	0.0066	0.0066	0.00041	U	U	0.0035	0.0035	0.0007	U	U	0.0033	0.0033	0.00066	U	U
Dibromoethane, 1,2-	mg/kg						0.0066	0.0066	0.00054	U	U										
Dichlorobenzene, 1,2-	mg/kg						0.0066	0.0066	0.00054	U	U										
Dichlorobenzene, 1,3-	mg/kg						0.0066	0.0066	0.00038	U	U										
Dichlorobenzene, 1,4-	mg/kg						0.0066	0.0066	0.00062	U	U										
Dichlorodifluoromethane	mg/kg						0.0066	0.0066	0.00046	U	UJ										
Dichloroethane, 1,1-	mg/kg	0.0034	0.0034	0.00074	U	U	0.0066	0.0066	0.00033	U	U	0.0035	0.0035	0.00077	U	U	0.0033	0.0033	0.00073	U	U
Dichloroethane, 1,2-	mg/kg	0.0034	0.0034	0.00067	U	U	0.0066	0.0066	0.00037	U	U	0.0035	0.0035	0.0007	U	U	0.0033	0.0033	0.00066	U	U
Dichloroethene, 1,1-	mg/kg	0.0034	0.0034	0.00094	U	U	0.0066	0.0066	0.00049	U	U	0.0035	0.0035	0.00098	U	U	0.0033	0.0033	0.00093	U	U
Dichloroethene, cis-1,2-	mg/kg	0.0034	0.0034	0.001	U	U	0.0066	0.0066	0.00029	U	U	0.0035	0.0035	0.001	U	U	0.0033	0.0033	0.00099	U	U
Dichloroethene, trans-1,2-	mg/kg	0.0034	0.0034	0.001	U	U	0.0066	0.0066	0.00046	U	U	0.0035	0.0035	0.001	U	U	0.0033	0.0033	0.00099	U	U
Dichloropropane, 1,2-	mg/kg	0.0034	0.0034	0.00081	U	U	0.0066	0.0066	0.00064	U	U	0.0035	0.0035	0.00084	U	U	0.0033	0.0033	0.00079	U	U
Dichloropropene, cis-1,3-	mg/kg	0.0034	0.0034	0.00067	U	U	0.0066	0.0066	0.00024	U	U	0.0035	0.0035	0.0007	U	U	0.0033	0.0033	0.00066	U	U
Dichloropropene, trans-1,3-	mg/kg	0.0034	0.0034	0.00074	U	U	0.0066	0.0066	0.00042	U	U	0.0035	0.0035	0.00077	U	U	0.0033	0.0033	0.00073	U	U
Ethylbenzene	mg/kg	0.0034	0.0034	0.00067	U	U	0.0066	0.0066	0.00055	U	U	0.0035	0.0035	0.0007	U	U	0.0033	0.0033	0.00066	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB10					ULA-SB10					ULA-SB11					ULA-SB11				
SAMPLE NO		ULA0041					ULA0042					ULA0027					ULA0043				
SAMPLE DATE		19-May-11					19-May-11					19-May-11					19-May-11				
DEPTH		8 - 10 Ft					8 - 10 Ft					3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		FD					FS					REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexanone, 2-	mg/kg	0.017	0.017	0.0036	U	U	0.026	0.026	0.00079	U	U	0.017	0.017	0.0038	U	U	0.017	0.017	0.0036	U	U
Isopropylbenzene	mg/kg						0.0066	0.0066	0.00049	U	U										
METHYL ACETATE	mg/kg						0.013	0.013	0.00084	U	U										
Methyl Tertiary Butyl Ether	mg/kg						0.026	0.026	0.00033	U	U										
Methyl-2-pentanone, 4-	mg/kg	0.017	0.017	0.0037	U	U	0.026	0.026	0.00089	U	U	0.017	0.017	0.0038	U	U	0.017	0.017	0.0036	U	U
Methylcyclohexane	mg/kg						0.013	0.013	0.00031	U	U										
Methylene chloride	mg/kg	0.0035	0.0067	0.0031	J	J	0.008	0.0066	0.0013			0.007	0.007	0.0032	U	U	0.0066	0.0066	0.003	U	U
Styrene	mg/kg	0.0034	0.0034	0.0017	U	U	0.0066	0.0066	0.00035	U	U	0.0035	0.0035	0.0018	U	U	0.0033	0.0033	0.0017	U	U
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0034	0.0034	0.00081	U	U	0.0066	0.0066	0.0003	U	U	0.0035	0.0035	0.00084	U	U	0.0033	0.0033	0.00079	U	U
Tetrachloroethene	mg/kg	0.0034	0.0034	0.00067	U	U	0.0066	0.0066	0.00054	U	U	0.0035	0.0035	0.0007	U	U	0.0033	0.0033	0.00066	U	U
Toluene	mg/kg	0.0034	0.0034	0.00081	U	U	0.0066	0.0066	0.00042	U	U	0.0018	0.0035	0.00084	J	J	0.0033	0.0033	0.00079	U	U
Trichlorobenzene, 1,2,4-	mg/kg						0.0066	0.0066	0.00076	U	U										
Trichloroethane, 1,1,1-	mg/kg	0.0034	0.0034	0.00074	U	U	0.0066	0.0066	0.00034	U	U	0.0035	0.0035	0.00077	U	U	0.0033	0.0033	0.00073	U	U
Trichloroethane, 1,1,2-	mg/kg	0.0034	0.0034	0.00074	U	U	0.0066	0.0066	0.00083	U	U	0.0035	0.0035	0.00077	U	U	0.0033	0.0033	0.00073	U	U
Trichloroethene	mg/kg	0.0034	0.0034	0.00081	U	U	0.0066	0.0066	0.00038	U	U	0.0035	0.0035	0.00084	U	U	0.0033	0.0033	0.00079	U	U
Trichlorofluoromethane	mg/kg						0.0066	0.0066	0.00033	U	U										
Trichlorotrifluoroethane	mg/kg						0.0066	0.0066	0.00058	U	U										
Vinyl chloride	mg/kg	0.0034	0.0034	0.001	U	U	0.0066	0.0066	0.00035	U	U	0.0035	0.0035	0.001	U	U	0.0033	0.0033	0.00099	U	U
Xylenes, total	mg/kg	0.01	0.01	0.0022	U	U	0.013	0.013	0.0011	U	U	0.01	0.01	0.0022	U	U	0.0099	0.0099	0.0021	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB12					ULA-SB12				
SAMPLE NO		ULA0028					ULA0044				
SAMPLE DATE		19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives											
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Dinitrobenzene, 1,3-	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Dinitrotoluene, 2,4-	mg/kg	0.15	0.15	0.075	U	U	0.18	0.18	0.087	U	U
Dinitrotoluene, 2,6-	mg/kg	0.15	0.15	0.067	U	U	0.18	0.18	0.078	U	U
HMX	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Nitrobenzene	mg/kg	0.15	0.15	0.072	U	U	0.18	0.18	0.084	U	U
Nitrotoluene, 2-	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Nitrotoluene, 3-	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Nitrotoluene, 4-	mg/kg	0.15	0.15	0.078	U	U	0.18	0.18	0.091	U	U
RDX	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Tetryl	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.15	0.15	0.062	U	U	0.18	0.18	0.072	U	U
General Chemistry											
% Solids	Percent	79.8	0				78.5	0			
Metals											
Aluminum	mg/kg	8680	45	5.4			5530	11	1.3		
Antimony	mg/kg	4.5	4.5	0.23	U	U	4.4	4.4	0.22	U	U
Arsenic	mg/kg	5.6	2.3	0.23			4.9	0.55	0.055		
Barium	mg/kg	35	45	0.9	B	J	49.2	11	0.22		
Beryllium	mg/kg	0.42	1.1	0.023	B	J	0.31	0.27	0.0055		
Cadmium	mg/kg	0.9	0.9	0.023	U	U	0.14	0.22	0.0055	B	J
Calcium	mg/kg	619	1100	11	B	J	49600	1100	11		
Chromium	mg/kg	14.4	2.3	0.23			11.8	2.2	0.22		
Cobalt	mg/kg	5.2	11	0.23	B	J	7	2.7	0.055		
Copper	mg/kg	58.4	5.6	0.23			18.9	5.5	0.22		
Iron	mg/kg	18500	68	5.2			11700	16	1.3		
Lead	mg/kg	69	1.1	0.056			10.5	4.4	0.22		
Magnesium	mg/kg	1240	1100	11			11100	270	2.7		
Manganese	mg/kg	130	3.4	0.23			584	3.3	0.22		
Mercury	mg/kg	0.028	0.092	0.0065	B	J	0.017	0.1	0.0073	B	J
Nickel	mg/kg	14.7	9	0.23			15.6	2.2	0.055		
Potassium	mg/kg	423	2300	11	B	J	999	550	2.7		
Selenium	mg/kg	4.5	4.5	0.45	U	U	4.4	4.4	0.44	U	U
Silver	mg/kg	2.3	2.3	0.23	U	U	0.55	0.55	0.055	U	U
Sodium	mg/kg	2300	2300	190	U	U	400	550	47	B	J
Thallium	mg/kg	2.8	2.8	0.85	U	U	2.2	2.2	0.33	U	U
Vanadium	mg/kg	25.1	11	0.23			12.5	2.7	0.055		
Zinc	mg/kg	48.6	4.5	0.23			49.1	4.4	0.22		
Pesticides/PCBs											
Aroclor 1016	mg/kg	0.021	0.021	0.0084	U	U	0.021	0.021	0.0085	U	U
Aroclor 1221	mg/kg	0.021	0.021	0.01	U	U	0.021	0.021	0.011	U	U
Aroclor 1232	mg/kg	0.021	0.021	0.01	U	U	0.021	0.021	0.011	U	U
Aroclor 1242	mg/kg	0.021	0.021	0.0084	U	U	0.021	0.021	0.0085	U	U
Aroclor 1248	mg/kg	0.021	0.021	0.0084	U	U	0.021	0.021	0.0085	U	U
Aroclor 1254	mg/kg	0.021	0.021	0.0084	U	U	0.021	0.021	0.0085	U	U
Aroclor 1260	mg/kg	0.021	0.021	0.0084	U	U	0.021	0.021	0.0085	U	U
Aroclor 1268	mg/kg	0.021	0.021	0.0084	U	U	0.021	0.021	0.0085	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB12					ULA-SB12				
SAMPLE NO		ULA0028					ULA0044				
SAMPLE DATE		19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Semivolatile Organics											
3-Methylphenol and 4-Methylphenol	mg/kg	0.21	0.21	0.03	U	U	0.21	0.21	0.03	U	U
Acenaphthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Acenaphthylene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Acetophenone	mg/kg										
Anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Atrazine	mg/kg										
Benzaldehyde	mg/kg										
Benzo(a)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzo(a)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzo(b)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzo(ghi)perylene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzo(k)fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Benzoic acid	mg/kg	1	1	0.37	U	U	1.1	1.1	0.37	U	U
Benzyl alcohol	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Bibenzene	mg/kg										
Bis(2-chloroethoxy)methane	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroethyl)ether	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroisopropyl)ether	mg/kg	0.21	0.21	0.021	U	UJ	0.21	0.21	0.021	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.42	0.42	0.084	U	UJ	0.42	0.42	0.084	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Butyl benzyl phthalate	mg/kg	0.21	0.21	0.042	U	UJ	0.21	0.21	0.042	U	U
Caprolactam	mg/kg										
Carbazole	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chloroaniline, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Chlorophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Chrysene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Dibenz(a,h)anthracene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Dibenzofuran	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Dichlorobenzene, 1,2-	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,3-	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Dichlorobenzene, 1,4-	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.42	0.42	0.042	U	U	0.42	0.42	0.042	U	U
Dichlorophenol, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Diethyl phthalate	mg/kg	0.42	0.42	0.084	U	U	0.42	0.42	0.084	U	U
Dimethyl phthalate	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Dimethylphenol, 2,4-	mg/kg	0.21	0.21	0.026	U	U	0.21	0.21	0.027	U	U
Di-n-butyl phthalate	mg/kg	0.42	0.42	0.084	U	U	0.42	0.42	0.084	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.42	0.42	0.084	U	U	0.42	0.42	0.084	U	U
Dinitrophenol, 2,4-	mg/kg	1	1	0.42	U	U	1.1	1.1	0.42	U	U
Dinitrotoluene, 2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Dinitrotoluene, 2,6-	mg/kg	0.21	0.21	0.025	U	U	0.21	0.21	0.025	U	U
Di-n-octyl phthalate	mg/kg	0.21	0.21	0.042	U	UJ	0.21	0.21	0.042	U	U
Fluoranthene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Fluorene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Hexachlorobenzene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Hexachlorobutadiene	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Hexachlorocyclopentadiene	mg/kg	0.21	0.21	0.092	U	U	0.21	0.21	0.093	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB12					ULA-SB12				
SAMPLE NO		ULA0028					ULA0044				
SAMPLE DATE		19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexachloroethane	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Isophorone	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Methylnaphthalene, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Methylphenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Naphthalene	mg/kg	0.21	0.21	0.033	U	U	0.21	0.21	0.034	U	U
Nitroaniline, 2-	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 3-	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Nitroaniline, 4-	mg/kg	0.21	0.21	0.042	U	U	0.21	0.21	0.042	U	U
Nitrobenzene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 2-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 4-	mg/kg	1	1	0.17	U	U	1.1	1.1	0.17	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
n-Nitrosodiphenylamine	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Pentachlorophenol	mg/kg	1	1	0.25	U	U	1.1	1.1	0.25	U	U
Phenanthrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Phenol	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Pyrene	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.21	0.21	0.021	U	U	0.21	0.21	0.021	U	U
Volatile Organics											
Acetone	mg/kg	0.0585	0.032	0.013	J	J	0.04	0.04	0.016	U	U
Benzene	mg/kg	0.0032	0.0032	0.00096	U	U	0.0015	0.004	0.0012	J	J
Bromodichloromethane	mg/kg	0.0032	0.0032	0.00071	U	U	0.004	0.004	0.00088	U	U
Bromoform	mg/kg	0.0032	0.0032	0.00096	U	U	0.004	0.004	0.0012	U	U
Bromomethane	mg/kg	0.0032	0.0032	0.0013	U	U	0.004	0.004	0.0016	U	U
Butanone, 2-	mg/kg	0.016	0.016	0.0039	U	U	0.02	0.02	0.0049	U	U
Carbon disulfide	mg/kg	0.0032	0.0032	0.0013	U	U	0.004	0.004	0.0016	U	U
Carbon tetrachloride	mg/kg	0.0032	0.0032	0.0012	U	U	0.004	0.004	0.0014	U	U
Chlorobenzene	mg/kg	0.0032	0.0032	0.00064	U	U	0.004	0.004	0.0008	U	U
Chloroethane	mg/kg	0.0032	0.0032	0.0013	U	U	0.004	0.004	0.0016	U	U
Chloroform	mg/kg	0.0032	0.0032	0.00077	U	U	0.004	0.004	0.00096	U	U
Chloromethane	mg/kg	0.0032	0.0032	0.0013	U	U	0.004	0.004	0.0016	U	U
Cyclohexane	mg/kg										
Dibromo-3-chloropropane, 1,2-	mg/kg										
Dibromochloromethane	mg/kg	0.0032	0.0032	0.00064	U	U	0.004	0.004	0.0008	U	U
Dibromoethane, 1,2-	mg/kg										
Dichlorobenzene, 1,2-	mg/kg										
Dichlorobenzene, 1,3-	mg/kg										
Dichlorobenzene, 1,4-	mg/kg										
Dichlorodifluoromethane	mg/kg										
Dichloroethane, 1,1-	mg/kg	0.0032	0.0032	0.00071	U	U	0.004	0.004	0.00088	U	U
Dichloroethane, 1,2-	mg/kg	0.0032	0.0032	0.00064	U	U	0.004	0.004	0.0008	U	U
Dichloroethene, 1,1-	mg/kg	0.0032	0.0032	0.0009	U	U	0.004	0.004	0.0011	U	U
Dichloroethene, cis-1,2-	mg/kg	0.0032	0.0032	0.00096	U	U	0.004	0.004	0.0012	U	U
Dichloroethene, trans-1,2-	mg/kg	0.0032	0.0032	0.00096	U	U	0.004	0.004	0.0012	U	U
Dichloropropane, 1,2-	mg/kg	0.0032	0.0032	0.00077	U	U	0.004	0.004	0.00096	U	U
Dichloropropene, cis-1,3-	mg/kg	0.0032	0.0032	0.00064	U	U	0.004	0.004	0.0008	U	U
Dichloropropene, trans-1,3-	mg/kg	0.0032	0.0032	0.00071	U	U	0.004	0.004	0.00088	U	U
Ethylbenzene	mg/kg	0.0032	0.0032	0.00064	U	U	0.004	0.004	0.0008	U	U

Table E-2

Subsurface Soil Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

LOCATION CODE		ULA-SB12					ULA-SB12				
SAMPLE NO		ULA0028					ULA0044				
SAMPLE DATE		19-May-11					19-May-11				
DEPTH		3 - 5 Ft					8 - 10 Ft				
SAMPLE PURPOSE		REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Hexanone, 2-	mg/kg	0.016	0.016	0.0035	U	U	0.02	0.02	0.0043	U	U
Isopropylbenzene	mg/kg										
METHYL ACETATE	mg/kg										
Methyl Tertiary Butyl Ether	mg/kg										
Methyl-2-pentanone, 4-	mg/kg	0.016	0.016	0.0035	U	U	0.02	0.02	0.0044	U	U
Methylcyclohexane	mg/kg										
Methylene chloride	mg/kg	0.0064	0.0064	0.003	U	U	0.008	0.008	0.0037	U	U
Styrene	mg/kg	0.0032	0.0032	0.0017	U	U	0.004	0.004	0.0021	U	U
Tetrachloroethane, 1,1,2,2-	mg/kg	0.0032	0.0032	0.00077	U	U	0.004	0.004	0.00096	U	U
Tetrachloroethene	mg/kg	0.0032	0.0032	0.00064	U	U	0.004	0.004	0.0008	U	U
Toluene	mg/kg	0.0032	0.0032	0.00077	U	U	0.0019	0.004	0.00096	J	J
Trichlorobenzene, 1,2,4-	mg/kg										
Trichloroethane, 1,1,1-	mg/kg	0.0032	0.0032	0.00071	U	U	0.004	0.004	0.00088	U	U
Trichloroethane, 1,1,2-	mg/kg	0.0032	0.0032	0.00071	U	U	0.004	0.004	0.00088	U	U
Trichloroethene	mg/kg	0.0032	0.0032	0.00077	U	U	0.004	0.004	0.00096	U	U
Trichlorofluoromethane	mg/kg										
Trichlorotrifluoroethane	mg/kg										
Vinyl chloride	mg/kg	0.0032	0.0032	0.00096	U	U	0.004	0.004	0.0012	U	U
Xylenes, total	mg/kg	0.0096	0.0096	0.0021	U	U	0.012	0.012	0.0026	U	U

FD - Field duplicate.
LQ - Laboratory qualifier.
MDL - Method detection limit.
mg/kg - Milligrams per kilogram.
REG - Regular sample.
RL - Reporting limit.
VQ - Validation qualifier.

VQ Definitions: U = Not detected; J = Parameter detected, but below the reporting limit. Concentration is considered estimated; B = Blank contaminated. "B" LQ = Concentration is estimated (for metals) or associated with the sample blank (organics).

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW01					ULA-MW01				
		SAMPLE NO	ULA3010					ULA3011					ULA3012					ULA3015				
		SAMPLE DATE	9-Dec-11					9-Dec-11					9-Dec-11					1-May-12				
		DEPTH	4.3 - 4.36 Ft					4.3 - 4.36 Ft					4.3 - 4.36 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																						
Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.2	0.2	0.081	U	U	0.2	0.2	0.082	U	U	0.05	0.1	0.05	U	U	0.2	0.2	0.08	U	U
Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.1	0.2	0.1	U	U	0.2	0.2	0.078	U	U
Dinitrobenzene, 1,3-	N	µg/L	0.2	0.2	0.096	U	U	0.2	0.2	0.097	U	U	0.05	0.1	0.05	U	U	0.2	0.2	0.095	U	U
Dinitrotoluene, 2,4-	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.05	0.1	0.05	U	U	0.2	0.2	0.078	U	U
Dinitrotoluene, 2,6-	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.05	0.1	0.05	U	U	0.2	0.2	0.078	U	U
HMX	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.05	0.1	0.036	U	U	0.2	0.2	0.078	U	U
Nitrobenzene	N	µg/L	0.2	0.2	0.083	U	U	0.2	0.2	0.084	U	U	0.05	0.1	0.05	U	U	0.2	0.2	0.082	U	U
Nitrotoluene, 2-	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.1	0.5	0.088	U	U	0.2	0.2	0.078	U	U
Nitrotoluene, 3-	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.1	0.5	0.057	U	U	0.2	0.2	0.078	U	U
Nitrotoluene, 4-	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.1	0.65	0.088	U	U	0.2	0.2	0.078	U	U
RDX	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.05	0.1	0.036	U	U	0.2	0.2	0.078	U	U
Tetryl	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.05	0.1	0.05	U	U	0.2	0.2	0.078	U	U
Trinitrobenzene, 1,3,5-	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.05	0.1	0.03	U	U	0.2	0.2	0.078	U	U
Trinitrotoluene, 2,4,6-	N	µg/L	0.2	0.2	0.079	U	U	0.2	0.2	0.08	U	U	0.05	0.1	0.05	U	U	0.2	0.2	0.078	U	U
Field Tests																						
Dissolved Oxygen	N	mg/L	0.48	0.3														4.58	0.3			
Ferrous Iron	N	mg/L	0.6	0.042														1.6	0.042			
Oxidation Reduction Potential	N	mV	-14.9	0.02														-69	0.02			
pH	N	pH_units	6.98	0														7.85	0			
Specific Conductivity	N	mS/cm	0.00091	0														0.944	0			
Temperature	N	°C	8.01	0														14.7	0			
Turbidity	N	NTU	6.6	10														0	10			
General Chemistry																						
Alkalinity	N	mg/L											410	5	2.7			452	5	2.5		J
Alkalinity, Carbonate	N	mg/L	370	5	2.5			390	5	2.5												
Chloride	N	mg/L	10.2	2	1		J	10	2	1		J	7.8	1	0.1			10.8	4	2		
Cyanide, total	N	mg/L	0.01	0.01	0.005	U	U	0.01	0.01	0.005	U	U	0.01	0.01	0.005	U	UJ	0.01	0.01	0.005	U	U
Hardness (as CaCO3)	N	mg/L	458	23	0.66			476	23	0.66			410	10	6.2			522	23	0.66		
Nitrate-Nitrite	N	mg/L	0.1	0.1	0.05	U	UJ	0.1	0.1	0.05	U	UJ	0.077	0.1	0.014	J	J	0.1	0.1	0.05	U	U
Sulfate	N	mg/L	105	4	2		J	110	4	2		J	110	1	0.12			105	4	2		
Total dissolved solids	N	mg/L	547	100	10			525	100	10			590	10	7.4			598	100	10		
Total suspended solids	N	mg/L	10	10	4	U	U	4	10	4	B	J	2	4	1.8	J	J	8	10	4	B	J
Turbidity	N	NTU	2.8	1	1		J	4.1	1	1		J	3.1	0.5	0.11			2.9	1	1		
Metals																						
Aluminum	N	µg/L	62.3	200	20	B	J	70.7	200	20	B	J	95	300	75	J	J	31.3	200	20	B	J
Aluminum	Y	µg/L	200	200	20	U	U	200	200	20	U	U	300	300	75	U	U	200	200	20	U	U
Antimony	N	µg/L	6	6	1	U	U	6	6	1	U	U	25	25	7.4	U	U	6	6	1	U	U
Antimony	Y	µg/L	6	6	1	U	U	6	6	1	U	U	25	25	7.4	U	U	6	6	1	U	U
Arsenic	N	µg/L	10	10	1	U	U	10	10	1	U	U	4.8	10	3.3	J	J	10	10	1	U	U
Arsenic	Y	µg/L	10	10	1	U	U	10	10	1	U	U	10	10	3.3	U	U	10	10	1	U	U
Barium	N	µg/L	77.3	200	1	B	J	81.5	200	1	B	J	80	200	2.8	J	J	96.7	200	1	B	J
Barium	Y	µg/L	76	200	1	B	J	74	200	1	B	J	77	200	2.8	J	J	92.7	200	1	B	J
Beryllium	N	µg/L	4	4	0.1	U	U	4	4	0.1	U	U	5	5	0.56	U	U	4	4	0.1	U	U
Beryllium	Y	µg/L	4	4	0.1	U	U	4	4	0.1	U	U	5	5	0.56	U	U	4	4	0.1	U	U
Cadmium	N	µg/L	5	5	0.1	U	U	5	5	0.1	U	U	5	5	0.39	U	U	5	5	0.1	U	U
Cadmium	Y	µg/L	5	5	0.1	U	U	5	5	0.1	U	U	5	5	0.39	U	U	5	5	0.1	U	U
Calcium	N	µg/L	127000	1000	50			132000	1000	50			130000	5000	630			142000	1000	50		
Calcium	Y	µg/L	126000	1000	50			120000	1000	50			130000	5000	630			143000	1000	50		

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW01					ULA-MW01				
		SAMPLE NO	ULA3010					ULA3011					ULA3012					ULA3015				
		SAMPLE DATE	9-Dec-11					9-Dec-11					9-Dec-11					1-May-12				
		DEPTH	4.3 - 4.36 Ft					4.3 - 4.36 Ft					4.3 - 4.36 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Chromium	N	µg/L	1	10	1	B	J	10	10	1	U	U	7	7	1.4	U	U	10	10	1	U	U
Chromium	Y	µg/L	10	10	1	U	U	10	10	1	U	U	7	7	1.4	U	U	10	10	1	U	U
Cobalt	N	µg/L	50	50	1	U	U	50	50	1	U	U	7	7	1.5	U	U	50	50	1	U	U
Cobalt	Y	µg/L	50	50	1	U	U	50	50	1	U	U	7	7	1.5	U	U	50	50	1	U	U
Copper	N	µg/L	2.1	25	1	B	J	2.5	25	1	B	J	25	25	4.4	U	U	25	25	1	U	U
Copper	Y	µg/L	2.1	25	1	B	J	25	25	1	U	U	25	25	4.4	U	U	25	25	1	U	U
Iron	N	µg/L	403	300	34			405	300	34			420	250	64			1200	300	34		
Iron	Y	µg/L	286	300	34	B	J	277	300	34	B	J	280	250	64			954	300	34		
Lead	N	µg/L	5	5	1	U	U	5	5	1	U	U	10	10	1.7	U	U	1.2	5	1	B	J
Lead	Y	µg/L	5	5	1	U	U	5	5	1	U	U	10	10	1.7	U	U	5	5	1	U	U
Magnesium	N	µg/L	34100	5000	50			35500	5000	50			35000	5000	120	B	J	40600	5000	50		
Magnesium	Y	µg/L	34000	5000	50			31700	5000	50			34000	5000	120	B	J	39900	5000	50		
Manganese	N	µg/L	120	15	1			127	15	1			120	15	1.8			189	15	1		
Manganese	Y	µg/L	116	15	1			115	15	1			120	15	1.8			167	15	1		
Mercury	N	µg/L	1	1	0.071	U	U	1	1	0.071	U	U	0.2	0.2	0.12	U	U	1	1	0.04	U	U
Mercury	Y	µg/L	1	1	0.071	U	U	1	1	0.071	U	U	0.2	0.2	0.12	U	U	1	1	0.04	U	U
Nickel	N	µg/L	40	40	1	U	U	40	40	1	U	U	40	40	2.2	U	U	2	40	1	B	J
Nickel	Y	µg/L	40	40	1	U	U	40	40	1	U	U	2.3	40	2.2	J	J	40	40	1	U	U
Potassium	N	µg/L	1820	10000	50	B	J	1870	10000	50	B	J	1700	5000	300	J	J	2020	10000	50	B	J
Potassium	Y	µg/L	1710	10000	50	B	J	1600	10000	50	B	J	1600	5000	300	J	J	1800	10000	50	B	J
Selenium	N	µg/L	3.2	10	2	B	J	2.8	10	2	B	J	15	15	4	U	U	10	10	2	U	U
Selenium	Y	µg/L	2.2	10	2	B	J	3.3	10	2	B	J	15	15	4	U	U	10	10	2	U	U
Silver	N	µg/L	10	10	1	U	U	10	10	1	U	U	7	7	1.7	U	U	10	10	1	U	U
Silver	Y	µg/L	10	10	1	U	U	10	10	1	U	U	7	7	1.7	U	U	10	10	1	U	U
Sodium	N	µg/L	24100	10000	750			24500	10000	750			22000	5000	970			31100	10000	750		
Sodium	Y	µg/L	23100	10000	750			22400	10000	750			21000	5000	970			29700	10000	750		
Thallium	N	µg/L	10	10	1	U	U	10	10	1	U	U	30	30	9.1	U	U	10	10	1	U	U
Thallium	Y	µg/L	10	10	1	U	U	10	10	1	U	U	30	30	9.1	U	U	10	10	1	U	U
Vanadium	N	µg/L	50	50	1	U	U	50	50	1	U	U	7	7	1.3	U	U	50	50	1	U	U
Vanadium	Y	µg/L	50	50	1	U	U	50	50	1	U	U	7	7	1.3	U	U	50	50	1	U	U
Zinc	N	µg/L	20	20	1	U	U	20	20	1	U	U	50	50	15	U	U	9.6	20	1	B	J
Zinc	Y	µg/L	20	20	1	U	U	20	20	1	U	U	50	50	15	U	U	5.2	20	1	B	J
Semivolatile Organics																						
3-Methylphenol and 4-Methylphenol	N	µg/L	4.8	4.8	1	U	U	4.8	4.8	1.1	U	U	2.1	2.1	0.85	U	U	4.8	4.8	1	U	U
Acenaphthene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Acenaphthylene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Acetophenone	N	µg/L											1.1	1.1	0.36	U	U					
Anthracene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Atrazine	N	µg/L											1.1	1.1	0.36	U	U					
Benzaldehyde	N	µg/L											1.1	1.1	0.41	U	U					
Benzo(a)anthracene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Benzo(a)pyrene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Benzo(b)fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Benzo(ghi)perylene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Benzo(k)fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Benzoic acid	N	µg/L	48	48	9.5	U	U	48	48	9.6	U	U						48	48	9.5	U	U
Benzyl alcohol	N	µg/L	4.8	4.8	0.95	U	U	4.8	4.8	0.96	U	U						4.8	4.8	0.95	U	U
Bibenzene	N	µg/L											1.1	1.1	0.85	U	U					
Bis(2-chloroethoxy)methane	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	1.1	1.1	0.34	U	U	4.8	4.8	0.48	U	U
Bis(2-chloroethyl)ether	N	µg/L	4.8	4.8	0.51	U	U	4.8	4.8	0.52	U	U	1.1	1.1	0.11	U	U	4.8	4.8	0.51	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW01					ULA-MW01				
		SAMPLE NO	ULA3010					ULA3011					ULA3012					ULA3015				
		SAMPLE DATE	9-Dec-11					9-Dec-11					9-Dec-11					1-May-12				
		DEPTH	4.3 - 4.36 Ft					4.3 - 4.36 Ft					4.3 - 4.36 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Bis(2-chloroisopropyl)ether	N	µg/L	4.8	4.8	0.51	U	U	4.8	4.8	0.52	U	U	1.1	1.1	0.43	U	U	4.8	4.8	0.51	U	U
Bis(2-ethylhexyl)phthalate	N	µg/L	4.8	4.8	1	U	U	4.8	4.8	1.1	U	U	2.1	2.1	0.85	U	U	4.8	4.8	1	U	U
Bromophenyl phenyl ether, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	2.1	2.1	0.85	U	U	4.8	4.8	0.48	U	U
Butyl benzyl phthalate	N	µg/L	4.8	4.8	1	U	U	4.8	4.8	1.1	U	U	1.1	1.1	0.85	U	U	4.8	4.8	1	U	U
Caprolactam	N	µg/L											5.3	5.3	0.85	U	U					
Carbazole	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	1.1	1.1	0.3	U	U	4.8	4.8	0.48	U	U
Chloro-3-methylphenol, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	2.1	2.1	0.85	U	U	4.8	4.8	0.48	U	U
Chloroaniline, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	2.1	2.1	0.85	U	U	4.8	4.8	0.48	U	U
Chloronaphthalene, 2-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	1.1	1.1	0.11	U	U	4.8	4.8	0.48	U	U
Chlorophenol, 2-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	1.1	1.1	0.31	U	U	4.8	4.8	0.48	U	U
Chlorophenyl phenyl ether, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	2.1	2.1	0.32	U	U	4.8	4.8	0.48	U	U
Chrysene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Dibenz(a,h)anthracene	N	µg/L	4.8	4.8	0.5	U	U	4.8	4.8	0.5	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.5	U	U
Dibenzofuran	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	1.1	1.1	0.11	U	U	4.8	4.8	0.48	U	U
Dichlorobenzene, 1,2-	N	µg/L	4.8	4.8	0.95	U	U	4.8	4.8	0.96	U	U						4.8	4.8	0.95	U	U
Dichlorobenzene, 1,3-	N	µg/L	4.8	4.8	0.95	U	U	4.8	4.8	0.96	U	U						4.8	4.8	0.95	U	U
Dichlorobenzene, 1,4-	N	µg/L	4.8	4.8	0.95	U	U	4.8	4.8	0.96	U	U						4.8	4.8	0.95	U	U
Dichlorobenzidine, 3,3'-	N	µg/L	9.5	9.5	0.95	U	U	9.6	9.6	0.96	U	U	5.3	5.3	0.39	U	U	9.5	9.5	0.95	U	U
Dichlorophenol, 2,4-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	2.1	2.1	0.85	U	U	4.8	4.8	0.48	U	U
Diethyl phthalate	N	µg/L	4.8	4.8	1	U	U	4.8	4.8	1.1	U	U	1.1	1.1	0.64	U	U	4.8	4.8	1	U	U
Dimethyl phthalate	N	µg/L	4.8	4.8	0.94	U	U	4.8	4.8	0.95	U	U	1.1	1.1	0.31	U	U	4.8	4.8	0.94	U	U
Dimethylphenol, 2,4-	N	µg/L	4.8	4.8	1	U	U	4.8	4.8	1.1	U	U	2.1	2.1	0.85	U	U	4.8	4.8	1	U	U
Di-n-butyl phthalate	N	µg/L	4.8	4.8	0.83	U	U	1.6	4.8	0.84	J	J	1.1	1.1	0.71	U	U	4.8	4.8	0.83	U	U
Dinitro-2-methylphenol, 4,6-	N	µg/L	9.5	9.5	1.9	U	U	9.6	9.6	1.9	U	U	5.3	5.3	2.6	U	U	9.5	9.5	1.9	U	U
Dinitrophenol, 2,4-	N	µg/L	24	24	9.5	U	U	24	24	9.6	U	U	5.3	5.3	2.6	U	U	24	24	9.5	U	U
Dinitrotoluene, 2,4-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	5.3	5.3	0.29	U	U	4.8	4.8	0.48	U	U
Dinitrotoluene, 2,6-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	5.3	5.3	0.85	U	U	4.8	4.8	0.48	U	U
Di-n-octyl phthalate	N	µg/L	4.8	4.8	1	U	U	4.8	4.8	1.1	U	U	1.1	1.1	0.85	U	U	4.8	4.8	1	U	U
Fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Fluorene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Hexachlorobenzene	N	µg/L	4.8	4.8	0.53	U	U	4.8	4.8	0.54	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.53	U	U
Hexachlorobutadiene	N	µg/L	4.8	4.8	0.95	U	U	4.8	4.8	0.96	U	U	1.1	1.1	0.29	U	U	4.8	4.8	0.95	U	U
Hexachlorocyclopentadiene	N	µg/L	9.5	9.5	1.8	U	U	9.6	9.6	1.8	U	U	11	11	0.85	U	U	9.5	9.5	1.8	U	U
Hexachloroethane	N	µg/L	4.8	4.8	0.95	U	U	4.8	4.8	0.96	U	U	1.1	1.1	0.85	U	U	4.8	4.8	0.95	U	U
Indeno(1,2,3-cd)pyrene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Isophorone	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	1.1	1.1	0.29	U	U	4.8	4.8	0.48	U	U
Methylnaphthalene, 2-	N	µg/L	4.8	4.8	0.54	U	U	4.8	4.8	0.55	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.54	U	U
Methylphenol, 2-	N	µg/L	4.8	4.8	0.51	U	U	4.8	4.8	0.52	U	U	1.1	1.1	0.85	U	U	4.8	4.8	0.51	U	U
Naphthalene	N	µg/L	4.8	4.8	0.76	U	U	4.8	4.8	0.77	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.76	U	U
Nitroaniline, 2-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	2.1	2.1	0.85	U	U	4.8	4.8	0.48	U	U
Nitroaniline, 3-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	2.1	2.1	0.3	U	U	4.8	4.8	0.48	U	U
Nitroaniline, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	2.1	2.1	0.85	U	U	4.8	4.8	0.48	U	U
Nitrobenzene	N	µg/L	4.8	4.8	0.56	U	U	4.8	4.8	0.57	U	U	1.1	1.1	0.043	U	U	4.8	4.8	0.56	U	U
Nitrophenol, 2-	N	µg/L	4.8	4.8	0.51	U	U	4.8	4.8	0.52	U	U	2.1	2.1	0.3	U	U	4.8	4.8	0.51	U	U
Nitrophenol, 4-	N	µg/L	24	24	4.8	U	U	24	24	4.8	U	U	5.3	5.3	2.6	U	U	24	24	4.8	U	U
n-Nitroso-di-n-propylamine	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	1.1	1.1	0.85	U	U	4.8	4.8	0.48	U	U
n-Nitrosodiphenylamine	N	µg/L	4.8	4.8	0.95	U	U	4.8	4.8	0.96	U	U	1.1	1.1	0.33	U	U	4.8	4.8	0.95	U	U
Pentachlorophenol	N	µg/L	24	24	5.1	U	U	24	24	5.2	U	U	5.3	5.3	2.6	U	U	24	24	5.1	U	U
Phenanthrene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW01					ULA-MW01				
		SAMPLE NO	ULA3010					ULA3011					ULA3012					ULA3015				
		SAMPLE DATE	9-Dec-11					9-Dec-11					9-Dec-11					1-May-12				
		DEPTH	4.3 - 4.36 Ft					4.3 - 4.36 Ft					4.3 - 4.36 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Phenol	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	1.1	1.1	0.64	U	U	4.8	4.8	0.48	U	U
Pyrene	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	0.21	0.21	0.11	U	U	4.8	4.8	0.48	U	U
Trichlorobenzene, 1,2,4-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U						4.8	4.8	0.48	U	U
Trichlorophenol, 2,4,5-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	5.3	5.3	0.32	U	U	4.8	4.8	0.48	U	U
Trichlorophenol, 2,4,6-	N	µg/L	4.8	4.8	0.48	U	U	4.8	4.8	0.48	U	U	5.3	5.3	0.85	U	U	4.8	4.8	0.48	U	U
Volatile Organics																						
Acetone	N	µg/L	25	25	10	U	UJ	25	25	10	U	UJ	10	10	1.1	U	U	25	25	10	U	R
Benzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.13	U	U	1	1	0.2	U	U
Bromodichloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.15	U	U	1	1	0.2	U	U
Bromoform	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.64	U	U	1	1	0.2	U	U
Bromomethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	1	1	0.41	U	U	2	2	0.5	U	U
Butanone, 2-	N	µg/L	5	5	2	U	U	5	5	2	U	U	10	10	0.57	U	UJ	5	5	2	U	U
Carbon disulfide	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	1	1	0.13	U	U	2	2	0.5	U	U
Carbon tetrachloride	N	µg/L	1	1	0.25	U	UJ	1	1	0.25	U	UJ	1	1	0.13	U	U	1	1	0.25	U	U
Chlorobenzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.15	U	U	1	1	0.2	U	U
Chloroethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	1	1	0.29	U	U	2	2	0.5	U	U
Chloroform	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.16	U	U	1	1	0.22	U	U
Chloromethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	1	1	0.3	U	U	2	2	0.5	U	U
Cyclohexane	N	µg/L											1	1	0.12	U	U					
Dibromo-3-chloropropane, 1,2-	N	µg/L											2	2	0.67	U	U					
Dibromochloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.18	U	U	1	1	0.2	U	U
Dibromoethane, 1,2-	N	µg/L											1	1	0.24	U	U					
Dichlorobenzene, 1,2-	N	µg/L											1	1	0.13	U	U					
Dichlorobenzene, 1,3-	N	µg/L											1	1	0.14	U	U					
Dichlorobenzene, 1,4-	N	µg/L											1	1	0.13	U	U					
Dichlorodifluoromethane	N	µg/L											1	1	0.31	U	U					
Dichloroethane, 1,1-	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.15	U	U	1	1	0.25	U	U
Dichloroethane, 1,2-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.22	U	U	1	1	0.2	U	U
Dichloroethene, 1,1-	N	µg/L	1	1	0.23	U	U	1	1	0.23	U	U	1	1	0.19	U	U	1	1	0.23	U	U
Dichloroethene, cis-1,2-	N	µg/L	1	1	0.26	U	U	1	1	0.26	U	U	1	1	0.17	U	U	1	1	0.26	U	U
Dichloroethene, trans-1,2-	N	µg/L	1	1	0.35	U	U	1	1	0.35	U	U	1	1	0.19	U	U	1	1	0.35	U	U
Dichloropropane, 1,2-	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.18	U	U	1	1	0.25	U	U
Dichloropropene, cis-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.14	U	U	1	1	0.2	U	U
Dichloropropene, trans-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.19	U	U	1	1	0.2	U	U
Ethylbenzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.17	U	U	1	1	0.2	U	U
Hexanone, 2-	N	µg/L	10	10	4	U	UJ	10	10	4	U	UJ	10	10	0.41	U	U	10	10	4	U	U
Isopropylbenzene	N	µg/L											1	1	0.13	U	U					
METHYL ACETATE	N	µg/L											10	10	0.38	U	U					
Methyl Tertiary Butyl Ether	N	µg/L											1	1	0.17	U	U					
Methyl-2-pentanone, 4-	N	µg/L	5	5	2	U	U	5	5	2	U	U	10	10	0.32	U	U	5	5	2	U	U
Methylcyclohexane	N	µg/L											1	1	0.13	U	U					
Methylene chloride	N	µg/L	5	5	2	U	UJ	5	5	2	U	UJ	1	1	0.33	U	U	5	5	2	U	U
Styrene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.11	U	U	1	1	0.2	U	U
Tetrachloroethane, 1,1,2,2-	N	µg/L	1	1	0.23	U	U	1	1	0.23	U	U	1	1	0.18	U	U	1	1	0.23	U	U
Tetrachloroethene	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.29	U	U	1	1	0.25	U	U
Toluene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.13	U	U	1	1	0.2	U	U
Trichlorobenzene, 1,2,4-	N	µg/L											1	1	0.15	U	U					
Trichloroethane, 1,1,1-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.22	U	U	1	1	0.2	U	U
Trichloroethane, 1,1,2-	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.27	U	U	1	1	0.22	U	U
Trichloroethene	N	µg/L	1	1	0.26	U	U	1	1	0.26	U	U	1	1	0.17	U	U	1	1	0.26	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW01					ULA-MW01				
		SAMPLE NO	ULA3010					ULA3011					ULA3012					ULA3015				
		SAMPLE DATE	9-Dec-11					9-Dec-11					9-Dec-11					1-May-12				
		DEPTH	4.3 - 4.36 Ft					4.3 - 4.36 Ft					4.3 - 4.36 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Trichlorofluoromethane	N	µg/L											1	1	0.21	U	U					
Trichlorotrifluoroethane	N	µg/L											1	1	0.28	U	U					
Vinyl chloride	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U
Xylenes, total	N	µg/L	3	3	0.52	U	U	3	3	0.52	U	U	2	2	0.28	U	U	3	3	0.52	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW02					ULA-MW02				
		SAMPLE NO	ULA3016					ULA3017					ULA3013					ULA3018				
		SAMPLE DATE	1-May-12					1-May-12					13-Dec-11					30-Apr-12				
		DEPTH	0 - 0 Ft					0 - 0 Ft					7.56 - 7.83 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	FD					FS					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																						
Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.19	0.19	0.079	U	U	0.1	0.1	0.05	U	U	0.2	0.2	0.081	U	U	0.19	0.19	0.08	U	U
Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.19	0.19	0.077	U	U	0.1	0.2	0.017	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
Dinitrobenzene, 1,3-	N	µg/L	0.19	0.19	0.093	U	U	0.1	0.1	0.05	U	U	0.2	0.2	0.096	U	U	0.19	0.19	0.094	U	U
Dinitrotoluene, 2,4-	N	µg/L	0.19	0.19	0.077	U	U	0.1	0.1	0.05	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
Dinitrotoluene, 2,6-	N	µg/L	0.19	0.19	0.077	U	U	0.1	0.1	0.05	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
HMX	N	µg/L	0.19	0.19	0.077	U	U	0.05	0.1	0.036	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
Nitrobenzene	N	µg/L	0.19	0.19	0.081	U	U	0.1	0.1	0.05	U	U	0.2	0.2	0.083	U	U	0.19	0.19	0.082	U	U
Nitrotoluene, 2-	N	µg/L	0.19	0.19	0.077	U	U	0.1	0.5	0.089	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
Nitrotoluene, 3-	N	µg/L	0.19	0.19	0.077	U	U	0.1	0.5	0.058	U	U	0.2	0.2	0.4	U	U	0.19	0.19	0.078	U	U
Nitrotoluene, 4-	N	µg/L	0.19	0.19	0.077	U	U	0.1	0.66	0.089	U	U	0.2	0.2	0.2	U	U	0.19	0.19	0.078	U	U
RDX	N	µg/L	0.19	0.19	0.077	U	U	0.05	0.1	0.036	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
Tetryl	N	µg/L	0.19	0.19	0.077	U	U	0.1	0.1	0.05	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
Trinitrobenzene, 1,3,5-	N	µg/L	0.19	0.19	0.077	U	U	0.05	0.1	0.03	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
Trinitrotoluene, 2,4,6-	N	µg/L	0.19	0.19	0.077	U	U	0.1	0.1	0.05	U	U	0.2	0.2	0.079	U	U	0.19	0.19	0.078	U	U
Field Tests																						
Dissolved Oxygen	N	mg/L											3.14	0.3				4.16	0.3			
Ferrous Iron	N	mg/L											5	0.042				3.8	0.042			
Oxidation Reduction Potential	N	mV											-25.2	0.02				-77	0.02			
pH	N	pH_units											7.27	0				8.03	0			
Specific Conductivity	N	mS/cm											0.000998	0				0.837	0			
Temperature	N	°C											10.41	0				13.08	0			
Turbidity	N	NTU											0	10				0	10			
General Chemistry																						
Alkalinity	N	mg/L	420	5	2.5			450	5	2.7	B							408	5	2.5		
Alkalinity, Carbonate	N	mg/L											428	5	2.5							
Chloride	N	mg/L	10.8	4	2			8.7	1	0.1			11.8	2	1			10.7	2	1		
Cyanide, total	N	mg/L	0.01	0.01	0.005	U	U	0.01	0.01	0.005	U	U	0.01	0.01	0.005	U	U	0.01	0.01	0.005	U	U
Hardness (as CaCO3)	N	mg/L	513	23	0.66			560	25	16			387	23	0.66			380	23	0.66		
Nitrate-Nitrite	N	mg/L	0.1	0.1	0.05	U	U	0.1	0.1	0.014	U	U	0.1	0.1	0.05	U	U	0.1	0.1	0.05	U	UJ
Sulfate	N	mg/L	111	4	2			120	1	0.12			129	4	2			82.6	2	1		J
Total dissolved solids	N	mg/L	639	100	10			610	10	7.4			603	100	10			511	100	10		
Total suspended solids	N	mg/L	5	10	4	B	J	4	4	1.8			12	10	4			10	10	4		J
Turbidity	N	NTU	3.3	1	1			6.2	0.5	0.11			3.5	1	1			29.3	1	1		
Metals																						
Aluminum	N	µg/L	46.1	200	20	B	J	300	300	75	U	U	38.4	200	20	B	J	25.8	200	20	B	J
Aluminum	Y	µg/L	200	200	20	U	U	300	300	75	U	U	200	200	20	U	U	200	200	20	U	U
Antimony	N	µg/L	6	6	1	U	U	25	25	7.4	U	U	2.3	6	1	B	J	6	6	1	U	U
Antimony	Y	µg/L	6	6	1	U	U	25	25	7.4	U	U	6	6	1	U	U	6	6	1	U	U
Arsenic	N	µg/L	10	10	1	U	U	10	10	3.3	U	U	2.1	10	1	B	J	5.8	10	1	B	J
Arsenic	Y	µg/L	10	10	1	U	U	10	10	3.3	U	U	2.8	10	1	B	J	5.9	10	1	B	J
Barium	N	µg/L	95	200	1	B	J	110	200	2.8	J	J	239	200	1			242	200	1		
Barium	Y	µg/L	93.2	200	1	B	J	92	200	2.8	J	J	216	200	1			231	200	1		
Beryllium	N	µg/L	4	4	0.1	U	U	5	5	0.56	U	U	4	4	0.1	U	U	4	4	0.1	U	U
Beryllium	Y	µg/L	4	4	0.1	U	U	5	5	0.56	U	U	4	4	0.1	U	U	4	4	0.1	U	U
Cadmium	N	µg/L	5	5	0.1	U	U	5	5	0.39	U	U	5	5	0.1	U	U	5	5	0.1	U	U
Cadmium	Y	µg/L	5	5	0.1	U	U	5	5	0.39	U	U	5	5	0.1	U	U	5	5	0.1	U	U
Calcium	N	µg/L	140000	1000	50			140000	5000	630			92100	1000	50			87600	1000	50		
Calcium	Y	µg/L	141000	1000	50			140000	5000	630			82800	1000	50			81900	1000	50		

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW02					ULA-MW02				
		SAMPLE NO	ULA3016					ULA3017					ULA3013					ULA3018				
		SAMPLE DATE	1-May-12					1-May-12					13-Dec-11					30-Apr-12				
		DEPTH	0 - 0 Ft					0 - 0 Ft					7.56 - 7.83 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	FD					FS					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Chromium	N	µg/L	10	10	1	U	U	7	7	1.4	U	U	10	10	1	U	U	10	10	1	U	U
Chromium	Y	µg/L	10	10	1	U	U	7	7	1.4	U	U	10	10	1	U	U	10	10	1	U	U
Cobalt	N	µg/L	50	50	1	U	U	7	7	1.5	U	U	1.8	50	1	B	J	2	50	1	B	J
Cobalt	Y	µg/L	50	50	1	U	U	7	7	1.5	U	U	1.6	50	1	B	J	2	50	1	B	J
Copper	N	µg/L	25	25	1	U	U	25	25	4.4	U	U	25	25	1	U	U	25	25	1	U	U
Copper	Y	µg/L	25	25	1	U	U	25	25	4.4	U	U	25	25	1	U	U	25	25	1	U	U
Iron	N	µg/L	1200	300	34			1500	250	64			1710	300	34			3640	300	34		
Iron	Y	µg/L	931	300	34			930	250	64			957	300	34			3270	300	34		
Lead	N	µg/L	1	5	1	B	J	10	10	1.7	U	U	5	5	1	U	U	5	5	1	U	U
Lead	Y	µg/L	5	5	1	U	U	10	10	1.7	U	U	5	5	1	U	U	5	5	1	U	U
Magnesium	N	µg/L	39700	5000	50			39000	5000	120	B		38100	5000	50			39200	5000	50		
Magnesium	Y	µg/L	39700	5000	50			39000	5000	120	B		34300	5000	50			36700	5000	50		
Manganese	N	µg/L	183	15	1			220	15	1.8			281	15	1			275	15	1		
Manganese	Y	µg/L	167	15	1			170	15	1.8			250	15	1			254	15	1		
Mercury	N	µg/L	1	1	0.04	U	U	0.2	0.2	0.12	U	U	1	1	0.071	U	U	1	1	0.04	U	U
Mercury	Y	µg/L	1	1	0.04	U	U	0.2	0.2	0.12	U	U	0.18	1	0.071	B	J	1	1	0.04	U	U
Nickel	N	µg/L	40	40	1	U	U	2.8	40	2.2	J	J	40	40	1	U	U	40	40	1	U	U
Nickel	Y	µg/L	40	40	1	U	U	40	40	2.2	U	U	40	40	1	U	U	40	40	1	U	U
Potassium	N	µg/L	1920	10000	50	B	J	2800	5000	300	J	J	4850	10000	50	B	J	6360	10000	50	B	J
Potassium	Y	µg/L	1750	10000	50	B	J	1900	5000	300	J	J	4470	10000	50	B	J	6040	10000	50	B	J
Selenium	N	µg/L	10	10	2	U	U	15	15	4	U	U	10	10	2	U	U	10	10	2	U	U
Selenium	Y	µg/L	10	10	2	U	U	15	15	4	U	U	10	10	2	U	U	10	10	2	U	U
Silver	N	µg/L	10	10	1	U	U	7	7	1.7	U	U	10	10	1	U	U	10	10	1	U	U
Silver	Y	µg/L	10	10	1	U	U	7	7	1.7	U	U	10	10	1	U	U	10	10	1	U	U
Sodium	N	µg/L	31300	10000	750			30000	5000	970			78200	10000	750			57000	10000	750		
Sodium	Y	µg/L	29400	10000	750			27000	5000	970			70100	10000	750			54000	10000	750		
Thallium	N	µg/L	10	10	1	U	U	30	30	9.1	U	U	10	10	1	U	U	10	10	1	U	U
Thallium	Y	µg/L	10	10	1	U	U	30	30	9.1	U	U	10	10	1	U	U	10	10	1	U	U
Vanadium	N	µg/L	50	50	1	U	U	7	7	1.3	U	U	50	50	1	U	U	50	50	1	U	U
Vanadium	Y	µg/L	50	50	1	U	U	7	7	1.3	U	U	50	50	1	U	U	50	50	1	U	U
Zinc	N	µg/L	20	20	1	U	U	50	50	15	U	U	20	20	1	U	U	20	20	1	U	U
Zinc	Y	µg/L	5.8	20	1	B	J	15	50	15	J	J	20	20	1	U	U	5.8	20	1	B	J
Semivolatile Organics																						
3-Methylphenol and 4-Methylphenol	N	µg/L	4.8	4.8	1.1	U	U	2.1	2.1	0.82	U	U	4.9	4.9	1.1	U	U	4.8	4.8	1.1	U	U
Acenaphthene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Acenaphthylene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Acetophenone	N	µg/L						1	1	0.35	U	U										
Anthracene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Atrazine	N	µg/L						1	1	0.35	U	U										
Benzaldehyde	N	µg/L						1	1	0.4	U	U										
Benzo(a)anthracene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Benzo(a)pyrene	N	µg/L	4.8	4.8	0.48	U	U	0.2	0.2	0.099	U H	UJ	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Benzo(b)fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Benzo(ghi)perylene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Benzo(k)fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Benzoic acid	N	µg/L	48	48	9.6	U	U						49	49	9.7	U	U	48	48	9.6	U	U
Benzyl alcohol	N	µg/L	4.8	4.8	0.96	U	U						4.9	4.9	0.97	U	U	4.8	4.8	0.96	U	U
Bibenzene	N	µg/L						1	1	0.82	U	U										
Bis(2-chloroethoxy)methane	N	µg/L	4.8	4.8	0.48	U	U	1	1	0.33	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Bis(2-chloroethyl)ether	N	µg/L	4.8	4.8	0.52	U	U	1	1	0.1	U	U	4.9	4.9	0.52	U	U	4.8	4.8	0.52	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW02					ULA-MW02				
		SAMPLE NO	ULA3016					ULA3017					ULA3013					ULA3018				
		SAMPLE DATE	1-May-12					1-May-12					13-Dec-11					30-Apr-12				
		DEPTH	0 - 0 Ft					0 - 0 Ft					7.56 - 7.83 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	FD					FS					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Bis(2-chloroisopropyl)ether	N	µg/L	4.8	4.8	0.52	U	U	1	1	0.41	U	U	4.9	4.9	0.52	U	U	4.8	4.8	0.52	U	U
Bis(2-ethylhexyl)phthalate	N	µg/L	4.8	4.8	1.1	U	U	2.1	2.1	0.82	U	U	4.9	4.9	1.1	U	U	4.8	4.8	1.1	U	U
Bromophenyl phenyl ether, 4-	N	µg/L	4.8	4.8	0.48	U	U	2.1	2.1	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Butyl benzyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	1	1	0.82	U	U	4.9	4.9	1.1	U	U	4.8	4.8	1.1	U	U
Caprolactam	N	µg/L						5.2	5.2	0.82	U	U										
Carbazole	N	µg/L	4.8	4.8	0.48	U	U	1	1	0.29	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Chloro-3-methylphenol, 4-	N	µg/L	4.8	4.8	0.48	U	U	2.1	2.1	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Chloroaniline, 4-	N	µg/L	4.8	4.8	0.48	U	U	2.1	2.1	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Chloronaphthalene, 2-	N	µg/L	4.8	4.8	0.48	U	U	1	1	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Chlorophenol, 2-	N	µg/L	4.8	4.8	0.48	U	U	1	1	0.3	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Chlorophenyl phenyl ether, 4-	N	µg/L	4.8	4.8	0.48	U	U	2.1	2.1	0.31	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Chrysene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Dibenz(a,h)anthracene	N	µg/L	4.8	4.8	0.5	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.5	U	U	4.8	4.8	0.5	U	U
Dibenzofuran	N	µg/L	4.8	4.8	0.48	U	U	1	1	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Dichlorobenzene, 1,2-	N	µg/L	4.8	4.8	0.96	U	U						4.9	4.9	0.97	U	U	4.8	4.8	0.96	U	U
Dichlorobenzene, 1,3-	N	µg/L	4.8	4.8	0.96	U	U						4.9	4.9	0.97	U	U	4.8	4.8	0.96	U	U
Dichlorobenzene, 1,4-	N	µg/L	4.8	4.8	0.96	U	U						4.9	4.9	0.97	U	U	4.8	4.8	0.96	U	U
Dichlorobenzidine, 3,3'-	N	µg/L	9.6	9.6	0.96	U	U	5.2	5.2	0.38	U	U	9.7	9.7	0.97	U	U	9.6	9.6	0.96	U	U
Dichlorophenol, 2,4-	N	µg/L	4.8	4.8	0.48	U	U	2.1	2.1	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Diethyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	1	1	0.62	U	U	4.9	4.9	1.1	U	U	4.8	4.8	1.1	U	U
Dimethyl phthalate	N	µg/L	4.8	4.8	0.95	U	U	1	1	0.3	U	U	4.9	4.9	0.96	U	U	4.8	4.8	0.95	U	U
Dimethylphenol, 2,4-	N	µg/L	4.8	4.8	1.1	U	U	2.1	2.1	0.82	U	U	4.9	4.9	1.1	U	U	4.8	4.8	1.1	U	U
Di-n-butyl phthalate	N	µg/L	4.8	4.8	0.84	U	U	1	1	0.69	U	U	4.9	4.9	0.84	U	U	4.8	4.8	0.84	U	U
Dinitro-2-methylphenol, 4,6-	N	µg/L	9.6	9.6	1.9	U	U	5.2	5.2	2.5	U	U	9.7	9.7	1.9	U	U	9.6	9.6	1.9	U	U
Dinitrophenol, 2,4-	N	µg/L	24	24	9.6	U	U	5.2	5.2	2.5	U	U	24	24	9.7	U	U	24	24	9.6	U	U
Dinitrotoluene, 2,4-	N	µg/L	4.8	4.8	0.48	U	U	5.2	5.2	0.28	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Dinitrotoluene, 2,6-	N	µg/L	4.8	4.8	0.48	U	U	5.2	5.2	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Di-n-octyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	1	1	0.82	U	U	4.9	4.9	1.1	U	U	4.8	4.8	1.1	U	U
Fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Fluorene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Hexachlorobenzene	N	µg/L	4.8	4.8	0.54	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.54	U	U	4.8	4.8	0.54	U	U
Hexachlorobutadiene	N	µg/L	4.8	4.8	0.96	U	U	1	1	0.28	U	U	4.9	4.9	0.97	U	U	4.8	4.8	0.96	U	U
Hexachlorocyclopentadiene	N	µg/L	9.6	9.6	1.8	U	U	10	10	0.82	U	U	9.7	9.7	1.8	U	U	9.6	9.6	1.8	U	U
Hexachloroethane	N	µg/L	4.8	4.8	0.96	U	U	1	1	0.82	U	U	4.9	4.9	0.97	U	U	4.8	4.8	0.96	U	U
Indeno(1,2,3-cd)pyrene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Isophorone	N	µg/L	4.8	4.8	0.48	U	U	1	1	0.28	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Methylnaphthalene, 2-	N	µg/L	4.8	4.8	0.55	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.55	U	U	4.8	4.8	0.55	U	U
Methylphenol, 2-	N	µg/L	4.8	4.8	0.52	U	U	1	1	0.82	U	U	4.9	4.9	0.52	U	U	4.8	4.8	0.52	U	U
Naphthalene	N	µg/L	4.8	4.8	0.77	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.78	U	U	4.8	4.8	0.77	U	U
Nitroaniline, 2-	N	µg/L	4.8	4.8	0.48	U	U	2.1	2.1	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Nitroaniline, 3-	N	µg/L	4.8	4.8	0.48	U	U	2.1	2.1	0.29	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Nitroaniline, 4-	N	µg/L	4.8	4.8	0.48	U	U	2.1	2.1	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Nitrobenzene	N	µg/L	4.8	4.8	0.57	U	U	1	1	0.041	U	U	4.9	4.9	0.57	U	U	4.8	4.8	0.57	U	U
Nitrophenol, 2-	N	µg/L	4.8	4.8	0.52	U	U	2.1	2.1	0.29	U	U	4.9	4.9	0.52	U	U	4.8	4.8	0.52	U	U
Nitrophenol, 4-	N	µg/L	24	24	4.8	U	U	5.2	5.2	2.5	U	U	24	24	4.9	U	U	24	24	4.8	U	U
n-Nitroso-di-n-propylamine	N	µg/L	4.8	4.8	0.48	U	U	1	1	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
n-Nitrosodiphenylamine	N	µg/L	4.8	4.8	0.96	U	U	1	1	0.32	U	U	4.9	4.9	0.97	U	U	4.8	4.8	0.96	U	U
Pentachlorophenol	N	µg/L	24	24	5.2	U	U	5.2	5.2	2.5	U	U	24	24	5.2	U	U	24	24	5.2	U	U
Phenanthrene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW02					ULA-MW02				
		SAMPLE NO	ULA3016					ULA3017					ULA3013					ULA3018				
		SAMPLE DATE	1-May-12					1-May-12					13-Dec-11					30-Apr-12				
		DEPTH	0 - 0 Ft					0 - 0 Ft					7.56 - 7.83 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	FD					FS					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Phenol	N	µg/L	4.8	4.8	0.48	U	U	0.62	1	0.62	J	J	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Pyrene	N	µg/L	4.8	4.8	0.48	U	U	0.21	0.21	0.1	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Trichlorobenzene, 1,2,4-	N	µg/L	4.8	4.8	0.48	U	U						4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Trichlorophenol, 2,4,5-	N	µg/L	4.8	4.8	0.48	U	U	5.2	5.2	0.31	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Trichlorophenol, 2,4,6-	N	µg/L	4.8	4.8	0.48	U	U	5.2	5.2	0.82	U	U	4.9	4.9	0.49	U	U	4.8	4.8	0.48	U	U
Volatile Organics																						
Acetone	N	µg/L	25	25	10	U	R	3.1	10	1.1	J B	B	25	25	10	U	U	25	25	10	U	U
Benzene	N	µg/L	1	1	0.2	U	U	1	1	0.13	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Bromodichloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.15	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Bromoform	N	µg/L	1	1	0.2	U	U	1	1	0.64	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Bromomethane	N	µg/L	2	2	0.5	U	U	1	1	0.41	U	U	2	2	0.5	U	U	2	2	0.5	U	U
Butanone, 2-	N	µg/L	5	5	2	U	U	10	10	0.57	U	R	5	5	2	U	U	5	5	2	U	U
Carbon disulfide	N	µg/L	2	2	0.5	U	U	1	1	0.13	U	U	2	2	0.5	U	U	2	2	0.5	U	U
Carbon tetrachloride	N	µg/L	1	1	0.25	U	U	1	1	0.13	U	U	1	1	0.25	U	U	1	1	0.25	U	U
Chlorobenzene	N	µg/L	1	1	0.2	U	U	1	1	0.15	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Chloroethane	N	µg/L	2	2	0.5	U	U	1	1	0.29	U	U	2	2	0.5	U	U	2	2	0.5	U	U
Chloroform	N	µg/L	1	1	0.22	U	U	1	1	0.16	U	U	1	1	0.22	U	U	1	1	0.22	U	U
Chloromethane	N	µg/L	2	2	0.5	U	U	1	1	0.3	U	U	2	2	0.5	U	U	2	2	0.5	U	U
Cyclohexane	N	µg/L						1	1	0.12	U	U										
Dibromo-3-chloropropane, 1,2-	N	µg/L						2	2	0.67	U	R										
Dibromochloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.18	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Dibromoethane, 1,2-	N	µg/L						1	1	0.24	U	U										
Dichlorobenzene, 1,2-	N	µg/L						1	1	0.13	U	U										
Dichlorobenzene, 1,3-	N	µg/L						1	1	0.14	U	U										
Dichlorobenzene, 1,4-	N	µg/L						1	1	0.13	U	U										
Dichlorodifluoromethane	N	µg/L						1	1	0.31	U	UJ										
Dichloroethane, 1,1-	N	µg/L	1	1	0.25	U	U	1	1	0.15	U	U	1	1	0.25	U	U	1	1	0.25	U	U
Dichloroethane, 1,2-	N	µg/L	1	1	0.2	U	U	1	1	0.22	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Dichloroethene, 1,1-	N	µg/L	1	1	0.23	U	U	1	1	0.19	U	U	1	1	0.23	U	U	1	1	0.23	U	U
Dichloroethene, cis-1,2-	N	µg/L	1	1	0.26	U	U	1	1	0.17	U	U	1	1	0.26	U	U	1	1	0.26	U	U
Dichloroethene, trans-1,2-	N	µg/L	1	1	0.35	U	U	1	1	0.19	U	U	1	1	0.35	U	U	1	1	0.35	U	U
Dichloropropane, 1,2-	N	µg/L	1	1	0.25	U	U	1	1	0.18	U	U	1	1	0.25	U	U	1	1	0.25	U	U
Dichloropropene, cis-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.14	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Dichloropropene, trans-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.19	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Ethylbenzene	N	µg/L	1	1	0.2	U	U	1	1	0.17	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Hexanone, 2-	N	µg/L	10	10	4	U	U	10	10	0.41	U	U	10	10	4	U	U	10	10	4	U	U
Isopropylbenzene	N	µg/L						1	1	0.13	U	U										
METHYL ACETATE	N	µg/L						10	10	0.38	U	U										
Methyl Tertiary Butyl Ether	N	µg/L						1	1	0.17	U	U										
Methyl-2-pentanone, 4-	N	µg/L	5	5	2	U	U	10	10	0.32	U	U	5	5	2	U	U	5	5	2	U	U
Methylcyclohexane	N	µg/L						1	1	0.13	U	U										
Methylene chloride	N	µg/L	5	5	2	U	U	1	1	0.33	U	U	5	5	2	U	U	5	5	2	U	U
Styrene	N	µg/L	1	1	0.2	U	U	1	1	0.11	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Tetrachloroethane, 1,1,2,2-	N	µg/L	1	1	0.23	U	U	1	1	0.18	U	U	1	1	0.23	U	U	1	1	0.23	U	U
Tetrachloroethene	N	µg/L	1	1	0.25	U	U	1	1	0.29	U	U	1	1	0.25	U	U	1	1	0.25	U	U
Toluene	N	µg/L	1	1	0.2	U	U	1	1	0.13	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Trichlorobenzene, 1,2,4-	N	µg/L						1	1	0.15	U	U										
Trichloroethane, 1,1,1-	N	µg/L	1	1	0.2	U	U	1	1	0.22	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Trichloroethane, 1,1,2-	N	µg/L	1	1	0.22	U	U	1	1	0.27	U	U	1	1	0.22	U	U	1	1	0.22	U	U
Trichloroethene	N	µg/L	1	1	0.26	U	U	1	1	0.17	U	U	1	1	0.26	U	U	1	1	0.26	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW01					ULA-MW01					ULA-MW02					ULA-MW02				
		SAMPLE NO	ULA3016					ULA3017					ULA3013					ULA3018				
		SAMPLE DATE	1-May-12					1-May-12					13-Dec-11					30-Apr-12				
		DEPTH	0 - 0 Ft					0 - 0 Ft					7.56 - 7.83 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	FD					FS					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Trichlorofluoromethane	N	µg/L						1	1	0.21	U	U										
Trichlorotrifluoroethane	N	µg/L						1	1	0.28	U	U										
Vinyl chloride	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U
Xylenes, total	N	µg/L	3	3	0.52	U	U	2	2	0.28	U	U	3	3	0.52	U	U	3	3	0.52	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW03					ULA-MW03				
		SAMPLE NO	ULA3014					ULA3019				
		SAMPLE DATE	12-Dec-11					25-Apr-12				
		DEPTH	6.35 - 6.69 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives												
Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.2	0.2	0.082	U	U	0.19	0.19	0.08	U	U
Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
Dinitrobenzene, 1,3-	N	µg/L	0.2	0.2	0.097	U	U	0.19	0.19	0.094	U	U
Dinitrotoluene, 2,4-	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
Dinitrotoluene, 2,6-	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
HMX	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
Nitrobenzene	N	µg/L	0.2	0.2	0.084	U	U	0.19	0.19	0.19	U	U
Nitrotoluene, 2-	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
Nitrotoluene, 3-	N	µg/L	0.4	0.4	0.4	U	U	0.19	0.19	0.078	U	U
Nitrotoluene, 4-	N	µg/L	0.2	0.2	0.2	U	U	0.19	0.19	0.078	U	U
RDX	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
Tetryl	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
Trinitrobenzene, 1,3,5-	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
Trinitrotoluene, 2,4,6-	N	µg/L	0.2	0.2	0.08	U	U	0.19	0.19	0.078	U	U
Field Tests												
Dissolved Oxygen	N	mg/L	7.08	0.3				2.43	0.3			
Ferrous Iron	N	mg/L	0	0.042				0.3	0.042			
Oxidation Reduction Potential	N	mV	-25.3	0.02				-50.4	0.02			
pH	N	pH_units	7.28	0				7.51	0			
Specific Conductivity	N	mS/cm	0.000823	0				0.764	0			
Temperature	N	°C	8.29	0				12.36	0			
Turbidity	N	NTU	2.4	10				10.4	10			
General Chemistry												
Alkalinity	N	mg/L						356	5	2.5		
Alkalinity, Carbonate	N	mg/L	391	5	2.5							
Chloride	N	mg/L	7.5	2	1			9.1	2	1		
Cyanide, total	N	mg/L	0.01	0.01	0.005	U	U	0.01	0.01	0.005	U	U
Hardness (as CaCO3)	N	mg/L	413	23	0.66							
Nitrate-Nitrite	N	mg/L	0.28	0.1	0.05			0.1	0.1	0.05	U	U
Sulfate	N	mg/L	70.7	2	1			71.8	2	1		
Total dissolved solids	N	mg/L	487	100	10			462	100	10		
Total suspended solids	N	mg/L	8	10	4	B	J	18	10	4		
Turbidity	N	NTU	4.3	1	1			14.9	1	1		J
Metals												
Aluminum	N	µg/L	107	200	20	B	J	70.2	200	20	B	J
Aluminum	Y	µg/L	200	200	20	U	U					
Antimony	N	µg/L	6	6	1	U	U	2	6	1	B	J
Antimony	Y	µg/L	6	6	1	U	U					
Arsenic	N	µg/L	10	10	1	U	U	10	10	1	U	U
Arsenic	Y	µg/L	10	10	1	U	U					
Barium	N	µg/L	153	200	1	B	J	197	200	1	B	J
Barium	Y	µg/L	151	200	1	B	J					
Beryllium	N	µg/L	4	4	0.1	U	U	4	4	0.1	U	U
Beryllium	Y	µg/L	4	4	0.1	U	U					
Cadmium	N	µg/L	5	5	0.1	U	U	5	5	0.1	U	U
Cadmium	Y	µg/L	5	5	0.1	U	U					
Calcium	N	µg/L	103000	1000	50			97800	1000	50		
Calcium	Y	µg/L	103000	1000	50							

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW03					ULA-MW03				
		SAMPLE NO	ULA3014					ULA3019				
		SAMPLE DATE	12-Dec-11					25-Apr-12				
		DEPTH	6.35 - 6.69 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Chromium	N	µg/L	10	10	1	U	U	10	10	1	U	U
Chromium	Y	µg/L	10	10	1	U	U					
Cobalt	N	µg/L	50	50	1	U	U	50	50	1	U	U
Cobalt	Y	µg/L	50	50	1	U	U					
Copper	N	µg/L	25	25	1	U	U	25	25	1	U	U
Copper	Y	µg/L	25	25	1	U	U					
Iron	N	µg/L	228	300	34	B	J	156	300	34	B	J
Iron	Y	µg/L	300	300	34	U	U					
Lead	N	µg/L	5	5	1	U	U	5	5	1	U	U
Lead	Y	µg/L	5	5	1	U	U					
Magnesium	N	µg/L	37800	5000	50			40200	5000	50		
Magnesium	Y	µg/L	37500	5000	50							
Manganese	N	µg/L	37.3	15	1			138	15	1		
Manganese	Y	µg/L	33.6	15	1							
Mercury	N	µg/L	1	1	0.071	U	U	1	1	0.04	U	U
Mercury	Y	µg/L	1	1	0.071	U	U					
Nickel	N	µg/L	40	40	1	U	U	40	40	1	U	U
Nickel	Y	µg/L	40	40	1	U	U					
Potassium	N	µg/L	2430	10000	50	B	J	4200	10000	50	B	J
Potassium	Y	µg/L	2430	10000	50	B	J					
Selenium	N	µg/L	3.2	10	2	B	J	10	10	2	U	U
Selenium	Y	µg/L	2.8	10	2	B	J					
Silver	N	µg/L	10	10	1	U	U	10	10	1	U	U
Silver	Y	µg/L	10	10	1	U	U					
Sodium	N	µg/L	21300	10000	750			26300	10000	750		
Sodium	Y	µg/L	21200	10000	750							
Thallium	N	µg/L	10	10	1	U	U	10	10	1	U	U
Thallium	Y	µg/L	10	10	1	U	U					
Vanadium	N	µg/L	50	50	1	U	U	50	50	1	U	U
Vanadium	Y	µg/L	50	50	1	U	U					
Zinc	N	µg/L	20	20	1	U	U	5	20	1	B	J
Zinc	Y	µg/L	20	20	1	U	U					
Semivolatile Organics												
3-Methylphenol and 4-Methylphenol	N	µg/L	4.8	4.8	1.1	U	U	4.9	4.9	1.1	U	U
Acenaphthene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Acenaphthylene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Acetophenone	N	µg/L										
Anthracene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Atrazine	N	µg/L										
Benzaldehyde	N	µg/L										
Benzo(a)anthracene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Benzo(a)pyrene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Benzo(b)fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Benzo(ghi)perylene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Benzo(k)fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Benzoic acid	N	µg/L	48	48	9.6	U	U	49	49	9.8	U	U
Benzyl alcohol	N	µg/L	4.8	4.8	0.96	U	U	4.9	4.9	0.98	U	U
Bibenzene	N	µg/L										
Bis(2-chloroethoxy)methane	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Bis(2-chloroethyl)ether	N	µg/L	4.8	4.8	0.52	U	U	4.9	4.9	0.53	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW03					ULA-MW03				
		SAMPLE NO	ULA3014					ULA3019				
		SAMPLE DATE	12-Dec-11					25-Apr-12				
		DEPTH	6.35 - 6.69 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Bis(2-chloroisopropyl)ether	N	µg/L	4.8	4.8	0.52	U	U	4.9	4.9	0.53	U	U
Bis(2-ethylhexyl)phthalate	N	µg/L	4.8	4.8	1.1	U	U	4.9	4.9	1.1	U	U
Bromophenyl phenyl ether, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Butyl benzyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	4.9	4.9	1.1	U	U
Caprolactam	N	µg/L										
Carbazole	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Chloro-3-methylphenol, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Chloroaniline, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Chloronaphthalene, 2-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Chlorophenol, 2-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Chlorophenyl phenyl ether, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Chrysene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Dibenz(a,h)anthracene	N	µg/L	4.8	4.8	0.5	U	U	4.9	4.9	0.51	U	U
Dibenzofuran	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Dichlorobenzene, 1,2-	N	µg/L	4.8	4.8	0.96	U	U	4.9	4.9	0.98	U	U
Dichlorobenzene, 1,3-	N	µg/L	4.8	4.8	0.96	U	U	4.9	4.9	0.98	U	U
Dichlorobenzene, 1,4-	N	µg/L	4.8	4.8	0.96	U	U	4.9	4.9	0.98	U	U
Dichlorobenzidine, 3,3'-	N	µg/L	9.6	9.6	0.96	U	U	9.8	9.8	0.98	U	U
Dichlorophenol, 2,4-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Diethyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	4.9	4.9	1.1	U	U
Dimethyl phthalate	N	µg/L	4.8	4.8	0.95	U	U	4.9	4.9	0.97	U	U
Dimethylphenol, 2,4-	N	µg/L	4.8	4.8	1.1	U	U	4.9	4.9	1.1	U	U
Di-n-butyl phthalate	N	µg/L	4.8	4.8	0.84	U	U	4.9	4.9	0.85	U	U
Dinitro-2-methylphenol, 4,6-	N	µg/L	9.6	9.6	1.9	U	U	9.8	9.8	2	U	U
Dinitrophenol, 2,4-	N	µg/L	24	24	9.6	U	U	25	25	9.8	U	U
Dinitrotoluene, 2,4-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Dinitrotoluene, 2,6-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Di-n-octyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	4.9	4.9	1.1	U	U
Fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Fluorene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Hexachlorobenzene	N	µg/L	4.8	4.8	0.54	U	U	4.9	4.9	0.55	U	U
Hexachlorobutadiene	N	µg/L	4.8	4.8	0.96	U	U	4.9	4.9	0.98	U	U
Hexachlorocyclopentadiene	N	µg/L	9.6	9.6	1.8	U	U	9.8	9.8	1.9	U	U
Hexachloroethane	N	µg/L	4.8	4.8	0.96	U	U	4.9	4.9	0.98	U	U
Indeno(1,2,3-cd)pyrene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Isophorone	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Methylnaphthalene, 2-	N	µg/L	4.8	4.8	0.55	U	U	4.9	4.9	0.56	U	U
Methylphenol, 2-	N	µg/L	4.8	4.8	0.52	U	U	4.9	4.9	0.53	U	U
Naphthalene	N	µg/L	4.8	4.8	0.77	U	U	4.9	4.9	0.78	U	U
Nitroaniline, 2-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Nitroaniline, 3-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Nitroaniline, 4-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Nitrobenzene	N	µg/L	4.8	4.8	0.57	U	U	4.9	4.9	0.58	U	U
Nitrophenol, 2-	N	µg/L	4.8	4.8	0.52	U	U	4.9	4.9	0.53	U	U
Nitrophenol, 4-	N	µg/L	24	24	4.8	U	U	25	25	4.9	U	U
n-Nitroso-di-n-propylamine	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
n-Nitrosodiphenylamine	N	µg/L	4.8	4.8	0.96	U	U	4.9	4.9	0.98	U	U
Pentachlorophenol	N	µg/L	24	24	5.2	U	U	25	25	5.3	U	U
Phenanthrene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW03					ULA-MW03				
		SAMPLE NO	ULA3014					ULA3019				
		SAMPLE DATE	12-Dec-11					25-Apr-12				
		DEPTH	6.35 - 6.69 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Phenol	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Pyrene	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Trichlorobenzene, 1,2,4-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Trichlorophenol, 2,4,5-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Trichlorophenol, 2,4,6-	N	µg/L	4.8	4.8	0.48	U	U	4.9	4.9	0.49	U	U
Volatile Organics												
Acetone	N	µg/L	25	25	10	U	U	25	25	10	U	R
Benzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Bromodichloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Bromoform	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Bromomethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U
Butanone, 2-	N	µg/L	5	5	2	U	U	5	5	2	U	U
Carbon disulfide	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U
Carbon tetrachloride	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U
Chlorobenzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Chloroethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U
Chloroform	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U
Chloromethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U
Cyclohexane	N	µg/L										
Dibromo-3-chloropropane, 1,2-	N	µg/L										
Dibromochloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Dibromoethane, 1,2-	N	µg/L										
Dichlorobenzene, 1,2-	N	µg/L										
Dichlorobenzene, 1,3-	N	µg/L										
Dichlorobenzene, 1,4-	N	µg/L										
Dichlorodifluoromethane	N	µg/L										
Dichloroethane, 1,1-	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U
Dichloroethane, 1,2-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Dichloroethene, 1,1-	N	µg/L	1	1	0.23	U	U	1	1	0.23	U	U
Dichloroethene, cis-1,2-	N	µg/L	1	1	0.26	U	U	1	1	0.26	U	U
Dichloroethene, trans-1,2-	N	µg/L	1	1	0.35	U	U	1	1	0.35	U	U
Dichloropropane, 1,2-	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U
Dichloropropene, cis-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Dichloropropene, trans-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Ethylbenzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Hexanone, 2-	N	µg/L	10	10	4	U	U	10	10	4	U	U
Isopropylbenzene	N	µg/L										
METHYL ACETATE	N	µg/L										
Methyl Tertiary Butyl Ether	N	µg/L										
Methyl-2-pentanone, 4-	N	µg/L	5	5	2	U	U	5	5	2	U	U
Methylcyclohexane	N	µg/L										
Methylene chloride	N	µg/L	5	5	2	U	U	5	5	2	U	U
Styrene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Tetrachloroethane, 1,1,2,2-	N	µg/L	1	1	0.23	U	U	1	1	0.23	U	U
Tetrachloroethene	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U
Toluene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Trichlorobenzene, 1,2,4-	N	µg/L										
Trichloroethane, 1,1,1-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U
Trichloroethane, 1,1,2-	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U
Trichloroethene	N	µg/L	1	1	0.26	U	U	1	1	0.26	U	U

Table E-3

Monitoring Well Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-MW03					ULA-MW03				
		SAMPLE NO	ULA3014					ULA3019				
		SAMPLE DATE	12-Dec-11					25-Apr-12				
		DEPTH	6.35 - 6.69 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Trichlorofluoromethane	N	µg/L										
Trichlorotrifluoroethane	N	µg/L										
Vinyl chloride	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U
Xylenes, total	N	µg/L	3	3	0.52	U	U	3	3	0.52	U	U

°C - Degress Celsius.
FD - Field duplicate.
LQ - Laboratory qualifier.
MDL - Method detection limit.
µg/L - Micrograms per liter.
mg/L - Milligrams per liter.
mS/cm - Millisiemens per centimeter.
mV - Millivolt.
NTU - Nephelometric turbidity unit.
REG - Regular sample.
RL - Reporting limit.
VQ - Validation qualifier.

VQ Definitions: U = Not detected; J = Parameter detected, but below the reporting limit. Concentration is considered estimated; B = Blank contaminated. "B" LQ = Concentration is estimated (for metals) or associated with the sample blank (organics).

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-PZ01					ULA-PZ01					ULA-PZ01					ULA-PZ02				
		SAMPLE NO	ULA3000					ULA3001					ULA3002					ULA3003				
		SAMPLE DATE	16-Jun-11					16-Jun-11					16-Jun-11					17-Jun-11				
		DEPTH	0 - 0 Ft					0 - 0 Ft					0 - 0 Ft					7_72 - 22 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																						
Amino-2,6-dinitrotoluene, 4-	N	µg/L																				
Amino-4,6-dinitrotoluene, 2-	N	µg/L																				
Dinitrobenzene, 1,3-	N	µg/L																				
Dinitrotoluene, 2,4-	N	µg/L																				
Dinitrotoluene, 2,6-	N	µg/L																				
HMX	N	µg/L																				
Nitrobenzene	N	µg/L																				
Nitrotoluene, 2-	N	µg/L																				
Nitrotoluene, 3-	N	µg/L																				
Nitrotoluene, 4-	N	µg/L																				
RDX	N	µg/L																				
Tetryl	N	µg/L																				
Trinitrobenzene, 1,3,5-	N	µg/L																				
Trinitrotoluene, 2,4,6-	N	µg/L																				
Field Tests																						
Dissolved Oxygen	N	mg/L	7.4	0.3														5.29	0.3			
Ferrous Iron	N	mg/L																				
Oxidation Reduction Potential	N	mV	-52.9	0.02														-58.1	0.02			
pH	N	pH_units	7.61	0														7.73	0			
Specific Conductivity	N	mS/cm	0.000354	0														0.000342	0			
Temperature	N	°C	18.86	0														15.84	0			
Turbidity	N	NTU	316	10														1581	10			
General Chemistry																						
Alkalinity	N	mg/L																				
Alkalinity, Carbonate	N	mg/L																				
Chloride	N	mg/L																				
Cyanide, total	N	mg/L																				
Hardness (as CaCO3)	N	mg/L																				
Nitrate-Nitrite	N	mg/L																				
Sulfate	N	mg/L																				
Total dissolved solids	N	mg/L																				
Total suspended solids	N	mg/L																				
Turbidity	N	NTU																				
Metals																						
Aluminum	N	µg/L																				
Aluminum	Y	µg/L																				
Antimony	N	µg/L																				
Antimony	Y	µg/L																				
Arsenic	N	µg/L																				
Arsenic	Y	µg/L																				
Barium	N	µg/L																				
Barium	Y	µg/L																				
Beryllium	N	µg/L																				
Beryllium	Y	µg/L																				
Cadmium	N	µg/L																				
Cadmium	Y	µg/L																				
Calcium	N	µg/L																				
Calcium	Y	µg/L																				
Chromium	N	µg/L																				
Chromium	Y	µg/L																				
Cobalt	N	µg/L																				

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-PZ01					ULA-PZ01					ULA-PZ01					ULA-PZ02				
		SAMPLE NO	ULA3000					ULA3001					ULA3002					ULA3003				
		SAMPLE DATE	16-Jun-11					16-Jun-11					16-Jun-11					17-Jun-11				
		DEPTH	0 - 0 Ft					0 - 0 Ft					0 - 0 Ft					7_72 - 22 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Cobalt	Y	µg/L																				
Copper	N	µg/L																				
Copper	Y	µg/L																				
Iron	N	µg/L																				
Iron	Y	µg/L																				
Lead	N	µg/L																				
Lead	Y	µg/L																				
Magnesium	N	µg/L																				
Magnesium	Y	µg/L																				
Manganese	N	µg/L																				
Manganese	Y	µg/L																				
Mercury	N	µg/L																				
Mercury	Y	µg/L																				
Nickel	N	µg/L																				
Nickel	Y	µg/L																				
Potassium	N	µg/L																				
Potassium	Y	µg/L																				
Selenium	N	µg/L																				
Selenium	Y	µg/L																				
Silver	N	µg/L																				
Silver	Y	µg/L																				
Sodium	N	µg/L																				
Sodium	Y	µg/L																				
Thallium	N	µg/L																				
Thallium	Y	µg/L																				
Vanadium	N	µg/L																				
Vanadium	Y	µg/L																				
Zinc	N	µg/L																				
Zinc	Y	µg/L																				
Semivolatile Organics																						
3-Methylphenol and 4-Methylphenol	N	µg/L	4.9	4.9	1.1	U	U											4.9	4.9	1.1	U	U
Acenaphthene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Acenaphthylene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Anthracene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Benzo(a)anthracene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Benzo(a)pyrene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Benzo(b)fluoranthene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Benzo(ghi)perylene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Benzo(k)fluoranthene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Benzoic acid	N	µg/L	49	49	9.8	U	U											49	49	9.8	U	U
Benzyl alcohol	N	µg/L	4.9	4.9	0.98	U	U											4.9	4.9	0.98	U	U
Bis(2-chloroethoxy)methane	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Bis(2-chloroethyl)ether	N	µg/L	4.9	4.9	0.53	U	U											4.9	4.9	0.53	U	U
Bis(2-chloroisopropyl)ether	N	µg/L	4.9	4.9	0.53	U	U											4.9	4.9	0.53	U	U
Bis(2-ethylhexyl)phthalate	N	µg/L	4.9	4.9	1.1	U	U											4.9	4.9	1.1	U	U
Bromophenyl phenyl ether, 4-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Butyl benzyl phthalate	N	µg/L	4.9	4.9	1.1	U	U											4.9	4.9	1.1	U	U
Carbazole	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Chloro-3-methylphenol, 4-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Chloroaniline, 4-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Chloronaphthalene, 2-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Chlorophenol, 2-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-PZ01					ULA-PZ01					ULA-PZ01					ULA-PZ02				
		SAMPLE NO	ULA3000					ULA3001					ULA3002					ULA3003				
		SAMPLE DATE	16-Jun-11					16-Jun-11					16-Jun-11					17-Jun-11				
		DEPTH	0 - 0 Ft					0 - 0 Ft					0 - 0 Ft					7_72 - 22 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Chlorophenyl phenyl ether, 4-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Chrysene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Dibenz(a,h)anthracene	N	µg/L	4.9	4.9	0.51	U	U											4.9	4.9	0.51	U	U
Dibenzofuran	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Dichlorobenzene, 1,2-	N	µg/L	4.9	4.9	0.98	U	U											4.9	4.9	0.98	U	U
Dichlorobenzene, 1,3-	N	µg/L	4.9	4.9	0.98	U	U											4.9	4.9	0.98	U	U
Dichlorobenzene, 1,4-	N	µg/L	4.9	4.9	0.98	U	U											4.9	4.9	0.98	U	U
Dichlorobenzidine, 3,3'-	N	µg/L	9.8	9.8	0.98	U	U											9.8	9.8	0.98	U	U
Dichlorophenol, 2,4-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Diethyl phthalate	N	µg/L	4.9	4.9	1.1	U	U											4.9	4.9	1.1	U	U
Dimethyl phthalate	N	µg/L	4.9	4.9	0.97	U	U											4.9	4.9	0.97	U	U
Dimethylphenol, 2,4-	N	µg/L	4.9	4.9	1.1	U	U											4.9	4.9	1.1	U	U
Di-n-butyl phthalate	N	µg/L	4.9	4.9	0.85	U	U											4.9	4.9	0.85	U	U
Dinitro-2-methylphenol, 4,6-	N	µg/L	9.8	9.8	2	U	U											9.8	9.8	2	U	U
Dinitrophenol, 2,4-	N	µg/L	25	25	9.8	U	UJ											25	25	9.8	U	UJ
Dinitrotoluene, 2,4-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Dinitrotoluene, 2,6-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Di-n-octyl phthalate	N	µg/L	4.9	4.9	1.1	U	U											4.9	4.9	1.1	U	U
Fluoranthene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Fluorene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Hexachlorobenzene	N	µg/L	4.9	4.9	0.55	U	U											4.9	4.9	0.55	U	U
Hexachlorobutadiene	N	µg/L	4.9	4.9	0.98	U	U											4.9	4.9	0.98	U	U
Hexachlorocyclopentadiene	N	µg/L	9.8	9.8	1.9	U	U											9.8	9.8	1.9	U	U
Hexachloroethane	N	µg/L	4.9	4.9	0.98	U	U											4.9	4.9	0.98	U	U
Indeno(1,2,3-cd)pyrene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Isophorone	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Methylnaphthalene, 2-	N	µg/L	4.9	4.9	0.56	U	U											4.9	4.9	0.56	U	U
Methylphenol, 2-	N	µg/L	4.9	4.9	0.53	U	U											4.9	4.9	0.53	U	U
Naphthalene	N	µg/L	4.9	4.9	0.78	U	U											4.9	4.9	0.78	U	U
Nitroaniline, 2-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Nitroaniline, 3-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Nitroaniline, 4-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Nitrobenzene	N	µg/L	4.9	4.9	0.58	U	U											4.9	4.9	0.58	U	U
Nitrophenol, 2-	N	µg/L	4.9	4.9	0.53	U	U											4.9	4.9	0.53	U	U
Nitrophenol, 4-	N	µg/L	25	25	4.9	U	U											25	25	4.9	U	U
n-Nitroso-di-n-propylamine	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
n-Nitrosodiphenylamine	N	µg/L	4.9	4.9	0.98	U	U											4.9	4.9	0.98	U	U
Pentachlorophenol	N	µg/L	25	25	5.3	U	U											25	25	5.3	U	U
Phenanthrene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Phenol	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Pyrene	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Trichlorobenzene, 1,2,4-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Trichlorophenol, 2,4,5-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Trichlorophenol, 2,4,6-	N	µg/L	4.9	4.9	0.49	U	U											4.9	4.9	0.49	U	U
Volatile Organics																						
Acetone	N	µg/L	25	25	10	U	R	25	25	10	U	R	10	10	1.1	U	U	22.3	25	10	J	B
Benzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.13	U	U	1	1	0.2	U	UJ
Bromodichloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.15	U	U	1	1	0.2	U	UJ
Bromoform	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.64	U	U	1	1	0.2	U	UJ
Bromomethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	1	1	0.41	U	R	2	2	0.5	U	UJ
Butanone, 2-	N	µg/L	5	5	2	U	U	5	5	2	U	U	10	10	0.57	U	R	5	5	2	U	UJ
Carbon disulfide	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	1	1	0.13	U	U	2	2	0.5	U	UJ

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-PZ01					ULA-PZ01					ULA-PZ01					ULA-PZ02				
		SAMPLE NO	ULA3000					ULA3001					ULA3002					ULA3003				
		SAMPLE DATE	16-Jun-11					16-Jun-11					16-Jun-11					17-Jun-11				
		DEPTH	0 - 0 Ft					0 - 0 Ft					0 - 0 Ft					7_72 - 22 Ft				
		SAMPLE PURPOSE	REG					FD					FS					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Carbon tetrachloride	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.13	U	U	1	1	0.25	U	UJ
Chlorobenzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.15	U	U	1	1	0.2	U	UJ
Chloroethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	1	1	0.29	U	UJ	2	2	0.5	U	UJ
Chloroform	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.16	U	U	1	1	0.22	U	UJ
Chloromethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	1	1	0.3	U	U	2	2	0.5	U	UJ
Cyclohexane	N	µg/L											1	1	0.12	U	U					
Dibromo-3-chloropropane, 1,2-	N	µg/L											2	2	0.67	U	R					
Dibromochloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.18	U	U	1	1	0.2	U	UJ
Dibromoethane, 1,2-	N	µg/L											1	1	0.24	U	U					
Dichlorobenzene, 1,2-	N	µg/L											1	1	0.13	U	U					
Dichlorobenzene, 1,3-	N	µg/L											1	1	0.14	U	U					
Dichlorobenzene, 1,4-	N	µg/L											1	1	0.13	U	U					
Dichlorodifluoromethane	N	µg/L											1	1	0.31	U	U					
Dichloroethane, 1,1-	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.15	U	U	1	1	0.25	U	UJ
Dichloroethane, 1,2-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.22	U	U	1	1	0.2	U	UJ
Dichloroethene, 1,1-	N	µg/L	1	1	0.23	U	U	1	1	0.23	U	U	1	1	0.19	U	U	1	1	0.23	U	UJ
Dichloroethene, cis-1,2-	N	µg/L	1	1	0.26	U	U	1	1	0.26	U	U	1	1	0.17	U	U	1	1	0.26	U	UJ
Dichloroethene, trans-1,2-	N	µg/L	1	1	0.35	U	U	1	1	0.35	U	U	1	1	0.19	U	U	1	1	0.35	U	UJ
Dichloropropane, 1,2-	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.18	U	U	1	1	0.25	U	UJ
Dichloropropene, cis-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.14	U	U	1	1	0.2	U	UJ
Dichloropropene, trans-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.19	U	U	1	1	0.2	U	UJ
Ethylbenzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.17	U	U	1	1	0.2	U	UJ
Hexanone, 2-	N	µg/L	10	10	4	U	U	10	10	4	U	U	10	10	0.41	U	U	10	10	4	U	UJ
Isopropylbenzene	N	µg/L											1	1	0.13	U	U					
METHYL ACETATE	N	µg/L											10	10	0.38	U	U					
Methyl Tertiary Butyl Ether	N	µg/L											5	5	0.17	U	U					
Methyl-2-pentanone, 4-	N	µg/L	5	5	2	U	U	5	5	2	U	U	10	10	0.32	U	UJ	5	5	2	U	UJ
Methylcyclohexane	N	µg/L											1	1	0.13	U	U					
Methylene chloride	N	µg/L	5	5	2	U	U	5	5	2	U	U	1	1	0.33	U	UJ	5	5	2	U	UJ
Styrene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.11	U	U	1	1	0.2	U	UJ
Tetrachloroethane, 1,1,2,2-	N	µg/L	1	1	0.23	U	U	1	1	0.23	U	U	1	1	0.18	U	U	1	1	0.23	U	UJ
Tetrachloroethene	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.29	U	U	1	1	0.25	U	UJ
Toluene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.13	U	U	1	1	0.2	U	UJ
Trichlorobenzene, 1,2,4-	N	µg/L											1	1	0.15	U	U					
Trichloroethane, 1,1,1-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.22	U	U	1	1	0.2	U	UJ
Trichloroethane, 1,1,2-	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.27	U	U	1	1	0.22	U	UJ
Trichloroethene	N	µg/L	1	1	0.26	U	U	1	1	0.26	U	U	1	1	0.17	U	U	1	1	0.26	U	UJ
Trichlorofluoromethane	N	µg/L											1	1	0.21	U *	UJ					
Trichlorotrifluoroethane	N	µg/L											1	1	0.28	U	U					
Vinyl chloride	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	UJ
Xylenes, total	N	µg/L	3	3	0.52	U	U	3	3	0.52	U	U	2	2	0.28	U	U	3	3	0.52	U	UJ

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-PZ03					ULA-PZ04					ULA-PZ05					ULA-PZ06				
		SAMPLE NO	ULA3004					ULA3005					ULA3006					ULA3007				
		SAMPLE DATE	17-Jun-11					20-Jun-11					17-Jun-11					16-Jun-11				
		DEPTH	0 - 0 Ft					5_19 - 6_43 Ft					7_93 - 29_45 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives																						
Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.19	0.19	0.08	U	U	0.2	0.2	0.082	U	U										
Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Dinitrobenzene, 1,3-	N	µg/L	0.19	0.19	0.094	U	U	0.2	0.2	0.097	U	U										
Dinitrotoluene, 2,4-	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Dinitrotoluene, 2,6-	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
HMX	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Nitrobenzene	N	µg/L	0.19	0.19	0.082	U	U	0.2	0.2	0.084	U	U										
Nitrotoluene, 2-	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Nitrotoluene, 3-	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Nitrotoluene, 4-	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
RDX	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Tetryl	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Trinitrobenzene, 1,3,5-	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Trinitrotoluene, 2,4,6-	N	µg/L	0.19	0.19	0.078	U	U	0.2	0.2	0.08	U	U										
Field Tests																						
Dissolved Oxygen	N	mg/L	3.9	0.3				6.05	0.3				5.89	0.3				6.79	0.3			
Ferrous Iron	N	mg/L																				
Oxidation Reduction Potential	N	mV	-63.3	0.02				-39.2	0.02				-42.4	0.02				-44	0.02			
pH	N	pH_units	7.74	0				7.48	0				7.43	0				7.46	0			
Specific Conductivity	N	mS/cm	0.000363	0				0.000827	0				0.000454	0				0.000349	0			
Temperature	N	°C	18.61	0				16.15	0				17.06	0				16.95	0			
Turbidity	N	NTU	343	10				290	10				12	10				32.8	10			
General Chemistry																						
Alkalinity	N	mg/L																				
Alkalinity, Carbonate	N	mg/L						361	5	2.5												
Chloride	N	mg/L						7.1	2	1												
Cyanide, total	N	mg/L						0.01	0.01	0.005	U	UJ										
Hardness (as CaCO3)	N	mg/L						844	23	0.66			368	23	0.66							
Nitrate-Nitrite	N	mg/L						0.1	0.1	0.05	U	U										
Sulfate	N	mg/L						94.8	2	1		J										
Total dissolved solids	N	mg/L						496	100	10												
Total suspended solids	N	mg/L						5920	100	40												
Turbidity	N	NTU						142	10	10		J										
Metals																						
Aluminum	N	µg/L						7820	200	24		J	2030	200	20							
Aluminum	Y	µg/L						200	200	24	U	U	200	200	20	U	U					
Antimony	N	µg/L						6	6	1	U	U	6	6	1	U	U					
Antimony	Y	µg/L						6	6	1	U	U	6	6	1	U	U					
Arsenic	N	µg/L						25.9	10	1			9.8	10	1	B	J					
Arsenic	Y	µg/L						10	10	1	U	U	3.4	10	1	B	J					
Barium	N	µg/L						194	200	4	B	J	276	200	1							
Barium	Y	µg/L						128	200	4	B	J	274	200	1							
Beryllium	N	µg/L						4	4	0.1	U	U	4	4	0.1	U	U					
Beryllium	Y	µg/L						4	4	0.1	U	U	4	4	0.1	U	U					
Cadmium	N	µg/L						5	5	0.1	U	U	5	5	0.1	U	U					
Cadmium	Y	µg/L						5	5	0.1	U	U	5	5	0.1	U	U					
Calcium	N	µg/L						221000	1000	50		J	90700	1000	50							
Calcium	Y	µg/L						104000	1000	50			80000	1000	50							
Chromium	N	µg/L						13.3	10	1			4.1	10	1	B	J					
Chromium	Y	µg/L						10	10	1	U	U	10	10	1	U	U					
Cobalt	N	µg/L						10	50	1	B	J	1.9	50	1	B	J					

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-PZ03					ULA-PZ04					ULA-PZ05					ULA-PZ06				
		SAMPLE NO	ULA3004					ULA3005					ULA3006					ULA3007				
		SAMPLE DATE	17-Jun-11					20-Jun-11					17-Jun-11					16-Jun-11				
		DEPTH	0 - 0 Ft					5_19 - 6_43 Ft					7_93 - 29_45 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Cobalt	Y	µg/L						50	50	1	U	U	50	50	1	U	U					
Copper	N	µg/L						27.6	25	1			6.7	25	1	B	J					
Copper	Y	µg/L						25	25	1	U	U	2.1	25	1	B	J					
Iron	N	µg/L						28900	300	23		J	4220	300	34							
Iron	Y	µg/L						874	300	23			38.4	300	34	B	J					
Lead	N	µg/L						16.5	5	1			2.2	5	1	B	J					
Lead	Y	µg/L						5	5	1	U	U	5	5	1	U	U					
Magnesium	N	µg/L						71000	5000	50		J	34300	5000	50							
Magnesium	Y	µg/L						33700	5000	50			31300	5000	50							
Manganese	N	µg/L						947	15	1		J	858	15	1							
Manganese	Y	µg/L						191	15	1			751	15	1							
Mercury	N	µg/L						0.14	1	0.071	B	J	1	1	0.071	U	U					
Mercury	Y	µg/L						1	1	0.071	U	U	1	1	0.071	U	U					
Nickel	N	µg/L						25.8	40	1	B	J	5.8	40	1	B	J					
Nickel	Y	µg/L						40	40	1	U	U	40	40	1	U	U					
Potassium	N	µg/L						3810	10000	50	B	J	7570	10000	50	B	J					
Potassium	Y	µg/L						1470	10000	50	B	J	7520	10000	50	B	J					
Selenium	N	µg/L						2.1	10	2	B	J	10	10	2	U	U					
Selenium	Y	µg/L						2.1	10	2	B	J	10	10	2	U	U					
Silver	N	µg/L						10	10	1	U	UJ	10	10	1	U	U					
Silver	Y	µg/L						10	10	1	U	UJ	10	10	1	U	U					
Sodium	N	µg/L						14900	10000	850			42700	10000	750							
Sodium	Y	µg/L						14900	10000	850			45000	10000	750							
Thallium	N	µg/L						10	10	1.5	U	U	10	10	1	U	U					
Thallium	Y	µg/L						10	10	1.5	U	U	10	10	1	U	U					
Vanadium	N	µg/L						20.6	50	1	B	J	5.3	50	1	B	J					
Vanadium	Y	µg/L						50	50	1	U	U	50	50	1	U	U					
Zinc	N	µg/L						71.9	20	1		J	29.9	20	1							
Zinc	Y	µg/L						5.5	20	1	B	J	8.3	20	1	B	J					
Semivolatile Organics																						
3-Methylphenol and 4-Methylphenol	N	µg/L	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U
Acenaphthene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Acenaphthylene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Anthracene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Benzo(a)anthracene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Benzo(a)pyrene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Benzo(b)fluoranthene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Benzo(ghi)perylene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	UJ	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Benzo(k)fluoranthene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Benzoic acid	N	µg/L	49	49	9.7	U	U	49	49	9.7	U	U	49	49	9.7	U	U	49	49	9.7	U	U
Benzyl alcohol	N	µg/L	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U
Bis(2-chloroethoxy)methane	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Bis(2-chloroethyl)ether	N	µg/L	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U
Bis(2-chloroisopropyl)ether	N	µg/L	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U
Bis(2-ethylhexyl)phthalate	N	µg/L	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U
Bromophenyl phenyl ether, 4-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Butyl benzyl phthalate	N	µg/L	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U
Carbazole	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Chloro-3-methylphenol, 4-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Chloroaniline, 4-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Chloronaphthalene, 2-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Chlorophenol, 2-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-PZ03					ULA-PZ04					ULA-PZ05					ULA-PZ06				
		SAMPLE NO	ULA3004					ULA3005					ULA3006					ULA3007				
		SAMPLE DATE	17-Jun-11					20-Jun-11					17-Jun-11					16-Jun-11				
		DEPTH	0 - 0 Ft					5_19 - 6_43 Ft					7_93 - 29_45 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Chlorophenyl phenyl ether, 4-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Chrysene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Dibenz(a,h)anthracene	N	µg/L	4.9	4.9	0.5	U	U	4.9	4.9	0.5	U	U	4.9	4.9	0.5	U	U	4.9	4.9	0.5	U	U
Dibenzofuran	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Dichlorobenzene, 1,2-	N	µg/L	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U
Dichlorobenzene, 1,3-	N	µg/L	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U
Dichlorobenzene, 1,4-	N	µg/L	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U
Dichlorobenzidine, 3,3'-	N	µg/L	9.7	9.7	0.97	U	U	9.7	9.7	0.97	U	U	9.7	9.7	0.97	U	U	9.7	9.7	0.97	U	U
Dichlorophenol, 2,4-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Diethyl phthalate	N	µg/L	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U
Dimethyl phthalate	N	µg/L	4.9	4.9	0.96	U	U	4.9	4.9	0.96	U	U	4.9	4.9	0.96	U	U	4.9	4.9	0.96	U	U
Dimethylphenol, 2,4-	N	µg/L	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U
Di-n-butyl phthalate	N	µg/L	4.9	4.9	0.84	U	U	4.9	4.9	0.84	U	U	4.9	4.9	0.84	U	U	4.9	4.9	0.84	U	U
Dinitro-2-methylphenol, 4,6-	N	µg/L	9.7	9.7	1.9	U	U	9.7	9.7	1.9	U	U	9.7	9.7	1.9	U	U	9.7	9.7	1.9	U	U
Dinitrophenol, 2,4-	N	µg/L	24	24	9.7	U	UJ	24	24	9.7	U	U	24	24	9.7	U	UJ	24	24	9.7	U	UJ
Dinitrotoluene, 2,4-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Dinitrotoluene, 2,6-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Di-n-octyl phthalate	N	µg/L	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U	4.9	4.9	1.1	U	U
Fluoranthene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Fluorene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Hexachlorobenzene	N	µg/L	4.9	4.9	0.54	U	U	4.9	4.9	0.54	U	U	4.9	4.9	0.54	U	U	4.9	4.9	0.54	U	U
Hexachlorobutadiene	N	µg/L	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U
Hexachlorocyclopentadiene	N	µg/L	9.7	9.7	1.8	U	U	9.7	9.7	1.8	U	U	9.7	9.7	1.8	U	U	9.7	9.7	1.8	U	U
Hexachloroethane	N	µg/L	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U
Indeno(1,2,3-cd)pyrene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Isophorone	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Methylnaphthalene, 2-	N	µg/L	4.9	4.9	0.55	U	U	4.9	4.9	0.55	U	U	4.9	4.9	0.55	U	U	4.9	4.9	0.55	U	U
Methylphenol, 2-	N	µg/L	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U
Naphthalene	N	µg/L	4.9	4.9	0.78	U	U	4.9	4.9	0.78	U	U	4.9	4.9	0.78	U	U	4.9	4.9	0.78	U	U
Nitroaniline, 2-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Nitroaniline, 3-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Nitroaniline, 4-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Nitrobenzene	N	µg/L	4.9	4.9	0.57	U	U	4.9	4.9	0.57	U	U	4.9	4.9	0.57	U	U	4.9	4.9	0.57	U	U
Nitrophenol, 2-	N	µg/L	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U	4.9	4.9	0.52	U	U
Nitrophenol, 4-	N	µg/L	24	24	4.9	U	U	24	24	4.9	U	U	24	24	4.9	U	U	24	24	4.9	U	U
n-Nitroso-di-n-propylamine	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
n-Nitrosodiphenylamine	N	µg/L	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U	4.9	4.9	0.97	U	U
Pentachlorophenol	N	µg/L	24	24	5.2	U	U	24	24	5.2	U	U	24	24	5.2	U	U	24	24	5.2	U	U
Phenanthrene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Phenol	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Pyrene	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Trichlorobenzene, 1,2,4-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Trichlorophenol, 2,4,5-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Trichlorophenol, 2,4,6-	N	µg/L	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U	4.9	4.9	0.49	U	U
Volatile Organics																						
Acetone	N	µg/L	26.2	25	10		B	25	25	10	U	U	25	25	10	U	R	17	25	10	J	B
Benzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Bromodichloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	UJ
Bromoform	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	UJ
Bromomethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	2	2	0.5	U	U	2	2	0.5	U	U
Butanone, 2-	N	µg/L	5	5	2	U	U	5	5	2	U	U	5	5	2	U	U	5	5	2	U	U
Carbon disulfide	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	2	2	0.5	U	U	2	2	0.5	U	UJ

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION CODE	ULA-PZ03					ULA-PZ04					ULA-PZ05					ULA-PZ06				
		SAMPLE NO	ULA3004					ULA3005					ULA3006					ULA3007				
		SAMPLE DATE	17-Jun-11					20-Jun-11					17-Jun-11					16-Jun-11				
		DEPTH	0 - 0 Ft					5_19 - 6_43 Ft					7_93 - 29_45 Ft					0 - 0 Ft				
		SAMPLE PURPOSE	REG					REG					REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Carbon tetrachloride	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	UJ	1	1	0.25	U	U	1	1	0.25	U	U
Chlorobenzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Chloroethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	2	2	0.5	U	U	2	2	0.5	U	U
Chloroform	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U
Chloromethane	N	µg/L	2	2	0.5	U	U	2	2	0.5	U	U	2	2	0.5	U	U	2	2	0.5	U	U
Cyclohexane	N	µg/L																				
Dibromo-3-chloropropane, 1,2-	N	µg/L																				
Dibromochloromethane	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	UJ
Dibromoethane, 1,2-	N	µg/L																				
Dichlorobenzene, 1,2-	N	µg/L																				
Dichlorobenzene, 1,3-	N	µg/L																				
Dichlorobenzene, 1,4-	N	µg/L																				
Dichlorodifluoromethane	N	µg/L																				
Dichloroethane, 1,1-	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.25	U	U
Dichloroethane, 1,2-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	UJ
Dichloroethene, 1,1-	N	µg/L	1	1	0.23	U	U	1	1	0.23	U	U	1	1	0.23	U	U	1	1	0.23	U	U
Dichloroethene, cis-1,2-	N	µg/L	1	1	0.26	U	U	1	1	0.26	U	U	1	1	0.26	U	U	1	1	0.26	U	U
Dichloroethene, trans-1,2-	N	µg/L	1	1	0.35	U	U	1	1	0.35	U	U	1	1	0.35	U	U	1	1	0.35	U	U
Dichloropropane, 1,2-	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.25	U	U
Dichloropropene, cis-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	UJ	1	1	0.2	U	U	1	1	0.2	U	UJ
Dichloropropene, trans-1,3-	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	UJ
Ethylbenzene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Hexanone, 2-	N	µg/L	10	10	4	U	U	10	10	4	U	U	10	10	4	U	U	10	10	4	U	U
Isopropylbenzene	N	µg/L																				
METHYL ACETATE	N	µg/L																				
Methyl Tertiary Butyl Ether	N	µg/L																				
Methyl-2-pentanone, 4-	N	µg/L	5	5	2	U	U	5	5	2	U	U	5	5	2	U	U	5	5	2	U	U
Methylcyclohexane	N	µg/L																				
Methylene chloride	N	µg/L	5	5	2	U	U	5	5	2	U	U	5	5	2	U	U	5	5	2	U	U
Styrene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Tetrachloroethane, 1,1,2,2-	N	µg/L	1	1	0.23	U	U	1	1	0.23	U	U	1	1	0.23	U	U	1	1	0.23	U	U
Tetrachloroethene	N	µg/L	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.25	U	U	1	1	0.25	U	U
Toluene	N	µg/L	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U	1	1	0.2	U	U
Trichlorobenzene, 1,2,4-	N	µg/L																				
Trichloroethane, 1,1,1-	N	µg/L	1	1	0.2	U	U	7.9	1	0.2			1	1	0.2	U	U	1	1	0.2	U	U
Trichloroethane, 1,1,2-	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U
Trichloroethene	N	µg/L	1	1	0.26	U	U	1	1	0.26	U	U	1	1	0.26	U	U	1	1	0.26	U	U
Trichlorofluoromethane	N	µg/L																				
Trichlorotrifluoroethane	N	µg/L																				
Vinyl chloride	N	µg/L	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U	1	1	0.22	U	U
Xylenes, total	N	µg/L	3	3	0.52	U	U	3	3	0.52	U	U	3	3	0.52	U	U	3	3	0.52	U	U

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	LOCATION CODE		ULA-PZ07					ULA-PZ08				
	SAMPLE NO		ULA3008					ULA3009				
	SAMPLE DATE		16-Jun-11					17-Jun-11				
	DEPTH		0 - 0 Ft					0 - 0 Ft				
	SAMPLE PURPOSE		REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Explosives												
Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.2	0.2	0.08	U	U	0.2	0.2	0.08	U	U
Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Dinitrobenzene, 1,3-	N	µg/L	0.2	0.2	0.095	U	U	0.2	0.2	0.095	U	U
Dinitrotoluene, 2,4-	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Dinitrotoluene, 2,6-	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
HMX	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Nitrobenzene	N	µg/L	0.2	0.2	0.082	U	U	0.2	0.2	0.082	U	U
Nitrotoluene, 2-	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Nitrotoluene, 3-	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Nitrotoluene, 4-	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
RDX	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Tetryl	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Trinitrobenzene, 1,3,5-	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Trinitrotoluene, 2,4,6-	N	µg/L	0.2	0.2	0.078	U	U	0.2	0.2	0.078	U	U
Field Tests												
Dissolved Oxygen	N	mg/L	3.39	0.3				1.71	0.3			
Ferrous Iron	N	mg/L										
Oxidation Reduction Potential	N	mV	-50	0.02				-50.8	0.02			
pH	N	pH_units	7.55	0				7.49	0			
Specific Conductivity	N	mS/cm	0.000371	0				0.000693	0			
Temperature	N	°C	19.16	0				17.43	0			
Turbidity	N	NTU	240	10				1595	10			
General Chemistry												
Alkalinity	N	mg/L										
Alkalinity, Carbonate	N	mg/L										
Chloride	N	mg/L										
Cyanide, total	N	mg/L										
Hardness (as CaCO3)	N	mg/L										
Nitrate-Nitrite	N	mg/L										
Sulfate	N	mg/L										
Total dissolved solids	N	mg/L										
Total suspended solids	N	mg/L										
Turbidity	N	NTU										
Metals												
Aluminum	N	µg/L										
Aluminum	Y	µg/L										
Antimony	N	µg/L										
Antimony	Y	µg/L										
Arsenic	N	µg/L										
Arsenic	Y	µg/L										
Barium	N	µg/L										
Barium	Y	µg/L										
Beryllium	N	µg/L										
Beryllium	Y	µg/L										
Cadmium	N	µg/L										
Cadmium	Y	µg/L										
Calcium	N	µg/L										
Calcium	Y	µg/L										
Chromium	N	µg/L										
Chromium	Y	µg/L										
Cobalt	N	µg/L										

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	LOCATION CODE		ULA-PZ07					ULA-PZ08				
	SAMPLE NO		ULA3008					ULA3009				
	SAMPLE DATE		16-Jun-11					17-Jun-11				
	DEPTH		0 - 0 Ft					0 - 0 Ft				
	SAMPLE PURPOSE		REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Cobalt	Y	µg/L										
Copper	N	µg/L										
Copper	Y	µg/L										
Iron	N	µg/L										
Iron	Y	µg/L										
Lead	N	µg/L										
Lead	Y	µg/L										
Magnesium	N	µg/L										
Magnesium	Y	µg/L										
Manganese	N	µg/L										
Manganese	Y	µg/L										
Mercury	N	µg/L										
Mercury	Y	µg/L										
Nickel	N	µg/L										
Nickel	Y	µg/L										
Potassium	N	µg/L										
Potassium	Y	µg/L										
Selenium	N	µg/L										
Selenium	Y	µg/L										
Silver	N	µg/L										
Silver	Y	µg/L										
Sodium	N	µg/L										
Sodium	Y	µg/L										
Thallium	N	µg/L										
Thallium	Y	µg/L										
Vanadium	N	µg/L										
Vanadium	Y	µg/L										
Zinc	N	µg/L										
Zinc	Y	µg/L										
Semivolatile Organics												
3-Methylphenol and 4-Methylphenol	N	µg/L	4.8	4.8	1.1	U	U	5	5	1.1	U	U
Acenaphthene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Acenaphthylene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Anthracene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Benzo(a)anthracene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Benzo(a)pyrene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Benzo(b)fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Benzo(ghi)perylene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Benzo(k)fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Benzoic acid	N	µg/L	48	48	9.6	U	U	50	50	10	U	U
Benzyl alcohol	N	µg/L	4.8	4.8	0.96	U	U	5	5	1	U	U
Bis(2-chloroethoxy)methane	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Bis(2-chloroethyl)ether	N	µg/L	4.8	4.8	0.52	U	U	5	5	0.54	U	U
Bis(2-chloroisopropyl)ether	N	µg/L	4.8	4.8	0.52	U	U	5	5	0.54	U	U
Bis(2-ethylhexyl)phthalate	N	µg/L	4.8	4.8	1.1	U	U	5	5	1.1	U	U
Bromophenyl phenyl ether, 4-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Butyl benzyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	5	5	1.1	U	U
Carbazole	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Chloro-3-methylphenol, 4-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Chloroaniline, 4-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Chloronaphthalene, 2-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Chlorophenol, 2-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	LOCATION CODE		ULA-PZ07					ULA-PZ08				
	SAMPLE NO		ULA3008					ULA3009				
	SAMPLE DATE		16-Jun-11					17-Jun-11				
	DEPTH		0 - 0 Ft					0 - 0 Ft				
	SAMPLE PURPOSE		REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Chlorophenyl phenyl ether, 4-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Chrysene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Dibenz(a,h)anthracene	N	µg/L	4.8	4.8	0.5	U	U	5	5	0.52	U	U
Dibenzofuran	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Dichlorobenzene, 1,2-	N	µg/L	4.8	4.8	0.96	U	U	5	5	1	U	U
Dichlorobenzene, 1,3-	N	µg/L	4.8	4.8	0.96	U	U	5	5	1	U	U
Dichlorobenzene, 1,4-	N	µg/L	4.8	4.8	0.96	U	U	5	5	1	U	U
Dichlorobenzidine, 3,3'-	N	µg/L	9.6	9.6	0.96	U	U	10	10	1	U	U
Dichlorophenol, 2,4-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Diethyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	5	5	1.1	U	U
Dimethyl phthalate	N	µg/L	4.8	4.8	0.95	U	U	5	5	0.99	U	U
Dimethylphenol, 2,4-	N	µg/L	4.8	4.8	1.1	U	U	5	5	1.1	U	U
Di-n-butyl phthalate	N	µg/L	4.8	4.8	0.84	U	U	5	5	0.87	U	U
Dinitro-2-methylphenol, 4,6-	N	µg/L	9.6	9.6	1.9	U	U	10	10	2	U	U
Dinitrophenol, 2,4-	N	µg/L	24	24	9.6	U	UJ	25	25	10	U	UJ
Dinitrotoluene, 2,4-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Dinitrotoluene, 2,6-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Di-n-octyl phthalate	N	µg/L	4.8	4.8	1.1	U	U	5	5	1.1	U	U
Fluoranthene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Fluorene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Hexachlorobenzene	N	µg/L	4.8	4.8	0.54	U	U	5	5	0.56	U	U
Hexachlorobutadiene	N	µg/L	4.8	4.8	0.96	U	U	5	5	1	U	U
Hexachlorocyclopentadiene	N	µg/L	9.6	9.6	1.8	U	U	10	10	1.9	U	U
Hexachloroethane	N	µg/L	4.8	4.8	0.96	U	U	5	5	1	U	U
Indeno(1,2,3-cd)pyrene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Isophorone	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Methylnaphthalene, 2-	N	µg/L	4.8	4.8	0.55	U	U	5	5	0.57	U	U
Methylphenol, 2-	N	µg/L	4.8	4.8	0.52	U	U	5	5	0.54	U	U
Naphthalene	N	µg/L	4.8	4.8	0.77	U	U	5	5	0.8	U	U
Nitroaniline, 2-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Nitroaniline, 3-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Nitroaniline, 4-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Nitrobenzene	N	µg/L	4.8	4.8	0.57	U	U	5	5	0.59	U	U
Nitrophenol, 2-	N	µg/L	4.8	4.8	0.52	U	U	5	5	0.54	U	U
Nitrophenol, 4-	N	µg/L	24	24	4.8	U	U	25	25	5	U	U
n-Nitroso-di-n-propylamine	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
n-Nitrosodiphenylamine	N	µg/L	4.8	4.8	0.96	U	U	5	5	1	U	U
Pentachlorophenol	N	µg/L	24	24	5.2	U	U	25	25	5.4	U	U
Phenanthrene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Phenol	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Pyrene	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Trichlorobenzene, 1,2,4-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Trichlorophenol, 2,4,5-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Trichlorophenol, 2,4,6-	N	µg/L	4.8	4.8	0.48	U	U	5	5	0.5	U	U
Volatile Organics												
Acetone	N	µg/L	10.4	25	10	J	B	25	25	10	U	UJ
Benzene	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Bromodichloromethane	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Bromoform	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Bromomethane	N	µg/L	2	2	0.5	U	UJ	2	2	0.5	U	UJ
Butanone, 2-	N	µg/L	5	5	2	U	UJ	5	5	2	U	UJ
Carbon disulfide	N	µg/L	2	2	0.5	U	UJ	2	2	0.5	U	UJ

Table E-4

Piezometer Groundwater Data Used in the Baseline Human Health Risk Assessment
Unloading Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	LOCATION CODE		ULA-PZ07					ULA-PZ08				
	SAMPLE NO		ULA3008					ULA3009				
	SAMPLE DATE		16-Jun-11					17-Jun-11				
	DEPTH		0 - 0 Ft					0 - 0 Ft				
	SAMPLE PURPOSE		REG					REG				
Parameter	**Filtered**	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Carbon tetrachloride	N	µg/L	1	1	0.25	U	UJ	1	1	0.25	U	UJ
Chlorobenzene	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Chloroethane	N	µg/L	2	2	0.5	U	UJ	2	2	0.5	U	UJ
Chloroform	N	µg/L	1	1	0.22	U	UJ	1	1	0.22	U	UJ
Chloromethane	N	µg/L	2	2	0.5	U	UJ	2	2	0.5	U	UJ
Cyclohexane	N	µg/L										
Dibromo-3-chloropropane, 1,2-	N	µg/L										
Dibromochloromethane	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Dibromoethane, 1,2-	N	µg/L										
Dichlorobenzene, 1,2-	N	µg/L										
Dichlorobenzene, 1,3-	N	µg/L										
Dichlorobenzene, 1,4-	N	µg/L										
Dichlorodifluoromethane	N	µg/L										
Dichloroethane, 1,1-	N	µg/L	1	1	0.25	U	UJ	1	1	0.25	U	UJ
Dichloroethane, 1,2-	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Dichloroethene, 1,1-	N	µg/L	1	1	0.23	U	UJ	1	1	0.23	U	UJ
Dichloroethene, cis-1,2-	N	µg/L	1	1	0.26	U	UJ	1	1	0.26	U	UJ
Dichloroethene, trans-1,2-	N	µg/L	1	1	0.35	U	UJ	1	1	0.35	U	UJ
Dichloropropane, 1,2-	N	µg/L	1	1	0.25	U	UJ	1	1	0.25	U	UJ
Dichloropropene, cis-1,3-	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Dichloropropene, trans-1,3-	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Ethylbenzene	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Hexanone, 2-	N	µg/L	10	10	4	U	UJ	10	10	4	U	UJ
Isopropylbenzene	N	µg/L										
METHYL ACETATE	N	µg/L										
Methyl Tertiary Butyl Ether	N	µg/L										
Methyl-2-pentanone, 4-	N	µg/L	5	5	2	U	UJ	5	5	2	U	UJ
Methylcyclohexane	N	µg/L										
Methylene chloride	N	µg/L	5	5	2	U	UJ	5	5	2	U	UJ
Styrene	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Tetrachloroethane, 1,1,2,2-	N	µg/L	1	1	0.23	U	UJ	1	1	0.23	U	UJ
Tetrachloroethene	N	µg/L	1	1	0.25	U	UJ	1	1	0.25	U	UJ
Toluene	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Trichlorobenzene, 1,2,4-	N	µg/L										
Trichloroethane, 1,1,1-	N	µg/L	1	1	0.2	U	UJ	1	1	0.2	U	UJ
Trichloroethane, 1,1,2-	N	µg/L	1	1	0.22	U	UJ	1	1	0.22	U	UJ
Trichloroethene	N	µg/L	1	1	0.26	U	UJ	1	1	0.26	U	UJ
Trichlorofluoromethane	N	µg/L										
Trichlorotrifluoroethane	N	µg/L										
Vinyl chloride	N	µg/L	1	1	0.22	U	UJ	1	1	0.22	U	UJ
Xylenes, total	N	µg/L	3	3	0.52	U	UJ	3	3	0.52	U	UJ

°C - Degress Celsius.
FD - Field duplicate.
LQ - Laboratory qualifier.
MDL - Method detection limit.
µg/L - Micrograms per liter.
mg/L - Milligrams per liter.
mS/cm - Millisiemens per centimeter.
mV - Millivolt.
NTU - Nephelometric turbidity unit.

REG - Regular sample.
RL - Reporting limit.
VQ - Validation qualifier.

VQ Definitions: U = Not detected; J = Parameter detected, but below the reporting limit. Concentration is considered estimated; B = Blank contaminated. "B" LQ = Concentration is estimated (for metals) or associated with the sample blank (organics).

RESPONSE TO COMMENTS

Responses to Ohio Environmental Protection Agency Comments on the Draft Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment for the Garage Maintenance Area (Unloading Area) Former Plum Brook Ordnance Works, Sandusky, Ohio, Dated September 3, 2013

The Draft Baseline Human Health and Screening-Level Ecological Risk Assessments were submitted to the Ohio Environmental Protection Agency (EPA) for Comments. The Ohio EPA provided no comments, as indicated by correspondence received November 13, 2013.