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April 1, 2014

U.S. Army Engineer District, Nashville
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Subject: ***Submittal of the Final Remedial Investigation Report for Powerhouse 2 Ash Pits (Including Coal Yard No. 2)***
FUDS Project No. G05OH001822
Former Plum Brook Ordnance Works, Sandusky, Ohio
Contract No. W912P5-12-D-0001: Shaw Project Number 146394

Dear Ms. Coleman:

In accordance with the requirements of Task Order No. DO-02 of Contract No. W912P5-12-D-0001 to CB&I Federal Services LLC, we are pleased to submit the final Remedial Investigation Report for the Power House No. 2 Ash Pits (AP2) at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio. This report represents the full compilation and summary for the Remedial Investigation for AP2 (DERP-FUDS Project No. G05OH001820). This report was prepared consistent with the following: the site characterization report, baseline human health risk assessment, and the screening-level ecological risk assessment that were prepared and finalized for AP2; the agreements among the PBOW project delivery team members; and communications with the U.S. Army Corps of Engineers regarding the scope of this report. This final document incorporates all responses to comment.

Enclosed for your records are four copies of this report and a complete electronic copy is attached to each hard copy on compact disk (CD). Copies have also been sent to those on the distribution list as indicated for their records.

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

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Project Description: Remedial Investigation Report for Powerhouse 2 Ash Pits (Including Coal Yard No. 2)
DERP-FUDS Project No. G05OH001822, Former Plum Brook Ordnance Works, Sandusky, Ohio

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Final

Remedial Investigation Report
Powerhouse No. 2 Ash Pits
(Including Coal Yard No. 2)
FUDS Project No. G05OH001822

Former Plum Brook Ordnance Works,
Sandusky, Ohio

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April 2014

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List of Acronyms

amsl	above mean sea level
AP2	Powerhouse No. 2 Ash Pits
bgs	below ground surface
BHHRA	baseline human health risk assessment
BSC	background screening concentration
COPC	chemical of potential concern
COPEC	chemicals of potential ecological concern
CSEM	conceptual site exposure model
CY2	Coal Yard No. 2
DERP	Army Defense Environmental Restoration Program
D&M	Dames and Moore, Inc.
DNT	dinitroluene
DoD	U.S. Department of Defense
DQO	data quality objectives
EPA	U.S. Environmental Protection Agency
ESV	ecological screening value
FS	feasibility study
FUDS	Formerly Used Defense Sites
HI	hazard index
HQ	hazard quotient
ICI	International Consultants Incorporated
ILCR	incremental lifetime cancer risk
IT	IT Corporation
LRD	Great Lakes and Rivers Division
MCL	maximum contaminant level
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MK	Morrison Knudsen Corporation
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	no-observed-adverse-effects level
NWI	National Wetland Inventory
ODNR	Ohio Department of Natural Resources

List of Acronyms *(Continued)*

OEPA	Ohio Environmental Protection Agency
PBOW	Plum Brook Ordnance Works
PBS	Plum Brook Station
PCB	polychlorinated biphenyl
ppm	parts per million
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RBRC	risk-based remedial concentration
RBSC	risk-based screening concentration
RfD	reference dose
RI	remedial investigation
SCR	site characterization report
SDWR	Secondary Drinking Water Regulations
Shaw	Shaw Environmental, Inc.
SI	site inspection
SLERA	screening-level ecological risk assessment
SVOC	semivolatile organic compound
T&E	threatened or endangered
TAL	target analyte list
TDS	total dissolved solids
TNB	trinitrobenzene
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
TOC	total organic carbon
TRV	toxicity reference values
USACE	U.S. Corps of Engineers
VOC	volatile organic compound
WAA	War Assets Administration

Executive Summary

A remedial investigation (RI) was conducted for the Powerhouse No. 2 Ash Pits (AP2) and the associated Coal Yard No. 2 (CY2) at the Plum Brook Ordnance Works, Sandusky, Ohio. CY2 is administrated as part of Defense Environmental Restoration Program (DERP)-Formerly Used Defense Sites (FUDS) Project No. G05OH001822, which is referred to collectively as AP2. The results of the RI have been previously reported in the following six finalized documents:

- Shaw Environmental, Inc. (Shaw), 2010, *Powerhouse 2 Ash Pits, Site Characterization Report,* Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, September.

- Shaw Environmental, Inc. (Shaw), 2010, *Baseline Human Health Risk Assessment, Powerhouse 2 Ash Pits,* Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, September.

- Shaw Environmental, Inc. (Shaw), 2010, *Screening Level Ecological Risk Assessment, Powerhouse 2 Ash Pits,* Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, September.

- Shaw Environmental, Inc. (Shaw), 2012, Powerhouse No. 2 Ash Pits Site Characterization Report Addendum for Coal Yard No. 2, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, September.

- Shaw Environmental & Infrastructure, Inc. (Shaw), 2013, Powerhouse No. 2 Ash Pits Baseline Human Health Risk Assessment Addendum For Coal Yard No. 2, Final, Plum Brook Ordnance Works, Sandusky, Ohio, July.

- Shaw Environmental & Infrastructure, Inc. (Shaw), 2013, Powerhouse No. 2 Ash Pits Screening-Level Ecological Risk Assessment Addendum for Coal Yard No. 2, Final, Plum Brook *Ordnance Works, Sandusky, Ohio,* July.

This RI summarizes the findings of these six reports, which are appended. No additional investigation results, evaluation, or information concerning these sites is included in this RI. However, recommendations are provided based on this previously provided information. Thus, the purposes of this RI report are to 1) place all RI-related reports under a single cover, and 2) record a recommendation as to whether or not performance of a feasibility study is warranted.

Recommendations. Based on the RI results, including the baseline human health risk assessment and screening-level ecological risk assessment, the U.S. Army Corps of Engineers recommends no further action with respect to the AP2 and CY2 sites. Therefore, a feasibility

study is not warranted for DERP-FUDS Project No. G05OH001822. This recommendation is on the finding that the exposure to environmental media associated with these sites pose no unacceptable human health risks/hazards or ecological hazards that are attributable to past U.S. Department of Defense practices.

1.0 Introduction

The U.S. Army is conducting studies of environmental impacts attributable to releases associated with historical operations at the former Plum Brook Ordnance Works (PBOW) in Sandusky, Erie County, Ohio. This property was previously a government-owned, contractor-operated facility used to manufacture nitroaromatic explosives and pentolite for the U.S. Department of Defense (DoD). PBOW is an Army Defense Environmental Restoration Program (DERP) project under the Great Lakes and Rivers Division (LRD) Formerly Used Defense Sites (FUDS) program. The Louisville District Office of the U.S. Army Corps of Engineers (USACE) is the program management district for the LRD FUDS program. Management support for PBOW is provided by the USACE Huntington District Office, and technical oversight is provided by the USACE Nashville District Office.

This remedial investigation (RI) has been performed to determine if there have been any environmental impacts associated with the former Powerhouse 2 Ash Pits (AP2) disposal area and Coal Yard No. 2 (CY2) that present an unacceptable risk to human health or the environment. AP2 and CY2 are both part of the DERP-FUDS Project No. G05OH001822.

RI activities were conducted under Delivery Order Nos. DX05 (for AP2) and DX02 (for CY2), which are both part of Contract No. W912QR-08-D-0013 and previously held by Shaw Environmental & Infrastructure, Inc. Please note that the Shaw Group was acquired by CB&I in 2013. As a result, this contract and other contracts have been novated to CB&I Federal Services LLC. This report summarizes the information presented previously in the following reports:

Powerhouse No. 2 Ash Pits

Shaw Environmental (Shaw), 2010a, *Powerhouse 2 Ash Pits Site Characterization Report, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, Revision 1,* September.

Shaw Environmental, Inc. (Shaw), 2010b, *Baseline Human Health Risk Assessment, Powerhouse 2 Ash Pits, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio,* September.

Shaw Environmental, Inc. (Shaw), 2010c, *Screening Level Ecological Risk Assessment, Powerhouse 2 Ash Pits, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio,* September.

Coal Yard No. 2

Shaw Environmental, Inc. (Shaw), 2012, *Powerhouse No. 2 Ash Pits Site Characterization Report Addendum for Coal Yard No. 2, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio,* September.

Shaw Environmental & Infrastructure, Inc. (Shaw), 2013a, *Powerhouse No. 2 Ash Pits Baseline Human Health Risk Assessment Addendum For Coal Yard No. 2, Final, Plum Brook Ordnance Works, Sandusky, Ohio,* July.

Shaw Environmental & Infrastructure, Inc. (Shaw), 2013b, *Powerhouse No. 2 Ash Pits Screening-Level Ecological Risk Assessment Addendum for Coal Yard No. 2, Final, Plum Brook Ordnance Works, Sandusky, Ohio,* July.

It should be noted that this RI report generally presents and summarizes information directly as it was conveyed in these final approved reports. No new data are presented in this RI report. However, Section 2.4 includes an updated evaluation of groundwater quality in the vicinity of PBOW based on recent PBOW documents (e.g., Shaw [2008a] and USACE [2012]).

1.1 Report Organization

As part of the RI effort, both PBOW sites listed above were previously investigated and evaluated in a site characterization report (SCR), baseline human health risk assessment (BHHRA), and screening-level ecological risk assessment (SLERA). This RI report summarizes these six reports and presents recommendations based on their findings. The SCRs, BHHRAs, and SLERAs are appended to this report in their entirety (Appendices A through F) in electronic format on compact disk.

The remainder of this chapter provides a description and history of the PBOW facility as well as the history and current conditions of the ash disposal pits and coal storage area associated with Powerhouse No. 2. More specific information on AP2 and CY2 are included in the respective SCRs, BHHRAs, and SLERAs that are appended to this RI report. Chapter 2.0 of this report summarizes the physical setting of PBOW and specifically addresses the two sites currently being evaluated. This discussion of physical setting includes the physiography, topography, geology, hydrogeology and natural groundwater quality.

Chapter 3.0 summarizes the SCR, BHHRA, and SLERA for AP2, and summaries of the CY2 SCR, BHHRA, and SLERA are presented in Chapter 4.0. Chapter 5.0 presents site-specific recommendations for site management decisions. These recommendations primarily discuss whether or not a remedial action is warranted. These recommendations do not identify a specific technological approach, but are provided to help site managers form a basis for determining whether a feasibility study (FS) is required or if proceeding to a no-action proposed plan is the appropriate course for a given site. References used in the RI are provided in Chapter 6.0.

1.2 Facility Location and Description

The former 9,000-acre PBOW facility was used for the manufacture of nitroaromatics during World War II. The National Aeronautics and Space Administration (NASA) operates and maintains the site as the Plum Brook Station (PBS), which is a satellite of the John H. Glenn Research Center, located at Lewis Field in Cleveland, Ohio. PBOW is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland. Although primarily in Perkins and Oxford Townships, the eastern edge of PBOW 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 primarily agricultural and residential. Public access is prohibited at PBOW except during the annual deer hunting season, when hunting is allowed by permit only. Figure 1-1 shows the geographical location of the former PBOW facility.

1.3 Facility History and Background

PBOW was established by the War Department as a government-owned, contractor-operated (GOCO) facility for the production of 2,4,6-trinitrotoluene (TNT), 2,4 dinitrotoluene (DNT), and pentolite during World War II. The PBOW site originally consisted of approximately 9,100 acres, approximately 3,500 acres of which were used as a buffer area outside the facility fence line. The property was acquired in the name of the United States of America in 1941. The government contractor, Trojan Powder Company, operated the production facility from December 1941 until 1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during this period.

At the end of production in September 1945, PBOW was placed in standby operation status and the Army conducted decontamination and decommissioning activities. On December 17, 1945, the U.S. Army Ordnance Department (Ordnance Department) obtained physical control of the site. The Ordnance Department continued decontamination efforts until August 1946. In 1946, over 6,200 acres, 3,231 located within the fenced area, were transferred to the War Assets Administration (WAA), and approximately 2,800 acres were transferred to the Ravenna Arsenal. This 2,800-acre parcel, transferred to Ravenna Arsenal and referred to as the Magazine Area (and also the Plum Brook Depot), was transferred again in July 1947 to the Erie Ordnance Depot, LeCarne, Ohio (War Department, 1947). The Magazine Area included approximately 2,300 acres inside the fence line and 500 acres of the buffer area, outside of the fence line.

In 1949, the General Service Administration (GSA) took control of WAA's portion of the PBOW property, which included an indeterminate amount of acreage outside of the fence line due to conveyances by WAA to private landowners during the late 1940s and early 1950s. It is

believed that farmers were given the opportunity to buy back land in the buffer area, outside the fence line.

In June 1954, the Army reacquired the 3,231 acres within the PBOW fence line that were previously transferred to the WAA and subsequently to GSA. From August 1954 to some time in 1958, further decontamination was performed by the Army. The decontamination included removal of and disposal of contaminated surface and subsurface soil around the buildings and wooden and ceramic waste disposal lines containing TNT. This included thousands of pounds of TNT which were discovered in catch basins and removed and incinerated at the burning grounds.

Two property use agreements were entered into by the Army and the National Advisory Committee for Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration (NASA), in March 1956 and January 1958, respectively. The first agreement was for approximately 500 acres on which NACA built a nuclear reactor. The second agreement gave NACA (NASA as of October 1958) use of an additional 2,700 acres within the fenced area but outside the Magazine Area, for a total of 3,231 acres under the two use agreements. At this time, NASA had use of all property inside the PBOW fence except the 2,300 acres in the Magazine Area. The Army declared this 3,231-acre property as excess in October 1958.

In September 1961, the Army declared the Magazine Area as excess, and NASA formally requested custody of the property in October 1961 (NASA, 1961). On March 15, 1963, accountability and custody of the PBOW property (6,031 acres) were transferred from the Department of the Army to NASA.

However, prior to NASA's acceptance of the property in March 1963, Ravenna Arsenal performed additional decontamination and subsequently certified 500 acres of the former PBOW property as decontaminated and suitable for unrestricted future use. This decontamination certification was only for the 500 acres in the former pentolite manufacturing area (area where NASA built the nuclear reactor) under the first use agreement. NASA identified additional DoD-related contamination in 1963, after transfer of the property. NASA performed further decontamination efforts and the removal of structures in 1964.

NASA has operated and maintained the property inside the fence line since 1963, and the facility currently located there is the NASA Glenn Research Center, Plum Brook Station. NASA operates the property as a space research facility in support of its John Glenn Research Center at Lewis Field, Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the site have been demolished or are currently on standby or inactive status. During 1967 through

1971, NASA purchased approximately 2,000 acres outside of the fence line from local farmers as "buffer." On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. This excess included approximately 1,500 acres of farmland outside the fence, including those acres purchased from farmers beginning in 1967, and was sold as farmland (NASA, 2013). Also, 46 acres outside of the fence in the northeast corner of the PBOW facility near the guard house were conveyed to the Perkins Township Board of Education for use as a bus transportation area. In addition, the 2,152 acres of PBOW declared excess included a 604-acre parcel in the western part of the fenced area known as "Parcel 59." This area, although previously declared excess, was not transferred and remains under NASA control. According to a NASA newsletter, NASA presently controls approximately 6,432 acres (NASA, 2013); this includes approximately 5,500 acres within the fence line and 900 acres outside of the fence which have been leased for agriculture (NASA, 2012).

The former PBOW FUDS property includes the entire 9,100 acres, but the only project areas that have been approved (or proposed) for the property are located within the fenced area (currently controlled by NASA). The fence generally runs along the patrol road. The area outside the fence was used as a buffer zone during the PBOW manufacturing period, and there is no known or suspected DoD-related contamination outside the fence line. Both AP2 and CY2 are inside of the former PBOW and current NASA fence line.

1.4 Powerhouse 2 Ash Pits and Coal Yard No. 2 Description and History

During PBOW operation, three power stations, Powerhouse No. 1, Powerhouse No. 2, and Powerhouse No. 3, were constructed and utilized to support the TNT manufacturing process. Each power station consisted of a main powerhouse, a coal storage area (coal yard), and an aboveground fuel storage tank. Coal ash created from the burnt coal in each of the powerhouse boilers was collected in pits. Water was added to the ash, producing a slurry that flowed through a sluice trench to an ash sump located at the end of each powerhouse. From the ash sump, the ash slurry traveled through a pipeline to a nearby surface water/ash impoundment (i.e., ash pit) (USACE, 2000).

As shown on Figure 1-2, AP2 is located west of Campbell Street in an area that appears to be an old surface impoundment. Historical drawings indicated that the surface impoundment was rectangular in shape, measuring approximately 400 feet long by 200 feet wide, and was surrounded by an earthen embankment (USACE, 1995). Ash from coal-fired boilers was reportedly pumped into the ash pit through a pipeline.

CY2 is located immediately to the northeast of former Powerhouse No. 2 (Figure 1-2). The coal yard is estimated to have been approximately 200 feet wide by 290 feet in length, or nearly 1.4 acres, during plant operations. The area has recently been filled and graded (Shaw, 2012).

2.0 Physical Setting

2.1 Physiography and Topography

PBOW is located within the Eastern Lake Region of the Central Lowland Province (Soil Conservation Service, 1971). The facility is on a plain with a slight slope to the north-northeast toward Lake Erie at approximately 25 feet per mile. Elevations across the PBOW facility range from 680 feet above mean sea level (amsl) at the intersection of Taylor Road and Patrol Road on the southwestern side of the site to 625 feet amsl at the northern portion of the installation. In general, the topography of PBOW is characterized by a flat ground surface with occasional low hummocks caused primarily by glacial scouring and deposition. A low escarpment trends from the western to the northeastern portion of the site (Shaw, 2005).

The AP2 area was observed to be overgrown with trees and was nearly indistinguishable from the surrounding forest. Several moss-covered concrete slabs, approximately 7 feet long and 3 feet wide, were observed partially buried in the underbrush approximately 75 feet west of Campbell Street. These were located at the approximate location of historical soil sample PH2SO-01, collected during the 1996 AP2 site inspection (SI) (IT Corporation [IT], 1997a). A small hand-dug water well, constructed of exposed bricks and approximately 2 feet in diameter and 12 feet deep, was located near the concrete slabs. The well was filled with water to within 2 feet of the ground surface. A strong hydrogen sulfide odor was noted emanating from the hand-dug well. The origin of both the slabs and the well-like structure is thought to be related to a former farm that occupied the area before PBOW was constructed (Shaw, 2010a).

At the CY2 area, the ground surface was low lying with minimal relief and contained standing water. This water was interpreted to eventually percolate into the soil or evaporate since no surface drainage was noted. The presence of standing water and minimal relief suggests that limited site runoff occurs (Shaw, 2012).

2.2 Geology

The bedrock in northern Ohio and found at PBOW consists of Devonian and Silurian carbonates (limestone and dolomite) and clastics (shale, siltstone, and sandstone). At PBOW, three bedrock units have been encountered during well installation at AP2: the Delaware Limestone, the Olentangy Shale, and the Ohio Shale. Further details of PBOW-specific geology are presented in the SCR (Appendix A). AP2 site-specific geology is summarized in Section 3.2.2.2.

2.3 Hydrogeology

Groundwater at PBOW includes the shallow overburden/shale and the limestone bedrock aquifers. PBOW is located within a transition between the two aquifers; the shale is absent to the northwest. Both aquifers are overlain by a veneer of glacial drift, generally less than 20 feet thick, that is considered a poor source of groundwater. Flow in the overburden/shale is toward the local surface drainages, with a generally northerly trend. Groundwater flow in the Delaware Limestone is generally toward the north but is influenced by major fracture zones (Shaw, 2005). Site-specific hydrogeology of groundwater underlying AP2 is summarized in Section 3.2.2.3.

2.4 Groundwater Quality and Use

2.4.1 Groundwater Quality

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. The limestone unit typically yields an adequate volume of groundwater for a drinking water source but is regionally regarded by the Ohio Department of Natural Resources (ODNR) as being of low quality because of high mineral content (ODNR, 1962).

The two main water-bearing zones underlying the PBOW facility 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 exhibit similar water levels, suggesting substantial vertical communication, and are considered one hydrogeologic unit. Three overburden/shale (AP2-MW01, AP2-MW02, and AP2-MW03) and three bedrock (AP2-BEDGW-001, AP2-BEDGW-002, and AP2-BEDGW-003) monitoring wells were installed at AP2 to measure the groundwater quality. No overburden/shale or bedrock groundwater monitoring wells were installed at CY2.

Overburden/Shale Groundwater. Groundwater in the overburden is in discontinuous pockets during dry time periods (Shaw, 2005; IT, 1997b, 1999, 2001a). Also, the shallow overburden generally has low yields over most of PBOW due to the high percentage of silt and clay. Because of these conditions, the overburden/shale groundwater yields insufficient volume for potable use in many areas of the underlying PBOW. Additionally, groundwater from background wells in competent shale bedrock was found to have elevated concentrations of chloride, sulfate, iron, manganese, and total dissolved solids (TDS) (Shaw, 2006). Some of these concentrations, especially those of sulfate and TDS, were found at levels that far exceed the respective U.S. Environmental Protection Agency (EPA) Office of Groundwater Secondary

Drinking Water Regulations (SDWR) or health advisories (EPA, 2013). The SDWRs are nonenforceable levels that are based on aesthetic properties (e.g., taste, odor, or color) or cosmetic effects (e.g., skin or tooth discoloration). The following list compares concentrations of these analytes in samples from off-site upgradient background shale unit groundwater wells to the respective Office of Drinking Water SDWRs or health advisories.

- ***Chloride*** – Fifty percent of the background wells exceeded the chloride SDWR of 250 milligrams per liter (mg/L) or parts per million (ppm). The maximum background concentration (3,540 ppm) was 14 times higher than the SDWR.

- ***Sulfate*** – Eleven percent of the background wells exceeded the sulfate SDWR of 250 ppm. The maximum background concentration (514 ppm) was approximately twice the SDWR.

- ***Iron*** – Thirty-two percent of the background wells exceeded the iron SDWR of 0.3 ppm. The maximum background concentration (1.55 ppm) was approximately 5 times higher than the SDWR.

- ***Manganese*** – Sixty-one percent of the background wells exceeded the manganese SDWR of 0.05 ppm. The maximum background concentration (0.728 ppm) was over 14 times higher than the SDWR.

- ***Sodium*** – One hundred percent of the background wells exceeded the sodium health advisory level of 20 ppm. The maximum background concentration (1,390 ppm) was approximately 70 times higher than the sodium health advisory level. (Note that no SDWR exists for sodium.)

- ***TDS*** – Eighty-two percent of the background wells exceeded the TDS SDWR of 500 ppm. The maximum background concentration (6,850 ppm) was nearly 14 times higher than the SDWR.

Based on naturally occurring high TDS and other analytes as described above, this groundwater unit is consistent with the EPA guidelines for Class III nonpotable groundwater. Therefore, overburden/shale groundwater is not a suitable drinking water source based on both low yield and naturally poor quality.

This low yield in the overburden/shale groundwater that is characteristic under much of PBOW was observed in the vicinity of AP2. At the site, three of the seven piezometers were dry and thus could not be sampled. In addition, although all three of the overburden/shale monitoring well samples could be collected using the low-flow sampling methodology during the wet month of May, low groundwater yield prevented the use of low-flow methodology for the November sampling event.

Limestone Bedrock Groundwater. The limestone bedrock water-bearing zone yields groundwater year-round, although specific locations may not produce water due to limited bedrock fractures in some areas (AP2-BEDGW-001). During periods of low precipitation, only limited migration of contaminants would occur in the overburden due to reduced infiltration. Limestone bedrock groundwater underlying most of PBOW is of poor natural quality largely because of naturally occurring petroleum hydrocarbons and hydrogen sulfide gas emissions. Emissions of hydrogen sulfide gas from wells may result in nuisance odors and, at elevated levels, potential health concerns. The presence of hydrogen sulfide gas, which has direct and indirect corrosive effects, results in the rapid deterioration of metal components of well materials, pumps, and plumbing. Hydrogen sulfide was noted on the boring logs from all three AP2 bedrock monitoring wells (Shaw, 2010a).

Natural petroleum-derived hydrocarbon seeps are common along the walls of area quarries (Shaw, 2005). Petroleum hydrocarbons were observed at depth during the drilling of AP2 bedrock well AP2-BEDGW-002. Well AP2-BEDGW-002 had petroleum hydrocarbon seeping from fossil coral at a depth of 47.1 feet and an angular fracture at a depth of 69.0 feet below ground surface (bgs). Also, a hydrogen sulfide odor greater than 200 ppm was measured during the development of bedrock well AP2-BEDGW-003. Note that hydrogen sulfide has been observed at high concentrations in other bedrock wells at other PBOW sites. Notably, at Waste Water Treatment Plant No. 3, located east of AP2, petroleum was observed at depth in the rock cores of all three bedrock monitoring wells, including wells WTP3-BEDGW-001 (40.4 to 42.9, 47.6, 51.0, and 53.1 feet bgs), WTP3-BEDGW-002 (40.5 to 43.4 and 47.8 feet bgs), and WTP3-BEDGW-003 (40.2 to 44.2, 47.3, and 52.9 feet bgs). Well WTP3-BEDGW-002 also exhibited high levels of hydrogen sulfide (greater than 200 ppm) (Shaw, 2011). With petroleum hydrocarbon presence and excessive hydrogen sulfide measurements from both project sites AP2 and Waste Water Treatment Plant No. 3, indications are that bedrock groundwater in the vicinity of AP2 is of naturally poor quality.

Consistent with the findings of naturally occurring petroleum hydrocarbons in the limestone wells, benzene was detected in two of the AP2 bedrock wells (AP2-BEDGW-002 and AP2-BEDGW-003). No groundwater sample from monitoring well AP2-BEDGW-001 could be collected during either sampling event due to lack of groundwater. Groundwater samples from the other two bedrock wells at AP2 had benzene concentrations (6.2 to 336 micrograms per liter [µg/L]) that exceed the promulgated Safe Drinking Water Act maximum contaminant level (MCL) of 5 µg/L for benzene (EPA, 2013).

The TDS concentration of each AP2 limestone bedrock groundwater sample (2,000 to 2,240 mg/L) exceeded the SDWR for TDS of 500 mg/L. SDWRs are nonenforceable federal guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor, or color) of drinking water that are used by public water authorities as guidance for acceptability of water as a potable source. The most common components of TDS are common salts; very small particulates; and ionic forms of common elements such as calcium, magnesium, sodium, iron, sulfate, and strontium (Ohio Environmental Protection Agency [OEPA], 2009). The elevated TDS within the limestone bedrock that underlies PBOW likely results from the reducing conditions that mobilize metals. In addition, naturally occurring long-chained petroleum hydrocarbon molecules may also contribute to TDS in PBOW bedrock groundwater.

In summary, the limestone unit generally provides an adequate quantity of groundwater for hypothetical potable use. However, the natural quality of this water would fail drinking water standards with respect to naturally occurring benzene (which consistently exceeds the MCL) and the elevated TDS. The elevated benzene is related to naturally occurring petroleum hydrocarbons, and the high TDS is likely associated with naturally occurring reducing conditions.

2.4.2 Groundwater Use

Approximately 170 private drinking water wells permitted by the Erie County Health Department are located within 4 miles of PBOW. USACE conducted a private well survey for the area within 1 mile of the downgradient PBOW boundary. Only five private wells were identified within the 1-mile radius. Two of these were identified as being used for the irrigation of lawns and gardens and washing cars, and the other three were not used at all (Appendix A of Shaw [2006]). Groundwater is not used within the PBOW facility.

2.5 Surface Water

PBOW lies in the eastern region of the Pickeral Creek–Pipe Creek Basin, which in turn, lies within the St. Lawrence River drainage basin. The Huron River Basin lies approximately 3.5 miles east of PBOW. Sandusky Bay and Lake Erie are approximately 4.5 miles north of the site.

Eleven streams pass through or originate within PBOW and are a part of four drainage areas: 1) Sawmill Creek (southern PBOW), 2) Plum Brook (central (PBOW), 3) Pipe Creek (western PBOW), and 4) Storrs-Hemminger Ditch. All streams flow north or northeasterly into Sandusky Bay. Numerous ponds lie within and around PBOW. Pipe Creek flows in a northerly direction on the western perimeter of AP2.

The Erie County Health Department does not permit the use of surface water for private drinking water, and no surface water within PBOW is used as a drinking water supply.

3.0 Powerhouse No. 2 Ash Pits

This chapter provides a summary of the sampling, analyses, results, and evaluation of the environmental media associated with AP2 (i.e., soil, overburden/shale groundwater, limestone bedrock groundwater, surface water, and sediment) that have been presented in the AP2 SCR (Appendix A), BHHRA (Appendix B), and SLERA (Appendix C). The reference for each of these documents is provided below:

- Shaw Environmental, Inc. (Shaw), 2010a, *Powerhouse 2 Ash Pits Site Characterization Report, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio*, September.

- Shaw Environmental, Inc. (Shaw), 2010b, *Baseline Human Health Risk Assessment, Powerhouse 2 Ash Pits, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio*, September.

- Shaw Environmental & Infrastructure, Inc. (Shaw), 2010c, *Screening Level Ecological Risk Assessment, Powerhouse 2 Ash Pits, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio*, September.

In addition, results of the previous initial SI of AP2 (IT, 1997a) are briefly summarized in Section 3.1. Identification of the samples and the recommendations from the SI present a context for the performance of the RI and for some of the specific sampling locations and analyses performed in the RI.

Please note that this chapter provides no data or other information that has not been previously presented in the AP2 SCR, BHHRA, or SLERA (Appendices A, B, and C).

3.1 Previous Investigation and Evaluation

Prior to the RI, the following analytical samples were collected in 1996 as part of the SI of AP2 (IT, 1997a):

- Twelve (0 to 0.5 feet) surface soil samples
- Twelve subsurface soil samples (eleven from 2 to 3 feet and 1 from 3 to 4 feet).

Each soil sample was analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), target analyte list (TAL) metals, pesticides, polychlorinated biphenyls (PCB), and total cyanide.

The analytical results were compared to EPA Region 3 risk-based concentrations as a qualitative screening evaluation. Based on this screening evaluation, analytical results of six metals in surface soil samples and six metals in subsurface soil samples exceeded their respective risk-based concentrations. Based upon the exceedance, a risk assessment was recommended. This RI report addresses the concerns raised by the SI evaluation. The SI results are summarized in the SCR (Appendix A) and were further evaluated in the BHHRA (Appendix B) and SLERA (Appendix C) together with the RI analytical results.

3.2 Site Characterization and Evaluation

This section summarizes the RI sampling of environmental media at AP2, the analytical results, and an evaluation of these results. Additional details are provided in the SCR (Appendix A).

3.2.1 Samples and Analyses

The RI samples were collected using procedures consistent with the site-specific quality assurance project plan (QAPP) (Shaw, 2008b) and work plan for AP2 (Shaw, 2009a). Soil, groundwater, surface water, and sediment sampling locations are shown on Figure 3-1 along with the location of a staff gauge used for measurement of Pipe Creek water levels.

Surface and subsurface soil samples were collected from eight borings as part of the RI. Generally, surface soil is defined as samples collected from within the interval of 0 to 1 foot bgs, and subsurface soil is defined as samples collected from depths greater than 1 foot bgs per the RI work plan (Shaw, 2009a). It was also determined during the direct-push soil sampling that no fill material was present at the AP2 area. The work plan called for subsurface soil samples to be collected at depths of 3 to 5 and 8 to 10 feet bgs.

Seven piezometers were installed as described in the work plan. However, only three of these (AP2-PZ03, AP2-PZ04, and AP2-PZ07) yielded adequate groundwater volume for sampling.

Three overburden/shale groundwater monitoring wells (AP2-MW01, AP2-MW02, and AP2-MW03) and three limestone bedrock monitoring wells (AP2-BEDGW-001, AP2-BEDGW-002, and AP2-BEDGW-003) were installed at AP2 as designated by the work plan. The work plan was designed to include upgradient, on-site, and downgradient groundwater locations, as was done with respect to the overburden/shale wells. The placement of overburden monitoring wells was based on groundwater flow directions determined from newly installed piezometers. Site-wide limestone bedrock groundwater flow maps were used to place new bedrock monitoring wells.

Six collocated surface water and sediment samples were collected at locations within Pipe Creek adjacent and west of AP2.

The following list summarizes the samples and analyses collected for the RI:

- ***Surface Soil*** – Eight samples, including one quality control (QC) field duplicate sample and one quality assurance (QA) sample, were analyzed for nitroaromatics, SVOCs, TAL metals, and PCBs, and one sample was analyzed for total organic carbon (TOC).

- ***Subsurface Soil*** - Ten samples, including one QC field duplicate sample and one QA field split sample, from within an overall depth interval of 3 to 5 feet were analyzed for nitroaromatics, TAL metals, PCBs, and SVOCs. Ten samples, which include one QC field duplicate sample and one QA field split sample, from within a depth interval of 8 to 10 feet were analyzed for nitroaromatics, TAL metals, and SVOCs.

- ***Overburden/Shale Piezometers*** – Five groundwater samples, including one QC field duplicate sample and one QA field split sample, were analyzed for nitroaromatics, TAL metals (filtered and unfiltered), SVOCs, hardness, cyanide, and general chemistry parameters; field tests were also conducted.

- ***Overburden/Shale Monitoring Wells*** – A total of seven groundwater samples, five in the wet season (including one QC field duplicate sample and one QA field split sample) and two in the dry season, were analyzed for nitroaromatics, TAL metals (filtered and unfiltered), SVOCs, VOCs, and general chemistry parameters; field tests were also conducted.

- ***Limestone Bedrock Monitoring Wells*** – A total of eight groundwater samples, four in the wet season (including one QC field duplicate sample and one QA field split sample) and four in the dry season (including one QC field duplicate sample and one QA field split sample) were analyzed for nitroaromatics, TAL metals (filtered and unfiltered), SVOCs, VOCs, and general chemistry parameters; field tests were also conducted.

- ***Surface Water*** – Five samples were collected from Pipe Creek and analyzed for nitroaromatics, TAL metals, SVOCs, PCBs, and water quality readings. In addition, one collocated sample was analyzed for hardness.

- ***Sediment*** – Five samples that were collocated with the surface water samples were collected from Pipe Creek and analyzed for nitroaromatics, TAL metals, SVOCs, and PCBs. In addition, one sample was analyzed for TOC.

All analytical data from these samples were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following the guidelines

in the EPA *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (EPA, 2008) and EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004), the QAPP (Shaw, 2008b), and specific analytical method requirements. Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness, and comparability goals established to meet the project data quality objectives (DQO). The criteria for blank evaluation were based on those detailed in *Region 3 Modifications to National Functional Guidelines for Evaluating Organic Analyses* (EPA, 1994) and *Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1993). Additional information on data evaluation, data validation, and data quality are provided in the SCR and information included therein (Appendix A).

3.2.2 Physical Characteristics

3.2.2.1 Local Soils

Black ash and cinders are visible on the ground surface of AP2, suggesting no fill cover was placed in the vicinity of the former pit. The lack of fill material was confirmed, as no fill was encountered in any of the soil borings drilled within the former ash pit. An ash layer, resultant primarily from the burning of coal at Powerhouse No. 2 and from incinerated materials from Waste Water Treatment Plant No. 2 was encountered at AP2 in the upper 3 feet of soil. Below this ash layer, native soil consisted of a glacial till, glacial outwash, or a glacial lacustrine (lake) deposit. In general, a soft, mottled, brownish-colored silt was first encountered, followed by a loose, mottled, very fine-grain, brownish-colored sand. Below the sand, a stiff, low-plasticity, silty clay was encountered that continued to the top of bedrock, commonly found around 11 feet bgs. Shale or limestone fragments in the clay increased in quantity with depth until final probe refusal.

3.2.2.2 Local Geology

Bedrock units in the AP2 area are of Devonian age and consist of the Olentangy Shale and the underlying Delaware Limestone. The contact between these two units is believed to run near or immediately adjacent to AP2. The shale layer was not encountered in any of the limestone bedrock monitoring well borings. The only possible Olentangy Shale occurrence may have been at overburden well AP2-MW01, where the immediately underlying bedrock appears to be the shale layer. However, this is not definitive because only a small portion of the bedrock was recovered in the core. Well AP2-MW01 is located just southeast of AP2, adjacent to Campbell Road (Figure 3-1). This well is farther to the southeast than any of the bedrock wells; the

presence of shale toward the southeast is consistent with regional geology. If the shale layer is present at AP2, it is expected to be thin.

Delaware Limestone was found conclusively at depths ranging from 13 feet (619.4 feet amsl) in limestone bedrock well AP2-BEDGW-002 to 19.5 feet (618.9 feet amsl) in limestone bedrock well AP2-BEDGW-003. The limestone was typically found to be brown in color if very weathered and gray if less weathered, and hard and fossiliferous (brachiopods, corals, and styolites), with massive bedding below approximately 20 feet. Pyrite crystals were found on several cores. In addition, during drilling for monitoring well AP2-BEDGW-002 at around 47 and 70 feet bgs, petroleum hydrocarbon was found seeping from the rock core. This is believed to be natural petroleum common in the Delaware Limestone of the region.

3.2.2.3 Local Hydrogeology

Overburden/shale groundwater at AP2 was encountered at depths ranging from 1.7 feet bgs (AP2-SB03/PZ03) to 5 feet bgs (AP2-SB08/PZ07) in January 2009 (wet season) during soil boring drilling/piezometer installation. However, groundwater was only encountered in three of the eight soil borings. During monitoring well installation conducted in April 2009 (wet season), overburden/shale groundwater was encountered at depths of 2.1 feet bgs (AP2-MW03) to 8 to 10 feet bgs (AP2-MW01). The overburden/shale groundwater flow direction was found to be west-northwest toward Pipe Creek during both the May 2009 wet season (Figure 3-2) and the November 2009 dry season (Figure 3-3). Overburden/shale groundwater flow from both contour maps indicates that it mimics the surface topography.

In addition, one stream level staff gauge was placed in Pipe Creek and survey elevations recorded at the top and base of the rod. Water level measurements of Pipe Creek surface water were conducted from the staff gauge. When elevations are plotted in correlation with groundwater level measurements from overburden/shale monitoring wells, Pipe Creek meets the definition of a water “gaining” stream during the wet season month of May (Figure 3-2) and the definition of a water “losing” stream during the dry season month of November (Figure 3-3). Figure 3-2 shows May groundwater elevations in the AP2 area adjacent to Pipe Creek are greater than the water level elevation of Pipe Creek (indicating groundwater is flowing into the creek). Figure 3-3 shows November groundwater elevations near Pipe Creek are less than the water level elevation of Pipe Creek (indicating the creek is losing water to the adjacent overburden/shale groundwater system).

Three limestone bedrock wells (AP2-BEDGW-001, AP2-BEDGW-002, and AP2-BEDGW-003) are present at AP2. Limestone bedrock groundwater was encountered during April 2009 drilling

of these wells in fractures at depths of 46.9 to 50.1 feet (AP2-BEDGW-003), 72.6 feet (AP2-BEDGW-001), and 73.2 feet (AP2-BEDGW-002). The screened interval of each of these wells is within the Delaware Limestone bedrock. Groundwater level measurements collected from these three bedrock wells showed groundwater flow in a southwest direction, opposite of the regional north-northeast direction toward Lake Erie, as shown on Figure 3-4.

3.2.2.4 Local Surface Water

There are no surface water features on AP2 itself, but Pipe Creek, which flows toward the north-northeast is located just west of the site (Figure 1-3). AP2 as a whole drains to Pipe Creek, located approximately 800 feet west of Campbell Road. A drainage ditch that extends to Pipe Creek bisects AP2; no water was present in the ditch during sampling. During substantial precipitation events, this ditch would presumably carry localized drainage west-northwest to Pipe Creek. Because of the flat topography at AP2, water associated with precipitation events tends to pool in localized shallow depressions.

3.2.3 Summary of Analytical Results

The analytical results of the RI samples, described in Section 3.2.1, are summarized in this section. As part of this evaluation, analytes detected in the respective environmental media were compared to risk-based screening concentrations (RBSC) and background screening concentrations (BSC) as points of reference only. Concentrations of analytes that exceed the RBSCs are highlighted in the associated table (Tables 3-1 through 3-5). The derivation of RBSCs and BSCs are described in the AP2 BHHRA (Appendix B). RBSCs do not infer a regulatory limit or mandated cleanup level, nor is the identification of an exceedance intended to indicate an unacceptable human health risk or a need for remedial action. Formal evaluation of human health risks was performed in the BHHRA. Concentrations in individual samples that exceed the respective BSCs are identified by bold text in the Chapter 3.0 result Tables 3-1 through 3-5.

The evaluation of the analytical results of the samples and analyses, as presented in the SCR, are summarized below for each medium. Detected analytes that exceed RBSCs and BSCs in AP2 environmental media are shown on Figures 3-5 through 3-8.

Surface and Subsurface Soil Summary

- No nitroaromatics were detected above RBSCs or BSCs in surface or subsurface soil samples at AP2.

- The PCB mixture Aroclor 1016 was detected above the RBSC in the surface soil sample in boring AP2-SB02.

- No PCBs were detected in any subsurface soil samples.

- Nine SVOCs were detected in surface soil samples; however, only benzo(a)pyrene was detected above the RBSC in the surface soil from boring AP2-SB01.

- Phenanthrene was the only SVOC detected in subsurface soil samples; it was not above the RBSC or BSC in any of the samples.

- Two metals were detected above both the RBSC and BSC values in surface soil. Beryllium was detected above the RBSC and BSC in sample AP0111 from boring AP2-SB04 and sample AP0125 from boring AP2-SB08. Lead was also detected above both the RBSC and BSC in surface soil sample AP0100 in boring AP2-SB01.

- No metals were detected above both RBSC and BSC values in subsurface soils samples.

Piezometer Overburden/Shale Groundwater Sample Summary

- No nitroaromatics or SVOCs were detected above RBSCs or BSCs in the groundwater in AP2 piezometers.

- Iron was the only metal that exceeded both the RBSC and BSC in the unfiltered samples and only in the sample from piezometer AP2-PZ03.

- No metals exceeded both the RBSC and BSC in any filtered groundwater sample.

Monitoring Well Overburden/Shale Groundwater Sample Summary. Five groundwater samples, including one QA and one QC field duplicate sample, were collected during the wet season month of May 2009. Due to dry conditions during the month of November, only two wells, AP2-MW01 and AP2-MW02, yielded enough water for nitroaromatics analysis. Well AP2-MW03 was dry and could not be sampled. No nitroaromatics were detected in the groundwater from either AP2-MW01 or AP2-MW02. The major findings related to monitoring well locations, upgradient (AP2-MW01), source area (AP2-MW02), and downgradient (AP2-MW03), are summarized as follows:

Upgradient

- No analytical results exceeded RBSC or BSC screening levels in upgradient well AP2-MW01.

Source Area

- One metal (nickel) exceeded both the RBSC and BSC in two unfiltered samples (regular and QC field duplicate sample). Nickel also was above the RBSC and BSC screening value in the regular filtered sample.

Downgradient

- No analytical results exceeded RBSC or BSC screening levels in downgradient well AP2-MW03.

Limestone Bedrock Groundwater Sample Summary. Two of the three limestone bedrock groundwater monitoring wells could be sampled during the wet season month of May 2009 and two of the three monitoring wells could be sampled during the dry season month of November 2009. Groundwater samples from both monitoring wells during both sampling events were collected using the low-flow sampling methodology. During both these months, insufficient groundwater was found in the third monitoring well, AP2-BEDGW-001, for samples to be collected from this upgradient well. The major findings related to limestone bedrock monitoring well location (source area and downgradient) are summarized as follows:

Source Area

- No nitroaromatics were detected in source area well AP2-BEDGW-002 during the wet (May) or dry season (November) sampling event.

- Three VOCs exceeded both RBSCs and BSCs during the wet and dry season sampling events: the petroleum hydrocarbon-related compounds benzene, ethylbenzene, and total xylenes.

- The petroleum hydrocarbon-related SVOC naphthalene was detected above the RBSC during both sampling events and is likely attributable to the naturally occurring hydrocarbons.

- No metals exceeded both RBSC and BSC screening values in either the filtered or unfiltered groundwater samples during either sampling event.

Downgradient

- No nitroaromatics were detected in downgradient well AP2-BEDGW-003 during the wet (May) or dry season (November) sampling event.

- Three VOCs exceeded both RBSCs and BSCs during the wet and dry season sampling events: the petroleum hydrocarbon-related compounds benzene,

ethylbenzene, and total xylenes. Chloroform and chloromethane were detected above the RBSCs during the dry season sampling.

- The petroleum hydrocarbon-related SVOC naphthalene was detected above the RBSC during both sampling events and is likely attributable to the naturally occurring hydrocarbons.

- No metals exceeded both RBSC and BSC screening values in either the filtered or unfiltered groundwater samples during either sampling event.

Surface Water Summary. No analytes were detected above RBSC values in the seven surface water samples collected from Pipe Creek west of AP2.

Sediment Summary. The results of the sediment samples are summarized as follows:

- Nitroaromatics and SVOCs were not detected in any of the seven AP2 sediment samples at concentrations exceeding RBSCs, and PCBs were not detected in the sediment samples.

- Arsenic and chromium exceeded their respective RBSCs in each sediment sample.

- TOC was detected at a concentration of 0.57 ppm in the sample analyzed for it.

3.3 Baseline Human Health Risk Assessment

This section provides a summary of the AP2 BHHRA report (Shaw, 2010b), which is included as Appendix B. It is important to note that this site-specific risk assessment, including the evaluation of future land use and groundwater use, was performed to satisfy administrative requirements. All data and other information presented in this section have been previously presented in the full BHHRA and/or SCR (Appendix A) reports.

The BHHRA evaluates potential human health risks resulting from exposure to surface soil, subsurface soil, limestone bedrock groundwater, overburden groundwater, surface water, and sediment. The samples used in the BHHRA are shown in Table 3-1, and the AP2 sample locations are shown on Figure 3-1. This summary identifies the chemicals of potential concern (COPC); summarizes the receptors, environmental media, and exposure pathways evaluated; summarizes the risk characterization; and presents the BHHRA conclusions. The BHHRA was performed consistent with EPA guidance and with the procedures established in the BHHRA for TNTA and TNTC soil (IT, 2001b), the BHHRA for groundwater at PBOW (Shaw, 2006) and, most specifically, the AP2 BHHRA work plan (Shaw, 2009b).

3.3.1 Identification of Chemicals of Potential Concern

A screening procedure was conducted on the analytical data from each AP2 environmental medium. This 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, which also considers status as a human nutrient; a frequency-of-detection evaluation; and a background screening using PBOW-specific BSCs as described in the Chapter 2.4.3 of the BHHRA (Appendix B).

The COPC screening process resulted in the generation of a data summary table for each AP2 medium evaluated in the BHHRA. A data summary table for each AP2 medium is provided as follows: surface soil (Table 3-7), subsurface soil (Table 3-8), limestone bedrock groundwater (Table 3-9), overburden groundwater (Table 3-10), surface water (Table 3-11), and sediment (Table 3-12). Additional details of this data summary are discussed in the BHHRA (Appendix B). The COPCs for AP2 environmental media are listed below.

- ***Surface Soil*** – Beryllium, thallium, Aroclor 1016, benzo(a)pyrene, benzo(b)fluoranthene
- ***Subsurface Soil*** – Thallium
- ***Limestone Bedrock Groundwater*** – Selenium, naphthalene, benzene, chloromethane, trans-1,3-dichloropropene, ethylbenzene, xylenes
- ***Overburden Groundwater*** – Nickel
- ***Sediment*** – Arsenic, chromium
- ***Surface Water*** – None.

As described in the BHHRA work plan (Shaw, 2009b), certain receptors are assumed to be exposed to a mixture of surface and subsurface soil that is referred to as “total soil.” Because thallium is the only subsurface analyte identified as a COPC (and its presence at detectable levels is unlikely as described in Section 2.5 of the BHHRA), a determination was made to conservatively assume that the surface soil data set be used in the BHHRA represents total soil as well. It is recognized that this approach adds a high bias to the receptors evaluated for exposure to total soil.

3.3.2 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, 1989). The AP2 BHHRA characterizes potential exposure to COPCs in AP2 environmental media as portrayed by the conceptual site exposure model (CSEM).

The CSEM provides the basis for identifying and evaluating the potential risks to human health in the BHHRA. The CSEM, graphically depicted on Figure 3-9, includes the receptors appropriate to all plausible site-use scenarios and the potential exposure pathways.
The receptors and pathways on Figure 3-9 reflect scenarios developed from information regarding site background and history, topography, climate, and demographics as presented by D&M (1997) and the site-wide groundwater investigation (IT, 1997b).

No current or future exposure to off-site residents is evaluated because off-site residents are serviced by municipal water from surface water sources. Although there are numerous private groundwater wells in the vicinity, including several within 1 mile of the facility boundary, none of these are 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 (Shaw, 2008a); however, the groundwater underlying AP2 was not summarily excluded for consideration as a tap water source because OEPA has maintained that an assumption of potable use should initially be made under baseline conditions where no prior use restrictions are in place. Therefore, the development of groundwater for hypothetical on-site residential (or on-site worker) use as tap water was evaluated for purposes of this BHHRA at the request of OEPA. Groundwater quality and use are discussed further in Section 2.4.

Exposure associated with the COPCs was evaluated using the following receptors. Media quantitatively evaluated for each receptor (provided that COPCs are identified for that medium) are listed in parentheses:

- Current groundskeeper (surface soil)
- Future groundskeeper (total soil and groundwater)
- Future indoor worker (surface soil, subsurface soil [inhalation pathway only], and groundwater)
- Current/future construction worker (total soil and sediment)

- Future resident (total soil, sediment, overburden groundwater, and limestone bedrock 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, and the noncancer hazard results are presented separately for the child and adult residents. Cancer risk results for the child and adult resident were evaluated based on a 30-year combined child/adult exposure duration and are presented as combined child/adult cancer risks.

As mentioned in Section 3.3.1, no COPCs were identified in surface water, so exposure to surface water was not quantitatively evaluated. Also, as explained in Section 3.3.1, surface soil analytical data results were conservatively used to evaluate total soil.

The equations for the calculations of intake values for each exposure pathway, exposure assumptions, and the calculation of exposure point concentrations (EPC) of COPCs for modeled pathways (e.g., venison, airborne concentrations) are presented in the BHHRA (Appendix B).

3.3.3 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 COPCs. Noncancer hazards and cancer risks are characterized separately, including COPCs that induce both types of effects. The equations and input values used to calculate cancer risks and noncancer hazards are included in Appendix B.

3.3.3.1 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 incremental lifetime cancer risk (ILCR).

Total ILCRs in the range of 1E-6 to 1E-4 are regarded as acceptable (EPA, 1990); this range is referred to as the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) under the Comprehensive Environmental Restoration, Compensation, and Liability Act (EPA, 1990) risk management range. Risks less than this range are regarded as negligible. A target cancer risk goal of 1E-5 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.

3.3.3.2 Noncancer Effects of Chemicals

The hazards associated with noncancer effects of chemicals are evaluated by comparing an exposure level or intake with a chemical-specific chronic reference dose (RfD) as described in the BHHRA (Appendix B). A hazard quotient (HQ) of 1 indicates that the estimated intake equals the RfD. If the HQ is greater than 1, there may be concern for potential adverse health effects. In the case of simultaneous exposure of a receptor to multiple chemicals, a hazard index (HI) is calculated as the sum of the HQs.

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 (1989), however, acknowledges that the assumption of additivity is probably appropriate only for chemicals that induce adverse effects by the same mechanism. Therefore, if the total HI for a receptor exceeds 1, individual HI values may be calculated for each target organ, as described in Appendix B.

3.3.3.3 Risk Characterization Results

Cancer and noncancer risk characterization results were evaluated in the BHHRA for each environmental medium and each receptor scenario using the methods summarized in Sections 3.3.3.1 and 3.3.3.2 and described in Appendix B. Risk characterization for each receptor scenario that includes groundwater exposure was run separately for overburden groundwater and limestone bedrock groundwater. The cancer risks and noncancer hazards are presented for each receptor exposed to AP2 are shown in Table 3-13.

The overwhelming majority of the cancer risks (97 to 99 percent) and noncancer hazards (82 to 89 percent) associated with hypothetical exposure to AP2 limestone bedrock groundwater were attributed to benzene. Benzene is a petroleum constituent that is known to be naturally occurring in the limestone groundwater at PBOW (Shaw, 2006), and petroleum was reported seeping at depth (47 and 69.5 feet) in AP2 limestone bedrock well AP2-BEDGW-003 (Shaw, 2010b). Therefore, risk characterization for scenarios that include exposure to bedrock groundwater was run with and without the contribution of benzene. The results for these scenarios excluding the contribution of benzene in limestone bedrock groundwater are shown in Table 3-14.

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

- Current groundskeeper: ILCR = 2E-6; HI = 0.09
- Future groundskeeper – including overburden groundwater use: ILCR = 2E-6; HI = 0.1
- Future groundskeeper – including limestone bedrock groundwater use: **ILCR = 7E-5**; HI = 1 (excluding benzene: ILCR = 2E-6; HI = 0.2)
- Future indoor worker – including overburden groundwater use: ILCR = 2E-7; HI = 0.06
- Future indoor worker – including limestone bedrock groundwater use: **ILCR = 7E-5**; HI = 1 (excluding benzene: ILCR = 8E-7; HI = 0.2)
- Current/future construction worker: ILCR = 4E-7; HI = 0.4
- Future resident – including overburden groundwater use: ILCR = 5E-6; adult HI = 0.2; child HI = 0.9
- Future resident – including limestone bedrock groundwater use: ***ILCR = 3E-4; adult HI = 3; child HI = 7*** (excluding benzene: ILCR = 1E-5; adult HI = 0.3; child HI = 1)
- Current/future hunter: ILCR = 6E-8; HI = 0.003.
- Current/future hunter's child: ILCR = 4E-13; HI = 0.000003.

3.3.4 BHHRA Conclusions

The ILCR of the future resident that is hypothetically assumed to use limestone bedrock groundwater as household tap water exceeds the NCP risk management range (ILCR of 1E-6 to 1E-4) as well as the PBOW target cancer risk criterion (ILCR less than or equal to 1E-5). The HI values of the child and adult resident assumed to use groundwater also exceed the target criterion of 1, which would indicate that adverse human health risks under this scenario cannot be regarded as unlikely. The ILCR for each of the other future scenarios assumed to use limestone bedrock groundwater as a potable source had an ILCR that exceeds the PBOW target cancer risk criterion but was within the NCP risk management range.

Cancer risks and noncancer hazards to all potential receptors evaluated under current land use (i.e., current groundskeeper, construction worker, hunter, and hunter's child) are within or less

than the NCP risk management range, are less than the target HI criterion, and are less than the PBOW cancer risk criterion, indicating that cancer risks are at acceptable levels and adverse noncancer effects are unlikely to occur under potential current scenarios. Similarly, all future scenarios that assume overburden groundwater use meet the NCP risk management range, target HI criterion, and PBOW risk criterion.

Risks associated with the use of limestone bedrock groundwater as tap water easily account for the overwhelming majority of the ILCR and HI values for the future groundskeeper, indoor worker, and future resident. Benzene was identified as the only contaminant with an HI exceeding a value of 1 and an ILCR exceeding a value of 1E-5 for any receptor, and benzene in limestone bedrock groundwater is responsible for a great majority of the ILCR and HI for these receptors. Benzene is a petroleum constituent that is known to be naturally occurring in the limestone groundwater at PBOW and petroleum was reported seeping at depth in an AP2 limestone bedrock well (AP2-BEDGW-003), indicating that naturally occurring petroleum hydrocarbons are present in the groundwater underlying AP2. Without the contribution of benzene, the residual noncancer HI value for each receptor does not exceed a value of 1 and the ILCR does not exceed a value of 1E-5.

Because of poor water quality in the AP2 area and low, undependable groundwater yield, the potential for use of limestone bedrock groundwater as potable tap water is regarded as highly unlikely. This poor water quality is associated with the presence of hydrogen sulfide off-gassing in the area and the associated health and aesthetic issues with high-sulfate water and the presence of petroleum product, as encountered in well AP2-BEDGW-003.

If a more likely and serviceable source of tap water were assumed to be used by a future groundskeeper or residential receptor (e.g., municipal water or perhaps even overburden groundwater), then the ILCR and HI values would meet the NCP risk management range (1E-6 to 1E-4), PBOW cancer risk criterion of 1E-5, and target HI criterion of 1. Municipal water is already available at PBOW and used by nearby residents as potable water. Conversely, there are no known groundwater wells in the vicinity of PBOW that are used as a potable source, and groundwater is not used on former PBOW NASA property for any purpose.

3.4 Screening-Level Ecological Risk Assessment

This section provides a summary of the SLERA report for AP2 (Shaw, 2010c), which is included as Appendix C. It is important to note that this SLERA was performed to satisfy administrative requirements including those described by FUDS regulations (DoD, 2004). All data and other

information presented herein has been previously presented in the full AP2 SLERA and/or SCR reports (Appendices C and A, respectively).

The SLERA was performed to evaluate and provide an estimate of current and future ecological hazard associated with exposure to potential releases to soil, surface water, and sediment from AP2. This summary provides an ecological site description, identifies chemicals of potential ecological concern (COPEC), identifies ecological receptors, characterizes exposure, characterizes ecological risks, and presents the conclusions of the SLERA.

The AP2 SLERA is consistent with EPA guidance and with the procedures established in previous risk assessments performed at PBOW (e.g., the SLERA for TNTA and TNTC [IT, 2001c]) as well as the AP2 SLERA work plan (Shaw, 2009b).

3.4.1 Ecological Site Description

This ecological site description includes a summary of site background and the area of concern, surface water resources, wetlands, and vegetative communities; a species inventory; and a discussion of threatened and endangered (T&E) species. Ecological characterization of the study area was based on a compilation of existing ecological information and site reconnaissance activities discussed in Sections 3.4.1.1 and 3.4.1.2. Additional ecological site description is provided in Appendix C.

3.4.1.1 Site Background

PBOW is part of the Lake Plains region. Across PBOW, the land slopes gently to the north-northeast towards Lake Erie. The Lake Plains region itself is over 69 percent cropland, 2.7 percent pasture land, and 10.5 percent forest (ODNR, 1985). However, since the U.S. Army acquired the site in 1941 and removed the land from agricultural production, undeveloped portions of the former PBOW have become second generation forest and open fields. This has resulted in PBOW becoming an island of forest and open fields within the greater context of primarily agricultural land in north-central Ohio.

AP2 covers an area of approximately 5 acres. The ground surface is relatively flat with a few hummocks. The majority of the site is currently lowland woods and successional woods as described in Section 3.4.1.5. General descriptions of PBOW and AP2 are presented in Chapters 1.0 and 2.0.

3.4.1.2 Site Reconnaissance

Ecologists performed site reconnaissance visits to AP2 in the April, June, and September of 2009. These visits were performed at different times of year to identify early- and late-blooming plant species (especially T&E) and to identify migrating and nesting bird species. These site visits were also used to compile lists of other fauna observed at the site. No federally or state-listed species were observed. A full species list is presented in the SLERA (Appendix C).

Prior to arrival at PBOW, site personnel obtained maps and other relevant site information to determine the locations of potential ecological units, if present, such as streams, creeks, ponds, grasslands, forest, and wetlands on or near AP2. The locations of known or potential contaminant sources affecting the site and the probable gradient of the pathway by which contaminants may be released from the site to the surrounding environment were identified based on this preliminary information. Reconnaissance personnel used the site visit to evaluate the site for more subtle clues of potential effects from contaminant release. Information obtained during the reconnaissance trips was used to select representative receptors, refine exposure scenarios for the risk assessment, and identify protected species or habitats of special concern in the study area.

3.4.1.3 Surface Water

There are no surface water features on AP2 itself, but Pipe Creek is located just west of the site (Figure 1-3). AP2 as a whole drains to Pipe Creek, located approximately 800 feet west of Campbell Road. Because of the flat topography at AP2, water associated with precipitation events tends to pool in localized shallow depressions.

3.4.1.4 Wetlands

According to the National Wetland Inventory (NWI) Maps for the area (U.S. Fish and Wildlife Service, 2013), there are no designated wetlands at AP2. It should be noted that the accuracy of NWI maps is limited, especially in relatively flat landscapes (such as PBOW), because minor depressions often contain isolated wetlands not easily identified through aerial photograph interpretation (the process used by the U.S. Fish and Wildlife Service in preparing NWI maps).

Subsequent to completion of the RI, a wetland delineation of the NASA Plum Brook Station, including AP2, was performed for NASA and the results were provided in a delineation report (EnviroScience, 2012). Based on this report, a wetland area exists within a former ash impoundment area in the western portion of the AP2 study area, and wetlands exist along most of the drainage ditch that bisects AP2 (Figure 3-1). Also, small wetland areas were identified in

the southwest corner and the extreme northern portion of the AP2 study area. The findings of the EnviroScience (2012) wetland report have not been verified by the USACE."

3.4.1.5 Vegetative Communities

Vegetative communities at AP2 were classified during the site reconnaissance trips. Virtually all of AP2 was covered in lowland woods and successional woods, with the exception of a narrow swath of disturbed area along Campbell Road to the east. Plant species identified are listed in Table 2-1 of the SLERA (Appendix C). Based on site reconnaissance information, abundant and robust ecological resources appeared to be present on site, and there was no evidence that significant ecological threats exist at the site. Vegetative stress attributable to chemical contamination was not observed at AP2.

3.4.1.6 Species Inventory

Based on information from ODNR (1995) and collected during the site reconnaissance, species lists were prepared for plants, mammals, birds, reptiles, amphibians, and fish. The lists included species observed and those expected to be present. These species lists are included in the SLERA (Appendix C).

A total of 92 plant species were documented at AP2 during the vegetation surveys. Signs of five mammal species (opossum, cottontail rabbit, raccoon, red squirrel, and white-tailed deer) were observed at the site during reconnaissance visits, but no mammals were observed. A total of 21 bird species were observed during reconnaissance, 15 of which were observed during the breeding season. No reptiles or amphibians were observed during the site reconnaissance. Although no fish were visually observed during the site reconnaissance of the section of Pipe Creek adjacent to AP2, some of the smaller fish species are expected to be present in Pipe Creek. A list of species observed or expected to be present at the site is presented in the SLERA (Appendix C). No T&E plant or animal species were observed during site reconnaissance, and none are expected to be present, based on habitat considerations and known ranges of these species.

3.4.2 Identification of Chemicals of Potential Ecological Concern

A screening process was performed on the analytical data from the RI and SI to identify COPECs that may pose a threat to ecological receptors. These data include all soil samples collected to a depth of 6 feet, surface water, and sediment samples. Groundwater was excluded because exposure to this AP2 medium is considered to be an incomplete pathway for ecological receptors. A list of the AP2 environmental media samples used for the SLERA is presented in Table 3-15. Sample locations are presented on Figure 3-1.

The COPEC selection process was performed to develop a subset of chemicals detected at the site that are not naturally occurring or are associated with non-site-related sources. This selection process and the screening values used for COPEC selection are described in the SLERA (Appendix C). The results of the COPEC screening are presented in Tables 3-16 through 3-18 for soil, surface water, and sediment, respectively. The selected EPC is also presented for each chemical identified as a COPEC. For soil, two EPC results are presented, a total soil EPC for concentrations in the 0 to 6 feet bgs depth range and a surface soil EPC for concentrations in the 0 to 1 foot bgs depth range. These two sets of EPCs are used to evaluate various ecological receptors that may be exposed to different soil depths associated with their various life history characteristics.

Chemicals identified as COPECs were quantitatively evaluated in the SLERA predictive evaluation, which is summarized in Sections 3.4.3 through 3.4.6, where chemical-specific data were available.

3.4.3 Selection of Ecological Receptors

Ecological assessment receptors were selected in the SLERA to focus the exposure characterization on species, groups of species, or functional groups that are directly related to the following assessment endpoints: the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, and carnivorous birds. As part of this receptor selection process, site biota were organized into major functional groups. For terrestrial communities, the major groups are plants and wildlife, including terrestrial invertebrates, mammals, and birds.

Seven representative terrestrial receptor species that are expected or possible in the vicinity of AP2 (based on the ecological description of the site presented in Section 3.4.1) were selected as indicator species for the potential effects of COPECs. These indicator species represent two classes of vertebrate wildlife (mammals and birds) and a range of both body size and food habits and include herbivores, omnivores, and carnivores. The seven species selected include the deer mouse (*Peromyscus maniculatus*) (small omnivorous mammal), short-tailed shrew (*Blarina brevicauda*) (small insectivorous mammal), Eastern cottontail rabbit (*Sylvilagus floridanus*) (medium-sized terrestrial herbivorous mammal), marsh wren (*Cistothorus palustris*) (small insectivorous bird), white-tailed deer (*Odocoileus virginianus*) (large herbivorous mammal), raccoon (*Procyon lotor*), and red-tailed hawk (*Buteo jamaicensis*) (large carnivorous bird).
The only aquatic habitat at the site is Pipe Creek, which is a small stream adjacent to the western boundary of the site that flows from the southwest to northeast. Although water may pond in low

areas within the site itself, these ponds are considered ephemeral in nature and not true aquatic habitat (Shaw, 2010c).

Exposure to aquatic organisms within the creek is assumed to occur via direct exposure to contaminants in the water column and ingestion of benthic invertebrates as well as prey exposed to contaminants in surface water and sediment. Potential uptake through the aquatic food chain is evaluated for the raccoon (also considered as a terrestrial receptor) and muskrat (*Ondatra zibethicus*) (medium-sized aquatic herbivorous mammal). An avian aquatic omnivore such as the mallard (*Anas platyrhynchos*) is not evaluated because of the limited amount of aquatic habitat associated with the creek.

A terrestrial food web is presented on Figure 3-10, and an aquatic food web is presented on Figure 3-11. Many of the species evaluated, particularly the deer mouse, cottontail rabbit, short-tailed shrew, and marsh wren, have limited home ranges that make them particularly vulnerable to exposure from site contaminants. Further discussion of the selection of ecological receptors is provided in Appendix C.

3.4.4 Exposure Characterization

Ecological routes of exposure for biota may be direct (bioconcentration) or through the food web via the consumption of contaminated organisms (biomagnification). Exposure to soil, surface water, and sediment was evaluated for the pertinent representative terrestrial and aquatic assessment receptors, as described in Appendix C. Direct exposure routes include dermal contact, absorption, inhalation, and ingestion. Further discussion of exposure routes is provided in Appendix C.

Daily doses of COPECs for vertebrate receptors were calculated using standard exposure algorithms. These algorithms incorporate species-specific natural history parameters (e.g., feeding rates, water ingestion rates, and dietary composition) as well as site-specific area use factors. These algorithms are presented and described in the SLERA (Appendix C).

3.4.5 Risk Characterization

The risk characterization phase integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. Qualitative and semiquantitative approaches were used to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to COPECs.

Food chain modeling was used to estimate exposure rates for the representative assessment receptors. These exposure rates were compared with toxicity reference values (TRV) to calculate HQs for ecological receptors (Wentsel et al., 1996). Only conservative TRVs based on a no-observed-adverse-effects level (NOAEL) were used in the food chain model. HQs are calculated by summing intake doses across all exposure pathways for each chemical for a given receptor and dividing by the TRV. HQs less than or equal to 1 represent no probable hazard. Although OEPA considers all HQs above 1 to be potentially significant, the following uncertainties regarding HQ interpretation are noted:

- HQs are not measures of risk.
- HQs are not population based.
- HQs are not linearly scaled.
- HQs are often produced that are unrealistically high and toxicologically impossible (e.g., estimated HQs greater than 1,000).
- Trace soil concentrations of inorganic chemicals (including concentrations well below background levels) can lead to HQ threshold exceedances.

The following interpretation of HQ ranges from Wentsel et al. (1996) takes into consideration the uncertainties inherent in HQs and provides a basis for possible recommendations:

- HQs from 1 to less than 10 represent a low potential for environmental effects.
- HQs from 10 to less than 100 represent a significant potential that effects could result from greater exposure.
- HQs greater than 100 represent the highest potential for expected effects.

Therefore, it should be understood that HQs greater than 1 do not mean that adverse ecological effects are occurring at the site or may occur in the future.

Table 3-19 summarizes the NOAEL-based HQs for the seven evaluated terrestrial assessment receptors and two aquatic receptors, as presented in Section 3.4.3 of the SLERA (Appendix C). Note that the raccoon includes both terrestrial and aquatic components.

3.4.6 SLERA Conclusions

Four chemicals in soil, four chemicals in surface water, and one chemical in sediment were identified as COPECs for further evaluation. A food chain model was used to evaluate the

potential hazard associated with exposure to these chemicals by representative measurement receptors. Only thallium resulted in HQ values greater than 1. However, thallium is not considered to be a final COPEC for the site, because HQ values for thallium that were calculated using conservative toxicity and exposure values did not exceed 10 when rounded, and a review of the data indicated that all elevated thallium detections originated from historical data collected over 15 years ago. The historical data were obtained using a laboratory method (inductively coupled plasma) that often results in false positives for thallium. Samples collected in 2009 and analyzed using updated and more sensitive analytical methods (inductively coupled plasma/mass spectrometry) did not exceed background or ecological screening values (ESV). Therefore, the potential for adverse ecological impacts is considered to be negligible at this site, and no chemicals are selected for further evaluation for protection of the environment at AP2.

4.0 Coal Yard No. 2

This chapter provides a summary of the sampling, analyses, results, and evaluation of the environmental media associated with CY2 (i.e., surface soil) that have been presented in the AP2 SCR addendum for CY2 (Appendix D), BHHRA (Appendix E), and SLERA (Appendix F). The reference for each of these documents is provided below:

- Shaw Environmental, Inc. (Shaw), 2012, *Powerhouse No. 2 Ash Pits Site Characterization Report Addendum for Coal Yard No. 2, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio*, September.
- Shaw Environmental & Infrastructure, Inc. (Shaw), 2013a, *Powerhouse No. 2 Ash Pits Baseline Human Health Risk Assessment Addendum For Coal Yard No. 2, Final, Plum Brook Ordnance Works, Sandusky, Ohio*, July.
- Shaw Environmental & Infrastructure, Inc. (Shaw), 2013b, *Powerhouse No. 2 Ash Pits Screening-Level Ecological Risk Assessment Addendum for Coal Yard No. 2, Final, Plum Brook Ordnance Works, Sandusky, Ohio*, July.

Please note that this chapter provides no data or other information that has not been previously presented in the AP2 SCR, BHHRA, or SLERA addenda for CY2 (Appendices D, E, and F, respectively).

4.1 Previous Investigation and Evaluation

No previous investigations of CY2 are known to have been conducted. However, two samples were collected by MK in 1993 during an SI when two surface soil samples were collected from the triangle-shaped area (MK, 1994) that is included on Figure 3-1. Two surface soil samples (MK01SS06 and MK01SS07) were collected with a hand auger from the first 2 feet of soil and analyzed for nitroaromatics, VOCs, SVOCs, and inorganics. The locations, based on Figure 4-1 of MK (1994), are approximate because the soil borings were not surveyed. The soil sample collection area was said to “exhibit no visual limits.”

No nitroaromatic compounds were detected in either of the SI surface soil samples. The MK (1994) study concluded that all detected organic and inorganic constituents were below quantitation limits or were not at concentrations of concern.

4.2 Site Characterization and Evaluation

This section summarizes the RI sampling of surface soil and subsurface soil at CY2, the analytical results, and an evaluation of these results that are presented in the SCR addendum. Additional details are provided in the SCR addendum (Appendix D).

4.2.1 Samples and Analyses

The RI samples were collected consistent with the site-specific QAPP (Shaw, 2008b) and site-specific sampling and analysis plan (Shaw, 2011). Soil sampling locations are shown on Figure 3-1.

Six surface soil samples, including one QA field split sample and one QC field duplicate sample, and 10 subsurface soil samples were collected from four soil borings drilled at CY2. Soil samples were collected from approximate depths of 0 to 1, 3 to 5, and 8 to 10 feet bgs. Generally, surface soil is defined as samples collected from within the interval of 0 to 1 foot bgs and subsurface soil is defined as samples collected from depths greater than 1 foot bgs. Soil samples were analyzed for nitroaromatics, SVOCs, and TAL metals. Also, soil samples from the upper and middle sample collection intervals (0 to 1 or 0.5 to 1, and 3 to 5 feet) were analyzed for PCBs.

The following list summarizes the samples and analyses collected for the RI:

- ***Surface Soil*** – Six samples, including one QC field duplicate sample and one QA field split sample, were analyzed for nitroaromatics, SVOCs, TAL metals, and PCBs, and one sample was analyzed for TOC.

- ***Subsurface Soil*** - Ten samples from within an overall depth interval of 3 to 5 feet were analyzed for nitroaromatics, TAL metals, PCBs, and SVOCs. Ten samples, including one QC field duplicate sample and one QA field split sample, from within a depth interval of 8 to 10 feet were analyzed for nitroaromatics, TAL metals, and SVOCs.

All analytical data from these samples were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following the guidelines in the EPA *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (EPA, 2008) and EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004), the QAPP (Shaw, 2008b), and specific analytical method requirements. Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness, and comparability goals established to meet the project DQOs. The criteria for blank evaluation were based on those detailed in *Region 3 Modifications to National Functional Guidelines for Evaluating Organic Analyses* (EPA, 1994) and *Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1993). Additional information on data evaluation, data validation, and data quality are provided in the SCR addendum and information included therein (Appendix D).

4.2.2 Physical Characteristics

Descriptions and information regarding the local geography, topography, surface drainage, local geology and hydrogeology characteristics, and precipitation influence effects on local water levels has been summarized for AP2 in Section 3.2. This information is also applicable or assumed to be applicable for the adjacent CY2. Please note that no surface water bodies or drainage features were identified at CY2. A description of the local soils is the only information in this section that is specific to CY2.

Local Soils. No fill sand was encountered in any of the four CY2 soil borings drilled for this investigation. The ground surface at three of the four soil borings was covered with a mixture of coal, silt, and sand to a depth of approximately 0.5 foot. A thin (0.2 foot) coal layer was encountered near the surface of the fourth boring (CY2-SB04) at a depth of 0.5 foot. The surface material at this location consisted of clay. Figure 3-1 shows a CY2 site map with soil boring locations.

Below the coal layer or coal-containing layer, native soil was present which consisted of glacial till, glacial outwash, or possibly a glacial lacustrine (lake) deposit. In three (CY2-SB01, CY2-SB02, and CY2-SB03) of the four soil borings, a medium-stiff silt with clay was encountered to the total boring depth of 10 feet. The color of the silt changed from a yellowish-brown to a gray color at a depth of approximately 8 feet bgs in the three borings. In soil boring CY2-SB04, a medium-stiff, yellowish-brown silt with clay was again encountered to a depth of approximately 6 feet bgs. Below 6 feet bgs, a higher clay content was interpreted to be present to the total depth of 10 feet. Groundwater was encountered in all four soil borings at a depth of approximately 5 feet.

4.2.3 Summary of Analytical Results

The analytical results of the RI samples described in Section 4.2.1 are summarized in this section. As part of this evaluation, analytes detected in the environmental media were compared to RBSCs and BSCs as points of reference only. Concentrations of soil analytes that exceed the RBSCs are highlighted in associated tables (Table 4-1). The derivations of RBSCs and BSCs are described in the CY2 BHHRA (Appendix B). RBSCs do not infer a regulatory limit or mandated cleanup level, nor is the identification of an exceedance intended to indicate an unacceptable human health risk or a need for remedial action. Formal evaluation of human health risks was performed in the CY2 BHHRA. Concentrations in individual samples that exceed the respective BSCs are identified by bold text in Table 4-1.

The evaluation of the analytical results of the samples and analyses, as presented in the SCR, are summarized below.

Surface and Subsurface Soil Summary

- ***Surface Soil***
  - No nitroaromatics or PCBs were detected in any of the CY2 surface soil samples.
  - Eighteen SVOCs were detected in the six surface soil samples and only benzo(a)pyrene was detected above the RBSC screening level in one sample (QA field split sample).
  - No TAL metals were detected above both the RBSC and BSC screening values.

- ***Subsurface Soil***
  - No nitroaromatics or PCBs were detected in the CY2 subsurface (3 to 5 and 8 to 10 feet) soil samples.
  - Six SVOC compounds were detected in 2 of 10 subsurface soil samples, and all were below RBSC values.
  - No TAL metals exceeded both the RBSC and BSC screening values in subsurface soil samples.

4.3 Baseline Human Health Risk Assessment

The BHHRA evaluates potential human health risks associated with exposure to surface soil and subsurface soil at the CY2. The samples used in the BHHRA are shown in Table 4-2, and the sample locations are shown on Figure 3-1. This section summarizes the BHHRA developed as an addendum to the AP2 BHHRA (Shaw, 2013a) that is included as Appendix E. It presents the COPC screening process (Section 4.3.1) and the BHHRA conclusions (Section 4.3.2).

This BHHRA is consistent with EPA guidance, the procedures established in the BHHRA for TNTA and TNTC soil (IT, 2001b), and, most specifically, the AP2 BHHRA work plan (Shaw, 2009b).

4.3.1 Identification of Chemicals of Potential Concern

A screening procedure was conducted on the RI analytical data from CY2 surface soil and subsurface soil. This 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, which also considers status as a human nutrient; a frequency-of-detection evaluation; and a background screening using PBOW-specific BSCs as described in the Chapter 2.4.3 of the CY2 BHHRA Addendum (Appendix E).

The COPC screening process resulted in the generation of data summary tables for CY2 surface soil (Table 4-3) and subsurface soil (Table 4-4). As shown in these tables, no COPCs were identified based on the procedure. The risk-based screen used to screen COPCs uses chemical-specific, RBSCs based on an ILCR of 1E-6 and an HQ of 0.1. Chemicals with ILCRs and HQs less than these respective levels are identified in the work plan (Shaw, 2009b) as having insignificant contributions to risk/hazard. Because COPCs were not identified, a quantitative BHRRA that evaluated risks and hazards of the COPCs was not performed.

4.3.2 BHHRA Conclusions

None of the chemicals detected in Coal Yard No. 2 surface soil or subsurface soil are COPCs. The lack of COPCs at CY2 indicates that the cancer risks and noncancer hazards associated with exposure to Coal Yard No. 2 soils are negligible and/or are not greater than those associated with background soils. Therefore, a quantitative risk assessment is not necessary and was not performed.

4.4 Screening-Level Ecological Risk Assessment

This section provides a summary of the CY2 SLERA that was submitted as an addendum to the AP2 SLERA report (Shaw, 2013b). The CY2 SLERA is included as Appendix F to this RI report. It is important to note that the CY2 SLERA was performed to satisfy administrative requirements including those described by FUDS regulations (DoD, 2004). All data and other information presented herein have been previously presented in the full CY2 SLERA addendum (Appendix F), CY2 SCR addendum (Appendix D), AP2 SLERA (Appendix C), and/or AP2 SCR (Appendix A).

The CY2 SLERA was performed to evaluate and provide an estimate of current and future ecological hazard associated with exposure to potential releases to CY2 soil. This summary provides an ecological site description, an evaluation for COPECs, and the conclusions of the SLERA.

The CY2 SLERA is consistent with EPA guidance and with the procedures established in previous risk assessments performed at PBOW (e.g., the SLERA for TNTA and TNTC [IT, 2001c]) as well as the AP2 SLERA work plan (Shaw, 2009b).

4.4.1 Ecological Site Description

This ecological site description includes a summary of site background and features and characteristics of the area of concern. Ecological characterization of the study area was based on

a compilation of existing ecological information and site reconnaissance activities discussed in Sections 4.4.1.1 and 4.4.1.2. Additional ecological site description is provided in Appendix F and Appendix C.

4.4.1.1 Site Background

PBOW is part of the Lake Plains region. Across PBOW, the land slopes gently to the north-northeast towards Lake Erie. The Lake Plains region itself is over 69 percent cropland, 2.7 percent pasture land, and 10.5 percent forest (ODNR, 1985). However, since the U.S. Army acquired the site in 1941 and removed the land from agricultural production, undeveloped portions of the former PBOW have become second generation forest and open fields. This has resulted in PBOW becoming an island of forest and open fields within the greater context of primarily agricultural land in north-central Ohio.

General descriptions of PBOW and AP2 are presented in Chapters 1.0 and 2.0. CY2 is located immediately to the northeast of Powerhouse No. 2 (Figure 1-2). The former coal yard is estimated to have been approximately 200 feet wide by 290 feet in length, or approximately 1.3 acres.

4.4.1.2 Site Reconnaissance

Because CY 2 is in such close proximity to AP2, a formal ecological reconnaissance was not performed for CY2. The habitat description, sensitive ecological resources, and faunal assemblages (including potential threatened and endangered species) described in the AP2 SLERA (Appendix C) were determined to also be relevant for the CY2 site. Descriptions of the ecological resources in the vicinity of CY2, including common flora and fauna species in the area, discussion of threatened or endangered species, and habitat descriptions of the locality, are included in the AP2 SLERA (Appendix C). Additionally, a trained ecologist specifically visited CY2 in September 2011 to make general observations of site conditions (Appendix F).

During the September 2011 field visit, the majority of the CY2 area had been recently filled and graded. The area is covered with grass and brush along with some hydrophilic vegetation indicative of wetlands. The northern border of the coal yard consists of an early successional forest. Demolition of the former Powerhouse No. 2 building by NASA in 2010 resulted in some disturbance of surface soil and vegetation, primarily in areas outside of the footprint of the former coal yard. Minor amounts of coal were observed on the ground surface in isolated areas during previous site walks.

4.4.1.3 Surface Water

No permanent or semipermanent water bodies are present at CY2.

4.4.1.4 Wetlands

According to the NWI Maps for the area (U.S. Fish and Wildlife Service, 2013), there are no designated wetlands at CY2. It should be noted that the accuracy of NWI maps is limited, especially in relatively flat landscapes (such as PBOW), because minor depressions often contain isolated wetlands not easily identified through aerial photograph interpretation (the process used by the U.S. Fish and Wildlife Service in preparing NWI maps).

Subsequent to completion of the RI, a wetland delineation of NASA Plum Brook Station, including CY2, was performed for NASA and the results were provided in a wetland delineation report (EnviroScience, 2012). Based on this report, a wetland area exists near the center of the former coal storage perimeter, and extends toward the south and east (Figure 3-1). The findings of the wetland delineation report have not been verified by the USACE.

4.4.2 Identification of Chemicals of Potential Ecological Concern

A screening process was performed on the analytical data to identify COPECs that may pose a threat to ecological receptors. These data include all soil samples collected to a depth of 6 feet. Samples used in the SLERA are presented in Table 4-5, and sample locations are presented on Figure 3-1. Because no permanent or semipermanent water bodies are present at CY2, soil is the only medium evaluated in the SLERA.

The COPEC selection process was performed to develop a subset of chemicals detected at the site that are not naturally occurring or are associated with non-site-related sources. This selection process and the screening values used for COPEC selection are described in the SLERA (Appendix C). The results of the COPEC screening are presented in Table 4-6 for CY2 soil.

The results of the COPEC screening (Table 4-6) indicate that cadmium was the only chemical identified as a COPEC in soil. Cadmium was detected in four out of eight samples at concentrations ranging from 0.24 to 0.81 milligrams per kilogram (mg/kg). Concentrations from two samples (CY0028 = 0.72 mg/kg and CY0018 = 0.81 mg/kg) exceed the ESV of 0.36 mg/kg. No BSC is available for cadmium because it was nondetect in all 25 soil background samples (IT, 1998). However, the detected concentration reporting limit range in the background data set (range = 0.57 to 1.2 mg/kg) exceeded the detected concentrations at CY2. Therefore, although possibly associated with remnant pieces of coal at the site, the detected concentrations of cadmium could also be naturally occurring. Further, the ESV of 0.36 mg/kg is based on an

ecological soil screening level that is protective of a shrew receptor (EPA, 2008). Because of the very small area affected, the low concentrations detected, and the natural population dynamics for small mammals that can rapidly compensate for localized impacts, it is highly unlikely that adverse population-level effects to shrews or other small mammals are occurring at this site. Therefore, cadmium is not recommended for further evaluation.

4.4.3 SLERA Conclusions

Chemicals detected in soil were screened against conservative benchmark values and other criteria to identify COPECs at CY2. Because of the small size of the site, CY2 is not spatially relevant to any significant degree for most ecological receptors.

Cadmium was the only chemical in soil that was identified as a COPEC. However, because cadmium was detected in two samples at concentrations that marginally exceeded its ESV, and because of the very limited spatial size of the site as well as the area where the slightly elevated cadmium was detected, it was judged that the presence of cadmium is either naturally occurring, inconsequential from an ecological standpoint, or both. Therefore, no further investigation of cadmium is considered necessary for the purposes of environmental protection, and the potential for ecological hazard associated with cadmium exposure is considered negligible.

5.0 DERP-FUDS Project No. G05OH001822 Recommendations

The purpose of the RI is to gather information concerning the site characteristics so that appropriate remedial alternatives may be developed in the FS. However, it is unnecessary to perform an FS if the BHHRA indicates that the human health risk goals are met under baseline conditions and the ecological risk assessment indicates a lack of adverse ecological effects (DoD, 2004; 2012).

Based on the RI results, including the BHHRA and SLERA, the USACE recommends no further action with respect to the AP2 and CY2 sites. Therefore, a feasibility study is not warranted for DERP-FUDS Project No. G05OH001822. This recommendation is based on the finding that the exposure to environmental media associated with these sites poses no unacceptable human health risks/hazards or ecological hazards that are attributable to past DoD practices.

6.0 References

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TABLES

Table 3-1

Detections Above RBSCs and/or BSCs in Surface and Subsurface Soil Samples
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-SB01						AP2-SB02									
				Sample Number:	AP0100		AP0101		AP0102		AP0103		AP0104		AP0105		AP0106		AP0107	
				Sample Date:	15-Jan-09		15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface		Surface		Subsurface		Subsurface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		3 - 5 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG		REG		REG		FD		FS		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs																				
Aroclor 1016	mg/kg	0.39	NE	0.525	-	-	-	-	-	-	0.525	J	-	-	-	-	-	-	-	-
Aroclor 1260	mg/kg	0.22	NE	0.0162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEMIVOLATILES																				
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	0.0827	J	-	-	-	-	0.0464	J	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	0.0844	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	0.13	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	-	-	-	-	-	-	1.43		-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	0.0979	J	-	-	-	-	0.0639	J	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	0.132	J	-	-	-	-	0.131	J	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	0.0446	J	-	-	-	-	0.0559	J	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	0.0733	J	-	-	0.0855	J	0.0964	J	-	-	-	-	-	-	0.0544	J
Pyrene	mg/kg	170	NE	0.111	0.111	J	-	-	-	-	0.0894	J	-	-	-	-	-	-	-	-
METALS																				
Aluminum	mg/kg	7700	15500	15100	6,460	J	6,420	J	8,750	J	9,310	J	12,700	J	8,930	J	6,930		10,700	J
Antimony	mg/kg	3.1	9.3	0.958	0.81		0.269	J	0.355	J	0.958		0.362	J	0.287	J	-	-	0.626	
Arsenic	mg/kg	0.39	36.5	26.8	11.6		4.93		11.3		15.3		15.7	J	8.31	J	4		12.1	
Barium	mg/kg	1500	826	109	55.7	J	45.6		26.8		84.4	J	85.3	J	59.4	J	54.4		41.2	J
Beryllium	mg/kg	16	1	16.9	**4.74**		**5.97**		**6.72**		**15.3**	J	**9.06**	J	**6.76**	J	-	-	**7.06**	J
Cadmium	mg/kg	7	NE	0.716	0.436	J	-	-	-	-	0.381	J	-	-	-	-	-	-	-	-
Calcium	mg/kg	NE	52300	153000	47,200	J	4,310		47,400		7,110		23,300		16,100		7,170	J	46,600	
Chromium	mg/kg	0.29	29	22.4	8.64		11.5		13		11.1		19.8		13.7		10.6		16	
Cobalt	mg/kg	2.3	116	15.6	7.74		8.32		11.9		14.6	J	13.4	J	10.9	J	8.3		11.7	J
Copper	mg/kg	310	56.2	38.4	23.6	J	18.3	J	32	J	33.7	J	28.9	J	20.9	J	13.4		27.8	J
Iron	mg/kg	5500	234000	109000	14,300	J	16,500	J	23,100	J	61,300	J	30,500	J	19,400	J	13,300		23,200	J
Lead	mg/kg	40	48.6	50.7	**50.7**		8.39		13		22.5		13.8		11.9		7.5		18.9	
Magnesium	mg/kg	NE	10400	12200	8,960	J	2,350	J	**11,400**	J	1,560	J	8,640	J	4,940	J	3,340		**10,800**	J
Manganese	mg/kg	180	3506	726	354	J	172		386		546		726	J	351	J	320		431	
Mercury	mg/kg	2.3	0.09	0.118	**0.0959**		0.0245		0.0128	J	0.0539		0.0162	J	0.0164	J	-	-	-	-
Nickel	mg/kg	150	55.1	39.7	18.3	J	20.2		32.6		35.5		35.6		26.9		18.7		30.8	
PotaSurfaceium	mg/kg	NE	3390	2870	893	J	589		1,160		587		1,170		803		1,070	J	1,450	
Selenium	mg/kg	39	2	1.44	0.727	J	-	-	-	-	1.36		-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	152	55.1	B	68.7	B	107		60.4	B	93.9		64.9	B	-	-	152	
Thallium	mg/kg	NE	1.3	0.939	0.425	J	-	-	0.423	J	0.416	J	0.3	J	-	-	-	-	0.343	J
Vanadium	mg/kg	39	40.9	26.9	15.9		16.5		17.3		21.4		26.2		18.1		13		20.2	
Zinc	mg/kg	2300	322	102	64		67.4		59.1		88.6		74.6		66.2		43.5		62.9	
GENERAL CHEMISTRY																				
Total organic carbon	mg/kg	NE	NE	11400	-	-	-	-	-	-	11,400		-	-	-	-	-	-	-	-

Table 3-1

Detections Above RBSCs and/or BSCs in Surface and Subsurface Soil Samples
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-SB03						AP2-SB04						AP2-SB05					
				Sample Number:	AP0108		AP0109		AP0110		AP0111		AP0112		AP0113		AP0114		AP0115		AP0116	
				Sample Date:	18-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09		19-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface		Surface		Subsurface		Subsurface		Surface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG		REG		REG		REG		REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs																						
Aroclor 1016	mg/kg	0.39	NE	0.525	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	mg/kg	0.22	NE	0.0162	0.0162	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEMIVOLATILES																						
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	0.0307		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	0.0599	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	-	-	-	-	-	-	-	-	-	-	-	-	0.0444	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	-	-	-	-	0.0667	J	-	-	-	-	0.0453	J	-	-	-	-	0.0491	J
Pyrene	mg/kg	170	NE	0.111	0.044	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
METALS																						
Aluminum	mg/kg	7700	15500	15100	8,070		15,000		7,720		7,130		7,830		8,670		8,800	J	8,060	J	9,300	J
Antimony	mg/kg	3.1	9.3	0.958	0.637		0.257	J	0.329	J	0.485		0.312	J	0.392	J	0.922		0.259	J	0.486	
Arsenic	mg/kg	0.39	36.5	26.8	7.71	J	5.27	J	12.6	J	26.8	J	4.51	J	12.1	J	24.4		6.27		11.1	
Barium	mg/kg	1500	826	109	69.4	J	98.9	J	18.6	J	98.4	J	61.5	J	35.6	J	109	J	68.2	J	49	J
Beryllium	mg/kg	16	1	16.9	**6.46**	J	**7.43**	J	**6.35**	J	**16.3**	J	**6.68**	J	**7.02**	J	**15.5**	J	**7.61**	J	**7.53**	J
Cadmium	mg/kg	7	NE	0.716	0.558		-	-	-	-	-	-	-	-	-	-	0.716		-	-	0.276	J
Calcium	mg/kg	NE	52300	153000	3,430	J	36,500	J	**54,300**	J	2,160	J	3,010	J	50,700	J	4,140		351		42,300	
Chromium	mg/kg	0.29	29	22.4	12	J	22.1	J	11.8	J	10.5	J	11.9	J	12.7	J	12.8		11.7		14.4	
Cobalt	mg/kg	2.3	116	15.6	8.68	J	10.8	J	10.7	J	5.96	J	7.88	J	11	J	8.29	J	6.67	J	14	J
Copper	mg/kg	310	56.2	38.4	22.5		29.8		29.6		26		20.9		38.4		31.3	J	15.6	J	33.6	J
Iron	mg/kg	5500	234000	109000	19,100		24,900		22,100		109,000		19,200		24,400		61,600	J	22,100	J	24,500	J
Lead	mg/kg	40	48.6	50.7	27.7	J	16.7	J	15.8	J	10.1	J	18.9	J	16	J	27.4		12.2		13.4	
Magnesium	mg/kg	NE	10400	12200	2,150	J	10,100	J	**10,400**	J	442	J	2,530	J	**10,800**	J	1,320	J	1,980	J	8,760	J
Manganese	mg/kg	180	3506	726	211		436		414		116		87.4		522		319		100		551	
Mercury	mg/kg	2.3	0.09	0.118	0.0642		0.013	J	0.0132	J	0.0265		0.0352		0.0147	J	**0.118**		0.0242	J	-	-
Nickel	mg/kg	150	55.1	39.7	21.7	J	31.5	J	27.4	J	17.1	J	24.8	J	28.8	J	20.5		18		36.8	
PotaSurfaceium	mg/kg	NE	3390	2870	745		1,570		1,110		827		705		1,150		837		513		990	
Selenium	mg/kg	39	2	1.44	0.928	J	-	-	-	-	0.678	J	0.859	J	-	-	1.44		-	-	0.779	J
Sodium	mg/kg	NE	NE	152	36.3	B	119		120		55.7	B	43.6	B	119		79.2		18.4	B	91.4	
Thallium	mg/kg	NE	1.3	0.939	0.47	J	0.35	J	0.336	J	0.468	J	-	-	0.315	J	0.939		-	-	0.347	J
Vanadium	mg/kg	39	40.9	26.9	18.7		25.3		15.4		26.9		17.8		17.5		23		17		18.2	
Zinc	mg/kg	2300	322	102	80	J	68.5	J	61.5	J	57	J	64.4	J	60.4	J	102		68.9		85.3	
GENERAL CHEMISTRY																						
Total organic carbon	mg/kg	NE	NE	11400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3-1

Detections Above RBSCs and/or BSCs in Surface and Subsurface Soil Samples
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-SB06						AP2-SB07									
				Sample Number:	AP0117		AP0118		AP0119		AP0120		AP0121		AP0122		AP0123		AP0124	
				Sample Date:	15-Jan-09		15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface		Surface		Surface		Surface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		0 - 1 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG		REG		FD		FS		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs																				
Aroclor 1016	mg/kg	0.39	NE	0.525	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	mg/kg	0.22	NE	0.0162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEMIVOLATILES																				
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	0.622		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	-	-	-	-	0.0403	J	-	-	-	-	-	-	-	-	0.0798	J
Pyrene	mg/kg	170	NE	0.111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
METALS																				
Aluminum	mg/kg	7700	15500	15100	7,150	J	6,750	J	13,200	J	7,100	J	8,180	J	7,200		5,250	J	7,150	J
Antimony	mg/kg	3.1	9.3	0.958	0.708		0.412	J	0.44	J	0.336	J	0.291	J	-	-	0.269	J	0.479	
Arsenic	mg/kg	0.39	36.5	26.8	11.4		6.33		3.55		6.09		6.04		5.5		6.18		10.9	
Barium	mg/kg	1500	826	109	98.7		58.3		53.4	J	44.5		56.7		48.6		43.7		20.8	J
Beryllium	mg/kg	16	1	16.9	**12.1**		**6.9**		**7.73**	J	**6.01**		**6.41**		-	-	**5.46**		**6.31**	J
Cadmium	mg/kg	7	NE	0.716	0.423	J	0.293	J	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	mg/kg	NE	52300	153000	2,830		2,090		44,000		2,100		2,270		1,820	J	1,840		**153,000**	
Chromium	mg/kg	0.29	29	22.4	7.84		10.1		19.4		10.6		11.8		10.4		8.82		11	
Cobalt	mg/kg	2.3	116	15.6	4.64		8.93		14.6	J	8.14		8.99		7.7		7.46		11	J
Copper	mg/kg	310	56.2	38.4	22.2	J	12.6	J	32.1	J	18	J	16.5	J	14.6		13.8	J	31.5	J
Iron	mg/kg	5500	234000	109000	51,800	J	19,900	J	24,000	J	17,600	J	19,100	J	16,600		15,500	J	55,100	J
Lead	mg/kg	40	48.6	50.7	12.5		11.2		14.3		12.5		12.8		9.3		9.74		15.9	
Magnesium	mg/kg	NE	10400	12200	819	J	2,110	J	**12,000**	J	2,100	J	2,350	J	1,880		1,730	J	9,490	J
Manganese	mg/kg	180	3506	726	243		234		392		198		226		169		152		372	
Mercury	mg/kg	2.3	0.09	0.118	0.0688		0.0156	J	0.0132	J	0.0203	J	0.0193	J	-	-	0.0112	J	-	-
Nickel	mg/kg	150	55.1	39.7	13.7		21.8		36.7		19.1		20.2		17.9		18.5		32.5	
PotaSurfaceium	mg/kg	NE	3390	2870	616		426		1,730		450		470		703	J	323		1,060	
Selenium	mg/kg	39	2	1.44	0.737	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	152	76.3	B	37.1	B	135		28.4	B	28	B	-	-	43.3	B	116	
Thallium	mg/kg	NE	1.3	0.939	0.312	J	-	-	0.293	J	-	-	-	-	-	-	-	-	0.316	J
Vanadium	mg/kg	39	40.9	26.9	17.3		15.5		23.2		15.4		17.4		14.1		13.6		13.6	
Zinc	mg/kg	2300	322	102	53.2		63.7		73		63.2		27.8		51.4		55.4		52.7	
GENERAL CHEMISTRY																				
Total organic carbon	mg/kg	NE	NE	11400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3-1

Detections Above RBSCs and/or BSCs in Surface and Subsurface Soil Samples
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-SB08									
				Sample Number:	AP0125		AP0126		AP0127		AP0128		AP0129	
				Sample Date:	16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG		FD		FS	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs														
Aroclor 1016	mg/kg	0.39	NE	0.525	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	mg/kg	0.22	NE	0.0162	-	-	-	-	-	-	-	-	-	-
SEMIVOLATILES														
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	-	-	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	-	-	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	-	-	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	-	-	-	-	-	-	-	-	-	-
Pyrene	mg/kg	170	NE	0.111	-	-	-	-	-	-	-	-	-	-
METALS														
Aluminum	mg/kg	7700	15500	15100	4,070	J	5,350	J	15,100	J	14,900	J	12,100	
Antimony	mg/kg	3.1	9.3	0.958	-	-	0.227	J	-	-	0.248	J	-	-
Arsenic	mg/kg	0.39	36.5	26.8	12.8		12.6		6.16		6.61		7	
Barium	mg/kg	1500	826	109	73.2	J	56	J	81	J	83.7	J	85	
Beryllium	mg/kg	16	1	16.9	**16.9**	J	**8.48**	J	**8.51**	J	**8.11**	J	-	-
Cadmium	mg/kg	7	NE	0.716	-	-	-	-	-	-	-	-	-	-
Calcium	mg/kg	NE	52300	153000	1,650		1,860		44,800		45,500		45,000	J
Chromium	mg/kg	0.29	29	22.4	6.13		8.82		22.4		21.9		18.5	
Cobalt	mg/kg	2.3	116	15.6	3.9	J	8.7	J	15.6	J	14.6	J	12.4	
Copper	mg/kg	310	56.2	38.4	21.3	J	11	J	31.1	J	30.1	J	23.9	
Iron	mg/kg	5500	234000	109000	72,600	J	28,000	J	26,600	J	28,500	J	23,900	
Lead	mg/kg	40	48.6	50.7	4.64		9.05		11.6		14.1		10.7	
Magnesium	mg/kg	NE	10400	12200	312	J	1,730	J	**12,200**	J	**11,500**	J	10,100	
Manganese	mg/kg	180	3506	726	98.2		196		473		432		363	
Mercury	mg/kg	2.3	0.09	0.118	0.034		0.0151	J	-	-	-	-	-	-
Nickel	mg/kg	150	55.1	39.7	10.5		22		39.7		38		32.8	
PotaSurfaceium	mg/kg	NE	3390	2870	477		371		1,980		1,990		2,870	J
Selenium	mg/kg	39	2	1.44	0.914	J	-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	152	36.4	B	27.4	B	145		134		-	-
Thallium	mg/kg	NE	1.3	0.939	0.308	J	-	-	-	-	-	-	-	-
Vanadium	mg/kg	39	40.9	26.9	18.8		15.1		25.4		24.7		20.5	
Zinc	mg/kg	2300	322	102	41.4		58.9		76.6		73.4		61.3	
GENERAL CHEMISTRY														
Total organic carbon	mg/kg	NE	NE	11400	-	-	-	-	-	-	-	-	-	-

Table 3-1

Detections Above RBSCs and/or BSCs in Surface and Subsurface Soil Samples
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

NE - Not established (RBSCs), not evaluated (BSCs).
Shaded cell indicates value is greater than RBSC.
Bold text indicates value is greater than the BSC.
BSC - Background screening concentration.
mg/kg - Milligrams per kilogram.
RBSC - Risk-based screening concentration. Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1. For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
MDC - Maximum detected concentration for the area of concern ("B"-qualified data not included).
"-" - Not detected.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

Source: Shaw, 2010a.

Table 3-2

Detections Above RBSCs and/or BSCs in Piezometer and Overburden/Shale Groundwater
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-PZ03		AP2-PZ04		AP2-PZ07						AP2-MW01		AP2-MW02						AP2-MW03	
				Sample Number:	AP3018		AP3019		AP3022		AP3015		AP3016		AP3057		AP3058		AP3059		AP3060		AP3061	
				Sample Date:	31-Jan-09		1-Feb-09		2-Feb-09		2-Feb-09		2-Feb-09		23-May-09		25-May-09		25-May-09		26-May-09		24-May-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		REG		REG		FD		FS		REG		REG		FD		FS		REG	
				Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Semivolatiles																								
Dimethylphenol, 2,4-	µg/L	73	NE	3.38	-	-	-	-	-	-	3.38	J	-	-	-	-	-	-	-	-	-	-	-	-
Metals-Unfiltered																								
Aluminum	µg/L	3,700	309	2,400	**2,400**		74.3	J	147	J	93.3	J	-	-	133	J	79.1	J	77.6	J	-	-	47.1	J
Barium	µg/L	730	11,800	98	51.1		24		31.9		31.3		-	-	98	J	25.3	J	24.5	J	-	-	25.2	J
Cadmium	µg/L	1.8	NE	4.3	4.16	J	4.28	J	3.91	J	4.27	J	-	-	-	-	1.1	J	1	J	-	-	-	-
Calcium	µg/L	NE	316,000	179,000	179,000		135,000		110,000		110,000		101,000		112,000		102,000		102,000		94,900		54,400	
Cobalt	µg/L	1.1	12.1	8.3	-	-	-	-	-	-	-	-	-	-	-	-	7.9	J	8.3	J	-	-	-	-
Copper	µg/L	150	19.8	12.3	12.3		5.63	J	-	-	5.71	J	-	-	-	-	-	-	-	-	-	-	-	-
Iron	µg/L	2,600	1,550	5,060	**5,060**		203		593	J	325	J	191		80.8	J	-	-	-	-	-	-	37	J
Lead	µg/L	15	NE	3.02	3.02	J	-	-	-	-	-	-	-	-	2.4	J	-	-	-	-	-	-	-	-
Magnesium	µg/L	NE	217,000	42,700	42,700		39,600		31,900		32,200		29,200		38,700		11,600		11,600		10,800		12,700	
Manganese	µg/L	88	636	229	51.8		22.1		24.5		21.6		20.7		82.2		229		229		212		173	
Nickel	µg/L	73	8.6	74.2	6.28	J	5.36	J	-	-	4	J	-	-	-	-	**74.2**		**74.2**		**68.9**		-	-
Potassium	µg/L	NE	116,000	8,940	1,260		405	J	548	J	521	J	-	-	4,150	J	7,690	J	7,410	J	8,940		1,500	J
Selenium	µg/L	18	NE	7.6	7.55	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.7	B
Sodium	µg/L	NE	1,390,000	12,200	12,200		9,150		6,990		6,860		6,380		7,440	J	2,560	J	2,460	J	-	-	10,200	J
Vanadium	µg/L	18	NE	5.4	5.39		-	-	-	-	-	-	-	-	3.7	J	-	-	-	-	-	-	1.4	J
Zinc	µg/L	1,100	507	42.6	-	-	-	-	-	-	-	-	-	-	-	-	42.6		33.9		29.9		-	-
Metals-Filtered																								
Aluminum	µg/L	3,700	309	45.4	-	-	-	-	-	-	-	-	-	-	-	-	45.4	J	44	J	-	-	-	-
Barium	µg/L	730	11,800	88.1	34.9		22.8		28.2		29.3		-	-	88.1	J	23.9	J	23.6	J	-	-	22.3	J
Cadmium	µg/L	1.8	NE	4.4	4.36	J	4.13	J	3.9	J	3.98	J	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	µg/L	NE	316,000	172,000	172,000		135,000		103,000		108,000		103,000		102,000		96,400		93,100		103,000		47,200	
Cobalt	µg/L	1.1	12.1	8.9	-	-	-	-	-	-	-	-	-	-	-	-	8.9	J	8.7	J	-	-	-	-
Copper	µg/L	150	19.8	6.9	6.9	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	µg/L	15	NE	2.10	-	-	-	-	-	-	-	-	-	-	2.1	B	-	-	-	-	-	-	-	-
Magnesium	µg/L	NE	217,000	42,800	42,800		40,800		31,400		31,100		29,900		34,100		11,000		10,600		11,900	J	11,500	
Manganese	µg/L	88	636	220	-	-	16.2		19		17.1		30.7		72.3		220		214		218		171	
Nickel	µg/L	73	8.6	74.5	-	-	-	-	-	-	-	-	-	-	-	-	**74.5**		**72.1**		**72.6**		-	-
Potassium	µg/L	NE	116,000	9,500	510	J	346	J	May 2009	J	445	J	-	-	5,030	J	9,090	J	8,950	J	9,500		1,950	J
Selenium	µg/L	18	NE	6.8	6.82	J	-	-	-	-	-	-	-	-	3.5	J	-	-	-	-	-	-	-	-
Sodium	µg/L	NE	1,390,000	12,500	12,500		9,280		7,000		6,840		6,180		8,520	J	3,030	J	2,930	J	-	-	11,000	
Vanadium	µg/L	18	NE	3.5	-	-	-	-	-	-	-	-	-	-	3.5		-	-	-	-	-	-	-	-
Zinc	µg/L	1,100	507	33.6	-	-	-	-	-	-	-	-	-	-	-	-	33.6		32.4		31		-	-

Table 3-2

Detections Above RBSCs and/or BSCs in Piezometer and Overburden/Shale Groundwater
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-PZ03		AP2-PZ04		AP2-PZ07						AP2-MW01		AP2-MW02						AP2-MW03	
				Sample Number:	AP3018		AP3019		AP3022		AP3015		AP3016		AP3057		AP3058		AP3059		AP3060		AP3061	
				Sample Date:	31-Jan-09		1-Feb-09		2-Feb-09		2-Feb-09		2-Feb-09		23-May-09		25-May-09		25-May-09		26-May-09		24-May-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		REG		REG		FD		FS		REG		REG		FD		FS		REG	
				Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Water Quality Parameters																								
Alkalinity	µg/L	NE	NE	362,000	231,000		132,000		169,000		222,000		260,000		362,000		70,300		73,400		72,000		116,000	
Chloride	µg/L	NE	NE	12,600	11,600	J	5,140	J	3,040	J	2,810	J	2,100		4,600		4,100		3,600		12,600		6,500	
Cyanide, total	µg/L	73	NE	44									44		-	-	-	-	-	-	-	-	-	-
Hardness	µg/L	NE	NE	622,000	622,000		501,000		407,000		408,000		620,000								330,000			
HARDNESS (as CaCO3)	µg/L	NE	NE	439,000											439,000		300,000		302,000				188,000	
Nitrate-Nitrite	µg/L	NE	NE	10,900	566	J	49	J	28	J	-	-			65	J	10,900		10,900		8,700		610	
Sulfate	µg/L	NE	NE	341,000	341,000		236,000		80,600		79,600		177,000		81,500		165,000		159,000		173,000		94,900	
Total dissolved solids	µg/L	NE	NE	804,000	804,000		619,000		450,000		442,000		450,000		294,000	J	507,000	J	508,000	J	460,000		295,000	J
Total suspended solids	µg/L	NE	NE	59,000	59,000		3,000	J	4,000		-	-	-	-	-	-	-	-	4,000	J	-	-	-	-
Turbidity	NTU	NE	NE	51.50	51.5	J	4.56	J	4.52		4.93		1.3		-	-	-	-	-	-	-	-	1	J

Source: Shaw, 2010a.

NE - Not established (RBSCs), not evaluated (BSCs).
NA - Not analyzed.
Shaded cell indicates value is greater than RBSC.
Bold text indicates value is greater than the BSC.
BSC - Background screening concentration.
MDC - Maximum detected concentration for the area of concern ("B"-qualified data not included).
RBSC - Risk-based screening concentration. Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.
For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
"-" - Not Detected.
µg/L - Micrograms per liter.
mg/L - Milligrams per liter.
NM - Not measured.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

Table 3-3

Detections Above RBSCs and/or BSCs in Bedrock Groundwater
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

					Location Code:	AP2-BEDGW-002								AP2-BEDGW-003							
					Sample Number:	AP3063		AP3079		AP3081		AP3082		AP3064		AP3065		AP3066		AP3080	
					Sample Date:	24-May-09		17-Nov-09		17-Nov-09		17-Nov-09		23-May-09		23-May-09		23-May-09		16-Nov-09	
					Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
					Sample Purpose:	REG		REG		FD		FS		REG		FD		FS		REG	
					Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Filtered	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatiles																					
Acetone	N	µg/L	2,200	NE	50.6	-	-	50.6	J	34.4	J	-	-	-	-	-	-	-	-	86.1	J
Benzene	N	µg/L	0.41	2.4	100	**8.5**		**9.4**	J	**6.2**	J	**4.1**		**94.1**		**91.3**		**100**		**336**	
Butanone, 2-	N	µg/L	710	NE	7.4	7.4		2.4	J	-	-	-	-	4.3	J	4.9	J	-	-	-	-
Carbon disulfide	N	µg/L	100	NE	5.2	-	-	-	-	1.2	B	1.3		-	-	-	-	5.2		3.7	J
Chloroform	N	µg/L	0.19	NE	5.6	-	-	5.6	B	4	B	-	-	-	-	-	-	-	-	14.6	B
Chloromethane	N	µg/L	19	NE	7.7	-	-	7.7	J	3.5	J	-	-	-	-	-	-	-	-	44.9	J
Cyclohexane	N	µg/L	1,300	NE	74							54						74			
Dichloropropene, trans-1,3	N	µg/L	NE	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	J
Ethylbenzene	N	µg/L	1.5	0.87	21	**9.6**		**9.7**	J	**6.6**	J	**5**		**17.7**		**17.2**		**21**		**57.1**	
Isopropylbenzene	N	µg/L	68	NE	5.8							2.5						5.8			
Methylcyclohexane	N	µg/L	NE	NE	39							39						29			
Methylene chloride	N	µg/L	4.8	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.4	B
Toluene	N	µg/L	230	1.7	54	**5.3**		**4.8**	J	**3.3**	J	**2.3**		**41.3**		**39.6**		**54**		**147**	
Xylenes, total	N	µg/L	20	5.5	260	**63.2**		**55.7**	J	**36.8**	J	**29**		**193**		**185**		**260**		**630**	
Semivolatiles																					
Dimethylphenol, 2,4-	N	µg/L	73	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	J
Methylnaphthalene, 2-	N	µg/L	15	NE	2.8	2.8	J	2.8	J	2.5	J	-	-	1.9	J	1.3	J	-	-	6.3	
Naphthalene	N	µg/L	0.14	NE	2.9	2	J	1.9	J	1.6	J	-	-	2.9	J	1.9	J	-	-	7.4	
Metals-Unfiltered																					
Aluminum	N	µg/L	3,700	309	46.7	42.8	J	46.7	J	45.5	J	-	-	-	-	17.4	J	-	-	33.9	J
Barium	N	µg/L	730	11,800	184	22.7	J	21.1	J	21.3	J	-	-	175	J	184	J	-	-	161	J
Cadmium	N	µg/L	1.8	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	N	µg/L	NE	316,000	404000	**377,000**		**392,000**	J	**385,000**	J	**404,000**		266,000	J	275,000		**317,000**		280,000	J
Cobalt	N	µg/L	1.1	12.1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	N	µg/L	150	19.8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	N	µg/L	2,600	1,550	283	283	J	-	-	-	-	194		-	-	33	J	-	-	-	-
Lead	N	µg/L	15	NE	2.4	-	-	-	-	2.4	B	-	-	-	-	-	-	-	-	-	-
Magnesium	N	µg/L	NE	217,000	124000	121,000		124,000		123,000		119,000		103,000	J	110,000		120,000		112,000	
Manganese	N	µg/L	88	636	53.7	53.7		11.1	J	10.7	J	-	-	5.9	J	5.4	J	-	-	7.1	J
Nickel	N	µg/L	73	8.6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	N	µg/L	NE	116,000	13300	7,740	J	10,900		11,000		7,380		13,300		11,500	J	11,300		15,600	
Selenium	N	µg/L	18	NE	21.3	-	-	21.3	J	17.7	J	-	-	6.7	B	14.3	B	-	-	12.4	J
Sodium	N	µg/L	NE	1,390,000	63000	26,400		32,100	J	32,100	J	28,500		56,600	J	58,500		63,000		61,100	J
Vanadium	N	µg/L	18	NE	1.6	1.6	J	1.1	J	-	-	-	-	1	J	1.3	J	-	-	-	-
Zinc	N	µg/L	1,100	507	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals-Filtered																					
Aluminum	Y	µg/L	3,700	309	39.3	16.2	J	37.4	B	39.3	B	-	-	-	-	12.4	J	-	-	40.8	B
Barium	Y	µg/L	730	11,800	186	22.6	J	19.8	J	18.8	J	-	-	171	J	186	J	-	-	164	J
Cadmium	Y	µg/L	1.8	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	Y	µg/L	NE	316,000	411000	**389,000**		**347,000**	J	**335,000**	J	**411,000**		257,000		281,000		**323,000**		256,000	J

Table 3-3

Detections Above RBSCs and/or BSCs in Bedrock Groundwater
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

					Location Code:	AP2-BEDGW-002								AP2-BEDGW-003							
					Sample Number:	AP3063		AP3079		AP3081		AP3082		AP3064		AP3065		AP3066		AP3080	
					Sample Date:	24-May-09		17-Nov-09		17-Nov-09		17-Nov-09		23-May-09		23-May-09		23-May-09		16-Nov-09	
					Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
					Sample Purpose:	REG		REG		FD		FS		REG		FD		FS		REG	
					Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Filtered	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Cobalt	Y	µg/L	1.1	12.1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	Y	µg/L	150	19.8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	Y	µg/L	2,600	1,550	46.5	-	-	36.1	J	46.5	J	-	-	-	-	-	-	-	-	65.5	J
Lead	Y	µg/L	15	NE	2.1	2.1	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	Y	µg/L	NE	217,000	123000	119,000		118,000	J	113,000	J	121,000		98,700	J	108,000		123,000		109,000	J
Manganese	Y	µg/L	88	636	52.4	52.4		9.6	J	9.3	J	-	-	5.6	J	6.1	J	-	-	7.2	J
Nickel	Y	µg/L	73	8.6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	Y	µg/L	NE	116,000	13800	9,790	J	11,500	J	11,000	J	7,540		13,000		13,800		11,800		16,300	J
Selenium	Y	µg/L	18	NE	74.9	-	-	74.9	J	14.3	J	-	-	8.1	J	8.8	J	-	-	22.4	J
Sodium	Y	µg/L	NE	1,390,000	65900	28,900		33,100		31,400		29,100		55,700		58,700		65,900		63,100	
Vanadium	Y	µg/L	18	NE	2.3	1.1	J	2	J	2.3	J	-	-	1.2	J	1.1	J	-	-	2.6	J
Zinc	Y	µg/L	1,100	507	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Quality Parameters																					
Alkalinity	N	µg/L	NE	NE	649000	417,000		472,000	J	492,000	J	490,000		649,000	J	632,000		590,000		662,000	J
Chloride	N	µg/L	NE	NE	111000	40,600		74,200	J	46,900	J	48,800		111,000		105,000		93,600		118,000	
Cyanide, total	N	µg/L	73	NE	710	7.2	J	-	-	-	-	510		-	-	-	-	710		-	-
Hardness	N	µg/L	NE	NE	1600000							1,600,000						1,200,000			
HARDNESS (as CaCO3)	N	µg/L	NE	NE	1490000	1,440,000		1,490,000		1,460,000				1,090,000		1,140,000				1,160,000	
Nitrate-Nitrite	N	µg/L	NE	NE	2000	-	-	2,000	J	54	B			760	J	-	-	-	-	47	B
Sulfate	N	µg/L	NE	NE	1080000	946,000		776,000	J	1,070,000	J	1,080,000		519,000		476,000		626,000		496,000	
Total dissolved solids	N	µg/L	NE	NE	2240000	2,240,000	J	2,200,000	J	2,050,000	J	2,000,000		1,900,000	J	1,740,000	J	1,500,000		1,570,000	J
Total suspended solids	N	µg/L	NE	NE	18000	18,000		4,000	UJ	-	-	-	-	-	-	17,000		-	-	-	-
Turbidity	N	NTU	NE	NE	110	38.2	J	1.7	J	21.4	J	110		14	J	-	-	94		51.2	

Source: Shaw, 2010a.

NE - Not established (RBSCs), not evaluated (BSCs).
NA - Not analyzed.
Shaded cell indicates value is greater than RBSC.
Bold text indicates value is greater than the BSC.
BSC - Background screening concentration.
MDC - Maximum detected concentration for the area of concern ("B"-qualified data not included.)
RBSC - Risk-based screening concentration. Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.
For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration
(using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
"-" - Not detected.
µg/L - Micrograms per liter.
mg/L - Milligrams per liter.
Ferrous iron measured in field using Hach test kit.
Oxidation-reduction potential - Final YSI water quality meter field measurement prior to groundwater sample collection.
NM - Not measured.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

Table 3-4

Detections Above RBSCs in Surface Water Samples
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION CODE	AP2-SW01		AP2-SW02		AP2-SW03						AP2-SW04		AP2-SW05	
			SAMPLE NO	AP2000		AP2001		AP2002		AP2003		AP2004		AP2005		AP2006	
			SAMPLE DATE	24-May-09		24-May-09		24-May-09		24-May-09		24-May-09		25-May-09		25-May-09	
			DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE PURPOSE	REG		REG		REG		FD		FS		REG		REG	
Parameter	Units	RBSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES																	
Bis(2-ethylhexyl)phthalate	µg/L	48	2	-	-	-	-	-	-	2	J	-	-	-	-	-	-
METALS																	
Aluminum	µg/L	37000	1030	720		531		357		377		368		1,030	J	359	
Barium	µg/L	7300	50.9	48.4	J	46.8	J	44.7	J	45.3	J	-	-	50.9	J	43.9	J
Calcium	µg/L	NE	80900	79,100		78,800		76,400		77,400		80,900		80,700		75,900	
Cobalt	µg/L	11	1.2	-	-	-	-	-	-	-	-	-	-	1.2	J	-	-
Iron	µg/L	26000	1060	1,060		700		451		455		546		1,020		376	
Lead	µg/L	NE	2.9	-	-	-	-	2.9	J	-	-	-	-	2.9	J	-	-
Magnesium	µg/L	NE	22300	21,400		21,200		20,500		20,800		22,300	J	20,700		19,800	
Manganese	µg/L	880	102	102		63		52.6		52.9		53.4		83.1		53.3	
Nickel	µg/L	730	6.2	-	-	-	-	-	-	-	-	-	-	6.2	J	-	-
Potassium	µg/L	NE	4400	3,290	J	3,340	J	3,150	J	3,190	J	-	-	4,400	J	2,900	J
Sodium	µg/L	NE	40000	32,800		32,700		32,100		32,800		40,000		34,800		30,300	
Vanadium	µg/L	180	3.1	2.6	J	1.8	J	1.7	J	1.6	J	-	-	3.1	J	2	J
Zinc	µg/L	11000	12.4	12.1	J	12.4	J	-	-	8.1	J	-	-	10.6	J	9.9	J
GENERAL CHEMISTRY																	
HARDNESS (as CaCO3)	µg/L	NE	286000	286,000		-	-	-	-	-	-	-	-	-	-	-	-

RBSC - Risk-based screening concentration. Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.
For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration
(using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
MDC - Maximum detected concentration for the area of concern ("B"-qualified data not included).
"-" - Not detected.
µg/L - Micrograms per liter.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is estimated.

Source: Shaw, 2010a.

Table 3-5

Detections Above RBSCs in Sediment Samples
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location Code:	AP2-SD01		AP2-SD02		AP2-SD03		AP2-SD04						AP2-SD05	
			Sample No.:	AP1000		AP1001		AP1002		AP1003		AP1004		AP1005		AP1006	
			Sample Date:	24-May-09		24-May-09		24-May-09		25-May-09		25-May-09		25-May-09		25-May-09	
			Sample Depth:	0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft	
			Sample Purpose:	REG		REG		REG		REG		FD		FS		REG	
Parameter	Units	RBSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES																	
Trinitrotoluene, 2,4,6-	mg/kg	36	0.0647	-	-	-	-	0.0647	J	-	-	-	-	-	-	-	-
SEMIVOLATILES																	
Fluoranthene	mg/kg	2300	0.0547	-	-	-	-	0.0525	J	-	-	-	-	-	-	0.0547	J
METALS																	
Aluminum	mg/kg	77000	8000	3,640		6,310		7,220		8,000		6,840		6,780		4,690	
Arsenic	mg/kg	3.9	10.1	4.1		5.1		10.1	J	9.3		7.8		8.8		3.9	
Barium	mg/kg	15000	67.1	22.8		43.5		67.1	J	59.8		50		53		43.1	
Beryllium	mg/kg	160	0.59	0.36		0.49		0.52		0.59		0.53		-	-	0.42	
Cadmium	mg/kg	70	0.6	0.24	J	0.37		-	-	0.6		0.53		-	-	0.26	J
Calcium	mg/kg	NE	37600	7,660		26,000		12,900	J	28,700		25,200		37,600		9,790	
Chromium	mg/kg	2.9	12.8	6.4		10.5		8.6	J	12.8		10.5		11.6		7.7	
Cobalt	mg/kg	23	14.1	7.4		7.4		6.2	J	14.1		9.8		9.9		8	
Copper	mg/kg	3100	23.7	9.6		14.2		17.2		23.7		20.4		22.8		12.2	
Iron	mg/kg	55000	39100	10,400		14,000		39,100	J	19,400		17,700		20,700		10,400	
Lead	mg/kg	400	15.2	7.9		7.9		10.6	J	15.2	J	9.1	J	11		9.7	
Magnesium	mg/kg	NE	8170	1,950		7,440		7,470	J	6,110		6,040		8,170		2,450	
Manganese	mg/kg	1800	668	127		379		151	J	668		547		413		187	
Mercury	mg/kg	23	0.025	-	-	0.018	J	0.016	J	0.015	J	0.019	J	-	-	0.025	J
Nickel	mg/kg	1500	27.6	15.7		16.1		16	J	27.6		22.6		27.1		17.8	
Potassium	mg/kg	NE	1850	498	J	1,300		1,060	J	1,850		1,470		1,420		628	J
Selenium	mg/kg	390	1	1	J	0.39	J	0.92	J	0.83	J	0.48	J	-	-	0.96	J
Silver	mg/kg	390	0.083	-	-	-	-	0.083	J	-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	170	85.2	J	157	J	54.8	J	170	J	157	J	-	-	123	J
Vanadium	mg/kg	390	15.2	9.4		15.2		13.6	J	14.9		12.5		13.3		11.1	
Zinc	mg/kg	23000	62.5	34.7		38.9		27	J	59.7		54.9		62.5		45.1	
GENERAL CHEMISTRY																	
Total organic carbon	mg/kg	NE	0.57	0.57		-	-	-	-	-	-	-	-	-	-	-	-

NE - Not established (RBSCs).
Shaded cell indicates value is greater than RBSC.
RBSC - Risk-based screening concentration. Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.
For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration
(using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
MDC - Maximum detected concentration for the area of concern ("B"-qualified data not included).
"-" - Not detected.
mg/kg - Milligrams per kilogram.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is estimated.

Source: Shaw, 2010a

Table 3-6

Summary of Samples Evaluated in the BHHRA
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
Surface Soil					
ASH PIT 2-SB01	AP0100	REG	15-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0103	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB03	AP0108	REG	18-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB04	AP0111	REG	18-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB05	AP0114	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB06	AP0117	REG	15-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0120	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0121	FD	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB08	AP0125	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
PH2SO01	4010	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO02	4030	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO03	4050	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4070	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO05	4090	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO06	4110	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO07	4130	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4150	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO09	4170	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO10	4190	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO11	4210	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO12	4230	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
Subsurface Soil					
ASH PIT 2-SB01	AP0101	REG	15-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB01	AP0102	REG	15-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB02	AP0104	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0105	FD	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0107	REG	16-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB03	AP0109	REG	18-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB03	AP0110	REG	18-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB04	AP0112	REG	18-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB04	AP0113	REG	19-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB05	AP0115	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB05	AP0116	REG	16-Jan-09	8 - 10	Exp, Metals, SVOC

Table 3-6

Summary of Samples Evaluated in the BHHRA
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
ASH PIT 2-SB06	AP0118	REG	15-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB06	AP0119	REG	15-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB07	AP0123	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0124	REG	16-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB08	AP0126	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB08	AP0127	REG	16-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB08	AP0128	FD	16-Jan-09	8 - 10	Exp, Metals, SVOC
PH2SO01	4020	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO02	4040	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO03	4060	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4080	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4081	FD	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO05	4100	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO06	4120	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO07	4140	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4160	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4161	FD	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO09	4180	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO10	4200	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO11	4220	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO12	4240	REG	29-Sep-96	3 - 4	Cyanide, Metals, Pest, PCB, SVOC, VOC
Groundwater Samples					
Overburden Well Samples					
AP2-MW01	AP3057	REG	23-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f& uf), PCB, SVOC, VOC
AP2-MW01	AP3075	REG	13-Nov-09	NA	Exp, Field Tests
AP2-MW02	AP3058	REG	25-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f& uf), PCB, SVOC, VOC
AP2-MW02	AP3059	FD	25-May-09	NA	Exp, Gen Chem, Metals (f & uf), PCB, SVOC, VOC
AP2-MW02	AP3076	REG	13-Nov-09	NA	Exp
AP2-MW03	AP3061	REG	24-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f& uf), PCB, SVOC, VOC

Table 3-6

Summary of Samples Evaluated in the BHHRA
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
Bedrock Well Samples					
AP2-BEDGW-002	AP3063	REG	24-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), PCB, SVOC, VOC
AP2-BEDGW-002	AP3079	REG	17-Nov-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
AP2-BEDGW-002	AP3081	FD	17-Nov-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
AP2-BEDGW-003	AP3064	REG	23-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), PCB, SVOC, VOC
AP2-BEDGW-003	AP3065	FD	23-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), PCB, SVOC, VOC
AP2-BEDGW-003	AP3080	REG	16-Nov-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
Sediment Samples					
ASH PIT 2-SD01	AP1000	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD02	AP1001	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD03	AP1002	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD04	AP1003	REG	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD04	AP1004	FD	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD05	AP1006	REG	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
Surface Water Samples					
AP2-SW01	AP2000	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW02	AP2001	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW03	AP2002	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW03	AP2003	FD	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW04	AP2005	REG	25-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW05	AP2006	REG	25-May-09	NA	Exp, Metals, PCB, SVOC

FD - Field duplicate.
Exp - Explosives.
Pest - Organochlorine pesticides.
PCB - Polychlorinated biphenyls.
SVOC - Semivolatile organic compounds.
VOC - Volatile organic compounds.

Source: Shaw, 2010b.

Table 3-7

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil
Powerhouse No. 2 Ash Pits
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	20 / 20	100	4.07E+03	J	1.39E+04		1.82E+00	3.57E+01	9.46E+03	1.55E+04	7.70E+03	N (b)		---
Antimony	7 / 20	35	3.14E-01	JJ	9.58E-01		4.54E-01	1.07E+01	3.02E+00	9.30E+00	3.10E+00	N (b)		---
Arsenic	20 / 20	100	6.07E+00		2.68E+01	J	9.08E-01	1.80E+00	1.46E+01	3.65E+01	3.90E-01	N (b)		---
Barium	20 / 20	100	5.06E+01		1.41E+02		1.82E-01	3.57E+01	9.88E+01	8.26E+02	1.50E+03	N (b)		---
Beryllium	20 / 20	100	7.30E-01		1.69E+01	J	1.82E-01	8.90E-01	5.36E+00	1.00E+00	1.60E+01	Y	1.14E+01	1.14E+01
Cadmium	7 / 20	35	3.81E-01	J	1.40E+00		4.54E-01	8.90E-01	4.79E-01		7.00E+00	N (a)		---
Calcium	20 / 20	100	1.65E+03		4.72E+04	J	4.54E+00	8.91E+02	7.86E+03	5.23E+04	Nutrient	N (c)		---
Chromium	20 / 20	100	1.90E+00		1.77E+01		4.54E-01	1.80E+00	1.15E+01	2.90E+01	2.90E-01	N (b)		---
Cobalt	20 / 20	100	3.90E+00	J	1.90E+01		3.63E-01	8.90E+00	1.19E+01	1.16E+02	2.30E+00	N (b)		---
Copper	20 / 20	100	1.68E+01		3.86E+01		4.54E-01	4.50E+00	2.58E+01	5.62E+01	3.10E+02	N (b)		---
Iron	20 / 20	100	1.43E+04	J	1.09E+05		3.67E+00	3.79E+01	4.78E+04	2.34E+05	5.50E+03	N (b)		---
Lead	20 / 20	100	4.64E+00		5.07E+01		3.80E-01	5.99E-01	2.04E+01	4.86E+01	4.00E+02	N (a)		---
Magnesium	20 / 20	100	3.12E+02	J	8.96E+03	J	1.82E+00	8.91E+02	2.07E+03	1.04E+04	Nutrient	N (c)		---
Manganese	20 / 20	100	9.82E+01		1.02E+03		1.82E-01	2.70E+00	3.59E+02	3.51E+03	1.80E+02	N (b)		---
Mercury	17 / 20	85	1.98E-02	JJ	1.40E-01		2.22E-02	5.90E-02	6.51E-02	8.50E-02	2.30E+00	N (a)		---
Nickel	20 / 20	100	1.05E+01		4.19E+01		2.72E-01	7.10E+00	2.47E+01	5.51E+01	1.50E+02	N (b)		---
Potassium	20 / 20	100	4.60E+02		2.26E+03		2.27E+01	8.91E+02	1.16E+03	3.39E+03	Nutrient	N (c)		---
Selenium	18 / 20	90	6.50E-01		2.60E+00		6.30E-01	1.20E+00	1.40E+00	2.00E+00	3.90E+01	N (a)		---
Silver	3 / 20	15	1.60E+00		2.00E+00		4.54E-01	1.80E+00	7.22E-01	1.11E+01	3.90E+01	N (b)		---
Sodium	8 / 20	40	2.82E+01		7.92E+01		9.08E+00	8.91E+02	2.52E+02		Nutrient	N (c)		---
Thallium	14 / 20	70	3.08E-01	J	8.50E+00		4.54E-01	1.80E+00	1.79E+00	1.30E+00	5.10E-01 f	Y	2.95E+00	2.95E+00
Vanadium	19 / 20	95	8.80E+00		2.69E+01		1.82E-01	8.90E+00	1.82E+01	4.09E+01	3.90E+01	N (b)		---
Zinc	20 / 20	100	4.14E+01		1.27E+02		2.27E+00	3.60E+00	7.40E+01	3.22E+02	2.30E+03	N (b)		---
Cyanide														
Cyanide, total	3 / 12	25	7.10E-01		9.30E-01		6.30E-01	8.90E-01	4.93E-01		1.60E+02	N (a)		---
Polychlorinated biphenyls (PCB)														
Aroclor 1016	1 / 20	5	5.25E-01	J	5.25E-01	J	4.05E-02	5.90E-02	4.91E-02		3.90E-01	Y	1.58E-01	1.58E-01
Aroclor 1260	1 / 20	5	1.62E-02	J	1.62E-02	J	4.05E-02	5.90E-02	2.38E-02		2.20E-01	N (a)		---
Organochlorine Pesticides														
DDE, 4,4'-	7 / 12	58	2.40E-03		7.40E-03		2.20E-03	3.00E-03	3.30E-03		1.40E+00	N (a)		---
DDT, 4,4'-	8 / 12	67	2.60E-03		7.10E-03		2.20E-03	3.00E-03	3.45E-03		1.70E+00	N (a)		---
Methoxychlor	2 / 12	17	6.10E-03		6.50E-03		4.20E-03	5.90E-03	3.14E-03		3.10E+01	N (a)		---
Semivolatile Organic Compounds														
Acenaphthylene	1 / 20	5	1.10E-01	J	1.10E-01	J	4.05E-01	5.90E-01	2.33E-01		1.70E+03 g	N (a)		---
Anthracene	1 / 20	5	5.80E-02	J	5.80E-02	J	4.05E-01	5.90E-01	2.31E-01		1.70E+03	N (a)		---
Benzo(a)anthracene	5 / 20	25	3.07E-02		1.30E-01	J	4.05E-01	5.90E-01	1.98E-01		1.50E-01	N (a)		---
Benzo(a)pyrene	3 / 20	15	8.44E-02	J	1.70E-01	J	4.05E-01	5.90E-01	2.21E-01		1.50E-02	Y	4.84E-01	1.70E-01
Benzo(b)fluoranthene	2 / 20	10	1.30E-01	J	1.60E-01	J	4.05E-01	5.90E-01	2.32E-01		1.50E-01	Y	4.95E-01	1.60E-01
Benzo(ghi)perylene	1 / 20	5	1.30E-01	J	1.30E-01	J	4.05E-01	5.90E-01	2.34E-01		1.70E+02 h	N (a)		---
Benzo(k)fluoranthene	1 / 20	5	2.30E-01	J	2.30E-01	J	4.05E-01	5.90E-01	2.39E-01		1.50E+00	N (a)		---
Benzoic acid	2 / 8	25	6.22E-01		1.43E+00		4.05E-01	4.99E-01	4.22E-01		2.40E+04	N (a)		---
Bis(2-ethylhexyl)phthalate	1 / 20	5	9.50E-02	J	9.50E-02	J	4.05E-01	5.90E-01	2.31E-01		3.50E+01	N (a)		---

Table 3-7

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil
Powerhouse No. 2 Ash Pits
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
Chrysene	4 / 20	20	6.39E-02	J	1.60E-01	J	4.05E-01	5.90E-01	2.12E-01		1.50E+01	N (a)		---
Di-n-butyl phthalate	1 / 20	5	1.70E-01	J	1.70E-01	J	4.05E-01	5.90E-01	2.36E-01		6.10E+02	N (a)		---
Fluoranthene	8 / 20	40	5.99E-02	J	3.00E-01	J	4.05E-01	5.90E-01	1.93E-01		2.30E+02	N (a)		---
Indeno(1,2,3-cd)pyrene	1 / 20	5	1.20E-01	J	1.20E-01	J	4.05E-01	5.90E-01	2.34E-01		1.50E-01	N (a)		---
Naphthalene	3 / 20	15	4.44E-02	J	5.59E-02	J	4.05E-01	5.90E-01	2.14E-01		3.60E+00	N (a)		---
Phenanthrene	4 / 20	20	6.30E-02	J	1.00E-01	J	4.05E-01	5.90E-01	2.08E-01		1.70E+02 [h]	N (a)		---
Pyrene	8 / 20	40	4.40E-02	J	2.50E-01	J	4.05E-01	5.90E-01	1.82E-01		1.70E+02	N (a)		---
Volatile Organic Compounds														
Acetone	2 / 12	17	4.20E-02	J	1.20E-01	J	2.50E-02	1.80E-01	6.46E-02		6.10E+03	N (a)		---
Methylene chloride	1 / 12	8	5.20E-02	J	5.20E-02	J	6.30E-03	4.50E-02	1.85E-02		1.10E+01	N (a)		---
Toluene	1 / 12	8	1.80E-02	J	1.80E-02	J	6.30E-03	4.50E-02	1.43E-02		5.00E+02	N (a)		---

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 Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA) Regional Screening Level Table (December 2009) residential s 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) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
[c] Y = Chemical is chosen as COPC.
[d] 95% UCL determined using ProUCL Version 4.00.04 (U.S. Environmental Protection Agency (EPA), 2009, ProUCL Version 4.00.04, 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). Calculated only for COPC
[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower. The EPC used to evaluate lead using the Lead Model (see text for details) is equal to the arithmetic mean.
[f] RBSC based on thallium from IRIS, 2009.
[g] RBSC based on anthracene.
[h] RBSC based on pyrene.

Source: Shaw, 2010b.

Table 3-8

Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil
Powerhouse No. 2 Ash Pits
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 mg/kg	RBSC mg/kg	COPC? [b,c]	95% UCL [d] mg/kg	EPC [e] mg/kg
Inorganics														
Aluminum	28 / 28	100	3.52E+03		1.50E+04	JJ	1.71E+00	2.55E+01	8.33E+03	1.55E+04	7.70E+03	N (b)		---
Antimony	16 / 28	57	2.27E-01	J	6.26E-01		4.13E-01	7.60E+00	1.70E+00	9.30E+00	3.10E+00	N (b)		---
Arsenic	28 / 28	100	3.55E+00		1.26E+01		8.27E-01	1.30E+00	7.11E+00	3.65E+01	3.90E-01	N (b)		---
Barium	28 / 28	100	1.86E+01	J	9.89E+01	J	1.65E-01	2.55E+01	5.52E+01	8.26E+02	1.50E+03	N (b)		---
Beryllium	21 / 28	75	5.90E-01		8.48E+00	J	1.65E-01	6.40E-01	4.25E+00	1.00E+00	1.60E+01	N (a)		---
Cadmium	2 / 28	7	2.76E-01	J	2.93E-01	J	4.13E-01	6.40E-01	2.62E-01		7.00E+00	N (a)		---
Calcium	28 / 28	100	3.51E+02		1.53E+05		4.39E+00	6.37E+02	2.09E+04	5.23E+04	Nutrient	N (c)		---
Chromium	28 / 28	100	6.10E+00		2.22E+01		4.13E-01	1.30E+00	1.24E+01	2.90E+01	2.90E-01	N (b)		---
Cobalt	28 / 28	100	5.60E+00		2.47E+01		3.31E-01	6.40E+00	1.15E+01	1.16E+02	2.30E+00	N (b)		---
Copper	28 / 28	100	8.30E+00		3.84E+01		4.13E-01	3.20E+00	2.08E+01	5.62E+01	3.10E+02	N (b)		---
Iron	28 / 28	100	1.05E+04		5.51E+04	J	1.90E+00	1.27E+01	2.18E+04	2.34E+05	5.50E+03	N (b)		---
Lead	28 / 28	100	6.10E+00		1.89E+01	J	3.30E-01	5.41E-01	1.20E+01	4.86E+01	4.00E+02	N (b)		---
Magnesium	28 / 28	100	1.19E+03		1.20E+04	J	1.65E+00	6.37E+02	5.05E+03	1.04E+04	Nutrient	N (c)		---
Manganese	28 / 28	100	8.21E+01	J	1.56E+03	J	1.65E-01	1.90E+00	3.69E+02	3.51E+03	1.80E+02	N (b)		---
Mercury	13 / 28	46	1.12E-02	J	3.90E-02		1.94E-02	4.20E-02	1.80E-02	8.50E-02	2.30E+00	N (b)		---
Nickel	28 / 28	100	1.38E+01		3.89E+01		2.48E-01	5.10E+00	2.64E+01	5.51E+01	1.50E+02	N (b)		---
Potassium	27 / 28	96	3.23E+02		1.99E+03		2.07E+01	6.37E+02	9.46E+02	3.39E+03	Nutrient	N (c)		---
Selenium	4 / 28	14	6.40E-01		8.59E-01	J	5.40E-01	1.08E+00	4.45E-01	2.00E+00	3.90E+01	N (b)		---
Silver	2 / 28	7	1.20E+00		1.60E+00		4.13E-01	1.30E+00	4.44E-01	1.11E+01	3.90E+01	N (b)		---
Sodium	16 / 28	57	1.84E+01		1.52E+02		8.27E+00	6.37E+02	1.75E+02		Nutrient	N (c)		---
Thallium	14 / 28	50	2.93E-01	J	2.40E+00		4.13E-01	1.30E+00	6.22E-01	1.30E+00	5.10E-01 [f]	Y	7.77E-01	7.77E-01
Vanadium	28 / 28	100	7.50E+00		2.53E+01		1.65E-01	6.40E+00	1.65E+01	4.09E+01	3.90E+01	N (b)		---
Zinc	28 / 28	100	3.53E+01		8.53E+01		2.07E+00	2.71E+00	6.20E+01	3.22E+02	2.30E+03	N (b)		---
Semivolatile Organic Compounds														
Bis(2-ethylhexyl)phthalate	1 / 28	4	6.60E-02	J	6.60E-02	J	3.60E-01	4.51E-01	1.94E-01		3.50E+01	N (a)		---
Di-n-butyl phthalate	1 / 28	4	6.60E-02	J	6.60E-02	J	3.60E-01	4.51E-01	1.94E-01		6.10E+02	N (a)		---
Phenanthrene	7 / 28	25	4.03E-02	J	8.55E-02	J	3.60E-01	4.51E-01	1.65E-01		1.70E+02 [g]	N (a)		---
Volatile Organic Compounds														
Acetone	2 / 12	17	1.30E-02	J	1.20E-01		2.20E-02	1.30E-01	2.52E-02		6.10E+03	N (a)		---
Bromomethane	1 / 12	8	1.10E-03	J	1.10E-03	J	1.10E-02	6.40E-02	9.51E-03		7.30E-01	N (a)		---
Toluene	1 / 12	8	1.10E-02		1.10E-02		5.40E-03	3.20E-02	5.56E-03		5.00E+02	N (a)		---
Xylenes, total	1 / 12	8	6.50E-03		6.50E-03		5.40E-03	3.20E-02	5.18E-03		6.30E+01	N (a)		---

RBSC - Risk-based screening concentration.
COPC - Chemical of potential concern.
mg/kg - Milligrams per kilogram.
BSC - Background screening criterion.
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] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency Regional Screening Level Table (December 2009) residential soil 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) = maximum detected concentration is less than the BSC. (c) = essential nutrient.
[c] Y = Chemical is chosen as COPC.
[d] 95% UCL determined using ProUCL Version 4.00.04 (U.S. Environmental Protection Agency (EPA), 2009, ProUCL Version 4.00.04, 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). Calculated only for COPC.
[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.
[f] RBSC based on thallium from IRIS, 2009.
[g] RBSC based on pyrene.

Source: Shaw, 2010b.

Table 3-9

Statistical Summary and COPC Selection of Chemicals Detected in Bedrock Groundwater
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent hits	Range of values, µg/L: Detected Concentrations Minimum	VQ	Detected Concentrations Maximum	VQ	Reporting Limits Minimum	Reporting Limits Maximum	Arithmetic Mean µg/L	BSC [a] µg/L	RBSC [b] µg/L	COPC? [c,d]	EPC [e] µg/L
Metals													
Aluminum	4 / 4	100	1.74E+01	J	4.61E+01	JJ	2.00E+02	2.00E+02	3.51E+01	3.09E+02	3.70E+03	N (a)	---
Barium	4 / 4	100	2.12E+01	J/J	1.80E+02	J/J	2.00E+02	2.00E+02	9.61E+01	1.18E+04	7.30E+02	N (a)	---
Calcium	4 / 4	100	2.71E+05	J	3.89E+05	J/J	1.00E+03	1.00E+03	3.29E+05	3.16E+05	Nutrient	N (c)	---
Iron	2 / 4	50	3.30E+01	J	2.83E+02	J	3.00E+02	3.00E+02	1.54E+02	1.55E+03	2.60E+03	N (a)	---
Magnesium	4 / 4	100	1.07E+05	J	1.24E+05		5.00E+03	5.00E+03	1.16E+05	2.17E+05	Nutrient	N (c)	---
Manganese	4 / 4	100	5.65E+00	J/J	5.37E+01		1.50E+01	1.50E+01	1.93E+01	6.36E+02	8.80E+01	N (a)	---
Potassium	4 / 4	100	7.74E+03	J	1.56E+04		1.00E+04	2.00E+04	1.17E+04	1.16E+05	Nutrient	N (c)	---
Selenium	2 / 3	67	1.24E+01	J	1.95E+01	J/J	1.00E+01	1.00E+01	1.23E+01		1.80E+01	Y	1.95E+01
Sodium	4 / 4	100	2.64E+04		6.11E+04	J	1.00E+04	2.00E+04	4.43E+04	1.39E+06	Nutrient	N (c)	---
Vanadium	3 / 4	75	1.10E+00	J	1.60E+00	J	5.00E+01	5.00E+01	7.21E+00	5.01E+02	1.80E+01	N (a)	---
Semivolatile Organic Compounds													
Dimethylphenol, 2,4-	1 / 4	25	1.70E+00	J	1.70E+00	J	4.80E+00	4.80E+00	2.23E+00		7.30E+01	N (a)	---
Methylnaphthalene, 2-	4 / 4	100	1.60E+00	J/J	6.30E+00		4.80E+00	4.80E+00	3.34E+00		1.50E+01	N (a)	---
Naphthalene	4 / 4	100	1.75E+00	J/J	7.40E+00		4.80E+00	4.80E+00	3.39E+00		1.40E-01	Y	7.40E+00
Volatile Organic Compounds													
Acetone	2 / 2	100	4.25E+01	J/J	8.61E+01	J	2.50E+01	1.30E+02	6.43E+01		2.20E+03	N (a)	---
Benzene	4 / 4	100	7.80E+00	J/J	3.36E+02		1.00E+00	5.00E+00	1.11E+02		4.10E-01	Y	3.36E+02
Butanone, 2-	3 / 4	75	2.40E+00	J	7.40E+00		5.00E+00	2.50E+01	6.73E+00		7.10E+02	N (a)	---
Carbon disulfide	1 / 4	25	3.70E+00	J	3.70E+00	J	2.00E+00	1.00E+01	1.68E+00		1.00E+02	N (a)	---
Chloromethane	2 / 4	50	5.60E+00	J/J	4.49E+01	J	2.00E+00	1.00E+01	1.31E+01		1.90E+01	Y	4.49E+01
Dichloropropene, trans-1,3-	1 / 4	25	1.70E+00	J	1.70E+00	J	1.00E+00	5.00E+00	8.00E-01		4.30E-01	Y	1.70E+00
Ethylbenzene	4 / 4	100	8.15E+00	J/J	5.71E+01		1.00E+00	5.00E+00	2.31E+01		1.50E+00	Y	5.71E+01
Toluene	4 / 4	100	4.05E+00	J/J	1.47E+02		1.00E+00	5.00E+00	4.92E+01		2.30E+02	N (a)	---
Xylenes, total	4 / 4	100	4.63E+01	J/J	6.30E+02		3.00E+00	1.50E+01	2.32E+02		2.00E+01	Y	6.30E+02
General Chemistry (mg/L)													
Chloride	4 / 4	100	4.06E+01		1.18E+02		2.00E+00	2.50E+01	8.18E+01		Nutrient	N (c)	---
Cyanide, total	1 / 4	25	7.20E-03	J	7.20E-03	J	1.00E-02	1.00E-02	5.55E-03		7.30E-02	N (a)	---
Sulfate	4 / 4	100	4.96E+02		9.46E+02		1.00E+01	4.00E+01	7.16E+02		2.50E+05 [g]	N (a)	---

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
µg/L - Micrograms per liter.
RBSC - Risk-based screening concentration.
VQ - Validation qualifier.

[a] Shaw Environmental, Inc. (Shaw), 2005b, *2004 Groundwater Data Summary and Evaluation Report*, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, April.
[b] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency Regional Screening Level Table (December 2009) tap water 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] Concentration used in risk assessment is equal to maximum detected concentration.
[f] Screening criteria for lead based on the action level of 15 µg/L (EPA, 1996, *Drinking Water Regulations and Health Advisories*, Office of Water, Washington, D.C., October).
[g] US Environmental Protection Agency (EPA), 2009, *2009 Edition of the Drinking Water Standards and Health Advisories*, Office of Water, October, EPA 822-R-09-011.

Source: Shaw, 2010b.

Table 3-10

Statistical Summary and COPC Selection of Chemicals Detected in Overburden Groundwater
Powerhouse No. 2 Ash Pits
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		COPC? [c,d]	Source-Term Concentration [e] µg/L
Inorganics														
Aluminum	3 / 3	100	4.71E+01	J	1.33E+02	J	2.00E+02	2.00E+02	8.62E+01	3.09E+02	3.70E+03		N (a)	---
Barium	3 / 3	100	2.49E+01	JJ	9.80E+01	J	2.00E+02	2.00E+02	4.94E+01	1.18E+04	7.30E+02		N (a)	---
Cadmium	1 / 3	33	1.05E+00	JJ	1.05E+00	JJ	5.00E+00	5.00E+00	2.02E+00		1.80E+00		N (a)	---
Calcium	3 / 3	100	5.44E+04		1.12E+05		1.00E+03	1.00E+03	8.95E+04	3.16E+05	Nutrient		N (c)	---
Cobalt	1 / 3	33	8.10E+00	JJ	8.10E+00	JJ	5.00E+01	5.00E+01	1.94E+01	1.21E+01	1.10E+00		N (b)	---
Iron	2 / 3	67	3.70E+01	J	8.08E+01	J	3.00E+02	3.00E+02	8.93E+01	1.55E+03	2.60E+03		N (a)	---
Lead	1 / 3	33	2.40E+00	J	2.40E+00	J	5.00E+00	5.00E+00	2.47E+00		1.50E+01	f	N (a)	---
Magnesium	3 / 3	100	1.16E+04		3.87E+04		5.00E+03	5.00E+03	2.10E+04	2.17E+05	Nutrient		N (c)	---
Manganese	3 / 3	100	8.22E+01		2.29E+02		1.50E+01	1.50E+01	1.61E+02	6.36E+02	8.80E+01		N (b)	---
Nickel	1 / 3	33	7.42E+01		7.42E+01		4.00E+01	4.00E+01	3.81E+01	8.60E+00	7.30E+01		Y	7.42E+01
Potassium	3 / 3	100	1.50E+03	J	7.55E+03	JJ	1.00E+04	2.00E+04	4.40E+03	1.16E+05	Nutrient		N (c)	---
Sodium	3 / 3	100	2.51E+03	JJ	1.02E+04	J	1.00E+04	2.00E+04	6.72E+03	1.39E+06	Nutrient		N (c)	---
Vanadium	2 / 3	67	1.40E+00	J	3.70E+00	J	5.00E+01	5.00E+01	1.00E+01		1.80E+01		N (a)	---
Zinc	1 / 3	33	3.83E+01		3.83E+01		2.00E+01	2.00E+01	1.94E+01	5.01E+02	1.10E+03		N (a)	---
General Chemistry (mg/L)														
Sulfate	3 / 3	100	81.5		162		2	10	1.13E+02		2.50E+02	g	N (a)	---

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.
µg/L - Micrograms per liter.
RBSC - Risk-based screening concentration.
VQ - Validation qualifier.

[a] Shaw Environmental, Inc. (Shaw), 2005b, *2004 Groundwater Data Summary and Evaluation Report*, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, April.
[b] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA)Regional Screening Level Table (December 2009) ta 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] Concentration used in risk assessment is equal to maximum detected concentration.
[f] Screening criteria for lead based on the action level of 15 µg/L (EPA, 1996, *Drinking Water Regulations and Health Advisories*, Office of Water, Washington, D.C., October).
[g] U.S. Environmental Protection Agency (EPA), 2009, *2009 Edition of the Drinking Water Standards and Health Advisories*, Office of Water, October, EPA 822-R-09-011.

Source: Shaw, 2010b.

Table 3-11

Statistical Summary and COPC Selection of Chemicals Detected in Surface Water
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent hits	Range of values, µg/L: Detected Conc Minimum	VQ	Detected Conc Maximum	VQ	Reporting Limits Minimum	Reporting Limits Maximum	Arithmetic Mean µg/L	RBSC [a] µg/L		COPC? [b,c]
Metals												
Aluminum	5 / 5	100	359		1030	J	200	200	6.01E+02	3.70E+04		N (a)
Barium	5 / 5	100	43.9		50.9	J	200	200	4.70E+01	7.30E+03		N (a)
Calcium	5 / 5	100	75900		80700		1000	1000	7.83E+04	Nutrient		N (b)
Cobalt	1 / 5	20	1.2	J	1.2	J	50	50	2.02E+01	1.10E+01		N (a)
Iron	5 / 5	100	376		1060		300	300	7.22E+02	2.60E+04		N (a)
Lead	2 / 5	40	2.9	J	2.9	J	5	10	2.66E+00	1.50E+01	d	N (a)
Magnesium	5 / 5	100	19800		21400		5000	5000	2.08E+04	Nutrient		N (b)
Manganese	5 / 5	100	52.75		102		15	15	7.08E+01	8.80E+02		N (a)
Nickel	1 / 5	20	6.2	J	6.2	J	40	40	1.72E+01	7.30E+02		N (a)
Potassium	5 / 5	100	2900		4400	J	10000	20000	3.42E+03	Nutrient		N (b)
Sodium	5 / 5	100	30300		34800		10000	20000	3.26E+04	Nutrient		N (b)
Vanadium	5 / 5	100	1.65	JJ	3.1	J	50	50	2.23E+00	1.80E+02		N (a)
Zinc	5 / 5	100	8.1	J	12.4	J	20	20	1.06E+01	1.10E+04		N (a)
Semivolatile Organic Compounds												
Bis(2-ethylhexyl)phthalate	1 / 5	20	2	J	2	J	4.8	4.8	2.32E+00	4.80E+00		N (a)

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.
µg/L - Micrograms per liter.
RBSC - Risk-based screening concentration.
VQ - Validation qualifier.

[a] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency Regional Screening Level Table (December 2009) tap water values are based on a risk level of 1.0E-06 and a hazard index of 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] 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).

Source: Shaw, 2010b.

Table 3-12

Statistical Summary and COPC Selection of Chemicals Detected in Sediment
Powerhouse No. 2 Ash Pits
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	RBSC [a] mg/kg	COPC? [b,c]	95% UCL [d] mg/kg	EPC [e] mg/kg
Inorganics													
Aluminum	5 / 5	100	3.64E+03		7.42E+03		1.20E+01	1.50E+01	5.86E+03	7.70E+04	N (a)		---
Arsenic	5 / 5	100	3.90E+00		1.01E+01	J	4.75E-01	9.50E-01	6.35E+00	3.90E-01	Y	9.03E+00	9.03E+00
Barium	5 / 5	100	2.28E+01		6.71E+01	J	1.20E+01	1.50E+01	4.63E+01	1.50E+04	N (a)		---
Beryllium	5 / 5	100	3.60E-01		5.60E-01		3.00E-01	3.60E-01	4.70E-01	1.60E+02	N (a)		---
Cadmium	4 / 5	80	2.40E-01	J	5.65E-01		2.40E-01	4.80E-01	3.35E-01	7.00E+01	N (a)		---
Calcium	5 / 5	100	7.66E+03		2.70E+04		3.00E+02	3.60E+02	1.67E+04	Nutrient	N (b)		---
Chromium	5 / 5	100	6.40E+00		1.17E+01		5.95E-01	7.30E-01	8.97E+00	2.90E-01	Y	1.10E+01	1.10E+01
Cobalt	5 / 5	100	6.20E+00	J	1.20E+01		3.00E+00	3.60E+00	8.19E+00	2.30E+01	N (a)		---
Copper	5 / 5	100	9.60E+00		2.21E+01		1.50E+00	1.80E+00	1.51E+01	3.10E+03	N (a)		---
Iron	5 / 5	100	1.04E+04		3.91E+04	J	5.95E+00	1.20E+01	1.85E+04	5.50E+04	N (a)		---
Lead	5 / 5	100	7.90E+00		1.22E+01	JJ	5.95E+00	1.20E+01	9.65E+00	4.00E+02	N (a)		---
Magnesium	5 / 5	100	1.95E+03		7.47E+03	J	3.00E+02	3.60E+02	5.08E+03	Nutrient	N (b)		---
Manganese	5 / 5	100	1.27E+02		6.08E+02		9.90E-01	4.45E+00	2.90E+02	1.80E+03	N (a)		---
Mercury	4 / 5	80	1.60E-02	J	2.50E-02	J	9.80E-02	1.20E-01	2.62E-02	2.30E+01	N (a)		---
Nickel	5 / 5	100	1.57E+01		2.51E+01		2.40E+00	2.90E+00	1.81E+01	1.50E+03	N (a)		---
Potassium	5 / 5	100	4.98E+02	J	1.66E+03		6.00E+02	1.50E+03	1.03E+03	Nutrient	N (b)		---
Selenium	5 / 5	100	3.90E-01	J	1.00E+00	J	5.95E+00	1.20E+01	7.85E-01	3.90E+02	N (a)		---
Silver	1 / 5	20	8.30E-02	J	8.30E-02	J	5.95E-01	7.30E-01	2.79E-01	3.90E+02	N (a)		---
Sodium	5 / 5	100	5.48E+01	J	1.64E+02	JJ	6.00E+02	1.50E+03	1.17E+02	Nutrient	N (b)		---
Vanadium	5 / 5	100	9.40E+00		1.52E+01		3.00E+00	6.00E+00	1.26E+01	3.90E+02	N (a)		---
Zinc	5 / 5	100	2.70E+01	J	5.73E+01		1.20E+00	1.50E+00	4.06E+01	2.30E+04	N (a)		---
Explosives													
Trinitrotoluene, 2,4,6-	1 / 5	20	6.47E-02	J	6.47E-02	J	1.55E-01	1.90E-01	8.14E-02	1.90E+01	N (a)		---
Semivolatiles Organic Compounds													
Fluoranthene	2 / 5	40	5.25E-02	J	5.47E-02	J	2.05E-01	2.60E-01	8.49E-02	2.30E+03	N (a)		---

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.
µg/L - Micrograms per liter.
RBSC - Risk-based screening concentration.
VQ - Validation qualifier.

[a] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency Regional Screening Level Table (December 2009) residential soil and are based on a risk level of 1.0E-06 and a hazard index of 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 determined using ProUCL Version 4.00.04 (U.S. Environmental Protection Agency (EPA), 2009, ProUCL Version 4.00.04, 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). Calculated only for COPC.
[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

Source: Shaw, 2010b.

Table 3-13

Summary of Risk for All Receptors
Powerhouse No. 2 Ash Pits
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
Bedrock Groundwater Use													
Exposure to:													
Soil [b]	1.56E-06	0.09	9.08E-08	0.3	2.39E-07	0.03	2.84E-06	0.07	0.6	5.97E-08	0.003	4.43E-13	0.000003
Groundwater	7.01E-05	1.0	NE	NE	7.01E-05	1.0	3.39E-04	2.9	6.5	NE	NE	NE	NE
Sediment	NE	NE	3.40E-07	0.1	NE	NE	2.15E-06	0.004	0.04	NE	NE	NE	NE
Surface Water	NE	NE	NA	NA	NE	NE	NA	NA	NA	NE	NE	NE	NE
Total ILCR or HI	**7.E-05**	**1**	**4.E-07**	**0.4**	**7.E-05**	**1**	**3.E-04**	**3**	**7**	**6.E-08**	**0.003**	**4.E-13**	**0.000003**
Overburden Groundwater Use													
Exposure to:													
Soil [b]	1.56E-06	0.09	9.08E-08	0.3	2.39E-07	0.03	2.84E-06	0.07	0.6	5.97E-08	0.003	4.43E-13	0.000003
Groundwater	NA	0.04	NE	NE	NA	0.04	NA	0.1	0.2	NE	NE	NE	NE
Sediment	NE	NE	3.40E-07	0.1	NE	NE	2.15E-06	0.004	0.04	NE	NE	NE	NE
Surface Water	NE	NE	NA	NA	NE	NE	NA	NA	NA	NE	NE	NE	NE
Total ILCR or HI	**2.E-06**	**0.1**	**4.E-07**	**0.4**	**2.E-07**	**0.06**	**5.E-06**	**0.2**	**0.9**	**6.E-08**	**0.003**	**4.E-13**	**0.000003**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - No chemicals of potential concern available for exposure evaluation.
NE - Pathway not evaluated for this receptor.

[a] Total ILCR and total HI values for the groundskeeper reflect the respective totals for the future groundskeeper assumed to use either bedrock or overburden groundwater. The total ILCR and HI values for the current groundskeeper are simply those shown for soil. The rounded current groundskeeper ILCR is 2E-6 and the HI is 0.09.
[b] Because the surface soil data set is used to represent total soil (refer to Section 2.5 of text), associated risk of total soil and surface soil are not shown separately.

Source: Shaw, 2010b.

Table 3-14

Summary of Risk for Receptors Exposed to Bedrock Groundwater Without the Contributions of Benzene
Powerhouse No. 2 Ash Pits
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
Bedrock Groundwater Use							
Exposure to:							
Soil	1.56E-06	0.09	2.39E-07	0.03	2.84E-06	0.07	0.6
Groundwater	6.10E-07	0.1	6.10E-07	0.1	5.44E-06	0.3	0.6
Sediment	NE	NE	NE	NE	2.15E-06	0.004	0.04
Surface Water	NE	NE	NE	NE	NA	NA	NA
Total ILCR or HI	**2.E-06**	**0.2**	**8.E-07**	**0.1**	**1.E-05**	**0.3**	**1**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - No chemicals of potential concern available for exposure evaluation.
NE - Pathway not evaluated for this receptor.

Note: Benzene is naturally occurring in bedrock groundwater underlying the Powerhouse 2 Ash Pits; refer to Section 7.2 of the text.

Source: Shaw, 2010b.

Table 3-15

Summary of Samples Evaluated in the SLERA
Power House No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location	Sample Number		Sample Date	Depth (ft)	Analyses
Soil Samples					
ASH PIT 2-SB01	AP0100	REG	15-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0103	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB03	AP0108	REG	18-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB04	AP0111	REG	18-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB05	AP0114	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB06	AP0117	REG	15-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0120	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0121	FD	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB08	AP0125	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
PH2SO01	4010	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO02	4030	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO03	4050	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4070	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO05	4090	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO06	4110	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO07	4130	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4150	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO09	4170	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO10	4190	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO11	4210	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO12	4230	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
ASH PIT 2-SB01	AP0101	REG	15-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0104	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0105	FD	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB03	AP0109	REG	18-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB04	AP0112	REG	18-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB05	AP0115	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB06	AP0118	REG	15-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0123	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB08	AP0126	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
PH2SO01	4020	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO02	4040	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO03	4060	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4080	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4081	FD	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO05	4100	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO06	4120	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO07	4140	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4160	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4161	FD	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO09	4180	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO10	4200	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO11	4220	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO12	4240	REG	29-Sep-96	3 - 4	Cyanide, Metals, Pest, PCB, SVOC, VOC
Sediment Samples					
ASH PIT 2-SD01	AP1000	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD02	AP1001	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD03	AP1002	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD04	AP1003	REG	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD04	AP1004	FD	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD05	AP1006	REG	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
Surface Water Samples					
AP2-SW01	AP2000	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW02	AP2001	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW03	AP2002	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW03	AP2003	FD	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW04	AP2005	REG	25-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW05	AP2006	REG	25-May-09	NA	Exp, Metals, PCB, SVOC

FD - Field duplicate.
Exp - Explosives.
NA - Not applicable.
Pest - Organochlorine pesticides.
PCB - Polychlorinated biphenyls.
SLERA - Screening-level ecological risk assessment.
SVOC - Semivolatile organic compounds.
VOC - Volatile organic compounds.

Source: Shaw, 2010c.

Table 3-16

Statistical Summary and COPEC Selection of Chemicals Detected in Total Soil (0 to 6 Feet bgs)
Power House No. 2 Ash Pits
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)	ESV [b] (mg/kg)	COPEC? [c,d]	Distribution [e]	95% UCL [e] (mg/kg)	EPC [f] (mg/kg)	EPC 0-1' soil depth [g] (mg/kg)
Inorganics																
Aluminum	40 / 40	100	3.52E+03		1.50E+04		1.75E+00	3.57E+01	8.55E+03	1.55E+04	pH Dependent	N (b)			---	---
Antimony	15 / 40	38	2.27E-01	J	9.58E-01		4.39E-01	1.07E+01	2.62E+00	9.30E+00	0.27	N (b)			---	---
Arsenic	40 / 40	100	3.60E+00		2.68E+01	J	8.77E-01	1.80E+00	1.03E+01	3.65E+01	18	N (b)			---	---
Barium	40 / 40	100	2.99E+01		1.41E+02		1.75E-01	3.57E+01	7.98E+01	8.26E+02	330	N (a)			---	---
Beryllium	33 / 40	83	5.90E-01		1.69E+01	J	1.75E-01	8.90E-01	4.23E+00	1.00E+00	21	N (a)			---	---
Cadmium	8 / 40	20	2.93E-01	J	1.40E+00		4.39E-01	8.90E-01	3.76E-01		0.36	Y	Normal	5.32E-01	5.32E-01	6.50E-01
Calcium	40 / 40	100	3.51E+02		4.72E+04	J	4.39E+00	8.91E+02	6.48E+03	5.23E+04	Nutrient	N (c)			---	---
Chromium	40 / 40	100	1.90E+00		2.21E+01	J	4.39E-01	1.80E+00	1.14E+01	2.90E+01	26	N (a)			---	---
Cobalt	40 / 40	100	3.90E+00	J	2.47E+01		3.51E-01	8.90E+00	1.15E+01	1.16E+02	13	N (b)			---	---
Copper	40 / 40	100	8.30E+00		3.86E+01		4.39E-01	4.50E+00	2.11E+01	5.62E+01	28	N (b)			---	---
Iron	40 / 40	100	1.05E+04		1.09E+05		1.93E+00	3.79E+01	3.35E+04	2.34E+05	pH Dependent	N (b)			---	---
Lead	40 / 40	100	4.64E+00		5.07E+01		3.30E-01	5.99E-01	1.56E+01	4.86E+01	11	N (d)			---	---
Magnesium	40 / 40	100	3.12E+02	J	1.01E+04	J	1.75E+00	8.91E+02	2.43E+03	1.04E+04	Nutrient	N (c)			---	---
Manganese	40 / 40	100	8.21E+01	J	1.56E+03	J	1.75E-01	2.70E+00	3.50E+02	3.51E+03	220	N (b)			---	---
Mercury	26 / 40	65	1.12E-02	J	1.40E-01		1.94E-02	5.90E-02	4.27E-02	8.50E-02	0.00051	Y	Gamma	5.28E-02	5.28E-02	7.96E-02
Nickel	40 / 40	100	1.05E+01		4.19E+01		2.63E-01	7.10E+00	2.42E+01	5.51E+01	38	N (b)			---	---
Potassium	39 / 40	98	3.23E+02		2.26E+03		2.19E+01	8.91E+02	9.77E+02	3.39E+03	Nutrient	N (c)			---	---
Selenium	21 / 40	53	6.40E-01		2.60E+00		5.40E-01	1.20E+00	9.12E-01	2.00E+00	0.52	Y	Normal	1.22E+00	1.22E+00	1.66E+00
Silver	5 / 40	13	1.20E+00		2.00E+00		4.39E-01	1.80E+00	6.25E-01	1.11E+01	4.2	N (a)			---	---
Sodium	16 / 40	40	1.84E+01		1.19E+02		8.77E+00	8.91E+02	2.24E+02		Nutrient	N (c)			---	---
Thallium	21 / 40	53	3.00E-01	J	8.50E+00		4.39E-01	1.80E+00	1.26E+00	1.30E+00	1	Y	Approx. Gamma	1.67E+00	1.67E+00	1.68E+00
Vanadium	39 / 40	98	7.50E+00		2.69E+01		1.75E-01	8.90E+00	1.69E+01	4.09E+01	7.8	N (b)			---	---
Zinc	40 / 40	100	3.53E+01		1.27E+02		2.19E+00	3.60E+00	6.71E+01	3.22E+02	46	N (b)			---	---
Cyanide																
Cyanide, total	3 / 24	13	7.10E-01		9.30E-01		5.40E-01	8.90E-01	3.92E-01		1.33	N (a)			---	---
Polychlorinated biphenyls (PCB)																
Aroclor 1016	1 / 40	3	5.25E-01	J	5.25E-01	J	3.60E-02	5.90E-02	3.44E-02		0.371	N (e)			---	---
Aroclor 1260	1 / 40	3	1.62E-02	J	1.62E-02	J	3.60E-02	5.90E-02	2.18E-02		0.371	N (a)			---	---
Organochlorine Pesticides																
DDE, 4,4'-	7 / 24	29	2.40E-03		7.40E-03		1.80E-03	3.00E-03	2.15E-03		0.021	N (a)			---	---
DDT, 4,4'-	8 / 24	33	2.60E-03		7.10E-03		1.80E-03	3.00E-03	2.22E-03		0.021	N (a)			---	---
Methoxychlor	2 / 24	8	6.10E-03		6.50E-03		3.60E-03	5.90E-03	2.53E-03		0.0199	N (a)			---	---
Semivolatile Organic Compounds																
Acenaphthylene	1 / 40	3	1.10E-01	J	1.10E-01	J	3.60E-01	5.90E-01	2.16E-01		29	N (a)			---	---
Anthracene	1 / 40	3	5.80E-02	J	5.80E-02	J	3.60E-01	5.90E-01	2.15E-01		29	N (a)			---	---
Benzo(a)anthracene	5 / 40	13	3.07E-02		1.30E-01	J	3.60E-01	5.90E-01	1.98E-01		1.1	N (a)			---	---
Benzo(a)pyrene	3 / 40	8	8.44E-02	J	1.70E-01	J	3.60E-01	5.90E-01	2.10E-01		1.1	N (a)			---	---
Benzo(b)fluoranthene	2 / 40	5	1.30E-01	J	1.60E-01	J	3.60E-01	5.90E-01	2.15E-01		1.1	N (a)			---	---
Benzo(ghi)perylene	1 / 40	3	1.30E-01	J	1.30E-01	J	3.60E-01	5.90E-01	2.16E-01		1.1	N (a)			---	---
Benzo(k)fluoranthene	1 / 40	3	2.30E-01	J	2.30E-01	J	3.60E-01	5.90E-01	2.19E-01		1.1	N (a)			---	---
Benzoic acid	2 / 16	13	6.22E-01		1.43E+00		3.80E-01	4.99E-01	3.14E-01		NSV	N (a)			---	---
Bis(2-ethylhexyl)phthalate	2 / 40	5	6.60E-02	J	9.50E-02	J	3.60E-01	5.90E-01	2.12E-01		0.925	N (a)			---	---
Chrysene	4 / 40	10	6.39E-02	J	1.60E-01	J	3.60E-01	5.90E-01	2.05E-01		1.1	N (a)			---	---
Di-n-butyl phthalate	2 / 40	5	6.60E-02	J	1.70E-01	J	3.60E-01	5.90E-01	2.15E-01		200	N (a)			---	---
Fluoranthene	8 / 40	20	5.99E-02	J	3.00E-01	J	3.60E-01	5.90E-01	1.96E-01		1.1	N (a)			---	---
Indeno(1,2,3-cd)pyrene	1 / 40	3	1.20E-01	J	1.20E-01	J	3.60E-01	5.90E-01	2.16E-01		1.1	N (a)			---	---
Naphthalene	3 / 40	8	4.44E-02	J	5.59E-02	J	3.60E-01	5.90E-01	2.06E-01		29	N (a)			---	---
Phenanthrene	4 / 40	10	6.30E-02	J	1.00E-01	J	3.60E-01	5.90E-01	2.03E-01		29	N (a)			---	---
Pyrene	8 / 40	20	4.40E-02	J	2.50E-01	J	3.60E-01	5.90E-01	1.90E-01		1.1	N (a)			---	---
Volatile Organic Compounds																
Acetone	4 / 24	17	1.30E-02	J	1.20E-01		2.20E-02	1.80E-01	4.49E-02		2.5	N (a)			---	---
Bromomethane	1 / 24	4	1.10E-03	J	1.10E-03	J	1.10E-02	8.90E-02	1.93E-02		0.235	N (a)			---	---
Methylene chloride	1 / 24	4	5.20E-02	J	5.20E-02	J	5.40E-03	4.50E-02	1.17E-02		4.05	N (a)			---	---
Toluene	2 / 24	8	1.10E-02		1.80E-02	J	5.40E-03	4.50E-02	9.91E-03		200	N (a)			---	---
Xylenes, total	1 / 24	4	6.50E-03		6.50E-03		5.40E-03	4.50E-02	9.86E-03		10	N (a)			---	---

Table 3-16

Statistical Summary and COPEC Selection of Chemicals Detected in Total Soil (0 to 6 Feet bgs)
Power House No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

BSC - Background screening concentration.
COPEC - Chemical of potential ecological concern.
EPC - Exposure point concentration.
ESV - Ecological screening value.
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.
VQ - Validation qualifier.
NSV - No screening value.
UCL - Upper confidence limit.

[a] IT Corporation (IT), 1998, *Site Investigation of Acid Areas, Plum Brook Ordnance Works, Sandusky, Ohio* , August.
[b] ESVs and their sources are in Appendix B.
[c] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
(d) = statistical test shows background and site data to be the same; see Appendix C.
(e) = infrequently detected (fewer than 5 percent of all samples)
[d] Y = Chemical is chosen as COPEC.
[e] 95% UCL determined using ProUCL Version 4.00.04 (EPA, 2009, ProUCL Version 4.00.04, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April, on line at http://www.epa.gov/esd/tsc/form.htm). UCLs are calculated only for chemicals selected as COPECs.
[f] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.
[g] The EPC for the COPEC at the 0-1 foot soil depth range is used as the exposure concentration for some ecological receptors. See text for details.

Source: Shaw, 2010c.

Table 3-17

Statistical Summary and COPEC Selection of Chemicals Detected in Surface Water
Power House No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of values, µg/L: Detected Conc Minimum	VQ	Detected Conc Maximum	VQ	Reporting Limits Minimum	Reporting Limits Maximum	Arithmetic Mean µg/L	ESV [a] µg/L	COPEC? [b,c]	Distribution [d]	95% UCL [d] µg/L	EPC [e] µg/L
Metals														
Aluminum	5 / 5	100	359		1030	J	200	200	6.01E+02	8.70E+01	Y	Normal	8.70E+02	8.70E+02
Barium	5 / 5	100	43.9		50.9	J	200	200	4.70E+01	4.00E+00	Y	Normal	4.97E+01	4.97E+01
Calcium	5 / 5	100	75900		80700		1000	1000	7.83E+04	Nutrient	N (b)			---
Cobalt	1 / 5	20	1.2	J	1.2	J	50	50	2.02E+01	2.30E+01	N (a)			---
Iron	5 / 5	100	376		1060		300	300	7.22E+02	1.00E+03	N (b)			---
Lead	2 / 5	40	2.9	J	2.9	J	5	10	2.66E+00	1.17E+00	Y	Nonparametric	2.87E+00	2.87E+00
Magnesium	5 / 5	100	19800		21400		5000	5000	2.08E+04	Nutrient	N (b)			---
Manganese	5 / 5	100	52.75		102		15	15	7.08E+01	1.20E+02	N (a)			---
Nickel	1 / 5	20	6.2	J	6.2	J	40	40	1.72E+01	2.90E+01	N (a)			---
Potassium	5 / 5	100	2900		4400	J	10000	20000	3.42E+03	Nutrient	N (b)			---
Sodium	5 / 5	100	30300		34800		10000	20000	3.26E+04	Nutrient	N (b)			---
Vanadium	5 / 5	100	1.65	JJ	3.1	J	50	50	2.23E+00	1.20E+01	N (a)			---
Zinc	5 / 5	100	8.1	J	12.4	J	20	20	1.06E+01	6.57E+01	N (a)			---
Semivolatile Organic Compounds														
Bis(2-ethylhexyl)phthalate	1 / 5	20	2	J	2	J	4.8	4.8	2.32E+00	1.20E-01	Y	Nonparametric	2.49E+00	2.00E+00

ESV - Ecological screening value.
EPC - Exposure point concentration.
COPEC - Chemical of potential ecological concern.
µg/L - Micrograms per liter.
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] ESVs and their sources are in Appendix B.
[b] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = essential nutrient.
[c] Y = Chemical is chosen as COPEC.
[d] 95% UCL determined using ProUCL Version 4.00.04 (EPA, 2009, ProUCL Version 4.00.04, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April, on line at http://www.epa.gov/esd/tsc/form.htm). UCLs are calculated only for chemicals selected as COPECs
[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

Source: Shaw, 2010c.

Table 3-18

Statistical Summary and COPEC Selection of Chemicals Detected in Sediment
Power House No. 2 Ash Pits
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	ESV [b] mg/kg	COPC? [c,d]	Distribution [e]	95% UCL [e] (mg/kg)	EPC [f] mg/kg
Inorganics															
Aluminum	5 / 5	100	3.64E+03		7.42E+03		1.20E+01	1.50E+01	5.86E+03	1.55E+04	NSV	N (b)			---
Arsenic	5 / 5	100	3.90E+00		1.01E+01	J	4.75E-01	9.50E-01	6.35E+00	3.65E+01	9.79E+00	N (b)			---
Barium	5 / 5	100	2.28E+01		6.71E+01	J	1.20E+01	1.50E+01	4.63E+01	8.26E+02	NSV	N (b)			---
Beryllium	5 / 5	100	3.60E-01		5.60E-01		3.00E-01	3.60E-01	4.70E-01	1.00E+00	NSV	N (b)			---
Cadmium	4 / 5	80	2.40E-01	J	5.65E-01		2.40E-01	4.80E-01	3.35E-01	NA	9.90E-01	N (a)			---
Calcium	5 / 5	100	7.66E+03		2.70E+04		3.00E+02	3.60E+02	1.67E+04	5.23E+04	NSV	N (c)			---
Chromium	5 / 5	100	6.40E+00		1.17E+01		5.95E-01	7.30E-01	8.97E+00	2.90E+01	4.34E+01	N (a)			---
Cobalt	5 / 5	100	6.20E+00	J	1.20E+01		3.00E+00	3.60E+00	8.19E+00	1.16E+02	5.00E+01	N (a)			---
Copper	5 / 5	100	9.60E+00		2.21E+01		1.50E+00	1.80E+00	1.51E+01	5.62E+01	3.16E+01	N (b)			---
Iron	5 / 5	100	1.04E+04		3.91E+04	J	5.95E+00	1.20E+01	1.85E+04	2.34E+05	NSV	N (b)			---
Lead	5 / 5	100	7.90E+00		1.22E+01	JJ	5.95E+00	1.20E+01	9.65E+00	4.86E+01	3.58E+01	N (a)			---
Magnesium	5 / 5	100	1.95E+03		7.47E+03	J	3.00E+02	3.60E+02	5.08E+03	1.04E+04	NSV	N (c)			---
Manganese	5 / 5	100	1.27E+02		6.08E+02		9.90E-01	4.45E+00	2.90E+02	3.51E+03	4.60E+02	N (b)			---
Mercury	4 / 5	80	1.60E-02	J	2.50E-02	J	9.80E-02	1.20E-01	2.62E-02	8.50E-02	1.80E-01	N (a)			---
Nickel	5 / 5	100	1.57E+01		2.51E+01		2.40E+00	2.90E+00	1.81E+01	5.51E+01	2.27E+01	N (b)			---
Potassium	5 / 5	100	4.98E+02	J	1.66E+03		6.00E+02	1.50E+03	1.03E+03	3.39E+03	NSV	N (c)			---
Selenium	5 / 5	100	3.90E-01	J	1.00E+00	J	5.95E+00	1.20E+01	7.85E-01	2.00E+00	NSV	N (b)			---
Silver	1 / 5	20	8.30E-02	J	8.30E-02	J	5.95E-01	7.30E-01	2.79E-01	1.11E+01	5.00E-01	N (a)			---
Sodium	5 / 5	100	5.48E+01	J	1.64E+02	JJ	6.00E+02	1.50E+03	1.17E+02	NA	NSV	N (c)			---
Vanadium	5 / 5	100	9.40E+00		1.52E+01		3.00E+00	6.00E+00	1.26E+01	4.09E+01	NSV	N (b)			---
Zinc	5 / 5	100	2.70E+01	J	5.73E+01		1.20E+00	1.50E+00	4.06E+01	3.22E+02	1.21E+02	N (a)			---
Explosives															
2,4,6-Trinitrotoluene	1 / 5	20	6.47E-02	J	6.47E-02	J	1.55E-01	1.90E-01	8.14E-02		NSV	Y	Normal	9.22E-02	6.47E-02
Semivolatiles Organic Compounds															
Fluoranthene	2 / 5	40	5.25E-02	J	5.47E-02	J	2.05E-01	2.60E-01	8.49E-02		4.23E-01	N (a)			---

BSC - Background screening concentration. The soil BSC is used for sediment in this evaluation. See text for details.
COPEC - Chemical of potential ecological concern.
EPC - Exposure point concentration.
ESV - Ecological screening value.
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.
NSV - No screening value available.
VQ - Validation qualifier.

[a] Soil background screening concentrations are used for sediment. See text for details.
[b] ESVs and their sources are in Appendix B.
[c] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
[d] Y = Chemical is chosen as COPEC.
[e] 95% UCL determined using ProUCL Version 4.00.04 (EPA, 2009, ProUCL Version 4.00.04, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April, on line at http://www.epa.gov/esd/tsc/form.htm). UCLs are calculated only for chemicals selected as COPECs.
[f] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

Source: Shaw, 2010c.

Table 3-19

Wildlife Hazard Quotient for All Assessment Receptors
Power House No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPEC	Deer Mouse		Short-tailed Shrew		Cottontail Rabbit		Marsh Wren		White-tailed Deer		Raccoon		Red-Tailed Hawk		Muskrat	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals																
Aluminum	6.70E-02	6.70E-03	6.91E-02	6.91E-03	2.86E-02	2.86E-03	2.13E-03	2.13E-04	1.15E-04	1.15E-05	5.15E-03	5.15E-04	1.13E-06	1.13E-07	4.22E-02	4.22E-03
Barium	1.45E-03	3.73E-04	1.49E-03	3.84E-04	6.17E-04	1.59E-04	6.44E-04	3.21E-04	2.49E-06	6.42E-07	2.95E-05	7.59E-06	3.42E-07	1.70E-07	9.12E-04	2.35E-04
Cadmium	4.93E-01	4.93E-02	7.44E-01	7.44E-02	2.95E-02	2.95E-03	1.18E+00	8.54E-02	5.78E-05	5.78E-06	1.26E-03	1.26E-04	2.42E-05	1.75E-06	0.00E+00	0.00E+00
Lead	5.34E-05	5.34E-06	5.51E-05	5.51E-06	2.28E-05	2.28E-06	6.86E-04	6.86E-05	9.20E-08	9.20E-09	6.97E-07	6.97E-08	1.07E-07	1.07E-08	3.36E-05	3.36E-06
Mercury	3.46E-03	3.46E-04	4.61E-03	4.61E-04	4.14E-04	4.14E-05	3.03E-01	1.52E-01	7.39E-07	7.39E-08	1.09E-04	2.18E-05	5.37E-06	2.68E-06	0.00E+00	0.00E+00
Selenium	1.04E+00	6.28E-01	8.78E-01	5.32E-01	2.73E-01	1.66E-01	7.99E-01	3.99E-01	4.18E-04	2.53E-04	2.34E-03	1.42E-03	2.70E-04	7.93E-05	0.00E+00	0.00E+00
Thallium	**5.95E+00**	5.95E-01	**1.34E+01**	1.34E+00	8.21E-01	8.21E-02	4.46E-01	4.46E-02	6.42E-04	6.42E-05	2.16E-02	2.16E-03	9.82E-05	9.82E-06	0.00E+00	0.00E+00
Explosives																
2,4,6-Trinitrotoluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.10E-04	4.10E-05	0.00E+00	0.00E+00	4.10E-01	4.10E-02
Semivolatile Organics																
Bis(2-ethylhexyl) phthalate	1.62E-05	1.62E-06	1.67E-05	1.68E-06	6.92E-06	6.93E-07	4.86E-04	4.86E-05	2.79E-08	2.80E-09	6.25E-07	6.26E-08	2.58E-07	2.58E-08	1.02E-05	1.02E-06

COPEC - Chemical of potential ecological concern.
LOAEL - Lowest-observed-adverse-effect level.
NOAEL - No-observed-adverse-effect level

Shaded cells indicate a hazard quotient greater than 1, when rounded.

Source: Shaw, 2010c.

Table 4-1

Detected Analytes in Soil Samples Above RBSCs and/or BSCs
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

				LOCATION	CY2-SB01										CY2-SB02										CY2-SB03						CY2-SB04					
				SAMPLE NO	CY0015		CY0016		CY0017		CY0018		CY0019		CY0020		CY0021		CY0022		CY0023		CY0024		CY0025		CY0026		CY0027		CY0028		CY0029		CY0030	
				DATE	27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		26-Oct-11		26-Oct-11		26-Oct-11		26-Oct-11		26-Oct-11		26-Oct-11	
				DEPTH	0.5 - 1 Ft		0.5 - 1 Ft		0.5 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0.5 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft		0.5 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				PURPOSE	REG		FD		FS		REG		REG		REG		REG		REG		FD		FS		REG		REG		REG		REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES																																				
Acenaphthylene	mg/kg	NE	NE	0.013	-	-	-	-	0.013		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acetophenone	mg/kg	780	NE	0.047	-	-	-	-	0.047	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	1,700	NE	0.02	-	-	-	-	0.02		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.15	NE	0.043	-	-	-	-	0.043		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)flouranthene	mg/kg	0.15	NE	0.039	-	-	-	-	0.039		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)flouroanthene	mg/kg	1.5	NE	0.018	-	-	-	-	0.018		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	NE	NE	0.024	-	-	-	-	0.024		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.039	-	-	-	-	0.039		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1'-Biphenyl	mg/kg	5.1	NE	0.034	-	-	-	-	0.034	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	mg/kg	35	NE	0.321	-	-	-	-	-	-	0.321	J	-	-	-	-	-	-	-	-	-	-	0.025	J	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.055	-	-	-	-	0.055		-	-	-	-	-	-	-	-	-	-	-	-	0.028		-	-	-	-	-	-	-	-	-	-	-	-
Dibenzofuran	mg/kg	7.8	NE	0.14	-	-	-	-	0.14		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.051	-	-	0.0293	J	0.051		-	-	-	-	0.031	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flourene	mg/kg	230	NE	0.018	-	-	-	-	0.018		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methylnaphthalene, 2-	mg/kg	31	NE	0.65	-	-	-	-	0.65		-	-	-	-	-	-	-	-	-	-	-	-	0.025		-	-	-	-	-	-	0.0429	J	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.4	-	-	-	-	0.4		-	-	-	-	-	-	-	-	-	-	-	-	0.015		-	-	-	-	-	-	0.0321	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.22	-	-	-	-	0.22		-	-	-	-	0.0292	J	-	-	-	-	-	-	0.02		-	-	-	-	-	-	-	-	-	-	-	-
Pyrene	mg/kg	170	NE	0.054	-	-	0.0268	J	0.054		-	-	-	-	-	-	-	-	-	-	-	-	0.013		-	-	-	-	-	-	-	-	-	-	-	-
METALS																																				
Aluminum	mg/kg	7,700	15,500	14,500	8,000	J	14,500	J	14,000		5,150		6,090		7,330		8,500		7,090		5,780		8,400		9,880		7,300		6,660		6,650		5,140		5,510	
Antimony	mg/kg	3.1	9.3	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.25	J	-	-	-	-
Arsenic	mg/kg	0.39	36.5	13.5	10		10		12		5.8		3.2		13.5		2.1		4.3	J	8	J	7.3		12.2		10.8		2		6.1		11.5		5.4	
Barium	mg/kg	1,500	826	86.6	49.2	J	86.6	J	85		35.2		53.8		57.3		67.6		72.1		50.4		52		68		63.8		37.1		35.2		70.9		40.3	
Beryllium	mg/kg	16	1	0.87	0.67	J	0.87	J	0.48	J	0.36	J	0.44	J	0.36	J	0.49	J	0.46	J	0.4	J	0.32	J	0.48	J	0.49		0.46	J	0.27		0.42	J	0.46	J
Cadmium	mg/kg	7	NE	0.89	-	-	-	-	0.063	J	0.81		0.89		-	-	-	-	0.83	J	0.17	J	0.24	J	-	-	0.28	J	0.73		0.72		0.24	J	-	-
Calcium	mg/kg	NE	52,300	60,700	3,260	J	9,300	J	4,700		**52,500**		**60,700**		1,270		34,600		49,500		51,200		52,000		1,740		43,200		45,200		3,380		39,900		**54,100**	
Chromium	mg/kg	NE	29	22	16.7		19.1		19		9.8		13		14.9		12.9		13.8		12.6		15		22		16.7		12.9		10.4		11.8		12.7	
Cobalt	mg/kg	2.3	116	15.1	11.4		10.6	J	8.7		5.5		6.5		4.7	J	9.6	J	6.9		10		11		6.8	J	15.1		6.9		3.5		9.9	J	9.1	
Copper	mg/kg	310	56.2	26.4	24.6		24.2		24		18.8		23.9		22.5		20.6		23		22.2		24		23.5		26.4		21.6		11.2		20.9		21.8	
Iron	mg/kg	5,500	234,000	34,300	28,700		27,700		31,000	B	17,100		19,800		23,800		17,100		22,700		17,800		21,000	B	34,300		18,800		20,400		16,400		20,200		17,500	
Lead	mg/kg	40	48.6	15.3	13.4		13		14		12.8		13		11		11		12.9		12.2		12		9.6		15.3		12.7		7.4		8.3		13.2	
Magnesium	mg/kg	NE	10,400	23,700	3,000		4,370		4,300	B	**15,300**		**17,300**		1,810		**14,600**		**14,800**		**13,800**		**17,000**	B	3,100		**14,100**		**14,700**		2,430		**16,300**		**23,700**	
Manganese	mg/kg	180	3,506	816	249		199		200		454		538		81.1		492		413		450		420		121		816		514		103		672		488	
Mercury	mg/kg	1	0.09	0.054	0.038	J	0.052	J	0.054	J B	0.019	J	0.021	J	0.043	J	0.04	J	0.016	J	0.015	J	0.029	J B	0.035	J	0.011	J	0.023	J	0.034	J	0.017	J	0.012	J
Nickel	mg/kg	150	55.1	40	26.6		30		25		16.1		17.3		19.2		26.8		18.8		25.3		27		23.5		40		19.3		10.7		25.7		25.3	
Potassium	mg/kg	NE	3,390	1,540	599	J	815	J	850		1,020	J	1,440	J	567	J	990	J	1,540		1,160		1,400		698	J	1,210		1,450		472		848	J	1,220	J
Selenium	mg/kg	39	2	1.1	1	J	-	-	-	-	0.43	J	-	-	0.91	J	-	-	0.65	J	-	-	-	-	1.1	J	-	-	0.72	J	-	-	-	-	-	-
Silver	mg/kg	39	11.1	0.088	-	-	-	-	-	-	0.053	J	0.086	J	-	-	0.063	J	0.079	J	-	-	-	-	-	-	-	-	0.087	J	0.088	J	-	-	-	-
Sodium	mg/kg	NE	NE	150	-	-	-	-	-	-	124	J	-	-	-	-	-	-	150	J	135	J	-	-	-	-	114	J	146	J	52.6	J	-	-	-	-
Thallium	mg/kg	0.078	1.3	0.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.39	J	-	-	-	-	-	-	-	-
Vanadium	mg/kg	39	40.9	32.4	26.4		28		27		11.5		11.4		24.8		17.5		13.8		16.7		19		32.4		24.9		13.4		16.1		20		12.3	
Zinc	mg/kg	2,300	321.75	70	-	-	-	-	70		-	-	-	-	-	-	-	-	-	-	-	-	57		-	-	-	-	-	-	24.2		-	-	-	-

NE - Not established (RBSCs), not evaluated (BSCs).
Shaded cell indicates value is greater than RBSC.
Bolded text indicates values are greater than BSC.

BSC - Background screening concentration.
MDC - Maximum detected concentration for the area of concern.
mg/kg - Milligrams per kilogram.
RBSC - Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1. For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
SCR - Site characterization report.
"-" - Not detected.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

Table 4-2

Summary of Samples Evaluated in the BHHRA
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location	Sample Number	Sample Purpose	Sample Date	Depth of Sample (ft bgs)			Analysis
CY2-SB01	CY0015	REG	10/27/2011	0.5	-	1	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0016	FD	10/27/2011	0.5	-	1	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0016	FS	10/27/2011	0.5	-	1	PCB [a]
CY2-SB01	CY0018	REG	10/27/2011	3	-	5	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0019	REG	10/27/2011	8	-	10	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB02	CY0020	REG	10/27/2011	0.5	-	1	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB02	CY0021	REG	10/27/2011	3	-	5	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB02	CY0022	REG	10/27/2011	8	-	10	Explosives, Gen Chem, Metals, SVOC
CY2-SB02	CY0023	FD	10/27/2011	8	-	10	Explosives, Gen Chem, Metals, SVOC
CY2-SB03	CY0025	REG	10/26/2011	0.5	-	1	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB03	CY0026	REG	10/26/2011	3	-	5	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB03	CY0027	REG	10/26/2011	8	-	10	Explosives, Gen Chem, Metals, SVOC
CY2-SB04	CY0028	REG	10/26/2011	0	-	1	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB04	CY0029	REG	10/26/2011	3	-	5	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB04	CY0030	REG	10/26/2011	8	-	10	Explosives, Gen Chem, Metals, SVOC

[a] The field split sample PCB results were used for surface soil location CY2-SB01 because PCBs were inadvertently not analyzed in the original sample as the result of a paperwork error.

FD - Field duplicate; averaged with regular sample.
ft bgs - feet below ground surface
Exp - Explosives.
PCB - Polychlorinated biphenyls.
REG - Regular sample.
SVOC - Semivolatile organic compounds.

Source: Shaw, 2013a.

Table 4-3

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Method Detection Limit Minimum	Maximum	Mean mg/kg	BSC [a] mg/kg	RBSC [b] mg/kg		COPC? [c,d]
Inorganics													
Aluminum	4 / 4	100	6.65E+03		1.13E+04	J	9.10E-01	3.34E+00	8.78E+03	1.55E+04	7700		N (b)
Antimony	1 / 4	25	2.50E-01	J	2.50E-01	J	4.60E-02	2.50E-01	2.28E-01	9.30E+00	3.1		N (b)
Arsenic	4 / 4	100	6.10E+00		1.35E+01		4.60E-02	2.50E-01	1.05E+01	3.65E+01	0.39		N (b)
Barium	4 / 4	100	3.52E+01		6.80E+01		1.90E-01	1.00E+00	5.71E+01	8.26E+02	1500		N (b)
Beryllium	4 / 4	100	2.70E-01		7.70E-01	J	4.60E-03	2.50E-02	4.70E-01	1.00E+00	16		N (b)
Cadmium	1 / 4	25	7.20E-01		7.20E-01		4.60E-03	2.50E-02	1.97E-01	NA	7		N (a)
Calcium	4 / 4	100	1.27E+03		6.28E+03	J	2.30E+00	1.30E+01	3.17E+03	5.23E+04	Nutrient		N (c)
Chromium	4 / 4	100	1.04E+01		2.20E+01		4.60E-02	2.50E-01	1.63E+01	2.90E+01	0.29		N (b)
Cobalt	4 / 4	100	3.50E+00		1.10E+01	J	4.60E-02	2.50E-01	6.50E+00	1.16E+02	2.3		N (b)
Copper	4 / 4	100	1.12E+01		2.44E+01		4.60E-02	2.50E-01	2.04E+01	5.62E+01	310		N (b)
Iron	4 / 4	100	1.64E+04		3.43E+04		1.10E+00	5.80E+00	2.57E+04	2.34E+05	5500		N (b)
Lead	4 / 4	100	7.40E+00		1.32E+01		3.80E-02	5.10E-02	1.03E+01	4.86E+01	400		N (b)
Magnesium	4 / 4	100	1.81E+03		3.69E+03		2.30E+00	1.30E+01	2.76E+03	1.04E+04	Nutrient		N (c)
Manganese	4 / 4	100	8.11E+01		2.24E+02		4.60E-02	2.50E-01	1.32E+02	3.51E+03	180		N (b)
Mercury	4 / 4	100	3.40E-02	J	4.50E-02	J	6.20E-03	6.90E-03	3.93E-02	8.50E-02	2.3		N (b)
Nickel	4 / 4	100	1.07E+01		2.83E+01		4.60E-02	2.50E-01	2.04E+01	5.51E+01	150		N (b)
Potassium	4 / 4	100	4.72E+02		7.07E+02	J	2.30E+00	1.30E+01	6.11E+02	3.39E+03	Nutrient		N (c)
Selenium	3 / 4	75	9.10E-01	J	1.70E+00	J	3.80E-01	4.65E+00	2.09E+00	2.00E+00	39		N (b)
Silver	1 / 4	25	8.80E-02	J	8.80E-02	J	4.60E-02	2.50E-01	1.87E-01	1.11E+01	39		N (b)
Sodium	1 / 4	25	5.26E+01	J	5.26E+01	J	3.90E+01	2.20E+02	1.54E+02	NA	Nutrient		N (c)
Vanadium	4 / 4	100	1.61E+01		3.24E+01		4.60E-02	2.50E-01	2.51E+01	4.09E+01	39		N (b)
Zinc	4 / 4	100	2.42E+01		6.78E+01		4.60E-02	2.50E-01	5.01E+01	3.22E+02	2300		N (b)
Semivolatile Organic Compounds													
Fluoranthene	2 / 4	50	3.10E-02	J	6.47E-02	J	1.90E-02	2.00E-02	3.37E-02		230		N (a)
Methylnaphthalene, 2-	1 / 4	25	4.29E-02	J	4.29E-02	J	1.90E-02	2.00E-02	2.55E-02		23		N (a)
Naphthalene	1 / 4	25	3.21E-02	J	3.21E-02	J	3.10E-02	3.20E-02	3.18E-02		3.6		N (a)
Phenanthrene	1 / 4	25	2.92E-02	J	2.92E-02	J	1.90E-02	2.00E-02	2.21E-02		170	e	N (a)
Pyrene	1 / 4	25	6.34E-02	J	6.34E-02	J	1.90E-02	2.00E-02	3.04E-02		170		N (a)

BSC - Background screening concentration.
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] Value is either the 95th percent upper tolerance limit or the maximum detected value of the background data set, whichever is less. Source: IT Corporation (IT), 2000, *TNT Areas A and C Remedial Investigation, Volume 2 Baseline Human Health Risk Assessment*, Final, Former Plum Brook Ordnance Works, November, and reports
[b] Risk-Based Screening Concentrations based on USEPA Regional Screening Level Table (November 2012) 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] RBSC based on acenapthene.

Source: Shaw, 2013a.

Table 4-4

Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil
Coal Yard No. 2
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	8 / 8	100	5.14E+03		8.50E+03		1.00E+00	5.40E+00	6.35E+03	1.55E+04	7700	N (b)
Arsenic	8 / 8	100	2.00E+00		1.15E+01		4.50E-02	2.50E-01	5.87E+00	3.65E+01	0.39	N (b)
Barium	8 / 8	100	3.52E+01		7.09E+01		1.80E-01	9.00E-01	5.37E+01	8.26E+02	1500	N (b)
Beryllium	8 / 8	100	3.60E-01	J	4.90E-01		9.65E-03	2.20E-02	4.44E-01	1.00E+00	16	N (b)
Cadmium	6 / 8	75	2.40E-01	J	8.90E-01		5.30E-03	2.50E-02	4.36E-01	NA	7	N (a)
Calcium	8 / 8	100	3.46E+04		6.07E+04		4.90E+00	1.10E+01	4.76E+04	5.23E+04	Nutrient	N (c)
Chromium	8 / 8	100	9.80E+00		1.67E+01		1.10E-01	2.50E-01	1.29E+01	2.90E+01	0.29	N (b)
Cobalt	8 / 8	100	5.50E+00		1.51E+01		5.30E-02	2.50E-01	8.88E+00	1.16E+02	2.3	N (b)
Copper	8 / 8	100	1.88E+01		2.64E+01		1.10E-01	2.50E-01	2.21E+01	5.62E+01	310	N (b)
Iron	8 / 8	100	1.71E+04		2.04E+04		2.25E+00	5.20E+00	1.89E+04	2.34E+05	5500	N (b)
Lead	8 / 8	100	8.30E+00		1.53E+01		4.30E-02	2.20E-01	1.24E+01	4.86E+01	400	N (b)
Magnesium	8 / 8	100	1.41E+04		2.37E+04		4.90E+00	1.10E+01	1.63E+04	1.04E+04	Nutrient	N (c)
Manganese	8 / 8	100	4.32E+02		8.16E+02		1.40E-01	2.50E-01	5.51E+02	3.51E+03	180	N (b)
Mercury	8 / 8	100	1.10E-02	J	4.00E-02	J	6.40E-03	7.70E-03	1.98E-02	8.50E-02	2.3	N (b)
Nickel	8 / 8	100	1.61E+01		4.00E+01		5.30E-02	2.50E-01	2.41E+01	5.51E+01	150	N (b)
Potassium	8 / 8	100	8.48E+02	J	1.45E+03		4.90E+00	1.10E+01	1.19E+03	3.39E+03	Nutrient	N (c)
Selenium	3 / 8	38	4.30E-01	J	1.15E+00	J	2.10E-01	4.90E-01	5.58E-01	2.00E+00	39	N (b)
Silver	5 / 8	63	5.30E-02	J	4.65E-01	J	4.50E-02	2.50E-01	1.74E-01	1.11E+01	39	N (b)
Sodium	4 / 8	50	1.14E+02	J	1.46E+02	J	8.35E+01	1.90E+02	1.53E+02	NA	Nutrient	N (c)
Thallium	1 8	13	3.90E-01	J	3.90E-01	J	1.50E-01	6.70E+00	1.83E+00	1.30E+00	0.078	N (b)
Vanadium	8 / 8	100	1.14E+01		2.49E+01		4.50E-02	2.50E-01	1.58E+01	4.09E+01	39	N (b)
Zinc	8 / 8	100	4.60E+01		6.37E+01		1.10E-01	2.50E-01	5.36E+01	3.22E+02	2300	N (b)
Semivolatile Organic Compounds												
Bis(2-ethylhexyl)phthalate	1 / 8	13	3.21E-01	J	3.21E-01	J	8.10E-02	8.60E-02	1.14E-01		35	N (a)

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] Value is either the 95th percent upper tolerance limit or the maximum detected value of the background data set, whichever is less. Source: IT Corporation (IT), 2000, *TNT Areas A and C Remedial Investigation, Volume 2 Baseline Human Health Risk Assessment* , Final, Former Plum Brook Ordnance Works, November, and reports referenced therein.
[b] Risk-Based Screening Concentrations based on USEPA Regional Screening Level Table (November 2012) 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.

Source: Shaw, 2013a

Table 4-5

Summary of Surface Soil Samples Evaluated in the SLERA
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location	Sample Number	Sample Purpose	Sample Date	Depth of Sample (ft bgs)	Analysis
CY2-SB01	CY0015	REG	10/27/2011	0.5 - 1	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0016	FD	10/27/2011	0.5 - 1	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0017	FS [a]	10/27/2011	0.5 - 1	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB01	CY0018	REG	10/27/2011	3 - 5	Explosives, Gen Chem, Metals, SVOC
CY2-SB02	CY0020	REG	10/27/2011	0.5 - 1	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB02	CY0021	REG	10/27/2011	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB03	CY0025	REG	10/26/2011	0.5 - 1	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB03	CY0026	REG	10/26/2011	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB04	CY0028	REG	10/26/2011	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB04	CY0029	REG	10/26/2011	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC

[a] The PCB data for this field split sample were used for location CY2-SB01 because PCBs were inadvertently not analyzed for in the original or field duplicate samples for the 0.5 to 1 foot depth range.

ft bgs - Feet below ground surface.
FD - Field duplicate.
FS - Field split.
PCB - Polychlorinated biphenyls.
REG - Regular sample.
SLERA - Screening-level ecological risk assessment.
SVOC - Semivolatile organic compound.

Source: Shaw, 2013b.

Table 4-6

Statistical Summary and COPEC Selection of Chemicals Detected in Soil (0 to 6 Feet Below Ground Surface)
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Method Detection Limit Minimum	Maximum	Mean (mg/kg)	BSC [a] (mg/kg)	ESV [b] (mg/kg)	COPEC? [c,d]
Inorganics												
Aluminum	8 / 8	100	5.14E+03		1.13E+04	J	9.10E-01	5.40E+00	7.65E+03	1.55E+04	pH Dependent	N (b)
Antimony	1 / 8	13	2.50E-01	J	2.50E-01	J	4.60E-02	2.50E-01	2.13E-01	9.30E+00	0.27	N (a)
Arsenic	8 / 8	100	2.10E+00		1.35E+01		4.50E-02	2.50E-01	9.00E+00	3.65E+01	18	N (a)
Barium	8 / 8	100	3.52E+01		7.09E+01		1.90E-01	1.00E+00	5.82E+01	8.26E+02	330	N (a)
Beryllium	8 / 8	100	2.70E-01		7.70E-01	J	4.60E-03	2.50E-02	4.55E-01	1.00E+00	21	N (a)
Cadmium	4 / 8	50	2.40E-01	J	8.10E-01		4.60E-03	2.50E-02	2.67E-01	NA	0.36	Y
Calcium	8 / 8	100	1.27E+03		5.25E+04		2.30E+00	1.30E+01	2.29E+04	5.23E+04	Nutrient	N (c)
Chromium	8 / 8	100	9.80E+00		2.20E+01		4.60E-02	2.50E-01	1.46E+01	2.90E+01	26	N (a)
Cobalt	8 / 8	100	3.50E+00		1.51E+01		4.60E-02	2.50E-01	8.26E+00	1.16E+02	13	N (b)
Copper	8 / 8	100	1.12E+01		2.64E+01		4.60E-02	2.50E-01	2.10E+01	5.62E+01	28	N (a)
Iron	8 / 8	100	1.64E+04		3.43E+04		1.10E+00	5.80E+00	2.20E+04	2.34E+05	pH Dependent	N (b)
Lead	8 / 8	100	7.40E+00		1.53E+01		3.80E-02	1.10E-01	1.11E+01	4.86E+01	11	N (b)
Magnesium	8 / 8	100	1.81E+03		1.63E+04		2.30E+00	1.30E+01	8.92E+03	1.04E+04	Nutrient	N (c)
Manganese	8 / 8	100	8.11E+01		8.16E+02		4.60E-02	2.50E-01	3.70E+02	3.51E+03	220	N (b)
Mercury	8 / 8	100	1.10E-02	J	4.50E-02	J	6.20E-03	7.70E-03	3.05E-02	8.50E-02	0.00051	N (b)
Nickel	8 / 8	100	1.07E+01		4.00E+01		4.60E-02	2.50E-01	2.38E+01	5.51E+01	38	N (b)
Potassium	8 / 8	100	4.72E+02		1.21E+03		2.30E+00	1.30E+01	8.14E+02	3.39E+03	Nutrient	N (c)
Selenium	4 / 8	50	4.30E-01	J	1.70E+00	J	2.10E-01	4.65E+00	1.27E+00	2.00E+00	0.52	N (b)
Silver	3 / 8	38	5.30E-02	J	8.80E-02	J	4.50E-02	2.50E-01	1.66E-01	1.11E+01	4.2	N (a)
Sodium	3 / 8	38	5.26E+01	J	1.24E+02	J	3.90E+01	2.20E+02	1.53E+02	NA	Nutrient	N (c)
Thallium	1 / 8	13	3.90E-01	J	3.90E-01	J	1.50E-01	7.60E+00	5.08E+00	1.30E+00	1	N (a)
Vanadium	8 / 8	100	1.15E+01		3.24E+01		4.60E-02	2.50E-01	2.18E+01	4.09E+01	7.8	N (b)
Zinc	8 / 8	100	2.42E+01		6.78E+01		4.60E-02	2.50E-01	5.17E+01	3.22E+02	46	N (b)
Semivolatile Organic Compounds												
Bis(2-ethylhexyl)phthalate	1 / 8	13	3.21E-01	J	3.21E-01	J	7.70E-02	8.60E-02	1.11E-01		0.925	N (a)
Fluoranthene	2 / 8	25	3.10E-02	J	6.47E-02	J	1.90E-02	2.20E-02	2.73E-02		1.1	N (a)
Methylnaphthalene, 2-	1 / 8	13	4.29E-02	J	4.29E-02	J	1.90E-02	2.20E-02	2.32E-02		3.24	N (a)
Naphthalene	1 / 8	13	3.21E-02	J	3.21E-02	J	3.10E-02	3.40E-02	3.25E-02		29	N (a)
Phenanthrene	1 / 8	13	2.92E-02	J	2.92E-02	J	1.90E-02	2.20E-02	2.15E-02		29	N (a)
Pyrene	1 / 8	13	6.34E-02	J	6.34E-02	J	1.90E-02	2.20E-02	2.57E-02		1.1	N (a)

BSC - Background screening concentration.
COPEC - Chemical of potential ecological concern.
ESV - Ecological screening value.
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.
NA - Not available.
VQ - Validation qualifier.

[a] IT Corporation (IT), 1998, *Site Investigation of Acid Areas, Plum Brook Ordnance Works, Sandusky, Ohio* , August.
[b] ESVs and their sources are in Appendix A.
[c] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
[d] Y = Chemical is chosen as COPEC.

Source: Shaw, 2013b.

FIGURES

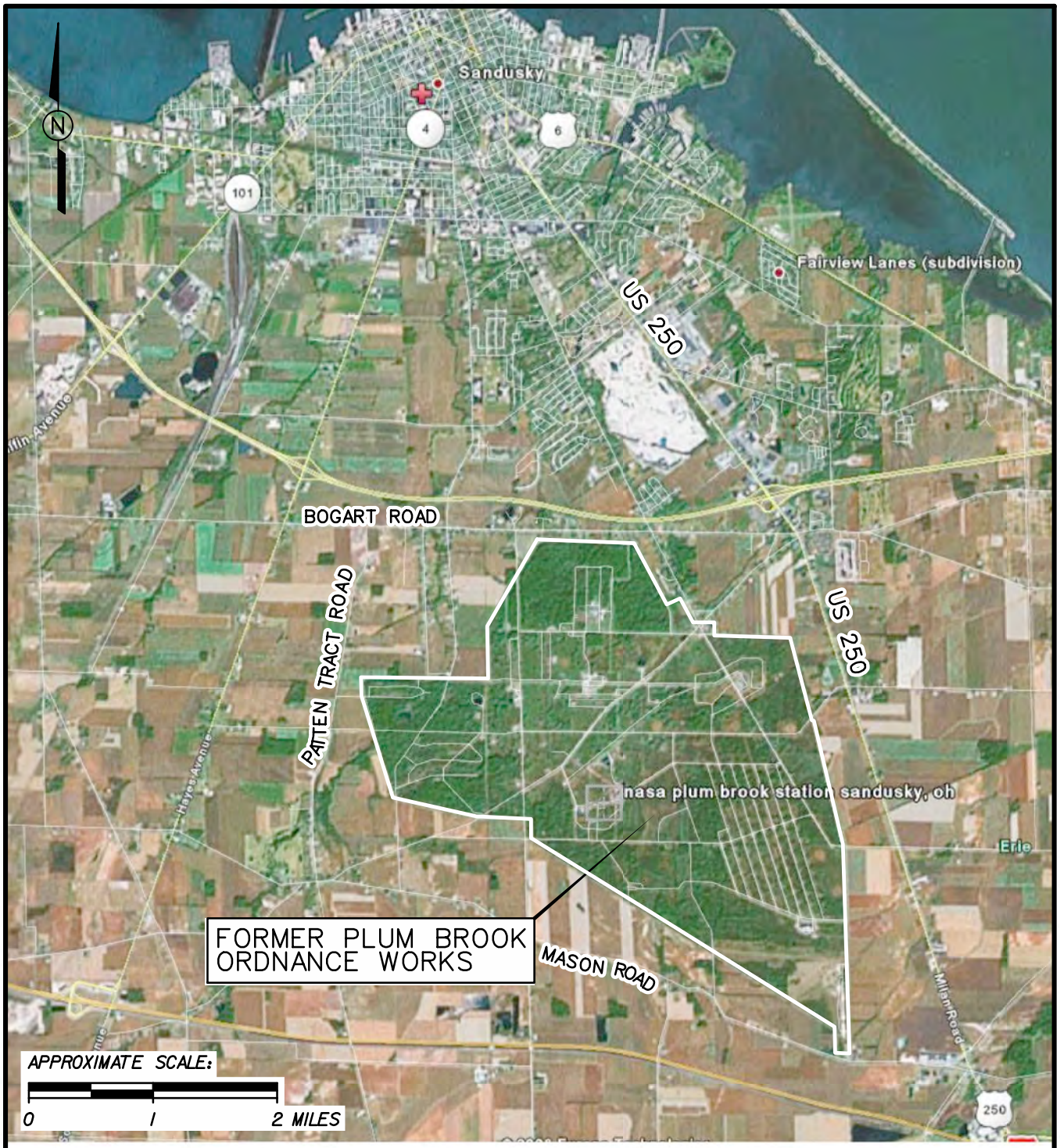

FIGURE 1-1
PBOW VICINITY MAP

POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

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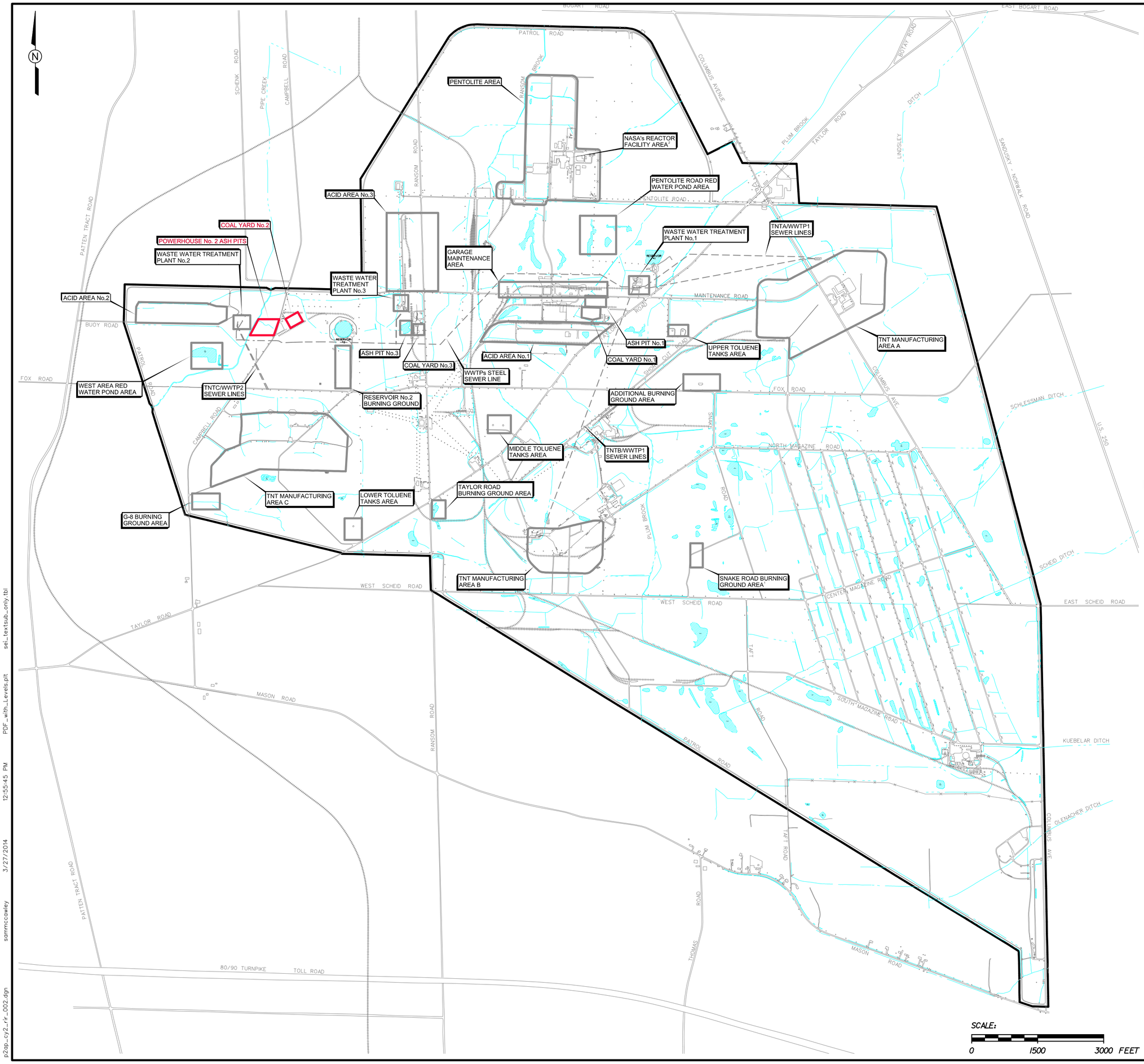

LEGEND:

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

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. REACTOR FACILITY CONSTRUCTED BY NASA POST WWII AND IS IDENTIFIED FOR LOCATION PURPOSES ONLY. DEMOLITION OF THE REACTOR WAS COMPLETED BY NASA IN 2012.

SCALE:

0 1500 3000 FEET

CB&I Federal Services LLC

FIGURE 1-2
LOCATIONS OF POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2 AT PBOW

POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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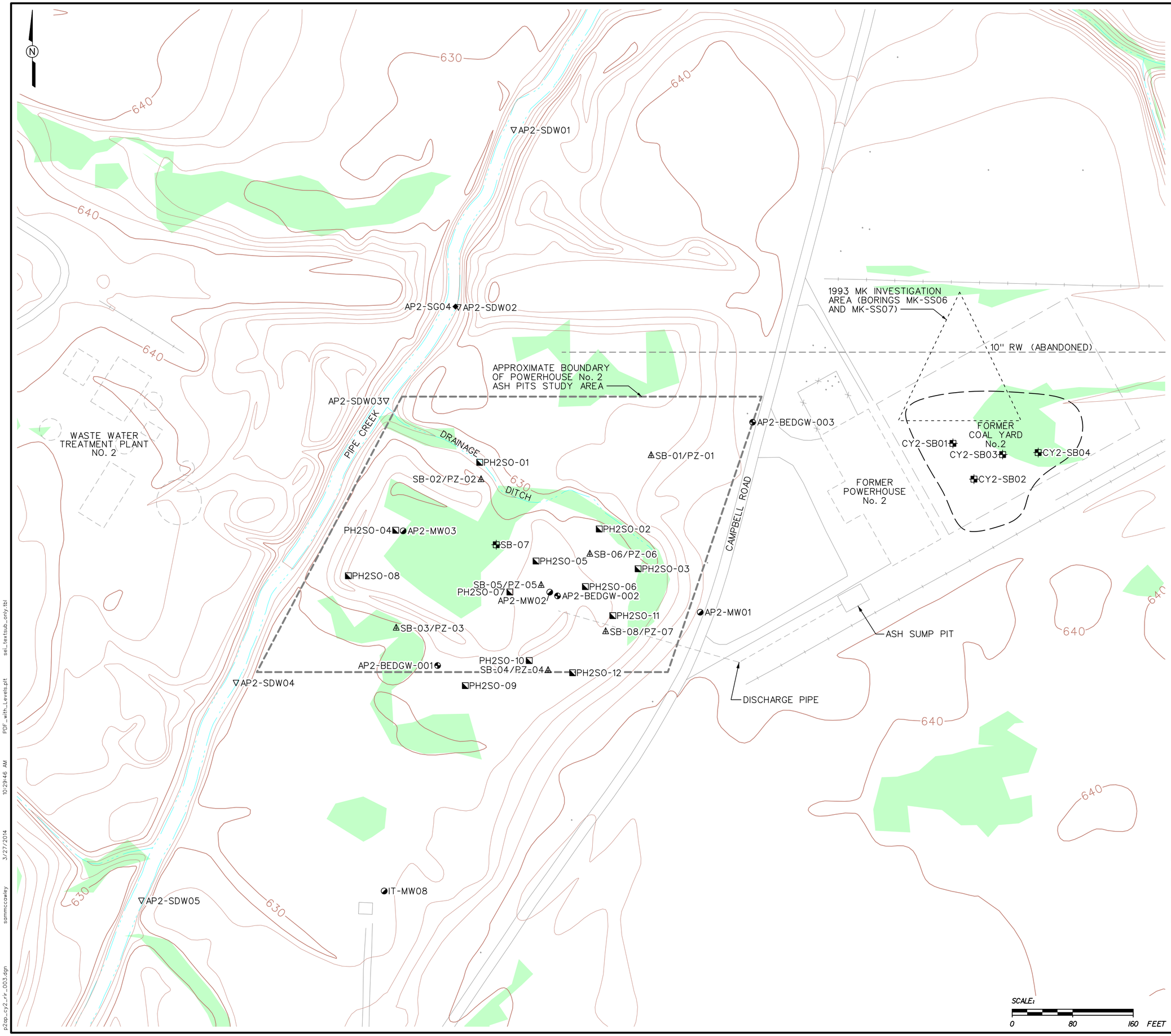

LEGEND:

- OVERBURDEN MONITORING WELL (SCREENED IN SHALE)
- BEDROCK MONITORING WELL (SCREENED IN LIMESTONE)
- HISTORIC SOIL BORING
- SOIL BORING
- SOIL BORING/PIEZOMETER
- SURFACE WATER/SEDIMENT SAMPLE
- STREAM STAFF GUAGE
- UTILITY POLE
- TOPOGRAPHIC CONTOUR (2 FT. INTERVAL)
- CREEK, DITCH, CONVEYANCE
- WETLAND AREA (ENVIROSCIENCE, 2012) (NOTE 4)
- ABANDONED RAILROAD
- ROAD
- APPROXIMATE LOCATION OF FORMER STRUCTURES
- RAW WATER LINE (RW)
- APPROXIMATE HISTORICAL COAL STORAGE PERIMETER BASED ON AERIAL PHOTO
- APPROXIMATE COAL STORAGE PERIMETER BASED ON OCTOBER 2011 FIELD FINDINGS AND EXISTING COAL THICKNESS

NOTES:

1. SPECIFIC HISTORICAL SAMPLING LOCATIONS MK-SS06 AND MK-SS07 ARE NOT SHOWN DUE TO LACK OF SURVEY DATA.
2. SOURCE OF 1993 MK SOIL BORINGS: MORRISON KNUDSEN CORPORATION (MK), 1994, SITE INSPECTION REPORT, PLUM BROOK STATION, SANDUSKY, OHIO, VOLUME 1, JANUARY.
3. HISTORIC SOIL BORING SAMPLES (PH2SO-**) COLLECTED IN 1996 AS PART OF A SITE INVESTIGATION (IT, 1997). TWO SAMPLES WERE COLLECTED FROM EACH BORING, ONE 0-0.5 FT. AND ONE 2-3 FT. BELOW GROUND SURFACE.
4. THE 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.

FIGURE 3-1
GENERAL SITE FEATURES OF POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2 WITH SITE TOPOGRAPHY AND SAMPLING LOCATIONS

POWERHOUSE 2 No. ASH PITS AND COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

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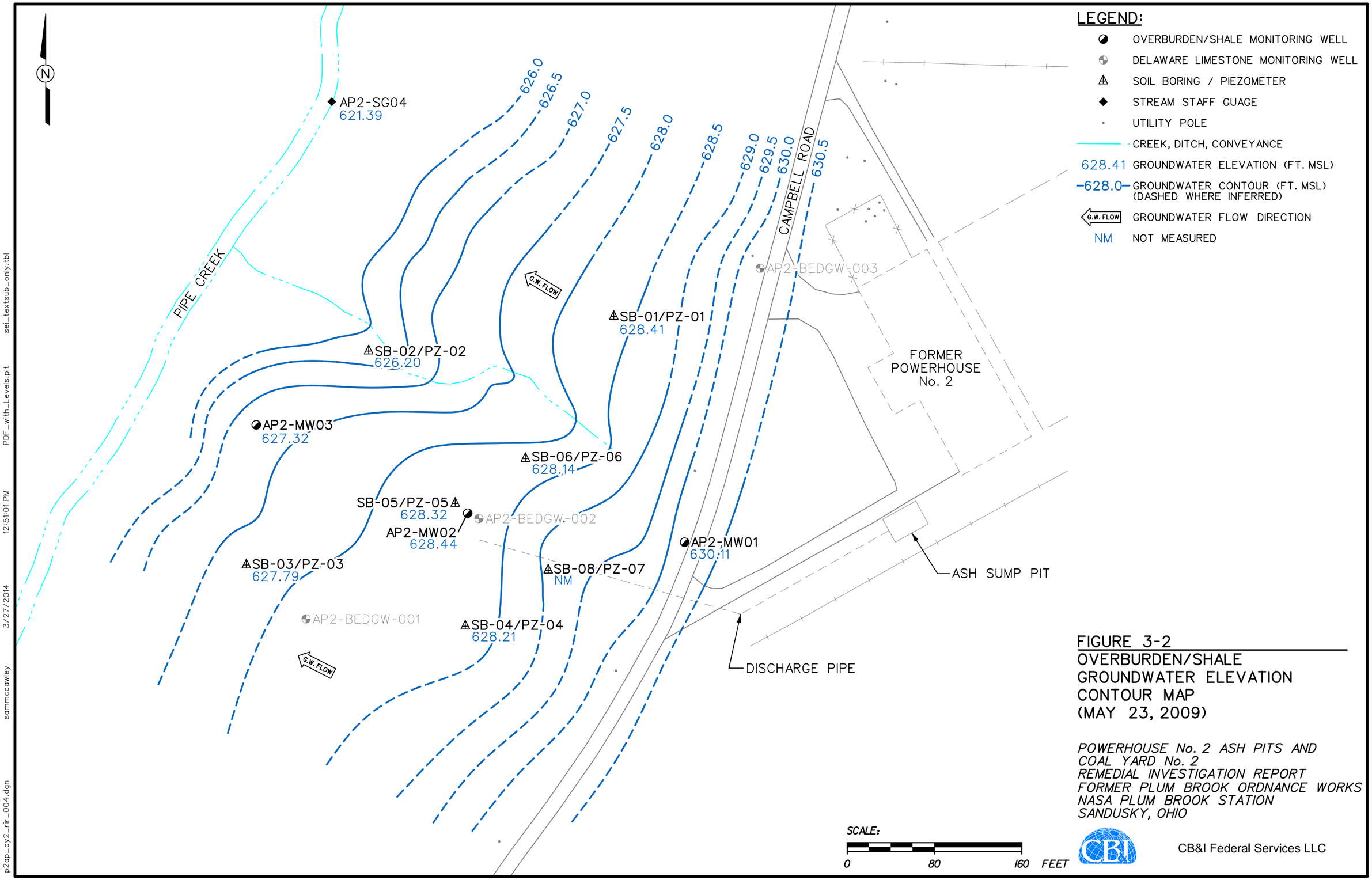

FIGURE 3-2
OVERBURDEN/SHALE
GROUNDWATER ELEVATION
CONTOUR MAP
(MAY 23, 2009)

POWERHOUSE No. 2 ASH PITS AND
COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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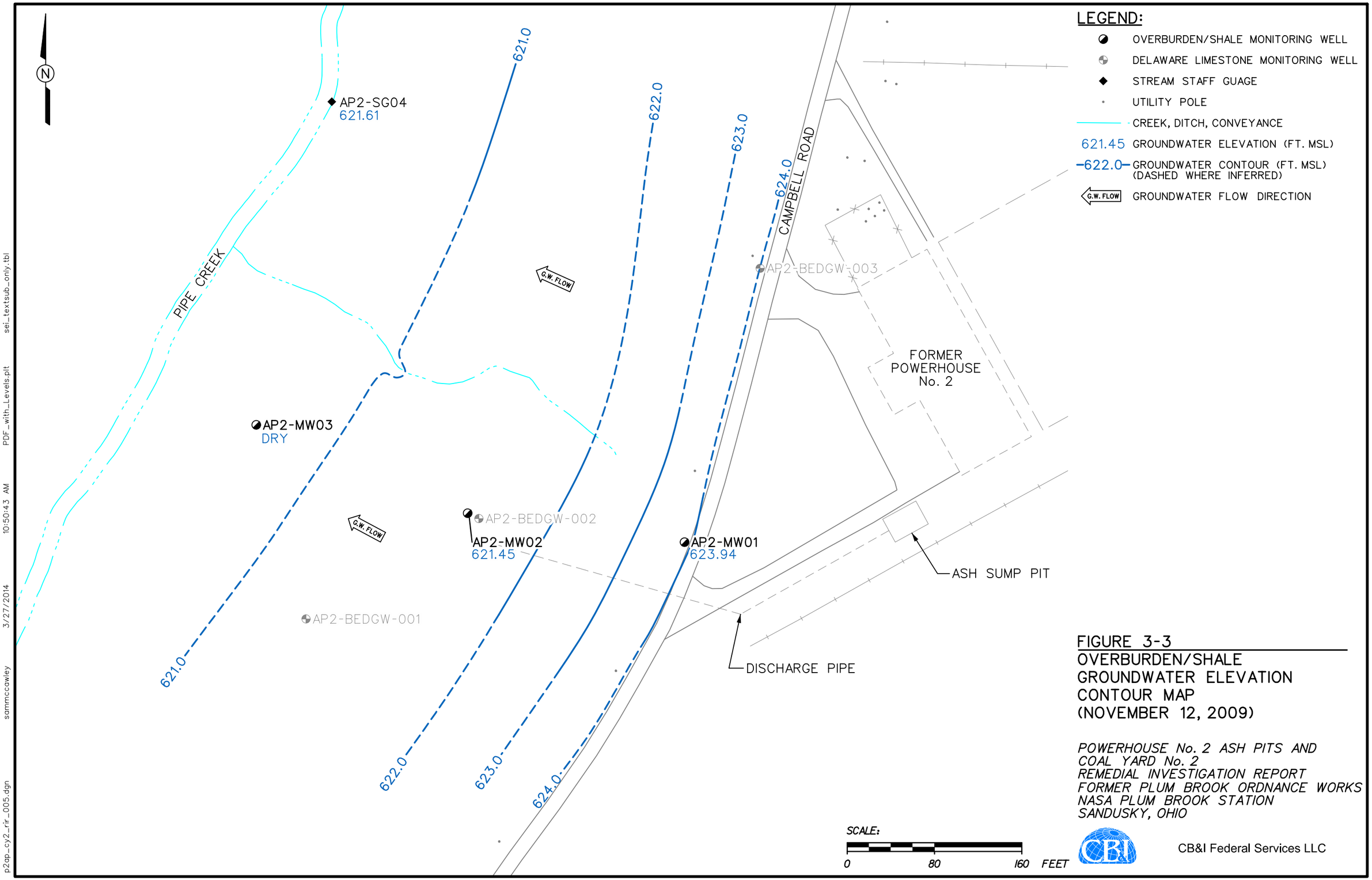


FIGURE 3-3
OVERBURDEN/SHALE
GROUNDWATER ELEVATION
CONTOUR MAP
(NOVEMBER 12, 2009)

POWERHOUSE No. 2 ASH PITS AND
COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

p2ap_cy2_rir_005.dgn sammccawley 3/27/2014 10:50:43 AM PDF_with_Levels.plt sei_textsub_only.tbl

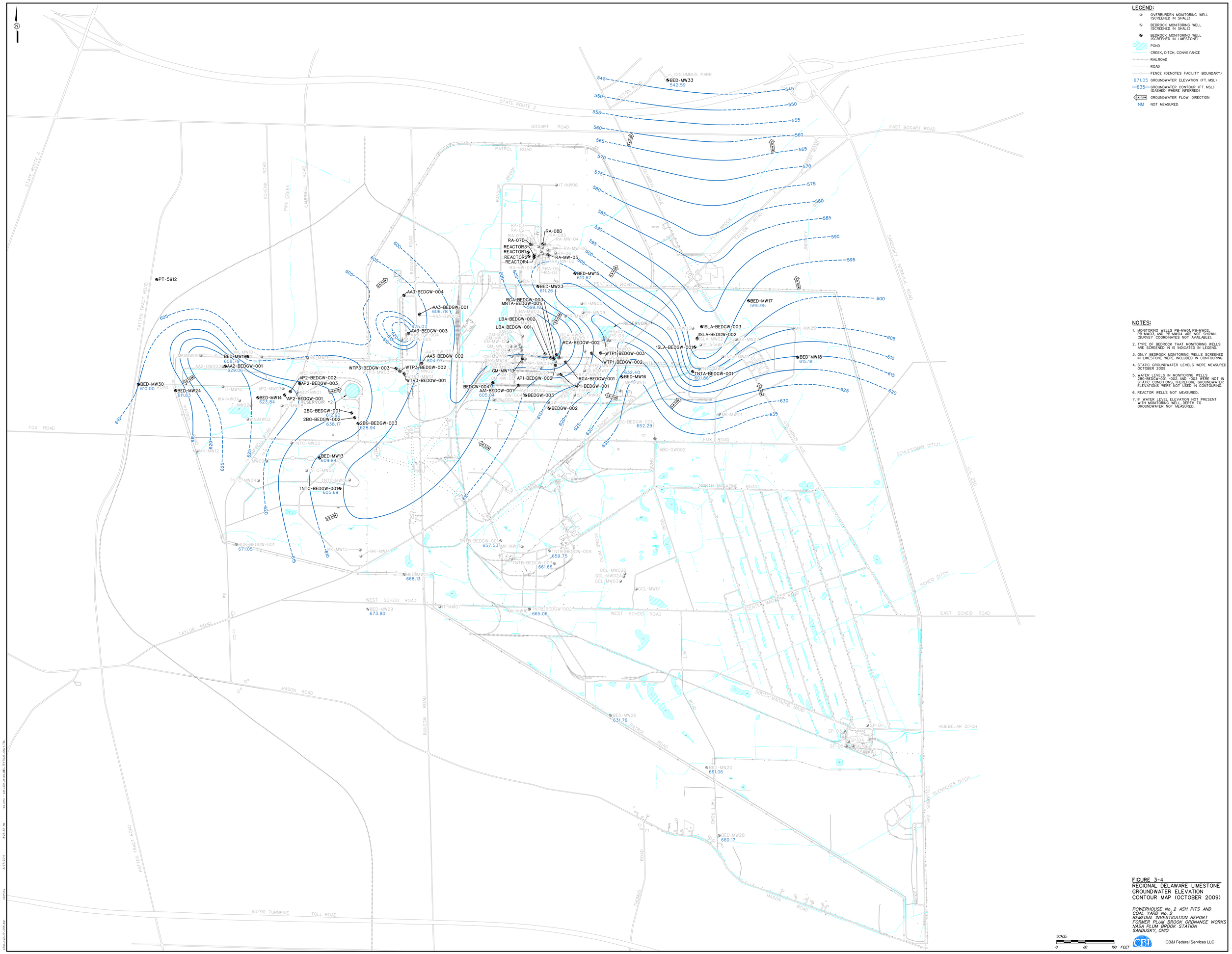
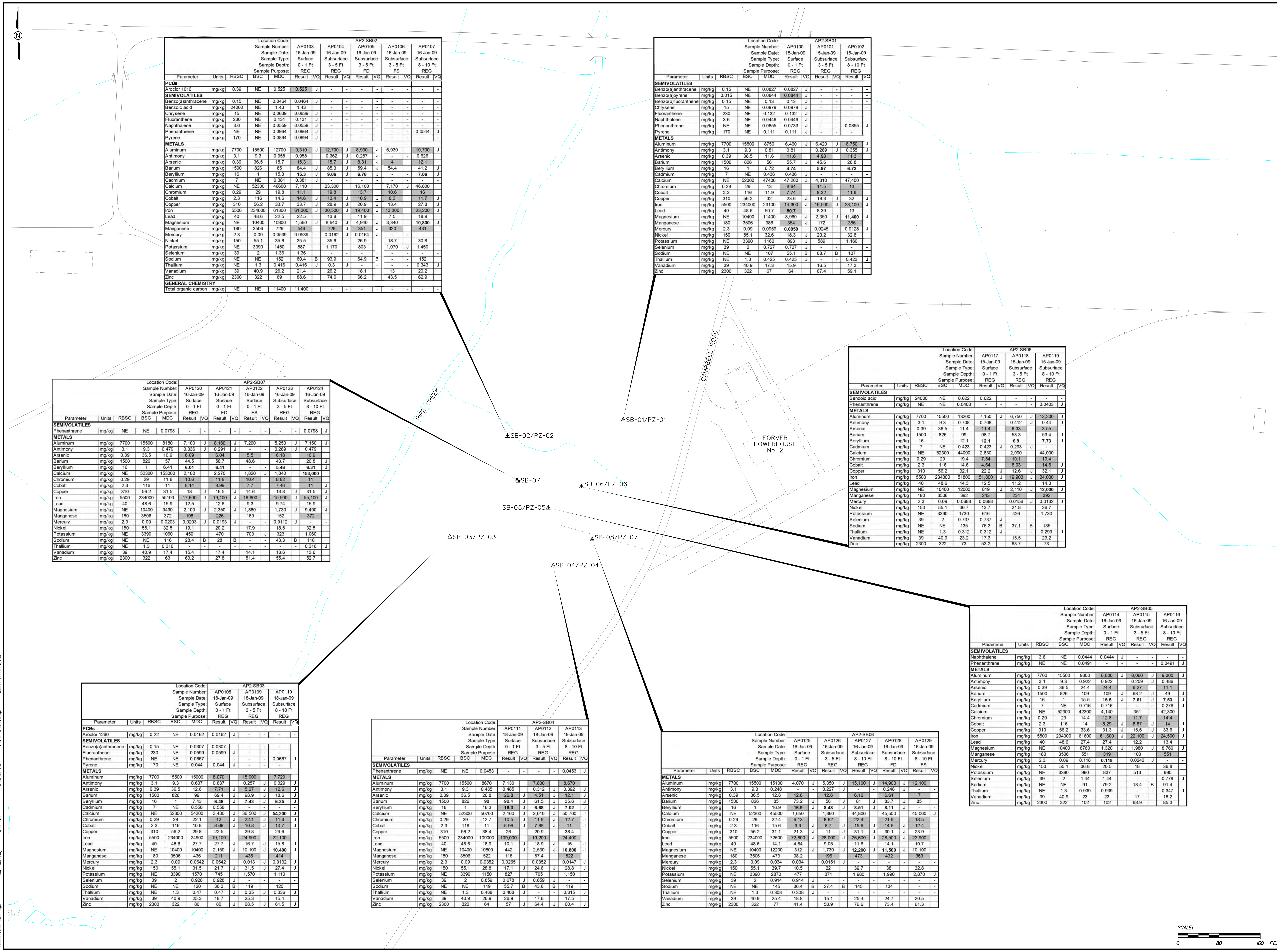


FIGURE 3-4
REGIONAL DELAWARE LIMESTONE GROUNDWATER ELEVATION CONTOUR MAP (OCTOBER 2009)

POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO



				Location Code:	AP2-SB02									
				Sample Number:	AP0103		AP0104		AP0105		AP0106		AP0107	
				Sample Date:	16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		3 - 5 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		FD		FS		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs														
Aroclor 1016	mg/kg	0.39	NE	0.525	0.525	J	-	-	-	-	-	-	-	-
SEMIVOLATILES														
Benzo(a)anthracene	mg/kg	0.15	NE	0.0464	0.0464	J	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	1.43		-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0639	0.0639	J	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.131	0.131	J	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	0.0559	J	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	0.0964	J	-	-	-	-	-	-	0.0544	J
Pyrene	mg/kg	170	NE	0.0894	0.0894	J	-	-	-	-	-	-	-	-
METALS														
Aluminum	mg/kg	7700	15500	12700	9,310	J	12,700	J	8,930	J	6,930		10,700	J
Antimony	mg/kg	3.1	9.3	0.958	0.958		0.362	J	0.287	J	-	-	0.626	
Arsenic	mg/kg	0.39	36.5	15.7	15.3		15.7	J	8.31	J	4		12.1	
Barium	mg/kg	1500	826	85	84.4	J	85.3	J	59.4	J	54.4		41.2	J
Beryllium	mg/kg	16	1	15.3	**15.3**	J	**9.06**	J	**6.76**	J	-	-	**7.06**	J
Cadmium	mg/kg	7	NE	0.381	0.381	J	-	-	-	-	-	-	-	-
Calcium	mg/kg	NE	52300	46600	7,110		23,300		16,100		7,170	J	46,600	
Chromium	mg/kg	0.29	29	19.8	11.1		19.8		13.7		10.6		16	
Cobalt	mg/kg	2.3	116	14.6	14.6	J	13.4	J	10.9	J	8.3		11.7	J
Copper	mg/kg	310	56.2	33.7	33.7	J	28.9	J	20.9	J	13.4		27.8	J
Iron	mg/kg	5500	234000	61300	61,300	J	30,500	J	19,400	J	13,300		23,200	J
Lead	mg/kg	40	48.6	22.5	22.5		13.8		11.9		7.5		18.9	
Magnesium	mg/kg	NE	10400	10800	1,560	J	8,640	J	4,940	J	3,340		**10,800**	J
Manganese	mg/kg	180	3506	726	546		726	J	351	J	320		431	
Mercury	mg/kg	2.3	0.09	0.0539	0.0539		0.0162	J	0.0164	J	-	-	-	-
Nickel	mg/kg	150	55.1	35.6	35.5		35.6		26.9		18.7		30.8	
Potassium	mg/kg	NE	3390	1450	587		1,170		803		1,070	J	1,450	
Selenium	mg/kg	39	2	1.36	1.36		-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	152	60.4	B	93.9		64.9	B	-	-	152	
Thallium	mg/kg	NE	1.3	0.416	0.416	J	0.3	J	-	-	-	-	0.343	J
Vanadium	mg/kg	39	40.9	26.2	21.4		26.2		18.1		13		20.2	
Zinc	mg/kg	2300	322	89	88.6		74.6		66.2		43.5		62.9	
GENERAL CHEMISTRY														
Total organic carbon	mg/kg	NE	NE	11400	11,400		-	-	-	-	-	-	-	-

				Location Code:	AP2-SB01					
				Sample Number:	AP0100		AP0101		AP0102	
				Sample Date:	15-Jan-09		15-Jan-09		15-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES										
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	0.0827	J	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	0.0844	J	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	0.13	J	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	0.0979	J	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	0.132	J	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0446	0.0446	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0855	0.0733	J	-	-	0.0855	J
Pyrene	mg/kg	170	NE	0.111	0.111	J	-	-	-	-
METALS										
Aluminum	mg/kg	7700	15500	8750	6,460	J	6,420	J	8,750	J
Antimony	mg/kg	3.1	9.3	0.81	0.81		0.269	J	0.355	J
Arsenic	mg/kg	0.39	36.5	11.6	11.6		4.93		11.3	
Barium	mg/kg	1500	826	56	55.7	J	45.6		26.8	
Beryllium	mg/kg	16	1	6.72	**4.74**		**5.97**		**6.72**	
Cadmium	mg/kg	7	NE	0.436	0.436	J	-	-	-	-
Calcium	mg/kg	NE	52300	47400	47,200	J	4,310		47,400	
Chromium	mg/kg	0.29	29	13	8.64		11.5		13	
Cobalt	mg/kg	2.3	116	11.9	7.74		8.32		11.9	
Copper	mg/kg	310	56.2	32	23.6	J	18.3	J	32	J
Iron	mg/kg	5500	234000	23100	14,300	J	16,500	J	23,100	J
Lead	mg/kg	40	48.6	50.7	**50.7**		8.39		13	
Magnesium	mg/kg	NE	10400	11400	8,960	J	2,350	J	**11,400**	J
Manganese	mg/kg	180	3506	386	354	J	172		386	
Mercury	mg/kg	2.3	0.09	0.0959	**0.0959**		0.0245		0.0128	J
Nickel	mg/kg	150	55.1	32.6	18.3	J	20.2		32.6	
Potassium	mg/kg	NE	3390	1160	893	J	589		1,160	
Selenium	mg/kg	39	2	0.727	0.727	J	-	-	-	-
Sodium	mg/kg	NE	NE	107	55.1	B	68.7	B	107	
Thallium	mg/kg	NE	1.3	0.425	0.425	J	-	-	0.423	J
Vanadium	mg/kg	39	40.9	17.3	15.9		16.5		17.3	
Zinc	mg/kg	2300	322	67	64		67.4		59.1	

LEGEND:

- SOIL BORING
- SOIL BORING/PIEZOMETER
- mg/kg MILLIGRAMS PER KILOGRAM
- NE NOT ESTABLISHED (RBSCs), NOT EVALUATED (BSCs)
- NM NOT MEASURED
- \- NOT DETECTED

NOTES:

1. SHADED CELL INDICATES VALUE IS GREATER THAN THE RBSC.
2. BOLD TEXT INDICATES VALUE IS GREATER THAN THE BSC.
3. RBSC VALUES REFLECT AN INCREMENTAL LIFETIME CANCER RISK (ILCR) OF 1E-6 OR A NONCANCER HAZARD QUOTIENT (HQ) OF 0.1. FOR CHEMICALS THAT EXHIBIT BOTH CANCER AND NONCANCER EFFECTS, WHICHEVER TYPE OF EFFECT IN A LOWER CONCENTRATION (USING AN ILCR OF 1E-6 AND AN HQ OF 0.1), THAT CONCENTRATION IS SELECTED AS THE RBSC.
4. BSC IS BACKGROUND SCREENING CONCENTRATION.
5. MDC IS MAXIMUM DETECTED CONCENTRATION FOR THE INVESTIGATION AREA ("B" QUALIFIED DATA NOT INCLUDED).
6. FERROUS IRON MEASURED IN FIELD USING HACH TEST KIT.
7. OXIDATION REDUCTION POTENTIAL - FINAL YSI WATER QUALITY METER FIELD MEASUREMENT PRIOR TO GROUNDWATER SAMPLE COLLECTION.
8. VALIDATION QUALIFIERS (VQ):
   B - THE ANALYTE WAS NOT DETECTED SIGNIFICANTLY ABOVE THE LEVELS FOUND IN THE ASSOCIATED METHOD BLANK OR FIELD BLANKS.
   J - THE ANALYTE WAS POSITIVELY IDENTIFIED; THE REPORTED VALUE IS ESTIMATED.

				Location Code:	AP2-SB06					
				Sample Number:	AP0117		AP0118		AP0119	
				Sample Date:	15-Jan-09		15-Jan-09		15-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES										
Benzoic acid	mg/kg	24000	NE	0.622	0.622		-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0403	-	-	-	-	0.0403	J
METALS										
Aluminum	mg/kg	7700	15500	13200	7,150	J	6,750	J	13,200	J
Antimony	mg/kg	3.1	9.3	0.708	0.708		0.412	J	0.44	J
Arsenic	mg/kg	0.39	36.5	11.4	11.4		6.33		3.55	
Barium	mg/kg	1500	826	99	98.7		58.3		53.4	J
Beryllium	mg/kg	16	1	12.1	**12.1**		**6.9**		**7.73**	J
Cadmium	mg/kg	7	NE	0.423	0.423	J	0.293	J	-	-
Calcium	mg/kg	NE	52300	44000	2,830		2,090		44,000	
Chromium	mg/kg	0.29	29	19.4	7.84		10.1		19.4	
Cobalt	mg/kg	2.3	116	14.6	4.64		8.93		14.6	J
Copper	mg/kg	310	56.2	32.1	22.2	J	12.6	J	32.1	J
Iron	mg/kg	5500	234000	51800	51,800	J	19,900	J	24,000	J
Lead	mg/kg	40	48.6	14.3	12.5		11.2		14.3	
Magnesium	mg/kg	NE	10400	12000	819	J	2,110	J	**12,000**	J
Manganese	mg/kg	180	3506	392	243		234		392	
Mercury	mg/kg	2.3	0.09	0.0688	0.0688		0.0156	J	0.0132	J
Nickel	mg/kg	150	55.1	36.7	13.7		21.8		36.7	
Potassium	mg/kg	NE	3390	1730	616		426		1,730	
Selenium	mg/kg	39	2	0.737	0.737	J	-	-	-	-
Sodium	mg/kg	NE	NE	135	76.3	B	37.1	B	135	
Thallium	mg/kg	NE	1.3	0.312	0.312	J	-	-	0.293	J
Vanadium	mg/kg	39	40.9	23.2	17.3		15.5		23.2	
Zinc	mg/kg	2300	322	73	53.2		63.7		73	

				Location Code:	AP2-SB07									
				Sample Number:	AP0120		AP0121		AP0122		AP0123		AP0124	
				Sample Date:	16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Surface		Surface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		0 - 1 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		FD		FS		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES														
Phenanthrene	mg/kg	NE	NE	0.0798	-	-	-	-	-	-	-	-	0.0798	J
METALS														
Aluminum	mg/kg	7700	15500	8180	7,100	J	8,180	J	7,200		5,250	J	7,150	J
Antimony	mg/kg	3.1	9.3	0.479	0.336	J	0.291	J	-	-	0.269	J	0.479	
Arsenic	mg/kg	0.39	36.5	10.9	6.09		6.04		5.5		6.18		10.9	
Barium	mg/kg	1500	826	57	44.5		56.7		48.6		43.7		20.8	J
Beryllium	mg/kg	16	1	6.41	**6.01**		**6.41**		-	-	**5.46**		**6.31**	J
Calcium	mg/kg	NE	52300	153000	2,100		2,270		1,820	J	1,840		**153,000**	
Chromium	mg/kg	0.29	29	11.8	10.6		11.8		10.4		8.82		11	
Cobalt	mg/kg	2.3	116	11	8.14		8.99		7.7		7.46		11	J
Copper	mg/kg	310	56.2	31.5	18	J	16.5	J	14.6		13.8	J	31.5	J
Iron	mg/kg	5500	234000	55100	17,600	J	19,100	J	16,600		15,500	J	55,100	J
Lead	mg/kg	40	48.6	15.9	12.5		12.8		9.3		9.74		15.9	
Magnesium	mg/kg	NE	10400	9490	2,100	J	2,350	J	1,880		1,730	J	9,490	J
Manganese	mg/kg	180	3506	372	198		226		169		152		372	
Mercury	mg/kg	2.3	0.09	0.0203	0.0203	J	0.0193	J	-	-	0.0112	J	-	-
Nickel	mg/kg	150	55.1	32.5	19.1		20.2		17.9		18.5		32.5	
Potassium	mg/kg	NE	3390	1060	450		470		703	J	323		1,060	
Sodium	mg/kg	NE	NE	116	28.4	B	28	B	-	-	43.3	B	116	
Thallium	mg/kg	NE	1.3	0.316	-	-	-	-	-	-	-	-	0.316	J
Vanadium	mg/kg	39	40.9	17.4	15.4		17.4		14.1		13.6		13.6	
Zinc	mg/kg	2300	322	63	63.2		27.8		51.4		55.4		52.7	

				Location Code:	AP2-SB05					
				Sample Number:	AP0114		AP0115		AP0116	
				Sample Date:	16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES										
Naphthalene	mg/kg	3.6	NE	0.0444	0.0444	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0491	-	-	-	-	0.0491	J
METALS										
Aluminum	mg/kg	7700	15500	9300	8,800	J	8,060	J	9,300	J
Antimony	mg/kg	3.1	9.3	0.922	0.922		0.259	J	0.486	
Arsenic	mg/kg	0.39	36.5	24.4	24.4		6.27		11.1	
Barium	mg/kg	1500	826	109	109	J	68.2	J	49	J
Beryllium	mg/kg	16	1	15.5	**15.5**	J	**7.61**	J	**7.53**	J
Cadmium	mg/kg	7	NE	0.716	0.716		-	-	0.276	J
Calcium	mg/kg	NE	52300	42300	4,140		351		42,300	
Chromium	mg/kg	0.29	29	14.4	12.8		11.7		14.4	
Cobalt	mg/kg	2.3	116	14	8.29	J	6.67	J	14	J
Copper	mg/kg	310	56.2	33.6	31.3	J	15.6	J	33.6	J
Iron	mg/kg	5500	234000	61600	61,600	J	22,100	J	24,500	J
Lead	mg/kg	40	48.6	27.4	27.4		12.2		13.4	
Magnesium	mg/kg	NE	10400	8760	1,320	J	1,980	J	8,760	J
Manganese	mg/kg	180	3506	551	319		100		551	
Mercury	mg/kg	2.3	0.09	0.118	**0.118**		0.0242	J	-	-
Nickel	mg/kg	150	55.1	36.8	20.5		18		36.8	
Potassium	mg/kg	NE	3390	990	837		513		990	
Selenium	mg/kg	39	2	1.44	1.44		-	-	0.779	J
Sodium	mg/kg	NE	NE	91	79.2		18.4	B	91.4	
Thallium	mg/kg	NE	1.3	0.939	0.939		-	-	0.347	J
Vanadium	mg/kg	39	40.9	23	23		17		18.2	
Zinc	mg/kg	2300	322	102	102		68.9		85.3	

				Location Code:	AP2-SB03					
				Sample Number:	AP0108		AP0109		AP0110	
				Sample Date:	18-Jan-09		18-Jan-09		18-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
PCBs										
Aroclor 1260	mg/kg	0.22	NE	0.0162	0.0162	J	-	-	-	-
SEMIVOLATILES										
Benzo(a)anthracene	mg/kg	0.15	NE	0.0307	0.0307		-	-	-	-
Fluoranthene	mg/kg	230	NE	0.0599	0.0599	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0667	-	-	-	-	0.0667	J
Pyrene	mg/kg	170	NE	0.044	0.044	J	-	-	-	-
METALS										
Aluminum	mg/kg	7700	15500	15000	8,070		15,000		7,720	
Antimony	mg/kg	3.1	9.3	0.637	0.637		0.257	J	0.329	J
Arsenic	mg/kg	0.39	36.5	12.6	7.71	J	5.27	J	12.6	J
Barium	mg/kg	1500	826	99	69.4	J	98.9	J	18.6	J
Beryllium	mg/kg	16	1	7.43	**6.46**	J	**7.43**	J	**6.35**	J
Cadmium	mg/kg	7	NE	0.558	0.558		-	-	-	-
Calcium	mg/kg	NE	52300	54300	3,430	J	36,500	J	**54,300**	J
Chromium	mg/kg	0.29	29	22.1	12	J	22.1	J	11.8	J
Cobalt	mg/kg	2.3	116	10.8	8.68	J	10.8	J	10.7	J
Copper	mg/kg	310	56.2	29.8	22.5		29.8		29.6	
Iron	mg/kg	5500	234000	24900	19,100		24,900		22,100	
Lead	mg/kg	40	48.6	27.7	27.7	J	16.7	J	15.8	J
Magnesium	mg/kg	NE	10400	10400	2,150	J	10,100	J	**10,400**	J
Manganese	mg/kg	180	3506	436	211		436		414	
Mercury	mg/kg	2.3	0.09	0.0642	0.0642		0.013	J	0.0132	J
Nickel	mg/kg	150	55.1	31.5	21.7	J	31.5	J	27.4	J
Potassium	mg/kg	NE	3390	1570	745		1,570		1,110	
Selenium	mg/kg	39	2	0.928	0.928	J	-	-	-	-
Sodium	mg/kg	NE	NE	120	36.3	B	119		120	
Thallium	mg/kg	NE	1.3	0.47	0.47	J	0.35	J	0.336	J
Vanadium	mg/kg	39	40.9	25.3	18.7		25.3		15.4	
Zinc	mg/kg	2300	322	80	80	J	68.5	J	61.5	J

				Location Code:	AP2-SB04					
				Sample Number:	AP0111		AP0112		AP0113	
				Sample Date:	18-Jan-09		18-Jan-09		19-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES										
Phenanthrene	mg/kg	NE	NE	0.0453	-	-	-	-	0.0453	J
METALS										
Aluminum	mg/kg	7700	15500	8670	7,130		7,830		8,670	
Antimony	mg/kg	3.1	9.3	0.485	0.485		0.312	J	0.392	J
Arsenic	mg/kg	0.39	36.5	26.8	26.8	J	4.51	J	12.1	J
Barium	mg/kg	1500	826	98	98.4	J	61.5	J	35.6	J
Beryllium	mg/kg	16	1	16.3	**16.3**	J	**6.68**	J	**7.02**	J
Calcium	mg/kg	NE	52300	50700	2,160	J	3,010	J	50,700	J
Chromium	mg/kg	0.29	29	12.7	10.5	J	11.9	J	12.7	J
Cobalt	mg/kg	2.3	116	11	5.96	J	7.88	J	11	J
Copper	mg/kg	310	56.2	38.4	26		20.9		38.4	
Iron	mg/kg	5500	234000	109000	109,000		19,200		24,400	
Lead	mg/kg	40	48.6	18.9	10.1	J	18.9	J	16	J
Magnesium	mg/kg	NE	10400	10800	442	J	2,530	J	**10,800**	J
Manganese	mg/kg	180	3506	522	116		87.4		522	
Mercury	mg/kg	2.3	0.09	0.0352	0.0265		0.0352		0.0147	J
Nickel	mg/kg	150	55.1	28.8	17.1	J	24.8	J	28.8	J
Potassium	mg/kg	NE	3390	1150	827		705		1,150	
Selenium	mg/kg	39	2	0.859	0.678	J	0.859	J	-	-
Sodium	mg/kg	NE	NE	119	55.7	B	43.6	B	119	
Thallium	mg/kg	NE	1.3	0.468	0.468	J	-	-	0.315	J
Vanadium	mg/kg	39	40.9	26.9	26.9		17.8		17.5	
Zinc	mg/kg	2300	322	64	57	J	64.4	J	60.4	J

				Location Code:	AP2-SB08									
				Sample Number:	AP0125		AP0126		AP0127		AP0128		AP0129	
				Sample Date:	16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG		FD		FS	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
METALS														
Aluminum	mg/kg	7700	15500	15100	4,070	J	5,350	J	15,100	J	14,900	J	12,100	
Antimony	mg/kg	3.1	9.3	0.248	-	-	0.227	J	-	-	0.248	J	-	-
Arsenic	mg/kg	0.39	36.5	12.8	12.8		12.6		6.16		6.61		7	
Barium	mg/kg	1500	826	85	73.2	J	56	J	81	J	83.7	J	85	
Beryllium	mg/kg	16	1	16.9	**16.9**	J	**8.48**	J	**8.51**	J	**8.11**	J	-	-
Calcium	mg/kg	NE	52300	45500	1,650		1,860		44,800		45,500		45,000	J
Chromium	mg/kg	0.29	29	22.4	6.13		8.82		22.4		21.9		18.5	
Cobalt	mg/kg	2.3	116	15.6	3.9	J	8.7	J	15.6	J	14.6	J	12.4	
Copper	mg/kg	310	56.2	31.1	21.3	J	11	J	31.1	J	30.1	J	23.9	
Iron	mg/kg	5500	234000	72600	72,600	J	28,000	J	26,600	J	28,500	J	23,900	
Lead	mg/kg	40	48.6	14.1	4.64		9.05		11.6		14.1		10.7	
Magnesium	mg/kg	NE	10400	12200	312	J	1,730	J	**12,200**	J	**11,500**	J	10,100	
Manganese	mg/kg	180	3506	473	98.2		196		473		432		363	
Mercury	mg/kg	2.3	0.09	0.034	0.034		0.0151	J	-	-	-	-	-	-
Nickel	mg/kg	150	55.1	39.7	10.5		22		39.7		38		32.8	
Potassium	mg/kg	NE	3390	2870	477		371		1,980		1,990		2,870	J
Selenium	mg/kg	39	2	0.914	0.914	J	-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	145	36.4	B	27.4	B	145		134		-	-
Thallium	mg/kg	NE	1.3	0.308	0.308	J	-	-	-	-	-	-	-	-
Vanadium	mg/kg	39	40.9	25.4	18.8		15.1		25.4		24.7		20.5	
Zinc	mg/kg	2300	322	77	41.4		58.9		76.6		73.4		61.3	

FIGURE 3-5

DETECTED CONSTITUENTS AT POWERHOUSE No. 2 ASH PITS IN SURFACE AND SUBSURFACE SOIL SAMPLES ABOVE RBSCs AND/OR BSCs (JANUARY 2009)

POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE: 0 80 160 FEET

CB&I Federal Services LLC

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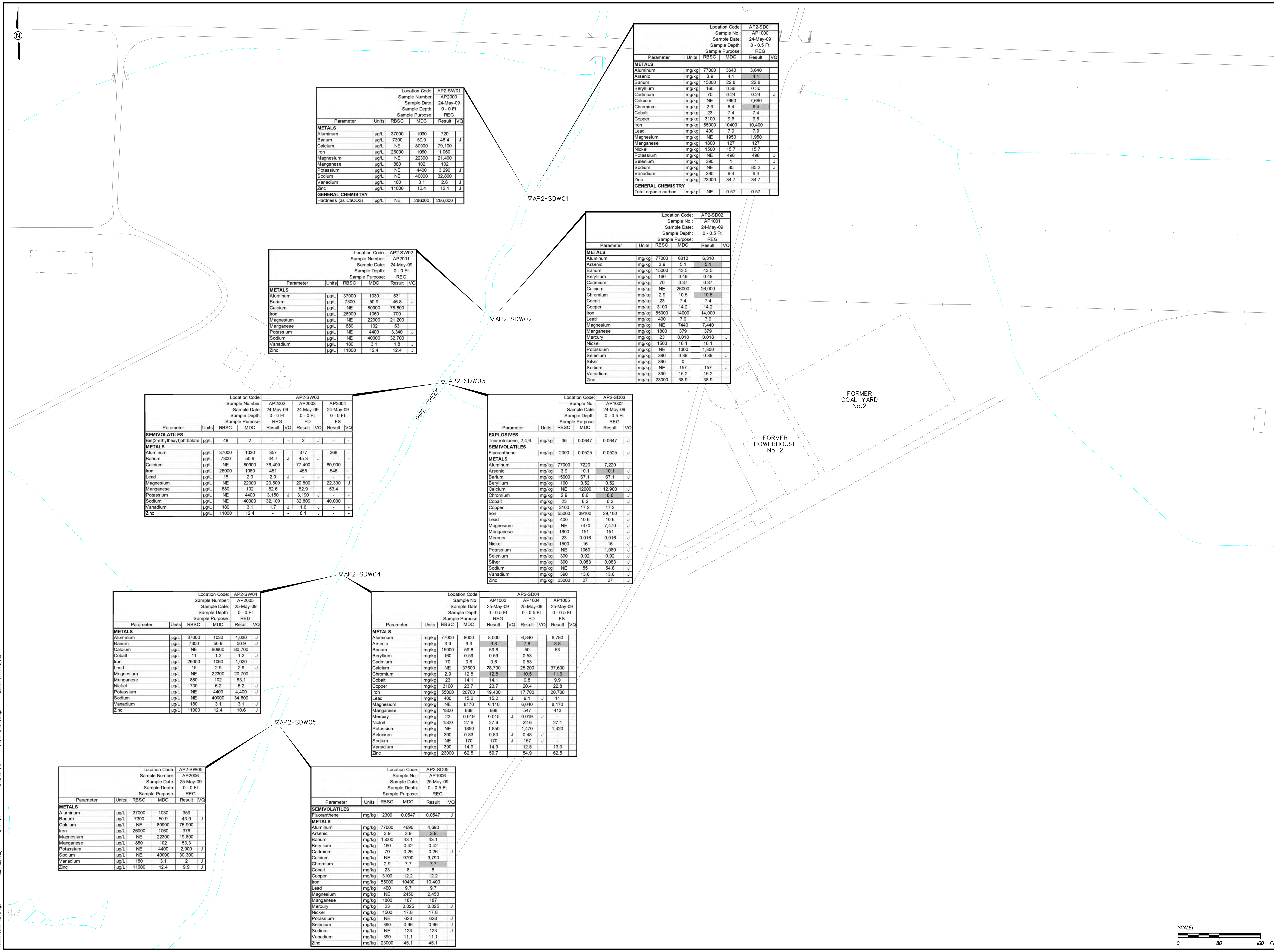


Location Code:				AP2-SW01	
Sample Number:				AP2000	
Sample Date:				24-May-09	
Sample Depth:				0 - 0 Ft	
Sample Purpose:				REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	µg/L	37000	1030	720	
Barium	µg/L	7300	50.9	48.4	J
Calcium	µg/L	NE	80900	79,100	
Iron	µg/L	26000	1060	1,060	
Magnesium	µg/L	NE	22300	21,400	
Manganese	µg/L	880	102	102	
Potassium	µg/L	NE	4400	3,290	J
Sodium	µg/L	NE	40000	32,800	
Vanadium	µg/L	180	3.1	2.6	J
Zinc	µg/L	11000	12.4	12.1	J
GENERAL CHEMISTRY					
Hardness (as CaCO3)	µg/L	NE	286000	286,000	

Location Code:				AP2-SD01	
Sample No.:				AP1000	
Sample Date:				24-May-09	
Sample Depth:				0 - 0.5 Ft	
Sample Purpose:				REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	mg/kg	77000	3640	3,640	
Arsenic	mg/kg	3.9	4.1	4.1	
Barium	mg/kg	15000	22.8	22.8	
Beryllium	mg/kg	160	0.36	0.36	
Cadmium	mg/kg	70	0.24	0.24	J
Calcium	mg/kg	NE	7660	7,660	
Chromium	mg/kg	2.9	6.4	6.4	
Cobalt	mg/kg	23	7.4	7.4	
Copper	mg/kg	3100	9.6	9.6	
Iron	mg/kg	55000	10400	10,400	
Lead	mg/kg	400	7.9	7.9	
Magnesium	mg/kg	NE	1950	1,950	
Manganese	mg/kg	1800	127	127	
Nickel	mg/kg	1500	15.7	15.7	
Potassium	mg/kg	NE	498	498	J
Selenium	mg/kg	390	1	1	J
Sodium	mg/kg	NE	85	85.2	J
Vanadium	mg/kg	390	9.4	9.4	
Zinc	mg/kg	23000	34.7	34.7	
GENERAL CHEMISTRY					
Total organic carbon	mg/kg	NE	0.57	0.57	

Location Code:				AP2-SW02	
Sample Number:				AP2001	
Sample Date:				24-May-09	
Sample Depth:				0 - 0 Ft	
Sample Purpose:				REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	µg/L	37000	1030	531	
Barium	µg/L	7300	50.9	46.8	J
Calcium	µg/L	NE	80900	78,800	
Iron	µg/L	26000	1060	700	
Magnesium	µg/L	NE	22300	21,200	
Manganese	µg/L	880	102	63	
Potassium	µg/L	NE	4400	3,340	J
Sodium	µg/L	NE	40000	32,700	
Vanadium	µg/L	180	3.1	1.8	J
Zinc	µg/L	11000	12.4	12.4	J

Location Code:				AP2-SD02	
Sample No.:				AP1001	
Sample Date:				24-May-09	
Sample Depth:				0 - 0.5 Ft	
Sample Purpose:				REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	mg/kg	77000	6310	6,310	
Arsenic	mg/kg	3.9	5.1	5.1	
Barium	mg/kg	15000	43.5	43.5	
Beryllium	mg/kg	160	0.49	0.49	
Cadmium	mg/kg	70	0.37	0.37	
Calcium	mg/kg	NE	26000	26,000	
Chromium	mg/kg	2.9	10.5	10.5	
Cobalt	mg/kg	23	7.4	7.4	
Copper	mg/kg	3100	14.2	14.2	
Iron	mg/kg	55000	14000	14,000	
Lead	mg/kg	400	7.9	7.9	
Magnesium	mg/kg	NE	7440	7,440	
Manganese	mg/kg	1800	379	379	
Mercury	mg/kg	23	0.018	0.018	J
Nickel	mg/kg	1500	16.1	16.1	
Potassium	mg/kg	NE	1300	1,300	
Selenium	mg/kg	390	0.39	0.39	J
Silver	mg/kg	390	0	-	-
Sodium	mg/kg	NE	157	157	J
Vanadium	mg/kg	390	15.2	15.2	
Zinc	mg/kg	23000	38.9	38.9	

Location Code:				AP2-SW03					
Sample Number:				AP2002		AP2003		AP2004	
Sample Date:				24-May-09		24-May-09		24-May-09	
Sample Depth:				0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
Sample Purpose:				REG		FD		FS	
Parameter	Units	RBSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES									
Bis(2-ethylhexyl)phthalate	µg/L	48	2	-	-	2	J	-	-
METALS									
Aluminum	µg/L	37000	1030	357		377		368	
Barium	µg/L	7300	50.9	44.7	J	45.3	J	-	-
Calcium	µg/L	NE	80900	76,400		77,400		80,900	
Iron	µg/L	26000	1060	451		455		546	
Lead	µg/L	15	2.9	2.9	J	-	-	-	-
Magnesium	µg/L	NE	22300	20,500		20,800		22,300	J
Manganese	µg/L	880	102	52.6		52.9		53.4	
Potassium	µg/L	NE	4400	3,150	J	3,190	J	-	-
Sodium	µg/L	NE	40000	32,100		32,800		40,000	
Vanadium	µg/L	180	3.1	1.7	J	1.6	J	-	-
Zinc	µg/L	11000	12.4	-	-	8.1	J	-	-

Location Code:				AP2-SD03	
Sample No.:				AP1002	
Sample Date:				24-May-09	
Sample Depth:				0 - 0.5 Ft	
Sample Purpose:				REG	
Parameter	Units	RBSC	MDC	Result	VQ
EXPLOSIVES					
Trinitrotoluene, 2,4,6-	mg/kg	36	0.0647	0.0647	J
SEMIVOLATILES					
Fluoranthene	mg/kg	2300	0.0525	0.0525	J
METALS					
Aluminum	mg/kg	77000	7220	7,220	
Arsenic	mg/kg	3.9	10.1	10.1	J
Barium	mg/kg	15000	67.1	67.1	J
Beryllium	mg/kg	160	0.52	0.52	
Calcium	mg/kg	NE	12900	12,900	J
Chromium	mg/kg	2.9	8.6	8.6	J
Cobalt	mg/kg	23	6.2	6.2	J
Copper	mg/kg	3100	17.2	17.2	
Iron	mg/kg	55000	39100	39,100	J
Lead	mg/kg	400	10.6	10.6	J
Magnesium	mg/kg	NE	7470	7,470	J
Manganese	mg/kg	1800	151	151	J
Mercury	mg/kg	23	0.016	0.016	J
Nickel	mg/kg	1500	16	16	J
Potassium	mg/kg	NE	1060	1,060	J
Selenium	mg/kg	390	0.92	0.92	J
Silver	mg/kg	390	0.083	0.083	J
Sodium	mg/kg	NE	55	54.8	J
Vanadium	mg/kg	390	13.6	13.6	J
Zinc	mg/kg	23000	27	27	J

Location Code:				AP2-SW04	
Sample Number:				AP2005	
Sample Date:				25-May-09	
Sample Depth:				0 - 0 Ft	
Sample Purpose:				REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	µg/L	37000	1030	1,030	J
Barium	µg/L	7300	50.9	50.9	J
Calcium	µg/L	NE	80900	80,700	
Cobalt	µg/L	11	1.2	1.2	J
Iron	µg/L	26000	1060	1,020	
Lead	µg/L	15	2.9	2.9	J
Magnesium	µg/L	NE	22300	20,700	
Manganese	µg/L	880	102	83.1	
Nickel	µg/L	730	6.2	6.2	J
Potassium	µg/L	NE	4400	4,400	J
Sodium	µg/L	NE	40000	34,800	
Vanadium	µg/L	180	3.1	3.1	J
Zinc	µg/L	11000	12.4	10.6	J

Location Code:				AP2-SD04					
Sample No.:				AP1003		AP1004		AP1005	
Sample Date:				25-May-09		25-May-09		25-May-09	
Sample Depth:				0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft	
Sample Purpose:				REG		FD		FS	
Parameter	Units	RBSC	MDC	Result	VQ	Result	VQ	Result	VQ
METALS									
Aluminum	mg/kg	77000	8000	8,000		6,840		6,780	
Arsenic	mg/kg	3.9	9.3	9.3		7.8		8.8	
Barium	mg/kg	15000	59.8	59.8		50		53	
Beryllium	mg/kg	160	0.59	0.59		0.53		-	-
Cadmium	mg/kg	70	0.6	0.6		0.53		-	-
Calcium	mg/kg	NE	37600	28,700		25,200		37,600	
Chromium	mg/kg	2.9	12.8	12.8		10.5		11.6	
Cobalt	mg/kg	23	14.1	14.1		9.8		9.9	
Copper	mg/kg	3100	23.7	23.7		20.4		22.8	
Iron	mg/kg	55000	20700	19,400		17,700		20,700	
Lead	mg/kg	400	15.2	15.2	J	9.1	J	11	
Magnesium	mg/kg	NE	8170	6,110		6,040		8,170	
Manganese	mg/kg	1800	668	668		547		413	
Mercury	mg/kg	23	0.019	0.015	J	0.019	J	-	-
Nickel	mg/kg	1500	27.6	27.6		22.6		27.1	
Potassium	mg/kg	NE	1850	1,850		1,470		1,420	
Selenium	mg/kg	390	0.83	0.83	J	0.48	J	-	-
Sodium	mg/kg	NE	170	170	J	157	J	-	-
Vanadium	mg/kg	390	14.9	14.9		12.5		13.3	
Zinc	mg/kg	23000	62.5	59.7		54.9		62.5	

Location Code:				AP2-SW05	
Sample Number:				AP2006	
Sample Date:				25-May-09	
Sample Depth:				0 - 0 Ft	
Sample Purpose:				REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	µg/L	37000	1030	359	
Barium	µg/L	7300	50.9	43.9	J
Calcium	µg/L	NE	80900	75,900	
Iron	µg/L	26000	1060	376	
Magnesium	µg/L	NE	22300	19,800	
Manganese	µg/L	880	102	53.3	
Potassium	µg/L	NE	4400	2,900	J
Sodium	µg/L	NE	40000	30,300	
Vanadium	µg/L	180	3.1	2	J
Zinc	µg/L	11000	12.4	9.9	J

Location Code:				AP2-SD05	
Sample No.:				AP1006	
Sample Date:				25-May-09	
Sample Depth:				0 - 0.5 Ft	
Sample Purpose:				REG	
Parameter	Units	RBSC	MDC	Result	VQ
SEMIVOLATILES					
Fluoranthene	mg/kg	2300	0.0547	0.0547	J
METALS					
Aluminum	mg/kg	77000	4690	4,690	
Arsenic	mg/kg	3.9	3.9	3.9	
Barium	mg/kg	15000	43.1	43.1	
Beryllium	mg/kg	160	0.42	0.42	
Cadmium	mg/kg	70	0.26	0.26	J
Calcium	mg/kg	NE	9790	9,790	
Chromium	mg/kg	2.9	7.7	7.7	
Cobalt	mg/kg	23	8	8	
Copper	mg/kg	3100	12.2	12.2	
Iron	mg/kg	55000	10400	10,400	
Lead	mg/kg	400	9.7	9.7	
Magnesium	mg/kg	NE	2450	2,450	
Manganese	mg/kg	1800	187	187	
Mercury	mg/kg	23	0.025	0.025	J
Nickel	mg/kg	1500	17.8	17.8	
Potassium	mg/kg	NE	628	628	J
Selenium	mg/kg	390	0.96	0.96	J
Sodium	mg/kg	NE	123	123	J
Vanadium	mg/kg	390	11.1	11.1	
Zinc	mg/kg	23000	45.1	45.1	

LEGEND:

- ▽ SURFACE WATER/SEDIMENT SAMPLE
- mg/kg MILLIGRAMS PER KILOGRAM
- ug/L MICROGRAMS PER LITER
- NE NOT ESTABLISHED (RBSCs), NOT EVALUATED (BSCs)
- NM NOT MEASURED
- \- NOT DETECTED

NOTES:

1. SHADED CELL INDICATES VALUE IS GREATER THAN THE RBSC.
2. RBSC VALUES REFLECT AN INCREMENTAL LIFETIME CANCER RISK (ILCR) OF 1E-6 OR A NONCANCER HAZARD QUOTIENT (HQ) OF 0.1. FOR CHEMICALS THAT EXHIBIT BOTH CANCER AND NONCANCER EFFECTS, WHICHEVER TYPE OF EFFECT IN A LOWER CONCENTRATION (USING AN ILCR OF 1E-6 AND AN HQ OF 0.1), THAT CONCENTRATION IS SELECTED AS THE RBSC.
3. MDC IS MAXIMUM DETECTED CONCENTRATION FOR THE INVESTIGATION AREA ("B" QUALIFIED DATA NOT INCLUDED).
4. VALIDATION QUALIFIERS (VQ):
   - B - THE ANALYTE WAS NOT DETECTED SIGNIFICANTLY ABOVE THE LEVELS FOUND IN THE ASSOCIATED METHOD BLANK OR FIELD BLANKS.
   - J - THE ANALYTE WAS POSITIVELY IDENTIFIED; THE REPORTED VALUE IS ESTIMATED.

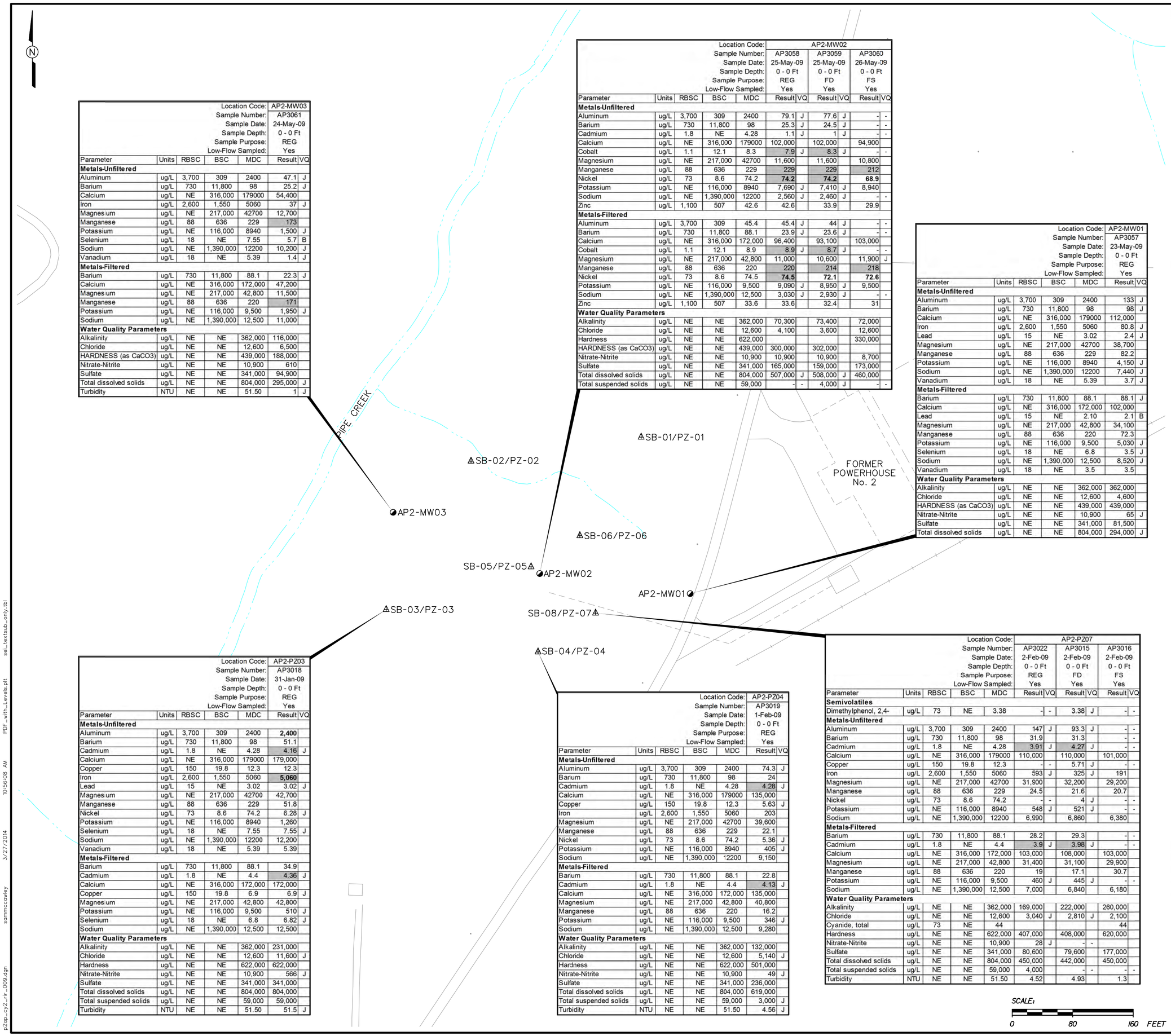
FIGURE 3-6

DETECTED CONSTITUENTS AT POWERHOUSE No. 2 ASH PITS IN SURFACE WATER AND SEDIMENT SAMPLES ABOVE RBSCs (MAY 2009)

POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

p2ap_cy2_rir_008.dgn sammccawley 3/27/2014 10:55:22 AM PDF_with_Levels.plt sei_textsub_only.tbl



LEGEND:

- OVERBURDEN MONITORING WELL
- SOIL BORING/PIEZOMETER
- ug/L — MICROGRAMS PER LITER
- NE — NOT ESTABLISHED (RBSCs), NOT EVALUATED (BSCs)
- NM — NOT MEASURED
- \- — NOT DETECTED

NOTES:

1. SHADED CELL INDICATES VALUE IS GREATER THAN THE RBSC.
2. BOLD TEXT INDICATES VALUE IS GREATER THAN THE BSC.
3. RBSC VALUES REFLECT AN INCREMENTAL LIFETIME CANCER RISK (ILCR) OF 1E-6 OR A NONCANCER HAZARD QUOTIENT (HQ) OF 0.1. FOR CHEMICALS THAT EXHIBIT BOTH CANCER AND NONCANCER EFFECTS, WHICHEVER TYPE OF EFFECT IN A LOWER CONCENTRATION (USING AN ILCR OF 1E-6 AND AN HQ OF 0.1), THAT CONCENTRATION IS SELECTED AS THE RBSC.
4. BSC IS BACKGROUND SCREENING CONCENTRATION.
5. MDC IS MAXIMUM DETECTED CONCENTRATION FOR THE INVESTIGATION AREA ("B" QUALIFIED DATA NOT INCLUDED).
6. VALIDATION QUALIFIERS (VQ):
   - B - THE ANALYTE WAS NOT DETECTED SIGNIFICANTLY ABOVE THE LEVELS FOUND IN THE ASSOCIATED METHOD BLANK OR FIELD BLANKS.
   - J - THE ANALYTE WAS POSITIVELY IDENTIFIED; THE REPORTED VALUE IS ESTIMATED.
7. ONLY NITROAROMATICS WERE ANALYZED IN GROUNDWATER DURING THE MONTH OF NOVEMBER. NO NITROAROMATICS WERE DETECTED THEREFORE NO DATA IS SHOWN.

				Location Code:	AP2-MW03	
				Sample Number:	AP3061	
				Sample Date:	24-May-09	
				Sample Depth:	0 - 0 Ft	
				Sample Purpose:	REG	
				Low-Flow Sampled:	Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ
Metals-Unfiltered						
Aluminum	ug/L	3,700	309	2400	47.1	J
Barium	ug/L	730	11,800	98	25.2	J
Calcium	ug/L	NE	316,000	179000	54,400	
Iron	ug/L	2,600	1,550	5060	37	J
Magnesium	ug/L	NE	217,000	42700	12,700	
Manganese	ug/L	88	636	229	173	
Potassium	ug/L	NE	116,000	8940	1,500	J
Selenium	ug/L	18	NE	7.55	5.7	B
Sodium	ug/L	NE	1,390,000	12200	10,200	J
Vanadium	ug/L	18	NE	5.39	1.4	J
Metals-Filtered						
Barium	ug/L	730	11,800	88.1	22.3	J
Calcium	ug/L	NE	316,000	172,000	47,200	
Magnesium	ug/L	NE	217,000	42,800	11,500	
Manganese	ug/L	88	636	220	171	
Potassium	ug/L	NE	116,000	9,500	1,950	J
Sodium	ug/L	NE	1,390,000	12,500	11,000	
Water Quality Parameters						
Alkalinity	ug/L	NE	NE	362,000	116,000	
Chloride	ug/L	NE	NE	12,600	6,500	
HARDNESS (as CaCO3)	ug/L	NE	NE	439,000	188,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	610	
Sulfate	ug/L	NE	NE	341,000	94,900	
Total dissolved solids	ug/L	NE	NE	804,000	295,000	J
Turbidity	NTU	NE	NE	51.50	1	J

				Location Code:	AP2-MW02					
				Sample Number:	AP3058		AP3059		AP3060	
				Sample Date:	25-May-09		25-May-09		26-May-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		FD		FS	
				Low-Flow Sampled:	Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
Metals-Unfiltered										
Aluminum	ug/L	3,700	309	2400	79.1	J	77.6	J	-	-
Barium	ug/L	730	11,800	98	25.3	J	24.5	J	-	-
Cadmium	ug/L	1.8	NE	4.28	1.1	J	1	J	-	-
Calcium	ug/L	NE	316,000	179000	102,000		102,000		94,900	
Cobalt	ug/L	1.1	12.1	8.3	7.9	J	8.3	J	-	-
Magnesium	ug/L	NE	217,000	42700	11,600		11,600		10,800	
Manganese	ug/L	88	636	229	229		229		212	
Nickel	ug/L	73	8.6	74.2	**74.2**		**74.2**		**68.9**	
Potassium	ug/L	NE	116,000	8940	7,690	J	7,410	J	8,940	
Sodium	ug/L	NE	1,390,000	12200	2,560	J	2,460	J	-	-
Zinc	ug/L	1,100	507	42.6	42.6		33.9		29.9	
Metals-Filtered										
Aluminum	ug/L	3,700	309	45.4	45.4	J	44	J	-	-
Barium	ug/L	730	11,800	88.1	23.9	J	23.6	J	-	-
Calcium	ug/L	NE	316,000	172,000	96,400		93,100		103,000	
Cobalt	ug/L	1.1	12.1	8.9	8.9	J	8.7	J	-	-
Magnesium	ug/L	NE	217,000	42,800	11,000		10,600		11,900	J
Manganese	ug/L	88	636	220	220		214		218	
Nickel	ug/L	73	8.6	74.5	**74.5**		**72.1**		**72.6**	
Potassium	ug/L	NE	116,000	9,500	9,090	J	8,950	J	9,500	
Sodium	ug/L	NE	1,390,000	12,500	3,030	J	2,930	J	-	-
Zinc	ug/L	1,100	507	33.6	33.6		32.4		31	
Water Quality Parameters										
Alkalinity	ug/L	NE	NE	362,000	70,300		73,400		72,000	
Chloride	ug/L	NE	NE	12,600	4,100		3,600		12,600	
Hardness	ug/L	NE	NE	622,000					330,000	
HARDNESS (as CaCO3)	ug/L	NE	NE	439,000	300,000		302,000			
Nitrate-Nitrite	ug/L	NE	NE	10,900	10,900		10,900		8,700	
Sulfate	ug/L	NE	NE	341,000	165,000		159,000		173,000	
Total dissolved solids	ug/L	NE	NE	804,000	507,000	J	508,000	J	460,000	
Total suspended solids	ug/L	NE	NE	59,000	-	-	4,000	J	-	-

				Location Code:	AP2-MW01	
				Sample Number:	AP3057	
				Sample Date:	23-May-09	
				Sample Depth:	0 - 0 Ft	
				Sample Purpose:	REG	
				Low-Flow Sampled:	Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ
Metals-Unfiltered						
Aluminum	ug/L	3,700	309	2400	133	J
Barium	ug/L	730	11,800	98	98	J
Calcium	ug/L	NE	316,000	179000	112,000	
Iron	ug/L	2,600	1,550	5060	80.8	J
Lead	ug/L	15	NE	3.02	2.4	J
Magnesium	ug/L	NE	217,000	42700	38,700	
Manganese	ug/L	88	636	229	82.2	
Potassium	ug/L	NE	116,000	8940	4,150	J
Sodium	ug/L	NE	1,390,000	12200	7,440	J
Vanadium	ug/L	18	NE	5.39	3.7	J
Metals-Filtered						
Barium	ug/L	730	11,800	88.1	88.1	J
Calcium	ug/L	NE	316,000	172,000	102,000	
Lead	ug/L	15	NE	2.10	2.1	B
Magnesium	ug/L	NE	217,000	42,800	34,100	
Manganese	ug/L	88	636	220	72.3	
Potassium	ug/L	NE	116,000	9,500	5,030	J
Selenium	ug/L	18	NE	6.8	3.5	J
Sodium	ug/L	NE	1,390,000	12,500	8,520	J
Vanadium	ug/L	18	NE	3.5	3.5	
Water Quality Parameters						
Alkalinity	ug/L	NE	NE	362,000	362,000	
Chloride	ug/L	NE	NE	12,600	4,600	
HARDNESS (as CaCO3)	ug/L	NE	NE	439,000	439,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	65	J
Sulfate	ug/L	NE	NE	341,000	81,500	
Total dissolved solids	ug/L	NE	NE	804,000	294,000	J

				Location Code:	AP2-PZ03	
				Sample Number:	AP3018	
				Sample Date:	31-Jan-09	
				Sample Depth:	0 - 0 Ft	
				Sample Purpose:	REG	
				Low-Flow Sampled:	Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ
Metals-Unfiltered						
Aluminum	ug/L	3,700	309	2400	**2,400**	
Barium	ug/L	730	11,800	98	51.1	
Cadmium	ug/L	1.8	NE	4.28	4.16	J
Calcium	ug/L	NE	316,000	179000	179,000	
Copper	ug/L	150	19.8	12.3	12.3	
Iron	ug/L	2,600	1,550	5060	**5,060**	
Lead	ug/L	15	NE	3.02	3.02	J
Magnesium	ug/L	NE	217,000	42700	42,700	
Manganese	ug/L	88	636	229	51.8	
Nickel	ug/L	73	8.6	74.2	6.28	J
Potassium	ug/L	NE	116,000	8940	1,260	
Selenium	ug/L	18	NE	7.55	7.55	J
Sodium	ug/L	NE	1,390,000	12200	12,200	
Vanadium	ug/L	18	NE	5.39	5.39	
Metals-Filtered						
Barium	ug/L	730	11,800	88.1	34.9	
Cadmium	ug/L	1.8	NE	4.4	4.36	J
Calcium	ug/L	NE	316,000	172,000	172,000	
Copper	ug/L	150	19.8	6.9	6.9	J
Magnesium	ug/L	NE	217,000	42,800	42,800	
Potassium	ug/L	NE	116,000	9,500	510	J
Selenium	ug/L	18	NE	6.8	6.82	J
Sodium	ug/L	NE	1,390,000	12,500	12,500	
Water Quality Parameters						
Alkalinity	ug/L	NE	NE	362,000	231,000	
Chloride	ug/L	NE	NE	12,600	11,600	J
Hardness	ug/L	NE	NE	622,000	622,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	566	J
Sulfate	ug/L	NE	NE	341,000	341,000	
Total dissolved solids	ug/L	NE	NE	804,000	804,000	
Total suspended solids	ug/L	NE	NE	59,000	59,000	
Turbidity	NTU	NE	NE	51.50	51.5	J

				Location Code:	AP2-PZ04	
				Sample Number:	AP3019	
				Sample Date:	1-Feb-09	
				Sample Depth:	0 - 0 Ft	
				Sample Purpose:	REG	
				Low-Flow Sampled:	Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ
Metals-Unfiltered						
Aluminum	ug/L	3,700	309	2400	74.3	J
Barium	ug/L	730	11,800	98	24	
Cadmium	ug/L	1.8	NE	4.28	4.28	J
Calcium	ug/L	NE	316,000	179000	135,000	
Copper	ug/L	150	19.8	12.3	5.63	J
Iron	ug/L	2,600	1,550	5060	203	
Magnesium	ug/L	NE	217,000	42700	39,600	
Manganese	ug/L	88	636	229	22.1	
Nickel	ug/L	73	8.6	74.2	5.36	J
Potassium	ug/L	NE	116,000	8940	405	J
Sodium	ug/L	NE	1,390,000	12200	9,150	
Metals-Filtered						
Barium	ug/L	730	11,800	88.1	22.8	
Cadmium	ug/L	1.8	NE	4.4	4.13	J
Calcium	ug/L	NE	316,000	172,000	135,000	
Magnesium	ug/L	NE	217,000	42,800	40,800	
Manganese	ug/L	88	636	220	16.2	
Potassium	ug/L	NE	116,000	9,500	346	J
Sodium	ug/L	NE	1,390,000	12,500	9,280	
Water Quality Parameters						
Alkalinity	ug/L	NE	NE	362,000	132,000	
Chloride	ug/L	NE	NE	12,600	5,140	J
Hardness	ug/L	NE	NE	622,000	501,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	49	J
Sulfate	ug/L	NE	NE	341,000	236,000	
Total dissolved solids	ug/L	NE	NE	804,000	619,000	
Total suspended solids	ug/L	NE	NE	59,000	3,000	J
Turbidity	NTU	NE	NE	51.50	4.56	J

				Location Code:	AP2-PZ07					
				Sample Number:	AP3022		AP3015		AP3016	
				Sample Date:	2-Feb-09		2-Feb-09		2-Feb-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		FD		FS	
				Low-Flow Sampled:	Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
Semivolatiles										
Dimethylphenol, 2,4-	ug/L	73	NE	3.38	-	-	3.38	J	-	-
Metals-Unfiltered										
Aluminum	ug/L	3,700	309	2400	147	J	93.3	J	-	-
Barium	ug/L	730	11,800	98	31.9		31.3		-	-
Cadmium	ug/L	1.8	NE	4.28	3.91	J	4.27	J	-	-
Calcium	ug/L	NE	316,000	179000	110,000		110,000		101,000	
Copper	ug/L	150	19.8	12.3	-	-	5.71	J	-	-
Iron	ug/L	2,600	1,550	5060	593	J	325	J	191	
Magnesium	ug/L	NE	217,000	42700	31,900		32,200		29,200	
Manganese	ug/L	88	636	229	24.5		21.6		20.7	
Nickel	ug/L	73	8.6	74.2	-	-	4	J	-	-
Potassium	ug/L	NE	116,000	8940	548	J	521	J	-	-
Sodium	ug/L	NE	1,390,000	12200	6,990		6,860		6,380	
Metals-Filtered										
Barium	ug/L	730	11,800	88.1	28.2		29.3		-	-
Cadmium	ug/L	1.8	NE	4.4	3.9	J	3.98	J	-	-
Calcium	ug/L	NE	316,000	172,000	103,000		108,000		103,000	
Magnesium	ug/L	NE	217,000	42,800	31,400		31,100		29,900	
Manganese	ug/L	88	636	220	19		17.1		30.7	
Potassium	ug/L	NE	116,000	9,500	460	J	445	J	-	-
Sodium	ug/L	NE	1,390,000	12,500	7,000		6,840		6,180	
Water Quality Parameters										
Alkalinity	ug/L	NE	NE	362,000	169,000		222,000		260,000	
Chloride	ug/L	NE	NE	12,600	3,040	J	2,810	J	2,100	
Cyanide, total	ug/L	73	NE	44					44	
Hardness	ug/L	NE	NE	622,000	407,000		408,000		620,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	28	J	-	-		
Sulfate	ug/L	NE	NE	341,000	80,600		79,600		177,000	
Total dissolved solids	ug/L	NE	NE	804,000	450,000		442,000		450,000	
Total suspended solids	ug/L	NE	NE	59,000	4,000		-	-	-	-
Turbidity	NTU	NE	NE	51.50	4.52		4.93		1.3	

SCALE:
0 80 160 FEET

FIGURE 3-7
DETECTED CONSTITUENTS AT POWERHOUSE No. 2 ASH PITS IN OVERBURDEN/SHALE GROUNDWATER SAMPLES ABOVE RBSCs AND/OR BSCs (JAN., FEB., MAY, AND NOV. 2009)

POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

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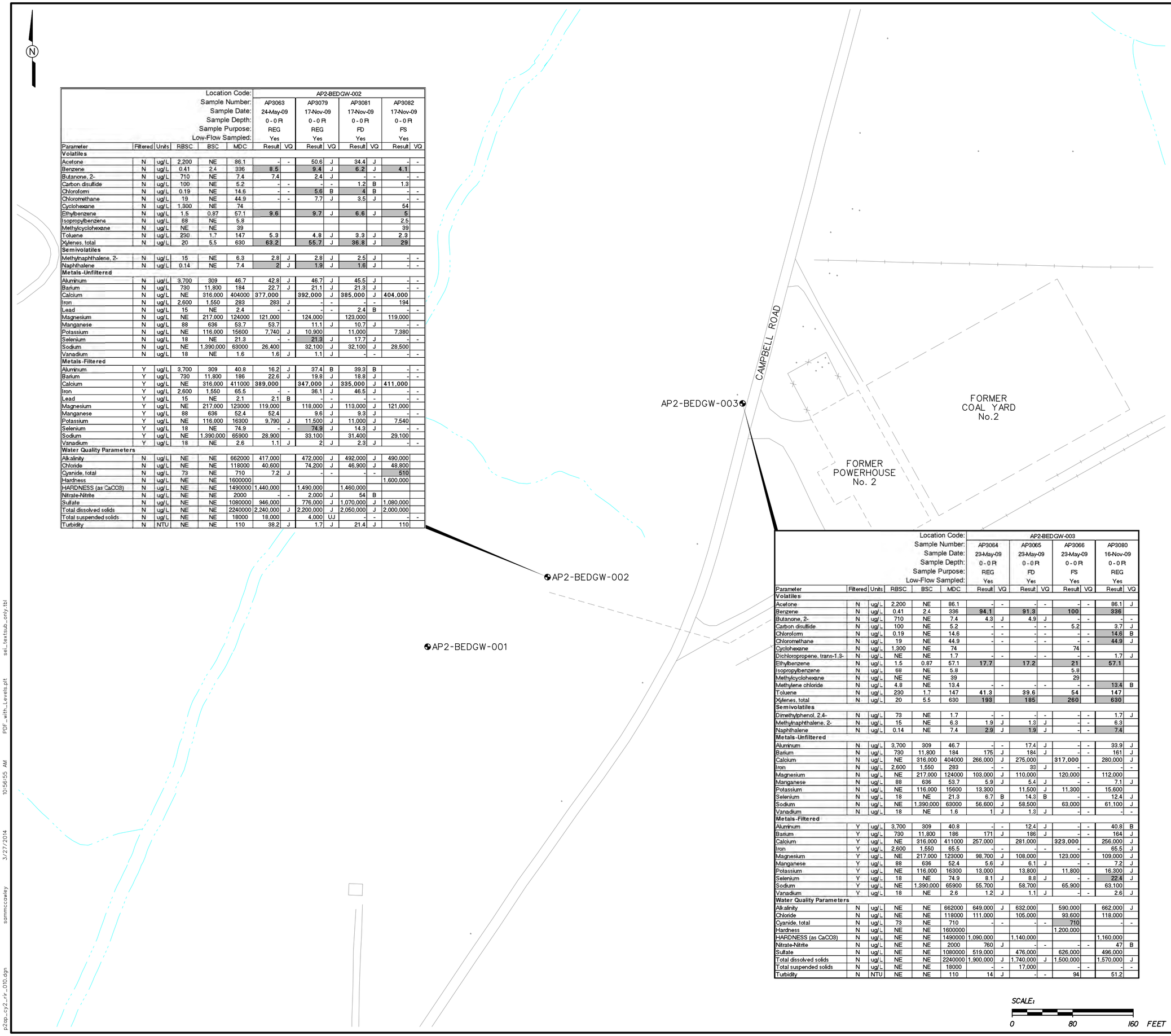


					Location Code:	AP2-BEDGW-002							
					Sample Number:	AP3063		AP3079		AP3081		AP3082	
					Sample Date:	24-May-09		17-Nov-09		17-Nov-09		17-Nov-09	
					Sample Depth:	0 - 0 R		0 - 0 R		0 - 0 R		0 - 0 R	
					Sample Purpose:	REG		REG		FD		FS	
					Low-Flow Sampled:	Yes		Yes		Yes		Yes	
Parameter	Filtered	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatiles													
Acetone	N	ug/L	2,200	NE	86.1	-	-	50.6	J	34.4	J	-	-
Benzene	N	ug/L	0.41	2.4	336	**8.5**		**9.4**	J	**6.2**	J	**4.1**	
Butanone, 2-	N	ug/L	710	NE	7.4	7.4		2.4	J	-	-	-	-
Carbon disulfide	N	ug/L	100	NE	5.2	-	-	-	-	1.2	B	1.3	
Chloroform	N	ug/L	0.19	NE	14.6	-	-	**5.6**	B	**4**	B	-	-
Chloromethane	N	ug/L	19	NE	44.9	-	-	7.7	J	3.5	J	-	-
Cyclohexane	N	ug/L	1,300	NE	74							54	
Ethylbenzene	N	ug/L	1.5	0.87	57.1	**9.6**		**9.7**	J	**6.6**	J	**5**	
Isopropylbenzene	N	ug/L	68	NE	5.8							2.5	
Methylcyclohexane	N	ug/L	NE	NE	39							39	
Toluene	N	ug/L	230	1.7	147	5.3		**4.8**	J	3.3	J	2.3	
Xylenes, total	N	ug/L	20	5.5	630	**63.2**		**55.7**	J	**36.8**	J	**29**	
Semivolatiles													
Methylnaphthalene, 2-	N	ug/L	15	NE	6.3	2.8	J	2.8	J	2.5	J	-	-
Naphthalene	N	ug/L	0.14	NE	7.4	**2**	J	**1.9**	J	**1.6**	J	-	-
Metals-Unfiltered													
Aluminum	N	ug/L	3,700	309	46.7	42.8	J	46.7	J	45.5	J	-	-
Barium	N	ug/L	730	11,800	184	22.7	J	21.1	J	21.3	J	-	-
Calcium	N	ug/L	NE	316,000	404000	**377,000**		**392,000**	J	**385,000**	J	**404,000**	
Iron	N	ug/L	2,600	1,550	283	283	J	-	-	-	-	194	
Lead	N	ug/L	15	NE	2.4	-	-	-	-	2.4	B	-	-
Magnesium	N	ug/L	NE	217,000	124000	121,000		124,000		123,000		119,000	
Manganese	N	ug/L	88	636	53.7	53.7		11.1	J	10.7	J	-	-
Potassium	N	ug/L	NE	116,000	15600	7,740	J	10,900		11,000		7,380	
Selenium	N	ug/L	18	NE	21.3	-	-	**21.3**	J	17.7	J	-	-
Sodium	N	ug/L	NE	1,390,000	63000	26,400		32,100	J	32,100	J	28,500	
Vanadium	N	ug/L	18	NE	1.6	1.6	J	1.1	J	-	-	-	-
Metals-Filtered													
Aluminum	Y	ug/L	3,700	309	40.8	16.2	J	37.4	B	39.3	B	-	-
Barium	Y	ug/L	730	11,800	186	22.6	J	19.8	J	18.8	J	-	-
Calcium	Y	ug/L	NE	316,000	411000	**389,000**		**347,000**	J	**335,000**	J	**411,000**	
Iron	Y	ug/L	2,600	1,550	65.5	-	-	36.1	J	46.5	J	-	-
Lead	Y	ug/L	15	NE	2.1	2.1	B	-	-	-	-	-	-
Magnesium	Y	ug/L	NE	217,000	123000	119,000		118,000	J	113,000	J	121,000	
Manganese	Y	ug/L	88	636	52.4	52.4		9.6	J	9.3	J	-	-
Potassium	Y	ug/L	NE	116,000	16300	9,790	J	11,500	J	11,000	J	7,540	
Selenium	Y	ug/L	18	NE	74.9	-	-	**74.9**	J	14.3	J	-	-
Sodium	Y	ug/L	NE	1,390,000	65900	28,900		33,100		31,400		29,100	
Vanadium	Y	ug/L	18	NE	2.6	1.1	J	2	J	2.3	J	-	-
Water Quality Parameters													
Alkalinity	N	ug/L	NE	NE	662000	417,000		472,000	J	492,000	J	490,000	
Chloride	N	ug/L	NE	NE	118000	40,600		74,200	J	46,900	J	48,800	
Cyanide, total	N	ug/L	73	NE	710	7.2	J	-	-	-	-	**510**	
Hardness	N	ug/L	NE	NE	1600000							1,600,000	
HARDNESS (as CaCO3)	N	ug/L	NE	NE	1490000	1,440,000		1,490,000		1,460,000			
Nitrate-Nitrite	N	ug/L	NE	NE	2000	-	-	2,000	J	54	B		
Sulfate	N	ug/L	NE	NE	1080000	946,000		776,000	J	1,070,000	J	1,080,000	
Total dissolved solids	N	ug/L	NE	NE	2240000	2,240,000	J	2,200,000	J	2,050,000	J	2,000,000	
Total suspended solids	N	ug/L	NE	NE	18000	18,000		4,000	UJ	-	-	-	-
Turbidity	N	NTU	NE	NE	110	38.2	J	1.7	J	21.4	J	110	

					Location Code:	AP2-BEDGW-003							
					Sample Number:	AP3064		AP3065		AP3066		AP3080	
					Sample Date:	23-May-09		23-May-09		23-May-09		16-Nov-09	
					Sample Depth:	0 - 0 R		0 - 0 R		0 - 0 R		0 - 0 R	
					Sample Purpose:	REG		FD		FS		REG	
					Low-Flow Sampled:	Yes		Yes		Yes		Yes	
Parameter	Filtered	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatiles													
Acetone	N	ug/L	2,200	NE	86.1	-	-	-	-	-	-	86.1	J
Benzene	N	ug/L	0.41	2.4	336	**94.1**		**91.3**		**100**		**336**	
Butanone, 2-	N	ug/L	710	NE	7.4	4.3	J	4.9	J	-	-	-	-
Carbon disulfide	N	ug/L	100	NE	5.2	-	-	-	-	5.2		3.7	J
Chloroform	N	ug/L	0.19	NE	14.6	-	-	-	-	-	-	**14.6**	B
Chloromethane	N	ug/L	19	NE	44.9	-	-	-	-	-	-	**44.9**	J
Cyclohexane	N	ug/L	1,300	NE	74					74			
Dichloropropene, trans-1,3-	N	ug/L	NE	NE	1.7	-	-	-	-	-	-	1.7	J
Ethylbenzene	N	ug/L	1.5	0.87	57.1	**17.7**		**17.2**		**21**		**57.1**	
Isopropylbenzene	N	ug/L	68	NE	5.8					5.8			
Methylcyclohexane	N	ug/L	NE	NE	39					29			
Methylene chloride	N	ug/L	4.8	NE	13.4	-	-	-	-	-	-	**13.4**	B
Toluene	N	ug/L	230	1.7	147	**41.3**		**39.6**		**54**		**147**	
Xylenes, total	N	ug/L	20	5.5	630	**193**		**185**		**260**		**630**	
Semivolatiles													
Dimethylphenol, 2,4-	N	ug/L	73	NE	1.7	-	-	-	-	-	-	1.7	J
Methylnaphthalene, 2-	N	ug/L	15	NE	6.3	1.9	J	1.3	J	-	-	6.3	
Naphthalene	N	ug/L	0.14	NE	7.4	**2.9**	J	**1.9**	J	-	-	**7.4**	
Metals-Unfiltered													
Aluminum	N	ug/L	3,700	309	46.7	-	-	17.4	J	-	-	33.9	J
Barium	N	ug/L	730	11,800	184	175	J	184	J	-	-	161	J
Calcium	N	ug/L	NE	316,000	404000	266,000	J	275,000		**317,000**		280,000	J
Iron	N	ug/L	2,600	1,550	283	-	-	33	J	-	-	-	-
Magnesium	N	ug/L	NE	217,000	124000	103,000	J	110,000		120,000		112,000	
Manganese	N	ug/L	88	636	53.7	5.9	J	5.4	J	-	-	7.1	J
Potassium	N	ug/L	NE	116,000	15600	13,300		11,500	J	11,300		15,600	
Selenium	N	ug/L	18	NE	21.3	6.7	B	14.3	B	-	-	12.4	J
Sodium	N	ug/L	NE	1,390,000	63000	56,600	J	58,500		63,000		61,100	J
Vanadium	N	ug/L	18	NE	1.6	1	J	1.3	J	-	-	-	-
Metals-Filtered													
Aluminum	Y	ug/L	3,700	309	40.8	-	-	12.4	J	-	-	40.8	B
Barium	Y	ug/L	730	11,800	186	171	J	186	J	-	-	164	J
Calcium	Y	ug/L	NE	316,000	411000	257,000		281,000		**323,000**		256,000	J
Iron	Y	ug/L	2,600	1,550	65.5	-	-	-	-	-	-	65.5	J
Magnesium	Y	ug/L	NE	217,000	123000	98,700	J	108,000		123,000		109,000	J
Manganese	Y	ug/L	88	636	52.4	5.6	J	6.1	J	-	-	7.2	J
Potassium	Y	ug/L	NE	116,000	16300	13,000		13,800		11,800		16,300	J
Selenium	Y	ug/L	18	NE	74.9	8.1	J	8.8	J	-	-	**22.4**	J
Sodium	Y	ug/L	NE	1,390,000	65900	55,700		58,700		65,900		63,100	
Vanadium	Y	ug/L	18	NE	2.6	1.2	J	1.1	J	-	-	2.6	J
Water Quality Parameters													
Alkalinity	N	ug/L	NE	NE	662000	649,000	J	632,000		590,000		662,000	J
Chloride	N	ug/L	NE	NE	118000	111,000		105,000		93,600		118,000	
Cyanide, total	N	ug/L	73	NE	710	-	-	-	-	**710**		-	-
Hardness	N	ug/L	NE	NE	1600000					1,200,000			
HARDNESS (as CaCO3)	N	ug/L	NE	NE	1490000	1,090,000		1,140,000				1,160,000	
Nitrate-Nitrite	N	ug/L	NE	NE	2000	760	J	-	-	-	-	47	B
Sulfate	N	ug/L	NE	NE	1080000	519,000		476,000		626,000		496,000	
Total dissolved solids	N	ug/L	NE	NE	2240000	1,900,000	J	1,740,000	J	1,500,000		1,570,000	J
Total suspended solids	N	ug/L	NE	NE	18000	-	-	17,000		-	-	-	-
Turbidity	N	NTU	NE	NE	110	14	J	-	-	94		51.2	

LEGEND:

- ◐ BEDROCK MONITORING WELL
- ug/L MICROGRAMS PER LITER
- NE NOT ESTABLISHED (RBSCs), NOT EVALUATED (BSCs)
- NM NOT MEASURED
- \- NOT DETECTED

NOTES:

1. SHADED CELL INDICATES VALUE IS GREATER THAN THE RBSC.
2. BOLD TEXT INDICATES VALUE IS GREATER THAN THE BSC.
3. RBSC VALUES REFLECT AN INCREMENTAL LIFETIME CANCER RISK (ILCR) OF 1E-6 OR A NONCANCER HAZARD QUOTIENT (HQ) OF 0.1. FOR CHEMICALS THAT EXHIBIT BOTH CANCER AND NONCANCER EFFECTS, WHICHEVER TYPE OF EFFECT IN A LOWER CONCENTRATION (USING AN ILCR OF 1E-6 AND AN HQ OF 0.1), THAT CONCENTRATION IS SELECTED AS THE RBSC.
4. BSC IS BACKGROUND SCREENING CONCENTRATION.
5. MDC IS MAXIMUM DETECTED CONCENTRATION FOR THE INVESTIGATION AREA ("B" QUALIFIED DATA NOT INCLUDED).
6. VALIDATION QUALIFIERS (VQ):
   - B - THE ANALYTE WAS NOT DETECTED SIGNIFICANTLY ABOVE THE LEVELS FOUND IN THE ASSOCIATED METHOD BLANK OR FIELD BLANKS.
   - J - THE ANALYTE WAS POSITIVELY IDENTIFIED; THE REPORTED VALUE IS ESTIMATED.

FIGURE 3-8
DETECTED CONSTITUENTS AT POWERHOUSE No. 2 ASH PITS IN BEDROCK GROUNDWATER SAMPLES ABOVE RBSCs AND/OR BSCs (MAY AND NOVEMBER 2009)

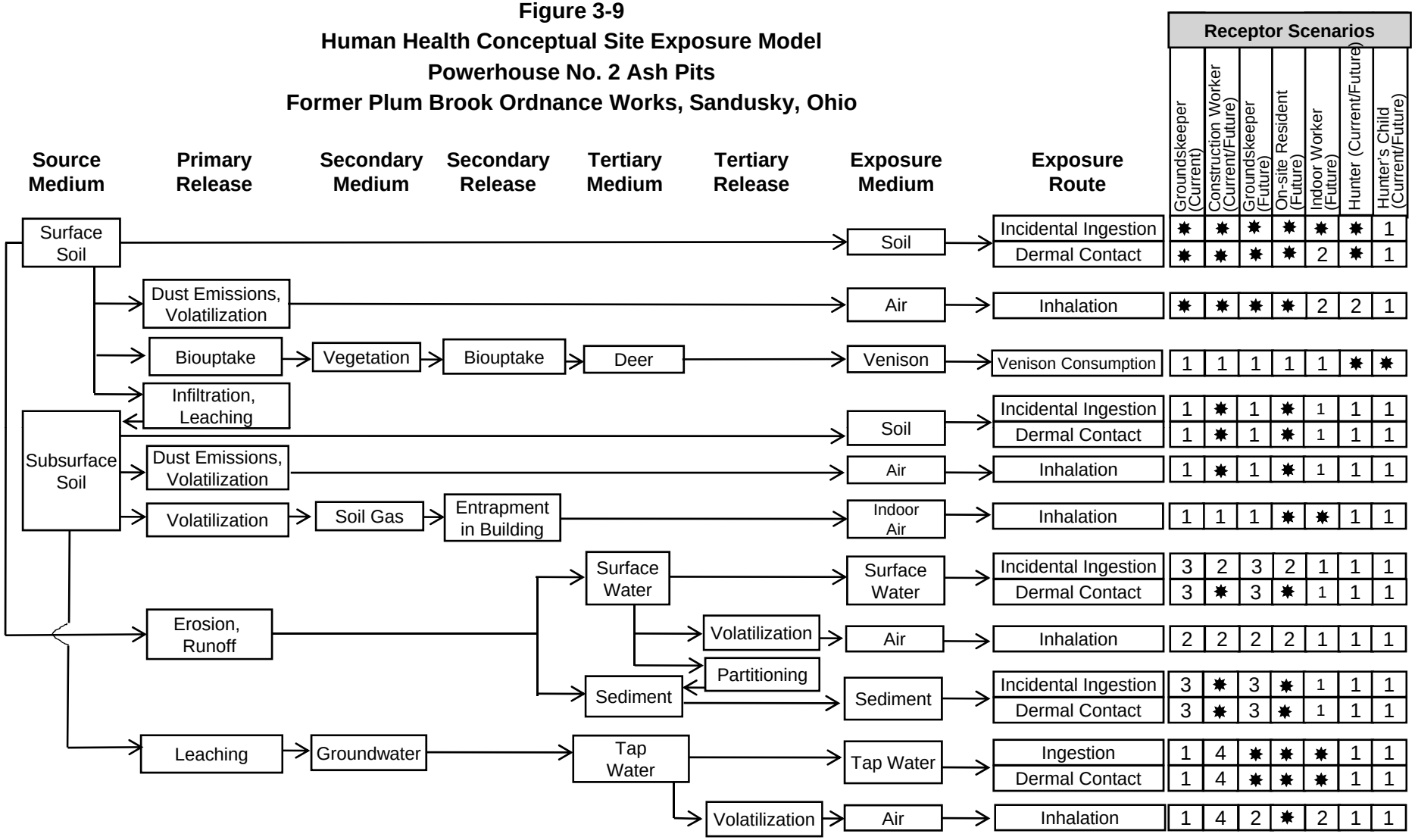
POWERHOUSE No. 2 ASH PITS AND COAL YARD No. 2
REMEDIAL INVESTIGATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE:
0 80 160 FEET

CB&I Federal Services LLC

p2op_cy2_rir_010.dgn sammccawley 3/27/2014 10:56:55 AM PDF_with_Levels.plt sei_textsub_only.tbl

Figure 3-9
Human Health Conceptual Site Exposure Model
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio



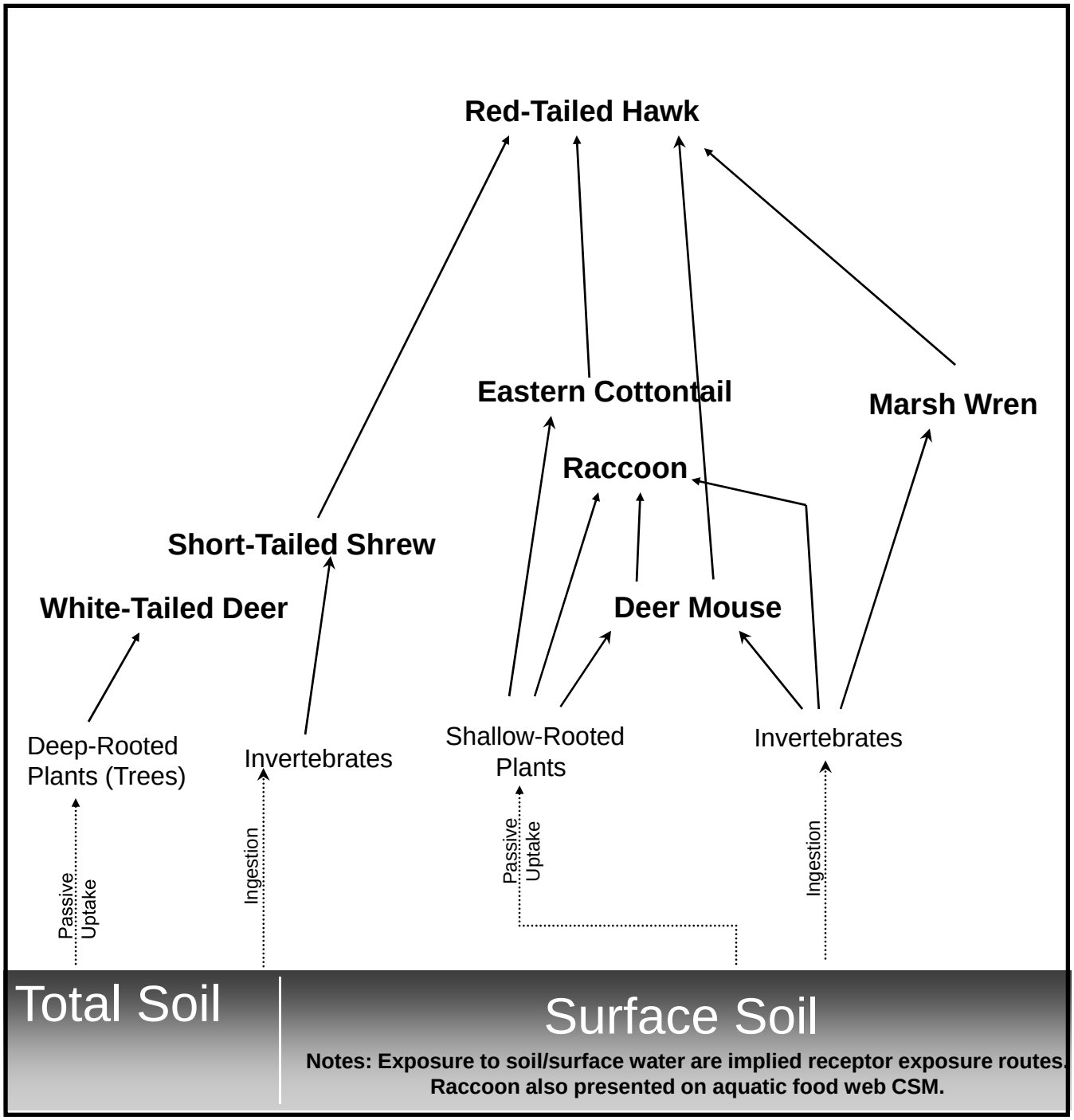
Exposure Route	Groundskeeper (Current)	Construction Worker (Current/Future)	Groundskeeper (Future)	On-site Resident (Future)	Indoor Worker (Future)	Hunter (Current/Future)	Hunter's Child (Current/Future)
Incidental Ingestion (Surface Soil → Soil)	✸	✸	✸	✸	✸	✸	1
Dermal Contact (Surface Soil → Soil)	✸	✸	✸	✸	2	✸	1
Inhalation (Surface Soil → Dust Emissions, Volatilization → Air)	✸	✸	✸	✸	2	2	1
Venison Consumption (Biouptake → Vegetation → Biouptake → Deer → Venison)	1	1	1	1	1	✸	✸
Incidental Ingestion (Subsurface Soil → Infiltration, Leaching → Soil)	1	✸	1	✸	1	1	1
Dermal Contact (Subsurface Soil → Infiltration, Leaching → Soil)	1	✸	1	✸	1	1	1
Inhalation (Subsurface Soil → Dust Emissions, Volatilization → Air)	1	✸	1	✸	1	1	1
Inhalation (Subsurface Soil → Volatilization → Soil Gas → Entrapment in Building → Indoor Air)	1	1	1	✸	✸	1	1
Incidental Ingestion (Erosion, Runoff → Surface Water → Surface Water)	3	2	3	2	1	1	1
Dermal Contact (Erosion, Runoff → Surface Water → Surface Water)	3	✸	3	✸	1	1	1
Inhalation (Erosion, Runoff → Surface Water → Volatilization → Air)	2	2	2	2	1	1	1
Incidental Ingestion (Erosion, Runoff → Surface Water → Partitioning → Sediment → Sediment)	3	✸	3	✸	1	1	1
Dermal Contact (Erosion, Runoff → Surface Water → Partitioning → Sediment → Sediment)	3	✸	3	✸	1	1	1
Ingestion (Leaching → Groundwater → Tap Water → Tap Water)	1	4	✸	✸	✸	1	1
Dermal Contact (Leaching → Groundwater → Tap Water → Tap Water)	1	4	✸	✸	✸	1	1
Inhalation (Leaching → Groundwater → Tap Water → Volatilization → Air)	1	4	2	✸	2	1	1

✸ = 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 = Contact with this medium, although plausible, is not part of this receptor's normal or expected activities; therefore contact would be sporadic and is not quantified.
4 = 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.

Source: Shaw, 2010b.

Figure 3-10

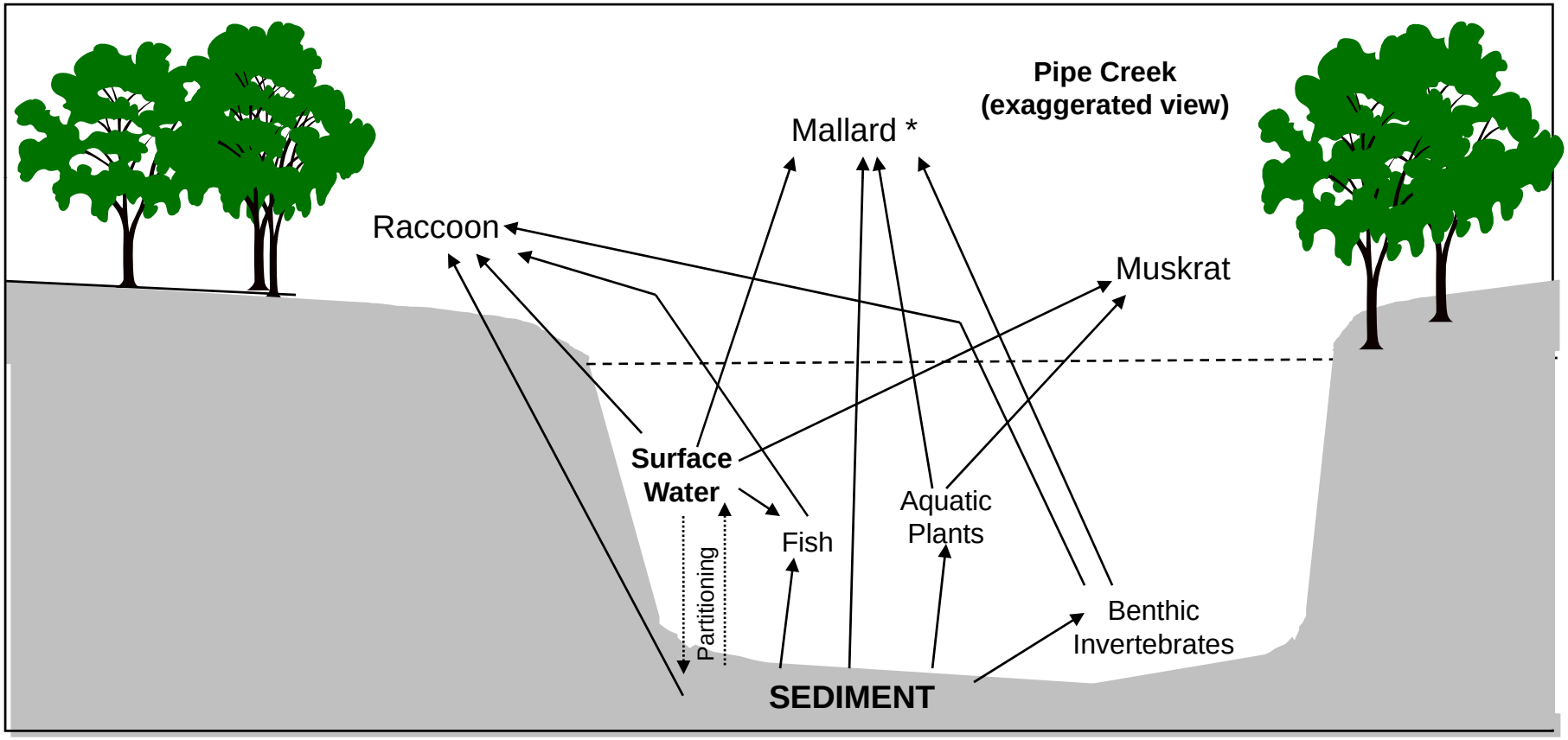
Simplified Terrestrial Food Web Conceptual Site Model
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio



Source: Shaw, 2010c

Figure 3-11

Simplified Aquatic Food Web Conceptual Site Model
Powerhouse No. 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio



Note: The raccoon is also presented on terrestrial food web CSM.

*** = The mallard is not evaluated in the risk assessment.**

Source: Shaw, 2010c

APPENDIX A

POWERHOUSE NO. 2 ASH PITS SCR

Shaw® a world of Solutions™

312 Directors Drive
Knoxville, Tennessee 37923
865.690.3211
FAX: 865.690.3626

September 17, 2010

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

Submittal of the Final Site Characterization Report for Powerhouse 2 Ash Pits
Former Plum Brook Ordnance Works, Sandusky, Ohio
Contract No. W912QR-08-D-0013: Shaw Project Number 133422

Dear Ms. McClanahan:

In accordance with the requirements of Delivery Order No. DX05 of Contract No. W912QR-08-D-0013, Shaw is pleased to submit this Final Site Characterization Report for Powerhouse 2 Ash Pits at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio.

Enclosed are four copies of this final 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 and Mark Boone (RAB) 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

Enclosures

Control Copy Distribution List

Name	Control Copy
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Former Plum Brook Ordnance Works, Sandusky, Ohio

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Final

Powerhouse 2 Ash Pits
Site Characterization Report

Former Plum Brook Ordnance Works
Sandusky, Ohio

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List of Acronyms

AP2	Powerhouse 2 Ash Pits
bgs	below ground surface
BHHRA	baseline human health risk assessment
BSC	background screening concentrations
D&M	Dames and Moore, Inc.
DNT	dinitrotoluene
DOD	U.S. Department of Defense
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FD	field duplicate
FS	field split
gpm	gallons per minute
GSA	General Services Administration
HSA	hollow-stem auger
HTRW	hazardous, toxic, and radiological waste
ID	inside diameter
IDW	investigation-derived waste
ILCR	incremental lifetime cancer risk
IT	IT Corporation
MDC	maximum detected concentrations
msl	mean sea level
NASA	National Aeronautics and Space Administration
OD	outside diameter
ORP	oxidation-reduction potential
PBOW	Plum Brook Ordnance Works
PBS	Plum Brook Station
PCB	polychlorinated biphenyl
PETN	pentolite
ppb	parts per billion
ppm	parts per million
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	site-wide quality assurance project plan

List of Acronyms (Continued)

RBC	risk-based concentration
RBSC	risk-based screening concentrations
RI	remedial investigation
SCR	Site Characterization Report
Shaw	Shaw Environmental, Inc.
SI	site investigation
SLERA	screening-level ecological risk assessment
SOW	scope of work
SVOC	semivolatile organic compound
SWSAP	site-wide sampling and analysis plan
SWSHP	site-wide health and safety plan
TCL	target compound list
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
TOC	total organic carbon
USGS	U.S. Geological Survey
VOC	volatile organic compound
USACE	U.S. Army Corps of Engineers

Executive Summary

The U.S. Army Corps of Engineers (USACE) is investigating the former Plum Brook Ordnance Works (PBOW), located in Sandusky, Erie County, Ohio, under the Defense Environmental Restoration Program's Formerly Used Defense Sites authorization and funding. During World War II the PBOW site was used for the manufacture of explosives. The former PBOW site is currently operated and maintained by the National Aeronautics and Space Administration (NASA) as Plum Brook Station, an active testing and research installation associated with NASA's John Glenn Research Center of Cleveland, Ohio. The USACE contracted Shaw Environmental, Inc. (Shaw) to conduct a remedial investigation (RI) of the former Powerhouse 2 Ash Pits Area (AP2) located on the west side of the PBOW facility. During the explosives manufacturing period the AP2 site served as an earthen banked impoundment for the coal ash slurry from nearby Powerhouse No. 2. Contamination that may have resulted from the ash pit operations would be expected to be primarily metals and possibly polycyclic aromatic hydrocarbons (PAH).

This Site Characterization Report (SCR) is Volume 1 of a three-volume RI report set for AP2 and details RI activities, including soil, groundwater, sediment, and surface water analytical results along with recommendations. Volume 2 is a Baseline Human Health Risk Assessment (BHHRA) Report and Volume 3 is a Screening-Level Ecological Risk Assessment (SLERA) Report, both to be submitted under separate cover.

In 1996, a site investigation (SI) was conducted of the surface and subsurface soil within the ash pits. Twelve surface (0 to 0.5 foot) and 12 subsurface (2 to 3 feet) soil samples were collected from 12 borings and analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides, polychlorinated biphenyls (PCB), target analyte list (TAL) metals, and total cyanide. Samples were not analyzed for nitroaromatics. No VOCs, pesticides, PCBs, or cyanide were detected above risk-based concentrations (RBC) derived from the U.S. Environmental Protection Agency (EPA) Region 3 table. However, one SVOC (benzo[a]pyrene) and six metals (aluminum, arsenic, beryllium, iron, manganese, and thallium) were detected above their RBCs. The SI concluded that the "major chemicals of concern in soils of this area include metals and total cyanide. A few pesticides were also detected in this area, although the concentrations were significantly below the RBCs." The SI went on to recommend a risk

assessment "to determine the necessity of further soil (or other media) investigations leading to site remediation or site closure."

RI activities were conducted by Shaw at AP2 in 2009. Eight direct-push borings were made, seven of which became temporary piezometer installations. Surface water and collocated sediment samples were collected from five locations on Pipe Creek. Three overburden/shale groundwater monitoring wells and three bedrock groundwater monitoring wells were installed in locations that represent upgradient, downgradient, and within the source area groundwater conditions.

The analytical results for the various media were compared to risk-based screening concentrations (RBSC) derived from Oak Ridge National Laboratory-EPA 2009 regional screening levels for a residential land-use scenario. In addition, the analytical results for the metals in the soil samples were compared to 1998 soil background screening concentrations (BSC) and results for metals in the groundwater samples were compared to 2005 groundwater BSCs. Background levels for the surface water and sediments have not been determined.

Including quality assurance/quality control (QA/QC) samples, 30 soil samples were collected from the eight direct-push borings - 10 representative of surface soil (0-1 foot), 10 from soil 3-5 feet below ground surface (bgs), and 10 from soil 8-10 feet bgs. Each soil sample was analyzed for target compound list (TCL) SVOCs, nitroaromatics, PCBs, and TAL metals. No nitroaromatics were detected in any of the soil samples. There were two PCB detections both in surface soil samples; one, Aroclor 1016 at 0.525 parts per million (ppm), was above its RBSC of 0.39 ppm. In addition, the only SVOC detected above its RBSC was benzo(a)pyrene, a PAH , detected in a surface soil sample near the road at 0.0844 ppm, the RBSC being 0.015 ppm. A total of 22 metals were detected in both the surface (0-1 foot) and subsurface (3 to 5 feet and 8 to 10 feet bgs) soil samples. Six metals (aluminum, arsenic, chromium, cobalt, iron, and manganese) were above RBSC limits in both surface and subsurface samples. Beryllium exceeded its BSC in both surface and subsurface samples, and in two surface samples it also exceeded its RBSC. Magnesium exceeded its BSC in several subsurface samples. Mercury exceeded its BSC in two surface samples. Lead was below screening criteria in all but one sample, a surface sample, in which lead exceeded both its RBSC and its BSC. These results confirm metals as the primary soil contaminants at the AP2 site.

Including QA/QC, seven surface water samples were collected and analyzed for TCL SVOCs, nitroaromatics, TAL metals, and hardness. Surface water samples exhibited no nitroaromatics or PCB detections, and no SVOCs or metals were detected above RBSC values. These results indicate the AP2 site is not impacting the surface water of the area.

Including QA/QC, seven sediment samples were collected. Each sediment sample was analyzed for TCL SVOCs, nitroaromatics, PCBs, and TAL metals. One sediment sample was also analyzed for total organic carbon (TOC). In the sediment samples, no PCBs were detected and no nitroaromatics or SVOCs were detected above RBSC values. Two metals (arsenic and chromium) were detected above RBSCs in each of the sediment samples. Since all the sediment samples have the same contaminants it isn't certain whether the AP2 site has contributed to the sediment contamination or not.

Including QA/QC, 5 overburden/shale groundwater samples were collected by low-flow methods from three of the seven piezometers and analyzed for TCL VOCs, TCL SVOCs, nitroaromatics, TAL metals (filtered and unfiltered), TOC, total cyanide, and water quality parameters. One overburden/shale groundwater sample from the most upgradient piezometer exhibited no detections above screening criteria; however, the two duplicates of that sample did have detections exceeding screening criteria. No nitroaromatics, VOCs, or cyanide were detected in any of the overburden/shale groundwater samples from the peizometers. There was one detection of an SVOC in a piezometer sample; however, the detected SVOC was well below its RBSC. Sixteen metals were detected in the overburden/shale groundwater samples from the temporary piezometers, three (aluminum, cadmium, and iron) at levels above screening criteria. Aluminum exceeded its BSC in one unfiltered sample. Cadmium exceeded its RBSC in all but one of the samples and filtration had little effect (cadmium lacks a BSC value). In one unfiltered sample iron exceeded both its RBSC and its BSC. Iron was not detected in the filtered samples. The results from the piezometer groundwater samples suggest the AP2 site may have impacted the overburden/shale groundwater zone.

Monitoring well sampling occurred in May (wet season) and November (dry season) of 2009. The monitoring well samples were to be analyzed for the same parameters as the piezometer samples: TCL VOCs, TCL SVOCs, nitroaromatics, TAL metals (filtered and unfiltered), TOC, total cyanide, and water quality parameters.

In May, the overburden/shale wells yielded five complete groundwater samples (including QA/QC), while in November the downgradient well was dry and the other two wells yielded only enough groundwater for nitroaromatics analysis. There were no detections of nitroaromatics, VOCs, SVOCs, or cyanide in any of the groundwater samples from the overburden/shale monitoring wells. The same 16 metals detected in the piezometer groundwater samples were also detected in the samples from the overburden/shale monitoring wells. The groundwater sample from the upgradient overburden/shale monitoring well exhibited no metals detections above screening criteria. Samples (primary and two duplicates) from the well within the ash pit exhibited cobalt, manganese, and nickel at levels above screening criteria; filtration had little effect. Cobalt was above its RBSC in two of the duplicate samples from the well while nickel was detected in all three samples at levels just below and just above the RBSC and far above the BSC. Manganese exceeded its RBSC in all three of the samples. Manganese was also the only metal detected above screening criteria in the sample from the downgradient overburden/shale monitoring well, it exceeded its RBSC. These results when taken with the soils data suggest the overburden/shale groundwater may have been impacted by the AP2 site.

For the bedrock wells, the upgradient well did not have enough water to yield a sample during either sampling period, while the other two bedrock wells did yield four (including QA/QC) complete groundwater samples for each sampling period. No nitroaromatics were detected in any of the bedrock groundwater samples. Fourteen VOCs were detected, four (benzene, chloroform, ethylbenzene, and total xylenes) at levels above their RBSC. Three SVOCs were detected; however, only one (naphthalene) at levels exceeding the RBSC. Of three cyanide detections two exceeded the RBSC; however, cyanide was not detected in any of the duplicates of these samples. Eleven metals were detected in the bedrock groundwater samples, only calcium and selenium at levels above screening criteria. Calcium levels exceeded the BSC; however, since calcium is an essential nutrient there is no RBSC. Selenium exceeded its RBSC (a BSC has not been determined) in two samples, November samples from both wells. For the sample from the well within the ash pit, selenium was above the RBSC in both the filtered and unfiltered evaluations, the level in the unfiltered being near the RBSC and the level in the filtered being more than three times greater. However, in one of the two duplicates for that sample selenium was not detected and its concentration in the other, although near the RBSC, did not exceed the RBSC. For the sample from the well downgradient of the ash pit, selenium exceeded RBSC in only the filtered evaluation. Considering the contaminants found in the soils and overburden/shale groundwater samples, it does not appear that the AP2 site has had any impact on the bedrock groundwater.

Recommendations:

- During a preliminary AP2 site visit a brick-lined, 12-foot-deep, 2-foot-diameter, hand-dug well was found with 10 feet of water in it and strong hydrogen sulfide odors emanating from it. The well is believed to predate AP2. Due to potential health and safety issues, the hand-dug well should be backfilled, although backfill of a preexisting condition is not responsibility of the USACE.

- Given the limited water level data from the new wells, additional water level readings should be made to improve the understanding of groundwater flow directions for the overburden/shale and bedrock water zones in the AP2 area. This can be accomplished by including the AP2 wells in the site-wide groundwater level measurement activities.

- Given there were no detections of potential contaminants above screening criteria in the surface water samples, no further action, evaluation, or risk assessment is recommended for the surface water in the AP2 area.

- Given the detections of contaminants above screening criteria in the soil, sediment, overburden/shale groundwater, and bedrock groundwater samples from the AP2 area a baseline human health risk assessment (BHHRA) and a screening-level ecological risk assessment (SLERA) should be conducted for these media using the SI and the RI data.

Activities In Progress:

- BHHRA and SLERA (draft reports anticipated to be complete in 2010).

1.0 Introduction

The U.S. Army is conducting a study of the environmental impact of a suspected hazardous waste site at a property previously owned by the U.S. Department of Defense (DOD). The former Plum Brook Ordnance Works (PBOW), located in Sandusky, Erie County, Ohio, is currently being investigated under the Defense Environmental Restoration Program for Formerly Used Defense Sites. Figure 1-1 shows the geographical location of the former PBOW site. This former 9,000-acre facility was used for the manufacture of nitroaromatics during World War II. The National Aeronautics and Space Administration (NASA) operates and maintains the site as the Plum Brook Station (PBS) of the John Glenn Research Center.

The investigation is being managed and technically overseen by the Nashville, Tennessee, and Huntington, West Virginia, District Offices of the U.S. Army Corps of Engineers (USACE). Fieldwork and reporting for Powerhouse 2 Ash Pits (AP2) is performed under Delivery Order DX05 for the USACE Louisville Architecture/Engineering Environmental Services Indefinite Delivery/Indefinite Quantity, Contract Number W912DR-08-D-0013. Shaw Environmental Inc. (Shaw) was contracted by the USACE Nashville District to conduct a soil, groundwater, surface water, and sediment remedial investigation (RI) at the former AP2 disposal area.

This Site Characterization Report (SCR) of AP2 is Volume 1 of three planned volumes. Volume 1 consists of the text, tables, figures, and appendices and presents final evaluations, conclusions, and recommendations for the AP2 disposal area RI. Background screening data will be used as a comparison and evaluation tool for analytical results. The background data set and derivation of background screening concentrations (BSC) for groundwater are described in the 2004 Groundwater Data Summary and Evaluation Report (Shaw, 2005) and the background data set and derivation of soil BSCs are described in the 1998 Site Investigation of Acid Areas report (IT Corporation [IT], 1998). Volume 2 will be the baseline human health risk assessment (BHHRA) and Volume 3 will be a screening-level ecological risk assessment (SLERA). Each volume will be submitted under separate covers. The BHHRA and SLERA reports will be prepared by Shaw and will describe all points and findings of the BHHRA and SLERA with respect to the investigation area.

Groundwater sampling at AP2 was conducted to determine the overburden/shale and bedrock groundwater quality. To determine if water quality could be affected by seasonal changes,

groundwater sampling was timed to monitor potential seasonal precipitation fluxes. As concluded in the 2004 Groundwater Data Summary and Evaluation Report by evaluating precipitation data specifically in the Sandusky area, two general seasons were determined to exist in reference to groundwater recharge: a wet season (January through June) and a dry season (July through December) (Shaw, 2005).

In addition, quarterly groundwater elevation measurements were conducted by Stillwater Environmental Services, Inc. (personal communication, 2010) to support ongoing investigation and remediation activities at PBOW. This information, critical to the evaluation of groundwater flow and contaminant transport, is incorporated into this report.

The field activities completed by Shaw for investigation of AP2 were conducted pursuant to the following documents:

General Site Activities

- Site-Wide Accident Prevention Plan/Site-Wide Health and Safety Plan Appendix (SWSHP) (Shaw, 2008a)
- Site-Wide Sampling and Analysis Plan (SWSAP) (Shaw, 2008b)
- Site-Wide Quality Assurance Project Plan (QAPP) (Shaw, 2008c).

Site-Specific Activities

- Work Plan, Remedial Investigation, Powerhouse 2 Ash Pits, Site-Specific Sampling and Analysis Plan, and Site-Specific Safety and Health Plan, (Shaw, 2009a).

1.1 Scope of Work and Project Objectives

The scope of the RI included preparation of a quality control plan and site-specific addenda to the SWSHP and SWSAP, soil sampling, installation of temporary piezometers and permanent monitoring wells, monitoring well development, groundwater sampling, analytical work, and investigation-derived waste (IDW) management and disposal. Figure 1-2 identifies the AP2 location in relation to other areas of concern and site features.

The objectives of this investigation include the following:

- Evaluate and use existing data appropriate to AP2.

- Define site physical features and characteristics.
- Determine nature and extent of DOD-related contamination in soil, sediment, surface water, and groundwater at AP2.
- Determine chemical characteristics of contamination.
- Evaluate fate and transport of contamination.
- Determine if overburden groundwater underlying AP2 is in sufficient volume and quality to be defined as a potential drinking water source in the state of Ohio.
- Obtain site data of quality, quantity, and distribution appropriate for site characterization, risk assessment, and feasibility study.

1.2 Report Organization

Chapter 2.0 of this report describes PBOW and the AP2 site, its physical setting, geology, and hydrogeology features. Sampling strategy and field procedures are described in Chapter 3.0. The analytical program and background comparison data are presented in Chapters 4.0. Chapter 5.0 describes specific-site information and historical and current analytical data. Chapter 6.0 presents media conclusions. Recommendations are provided in Chapter 7.0. References that were used in preparing the report are listed in Chapter 8.0.

Soil boring, monitoring well drill logs, well construction diagrams, sample collection logs, and rock core photographs are provided in Appendices A, B, and C, respectively. Well development water photographs and logs are included in Appendix D. Appendix E contains land survey data. Appendix F presents copies of wastes manifests used for disposal of the IDW. Appendices G through J contain analytical data pertinent to the soil sampling and two groundwater (May and November 2009) sampling events. Appendix K presents the chains of custody for laboratory analysis. Appendix L provides incoming comments and responses.

1.3 Facility Location and Description

The former PBOW site is currently utilized and maintained by NASA and is operated as the PBS, a satellite office of the NASA John Glenn Research Center, located at Lewis Field in Cleveland, Ohio. Most of the aerospace testing facilities built at the site in the 1960s are on standby or inactive status. The site is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland. Although primarily in Perkins and Oxford Townships, the

eastern edge of the site 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. Public access is restricted at PBOW except during the annual deer hunting season.

1.4 PBOW Site History and Previous Investigation

The PBOW site was built in early 1941 and manufactured 2,4,6- trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite (PETN). Production of explosives began in December 1941 and continued until 1945. During operation, three areas (TNT Area A [TNTA], TNT Area B [TNTB], and TNT Area C [TNTC]) manufactured TNT and DNT and one area manufactured PETN. TNTA consisted of manufacturing lines 1 through 4, TNTB consisted of lines 5 through 7, and TNTC consisted of lines 8 through 12. TNTA is located on the northeast side of PBOW, TNTB is located at the southern central part, and TNTC is located at the southwestern side of PBOW. The PETN manufacturing area is located in the north-central portion of PBOW and lies within the boundaries of Ransom Road on the west, Pentolite Road on the south, and Patrol Road on the north and east. The central portion of the former PETN manufacturing area is currently occupied by NASA's inactive nuclear reactor, which is presently in the process of being decommissioned.

It is estimated that more than one billion pounds of explosives were manufactured during the 4-year operating period. After the plant was shut down, decontamination of TNT, acid, PETN, and DNT processing lines began. Decontamination was considered complete during the last quarter of 1945. The property was initially transferred to the Ordnance Department after it was certified by the Army to be decontaminated in 1946. This transfer did not include the 2,800 acres comprising the Plum Brook area. The War Assets Administration accepted custody of the remaining acreage (approximately 3,230 acres) in 1946. The Department of the Army reacquired the 3,230 acres in 1954 and performed cleanup efforts during the 1950s through 1963.

Two property use agreements were entered into by the National Advisory Committee of Aeronautics, the predecessor of NASA, and the Army in 1956 and 1958. On March 15, 1963, accountability for and custody of the entire PBOW property (6,030 acres) was transferred to NASA by the Department of the Army. NASA performed further decontamination during 1964. The NASA decontamination process was accomplished in five steps (Dames and Moore, Inc. [D&M], 1997a):

1. Inspecting and removing contaminated surface soil above the drain tiles, flumes, etc.

2. Spot checking of subsurface soil in the vicinity of drain tiles, flumes, etc., to determine where the contaminated tiles and flumes were located. Where contamination was found, the flumes, tiles, etc., were removed in sections.

3. Removal of some items previously decontaminated to Level 3X (XXX-military decontamination level established primarily for worker safety that indicates potentially contaminated material or previously contaminated material that has been decontaminated to a zero residual contamination level) condition to a storage facility and additional decontamination of the remainder of the items to a 5X (XXXXX – level that indicates a decontaminated material with no detectable residual contamination) condition in order to be sold ("X" indicates the Army's specific decontamination level).

4. Destruction of all buildings by fire followed by removal of all debris and concrete foundations. All the materials, including the earth, in those areas was flashed and the area was then rough graded. [Soil investigations at the TNT areas prior to this RI suggest that at least portions of the concrete building foundations remain in place.

5. Decontamination of all sump basins and removal of the concrete.

The decontamination process also included burning of nitroaromatic-filled flumes that were excavated. As shown in the records review (D&M, 1997b) this was performed on July 10, 1963, near the intersection of Fox Road and Snake Road and is suspected to have also occurred at the Additional Burning Ground area.

On April 18, 1978, NASA declared approximately 2,152 acres of land as excess. This excess acreage included former buffer areas that were not formerly used by the Army and were not subject to decontamination efforts. The Perkins Township Board of Education acquired 46 acres of the excess for use as a bus transportation center. The General Services Administration retains the remaining acreage and currently has a use agreement with the Ohio National Guard for 604 acres of the land. NASA presently controls about 6,400 acres and is using the site to conduct space research as a satellite operation of the John Glenn Research Center based in Cleveland, Ohio. The details of these land transactions are listed in the site management plan (International Consultants Incorporated [ICI], 1995) and can be found at NASA PBS.

1.5 Powerhouse 2 Ash Pits

During PBOW operation, three power stations, Powerhouse 1, Powerhouse 2, and Powerhouse 3, were constructed and utilized to support the TNT manufacturing process. Each power station

consisted of a main powerhouse, a coal storage area, and an aboveground fuel storage tank. The fuel storage tank was surrounded by a berm to contain any potential spills or leaks. Each powerhouse building consisted of a boiler house, compressor room, electrical room, filter room, and locker room. The buildings also contained two to four large coal-burning boilers, a turboelectric generator, a feed water treatment system, and several steam-driven or electric air compressors. The generated steam was used for space heating, driving compressors, and generating electrical power. Coal ash generated from each of the boilers in the powerhouse was collected in pits. Water was added to the ash, producing a slurry that flowed through a sluice trench to an ash sump located at the end of each powerhouse. From the ash sump, the ash slurry traveled through a pipeline to a nearby surface water/ash impoundment (i.e., ash pit) (USACE, 2000). Based on topographical quadrangles (dated 1959 and 1969), aerial photographs, and a visual site survey conducted in 1999, the ash pit areas are noted to have essentially remained unchanged.

AP2 is located west of Campbell Street in an area that appears to be an old surface impoundment. Historical drawings indicated that the surface impoundment was rectangular in shape, measuring approximately 400 feet long by 200 feet wide, and was surrounded by an earthen embankment (USACE, 1995). As noted previously, ash from coal-fired boilers was reportedly pumped into the ash pit through a pipeline.

1996 Site Investigation. In September 1996, IT conducted an initial site investigation (SI) of AP2 (IT, 1997a). The sampling area was an ash pit that received discharge from nearby Powerhouse No. 2. As noted in the SI report, the layer of ash in the pit (black or dark brown) was generally 1 to 2 feet in thickness. However, the ash layer was found to be as great as 3.7 feet in thickness near the 6-inch steel drain pipe in the center of the pit. The steel drain pipe that discharged the slurry ash was also reported to be in good shape and was measured to be 144 feet in length from Campbell Street to the pipe’s end (8 feet per section by 18 sections). To determine if soil contamination was present at AP2, characteristic soil samples were collected from the native soil below the ash layer. IT collected 12 (0 to 0.5 foot) surface soil samples, and 11 (2 to 3 feet), and 1 (3 to 4 feet) native subsurface soil samples, with one surface and one subsurface soil sample from each of 12 boreholes. All of the soil samples below 2 feet were collected beneath the ash layer from native material. A native soil sample below the 3.7-foot ash layer was attempted but the soil boring encountered native soil at a depth of 2.8 feet bgs. During sample collection, bedrock was not encountered in any of the boring locations. The boring locations were selected using a systematic grid sampling strategy to minimize bias and to provide

complete site coverage. Figure 1-3 present the historical sample locations, and Tables 1-1 and 1-2 present historical organic and inorganic soil sample results.

Each soil sample was analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), target analyte list metals, pesticides, polychlorinated biphenyls (PCB), and total cyanide. Three VOCs were detected in surface soil (0 to 0.5 foot) and four VOCs were detected in subsurface soil; none were detected above their risk-based concentrations (RBC) and two, acetone and methylene chloride, are laboratory contaminants. A total of 14 SVOCs were detected in surface soil. Of these, only benzo(a)pyrene was detected above the RBC. Neither of the two SVOCs in subsurface soil was detected above its RBC. PCBs were not detected in surface or subsurface soils. Three pesticides were detected in surface soil, but at concentrations below their respective RBCs. Pesticides were not detected in any subsurface soils. Total cyanide, detected in three surface soil locations only, was below the established RBC. A total of 18 metals were present in surface soils at AP2; 6 metals exceeded their RBCs. A total of 17 metals were present in subsurface soils; 6 metals exceeded their RBCs. No groundwater, surface water, or sediment samples were collected during the 1996 RI field activities. The SI went on to recommend a risk assessment “to determine the necessity of further soil (or other media) investigations leading to site remediation or site closure.” (IT, 1997a).

2008 Site Walk. During a site walk conducted in October 2008, the AP2 area was observed to be overgrown with trees and was nearly indistinguishable from the surrounding forest. Several moss-covered concrete slabs approximately 7 feet long and 3 feet wide were observed partially buried in the underbrush approximately 75 feet west of Campbell Street at the approximate location of historical soil sample PH2SO-01, collected during the 1996 AP2 investigation by IT (IT, 1997a). A small hand-dug water well constructed of exposed bricks and approximately 2 feet in diameter was located near the concrete slabs. The well was filled with water to within 2 feet of the ground surface. Total depth of the well was approximately 12 feet. A strong hydrogen sulfide odor was noted emanating from the hand-dug well. The origin of both the slabs and the well-like structure is thought to be related to a former farm that occupied the area before PBOW was constructed, but review of historical drawings and other documents does not provide confirmation.

2009 Powerhouse 2 Demolition. During the end of October-start of November 2009, the Powerhouse No. 2 concrete building, source of all ash and cinders in AP2, was razed by NASA.

2.0 Physical Setting

2.1 Geography, Topography, and Surface Drainage

PBOW is located within the Eastern Lake Region of the Central Lowland Province (Soil Conservation Service, 1971). Erie County is overlain by lacustrine sediment, glacial outwash, and glacial till. The surface is a plain with a slight slope to the north-northeast toward Lake Erie at approximately 25 feet per mile. Elevations at the PBOW range from 680 feet above mean sea level (msl) at the intersection of Taylor Road and Patrol Road on the southwestern side of the site to 625 feet above msl at the northern portion of the installation. In general, the topography of PBOW is characterized by a flat ground surface with occasional low hummocks caused primarily by glacial scouring and deposition. A low escarpment trends from the western to the northeastern portion of the site (Shaw, 2005).

PBOW lies in the eastern region of the Pickeral Creek-Pipe Creek Basin, which is part of the St. Lawrence River drainage basin (D&M, 1997a). Eleven streams exist within PBOW and flow north-northeast toward Lake Erie, which is located approximately 3.5 miles north of the site. The site is part of four drainage areas: (1) Sawmill Creek (southern PBOW); (2) Plum Brook (central PBOW); (3) Pipe Creek (western PBOW); and (4) Storrs-Hemminger Ditch (north central PBOW), all of which flow into Sandusky Bay (D&M, 1997b). Surface water at AP2 drains from former Powerhouse No. 2 in a west-to-northwest direction into Pipe Creek. Overall, surface water drainage of PBOW is controlled by site topography. The streams are incised into bedrock and are poorly developed where they have not yet eroded to the bedrock. Four drainages at the site, Lindsley Ditch, Ransom Brook, Kuebler Ditch, and Plum Brook are monitored by NASA PBS under a National Pollutant Discharge Elimination System outfall permit (OEPA, 2007). In addition to the streams, 17 isolated ponds and reservoirs and former red water ponds are located at PBOW (U.S. Geological Survey [USGS], 1992; D&M, 1997b).

2.2 Geology

2.2.1 Regional Geology

The bedrock in northern Ohio consists of Devonian and Silurian carbonates (limestone and dolomite) and clastics (shale, siltstone, and sandstone). These units unconformably overlie older sedimentary sequences of Ordovician and Cambrian Age rocks, which in turn unconformably overlie pre-Cambrian basement rocks (D&M, 1997a). The local bedrock is situated on the

eastern flank of the Findlay Arch. In the Devonian and Silurian of northern and western Erie County, weathering of the carbonates has produced cavernous porosity and karst topography.

2.2.2 Local Geology

At PBOW, three bedrock units are present—the Delaware Limestone, the Olentangy Shale, and the Ohio Shale. The Delaware Limestone is the lowermost formation screened by PBOW site wells. It is characterized as a hard, dense, finely crystalline limestone and dolomite. The unit is typically buff colored, hard, and massive, and usually is described as fossiliferous with pyrite crystals. In the vicinity of PBOW, quarries (Hanson Aggregates to the north, Hanson-Sandusky Crushed Stone to the southwest, and abandoned Castalia quarry to the west) mine limestone from the Delaware. Traces of natural petroleum-derived hydrocarbons and hydrogen sulfide (H_2S) are common in all three quarries. Overlying the Delaware Limestone is the Olentangy Shale. Two members of the Olentangy Shale have been characterized at the site, the Plum Brook Shale and the overlying Prout Limestone. The Plum Brook Shale is interpreted to consist of approximately 35 feet of bluish-gray, soft, fossiliferous shale containing thin layers of dark, hard, fossiliferous limestone. The Prout Limestone has been described as an approximate 15-to-50- foot thick unit which occasionally outcrops in a 1,000-to-2,000-foot-wide, northeast-striking band across the middle portion of PBOW. It is described as a dark-gray to blue, very hard, siliceous, fossiliferous limestone or dolomitic mudstone. The Olentangy Shale of PBOW dips to the southeast at a slope of approximately 21.1 feet per mile. The uppermost formation at the site is the Ohio Shale. Geographic Information System data (Shaw, 2005) show that the Ohio Shale dips to the southeast at a slope of approximately 26.4 feet per mile (Shaw, 2005). Only one member of the Ohio Shale is present in the PBOW area, the Huron Shale. This unit is described as black, thinly bedded, with abundant carbonaceous matter. Some large pyrite/carbonate concretions are also present in the Huron Shale, some as large as 6 feet in diameter (D&M, 1997a).

2.2.3 Regional Hydrogeology

Regional groundwater flow is to the north-northeast towards Lake Erie, although local flow may vary due to local topography. Water in the limestone typically occurs in joints and along bedding planes or in solutionally enlarged openings. Although some limestone in the middle of the county provide well yields of up to 500 gallons per minute (gpm), the overburden and the majority of the other formations can sustain groundwater pumping of only 10 gpm or less (D&M, 1997b). A hydrogeological study conducted by USGS on the glacial deposits in 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 (USGS, 1992).

2.2.4 Local Hydrogeology

From domestic groundwater wells outside of PBOW boundaries, the bedrock groundwater is divided into three zones based on location and yield. Zone 1 occurs in the north and northwestern portion of PBOW. It is characterized as yielding from 100 to 500 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, 1997a).

Two main water-bearing zones at PBOW are present, one in the overburden/shale and one in the Delaware Limestone bedrock. Data from recent investigations (*2004 Groundwater Data Summary and Evaluation Report* [Shaw, 2005], *2002 Groundwater Data Summary and Evaluation*, [Shaw, 2003], TNT Areas A and C RI [IT, 2000a,b], *Summary Report, Site-Wide Groundwater Monitoring* [1997-1998] [IT, 1999], and the *Site-Wide Groundwater Investigation Report* [IT, 1997b]) have found that groundwater in the overburden is in discontinuous pockets during dry time periods exemplified by monitoring wells that are typically dry or site areas in which wells could not be installed due to a lack of water in the overburden soil at the time of drilling.

2.2.5 Influence of Precipitation on Water Levels

As mentioned in the 2004 Groundwater Data Summary and Evaluation Report (Shaw, 2005), previous investigations have indicated that there is a strong connection between precipitation and groundwater elevations, but no clear correlation exists between monthly precipitation rates and water level elevations in site wells. The lack of observed correlation is probably influenced by the amount of precipitation and the runoff rate. For example, summer thunderstorms that produce short periods of heavy precipitation may result in more surface runoff and less infiltration. Conversely, constant periods of precipitation at a lower rate over a period of days may result in more infiltration. Freezing rain or snow will also not result in an immediate recharge to groundwater. From review of local monthly precipitation data, evapotranspiration and rainfall runoff rates calculations, and a comparison table of sitewide monitoring well groundwater elevations verses aquifer recharge rates, a seasonal correlation was determined. During the months of January through June, a greater volume of groundwater in the overburden/shale

monitoring wells was present as compared to the months of July through December, when a lesser amount of water was present. Therefore, in general, the time period of January through June, when the greatest amount of water in a monitoring well is expected to be present, was given the term “wet” time period, while July through December was given the term “dry” time period.

3.0 Field Activities

3.1 Introduction

Field activities at the AP2 site were performed in accordance with the updated and revised SWSAP (Shaw, 2008b) and site-specific work plan, as noted in Chapter 1.0. Activities included direct-push drilling operations with soil sampling, installation of temporary piezometers within the AP2 site, installation of permanent monitoring wells upgradient, within and downgradient of the AP2 site, surface water and sediment sampling, two rounds of groundwater sampling (one conducted during the 2009 wet season and the second in the 2009 dry season), and disposal of IDW

Prior to any intrusive work, a NASA authorized dig permit was obtained for AP2. The dig permit process included review of utility maps for any underground utilities, including storm water, sewer, electrical, natural gas, telephone, cable, or fiber optic lines in the AP2 area. In addition, following Shaw's requirements, a Utility Mark-Out form was completed and any location to be bored was hand dug for the first 5 feet, verifying no utilities were present. To comply with NASA fire regulations, a NASA authorized burn permit was also obtained each time cutting and welding of steel isolation casing was required during bedrock monitoring well installation.

3.2 Direct-Push Soil Sampling/Piezometer Installation

Direct-push drilling was used to collect soil samples and install temporary piezometers at AP2. Eight soil borings were drilled and seven temporary piezometers installed (SB01/PZ01, SB0-2/PZ0-2, SB03/PZ03, SB04/PZ04, SB05/PZ05, SB06/PZ06, SB07, and SB08/PZ07). Figure 3-1 shows locations of direct-push borings. Direct-push drilling activities were conducted by Tri-State Drilling Company, of Chattanooga, Tennessee. A track-mounted, Geoprobe 6610 DT drill rig was used at all boring locations on January 15, 16, and 18, 2009. Locations of the soil boring/piezometers at AP2 were selected using data and knowledge from the 1997 SI report (IT, 1997a), topography, layout of historical disposal operations, and anticipated overburden/shale and 2004 RI bedrock groundwater flow directions.

Following PBOW closure and demolition of TNT manufacturing buildings, a fill material (sand) was graded over many PBOW areas covering remaining foundations and other former ground surface features. Direct push sampling at AP2 indicated the area had not been covered with any fill material. Three soil samples were collected from each soil boring from approximate depths of 0 to 1, 3 to 5, and 8 to 10 feet below ground surface (bgs) and analyzed for nitroaromatics,

SVOCs, and inorganics. Also, the 0 to 1 and 3 to 5 feet soil samples were analyzed for PCBs, and one surface soil sample (0 to 1 foot interval) was analyzed for total organic carbon (TOC).

Continuous lithologic logs were recorded for all soil borings during the drilling. Boreholes in which a piezometer was installed were advanced to refusal, and a 1-inch-diameter polyvinyl chloride (PVC) screen with 0.010-inch slots, typically 10 feet in length, and 1-inch diameter PVC riser, was placed into the 3.25-inch-diameter borehole. No filter pack material or bentonite was used during piezometer construction. To prevent rainwater from entering the borehole from the surface, the piezometer was surrounded with plastic sheeting to a depth of approximately 0.5 feet bgs, cardboard with a hole in the center was placed over the piezometer covering the borehole, and bentonite was placed over the cardboard and surrounding surface to a radius of approximately 1 foot. Hazardous, toxic, and radiological waste (HTRW) drilling logs for each borehole along with the associated temporary piezometer construction diagram, if appropriate, are included in Appendix A. Table 3-1 presents a summary of direct-push soil and groundwater samples collected.

3.3 Direct-Push Groundwater Sampling

As noted in Section 3.2, seven temporary piezometers were installed at AP2 (SB01/PZ01, SB02/PZ02, SB03/PZ03, SB04/PZ04, SB05/PZ05, SB06/PZ06, and SB08/PZ07). The purpose of the piezometers was to locate potentially contaminated groundwater, determine placement for permanent monitoring well installation, determine quantity and quality of overburden/shale groundwater, and to determine if the water is a potable supply. From January 31 through February 2, 2009, using the low-flow groundwater sampling method, only three groundwater samples from piezometers PZ03, PZ04, and PZ07 could be collected from the seven installed piezometers due to low yield. Groundwater from temporary piezometers was low-flow sampled using a peristaltic pump. Groundwater samples were analyzed for nitroaromatics, SVOCs, inorganics (filtered and unfiltered), hardness, and water quality parameters including alkalinity, chloride, cyanide, hardness, nitrate, sulfate, total dissolved solids, total suspended solids, turbidity, and ferrous iron. VOCs were not sampled from the piezometers. Appendix B contains sample collections logs from PZ03, PZ04, and PZ07.

3.4 Monitoring Well Installation

A total of six 2-inch monitoring wells, three overburden/shale (AP2-MW01, AP2-MW02, and AP2-MW03) and three bedrock (AP2-BEDGW-001, AP2-BEDGW-002, and AP2-BEDGW-003), were installed as part of the RI activities at AP2. Monitoring wells were installed in

upgradient, downgradient, and suspected source area locations based upon analytical data from soil and groundwater samples obtained during direct-push soil sampling, temporary piezometer groundwater sampling, February 18, 2009 overburden/shale groundwater flow directions, and 2004 bedrock groundwater flow directions. Figure 3-1 shows newly installed monitoring well locations along with soil boring and temporary piezometer locations at AP2.

Monitoring wells were installed in accordance with guidelines specified in the USACE Engineering Manual EM-1110-1-4000 (USACE, 1998) and following the procedures in the site-wide SWSAP (Shaw, 2008b). All monitoring wells were completed as described below.

Monitoring well installation was conducted March 30 through April 19, 2009 by A.E. Drilling Services of Greeneville, South Carolina. Prior to drilling, dig permits already in place with NASA for direct-push drilling were reviewed to ensure no underground utilities would be encountered during drilling at monitoring well borehole locations. In addition, the first 5 feet at each borehole location were manually dug with a 4-inch-outside diameter (OD) decontaminated, stainless-steel posthole digger to confirm no utilities were overlooked or were not identified by NASA utility location diagrams.

Following posthole digging to 5 feet, all overburden/shale boreholes were advanced by a CME-750 drill rig using 8-inch-OD (4.25-inch-inside diameter [ID]) hollow-stem augers (HSA) to the depth of auger refusal. At most boreholes, unless paired with an adjacent bedrock well in which lithologic soil sampling was conducted (AP-MW02/AP2-BEDGW-002), soil core samples were continuously collected from the ground surface to terminating depth using a 2-foot-long and 2-inch-OD stainless-steel split spoon. Soil core samples were visually examined by a Shaw field geologist and documented on HTRW drilling logs. Overburden/shale monitoring well construction logs are included in Appendix A. Well completion in each borehole was accomplished using 2-inch-diameter PVC Schedule 40 riser pipe and a 10-foot Schedule 40, PVC section of 0.010-inch factory slotted screen. No soil samples were submitted to an analytical laboratory, but each sample was screened by a Sirius air quality meter to measure any organic vapors. Well construction logs of the monitoring well associated with the appropriate borehole are also included in Appendix A.

For all bedrock wells, following posthole digging to 5 feet, a pilot borehole was drilled by a CME-750 drill rig using 4.25-inch-ID by 8-inch OD HSA to bedrock refusal. As with the overburden/shale borehole, soil core samples were continuously collected from the ground

surface to terminating depth using a 2-foot-long and 2-inch-OD stainless-steel split spoon. Soil core samples were visually examined by a Shaw field geologist, screened for organic vapors, and documented on HTRW drilling logs (Appendix A).

All bedrock wells were installed as double-cased wells. Therefore, following the pilot borehole drilling, each soil borehole was overdrilled with an 8.25-inch-ID by 12-inch-OD HSA until refusal. These augers were temporarily left in place to hold back overburden materials. Following the overdrilling, an 8-inch-OD roller cone bit was used to cut through the weathered bedrock, if present, and several feet into the competent bedrock. Roller cone drilling was performed using water for the purpose of both cooling the drill bit and washing rock cuttings from the borehole. The roller cone bit was advanced until at least 3 to 5 feet of competent drilling was completed, which was measured by the competency of cutting pressure, size and color of rock fragments, and sound of drill bit cutting “chatter.” Upon reaching the appropriate depth, black steel isolation casing (6-inch-ID by 6 5/8-inch-OD) was installed into the borehole and pressure grouted in place.

All pressure grouting was performed using an expendable grout shoe. The grout shoe was 6 5/8-inch PVC cap placed over the end of the isolation casing before insertion into the borehole. The center of the grout shoe consisted of a one-way valve, similar to the ball valve in a bailer. After the isolation casing and grout shoe were pushed to a depth approximately 2 to 3 inches above the drilled depth, a PVC tremie pipe was connected to the valve and grout was pumped through the shoe and into the borehole until freely flowing around the isolation casing at the surface. This method ensured a complete seal of the isolation casing.

After allowing the grout to cure for a minimum of 48 hours, bedrock was then cored with water using a CME-750 drill rig. Coring was conducted through the center of the black steel isolation casing using a custom manufactured PQ bit that collects a 3-inch-OD rock core but drills a 6-inch-OD borehole. All coring was performed using a 5-foot-long core barrel. Rock cores were visually examined and a lithology description prepared (Appendix A). Photographs of the rock cores were taken and are presented in Appendix C.

It was necessary to use tap water during coring of the bedrock for the purpose of flushing bedrock chips from the borehole, cooling the drill bit, and providing some type of lubrication between the bit and bedrock. This made the interpretation of knowing when or if groundwater was encountered difficult. After a 5- or 10-foot run was drilled and coring equipment was out of

the borehole, water was purged and any recovery rate measured. If groundwater was interpreted to have been encountered, well completion was accomplished using a 2-inch diameter Schedule 40 PVC riser pipe and 15-foot sections of 0.010-inch continuous wrap screen. Filter packs in screened wells were constructed with sand (tremied) beginning at a depth approximately 1 foot below the screen to approximately 2 feet above the screen. Three to 6 feet of pellet bentonite were then placed above the sand. The remaining annular space between the PVC riser and the borehole and the PVC riser and the black steel casing was filled (tremied) with bentonite-cement grout from the top of the bentonite to approximately 2 feet bgs.

Each well was completed to minimize frost heave. Beginning at a depth of around 2 feet bgs, bentonite was added within and around the protective casing above the bentonite-cement grout to ground surface. In addition, the concrete for the concrete pad was prevented from touching the protective casing by placing an expendable plastic spacer between the concrete and the casing. This was done in case the ground surface with the pad should heave due to frost and therefore allow the concrete pad to move without breaking. Surface completion at each well consisted of a 4-inch-square, lockable, metal, above-grade protective casing. A 4-foot-square, 4-inch-thick, concrete pad with sides sloping away was constructed around each well. Four protective steel posts were installed at each corner of the concrete pad. An identification plate with the well name, total depth, depth to screen, and survey information was secured to the protective casing.

Monitoring well construction details for the new monitoring wells are summarized in Table 3-2. Drilling logs and well construction diagrams are included in Appendix A.

3.5 Monitoring Well Development

All newly constructed monitoring wells were developed no sooner than 48 hours and no later than 7 days after completion of well construction. A Watera pump connected with 1-inch check valve and ½-inch-ID high-density polyethelyene tubing was used to perform well development. The Watera pump is an inertial pump that requires a 6- to 8-inch surging action for water removal. During development, the check valve and associated tubing were repositioned vertically throughout the screened interval to fully develop the entire well screen. Periodically, development was further enhanced by removal of the tubing from the pump and a more aggressive, manual, 1- to 2-foot length surging action was conducted. A well development log was completed for each well to document well development progress, field parameters, and other pertinent information. Photographs of development water and well development logs are included in Appendix D.

3.6 Piezometer Abandonment

On July 6, 2009, all seven of the temporary piezometers installed at AP2 for initial investigations purposes were abandoned. Prior to abandonment, the depth to groundwater was measured and recorded. Following measurement of the water level, the piezometer was manually removed from the ground and backfilled with granular bentonite consistent with Ohio regulatory requirements. Approximately 1.25 pounds of bentonite were used in each borehole. Abandonment forms for each piezometer were completed and filed with the Ohio Department of Natural Resources, Division of Water (www.dnr.state.oh.us).

3.7 Groundwater Sampling

Two low-flow groundwater sampling events were completed at AP2 during the PBOW wet and dry seasons. The first sampling event was conducted following well installation during the PBOW wet season of May 2009 and the second during the dry season of November 2009. Groundwater from the monitoring wells was low-flow sampled using a bladder pump. Groundwater samples were analyzed for nitroaromatics, inorganics (filtered and unfiltered), VOCs, SVOCs, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate/nitrite, sulfate, total dissolved solids, total suspended solids, turbidity, ferrous iron, and oxidation-reduction potential [ORP]).

To assess the potential air quality that may be at the well during purging activities, upon arrival at all monitoring wells and following removal of the security lock, the lid to the well was removed and vapors within the casing were immediately measured using a Sirius air quality meter that measures organic vapors, lower explosion level, carbon dioxide, oxygen, and hydrogen sulfide content. Measurement was performed as an early indication of the breathing air vapors that may be encountered when purging activities began. Once well purging activities commenced, breathing air concentrations were continuously measured and compared with the health and safety requirements (Shaw, 2008a). Hydrogen sulfide is one of the hazardous chemicals commonly encountered when purging groundwater from the bedrock wells screened within the Delaware Limestone. Hydrogen sulfide readings did not pose a problem at AP2 during either groundwater sampling event.

Three procedures were used for purging and sampling monitoring wells. Low-flow (minimal drawdown) was the preferred purging and sampling method in wells where adequate recharge was present. If a well did not recharge adequately to use the low-flow sampling method (i.e.,

water level dropped 6 inches or more), removal of three volumes of groundwater from above the top of screen was performed by continued pumping. If water recharge while above the screen was so minimal (less than 50 milliliters per minute) that this purging and sampling method could not be conducted in an efficient, timely manner, the water column in the well was removed entirely. Recharged groundwater was sampled the following day.

Samples collected for inorganics analysis were filtered in the field through a 0.45-micrometer high-capacity filter attached to the discharge line of the bladder pump. If the well was not sampled using the bladder pump (i.e., with a disposable Teflon® bailer), a hand-operated, disposable 0.45-micrometer filter was used.

All groundwater that was removed from the wells during purging activities was containerized and properly disposed of following the IDW management procedures as identified in the Shaw SWSAP (Shaw, 2008b) and Work Plan (Shaw, 2009a). Details of disposal activities are presented in Section 3.11.

Table 3-3 shows a list of the primary groundwater samples collected. Final field measurements recorded immediately before the water quality meter flow-through cell was disconnected and prior to groundwater sample collection are shown in Table 3-4. A final water quality reading was not recorded if adequate water volume was not present or if sample water would have possibly contaminated the recording instrument beyond decontamination efforts. Monitoring well locations are shown on Figure 3-1. Appendix B contains groundwater sample collection logs.

3.8 Surface Water and Sediment Sampling

Surface water and sediments samples were collected from Pipe Creek located adjacent to and west of AP2 (Figure 3-1). Six surface water samples (including one field duplicate [FD] sample) and six sediment samples (including one FD sample) were collected in collocated locations in Pipe Creek. Surface water and sediment samples were analyzed for nitroaromatics, inorganics, SVOCs, and PCBs. Water quality readings (ORP, pH, conductivity, turbidity, dissolved oxygen, and temperature) were also recorded for the surface water samples and are shown in Table 3-4. In addition, one surface water sample (AP2-SW01) was analyzed for hardness and collocated sediment sample (AP2-SD01) was analyzed for TOC. Table 3-5 presents a summary of surface water and sediment samples collected at the investigation areas. Appendix B contains surface water and sediment sample collection logs.

3.9 Decontamination Procedures

Decontamination of drill rigs, downhole tools, and sampling equipment was performed in accordance with Section 5.0 of the SWSAP (Shaw, 2008b). Specifically, drill rigs, rods, drill bits, and augers were cleaned at the decontamination pad using high-pressure hot water from a steam cleaner before entering the drilling site, between sites, and after completion of the last borehole. Other sampling equipment was decontaminated by rinsing in sequence with phosphate-free soapy water, tap water, methanol, and deionized water. Equipment was then air dried, if possible, before use. The bladder pump used during groundwater sampling was decontaminated by disassembling the pump and decontaminating individual pieces. Disposable tubing and bailers were used in the groundwater sampling. New tubing and a new bailer (if necessary) were used for each well.

3.10 Land Survey

An Ohio-registered professional land surveyor surveyed the direct-push soil boring and piezometer, overburden/shale and bedrock monitoring well, and surface water and sediment sampling locations during two mobilizations. During the first survey event, conducted from January 27 through 30, 2009, soil borings and piezometers were surveyed. During the second event, conducted from May 18 through 21, 2009, monitoring wells, surface water and sediment sampling locations, and a stream staff gauge were surveyed. Horizontal coordinates were surveyed to the closest 0.1 foot and referenced to the Ohio State Plane Coordinate System. Vertical coordinates (land surface and top-of-casing elevation) were surveyed to the nearest 0.01 foot and referenced to the 1929 National Geodetic Vertical Datum. Land survey data reports are included in Appendix E.

3.11 Investigation-Derived Waste Management

IDW generated during investigation activities included soil, groundwater, rock cores, decontamination water, and personal protective equipment. All IDW was managed and handled in accordance with procedures described in the SWSAP (Shaw, 2008b).

Coring fluids, decontamination, development, and purge water generated during field activities were stored in labeled 55-gallon drums. Soil generated during direct-push and monitoring well drilling was collected in 55-gallon drums and labeled with identification of contained material, content volume, date of generation, and source of origin as applicable. Personal protective equipment (Tyvek® suits, latex gloves, etc.) and general refuse were double bagged and disposed in an on-site, Shaw contracted industrial dumpster for disposal.

Following direct-push and monitoring well drilling, groundwater sampling, and analytical determination that the media were nonhazardous, soil and groundwater IDW was transported to a registered disposal facility. Disposed-of media include all soil and water generated during monitoring well installation activities and purge and decontamination water generated during groundwater sampling. All fluids and solids were transported by Triad Transport, Inc. to the Environmental Quality Company in Detroit, Michigan, for disposal. All rock cores are currently being stored inside a weather protected, secure NASA bunker. Upon USACE approval of reporting requirements and evaluation of related groundwater contaminant data to determine the disposition, the rock cores will be disposed.

RI activities at AP2 were conducted in sequence and simultaneously with other PBOW investigations. Although identification on the storage drums included contents, date generated, volume, and location of origin, disposal of the drums was based upon weight and area stored. A record of specific drums taken by the disposal company with each trip was not kept. Therefore, drums containing AP2 media (soil, purge water, isolation casing, rock core drill water, and decontamination water) may have been transported by the Environmental Quality Company on more than one date. Because the specific disposal dates of AP2 waste drums are unknown, all of the waste manifests generated during the drilling and sampling events are included in Appendix F.

4.0 Analytical Program

The following sections present the analytical program used in this investigation. This review includes the laboratories used for all samples, the analytical methods used, data quality evaluation, and blank analysis. In addition, a description and derivation of risk-based screening criteria (RBSC) is presented in Section 4.2.1. The derivation and use of BSCs and the analytical results are presented in Section 4.2.2.

4.1 Analytical Program and Methodologies

4.1.1 Sample Analysis and Data Validation

Primary and FD project samples collected in January and February 2009 were analyzed by AML Scientific, LLC of Olathe, Kansas. AML Scientific, LLC ceased operations at the end of February 2009. Regular and FD project samples collected after February 2009 were analyzed by Accutest Laboratories of Orlando, Florida. Field splits were analyzed by Test America, Inc., Canton, Ohio. Analysis for nitroaromatic field split samples was performed by Test America of Knoxville, Tennessee, and Test America of Denver, Colorado. Shaw performed the data validation. The validation summaries are provided in Appendix G. The analytical results are summarized in Appendix H. Tables of detected hits that exclude “B” qualified (Section 5.1.3) data are included in Appendix I. A data quality evaluation is located in Appendix J.

All data analyzed were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following the guidelines in the U.S. Environmental Protection Agency (EPA) *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (EPA, 2008) and EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004), the QAPP (Shaw, 2008c), and specific analytical method requirements. Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness, and comparability goals established to meet the project data quality objectives (DQO). The criteria for blank evaluation were based on those detailed in *Region 3 Modifications to National Functional Guidelines for Evaluating Organic Analyses* (EPA, 1994) and *Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1993).

4.1.2 Analytical Methods

Chemical analyses for the investigation were performed in accordance with guidelines detailed in EPA's *Test Methods for Evaluating Solid Waste (SW-846), Physical/Chemical Methods,* Third Edition, September 1986 (EPA, 1986) and subsequent revisions. The groundwater samples and associated quality assurance/quality control (QA/QC) samples were analyzed for VOCs, SVOCs, inorganics, nitroaromatics, and several water quality parameters. Methods used for analysis for all four events are summarized in Table 4-1.

4.1.3 Data Quality Evaluation

The reliability of the sampling and analytical procedures used during the investigation was demonstrated by implementing the project-specific quality assurance procedures specified in the SWSAP (Shaw, 2008b) and QAPP (Shaw, 2008c) and its site-specific attachments. Successful execution of these procedures provides strong supporting evidence that the data are representative of the areas under investigation.

The DQOs for this project were to produce scientifically valid data of known accuracy and precision that were complete with respect to identified critical samples, comparable with similar data types, and representative of the media sampled so as to be useful for the cited purposes. Evaluation of the data using the DQOs and the data validation process resulted in the determination that the data set is valid and of sufficient quality to meet the objectives of the investigation.

Thirteen VOC results and all nitroaromatic results for two samples were rejected during the data validation process. Nitroaromatic results for samples AP0114 and AP0125 were rejected due to surrogate recoveries of "0" and professional judgment during data validation process. These samples should have been reanalyzed by the laboratory. However, AML did not reanalyze these samples before ceasing operations in February 2009. Seven results for acetone, two results for 2-butanone, two results for 1,2-dibromo-3-chloropropane, and two results for chloromethane were rejected during data validation (i.e., "R" qualified) because of calibration problems. Acetone and 2-butanone are "poor performers" by SW-846 8260B and often exhibit relative response factors below acceptance criteria. None of the VOCs listed are constituents of concern at Ash Pit 2 and all were reported by the lab as non-detects. A complete evaluation of the analytical results is given in the data quality evaluation found in Appendix J.

4.1.4 Blank Evaluation

The purpose of blank analysis is to detect contamination resulting from laboratory and field activities. Blank evaluation involves qualification of data based on the results of associated field blanks, trip blanks, equipment rinsates, and laboratory method blanks. The criteria for blank evaluation are as follows:

- If a parameter is found in a blank but not detected in the sample, no action is taken.
- For organics, if the sample result is greater than the contract-required quantitation limit, but is less than 5 times (most analytes) or 10 times (common laboratory contaminants) that of the blank result, the sample result is qualified “B.”
- For organics, if the sample result is less than the contract-required quantitation limit and less than 5 times (most analytes) or 10 times (common laboratory contaminants) the blank result, the sample result is qualified "B." The "J" qualifier is not used.
- For inorganics, if the sample result is greater than the instrument detection limit but less than 5 times the blank result, the sample result is qualified "B."
- If the sample result is greater than 5 times (most analytes) or 10 times (common laboratory contaminants) the blank result, the sample result is not qualified.

In instances where more than one blank is associated with a given sample, qualification is based upon a comparison with the associated blank having the highest concentration of a contaminant. Blank results are not subtracted from sample concentrations. Note that data with “B” validation qualifiers are included in the Chapter 5.0 tables, but the associated concentrations are not included in the tables’ “maximum detected concentration” (MDC) column because “B” qualified data are not used in PBOW risk assessments.

4.2 Comparison to Screening Criteria

The analytical result tables presented in Chapter 5.0 include a comparison to RBSCs and BSCs as points of reference only. Concentrations of analytes that exceed the RBSCs are highlighted in the tables. RBSCs do not infer a regulatory limit or mandated cleanup level, nor is the identification of an exceedance intended to indicate an unacceptable human health risk or a need for remedial action. Formal evaluation of human health risks will be performed in the BHHRA. Concentrations in individual samples that exceed the respective BSCs are identified as bolded in the Chapter 5.0 result tables.

4.2.1 Risk-Based Screening Concentrations

The RBSCs are derived from Oak Ridge National Laboratory-EPA (2009) regional screening levels as described in the AP2 BHHRA work plan (Shaw, 2009b). The groundwater RBSCs are based on a generalized residential drinking water scenario, assumed to be the most restrictive use of groundwater, and correspond to a one-in-a-million (1E-6) incremental lifetime cancer risk (ILCR) or a noncancer hazard quotient of 0.1, whichever results in a lower concentration (Shaw, 2009b). The soil RBSCs are based on a long-term residential land-use scenario that assumes use by a young child for noncancer effects and use by the combined young child and adult life stages for carcinogenic effects. Together, these capture a worst plausible case for future land use. The soil RBSCs are likewise based on an ILCR of 1E-6 and an hazard quotient of 0.1. RBSCs for surface water and sediment are derived from the respective groundwater and soil RBSCs as described in the BHHRA work plan (Shaw, 2009b). As stated in Section 4.2, laboratory analytical results are compared to RBSCs only as a point of reference. Further details on the RBSCs and their derivation are provided in the BHHRA work plan.

4.2.2 Background Screening Concentrations

BSCs have been derived for inorganic analytes and benzene, toluene, ethylbenzene, and xylenes in groundwater as shown in the 2004 groundwater and data summary report (Shaw, 2005). Derivation and BSC values for PBOW soil are presented in the acid areas site investigation report (IT, 1998). Table 4-2 presents a complete list of background screening values generated for groundwater while Table 4-3 presents a complete list for metals in soil. The BSCs were derived from concentrations of these analytes found in PBOW background groundwater monitoring wells and soil data sets. The background soil samples were collected from near the property boundary, away from any potential source areas, and the background groundwater wells were installed in off-site areas upgradient of PBOW sources. Each BSC is either the MDC or the calculated 95th percent upper tolerance limit of the background data set, whichever value is lower, for each relevant analyte (IT, 1998; Shaw, 2005). The background monitoring well samples were collected using low-flow methodology and were not filtered.

5.0 Investigation Results

5.1 AP2 Local Physical Setting

5.1.1 AP2 Site-Specific Soils

At many PBOW sites, following closure and removal of the manufacturing structures, tanks, and equipment, a local fill sand was brought to the areas to cover the remaining concrete building foundations and demolition scars and to provide a natural landscape appearance. At AP2 black ash and cinders are visible on the ground surface suggesting no fill cover was placed there. In addition, no fill material was encountered in any of the soil borings drilled within the former ash pit (note: fill material was encountered at two borings [AP2-MW01 and AP2-BEDGW-003] drilled near the road, but this fill material was determined to be from road construction) (Appendix A). Figure 5-1 shows an AP2 site map with soil boring locations.

The ash layer was encountered at AP2 in the upper 3 feet of soil. Below this ash layer, native soil consisted of a glacial till, glacial outwash, or a glacial lacustrine (lake) deposit. In general, a soft, mottled, brownish colored silt was first encountered, followed by a loose, mottled, very fine grain, brownish colored sand. Below the sand, a stiff, low plasticity, silty clay was encountered that continued to the top of bedrock, commonly found around 11 feet bgs. Shale or limestone fragments in the clay increased in quantity with depth until final probe refusal.

5.1.2 AP2 Site-Specific Geology

Bedrock units in the AP2 area are of Devonian age and consist of the Olentangy Shale and the underlying Delaware Limestone. The contact between these two units is believed to run near or through AP2. Figure 5-2 presents a regional geological map. All the AP2 bedrock well borings encountered Delaware Limestone. The only possible Olentangy Shale occurrence may have been at overburden well AP2-MW01, but this is not definitive since only a small portion of bedrock is sampled to facilitate well installation. Delaware Limestone was found conclusively at depths ranging from 13 feet (619.4 feet above msl) in bedrock well AP2-BEDGW-002 to 19.5 feet (618.9 feet above msl) in bedrock well AP2-BEDGW-003. The limestone was typically found to be brown in color if very weathered and gray if less weathered, and hard, fossiliferous (brachiopods, corals, styolites), with massive bedding below approximately 20 feet. Pyrite crystals were found on several cores. In addition, during drilling for monitoring well AP2-BEDGW-002 at around 47 and 70 feet bgs petroleum hydrocarbon was found seeping from the rock core. This is believed to be a natural petroleum common in the Delaware Limestone of the

region. Table 5-1 lists information relative to PBOW monitoring well borings which encountered natural petroleum hydrocarbon vapors, rock core staining, or hydrogen sulfide vapors.

5.1.3 AP2 Site-Specific Hydrogeology

Overburden/shale groundwater at AP2 was encountered at depths ranging from 1.7 feet (SB03/PZ03) to 5 feet bgs (SB08/PZ07) in January 2009 (wet season) during soil boring drilling/piezometer installation. However, groundwater was only encountered in three of the eight soil borings. During monitoring well installation conducted in April 2009 (wet season), overburden/shale groundwater was encountered at depths of 2.1 feet (AP2-MW03) to 8 to 10 feet bgs (AP2-MW01). Table 5-2 shows water level elevations at piezometers and monitoring wells. As shown by the May 23, 2009 overburden/shale groundwater elevation contour map (Figure 5-3), which includes water level measurements from both the temporary piezometers and permanent monitoring wells, groundwater flow is in a west direction toward Pipe Creek. Figure 5-4 presents an overburden/shale groundwater potentiometric map of water level measurements taken November 12, 2009 (dry season) from the overburden/shale monitoring wells (the piezometers were abandoned in July 2009). The groundwater flow direction during November 2009 is also in a west-northwest direction. Overburden/shale groundwater flow from both contour maps indicates that it mimics the surface topography.

In addition, one stream level staff gauge was placed in Pipe Creek and survey elevations recorded at the top and base of the rod. Water level measurements of Pipe Creek surface water were conducted from the staff gauge. When elevations are plotted in correlation with groundwater level measurements from overburden/shale monitoring wells, Pipe Creek meets the definition of a water “gaining” stream during the wet season month of May (Figure 5-3) and the definition of a water “losing” stream during the dry season month of November (Figure 5-4). Figure 5-3 shows May groundwater elevations in the AP2 area adjacent to Pipe Creek are greater than the water level elevation of Pipe Creek indicating groundwater is flowing into the creek. Figure 5-4 shows November groundwater elevations near Pipe Creek are less than the water level elevation of Pipe Creek indicating the creek is losing water to the adjacent overburden/shale groundwater system.

Three bedrock wells (AP2-BEDGW-001, AP2-BEDGW-002, and AP2-BEDGW-003) are present at AP2. Bedrock groundwater was encountered during April 2009 drilling of these wells in fractures at depths of 46.9 to 50.1 feet (AP2-BEDGW-003), 72.6 feet (AP2-BEDGW-001), and 73.2 feet (AP2-BEDGW-002). The screened interval of each of these wells is within the

Delaware Limestone bedrock. Groundwater level measurements collected from these three bedrock wells showed groundwater flow in a southwest direction, opposite of the expected northeast direction toward Lake Erie. To confirm or deny this flow direction made by just three bedrock monitoring wells, a regional bedrock groundwater flow map (Figure 5-5) was constructed from October 2009 PBOW groundwater level data collected by Stillwater Company, Inc. (company contracted by USACE for conducting quarterly groundwater level measurements). Unfortunately, the AP2 monitoring wells were not part of the contracted groundwater level measurements so they are not included in the bedrock groundwater flow determination of Figure 5-5. Figure 5-5 shows the regional groundwater flow to be northeast toward Lake Erie. To clarify bedrock groundwater flow in the AP2 area, inclusion of the bedrock monitoring wells in the PBOW site-wide water level measurements is recommended.

5.1.4 AP2 Site-Specific Hydraulic Connection Between Zones

Vertical hydraulic gradients were calculated for paired wells AP2-MW02 and AP2-BEDGW-002, located at AP2 near the center of the ash pit (Table 5-3). These wells are the only paired wells at the AP2 site. Overburden well AP2-MW02 is screened within overburden material and bedrock well AP2-BEDGW-002 is screened within the Delaware Limestone. Groundwater elevations in the overburden well are higher than those in the bedrock well. This difference suggests that there may be relatively limited connectivity between the overburden and bedrock water-bearing zones at AP2. In addition, any vertical groundwater migration that occurs will be downward from the overburden into the bedrock. The vertical gradient at this well pair was compared with the vertical gradient at other PBOW well pairs (Table 5-3). In comparison with other well pairs at PBOW, this well pair has a relatively small vertical gradient for downward groundwater movement from the overburden/shale water zone to the bedrock aquifer.

5.2 Soil Analytical Results

On April 15, 16, and 18, 2009, eight borings were drilled within the former ash pit. One soil boring, SB07, was drilled to a depth of 10 feet and soil samples collected. Seven other soil borings (SB01/PZ01 through SB06/PZ06 and SB08/PZ07) were drilled to a depth of 10 feet, soil samples collected, and drilling continued until probe refusal for piezometer installation.

A total of 30 soil samples were collected from the eight borings at AP2. Ten surface soil samples (including one FD and one field split sample [FS]) from depths of 0 to 1 foot and 20 subsurface (including two FD and two FS samples) from depths of 3 to 5 and 8 to 10 feet were collected from soil boring SB07 and seven piezometer soil sample locations (SB01/PZ01 through

SB06/PZ06 and SB08/PZ07). Table 5-4 summarizes the soil concentrations above RBSCs and BSCs. Figure 5-6 shows soil sample locations along with corresponding analytical results above RBSCs and BSCs.

5.2.1 2009 Surface Soil Samples

No nitroaromatics were detected in the surface soil (0 to 1 foot) samples at AP2. Two PCBs, Aroclor 1016 and 1260, were detected in the soil. Aroclor 1016 was detected in SB02 at a concentration of 0.525 parts per million (ppm), above the RBSC of 0.39 ppm. Aroclor 1260 was detected in SB03 (0.0162 ppm), but the concentration was below the RBSC. A total of nine SVOCs were detected in the surface soil samples, but only benzo(a)pyrene in a sample from SB01 was above its RBSC value. It was found at a concentration of 0.0844 ppm, above the RBSC of 0.015 ppm.

Seven inorganics were detected above RBSC limits in surface soil samples from AP2, while four samples were above BSC values. Arsenic, chromium, cobalt, and iron were detected above RBSCs in each of the soil samples. Concentrations of arsenic above the RBSC of 0.39 ppm ranged from a low of 5.50 ppm in the field split sample from boring SB07 to a high concentration of 26.8 ppm found in boring SB04. Results for chromium ranged from 6.13 ppm in boring SB08 to a high of 12.8 ppm from boring SB05, above the RBSC of 0.29 ppm. Cobalt concentrations above the RBSC of 2.3 ppm ranged from 3.90 ppm in boring SB08 to a high of 14.6 ppm in boring SB02. Iron was also detected above the RBSC value of 5,500 ppm in all of the samples. Concentrations ranged from 14,300 ppm in SB01 to 109,000 ppm in boring SB04. Four borings exhibited four surface soil samples that were above aluminum RBSC limits (7,700 ppm). Concentrations ranged from 8,070 ppm in SB03 to 9,310 ppm in boring SB02. Concentrations of beryllium were above the RBSC limit of 16 ppm in only two samples, SB04 (16.3 ppm) and SB08 (16.9 ppm). Manganese was the last metal that was found above the RBSC value. It was detected above the value of 180 ppm in seven samples, with the highest result of 546 ppm in SB02. Three inorganics (beryllium, lead, and mercury) exceeded BSC values. Beryllium exceeded the BSC value of 1 ppm in all surface soil samples except the field split sample, with concentrations ranging from 4.74 ppm (SB01) to a maximum of 16.9 ppm in SB08. Lead was found above the BSC value of 48.6 ppm in only one sample, AP0100 from boring SB01, and mercury exhibited results from two samples AP0100 (SB01) and 0.118 ppm (SB05) above the BSC value of 0.09 ppm. TOC was 11,400 ppm in the one sample that was analyzed for TOC (the surface sample at SB02).

5.2.2 2009 Subsurface Soil Samples

No nitroaromatics or PCBs were detected in the subsurface (3 to 5 and 8 to 10 feet) soil samples at AP2. Phenanthrene was the only SVOC to be detected in subsurface soils, and it was below the RBSC in all seven 8 to 10 feet detections. No RBSC value is established for phenanthrene. Concentrations ranged from a low of 0.0403 ppm in boring SB06 to a high of 0.0855 ppm in boring SB01.

Six inorganics were detected above RBSCs in subsurface soil samples, and three were above BSCs. Inorganics that exceeded RBSC values included aluminum, arsenic, chromium, cobalt, iron, and manganese, and inorganics above background included most beryllium, calcium, and magnesium detections. Aluminum exceeded the RBSC of 7,700 ppm in 14 of the samples, with concentrations ranging from 7,720 ppm in the 8 to 10 feet sample from SB03 to 15,100 ppm in the 8 to 10 feet sample from SB08. Arsenic, chromium, cobalt, and iron exceeded the respective RBSC in every 3 to 5 and 8 to 10 feet sample. Arsenic concentrations ranged from a low of 3.55 ppm (8 to 10 feet; SB06) to a maximum of 15.7 ppm (3 to 5 feet; SB02), exceeding the RBSC of 0.39 ppm. Chromium concentrations ranged from a low of 8.82 ppm (3 to 5 feet; SB07) to a maximum of 22.4 ppm (8 to 10 feet; SB08), exceeding the RBSC of 0.29 ppm. Cobalt concentrations ranged from a low of 6.67 ppm (3 to 5 feet; SB05) to a maximum of 15.60 ppm (8 to 10 feet; SB08), exceeding the RBSC of 0.23 ppm, while iron concentrations ranged from a low of 13,300 ppm in the FS sample (3 to 5 feet; SB02) to a maximum of 55,100 ppm (8 to 10 feet; SB07), exceeding the RBSC of 5,500 ppm. Manganese was the last metal detected that exceeded RBSC values. The RBSC for manganese (180 ppm) was exceeded in 16 samples, with an MDC of 726 ppm from the 3 to 5 feet sample in boring SB02. Most of the beryllium concentrations exceeded the BSC value of 1 ppm, with results ranging from 5.46 ppm (3 to 5 feet; SB07) to 9.06 ppm (3 to 5 feet; SB02). Although not discussed because they are commonly occurring nutritionally essential elements, calcium had two detections and magnesium had seven detections that were above BSC values of 52,300 and 10,400 ppm, respectively.

5.3 Surface Water Analytical Results

On May 24 and 25, 2009, five surface water samples along with correlated QA/QC samples were collected from Pipe Creek. Surface water samples were analyzed for nitroaromatics, SVOCs, inorganics, PCBs, and water quality readings (ORP, pH, conductivity, turbidity, dissolved oxygen, and temperature) were recorded. In addition to the other parameters at one sample location, AP2-SW01, hardness was also analyzed. Surface water samples were not filtered. All samples were collected by submerging the appropriate sample bottle. Stream water flow was

gentle, in a northerly direction, and continuous. Sample bottles that contained preservative were submerged and nearly filled, but remaining bottle space was topped off with water from a non-preserved bottle. Sample collection began at the farthest downstream location and continued in the upstream direction. Table 3-4 presents final surface water quality field measurements. Table 5-5 presents detected constituents above RBSC values in surface water samples. Figure 5-7 presents surface water sample locations along with corresponding analytical results above RBSCs. Appendix B presents surface water sample collection logs.

No nitroaromatics or PCBs were detected in any surface water samples. The semivolatile bis(2-ethylhexyl)phthalate, a common laboratory contaminant, was detected in the FD of sample AP2-SW03 at a concentration of 2 parts per billion (ppb), far below the RBSC of 48 ppb. This was the only SVOC detected and it was not found in the regular sample or the field split sample also analyzed from this sample location. A total of nine inorganics, excluding essential human macronutrients (calcium, magnesium, potassium, and sodium) necessary for the human body livelihood, were detected in the five surface water samples. These essential human macronutrients are calcium, chloride, magnesium, phosphorous, potassium, and sodium, which are typically found in all sample media. Inorganic analytes detected included aluminum, barium, cobalt, iron, lead, manganese, nickel, vanadium, and zinc. None of the results were above the associated RBSC for that parameter, and in most cases, analytical results were one to two orders lower when compared to the appropriate RBSC value. Lead was the only analyte detected that was not a essential human macronutrients that does not have an established RBSC. Lead was detected in samples AP2-SW03 and AP2-SW04, with results in both samples at 2.9 ppb. Hardness was measured in surface water sample AP2-SW01 at a concentration of 286,000 ppb.

5.4 Sediment Analytical Results

Collocated with the surface water samples, five sediment samples and associated QA/QC samples were collected from Pipe Creek on May 24 and 25, 2009. Sediment samples were analyzed for nitroaromatics, SVOCs, inorganics, PCBs, and one sample, AP2-SD01, was also analyzed for TOC. Six inches (0.5 foot) of sediment were collected and placed in a new resealable plastic bag and homogenized. For each sample, if present, organics (leaves and roots) were removed prior to sample collection. Table 5-6 presents detected constituents in sediment samples above RBSC and BSC values. Figure 5-7 presents sediment sample locations along with corresponding analytical results above RBSCs and BSCs. Appendix B presents sediment sample collection logs.

One nitroaromatic, TNT, was detected in sediment sample AP2-SD03 at a concentration of 0.0647 ppm, below the RBSC of 36 ppm. Fluoranthene was the only SVOC parameter detected. It was found in sample AP2-SD03 at a concentration of 0.0525 ppm, far below the RBSC of 2,300 ppm. A total of 17 inorganics, excluding the 4 nutritionally essential inorganic elements, were detected in 5 sediment samples. Inorganic analytes detected included aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc. Most of the inorganics were found in each of the sediment samples collected. The only inorganics above RBSC values were arsenic and chromium. Arsenic was detected in each sample collected and was above the RBSC of 3.9 ppm. Concentrations ranged from a low of 3.9 ppm in sample AP2-SD05 to a high of 10.1 ppm in sample AP2-SD03. Chromium was found above the RBSC value of 2.9 ppm in each sample, with concentrations ranging from a low of 6.4 ppm in AP2-SD01 to 12.8 ppm in sample AP2-SD04. TOC was measured in sediment sample AP2-SD01 at a concentration of 0.57 ppm.

5.5 Overburden/Shale Groundwater Results

From January 31 through February 2, 2009, groundwater was collected from three of the seven piezometers installed at AP2- SB03/PZ03, SB04/PZ04, and SB08/PZ07. All samples were collected from temporary piezometers using the low-flow groundwater sampling methodology. Groundwater from other piezometers (SB01/PZ01, SB02/PZ02, SB05/PZ05, and SB06/PZ06) recharged at a flow rate less than 50 milliliters per minute, so no groundwater sample was collected. A total of five groundwater samples (including one FD and one FS sample) were collected from the three piezometers. Groundwater samples were analyzed for nitroaromatics, SVOCs, inorganics (filtered and unfiltered), hardness, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate, sulfate, total dissolved solids, total suspended solids, turbidity, oxidation reduction potential, and ferrous iron). Table 3-4 provides final water quality readings of the groundwater immediately prior to sample collection. Table 5-7 summarizes the groundwater analytical concentrations above RBSCs and BSCs. Figure 5-8 shows groundwater sample locations along with corresponding analytical results above the RBSCs and BSCs.

Overburden/shale groundwater was also sampled in permanently installed shallow monitoring wells AP2-MW01, AP2, MW02, and AP2-MW03. Groundwater was sampled near the end of May 2009 during the wet season and also sampled in November 2009 (dry season). Groundwater was collected during the month of May using a bladder pump and the low-flow sampling methodology. Due to dry conditions during the month of November, only nitroaromatics could be collected from wells AP2-MW01 and AP2-MW02. Groundwater from these two wells was

purged with a bladder pump one day and samples for nitroaromatics collected the following day by using a new, disposable Teflon bailer. Overburden/shale monitoring well AP2-MW03 was found dry during the month of November, so no groundwater sample was collected. Groundwater was analyzed for nitroaromatics, inorganics (filtered and unfiltered), VOCs, SVOCs, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate/nitrite, sulfate, total dissolved solids, total suspended solids, turbidity, ferrous iron, and ORP). Table 3-4 provides final water quality readings of the groundwater immediately prior to sample collection. Table 5-7 and Figure 5-8 show analytical results above the RBSCs and BSCs. (Note: Because monitoring wells AP2-MW01 and AP2-MW02 were analyzed only for nitroaromatics during the November 2009 sampling and no nitroaromatics were detected, and because the tables are presenting detections only, both wells are absent from the table).

5.5.1 Piezometer Analytical Data

All AP2 piezometer sampling took place in January and February of 2009 corresponding to wet season conditions. No nitroaromatics or SVOCs were detected above RBSCs or BSCs in the groundwater in AP2 piezometers. Two unfiltered inorganics were detected above RBSCs in the overburden/shale groundwater in the piezometers sampled. Cadmium was detected above the RBSC of 1.8 ppb in all samples and ranged from 3.91 ppb in groundwater from PZ07 to 4.28 ppb in piezometer PZ04. Iron was detected in groundwater above the RBSC of 2,600 ppb in one piezometer, PZ03, at a concentration of 5,060 ppb. This result also exceeded the BSC of 1,550 ppb. Aluminum exceeded the groundwater BSC of 309 ppb in PZ03 at a concentration of 2,400 ppb. Cadmium was the only metal that exhibited concentrations above the RBSC in the filtered samples. Cadmium concentrations were detected in each temporary piezometer and ranged from 3.90 ppb in PZ07 to 4.36 ppb in PZ03. No inorganic BSC values were exceeded in the filtered samples.

5.5.2 Overburden/Shale Monitoring Well Analytical Data

May 2009 (Wet Season). Similar to groundwater in temporary piezometers, no nitroaromatics or SVOCs were detected in the groundwater in AP2 overburden/shale monitoring wells. Three inorganics were detected above RBSCs in the unfiltered groundwater. Cobalt was detected above the RBSC of 1.1 ppb in the regular and FD sample from AP2-MW02 at concentrations of 7.9 and 8.3 ppb, respectively. Manganese was detected above the RBSC of 88 ppb in four samples, three from AP2-MW02 and one from AP2-MW03. The highest concentration in groundwater from AP2-MW02 was 229 ppb (regular and FD sample) to a low concentration of 173 ppb in

AP2-MW03. Nickel was detected in well AP2-MW02 at a concentration of 74.2 ppb in both the regular and FD sample, above the RBSC of 73 ppb. This result also exceeded the BSC for nickel of 8.6 ppb. In addition, although the concentration of nickel in the FS sample did not exceed the RBSC, the result of 68.9 ppb was above the BSC value. These same three elements also exceeded the RBSC and BSC values in the filtered samples. Cobalt was above the RBSC, with concentrations of 8.9 and 8.7 ppb in the regular and FD sample. Manganese was also above the RBSC in the three samples from AP2-MW02, with concentrations of 220 ppb (regular), 214 ppb (FD), and 218 ppb (FS). The manganese result above the RBSC of 88 ppb for well AP2-MW03 was 171 ppb. Nickel exceeded the RBSC in the regular sample, and the BSC value was also exceeded by all three AP2-MW02 concentrations.

November 2009 (Dry Season). As mentioned in Section 5.5, due to dry conditions during the month of November, wells AP2-MW01 and AP2-MW02 yielded only enough water for nitroaromatics analysis. Well AP2-MW03 was dry and could not be sampled. No nitroaromatics were detected in the groundwater from either AP2-MW01 or AP2-MW02. Because no nitroaromatics were present in either of these two wells, corresponding data for the month of November are absent in Table 5-8 (table shows detections only).

5.6 Bedrock Groundwater Results

In conjunction with the groundwater sampling of the overburden/shale monitoring wells, groundwater in the bedrock monitoring wells (AP2-BEDGW-001, AP2-BEDGW-002, and AP2-BEDGW-003) was also sampled. Monitoring well screens from all three of the bedrock monitoring wells are located within the Delaware Limestone bedrock unit. Like the overburden/shale wells, groundwater was sampled near the end of May 2009 during the wet season and also sampled in November 2009 during the PBOW dry season. During the months of May and November, insufficient groundwater was found in monitoring well AP2-BEDGW-001, so a groundwater sample could not be collected. Groundwater from the other bedrock wells (AP2-BEDGW-002 and AP2-BEDGW-003) was collected during both sampling events by low-flow sampling methodology using a bladder pump. During the month of May, in addition to the regular samples collected from both wells, an FD and an FS sample were collected from the groundwater of AP2-BEDGW-003. Then during the month of November, in addition to the regular samples, an FD and an FS sample were collected from well AP2-BEDGW-002. Groundwater was analyzed for nitroaromatics, inorganics (filtered and unfiltered), VOCs, SVOCs, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate/nitrite, sulfate, total dissolved solids, total suspended solids, turbidity, ferrous iron, and ORP). Table 3-4

provides final water quality readings of the groundwater immediately prior to sample collection. Table 5-9 and Figure 5-9 show analytical results above the RBSCs and/or BSCs.

5.6.1 May 2009 (Wet Season)

No nitroaromatics were detected in the groundwater from bedrock monitoring wells during the PBOW wet season month of May. Volatile organics above RBSCs included three compounds; benzene, ethylbenzene, and total xylenes. Results from these analytes and toluene also exceeded BSC values. Benzene was above the RBSC of 0.41 ppb and BSC of 2.4 ppb in both wells sampled. Concentrations range from 8.5 ppb in AP2-BEDGW-002 to 100 ppb in the FS sample in well AP2-BEDGW-003. Ethylbenzene was found at a concentration of 9.6 ppb in well AP2-BEDGE-002, above the 1.5 ppb RBSC and 0.87 ppb BSC value, while the FS sample of AP2-BEDGW-003 was 21 ppb. Groundwater from well AP2-BEDGW-002 showed a total xylene concentration of 63.2 ppb, above the RBSC of 20 ppb and BSC value of 5.5 ppb, while well AP2-BEDGW-003 showed a concentration nearly twice that amount in the FS sample, with a result of 260 ppb. SVOC naphthalene was found above the RBSC of 0.14 ppb in both wells, with results of 2 ppb in AP2-BEDGW-002 and 2.9 ppb in the regular sample in well AP2-BEDGW-003. No inorganics that are not nutritionally essential elements were detected above RBSC or BSC values in either the filtered or unfiltered samples. Calcium was the only inorganic that was detected above screening limits, and it exceeded its BSC value in both wells. Cyanide was detected above the RBSC in groundwater from bedrock well AP2-BEDGW-003 in the FS sample. It was found at a concentration of 710 ppb above the RBSC of 73 ppb. Cyanide was not detected in either of the other two associated samples (regular and FD sample) from the well.

5.6.2 November 2009 (Dry Season)

Like the wet season month of May, no nitroaromatics were detected in the bedrock groundwater at AP2. Volatile organics above RBSCs included benzene, chloroform, chloromethane, ethylbenzene, methylene chloride, and total xylenes. Benzene was above the RBSC of 0.41 ppb and BSC of 2.4 ppb in both wells sampled. Concentrations ranged from 4.1 ppb in AP2-BEDGW-002 (FS sample) to 336 ppb in well AP2-BEDGW-003. Ethylbenzene ranged from 5 ppb in well AP2-BEDGW-002 in the FS sample to 57.1 ppb in AP2-BEDGW-003. Groundwater from well AP2-BEDGW-002 showed total xylene concentrations ranging from 29 ppb in the FS sample from AP2-BEDGE-002 to 630 ppb in well AP2-BEDGW-003. Chloroform exceeded the RBSC value of 0.19 ppb, with concentrations of 4 ppb in well AP2-BEDGW-002 and a maximum concentration of 14.6 ppb in well AP2-BEDGW-003. Toluene exceeded the BSC value in all samples, with concentrations ranging from 2.3 ppb in the FS sample from well AP2-

BEDGW-003 to a maximum of 147 ppb in well AP2-BEDGW-003. Naphthalene exceeded the RBSC in groundwater results from both wells, with a maximum concentration of 1.9 ppm in well AP2-BEDGW-002 and a result of 7.4 ppb in AP2-BEDGW-003. Selenium was detected in both the unfiltered (21.3 ppb) and filtered (74.9 ppb) groundwater samples from well AP2-BEDGW-002, above the RBSC of 18 ppb, and was also detected in the filtered sample from well AP2-BEDGW-003 at a concentration of 22.4 ppb. Once again, nutritionally essential element calcium was detected above BSC values in both the filtered and unfiltered samples in well AP2-BEDGW-002. Cyanide was detected above the RBSC in groundwater from bedrock well AP2-BEDGW-002 in the FS sample. It was found at a concentration of 510 ppb, above the RBSC of 73 ppb. Cyanide was not detected in either of the other two associated samples (regular and FD sample) from the well.

6.0 Conclusions

This chapter presents conclusions of RI activities conducted at AP2. Activities were conducted from January to November 2009 and included soil borehole drilling, temporary piezometer installation, soil sample collection, overburden/shale groundwater sampling from temporary piezometers, permanent overburden/shale and Delaware Limestone bedrock monitoring well installation, two rounds of groundwater sampling from monitoring wells (one in the PBOW derived wet season and one in the dry season), surface water and sediment sampling, and IDW management and disposal. Analytical results obtained from all samples were screened against RBSC and BSC values. RBSC values do not infer a regulatory limit or mandated cleanup level, nor does an exceedance necessarily represent an unacceptable human health risk. They are used in this report only as points of reference. BSC values were derived from PBOW background samples and were also used as points of reference.

6.1 Surface Water Sample Summary

A total of seven surface water samples (FD and FS samples included in total) were collected from five locations in Pipe Creek. Surface water samples were analyzed for nitroaromatics, SVOCs, inorganics, PCBs, and water quality readings (ORP, pH, conductivity, turbidity, dissolved oxygen, and temperature). In addition, at sample location AP2-SW01, hardness was also analyzed. The major findings are summarized as follows:

- No nitroaromatics or PCBs were detected in any of the surface water samples from Pipe Creek.
- No SVOCs or inorganics were detected above RBSC or BSC values.
- Hardness was detected at a concentration of 286,000 ppb in Pipe Creek surface water.

6.2 Sediment Sample Summary

A total of seven sediment samples (FD and FS samples included in total) were collocated with the surface water sample locations in Pipe Creek. Sediment samples were analyzed for nitroaromatics, SVOCs, inorganics, and PCBs, and one sample, AP2-SD01, was also analyzed for TOC. Six inches (0.5 foot) of sediment were collected and placed in a new resealable bag and homogenized. The major findings are summarized as follows:

- No nitroaromatics or SVOCs were detected above RBSC values in the sediment samples from Pipe Creek.

- No PCBs were detected in any of the sediment samples.
- Only arsenic and chromium were detected above the RBSCs in each sample.
- TOC was found to be 0.57 ppm.

6.3 Soil Sample Summary

A total 30 soil samples were collected at AP2; 10 surface soil samples from depths of 0 to 1 foot and 20 subsurface soil samples from depths of 3 to 5 and 8 to 10 feet. Soil samples from depths of 0 to 1 and 3 to 5 feet were analyzed for nitroaromatics, inorganics, PCBs, and SVOCs and one 0 to 1 foot sample was analyzed for TOC. Soil from the 8 to 10 feet depth was analyzed for nitroaromatics, inorganics, and SVOCs. The major findings are summarized as follows:

- No nitroaromatics were detected in surface or subsurface soil samples at AP2.
- The PCB Aroclor 1016 was detected above the RBSC in one surface soil sample.
- Benzo(a)pyrene was detected in the surface soil in boring AP2-SB01 at a concentration of 0.0844 ppm, above the RBSC of 0.015 ppm.
- Metals found in the surface soil (0 to 1 foot) above the RBSC and BSC included aluminum, arsenic, beryllium, chromium, cobalt, iron, lead, manganese, and mercury.
- Metals found in the subsurface soil (3 to 5 and 8 to 10 feet) above the RBSC and BSC included aluminum, arsenic, beryllium, chromium, cobalt, iron, and manganese. In addition, the nutritionally essential calcium and magnesium were detected above BSC levels (as nutritionally essential elements they lack RBSC values).

6.4 Piezometer Overburden/Shale Groundwater Sample Summary

A total of five groundwater samples were collected from three temporary piezometers (FD and FS samples included in total) in January and February 2009 and analyzed for nitroaromatics, SVOCs, inorganics (filtered and unfiltered), hardness, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate, sulfate, total dissolved solids, total suspended solids, turbidity, ORP, and ferrous iron). The major findings are summarized as follows:

- No nitroaromatics were detected in piezometer overburden/shale groundwater samples at AP2.
- No SVOCs were detected above RBSC or BSC values in piezometer overburden/shale groundwater samples at AP2.

- Inorganics detected above the RBSC and BSC in the unfiltered samples included aluminum, cadmium, and iron.
- Inorganics detected above the RBSC in the filtered samples included only cadmium (BSC value not established).

6.5 Monitoring Well Overburden/Shale Groundwater Sample Summary

Five groundwater samples (FD and FS samples included in total) were collected during the wet season month of May 2009 and two groundwater samples were collected during the dry season month of November 2009. Groundwater was analyzed for nitroaromatics, inorganics (filtered and unfiltered), VOCs, SVOCs, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate/nitrite, sulfate, total dissolved solids, total suspended solids, turbidity, ORP, and ferrous iron). The two groundwater samples collected from overburden/shale monitoring wells during the dry season (November 2009) were analyzed only for nitroaromatics. The major findings are summarized as follows:

- No nitroaromatics were detected in monitoring well overburden/shale groundwater samples at AP2 during either the wet (May) or dry (November) season at AP2.
- No VOCs or SVOCs were detected in monitoring well overburden/shale groundwater samples collected during the wet month of May.
- Inorganics detected above the RBSC and BSC in the unfiltered samples included cobalt, manganese, and nickel.
- Inorganics detected above the RBSC and BSC in the filtered samples included cobalt, manganese, and nickel.

6.6 Bedrock Groundwater Sample Summary

Five groundwater samples (FD and FS samples included in total) were collected during the wet season of May 2009 and five groundwater samples were collected during the dry season month of November 2009. Groundwater samples were collected from wells AP2-BEDGW-002 and AP2-BEDGW-003. No samples were able to be collected from bedrock well AP2-BEDGW-001 during either sampling event due to the well being dry. Groundwater was analyzed for nitroaromatics, inorganics (filtered and unfiltered), VOCs, SVOCs, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate/nitrite, sulfate, total dissolved solids, total suspended solids, turbidity, ferrous iron, and ORP). The major findings are summarized as follows:

- No nitroaromatics were detected in bedrock groundwater samples at AP2.
- VOCs detected above RBSCs and/or BSCs during the months of May and November included petroleum related hydrocarbon compounds benzene, chloroform, chloromethane, ethylbenzene, methylene chloride, toluene, and total xylenes.
- Naphthalene was the only SVOC detected above the RBSC and that occurred during both the wet and dry seasons.
- Calcium was the only metal found at concentrations exceeding BSC values (as an essential nutrient calcium has no RBSC). Calcium exceeded its BSC in both filtered and unfiltered May and November samples.
- Selenium was the only metal found in the unfiltered samples above RBSC values, selenium lacks a BSC value. It exceeded its RBSC of 18 ppb in one of the November samples where it was detected at a concentration of 21.3 ppb,
- Selenium was the only metal found in the filtered samples above RBSC values. It exceeded its RBSC of 18 ppb in two November samples, one from AP2-BEDGW-002 (74.9 ppb) and one from AP2-BEDGW-003 (22.4 ppb).
- Total cyanide was detected in well AP2-BEDGW-002 (FS sample) during the dry season at a concentration of 510 ppb. Total cyanide was also detected above the RBSC in the FS sample from bedrock well AP2-BEDGW-003 during the wet season at a concentration of 710 ppb. Cyanide lacks a BSC value.
- Due to the presence of chloroform in the bedrock groundwater detected in both bedrock monitoring wells along with the detection of breakdown daughter products, chloromethane and methylene chloride, an anaerobic environment is indicated.

7.0 Recommendations

Based upon conclusions from soil, groundwater, sediment, and surface water, analytical results in this investigation, the following actions are recommended:

- Due to a potential health and safety issue, the hand-dug well should be backfilled.
- Given the limited water level data from the new wells, additional water level readings should be made to improve the understanding of groundwater flow directions for the overburden/shale and bedrock water zones in the AP2 area. This can be accomplished by including the AP2 wells in the site-wide groundwater level measurement activities.
- Given there were no detections of potential contaminants above screening criteria in the surface water samples, no further action, evaluation, or risk assessment is recommended for the surface water in the AP2 area.
- Given the detections of contaminants above screening criteria in the soil, sediment, overburden/shale groundwater and bedrock groundwater samples from the AP2 area a baseline human health risk assessment (BHHRA) and a screening-level ecological risk assessment (SLERA) should be conducted for these media using the SI and the RI data.

Planned Activities

- BHHRA and SLERA (draft reports anticipated to be complete in 2010).

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TABLES

Table 1-1

Historical Summary of Organics in Surface and Subsurface Soil
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Sample Location:	PH2SO-01		PH2SO-02		PH2SO-03		PH2SO-04		PH2SO-05		PH2SO-06	
	Sample Number:	4010	4020	4030	4040	4050	4060	4070	4080	4090	4100	4110	4120
	Sample Depth (feet):	0 - 0.5	2 - 3	0 - 0.5	2 - 3	0 - 0.5	2 - 3	0 - 0.5	2 - 3	0 - 0.5	2 - 3	0 - 0.5	2 - 3
	Sample Date:	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96
Parameter	RBC[a]	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Volatile Organic Compounds (µg/kg)													
Acetone	7.80E+05							120 J			120	42 J	
Bromomethane	1.10E+04												
Methylene chloride	8.50E+04									52 J			
Toluene	1.60E+06					18 J	11						
Xylene (total)	1.60E+07						6.5						
Semivolatile Organic Compounds (µg/kg)													
Anthracene	6.30E+06	58 J[b]											
Acenaphthylene	4.70E+05[c]	110 J											
Benzo(a)anthracene	880	130 J				76 J							
Benzo(a)pyrene	88	170 J				99 J							
Benzo(b)fluoranthene	880	160 J											
Benzo(g,h,i)perylene	2.30E+5[d]	130 J											
Benzo(k)fluoranthene	8.80E+03	230 J											
bis(2-Ethylhexyl)phthalate	4.60E+04												
Chrysene	8.80E+04	160 J				98 J							
di-n-butyl phthalate	7.80E+05												
Fluoranthene	3.10E+05	300 J		70 J		180 J							
indeno(1,2,3-cd)pyrene	880	120 J											
Phenanthrene	2.30E+6[e]	100 J				63 J							
Pyrene	2.30E+05	250 J		59 J		150 J							
Pesticides/PCBs (µg/kg)													
4,4' - DDE	1,900	7.4								3.4			
4,4' - DDT	1,900	6.3								3.6		2.6	
Methoxychlor	39,000			6.1		6.5							
Cyanide (µg/kg)													
Cyanide, total	1.60E+05[f]												

Table 1-1

Historical Summary of Organics in Surface and Subsurface Soil
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Sample Location:	PH2SO-07		PH2SO-08		PH2SO-09		PH2SO-10		PH2SO-11		PH2SO-12	
	Sample Number:	4130	4140	4150	4160	4170	4180	4190	4200	4210	4220	4230	4240
	Sample Depth (feet):	0 - 0.5	2 - 3	0 - 0.5	2 - 3	0 - 0.5	2 - 3	0 - 0.5	2 - 3	0 - 0.5	2 - 3	0 - 0.5	2 - 3
	Sample Date:	9/28/96	9/28/96	9/28/96	9/28/96	9/29/96	9/29/96	9/29/96	9/29/96	9/29/96	9/29/96	9/29/96	9/29/96
Parameter	RBC[a]	Result	Result	Result	Result	Result	Result	Result	Resulst	Result	Result	Result	Result
Volatile Organic Compounds (µg/kg)													
Acetone	7.80E+05												
Bromomethane	1.10E+04				1.1 J								
Methylene chloride	8.50E+04												
Toluene	1.60E+06												
Xylene (total)	1.60E+07												
Semivolatile Organic Compounds (µg/kg)													
Anthracene	6.30E+06												
Acenaphthylene	4.70E+05[c]												
Benzo(a)anthracene	880												
Benzo(a)pyrene	88												
Benzo(b)fluoranthene	880												
Benzo(g,h,i)perylene	2.30E+5[d]												
Benzo(k)fluoranthene	8.80E+03												
bis(2-Ethylhexyl)phthalate	4.60E+04							95 J			66 J		
Chrysene	8.80E+04												
di-n-butyl phthalate	7.80E+05									170 J			66 J
Fluoranthene	3.10E+05					79 J				83 J			
indeno(1,2,3-cd)pyrene	880												
Phenanthrene	2.30E+6[e]												
Pyrene	2.30E+05					52 J				67 J			
Pesticides/PCBs (µg/kg)													
4,4' - DDE	1,900	7.1		2.4		5.8		3.9		3.4			
4,4' - DDT	1,900	7.1		3.5		5.7		4.1		3.3			
Methoxychlor	39,000												
Cyanide (µg/kg)													
Cyanide, total	1.60E+05[f]	930				710		890					

[a]Risk-based concentration for residential soil taken from EPA, 1997, *Risk-Based Concentration Table*, 14 March, EPA Region III, Philadelphia, PA, on-line, unless otherwise noted; adjusted to reflect a cancer risk of 1E-6 and noncancer hazard index of 0.1 to provide additional protection for exposure to multiple chemicals or media.

[b]J qualifier. Analyte present. Reported value may not be accurate or precise.

[c]Based on the noncancer effects of acenaphthene, a structurally similar member of the same chemical class.

[d]Based on the noncancer effects of pyrene, a structurally similar member of the same chemical class.

[e]Based on the noncancer effects of anthracene, a structurally similar member of the same chemical class.

[f]Based on the value for free cyanide.

Note 1: 170

Note 2: Blank cells indicate that compound was analyzed for but was not detected.

µg/kg - Micrograms per kilogram.

Table 1-2

Historical Summary of Inorganics in Surface and Subsurface Soil
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Sample Location:	PH2SO-01		PH2SO-02		PH2SO-03		PH2SO-04		PH2SO-05		PH2SO-06		PH2SO-07	
	Sample Number:	4010	4020	4030	4040	4050	4060	4070	4080	4090	4100	4110	4120	4130	4140
	Sample Depth (feet):	0-0.5	1.5 - 2	0-0.5	2 - 3	0-0.5	2 - 3	0-0.5	2 - 3	0-0.5	2 - 3	0 - 0.5	2 - 3	0-0.5	2 - 3
	Sample Date:	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96	9/28/96
Parameter	RBC[a]	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Metals (mg/kg)															
Aluminum	7,800	**12700**	5880	**8210**	3520	**8940**	6580	**13900**	**9490**	**8300**	**9920**	**9850**	**8570**	**10300**	**8940**
Arsenic	0.43	**11.6**	**4.8**	**17.8**	**3.6**	**15.1**	**6.2**	**7**	**7.1**	**20.7**	**5.5**	**19**	**4.4**	**18.1**	**4.6**
Barium	550	85.3	40.3	141	29.9	108	60	90.2	59.4	133	82.9	121	73	141	90
Beryllium	0.15	**1.2**		**1.1**		**1.2**		**0.83**	**0.6**	**1.4**	**0.76**	**1**	**0.76**	**1.6**	**0.68**
Cadmium	3.9			1.1						1.4					
Chromium	39[b]	16.2	8.9	7.5	6.1	12.5	10.2	17.7	14.2	9.9	13.4	1.9	11.6	14.8	11.5
Cobalt	470	15.1	10.7	19	8.5	16.5	13.4	16.4	15.2	13.8	19.6	15.4	12.3	15.8	12.1
Copper	310	33.1	12.5	28.2	8.3	25.4	14.1	18.6	17.3	25.7	18	38.6	18.4	25	24.7
Iron	2,300	**38700**	**14000**	**74000**	**10500**	**28900**	**18000**	**25200**	**22500**	**45400**	**22500**	**107000**	**23700**	**41200**	**20800**
Lead	400[c]	32.2	7.7	15.6	6.1	25.4	10.3	14.8	10.5	18.8	11.1	15.6	10.9	19.1	11.1
Manganese	160	**189**	**259**	**1020**	129	**494**	**236**	**430**	**464**	**350**	**693**	**165**	**126**	**241**	**324**
Mercury (inorganic)	2.3	0.1		0.059		0.098				0.069				0.072	
Nickel	160	41.9	18.3	30.8	13.9	26	20.4	30.4	31.9	23.5	34.3	28.3	28.3	27	29.3
Selenium	39	2.1		1.8		2		0.65		2.2		1.8	0.64	1.7	
Silver	39			2				1.6	1.6		1.2	1.7			
Thallium	0.51[d]	**1.9**		**2.9**			**1.3**			**1.9**		**4.4**			
Vanadium	55	19.6	14.3	8.8	7.5	19	13.2	24.9	21.1	14.3	17.7		13.5	19.9	14.8
Zinc	2,300	127	39.2	73	35.3	78	56	88.7	73.2	61.5	78.5	45.7	76.5	73.6	68.8

Table 1-2

Historical Summary of Inorganics in Surface and Subsurface Soil
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Sample Location:	PH2SO-08		PH2SO-09		PH2SO-10		PH2SO-11		PH2SO-12	
	Sample Number:	4150	4160	4170	4180	4190	4200	4210	4220	4230	4240
	Sample Depth (feet):	0-0.5	2 - 3	0-0.5	2 - 3	0-0.5	2 - 3	0-0.5	2 - 3	0 - 0.5	3- 4
	Sample Date:	9/28/96	9/28/96	9/29/96	9/29/96	9/29/96	9/29/96	9/29/96	9/29/96	9/29/96	9/29/96
Parameter	RBC[a]	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Metals (mg/kg)											
Aluminum	7,800	**11500**	6950	**13800**	7100	**10500**	5650	**10900**	**9880**	**11600**	5370
Arsenic	0.43	**6.3**	**5.1**	**9.3**	**5**	**16.2**	**4.4**	**13.6**	**5.8**	**21.2**	**4.3**
Barium	550	74.3	54.2	103	55.2	107	40.8	102	90.3	131	38.3
Beryllium	0.15	**0.73**		**0.96**		**1.2**		**1.3**	**0.7**	**1.2**	
Cadmium	3.9										
Chromium	39[b]	14.5	9.9	17	9.8	14.4	8.1	15.8	13.7	8.1	7.4
Cobalt	470	14.6	11.3	14.5	11.9	12	7.5	13	24.7	9.4	5.6
Copper	310	16.8	12.8	25.3	12.9	26.9	12	23.8	20.7	31.5	9.6
Iron	2,300	**21300**	**16200**	**27700**	**16700**	**38000**	**13900**	**29300**	**23100**	**70300**	**12800**
Lead	400[c]	17.6	7.3	21.8	8.2	25.5	10.5	22.6	15.1	11.7	7
Manganese	160	**450**	**565**	**663**	**305**	**423 J[e]**	149 J	**394 J**	**1560 J**	**258 J**	82.1 J
Mercury (inorganic)	2.3	0.045		0.061		0.11		0.14			0.039
Nickel	160	26.2	22.9	33.6	21.1	23.6	16.2	23.7	35.2	21.4	13.8
Selenium	39			1.3		2.4		1.9	0.81	2.6	
Silver	39										
Thallium	0.51[d]		**1.5**			**5**	**2**	**3.9**	**2.4**	**8.5**	**1.4**
Vanadium	55	22.3	15.6	23.7	14.2	18.9	10.4	21.5	18.4	9.3	10.7
Zinc	2,300	81.1	53.6	103	50.3	85.4	42.2	79	77.2	51.6	37.2

[a]Risk-based concentration for residential soil taken from EPA, 1997, *Risk-Based Concentration Table*, 14 March, EPA Region III, Philadelphia, PA, on-line, unless otherwise noted; adjusted to reflect a cancer risk of 1E-6 and noncancer hazard index of 0.1 to provide additional protection for exposure to multiple chemicals or media.

[b]Based on the value for chromium (VI).

[c]Highest level in soil to which children may be regularly exposed for which exposure reduction is not recommended (EPA, 1994, "Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil," Memorandum from Lynn R. Golc Assistant Administrator, to EPA Regional Directors, dated July 14).

[d]RBC for thallium sulfate multiplied by 0.81 to adjust for differences in molecular weight.

[e]J qualifier. Analyte present. Reported value may not be accurate or precise.

Arsenic is identified as a carcinogenic.

Note 1: **12700** Concentration exceeds RBC.

Note 2: Blank cells indicate that compound was analyzed for but was not detected.

mg/kg - Milligrams per kilogram.

Table 3-1

Summary of Direct-Push Soil and Temporary Piezometer Groundwater Samples Collected
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Type	Sample Location	Sample Number	Sample Date	Sample Purpose	SDG Number
GW	ASH PIT 2-PZ01	AP3015	02/02/2009	FD	0902003
GW	ASH PIT 2-PZ01	AP3016	02/02/2009	FS	A9B030206
GW	ASH PIT 2-PZ01	AP3022	02/02/2009	REG	0902003
GW	ASH PIT 2-PZ03	AP3018	01/31/2009	REG	0902003
GW	ASH PIT 2-PZ04	AP3019	02/01/2009	REG	0902003
SS	ASH PIT 2-SB01	AP0100	01/15/2009	REG	0901026
DS	ASH PIT 2-SB01	AP0101	01/15/2009	REG	0901026
DS	ASH PIT 2-SB01	AP0102	01/15/2009	REG	0901026
SS	ASH PIT 2-SB02	AP0103	01/16/2009	REG	0901026
DS	ASH PIT 2-SB02	AP0104	01/16/2009	REG	0901026
DS	ASH PIT 2-SB02	AP0105	01/16/2009	FD	0901026
DS	ASH PIT 2-SB02	AP0106	01/16/2009	FS	A9A170114
DS	ASH PIT 2-SB02	AP0107	01/16/2009	REG	0901026
SS	ASH PIT 2-SB03	AP0108	01/18/2009	REG	0901027
DS	ASH PIT 2-SB03	AP0109	01/18/2009	REG	0901027
DS	ASH PIT 2-SB03	AP0110	01/18/2009	REG	0901027
SS	ASH PIT 2-SB04	AP0111	01/18/2009	REG	0901027
DS	ASH PIT 2-SB04	AP0112	01/18/2009	REG	0901027
DS	ASH PIT 2-SB04	AP0113	01/19/2009	REG	0901027
SS	ASH PIT 2-SB05	AP0114	01/16/2009	REG	0901026
DS	ASH PIT 2-SB05	AP0115	01/16/2009	REG	0901026
DS	ASH PIT 2-SB05	AP0116	01/16/2009	REG	0901026
SS	ASH PIT 2-SB06	AP0117	01/15/2009	REG	0901026
DS	ASH PIT 2-SB06	AP0118	01/15/2009	REG	0901026
DS	ASH PIT 2-SB06	AP0119	01/15/2009	REG	0901026
SS	ASH PIT 2-SB07	AP0120	01/16/2009	REG	0901026
SS	ASH PIT 2-SB07	AP0121	01/16/2009	FD	0901026
SS	ASH PIT 2-SB07	AP0122	01/16/2009	FS	A9A170114
DS	ASH PIT 2-SB07	AP0123	01/16/2009	REG	0901026
DS	ASH PIT 2-SB07	AP0124	01/16/2009	REG	0901026
SS	ASH PIT 2-SB08	AP0125	01/16/2009	REG	0901026
DS	ASH PIT 2-SB08	AP0126	01/16/2009	REG	0901026
DS	ASH PIT 2-SB08	AP0127	01/16/2009	REG	0901026
DS	ASH PIT 2-SB08	AP0128	01/16/2009	FD	0901026
DS	ASH PIT 2-SB08	AP0129	01/16/2009	FS	A9A170114

SDG - Sample delivery group.
GW - Groundwater.
FD - Field duplicate.
FS - Field split.
REG - Regular.
SS - Surface soil.
DS - Deep soil (subsurface).

Table 3-2

Monitoring Well Construction Details
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well ID	Coordinates (Ohio Plane) Northings (y)	Eastings (x)	Well Depth (feet bgs)	Date Installed	Installed By	Casing Type	Casing Diameter (inches)	Borehole Diameter (inches)	Screen Interval (feet bgs)	Geologic Unit Screened	Top of Filter Pack (feet bgs)	TOC Elevation (feet msl)	Ground Elevation (feet msl)	Well Bottom Elevation (feet msl)
Monitoring Wells Screened in Overburden														
AP2-MW01	622866.250	1911550.020	19.35	4/15/2009	Shaw	PVC (40)	2	8	9.0-19.0	Overburden	7.0	640.94	638.20	618.85
AP2-MW02	622892.790	1911351.160	15.35	4/15/2009	Shaw	PVC (40)	2	8	5.0-15.0	Overburden	4.0	635.53	632.50	617.15
AP2-MW03	622973.780	1911157.350	10.08	4/14/2009	Shaw	PVC (40)	2	8	4.9-9.9	Overburden	4.5	632.16	629.50	619.42
Monitoring Wells Screened in Delaware Limestone														
AP2-BEDGW-001	622795.83	1911202.97	85.85	4/18/2009	Shaw	Steel to 20.40', PVC (40) to 85.85'	2	12" to 14.5', 8" to 20.5', 6" to 87.0'	70.5-85.5	Delaware LM	66.0	633.46	630.40	544.55
AP2-BEDGW-002	622887.85	1911361.47	85.35	4/17/2009	Shaw	Steel to 21.1', PVC (40) to 85.35'	2	12" to 15.0', 8" to 21.1', 6" to 86.1'	70.0-85.0	Delaware LM	66.0	635.58	632.40	547.05
AP2-BEDGW-003	623117.29	1911619.32	60.35	4/15/2009	Shaw	Steel to 24.45', PVC (40) to 60.35'	2	12" to 19.5', 8" to 24.5', 6" to 61.0'	45.0-60.0	Delaware LM	41.0	640.83	638.40	578.05

Coordinates scaled to the Ohio State Plane coordinate system, North Zone, NAD 1983. Vertical datum is NAVD 1929.

bgs - Below ground surface.

msl - Mean sea level.

Table 3-3

Summary of Monitoring Well Groundwater Samples Collected
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works,Sandusky, Ohio

Sample Type	Sample Location	Sample Number	Sample Date	Sample Purpose	Lot Number
GW	AP2-BEDGW-002	AP3063	05/24/2009	REG	F65480
GW	AP2-BEDGW-003	AP3064	05/23/2009	REG	F65480
GW	AP2-BEDGW-003	AP3065	05/23/2009	FD	F65480
GW	AP2-BEDGW-003	AP3066	05/23/2009	FS	A9E270266
GW	AP2-MW01	AP3057	05/23/2009	REG	F65480
GW	AP2-MW02	AP3058	05/25/2009	REG	F65480
GW	AP2-MW02	AP3059	05/25/2009	FD	F65480
GW	AP2-MW02	AP3060	05/26/2009	FS	A9E270266
GW	AP2-MW03	AP3061	05/24/2009	REG	F65480
GW	AP2-BEDGW-002	AP3079	11/17/2009	REG	F69607
GW	AP2-BEDGW-003	AP3080	11/16/2009	REG	F69607
GW	AP2-BEDGW-002	AP3081	11/17/2009	FD	F69607
GW	AP2-BEDGW-002	AP3082	11/17/2009	FS	A9K190539
GW	AP2-MW02	AP3076	11/13/2009	REG	F69502
GW	AP2-MW01	AP3070	11/04/2009	REG	F69338

GW - Groundwater.
REG - Regular.
FD - Field duplicate.
FS - Field split.

Table 3-4

Final Field Measurements of Temporary Piezometer and Monitoring Well Groundwater and Surface Water Powerhouse 2 Ash Pits Site Characterization Report Former Plum Brook Ordnance Works, Sandusky, Ohio

Identification	Date	Low-Flow Sampled	Dissolved Oxygen (ppm)	Ferrous Iron (mg/L)	Oxidation Reduction Potential (mV)	pH	Electrical Conductivity (mS/cm)	Temperature (C^0)	Turbidity (NTU)	Amount Purged (L)
Temporary Piezometer										
AP2-PZ03	31-Jan-09	Yes	2.02	0.0	14.4	6.77	1.251	1.52	60.1	7.15
AP2-PZ04	01-Feb-09	Yes	1.10	0.0	23.7	6.55	0.958	7.31	26.6	7.33
AP2-PZ07	02-Feb-09	Yes	0.50	0.0	20.4	6.53	0.778	6.19	28.2	14.81
Overburden/Shale Monitoring Well										
AP2-MW01	23-May-09	Yes	10.27	0.0	-141.3	6.35	0.895	13.59	2.5	2.86
AP2-MW02	25-May-09	Yes	1.92	0.0	623.8	5.72	0.856	11.69	1.7	5.9
AP2-MW03	24-May-09	Yes	5.60	0.0	-394.8	6.29	1.368	13.20	10.1	3.72
AP2-MW01	13-Nov-09	No	1.32	NM	-8.3	6.99	0.980	14.59	7.8	
AP2-MW02	13-Nov-09	No		NM						
Delaware Limestone Monitoring Well										
AP2-BEDGW-002	24-May-09	Yes	1.64		-144.8	6.20	2.968	17.0	16.2	4.6
AP2-BEDGW-003	23-May-09	Yes	0.22	0.0	-315.1	6.15	2.141	25.59	5.9	5.58
AP2-BEDGW-002	17-Nov-09	No	1.01	2.0	-6.9	6.78	2.635	9.67	3.6	
AP2-BEDGW-003	16-Nov-09	No	4.51	0.0	-1.8	6.72	2.202	8.87	0.0	
Surface Water										
AP2-SW01	24-May-09	NA	7.55	NM	163.5	7.28	0.924	17.45	12.9	NA
AP2-SW02	24-May-09	NA	7.81	NM	124.3	7.42	0.912	18.94	12.5	NA
AP2-SW03	24-May-09	NA	7.94	NM	113.8	7.60	0.908	19.16	17.7	NA
AP2-SW04	24-May-09	NA	7.40	NM	193.5	7.43	0.885	15.93	24.6	NA
AP2-SW05	25-May-09	NA	8.37	NM	157.8	7.66	0.900	16.26	11.7	NA

Notes:

Water quality measurements recorded by YSI water quality instrument immediately prior to the sample collection time.

^{0}C - Degree Celsius.
Eh - oxidation-reduction potential.
L - Liters.
mS/cm - Millisiemens per centimeter.
mV - Millivolts.
NA - Not Applicable.
NM - Not measured.
ppm - Parts per million.
mg/L - Milligrams per liter (ppm).
NTU - Nephelometric turbidity unit.
Ferrous iron measured in field using Hach test kit.

Table 3-5

Summary of Surface Water and Sediment Samples Collected
Power House 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Type	Sample Location	Sample Number	Sample Date	Sample Purpose	Lot Number
SD	ASH PIT 2-SD01	AP1000	05/24/2009	REG	F65476
SD	ASH PIT 2-SD02	AP1001	05/24/2009	REG	F65476
SD	ASH PIT 2-SD03	AP1002	05/24/2009	REG	F65476
SD	ASH PIT 2-SD04	AP1003	05/25/2009	REG	F65476
SD	ASH PIT 2-SD04	AP1004	05/25/2009	FD	F65476
SD	ASH PIT 2-SD04	AP1005	05/25/2009	FS	A9E270266
SD	ASH PIT 2-SD05	AP1006	05/25/2009	REG	F65476
SW	AP2-SW01	AP2000	05/24/2009	REG	F65479
SW	AP2-SW02	AP2001	05/24/2009	REG	F65479
SW	AP2-SW03	AP2002	05/24/2009	REG	F65479
SW	AP2-SW03	AP2003	05/24/2009	FD	F65479
SW	AP2-SW03	AP2004	05/24/2009	FS	A9E270266
SW	AP2-SW04	AP2005	05/25/2009	REG	F65479
SW	AP2-SW05	AP2006	05/25/2009	REG	F65479

SD - Sediment.
SW - Surface water.
REG - Regular.
FD - Field duplicate.
FS - Field split.

Table 4-1

Summary of Analytical Parameters and Methods for Soil Temporary Piezometer, Groundwater, Surface Water, and Sediment Samples
Power House 2 Ash Pits Site Characterizaion Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Matrix	Analytical Parameters[a]	Analytical Method[b]
Groundwater	TCL Volatile Organic Compounds	SW-846 5030B/8260B
	TCL Semivolatile Organic Compounds	SW-846 3510C/8270C
	Nitroaromatic Compounds	SW-846 3535/8330A
	TAL Metals (T/D)	SW-846 3005A/6010B/6020A/7470A
	Turbidity	EPA 180.1
	Alkalinity	EPA 310.1
	Hardness	EPA 130.2
	Total Organic Carbon	SW-846 9060
	Total Dissolved Solids	EPA 160.1
	Total Suspended Solids	EPA 160.2
	Chloride	EPA 325.3
	Cyanide, total	SW-846 9010A/9012
	Nitrate	EPA 350.2
	Sulfate	EPA 375.3
Surface Water	TCL Semivolatile Organic Compounds	SW-846 3510C/8270C
	Nitroaromatic Compounds	SW-846 3535/8330A
	TAL Metals	SW-846 3005A/6010B/6020A/7470A
	Hardness	EPA 130.2
Soil	TCL Semivolatile Organic Compounds	SW-846 3541/8270C
	Nitroaromatic Compounds	SW-846 8330A
	PCBs	SW-846 8082
	TAL Metals	SW-846 3050B/6010B/6020A/7471A
Sediment	TCL Semivolatile Organic Compounds	SW-846 3541/8270C
	Nitroaromatic Compounds	SW-846 8330A
	PCBs	SW-846 8082
	Total Organic Carbon	Walkley-Black
	TAL Metals	SW-846 3050B/6010B/6020A/7471A

[a]Target analyte list (TAL) and target compound list (TCL) are used to designate parameter lists with no requirements for Contract Laboratory Program (CLP) method quality control or data reporting packages
[b]Analyses found in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* USEPA Publication, Third Edition and *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, March 1983 and subsequent revisions.
T/D - Total/dissolved.
TAL - Target analyte list.
TCL - Target compound list.
PCB - Polychlorinated biphenyl.

Table 4-2

Background Screening Concentrations for Inorganics and BTEX Compounds in Groundwater Powerhouse 2 Ash Pits Site Characterization Report Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent hits	Range of Values, µg/L: Detected Concentrations Minimum	Detected Concentrations Maximum	Reporting Limits Minimum	Reporting Limits Maximum	Mean µg/L	Standard Deviation	UTL [a] µg/L	BSC [b] µg/L
Metals - Unfiltered										
Aluminum	11 / 13	85	3.15E+01	3.09E+02	2.00E+02	2.00E+02	1.05E+02	6.98E+01	4.17E+02	309
Arsenic	4 / 26	15	3.30E+00	7.40E+00	1.00E+01	1.00E+01	4.99E+00	6.56E-01	7.92E+00	7.4
Barium	28 / 28	100	2.58E+01	1.18E+04	2.00E+02	2.00E+03	1.73E+03	3.77E+03	1.86E+04	11800
Calcium	28 / 28	100	1.74E+04	3.16E+05	5.00E+03	5.00E+03	1.38E+05	8.31E+04	5.09E+05	316000
Cobalt	6 / 27	22	1.00E+00	1.21E+01	5.00E+01	5.00E+01	2.05E+01	8.75E+00	5.96E+01	12.1
Copper	2 / 28	7	3.30E+00	1.98E+01	2.50E+01	2.50E+01	1.24E+01	2.26E+00	2.25E+01	19.8
Iron	24 / 27	89	3.82E+01	1.55E+03	1.00E+02	1.00E+02	4.15E+02	4.87E+02	2.59E+03	1550
Magnesium	28 / 28	100	7.28E+03	2.17E+05	5.00E+03	5.00E+03	7.17E+04	5.85E+04	3.33E+05	217000
Manganese	28 / 28	100	3.60E+00	6.88E+02	1.50E+01	1.50E+01	8.12E+01	1.24E+02	6.36E+02	636
Nickel	4 / 27	15	4.80E+00	8.60E+00	4.00E+01	4.00E+01	1.81E+01	4.67E+00	3.90E+01	8.6
Potassium	28 / 28	100	2.53E+03	1.16E+05	5.00E+03	5.00E+04	2.70E+04	3.06E+04	1.64E+05	116000
Sodium	28 / 28	100	1.33E+04	1.39E+06	5.00E+03	5.00E+04	3.55E+05	4.36E+05	2.30E+06	1390000
Zinc	14 / 19	74	8.30E-01	5.07E+02	2.00E+01	2.00E+01	5.55E+01	1.23E+02	6.06E+02	507
Volatile Organic Compounds										
Benzene	9 / 28	32	1.45E-01	2.40E+00	1.00E+00	5.00E+00	6.73E-01	5.43E-01	3.10E+00	2.4
Ethylbenzene	6 / 28	21	1.30E-01	8.70E-01	1.00E+00	5.00E+00	5.82E-01	4.00E-01	2.37E+00	0.87
Toluene	8 / 28	29	1.20E-01	1.70E+00	1.00E+00	5.00E+00	4.99E-01	2.83E-01	1.76E+00	1.7
Xylenes, total	8 / 28	29	3.60E-01	5.50E+00	1.00E+00	5.00E+00	1.22E+00	1.53E+00	8.07E+00	5.5

[a] The UTL (upper tolerance limit) is calculated using the Chebychev equation (mean + 4.47 * standard deviation).

[b] The BSC (background screening criterion) is the calculated UTL or the maximum detected concentration, whichever is less.

µg/L - Micrograms per liter.

mg/L - Milligrams per liter.

BTEX - Benzene, toluene, ethylbenzene, and xylenes.

Source: Shaw Environmental, Inc., 2005, 2004 Data Summary and Evaluation Report, Final, Plum Brook Ordnance Works, Sandusky, Ohio, April.

Table 4-3

Background Concentrations of Metals in Soil[a]
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UTL [b]	Background Screening Criterion [c]
Aluminum	12 / 12	3520 - 15500	NA	L	8.43E+03	2.69E+04	1.55E+04
Antimony	9 / 25	5.9 - 9.3	5.4 - 74	NP	4.68E+00	NA	9.30E+00
Arsenic	23 / 26	2.1 - 36.5	1.2 - 3.7	L	1.08E+01	7.10E+01	3.65E+01
Barium	9 / 12	35.6 - 826	23.2 - 24.7	L	1.16E+02	1.30E+03	8.26E+02
Beryllium	6 / 25	0.57 - 1	0.57 - 1.2	L	5.65E-01	1.17E+00	1.00E+00
Cadmium	0 / 25	NA	0.57 1.2	L	4.49E-01	NA	NA
Calcium	12 / 12	735 - 52300	NA	L	1.13E+04	2.18E+05	5.23E+04
Chromium	25 / 26	4.4 - 29	12.3 - 12.3	NP	1.34E+01	NA	2.90E+01
Cobalt	9 / 12	9.6 - 116	5.8 - 6.2	L	2.26E+01	2.48E+02	1.16E+02
Copper	23 / 26	2.3 - 56.2	2.2 - 2.9	L	1.70E+01	1.47E+02	5.62E+01
Iron	12 / 12	5880 - 234000	NA	L	4.01E+04	3.58E+05	2.34E+05
Lead	26 / 26	1.9 - 48.6	NA	L	1.28E+01	5.13E+01	4.86E+01
Magnesium	12 / 12	629 - 10400	NA	L	3.26E+03	3.08E+04	1.04E+04
Manganese	26 / 26	21 - 13300	NA	L	7.29E+02	3.51E+03	3.51E+03
Mercury	2 / 26	0.085 - 0.085	0.037 - 0.3	L	9.06E-02	5.60E-01	8.50E-02
Nickel	26 / 26	5.4 - 55.1	NA	L	2.28E+01	7.79E+01	5.51E+01
Potassium	11 / 12	579 - 3390	617 - 617	L	1.24E+03	6.08E+03	3.39E+03
Selenium	5 / 25	0.61 - 2	0.57 - 4.9	NP	1.55E+00	NA	2.00E+00
Silver	2 / 26	1.1 - 11.1	1.1 - 1.3	NP	1.00E+00	NA	1.11E+01
Sodium	0 / 12	NA	566 - 663	L	3.03E+02	NA	NA
Thallium	2 / 25	1.2 - 1.3	1.1 - 6.1	NP	1.91E+00	NA	1.30E+00
Vanadium	11 / 12	9 - 40.9	61.7 - 61.7	L	2.48E+01	8.31E+01	4.09E+01
Zinc	26 / 26	6.6 - 655	NA	L	7.30E+01	3.22E+02	3.22E+02

mg/kg - Milligrams per kilogram.
NA - Not applicable; not available.
[a] Data used to determine soil background are based on sampling from IT, 1998, ***Site Investigation of Acid Areas, Plum Brook Ordnance Works, Sandusky, Ohio.***
[b] 95% UTL = 95% upper tolerance limit calculated as described in Section 2.1.4 and rounded to 3 significant figures.
[c] The maximum detected concentration is used as the background screening criterion for nonparametric data sets; for normal or lognormal data sets, the 95% UTL or the maximum detected concentration, whichever is less, is used.
Note: Detection limits from sample 6990 were deleted when calculating results for antimony, beryllium, cadmium, selenium and thallium. The detection limits were elevated by dilution factors which greatly exceed any detected concentration and would bias results unrealistically high.

Table 5-1

Observances of Hydrocarbons in Bedrock During Borehole Coring
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Borehole Identification	Date Drilled	Location	Depth to Bedrock (ft)	Depth to Bedrock (refusal - ft)	Depth to Delaware Limestone[a] (ft)	Depth Drilled (ft)	Hydrocarbon/H_2S Odor Detected[b] (ft)	Hydrocarbon Stained Core[c] (ft)	Comments
TPCB-1 (Boring)	6/9/1941	Behind Water Clarification Bldg 416	3	Unknown	85	336.8	Gas 58-60;Oil intermittently	Unknown	
BED-MW22 (Well)	8/24/01-9/10/01	Downgradient Boundary, North of Reactor Area	19.5	19.5	19.5	43	20-24.5	40-43	
BED-MW23 (Well)	8/25/01-9/6/01	South of Reactor Area and Pentolite Road	26.3	26.3	26.3	74	30-74	33-74	Hydrocarbon observed seepng from rock core.
BED-MW24 (Well)	8/26/01-9/13/01	West of West Red Water Ponds, Downgradient	17.3	17.3	17.3	41.5	26.5-40.0	31.5-41.5	Hydrocarbon observed seepng from rock core. Gas discharge (gurgling) heard during water recharge.
BED-MW27 (Well) (Abandoned)	8/23/01-9/8/01	Downgradient Boundary, East-Northeast of Reactor Area	18.8	18.8	20	105	95-105	41-105	Hydrocarbon observed seepng from rock core. Well abandoned due to excessive (nuisance) hydrogen sulfide odors.
TNTA-BEDGW-001 (Well)	9/24/01-9/13/01	TNT Area A, Near Maintenance and Short Cut Rd, At Former Bldg 146	8.5	25	51	86	None	68-85	A thickness of approx. 3.5 feet free-phase hydrocarbon was encountered prior to sampling (10/9/01).
BED-MW30 (Well)	3/15/04-3/19/04	Near Bouy Road and Patten Tract .Intersection, Outside (west) PBOW Boundaries	24	24	24	58.3	31-58.3	34.5-35.7; 38.8-39.1; 39.5-49.5;	
BED-MW31 (Boring)	3/16/04-3/20/04	At former RR bed, West of Schenk Rd, Outside (downgradient) of PBOW Boundaries	13	14.5	13.8	90.2	17.5-90.2	20-30; 31.1; 40.1-21; 87.1-90.2	

Table 5-1

Observances of Hydrocarbons in Bedrock During Borehole Coring
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Former Plum Brook Ordnance Works, Sandusky, Ohio

Borehole Identification	Date Drilled	Location	Depth to Bedrock (ft)	Depth to Bedrock (refusal - ft)	Depth to Delaware Limestone[a] (ft)	Depth Drilled (ft)	Hydrocarbon/H_2S Odor Detected[b] (ft)	Hydrocarbon Stained Core[c] (ft)	Comments
BED-MW32 (Boring)	3/29/04-4/1/04	East of Columbus Rd, Between east and west bound lanes of Route 2; Outside (downgradient) of PBOW Boundaries	17.5	17.5	17.5	90.1	17.5-55.1	29-29.5; 30-40;	
BED-MW33 (Well)	3/30/04-4/2/04	Columbus Park, Northeast of facility; Outside (downgradeint) of PBOW Boundaries	15	15	15	89.5	20-39.5	38-39.5; 85.3-89	
BED-MW34 (Boring)	3/17/04-3/22/04	NASA's Old Sewage Water Treatment Plant Area; Outside (downgradient) of main PBOW facility	19	20	35.5	90.1	20-90.1	41.5-90.1	Core section very heavily stained. Heard gas "burping" in borehole 66.1-71.1'. Free-phase hydrocarbon on water (0.3 to 0.8'), prior to abandonment.
1SLA-BEDGW-001	2/26/09 - 3/6/09	TNTA Sewer line area, north of Maintenance Rd. and Short Cut Rd.	17.9	24.2	40.2	58.2	None	52.8 - 58.2	11-9-09 - Well gauging detected 0.08' product on water.
1SLA-BEDGW-002	2/26/09 - 3/4/09	TNTA Sewer line area, north of Maintenance Rd. and Short Cut Rd.	11.2	39	43.8	75.2	50 - 65	None	After setting well, strong hydrocarbon/H2S odors detected in vicinity of well until water level becoame static.

Table 5-1

Observances of Hydrocarbons in Bedrock During Borehole Coring
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Borehole Identification	Date Drilled	Location	Depth to Bedrock (ft)	Depth to Bedrock (refusal - ft)	Depth to Delaware Limestone[a] (ft)	Depth Drilled (ft)	Hydrocarbon/H_2S Odor Detected[b] (ft)	Hydrocarbon Stained Core[c] (ft)	Comments
AP1-BEDGW-001	3/13/09 - 3/18/09	AP1 area south of Maintenance Rd., in grass north of white block building.	25.5	44.8	44.6	81.3	57.5 - 81.3	57.5 - 66.0	11-6-09 - Well gauging detected 0.9' product on water.
AP1-BEDGW-002	3/15/09 - 3/29/09	AP1 area immediately south of Maintenance Rd. in grass.	21.4	40	39.5	61.3	None	None	Well emits H2S when cap is removed.
AP2-BEDGW-002	4/2/09 - 4/17/09	AP2 west of Campbell Rd.	15.8	21.1	15.8	86.1	None	47.1 seeping from coral, 69.5 seeping from rock	
LBA-BEDGW-002	3/25/09 - 3/30/09	LBA area southeast corner of building.	27	37	37.9	71.1	None	49.6 - 56.4	11-4-09 - Well gauging indicated 0.9' product on water.

Table 5-1

Observances of Hydrocarbons in Bedrock During Borehole Coring
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Borehole Identification	Date Drilled	Location	Depth to Bedrock (ft)	Depth to Bedrock (refusal - ft)	Depth to Delaware Limestone[a] (ft)	Depth Drilled (ft)	Hydrocarbon/H_2S Odor Detected[b] (ft)	Hydrocarbon Stained Core[c] (ft)	Comments
RCA-BEDGW-001	3/18/09 - 3/29/09	RCA area north of Maintenance Rd. in grass.	23.2	41.6	41.2	81.5	None	53.8 - 70.2	
RCA-BEDGW-002	3/17/09 - 3/29/09	RCA area north of Maintenance Rd. in thicket.	26	37.3	37.3	66	None	57.0 - 58.2	11-3-09 - Sheen noted on water during well gauging, not detectable with interface probe.
RCA- BEDGW-003	3/19/09 - 3/29/09	RCA area north of Maintenance Rd. north of creek.	24.8	35.5	35.5	105.8	None	63.7 - 80.2	
WTP1-BEDGW-003	3/3/09 - 3/14/09	WTP1 north of the intersection of Maintenance Rd and Taylor Rd.	21.2	37.95	38.5	61.5	None	49.9 - 55.8	

Table 5-1

Observances of Hydrocarbons in Bedrock During Borehole Coring
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Borehole Identification	Date Drilled	Location	Depth to Bedrock (ft)	Depth to Bedrock (refusal - ft)	Depth to Delaware Limestone[a] (ft)	Depth Drilled (ft)	Hydrocarbon/H_2S Odor Detected[b] (ft)	Hydrocarbon Stained Core[c] (ft)	Comments
WTP3-BEDGW-001	3/27/09 - 4/1/09	WTP3 on east side of gravel drive.	24	33	30	53.1	None	40.4 - 53.1	Well emits H2S when cap is removed.
WTP3-BEDGW-002	3/28/09 - 4/14/09	WTP3 in berm north of building	25	33	30	53.4	None	43.4 - 47.8	Well emits H2S when cap is removed.
WTP3-BEDGW-003	3/29/09 - 4/14/09	WTP3 west of creek.	25.8	33.3	30	52.9	None	40.2 - 52.9	

Notes

[a] Limestone unit interpretations from Regional Geologic Map, 2004 Groundwater Data Summary and Evaluation Report (Shaw, 2005).
[b] A hydrocarbon odor was detected by the olfactory senses. Photoionization detector readings in the breathing air remained below action levels.
[c] Hydrocarbon staining on the rock core is also seen in photographs (Appendix C).
A hydrocarbon thickness of 0.05 feet was measured in well BED-MW16 on 10/3/01.
A hydrocarbon thickness of 0.63 feet was measured in well AA1-BEDGW-001 on 10/4/01.
ft - Feet.
NASA - National Aeronautics and Space Administration.
PBOW - Plum Brook Ordnance Works.
TNT - Trinitrotoluene.
Identifies borehole/monitoring well of the Powerhouse 2 Ash Pits Area.

Table 5-2

Summary of Groundwater Level Measurements
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Coordinates (Ohio Plane)[a] Northing (y)	Easting (x)	Top of Casing Elevation[a] (ft msl)	Ground Elevation[a] (ft msl)	Groundwater Elevation Measurements (feet above mean sea level [msl]) 23-May-09 DTW	23-May-09 Elevation	12-Nov-09 DTW	12-Nov-09 Elevation
Tempoary Piezometer								
AP2-PZ01	623,073.14	1,911,485.20	634.97	631.70	6.56	628.41	[c]Abandoned	--
AP2-PZ02	623,041.37	1,911,260.38	630.32	627.50	4.12	626.20	[c]Abandoned	--
AP2-PZ03	622,845.22	1,911,148.24	630.69	627.70	2.90	627.79	[c]Abandoned	--
AP2-PZ04	622,789.21	1,911,348.96	633.70	630.00	5.49	628.21	[c]Abandoned	--
AP2-PZ05	622,901.66	1,911,339.77	633.97	631.80	5.65	628.32	[c]Abandoned	--
AP2-PZ06	622,942.86	1,911,404.17	633.42	629.70	5.28	628.14	[c]Abandoned	--
AP2-PZ07	622,955.41	1,911,280.43	632.92	629.8	NM	NA	[c]Abandoned	--
AP2-SG04	623,270.04	1,911,226.61	625.46	621.1[b]	4.07	621.39	3.85	621.61
Overburden/Shale Monitoring Well								
AP2-MW01	622,866.25	1,911,550.02	640.94	638.20	10.83	630.11	17.00	623.94
AP2-MW02	622,892.79	1,911,351.16	635.53	632.50	7.09	628.44	14.08	621.45
AP2-MW03	622,973.78	1,911,157.35	632.16	629.50	4.64	627.52	Dry	--
Delaware Limestone Monitoring Well								
AP2-BEDGW-001	622,795.83	1,911,202.97	633.46	630.40	87.17	546.29	85.52	547.94
AP2-BEDGW-002	622,887.85	1,911,361.47	635.58	632.40	23.02	612.56	28.06	607.52
AP2-BEDGW-003	623,117.29	1,911,619.32	640.83	638.40	27.55	613.28	32.68	608.15

Notes:

[a]Northings and Eastings are scaled to the Ohio State Plane Coordinate System (North Zone), NAD 1983. Vertical datum to NGVD 1929.

[b]Elevation is of Pipe Creek bottom.

[c]Piezometers were abandoned July 2009.

NM - Not measured.

NA - Not applicable.

DTW - Depth to water.

ft msl - Feet above mean sea level.

Table 5-3

Well Pair Vertical Hydraulic Gradients
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

	Well Name	Unit Monitored (ft bgs)	Well TD (ft bgs)	Depth of Monitored Zone (ft bgs)	Elevation of Ground Surface (ft)	Elevation of Center of Monitored Zone (ft)	Groundwater Elevation 5/6/2009	Groundwater Elevation 5/26/2009	Groundwater Elevation 11/9/2009	Average Vertical Gradient (ft/ft)
Pair 1	1SLA-MW02	OB/OS	28.75	13.4-28.4	630.8	609.90	620.7	625.88	629.38	
	1SLA-BEDGW-002	DL	74.6	64.2-74.2	630.9	561.70	Not measured	587.22	587.61	
	Distance between Center of Monitored Zones					48.20				
	Vertical Gradient						NA	0.802	0.867	0.834
Pair 2	AP1-MW02	OB/OLS	19.55	9.2-19.2	634.7	620.50	633.81	632.8	630.8	
	AP1-BEDGW-002	DL	59.35	44.0-59.0	634.5	583.00	599.63	594.1	596.5	
	Distance between Center of Monitored Zones					37.50				
	Vertical Gradient						0.911	1.032	0.915	0.953
Pair 3	AP2-MW02	OB	15.35	5.0-15.0	632.5	622.50	NA	628.44	621.45	
	AP2-BEDGW-002	DL	85.35	70.0-85.0	632.4	554.90	NA	612.56	607.45	
	Distance between Center of Monitored Zones					67.60				
	Vertical Gradient						NA	0.235	0.207	0.221
Pair 4	LBA-MW01	OB/OS	16.35	6.0-16.0	637.2	626.20	633.74	632.66	629.58	
	LBA-BEDGW-001	DL	100.35	85.0-100.0	637.3	544.80	538.44	538.15	541.56	
	Distance between Center of Monitored Zones					81.40				
	Vertical Gradient						1.171	1.161	1.081	1.138
Pair 5	LBA-MW-2	OB/OS	16.35	6.0-16.0	635.9	624.90	631.63	631.19	630.85	
	LBA-BEDGW-002	DL	70.35	55.0-70.0	636.30	573.80	573.03	567.58	574.38	
	Distance between Center of Monitored Zones					51.10				
	Vertical Gradient						1.147	1.245	1.105	1.166
Pair 6	RCA-MW01	OB/OS	9.35	4.0-9.0	638.4	631.90	634.1	633.21	629.99	
	RCA-BEDGW-001	DL	80.35	65.0-80.0	638.50	566.00	562.8	560.78	565.2	
	Distance between Center of Monitored Zones					65.90				
	Vertical Gradient						1.082	1.099	0.983	1.055
Pair 7	RCA-MW02	OB/OS	28.05	17.70-27.70	635.3	612.60	633.51	630.03	624.25	
	RCA-BEDGW-002	DL	65.35	50.0-65.0	635.50	578.00	583	599.31	597.89	
	Distance between Center of Monitored Zones					34.60				
	Vertical Gradient						1.460	0.888	0.762	1.037

Table 5-3

Well Pair Vertical Hydraulic Gradients
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Well Name	Unit Monitored (ft bgs)	Well TD (ft bgs)	Depth of Monitored Zone (ft bgs)	Elevation of Ground Surface (ft)	Elevation of Center of Monitored Zone (ft)	Groundwater Elevation 5/6/2009	Groundwater Elevation 5/26/2009	Groundwater Elevation 11/9/2009	Average Vertical Gradient (ft/ft)
Pair 8	WTP1-MW02	OB/OS	16.3	6.0-16.0	638.6	627.60	636.42	634.09	631.07	
	WTP1-BEDGW-002	DL	53.35	43.0-53.0	637.80	589.80	601.8	603.75	616.51	
	Distance between Center of Monitored Zones					37.80				
	Vertical Gradient						0.916	0.803	0.385	0.701
Pair 9	WTP1-MW03	OB/OS	16.3	6.0-16.0	637	626.00	635.63	633.52	630.7	
	WTP1-BEDGW-003	DL	55.35	45.0-55.0	637.10	587.10	600.74	599.29	600.85	
	Distance between Center of Monitored Zones					38.90				
	Vertical Gradient						0.897	0.880	0.767	0.848
Pair 10	WTP3-MW01	OB/OS	18.35	8.0-18.0	637	624.00	633.89	Not measured	626.07	
	WTP3-BEDGW-001	DL	52.35	37.0-52.0	637.10	592.60	603.05	Not measured	603.98	
	Distance between Center of Monitored Zones					31.40				
	Vertical Gradient						0.982	NA	0.704	0.843
Pair 11	WTP3-MW02	OB/OS	18.35	8.0-18.0	637.7	624.70	632.68	Not measured	628.97	
	WTP3-BEDGW-002	DL	52.35	37.0-52.0	637.60	593.10	603.64	Not measured	603.95	
	Distance between Center of Monitored Zones					31.60				
	Vertical Gradient						0.919	NA	0.792	0.855

A negative vertical gradient indicates an upward gradient.
A positive vertical gradient indicates a downward gradient.
bgs - Below ground surface.
ft - Feet.
OB - Overburden.
OS - Ohio Shale.
DL - Delaware limestone.
OLS - Olentangy shale.
Identifies monitoring wells of the Powerhouse 2 Ash Pits Area.

Table 5-4

Detected Constituents in Surface and Subsurface Soil Samples Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-SB01						AP2-SB02									
				Sample Number:	AP0100		AP0101		AP0102		AP0103		AP0104		AP0105		AP0106		AP0107	
				Sample Date:	15-Jan-09		15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface		Surface		Subsurface		Subsurface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		3 - 5 Ft		3 - 5 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG		REG		REG		FD		FS		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs																				
Aroclor 1016	mg/kg	0.39	NE	0.525	-	-	-	-	-	-	0.525	J	-	-	-	-	-	-	-	-
Aroclor 1260	mg/kg	0.22	NE	0.0162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEMIVOLATILES																				
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	0.0827	J	-	-	-	-	0.0464	J	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	0.0844	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	0.13	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	-	-	-	-	-	-	1.43		-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	0.0979	J	-	-	-	-	0.0639	J	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	0.132	J	-	-	-	-	0.131	J	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	0.0446	J	-	-	-	-	0.0559	J	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	0.0733	J	-	-	0.0855	J	0.0964	J	-	-	-	-	-	-	0.0544	J
Pyrene	mg/kg	170	NE	0.111	0.111	J	-	-	-	-	0.0894	J	-	-	-	-	-	-	-	-
METALS																				
Aluminum	mg/kg	7700	15500	15100	6,460	J	6,420	J	8,750	J	9,310	J	12,700	J	8,930	J	6,930		10,700	J
Antimony	mg/kg	3.1	9.3	0.958	0.81		0.269	J	0.355	J	0.958		0.362	J	0.287	J	-	-	0.626	
Arsenic	mg/kg	0.39	36.5	26.8	11.6		4.93		11.3		15.3		15.7	J	8.31	J	4		12.1	
Barium	mg/kg	1500	826	109	55.7	J	45.6		26.8		84.4	J	85.3	J	59.4	J	54.4		41.2	J
Beryllium	mg/kg	16	1	16.9	**4.74**		**5.97**		**6.72**		**15.3**	J	**9.06**	J	**6.76**	J	-	-	**7.06**	J
Cadmium	mg/kg	7	NE	0.716	0.436	J	-	-	-	-	0.381	J	-	-	-	-	-	-	-	-
Calcium	mg/kg	NE	52300	153000	47,200	J	4,310		47,400		7,110		23,300		16,100		7,170	J	46,600	
Chromium	mg/kg	0.29	29	22.4	8.64		11.5		13		11.1		19.8		13.7		10.6		16	
Cobalt	mg/kg	2.3	116	15.6	7.74		8.32		11.9		14.6	J	13.4	J	10.9	J	8.3		11.7	J
Copper	mg/kg	310	56.2	38.4	23.6	J	18.3	J	32	J	33.7	J	28.9	J	20.9	J	13.4		27.8	J
Iron	mg/kg	5500	234000	109000	14,300	J	16,500	J	23,100	J	61,300	J	30,500	J	19,400	J	13,300		23,200	J
Lead	mg/kg	40	48.6	50.7	**50.7**		8.39		13		22.5		13.8		11.9		7.5		18.9	
Magnesium	mg/kg	NE	10400	12200	8,960	J	2,350	J	**11,400**	J	1,560	J	8,640	J	4,940	J	3,340		**10,800**	J
Manganese	mg/kg	180	3506	726	354	J	172		386		546		726	J	351	J	320		431	
Mercury	mg/kg	2.3	0.09	0.118	**0.0959**		0.0245		0.0128	J	0.0539		0.0162	J	0.0164	J	-	-	-	-
Nickel	mg/kg	150	55.1	39.7	18.3	J	20.2		32.6		35.5		35.6		26.9		18.7		30.8	
PotaSurfaceium	mg/kg	NE	3390	2870	893	J	589		1,160		587		1,170		803		1,070	J	1,450	
Selenium	mg/kg	39	2	1.44	0.727	J	-	-	-	-	1.36		-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	152	55.1	B	68.7	B	107		60.4	B	93.9		64.9	B	-	-	152	
Thallium	mg/kg	NE	1.3	0.939	0.425	J	-	-	0.423	J	0.416	J	0.3	J	-	-	-	-	0.343	J
Vanadium	mg/kg	39	40.9	26.9	15.9		16.5		17.3		21.4		26.2		18.1		13		20.2	
Zinc	mg/kg	2300	322	102	64		67.4		59.1		88.6		74.6		66.2		43.5		62.9	
GENERAL CHEMISTRY																				
Total organic carbon	mg/kg	NE	NE	11400	-	-	-	-	-	-	11,400		-	-	-	-	-	-	-	-

Table 5-4

Detected Constituents in Surface and Subsurface Soil Samples Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location Code:		AP2-SB03						AP2-SB04						AP2-SB05					
			Sample Number:		AP0108		AP0109		AP0110		AP0111		AP0112		AP0113		AP0114		AP0115		AP0116	
			Sample Date:		18-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09		19-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			Sample Type:		Surface		Subsurface		Subsurface		Surface		Subsurface		Subsurface		Surface		Subsurface		Subsurface	
			Sample Depth:		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
			Sample Purpose:		REG		REG		REG		REG		REG		REG		REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs																						
Aroclor 1016	mg/kg	0.39	NE	0.525	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	mg/kg	0.22	NE	0.0162	0.0162	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEMIVOLATILES																						
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	0.0307		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	0.0599	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	-	-	-	-	-	-	-	-	-	-	-	-	0.0444	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	-	-	-	-	0.0667	J	-	-	-	-	0.0453	J	-	-	-	-	0.0491	J
Pyrene	mg/kg	170	NE	0.111	0.044	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
METALS																						
Aluminum	mg/kg	7700	15500	15100	8,070		15,000		7,720		7,130		7,830		8,670		8,800	J	8,060	J	9,300	J
Antimony	mg/kg	3.1	9.3	0.958	0.637		0.257	J	0.329	J	0.485		0.312	J	0.392	J	0.922		0.259	J	0.486	
Arsenic	mg/kg	0.39	36.5	26.8	7.71	J	5.27	J	12.6	J	26.8	J	4.51	J	12.1	J	24.4		6.27		11.1	
Barium	mg/kg	1500	826	109	69.4	J	98.9	J	18.6	J	98.4	J	61.5	J	35.6	J	109	J	68.2	J	49	J
Beryllium	mg/kg	16	1	16.9	**6.46**	J	**7.43**	J	**6.35**	J	16.3	J	**6.68**	J	**7.02**	J	**15.5**	J	**7.61**	J	**7.53**	J
Cadmium	mg/kg	7	NE	0.716	0.558		-	-	-	-	-	-	-	-	-	-	0.716		-	-	0.276	J
Calcium	mg/kg	NE	52300	153000	3,430	J	36,500	J	**54,300**	J	2,160	J	3,010	J	50,700	J	4,140		351		42,300	
Chromium	mg/kg	0.29	29	22.4	12	J	22.1	J	11.8	J	10.5	J	11.9	J	12.7	J	12.8		11.7		14.4	
Cobalt	mg/kg	2.3	116	15.6	8.68	J	10.8	J	10.7	J	5.96	J	7.88	J	11	J	8.29	J	6.67	J	14	J
Copper	mg/kg	310	56.2	38.4	22.5		29.8		29.6		26		20.9		38.4		31.3	J	15.6	J	33.6	J
Iron	mg/kg	5500	234000	109000	19,100		24,900		22,100		109,000		19,200		24,400		61,600	J	22,100	J	24,500	J
Lead	mg/kg	40	48.6	50.7	27.7	J	16.7	J	15.8	J	10.1	J	18.9	J	16	J	27.4		12.2		13.4	
Magnesium	mg/kg	NE	10400	12200	2,150	J	10,100	J	**10,400**	J	442	J	2,530	J	**10,800**	J	1,320	J	1,980	J	8,760	J
Manganese	mg/kg	180	3506	726	211		436		414		116		87.4		522		319		100		551	
Mercury	mg/kg	2.3	0.09	0.118	0.0642		0.013	J	0.0132	J	0.0265		0.0352		0.0147	J	**0.118**		0.0242	J	-	-
Nickel	mg/kg	150	55.1	39.7	21.7	J	31.5	J	27.4	J	17.1	J	24.8	J	28.8	J	20.5		18		36.8	
PotaSurfaceium	mg/kg	NE	3390	2870	745		1,570		1,110		827		705		1,150		837		513		990	
Selenium	mg/kg	39	2	1.44	0.928	J	-	-	-	-	0.678	J	0.859	J	-	-	1.44		-	-	0.779	J
Sodium	mg/kg	NE	NE	152	36.3	B	119		120		55.7	B	43.6	B	119		79.2		18.4	B	91.4	
Thallium	mg/kg	NE	1.3	0.939	0.47	J	0.35	J	0.336	J	0.468	J	-	-	0.315	J	0.939		-	-	0.347	J
Vanadium	mg/kg	39	40.9	26.9	18.7		25.3		15.4		26.9		17.8		17.5		23		17		18.2	
Zinc	mg/kg	2300	322	102	80	J	68.5	J	61.5	J	57	J	64.4	J	60.4	J	102		68.9		85.3	
GENERAL CHEMISTRY																						
Total organic carbon	mg/kg	NE	NE	11400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5-4

Detected Constituents in Surface and Subsurface Soil Samples Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location Code:		AP2-SB06						AP2-SB07									
			Sample Number:		AP0117		AP0118		AP0119		AP0120		AP0121		AP0122		AP0123		AP0124	
			Sample Date:		15-Jan-09		15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			Sample Type:		Surface		Subsurface		Subsurface		Surface		Surface		Surface		Subsurface		Subsurface	
			Sample Depth:		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		0 - 1 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
			Sample Purpose:		REG		REG		REG		REG		FD		FS		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs																				
Aroclor 1016	mg/kg	0.39	NE	0.525	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	mg/kg	0.22	NE	0.0162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEMIVOLATILES																				
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	0.622		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	-	-	-	-	0.0403	J	-	-	-	-	-	-	-	-	0.0798	J
Pyrene	mg/kg	170	NE	0.111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
METALS																				
Aluminum	mg/kg	7700	15500	15100	7,150	J	6,750	J	13,200	J	7,100	J	8,180	J	7,200		5,250	J	7,150	J
Antimony	mg/kg	3.1	9.3	0.958	0.708		0.412	J	0.44	J	0.336	J	0.291	J	-	-	0.269	J	0.479	
Arsenic	mg/kg	0.39	36.5	26.8	11.4		6.33		3.55		6.09		6.04		5.5		6.18		10.9	
Barium	mg/kg	1500	826	109	98.7		58.3		53.4	J	44.5		56.7		48.6		43.7		20.8	J
Beryllium	mg/kg	16	1	16.9	**12.1**		**6.9**		**7.73**	J	**6.01**		**6.41**		-	-	**5.46**		**6.31**	J
Cadmium	mg/kg	7	NE	0.716	0.423	J	0.293	J	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	mg/kg	NE	52300	153000	2,830		2,090		44,000		2,100		2,270		1,820	J	1,840		**153,000**	
Chromium	mg/kg	0.29	29	22.4	7.84		10.1		19.4		10.6		11.8		10.4		8.82		11	
Cobalt	mg/kg	2.3	116	15.6	4.64		8.93		14.6	J	8.14		8.99		7.7		7.46		11	J
Copper	mg/kg	310	56.2	38.4	22.2	J	12.6	J	32.1	J	18	J	16.5	J	14.6		13.8	J	31.5	J
Iron	mg/kg	5500	234000	109000	51,800	J	19,900	J	24,000	J	17,600	J	19,100	J	16,600		15,500	J	55,100	J
Lead	mg/kg	40	48.6	50.7	12.5		11.2		14.3		12.5		12.8		9.3		9.74		15.9	
Magnesium	mg/kg	NE	10400	12200	819	J	2,110	J	**12,000**	J	2,100	J	2,350	J	1,880		1,730	J	9,490	J
Manganese	mg/kg	180	3506	726	243		234		392		198		226		169		152		372	
Mercury	mg/kg	2.3	0.09	0.118	0.0688		0.0156	J	0.0132	J	0.0203	J	0.0193	J	-	-	0.0112	J	-	-
Nickel	mg/kg	150	55.1	39.7	13.7		21.8		36.7		19.1		20.2		17.9		18.5		32.5	
PotaSurfaceium	mg/kg	NE	3390	2870	616		426		1,730		450		470		703	J	323		1,060	
Selenium	mg/kg	39	2	1.44	0.737	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	152	76.3	B	37.1	B	135		28.4	B	28	B	-	-	43.3	B	116	
Thallium	mg/kg	NE	1.3	0.939	0.312	J	-	-	0.293	J	-	-	-	-	-	-	-	-	0.316	J
Vanadium	mg/kg	39	40.9	26.9	17.3		15.5		23.2		15.4		17.4		14.1		13.6		13.6	
Zinc	mg/kg	2300	322	102	53.2		63.7		73		63.2		27.8		51.4		55.4		52.7	
GENERAL CHEMISTRY																				
Total organic carbon	mg/kg	NE	NE	11400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5-4

Detected Constituents in Surface and Subsurface Soil Samples Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-SB08									
				Sample Number:	AP0125		AP0126		AP0127		AP0128		AP0129	
				Sample Date:	16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
				Sample Type:	Surface		Subsurface		Subsurface		Subsurface		Subsurface	
				Sample Depth:	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft	
				Sample Purpose:	REG		REG		REG		FD		FS	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs														
Aroclor 1016	mg/kg	0.39	NE	0.525	-	-	-	-	-	-	-	-	-	-
Aroclor 1260	mg/kg	0.22	NE	0.0162	-	-	-	-	-	-	-	-	-	-
SEMIVOLATILES														
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	-	-	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	-	-	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	-	-	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	-	-	-	-	-	-	-	-	-	-
Pyrene	mg/kg	170	NE	0.111	-	-	-	-	-	-	-	-	-	-
METALS														
Aluminum	mg/kg	7700	15500	15100	4,070	J	5,350	J	15,100	J	14,900	J	12,100	
Antimony	mg/kg	3.1	9.3	0.958	-	-	0.227	J	-	-	0.248	J	-	-
Arsenic	mg/kg	0.39	36.5	26.8	12.8		12.6		6.16		6.61		7	
Barium	mg/kg	1500	826	109	73.2	J	56	J	81	J	83.7	J	85	
Beryllium	mg/kg	16	1	16.9	**16.9**	J	**8.48**	J	**8.51**	J	**8.11**	J	-	-
Cadmium	mg/kg	7	NE	0.716	-	-	-	-	-	-	-	-	-	-
Calcium	mg/kg	NE	52300	153000	1,650		1,860		44,800		45,500		45,000	J
Chromium	mg/kg	0.29	29	22.4	6.13		8.82		22.4		21.9		18.5	
Cobalt	mg/kg	2.3	116	15.6	3.9	J	8.7	J	15.6	J	14.6	J	12.4	
Copper	mg/kg	310	56.2	38.4	21.3	J	11	J	31.1	J	30.1	J	23.9	
Iron	mg/kg	5500	234000	109000	72,600	J	28,000	J	26,600	J	28,500	J	23,900	
Lead	mg/kg	40	48.6	50.7	4.64		9.05		11.6		14.1		10.7	
Magnesium	mg/kg	NE	10400	12200	312	J	1,730	J	**12,200**	J	**11,500**	J	10,100	
Manganese	mg/kg	180	3506	726	98.2		196		473		432		363	
Mercury	mg/kg	2.3	0.09	0.118	0.034		0.0151	J	-	-	-	-	-	-
Nickel	mg/kg	150	55.1	39.7	10.5		22		39.7		38		32.8	
PotaSurfaceium	mg/kg	NE	3390	2870	477		371		1,980		1,990		2,870	J
Selenium	mg/kg	39	2	1.44	0.914	J	-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	152	36.4	B	27.4	B	145		134		-	-
Thallium	mg/kg	NE	1.3	0.939	0.308	J	-	-	-	-	-	-	-	-
Vanadium	mg/kg	39	40.9	26.9	18.8		15.1		25.4		24.7		20.5	
Zinc	mg/kg	2300	322	102	41.4		58.9		76.6		73.4		61.3	
GENERAL CHEMISTRY														
Total organic carbon	mg/kg	NE	NE	11400	-	-	-	-	-	-	-	-	-	-

Table 5-4

Detected Constituents in Surface and Subsurface Soil Samples Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

NE - Not established (RBSCs), not evaluated (BSCs).
Shaded cell indicates value is greater than RBSC.
Bold text indicates value is greater than the BSC.
RBSC - Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1. For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
MDC - Maximum detected concentration for the AOC ("B" qualified data not included).
BSC - Background screening concentration.
"-" - Not Detected.
mg/kg - Milligrams per kilogram.

Validation Qualifiers (VQ)
J - The analyte was postively identifed; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

Table 5-5

Detected Constituents in Surface Water Samples Above RBSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION CODE	AP2-SW01		AP2-SW02		AP2-SW03						AP2-SW04		AP2-SW05	
			SAMPLE NO	AP2000		AP2001		AP2002		AP2003		AP2004		AP2005		AP2006	
			SAMPLE DATE	24-May-09		24-May-09		24-May-09		24-May-09		24-May-09		25-May-09		25-May-09	
			DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE PURPOSE	REG		REG		REG		FD		FS		REG		REG	
Parameter	Units	RBSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES																	
Bis(2-ethylhexyl)phthalate	µg/L	48	2	-	-	-	-	-	-	2	J	-	-	-	-	-	-
METALS																	
Aluminum	µg/L	37000	1030	720		531		357		377		368		1,030	J	359	
Barium	µg/L	7300	50.9	48.4	J	46.8	J	44.7	J	45.3	J	-	-	50.9	J	43.9	J
Calcium	µg/L	NE	80900	79,100		78,800		76,400		77,400		80,900		80,700		75,900	
Cobalt	µg/L	11	1.2	-	-	-	-	-	-	-	-	-	-	1.2	J	-	-
Iron	µg/L	26000	1060	1,060		700		451		455		546		1,020		376	
Lead	µg/L	NE	2.9	-	-	-	-	2.9	J	-	-	-	-	2.9	J	-	-
Magnesium	µg/L	NE	22300	21,400		21,200		20,500		20,800		22,300	J	20,700		19,800	
Manganese	µg/L	880	102	102		63		52.6		52.9		53.4		83.1		53.3	
Nickel	µg/L	730	6.2	-	-	-	-	-	-	-	-	-	-	6.2	J	-	-
Potassium	µg/L	NE	4400	3,290	J	3,340	J	3,150	J	3,190	J	-	-	4,400	J	2,900	J
Sodium	µg/L	NE	40000	32,800		32,700		32,100		32,800		40,000		34,800		30,300	
Vanadium	µg/L	180	3.1	2.6	J	1.8	J	1.7	J	1.6	J	-	-	3.1	J	2	J
Zinc	µg/L	11000	12.4	12.1	J	12.4	J	-	-	8.1	J	-	-	10.6	J	9.9	J
GENERAL CHEMISTRY																	
HARDNESS (as CaCO3)	µg/L	NE	286000	286,000		-	-	-	-	-	-	-	-	-	-	-	-

RBSC - Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.
For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
MDC - Maximum detected concentration for the AOC ("B" qualified data not included).
"-" - Not Detected.
µg/L - Parts per billion.
NE - Not established.

Validation Qualifiers (VQ)
J - The analyte was postively identifed; the reported value is estimated.

Table 5-6

Detected Constituents in Sediment Samples Above RBSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Location Code:	AP2-SD01		AP2-SD02		AP2-SD03		AP2-SD04						AP2-SD05	
			Sample No.:	AP1000		AP1001		AP1002		AP1003		AP1004		AP1005		AP1006	
			Sample Date:	24-May-09		24-May-09		24-May-09		25-May-09		25-May-09		25-May-09		25-May-09	
			Sample Depth:	0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft	
			Sample Purpose:	REG		REG		REG		REG		FD		FS		REG	
Parameter	Units	RBSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
EXPLOSIVES																	
Trinitrotoluene, 2,4,6-	mg/kg	36	0.0647	-	-	-	-	0.0647	J	-	-	-	-	-	-	-	-
SEMIVOLATILES																	
Fluoranthene	mg/kg	2300	0.0547	-	-	-	-	0.0525	J	-	-	-	-	-	-	0.0547	J
METALS																	
Aluminum	mg/kg	77000	8000	3,640		6,310		7,220		8,000		6,840		6,780		4,690	
Arsenic	mg/kg	3.9	10.1	4.1		5.1		10.1	J	9.3		7.8		8.8		3.9	
Barium	mg/kg	15000	67.1	22.8		43.5		67.1	J	59.8		50		53		43.1	
Beryllium	mg/kg	160	0.59	0.36		0.49		0.52		0.59		0.53		-	-	0.42	
Cadmium	mg/kg	70	0.6	0.24	J	0.37		-	-	0.6		0.53		-	-	0.26	J
Calcium	mg/kg	NE	37600	7,660		26,000		12,900	J	28,700		25,200		37,600		9,790	
Chromium	mg/kg	2.9	12.8	6.4		10.5		8.6	J	12.8		10.5		11.6		7.7	
Cobalt	mg/kg	23	14.1	7.4		7.4		6.2	J	14.1		9.8		9.9		8	
Copper	mg/kg	3100	23.7	9.6		14.2		17.2		23.7		20.4		22.8		12.2	
Iron	mg/kg	55000	39100	10,400		14,000		39,100	J	19,400		17,700		20,700		10,400	
Lead	mg/kg	400	15.2	7.9		7.9		10.6	J	15.2	J	9.1	J	11		9.7	
Magnesium	mg/kg	NE	8170	1,950		7,440		7,470	J	6,110		6,040		8,170		2,450	
Manganese	mg/kg	1800	668	127		379		151	J	668		547		413		187	
Mercury	mg/kg	23	0.025	-	-	0.018	J	0.016	J	0.015	J	0.019	J	-	-	0.025	J
Nickel	mg/kg	1500	27.6	15.7		16.1		16	J	27.6		22.6		27.1		17.8	
Potassium	mg/kg	NE	1850	498	J	1,300		1,060	J	1,850		1,470		1,420		628	J
Selenium	mg/kg	390	1	1	J	0.39	J	0.92	J	0.83	J	0.48	J	-	-	0.96	J
Silver	mg/kg	390	0.083	-	-	-	-	0.083	J	-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	170	85.2	J	157	J	54.8	J	170	J	157	J	-	-	123	J
Vanadium	mg/kg	390	15.2	9.4		15.2		13.6	J	14.9		12.5		13.3		11.1	
Zinc	mg/kg	23000	62.5	34.7		38.9		27	J	59.7		54.9		62.5		45.1	
GENERAL CHEMISTRY																	
Total organic carbon	mg/kg	NE	0.57	0.57		-	-	-	-	-	-	-	-	-	-	-	-

NE - Not established (RBSCs).

Shaded cell indicates value is greater than RBSC.

RBSC - Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.

For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.

MDC - Maximum detected concentration for the AOC ("B" qualified data not included).

"-" - Not Detected.

mg/kg - Parts per million.

Validation Qualifiers (VQ)

J - The analyte was postively identifed; the reported value is estimated.

Table 5-7

Detected Constituents in Temporary Piezometers Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits SCR
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-PZ03		AP2-PZ04		AP2-PZ07					
				Sample Number:	AP3018		AP3019		AP3022		AP3015		AP3016	
				Sample Date:	31-Jan-09		1-Feb-09		2-Feb-09		2-Feb-09		2-Feb-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		REG		REG		FD		FS	
				Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Semivolatiles														
Dimethylphenol, 2,4-	µg/L	73	NE	3.38	-	-	-	-	-	-	3.38	J	-	-
Metals-Unfiltered														
Aluminum	µg/L	3,700	309	2,400	**2,400**		74.3	J	147	J	93.3	J	-	-
Barium	µg/L	730	11,800	51	51.1		24		31.9		31.3		-	-
Cadmium	µg/L	1.8	NE	4.3	4.16	J	4.28	J	3.91	J	4.27	J	-	-
Calcium	µg/L	NE	316,000	179,000	179,000		135,000		110,000		110,000		101,000	
Cobalt	µg/L	1.1	12.1	0.0	-	-	-	-	-	-	-	-	-	-
Copper	µg/L	150	19.8	12.3	12.3		5.63	J	-	-	5.71	J	-	-
Iron	µg/L	2,600	1,550	5,060	5,060		203		593	J	325	J	191	
Lead	µg/L	15	NE	3.02	3.02	J	-	-	-	-	-	-	-	-
Magnesium	µg/L	NE	217,000	42,700	42,700		39,600		31,900		32,200		29,200	
Manganese	µg/L	88	636	52	51.8		22.1		24.5		21.6		20.7	
Nickel	µg/L	73	8.6	6.3	6.28	J	5.36	J	-	-	4	J	-	-
Potassium	µg/L	NE	116,000	1,260	1,260		405	J	548	J	521	J	-	-
Selenium	µg/L	18	NE	7.6	7.55	J	-	-	-	-	-	-	-	-
Sodium	µg/L	NE	1,390,000	12,200	12,200		9,150		6,990		6,860		6,380	
Vanadium	µg/L	18	NE	5.4	5.39		-	-	-	-	-	-	-	-
Zinc	µg/L	1,100	507	0.0	-	-	-	-	-	-	-	-	-	-
Metals-Filtered														
Aluminum	µg/L	3,700	309	0.0	-	-	-	-	-	-	-	-	-	-
Barium	µg/L	730	11,800	34.9	34.9		22.8		28.2		29.3		-	-
Cadmium	µg/L	1.8	NE	4.4	4.36	J	4.13	J	3.9	J	3.98	J	-	-
Calcium	µg/L	NE	316,000	172,000	172,000		135,000		103,000		108,000		103,000	
Cobalt	µg/L	1.1	12.1	0.0	-	-	-	-	-	-	-	-	-	-
Copper	µg/L	150	19.8	6.9	6.9	J	-	-	-	-	-	-	-	-
Lead	µg/L	15	NE	0.00	-	-	-	-	-	-	-	-	-	-
Magnesium	µg/L	NE	217,000	42,800	42,800		40,800		31,400		31,100		29,900	
Manganese	µg/L	88	636	31	-	-	16.2		19		17.1		30.7	
Nickel	µg/L	73	8.6	0.0	-	-	-	-	-	-	-	-	-	-
Potassium	µg/L	NE	116,000	0,510	510	J	346	J	May 2009	J	445	J	-	-
Selenium	µg/L	18	NE	6.8	6.82	J	-	-	-	-	-	-	-	-
Sodium	µg/L	NE	1,390,000	12,500	12,500		9,280		7,000		6,840		6,180	
Vanadium	µg/L	18	NE	0.0	-	-	-	-	-	-	-	-	-	-
Zinc	µg/L	1,100	507	0.0	-	-	-	-	-	-	-	-	-	-
Water Quality Parameters														
Alkalinity	µg/L	NE	NE	260,000	231,000		132,000		169,000		222,000		260,000	
Chloride	µg/L	NE	NE	11,600	11,600	J	5,140	J	3,040	J	2,810	J	2,100	
Cyanide, total	µg/L	73	NE	44									44	
Hardness	µg/L	NE	NE	622,000	622,000		501,000		407,000		408,000		620,000	
HARDNESS (as CaCO3)	µg/L	NE	NE	0										
Nitrate-Nitrite	µg/L	NE	NE	566	566	J	49	J	28	J	-	-		
Sulfate	µg/L	NE	NE	341,000	341,000		236,000		80,600		79,600		177,000	
Total dissolved solids	µg/L	NE	NE	804,000	804,000		619,000		450,000		442,000		450,000	
Total suspended solids	µg/L	NE	NE	59,000	59,000		3,000	J	4,000		-	-	-	-
Turbidity	NTU	NE	NE	51.50	51.5	J	4.56	J	4.52		4.93		1.3	

NE - Not established (RBSCs), not evaluated (BSCs).
NA - Not analyzed.
Shaded cell indicates value is greater than RBSC.
Bold text indicates value is greater than the BSC.
RBSC - Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.
For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
MDC - Maximum detected concentration for the AOC ("B" qualified data not included).
BSC - Background screening concentration.
"-" - Not Detected.
µg/L - Micrograms per liter.
mg/L - Milligrams per liter.
NM - Not measured.

Validation Qualifiers (VQ)
J - The analyte was postively identifed; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

Table 5-8

Detected Constituents in Overburden/Shale Monitoring Wells Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-MW01		AP2-MW02						AP2-MW03	
				Sample Number:	AP3057		AP3058		AP3059		AP3060		AP3061	
				Sample Date:	23-May-09		25-May-09		25-May-09		26-May-09		24-May-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		REG		FD		FS		REG	
				Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Semivolatiles														
Dimethylphenol, 2,4-	µg/L	73	NE	0	-	-	-	-	-	-	-	-	-	-
Metals-Unfiltered														
Aluminum	µg/L	3,700	309	0,133	133	J	79.1	J	77.6	J	-	-	47.1	J
Barium	µg/L	730	11,800	98	98	J	25.3	J	24.5	J	-	-	25.2	J
Cadmium	µg/L	1.8	NE	1.1	-	-	1.1	J	1	J	-	-	-	-
Calcium	µg/L	NE	316,000	112,000	112,000		102,000		102,000		94,900		54,400	
Cobalt	µg/L	1.1	12.1	8.3	-	-	7.9	J	8.3	J	-	-	-	-
Copper	µg/L	150	19.8	0.0	-	-	-	-	-	-	-	-	-	-
Iron	µg/L	2,600	1,550	81	80.8	J	-	-	-	-	-	-	37	J
Lead	µg/L	15	NE	2.40	2.4	J	-	-	-	-	-	-	-	-
Magnesium	µg/L	NE	217,000	38,700	38,700		11,600		11,600		10,800		12,700	
Manganese	µg/L	88	636	229	82.2		229		229		212		173	
Nickel	µg/L	73	8.6	74.2	-	-	**74.2**		**74.2**		**68.9**		-	-
Potassium	µg/L	NE	116,000	8,940	4,150	J	7,690	J	7,410	J	8,940		1,500	J
Selenium	µg/L	18	NE	5.7	-	-	-	-	-	-	-	-	5.7	B
Sodium	µg/L	NE	1,390,000	10,200	7,440	J	2,560	J	2,460	J	-	-	10,200	J
Vanadium	µg/L	18	NE	3.7	3.7	J	-	-	-	-	-	-	1.4	J
Zinc	µg/L	1,100	507	42.6	-	-	42.6		33.9		29.9		-	-
Metals-Filtered														
Aluminum	µg/L	3,700	309	45.4	-	-	45.4	J	44	J	-	-	-	-
Barium	µg/L	730	11,800	88.1	88.1	J	23.9	J	23.6	J	-	-	22.3	J
Cadmium	µg/L	1.8	NE	0.0	-	-	-	-	-	-	-	-	-	-
Calcium	µg/L	NE	316,000	103,000	102,000		96,400		93,100		103,000		47,200	
Cobalt	µg/L	1.1	12.1	8.9	-	-	8.9	J	8.7	J	-	-	-	-
Copper	µg/L	150	19.8	0.0	-	-	-	-	-	-	-	-	-	-
Lead	µg/L	15	NE	2.10	2.1	B	-	-	-	-	-	-	-	-
Magnesium	µg/L	NE	217,000	34,100	34,100		11,000		10,600		11,900	J	11,500	
Manganese	µg/L	88	636	220	72.3		220		214		218		171	
Nickel	µg/L	73	8.6	74.5	-	-	**74.5**		**72.1**		**72.6**		-	-
Potassium	µg/L	NE	116,000	9,500	5,030	J	9,090	J	8,950	J	9,500		1,950	J
Selenium	µg/L	18	NE	3.5	3.5	J	-	-	-	-	-	-	-	-
Sodium	µg/L	NE	1,390,000	11,000	8,520	J	3,030	J	2,930	J	-	-	11,000	
Vanadium	µg/L	18	NE	3.5	3.5		-	-	-	-	-	-	-	-
Zinc	µg/L	1,100	507	33.6	-	-	33.6		32.4		31		-	-

Table 5-8

Detected Constituents in Overburden/Shale Monitoring Wells Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

				Location Code:	AP2-MW01		AP2-MW02						AP2-MW03	
				Sample Number:	AP3057		AP3058		AP3059		AP3060		AP3061	
				Sample Date:	23-May-09		25-May-09		25-May-09		26-May-09		24-May-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		REG		FD		FS		REG	
				Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Water Quality Parameters														
Alkalinity	µg/L	NE	NE	362,000	362,000		70,300		73,400		72,000		116,000	
Chloride	µg/L	NE	NE	12,600	4,600		4,100		3,600		12,600		6,500	
Cyanide, total	µg/L	73	NE	0	-	-	-	-	-	-	-	-	-	-
Hardness	µg/L	NE	NE	330,000							330,000			
HARDNESS (as CaCO3)	µg/L	NE	NE	439,000	439,000		300,000		302,000				188,000	
Nitrate-Nitrite	µg/L	NE	NE	10,900	65	J	10,900		10,900		8,700		610	
Sulfate	µg/L	NE	NE	173,000	81,500		165,000		159,000		173,000		94,900	
Total dissolved solids	µg/L	NE	NE	508,000	294,000	J	507,000	J	508,000	J	460,000		295,000	J
Total suspended solids	µg/L	NE	NE	4,000	-	-	-	-	4,000	J	-	-	-	-
Turbidity	NTU	NE	NE	1.00	-	-	-	-	-	-	-	-	1	J

NE - Not established (RBSCs), not evaluated (BSCs).
NA - Not analyzed.
Shaded cell indicates value is greater than RBSC.
Bold text indicates value is greater than the BSC.
RBSC - Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.
For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
MDC - Maximum detected concentration for the AOC ("B" qualified data not included).
BSC - Background screening concentration.
"-" - Not Detected.
µg/L - Micrograms per liter.
mg/L - Milligrams per liter.
NM - Not measured.

Validation Qualifiers (VQ)
J - The analyte was postively identifed; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

Table 5-9

Detected Constituents in Bedrock Monitoring Wells Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

(1 of 2)

					Location Code:	AP2-BEDGW-002								AP2-BEDGW-003							
					Sample Number:	AP3063		AP3079		AP3081		AP3082		AP3064		AP3065		AP3066		AP3080	
					Sample Date:	24-May-09		17-Nov-09		17-Nov-09		17-Nov-09		23-May-09		23-May-09		23-May-09		16-Nov-09	
					Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
					Sample Purpose:	REG		REG		FD		FS		REG		FD		FS		REG	
					Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Filtered	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatiles																					
Acetone	N	ug/L	2,200	NE	50.6	-	-	50.6	J	34.4	J	-	-	-	-	-	-	-	-	86.1	J
Benzene	N	ug/L	0.41	2.4	100	**8.5**		**9.4**	J	**6.2**	J	**4.1**		**94.1**		**91.3**		**100**		**336**	
Butanone, 2-	N	ug/L	710	NE	7.4	7.4		2.4	J	-	-	-	-	4.3	J	4.9	J	-	-	-	-
Carbon disulfide	N	ug/L	100	NE	5.2	-	-	-	-	1.2	B	1.3		-	-	-	-	5.2		3.7	J
Chloroform	N	ug/L	0.19	NE	5.6	-	-	5.6	B	4	B	-	-	-	-	-	-	-	-	14.6	B
Chloromethane	N	ug/L	19	NE	7.7	-	-	7.7	J	3.5	J	-	-	-	-	-	-	-	-	44.9	J
Cyclohexane	N	ug/L	1,300	NE	74							54						74			
Dichloropropene, trans-1,3-	N	ug/L	NE	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	J
Ethylbenzene	N	ug/L	1.5	0.87	21	**9.6**		**9.7**	J	**6.6**	J	**5**		**17.7**		**17.2**		**21**		**57.1**	
Isopropylbenzene	N	ug/L	68	NE	5.8							2.5						5.8			
Methylcyclohexane	N	ug/L	NE	NE	39							39						29			
Methylene chloride	N	ug/L	4.8	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.4	B
Toluene	N	ug/L	230	1.7	54	**5.3**		**4.8**	J	**3.3**	J	**2.3**		**41.3**		**39.6**		**54**		**147**	
Xylenes, total	N	ug/L	20	5.5	260	**63.2**		**55.7**	J	**36.8**	J	**29**		**193**		**185**		**260**		**630**	
Semivolatiles																					
Dimethylphenol, 2,4-	N	ug/L	73	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	J
Methylnaphthalene, 2-	N	ug/L	15	NE	2.8	2.8	J	2.8	J	2.5	J	-	-	1.9	J	1.3	J	-	-	6.3	
Naphthalene	N	ug/L	0.14	NE	2.9	2	J	1.9	J	1.6	J	-	-	2.9	J	1.9	J	-	-	7.4	
Metals-Unfiltered																					
Aluminum	N	ug/L	3,700	309	46.7	42.8	J	46.7	J	45.5	J	-	-	-	-	17.4	J	-	-	33.9	J
Barium	N	ug/L	730	11,800	184	22.7	J	21.1	J	21.3	J	-	-	175	J	184	J	-	-	161	J
Cadmium	N	ug/L	1.8	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	N	ug/L	NE	316,000	404000	**377,000**		**392,000**	J	**385,000**	J	**404,000**		266,000	J	275,000		**317,000**		280,000	J
Cobalt	N	ug/L	1.1	12.1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	N	ug/L	150	19.8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	N	ug/L	2,600	1,550	283	283	J	-	-	-	-	194		-	-	33	J	-	-	-	-
Lead	N	ug/L	15	NE	2.4	-	-	-	-	2.4	B	-	-	-	-	-	-	-	-	-	-
Magnesium	N	ug/L	NE	217,000	124000	121,000		124,000		123,000		119,000		103,000	J	110,000		120,000		112,000	
Manganese	N	ug/L	88	636	53.7	53.7		11.1	J	10.7	J	-	-	5.9	J	5.4	J	-	-	7.1	J
Nickel	N	ug/L	73	8.6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	N	ug/L	NE	116,000	13300	7,740	J	10,900		11,000		7,380		13,300		11,500	J	11,300		15,600	
Selenium	N	ug/L	18	NE	21.3	-	-	21.3	J	17.7	J	-	-	6.7	B	14.3	B	-	-	12.4	J
Sodium	N	ug/L	NE	1,390,000	63000	26,400		32,100	J	32,100	J	28,500		56,600	J	58,500		63,000		61,100	J
Vanadium	N	ug/L	18	NE	1.6	1.6	J	1.1	J	-	-	-	-	1	J	1.3	J	-	-	-	-
Zinc	N	ug/L	1,100	507	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5-9

Detected Constituents in Bedrock Monitoring Wells Above RBSCs and/or BSCs
Powerhouse 2 Ash Pits Site Characterization Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

(2 of 2)

					Location Code:	AP2-BEDGW-002								AP2-BEDGW-003							
					Sample Number:	AP3063		AP3079		AP3081		AP3082		AP3064		AP3065		AP3066		AP3080	
					Sample Date:	24-May-09		17-Nov-09		17-Nov-09		17-Nov-09		23-May-09		23-May-09		23-May-09		16-Nov-09	
					Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
					Sample Purpose:	REG		REG		FD		FS		REG		FD		FS		REG	
					Low-Flow Sampled:	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Parameter	Filtered	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals-Filtered																					
Aluminum	Y	ug/L	3,700	309	39.3	16.2	J	37.4	B	39.3	B	-	-	-	-	12.4	J	-	-	40.8	B
Barium	Y	ug/L	730	11,800	186	22.6	J	19.8	J	18.8	J	-	-	171	J	186	J	-	-	164	J
Cadmium	Y	ug/L	1.8	NE	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	Y	ug/L	NE	316,000	411000	**389,000**		**347,000**	J	**335,000**	J	**411,000**		257,000		281,000		**323,000**		256,000	J
Cobalt	Y	ug/L	1.1	12.1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	Y	ug/L	150	19.8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	Y	ug/L	2,600	1,550	46.5	-	-	36.1	J	46.5	J	-	-	-	-	-	-	-	-	65.5	J
Lead	Y	ug/L	15	NE	2.1	2.1	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	Y	ug/L	NE	217,000	123000	119,000		118,000	J	113,000	J	121,000		98,700	J	108,000		123,000		109,000	J
Manganese	Y	ug/L	88	636	52.4	52.4		9.6	J	9.3	J	-	-	5.6	J	6.1	J	-	-	7.2	J
Nickel	Y	ug/L	73	8.6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	Y	ug/L	NE	116,000	13800	9,790	J	11,500	J	11,000	J	7,540		13,000		13,800		11,800		16,300	J
Selenium	Y	ug/L	18	NE	74.9	-	-	74.9	J	14.3	J	-	-	8.1	J	8.8	J	-	-	22.4	J
Sodium	Y	ug/L	NE	1,390,000	65900	28,900		33,100		31,400		29,100		55,700		58,700		65,900		63,100	
Vanadium	Y	ug/L	18	NE	2.3	1.1	J	2	J	2.3	J	-	-	1.2	J	1.1	J	-	-	2.6	J
Zinc	Y	ug/L	1,100	507	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Quality Parameters																					
Alkalinity	N	ug/L	NE	NE	649000	417,000		472,000	J	492,000	J	490,000		649,000	J	632,000		590,000		662,000	J
Chloride	N	ug/L	NE	NE	111000	40,600		74,200	J	46,900	J	48,800		111,000		105,000		93,600		118,000	
Cyanide, total	N	ug/L	73	NE	710	7.2	J	-	-	-	-	510		-	-	-	-	710		-	-
Hardness	N	ug/L	NE	NE	1600000							1,600,000						1,200,000			
HARDNESS (as CaCO3)	N	ug/L	NE	NE	1490000	1,440,000		1,490,000		1,460,000				1,090,000		1,140,000				1,160,000	
Nitrate-Nitrite	N	ug/L	NE	NE	2000	-	-	2,000	J	54	B			760	J	-	-	-	-	47	B
Sulfate	N	ug/L	NE	NE	1080000	946,000		776,000	J	1,070,000	J	1,080,000		519,000		476,000		626,000		496,000	
Total dissolved solids	N	ug/L	NE	NE	2240000	2,240,000	J	2,200,000	J	2,050,000	J	2,000,000		1,900,000	J	1,740,000	J	1,500,000		1,570,000	J
Total suspended solids	N	ug/L	NE	NE	18000	18,000		4,000	UJ	-	-	-	-	-	-	17,000		-	-	-	-
Turbidity	N	NTU	NE	NE	110	38.2	J	1.7	J	21.4	J	110		14	J	-	-	94		51.2	

NE - Not established (RBSCs), not evaluated (BSCs).
NA - Not Analyized.
Shaded cell indicates value is greater than RBSC.
Bold text indicates value is greater than the BSC.
RBSC - Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1.
For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
MDC - Maximum detected concentration for the AOC ("B" qualified data not included).
BSC - Background screening concentration.
"-" - Not Detected.
µg/L - Parts per billion.
mg/L - Parts per million.

Ferrous iron measured in field using Hach test kit.
Oxidation reduction potential - Final YSI water quality meter field measurement prior to groundwater sample collection.
NM - Not measured.

Validation Qualifiers (VQ)
J - The analyte was postively identifed; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

FIGURES

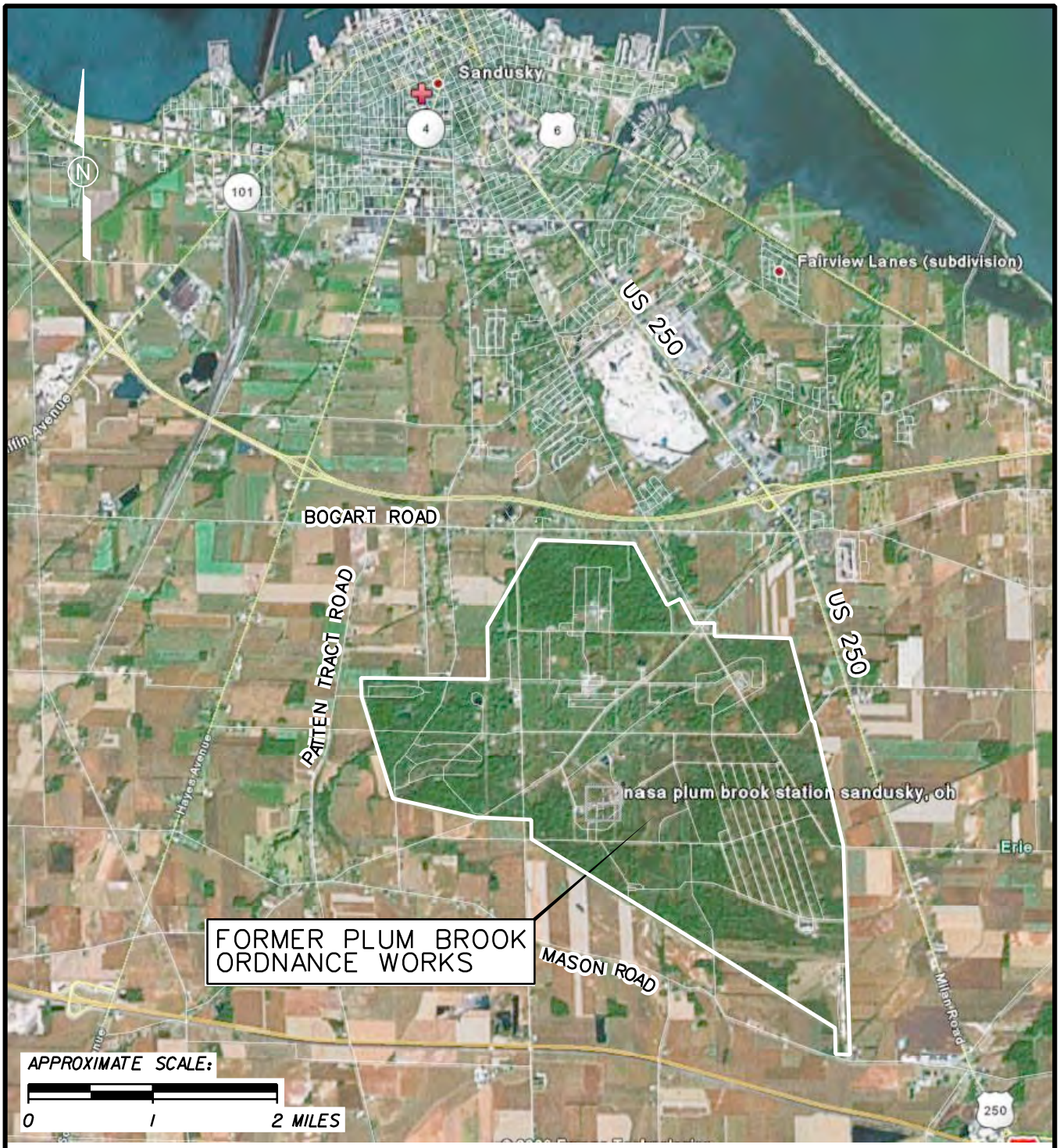

FIGURE 1-1
PBOW VICINITY MAP

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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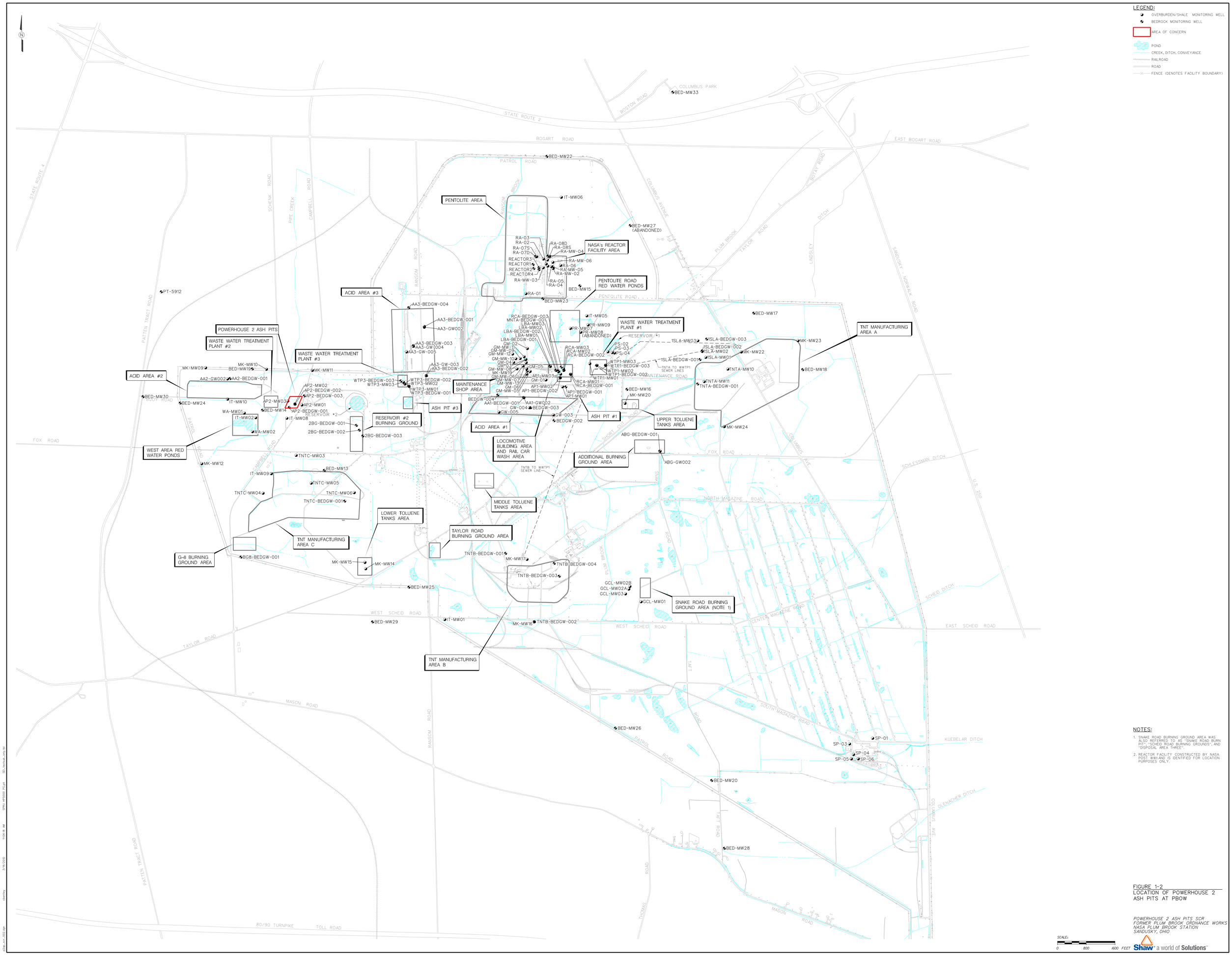
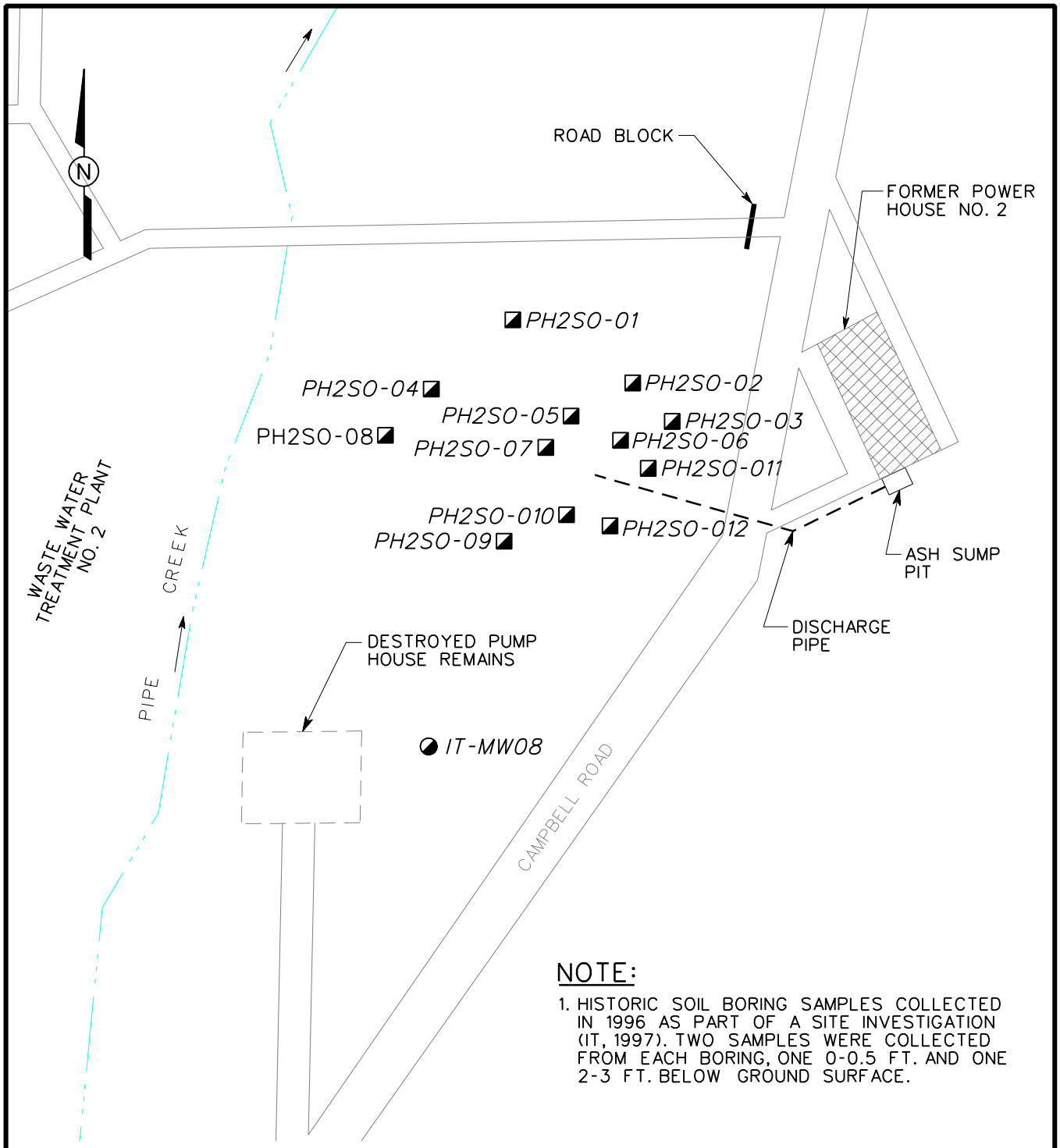


NOTES:

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

FIGURE 1-2
LOCATION OF POWERHOUSE 2 ASH PITS AT PBOW

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO



NOTE:

1. HISTORIC SOIL BORING SAMPLES COLLECTED IN 1996 AS PART OF A SITE INVESTIGATION (IT, 1997). TWO SAMPLES WERE COLLECTED FROM EACH BORING, ONE 0-0.5 FT. AND ONE 2-3 FT. BELOW GROUND SURFACE.

LEGEND:

- BUILDINGS
- DITCH
- HISTORIC SOIL BORING LOCATION (NOTE 1)
- EXISTING MONITORING WELL (OVERBURDEN/SHALE)

SCALE

0 200 400 FEET

FIGURE 1-3
HISTORIC SOIL BORING LOCATIONS POWERHOUSE 2 ASH PITS

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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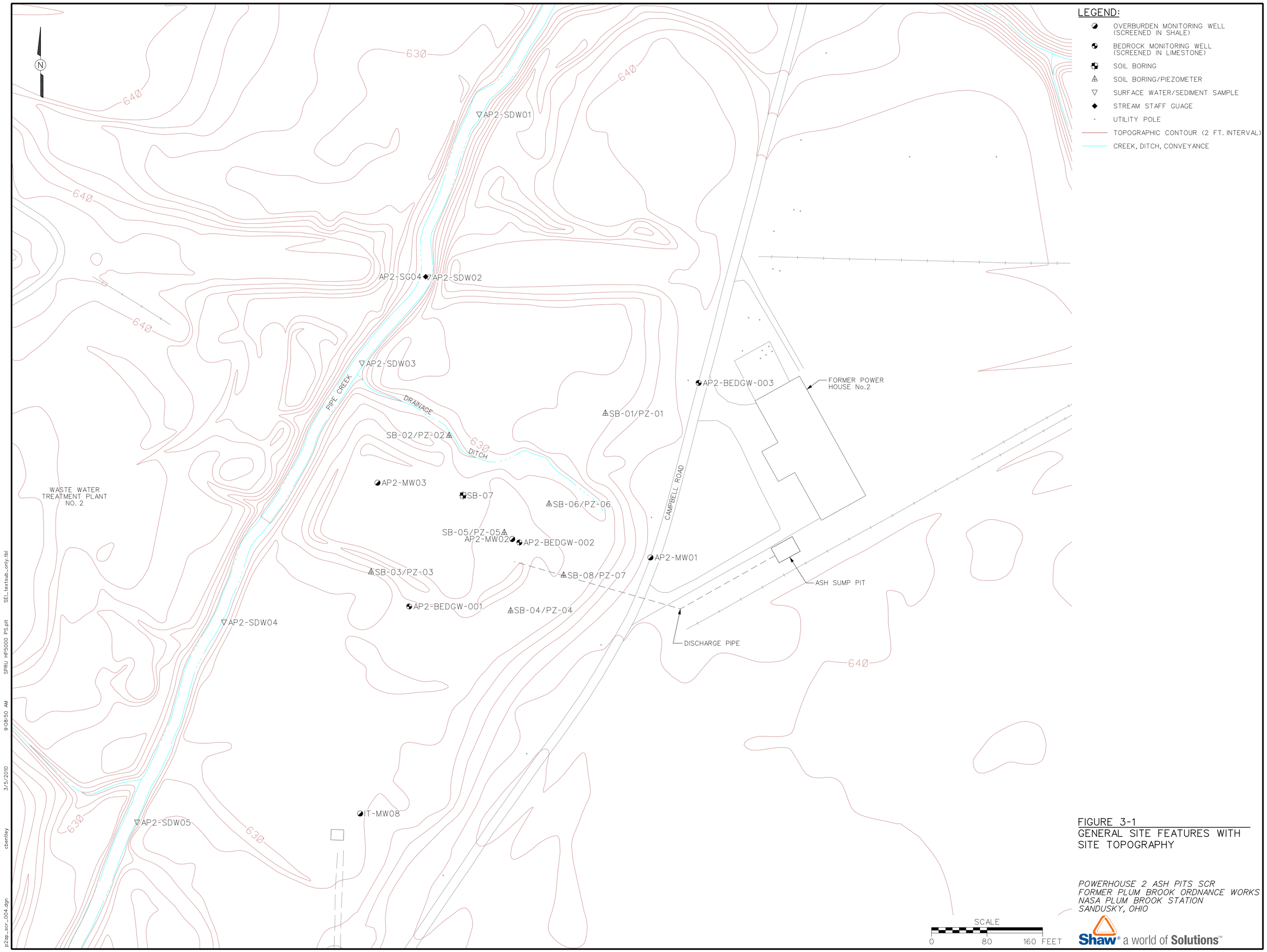

FIGURE 3-1
GENERAL SITE FEATURES WITH SITE TOPOGRAPHY

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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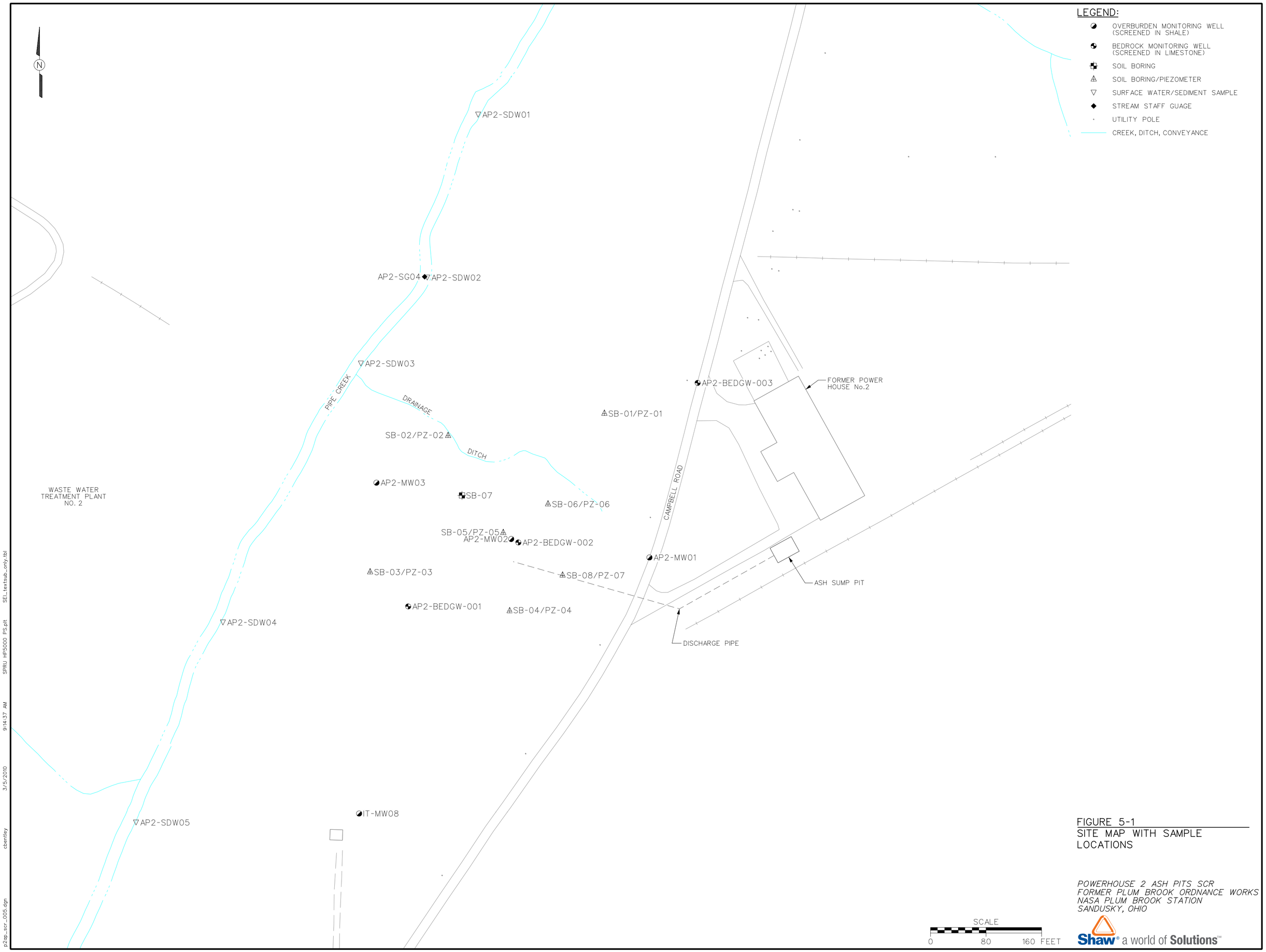
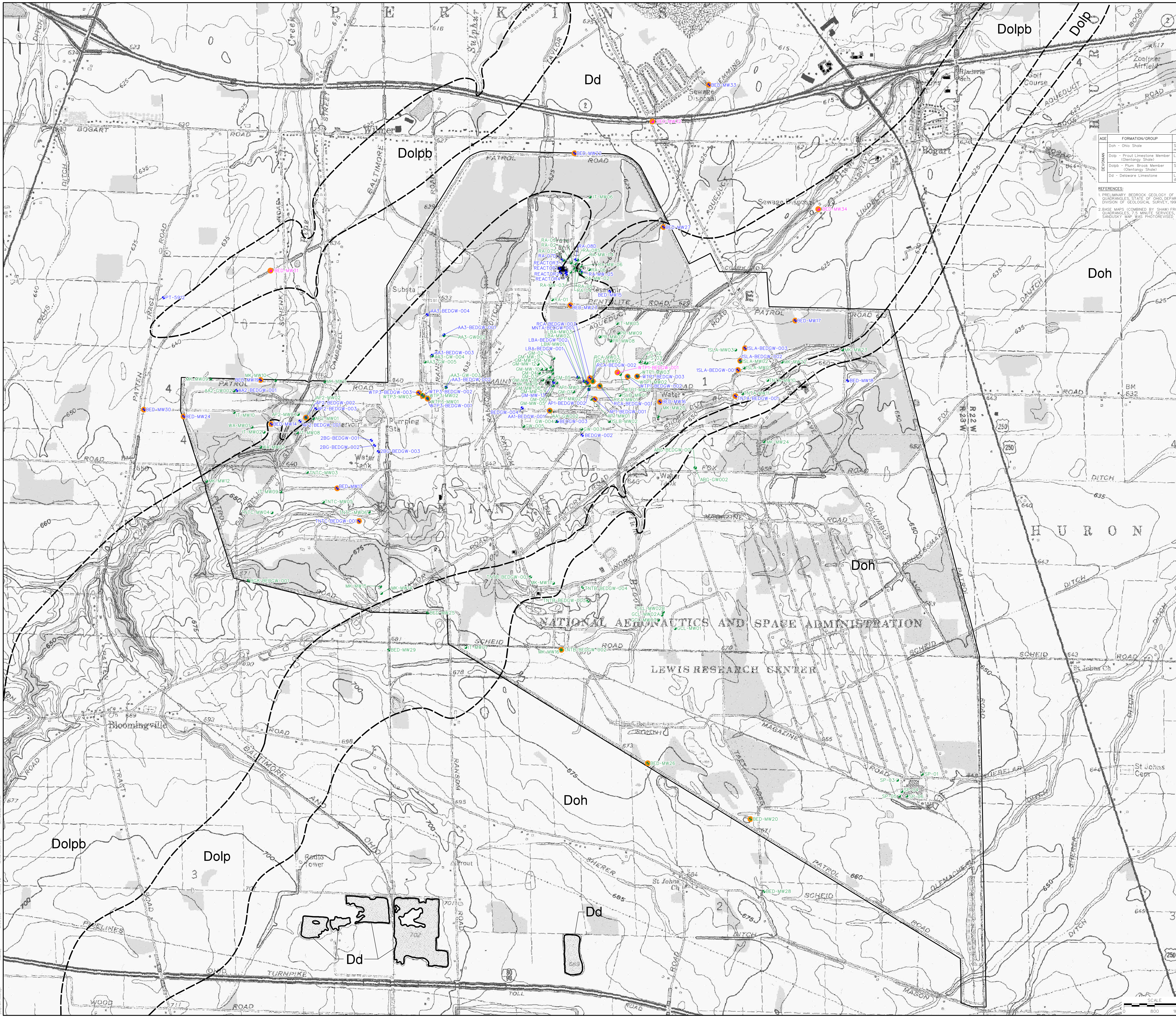


FIGURE 5-1
SITE MAP WITH SAMPLE LOCATIONS

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO



LEGEND:

- OVERBURDEN MONITORING WELL (SCREENED IN SHALE)
- BEDROCK MONITORING WELL (SCREENED IN SHALE)
- BEDROCK MONITORING WELL (SCREENED IN LIMESTONE)
- ABANDONED OVERBURDEN MONITORING WELL (SCREENED IN SHALE)
- ABANDONED BEDROCK MONITORING WELL (SCREENED IN LIMESTONE)
- ABANDONED BEDROCK WELL BORING
- H_2S AND/OR NATURAL GAS, AND/OR PETROLEUM HYDROCARBON WERE NOTED DURING BEDROCK DRILLING
- GEOLOGIC CONTACT; SOLID WHERE EXPOSED, DASHED WHERE CONCEALED BY SEDIMENTS

AGE	FORMATION/GROUP	ROCK DESCRIPTION
DEVONIAN	Doh - Ohio Shale	Shale: black, thin-bedded with bituminous and carboneous material, pyrite, natural gas pockets.
	Dolp - Prout Limestone Member (Olentangy Shale)	Limestone: light gray, calcareous.
	Dolpb - Plum Brook Member (Olentangy Shale)	Shale: dark gray, thin-bedded.
	Dd - Delaware Limestone	Limestone: buff, earthy, interbedded with brown crystalline dolomite, fossiliferous, hydrogen sulfide, petroleum hydrocarbon.

REFERENCES:

1. PRELIMINARY BEDROCK GEOLOGY OF THE KIMBALL AND SANDUSKY, OHIO, QUADRANGLES, STATE OF OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY, 1995.
2. BASE MAPS (COMBINED BY SHAW) FROM KIMBALL AND SANDUSKY QUADRANGLES, 7.5 MINUTE SERVICES, (TOPOGRAPHIC), 1969. SANDUSKY MAP WAS PHOTOREVISED 1979.

NOTES:

1. CONTACT LINES WERE ADJUSTED BASED ON 2009 MONITORING WELLS/SOIL BORING DATA.

FIGURE 5-2
REGIONAL GEOLOGIC MAP WITH WELL LOCATIONS

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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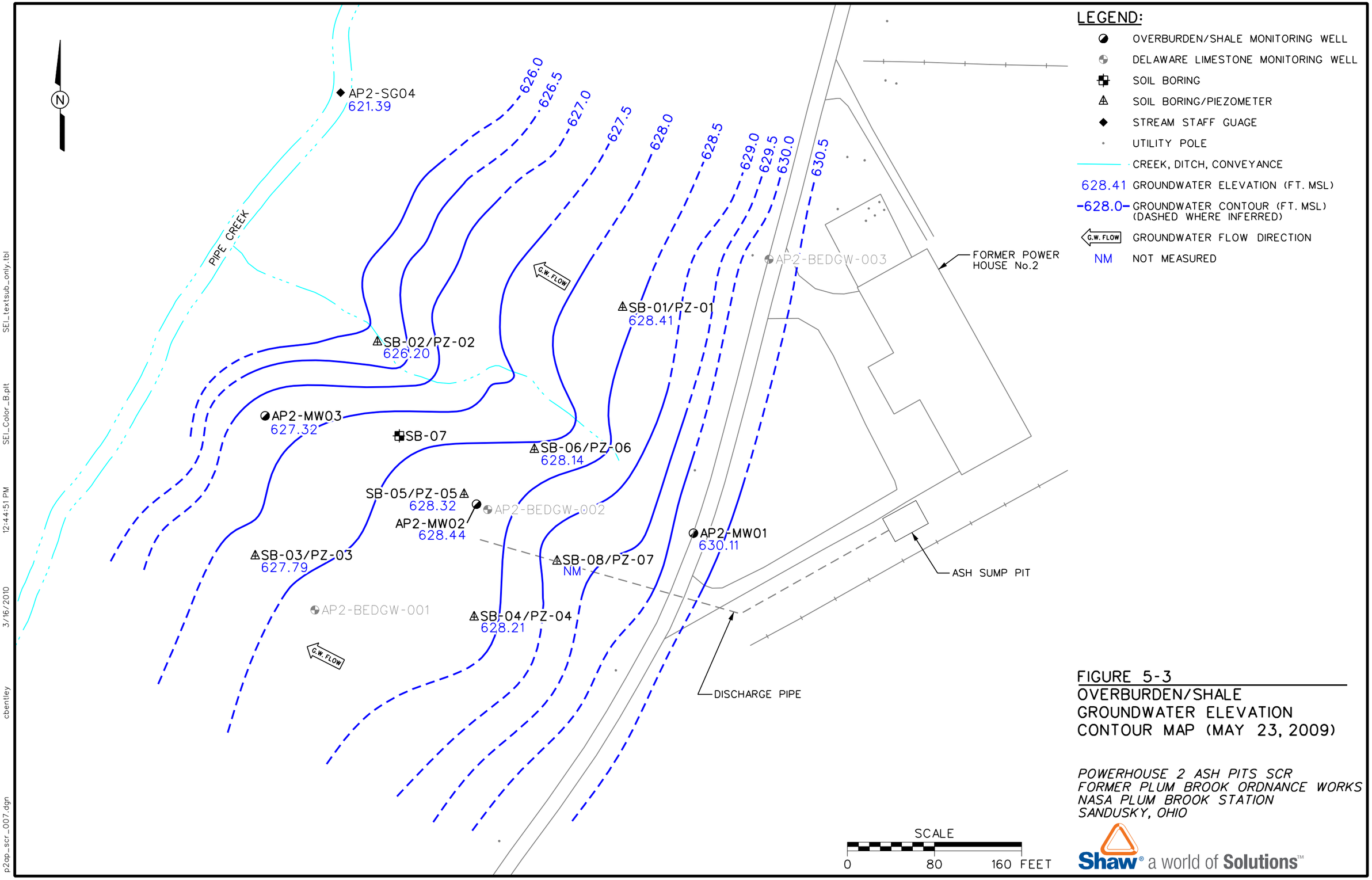

FIGURE 5-3
OVERBURDEN/SHALE
GROUNDWATER ELEVATION
CONTOUR MAP (MAY 23, 2009)

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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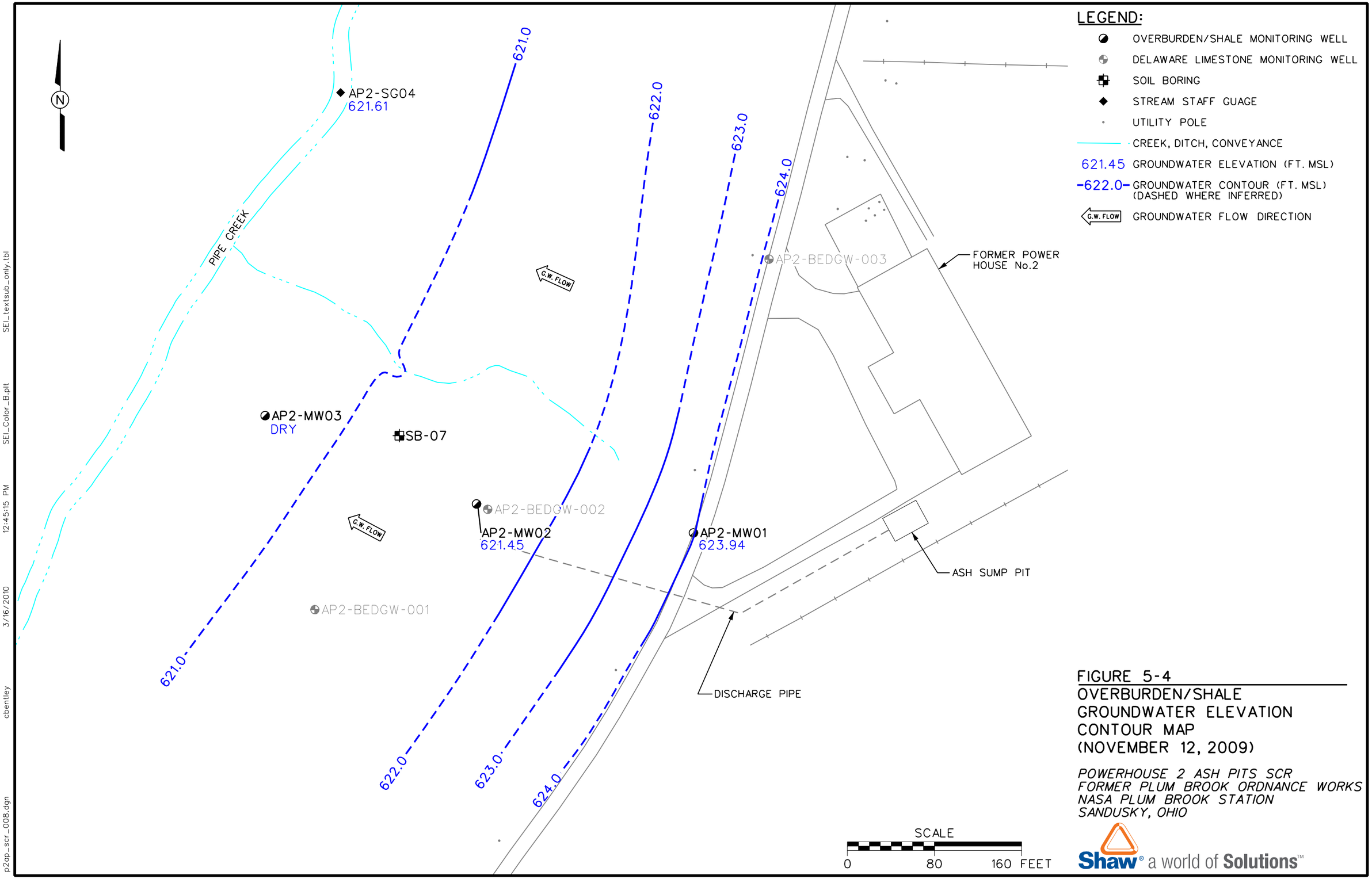

FIGURE 5-4
OVERBURDEN/SHALE GROUNDWATER ELEVATION CONTOUR MAP (NOVEMBER 12, 2009)

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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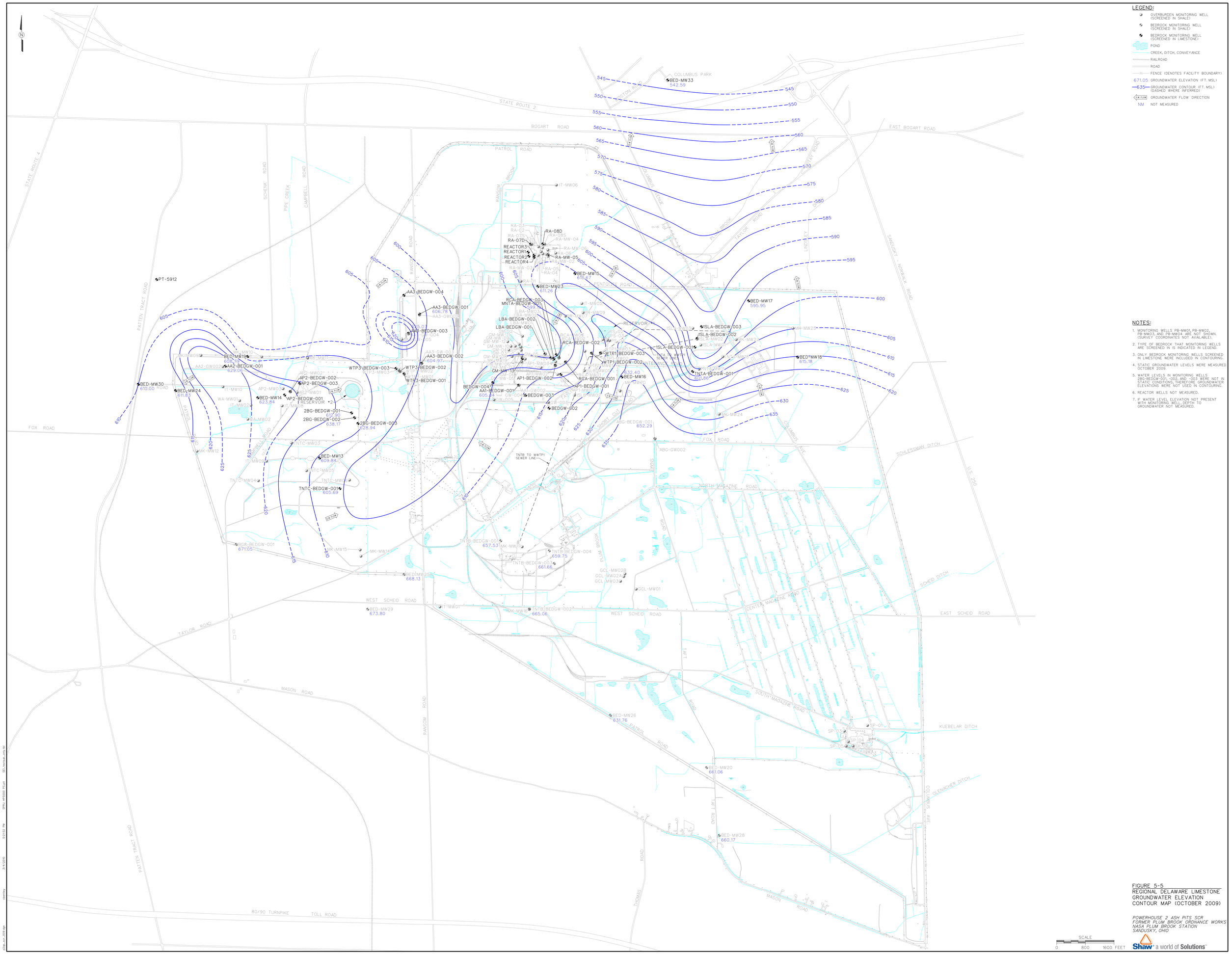
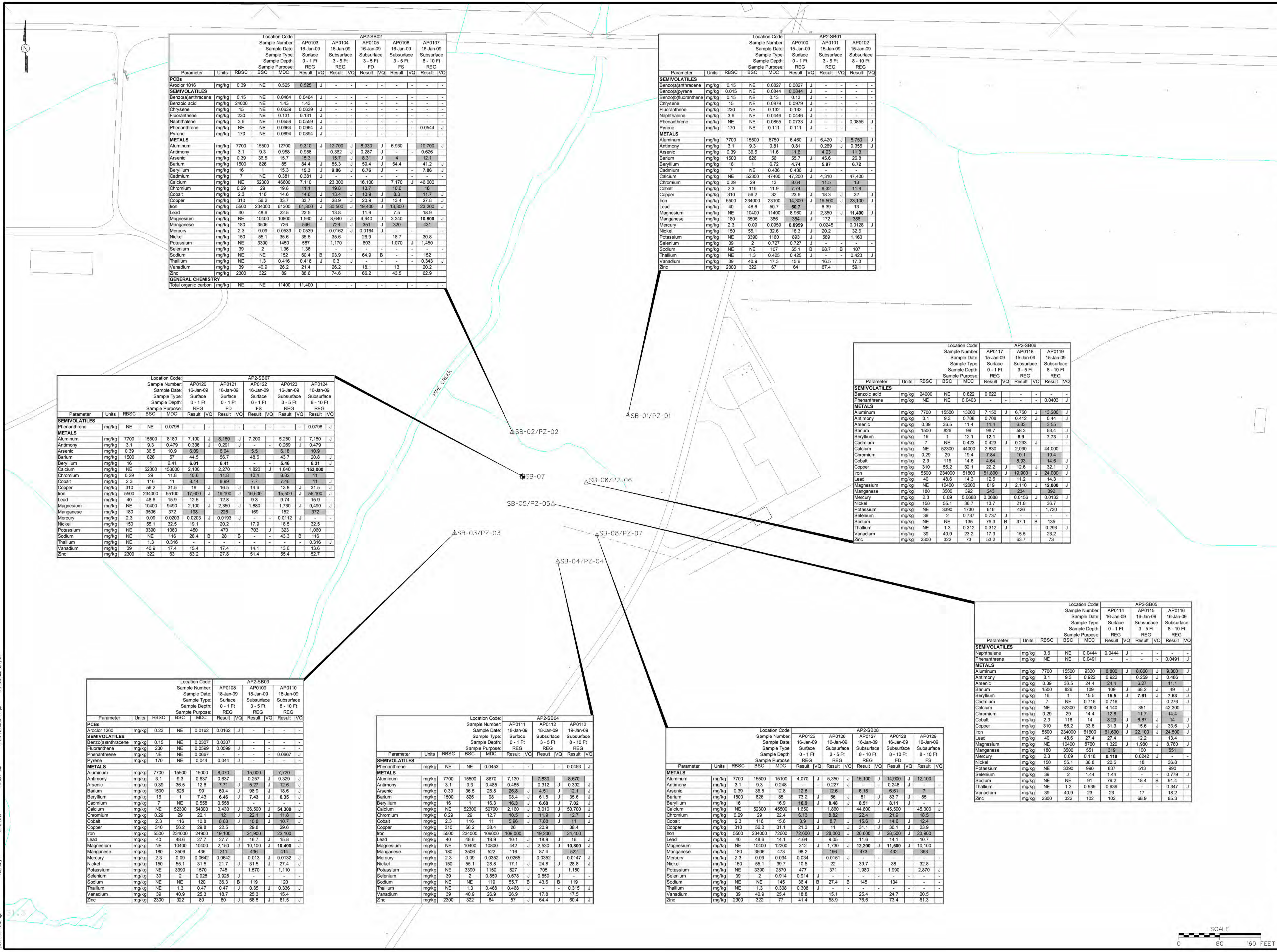


FIGURE 5-5
REGIONAL DELAWARE LIMESTONE GROUNDWATER ELEVATION CONTOUR MAP (OCTOBER 2009)

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO



Location Code:					AP2-SB02									
Sample Number:					AP0103		AP0104		AP0105		AP0106		AP0107	
Sample Date:					16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
Sample Type:					Surface		Subsurface		Subsurface		Subsurface		Subsurface	
Sample Depth:					0 - 1 Ft		3 - 5 Ft		3 - 5 Ft		3 - 5 Ft		8 - 10 Ft	
Sample Purpose:					REG		REG		FD		FS		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
PCBs														
Aroclor 1016	mg/kg	0.39	NE	0.525	0.525	J	-	-	-	-	-	-	-	-
SEMIVOLATILES														
Benzo(a)anthracene	mg/kg	0.15	NE	0.0464	0.0464	J	-	-	-	-	-	-	-	-
Benzoic acid	mg/kg	24000	NE	1.43	1.43		-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.0639	0.0639	J	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.131	0.131	J	-	-	-	-	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0559	0.0559	J	-	-	-	-	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0964	0.0964	J	-	-	-	-	-	-	0.0544	J
Pyrene	mg/kg	170	NE	0.0894	0.0894	J	-	-	-	-	-	-	-	-
METALS														
Aluminum	mg/kg	7700	15500	12700	9,310	J	12,700	J	8,930	J	6,930		10,700	J
Antimony	mg/kg	3.1	9.3	0.958	0.958		0.362	J	0.287	J	-	-	0.626	
Arsenic	mg/kg	0.39	36.5	15.7	15.3		15.7	J	8.31	J	4		12.1	
Barium	mg/kg	1500	826	85	84.4	J	85.3	J	59.4	J	54.4		41.2	J
Beryllium	mg/kg	16	1	15.3	**15.3**	J	**9.06**	J	**6.76**	J	-	-	**7.06**	J
Cadmium	mg/kg	7	NE	0.381	0.381	J	-	-	-	-	-	-	-	-
Calcium	mg/kg	NE	52300	46600	7,110		23,300		16,100		7,170	J	46,600	
Chromium	mg/kg	0.29	29	19.8	11.1		19.8		13.7		10.6		16	
Cobalt	mg/kg	2.3	116	14.6	14.6	J	13.4	J	10.9	J	8.3		11.7	J
Copper	mg/kg	310	56.2	33.7	33.7	J	28.9	J	20.9	J	13.4		27.8	J
Iron	mg/kg	5500	234000	61300	61,300	J	30,500	J	19,400	J	13,300		23,200	J
Lead	mg/kg	40	48.6	22.5	22.5		13.8		11.9		7.5		18.9	
Magnesium	mg/kg	NE	10400	10800	1,560	J	8,640	J	4,940	J	3,340		**10,800**	J
Manganese	mg/kg	180	3506	726	546		726	J	351	J	320		431	
Mercury	mg/kg	2.3	0.09	0.0539	0.0539		0.0162	J	0.0164	J	-	-	-	-
Nickel	mg/kg	150	55.1	35.6	35.5		35.6		26.9		18.7		30.8	
Potassium	mg/kg	NE	3390	1450	587		1,170		803		1,070	J	1,450	
Selenium	mg/kg	39	2	1.36	1.36		-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	152	60.4	B	93.9		64.9	B	-	-	152	
Thallium	mg/kg	NE	1.3	0.416	0.416	J	0.3	J	-	-	-	-	0.343	J
Vanadium	mg/kg	39	40.9	26.2	21.4		26.2		18.1		13		20.2	
Zinc	mg/kg	2300	322	89	88.6		74.6		66.2		43.5		62.9	
GENERAL CHEMISTRY														
Total organic carbon	mg/kg	NE	NE	11400	11,400		-	-	-	-	-	-	-	-

Location Code:					AP2-SB01					
Sample Number:					AP0100		AP0101		AP0102	
Sample Date:					15-Jan-09		15-Jan-09		15-Jan-09	
Sample Type:					Surface		Subsurface		Subsurface	
Sample Depth:					0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
Sample Purpose:					REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES										
Benzo(a)anthracene	mg/kg	0.15	NE	0.0827	0.0827	J	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.0844	0.0844	J	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.15	NE	0.13	0.13	J	-	-	-	-
Chrysene	mg/kg	15	NE	0.0979	0.0979	J	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.132	0.132	J	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.0446	0.0446	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0855	0.0733	J	-	-	0.0855	J
Pyrene	mg/kg	170	NE	0.111	0.111	J	-	-	-	-
METALS										
Aluminum	mg/kg	7700	15500	8750	6,460	J	6,420	J	8,750	J
Antimony	mg/kg	3.1	9.3	0.81	0.81		0.269	J	0.355	J
Arsenic	mg/kg	0.39	36.5	11.6	11.6		4.93		11.3	
Barium	mg/kg	1500	826	56	55.7	J	45.6		26.8	
Beryllium	mg/kg	16	1	6.72	**4.74**		**5.97**		**6.72**	
Cadmium	mg/kg	7	NE	0.436	0.436	J	-	-	-	-
Calcium	mg/kg	NE	52300	47400	47,200	J	4,310		47,400	
Chromium	mg/kg	0.29	29	13	8.64		11.5		13	
Cobalt	mg/kg	2.3	116	11.9	7.74		8.32		11.9	
Copper	mg/kg	310	56.2	32	23.6	J	18.3	J	32	J
Iron	mg/kg	5500	234000	23100	14,300	J	16,500	J	23,100	J
Lead	mg/kg	40	48.6	50.7	**50.7**		8.39		13	
Magnesium	mg/kg	NE	10400	11400	8,960	J	2,350	J	**11,400**	J
Manganese	mg/kg	180	3506	386	354	J	172		386	
Mercury	mg/kg	2.3	0.09	0.0959	**0.0959**		0.0245		0.0128	J
Nickel	mg/kg	150	55.1	32.6	18.3	J	20.2		32.6	
Potassium	mg/kg	NE	3390	1160	893	J	589		1,160	
Selenium	mg/kg	39	2	0.727	0.727	J	-	-	-	-
Sodium	mg/kg	NE	NE	107	55.1	B	68.7	B	107	
Thallium	mg/kg	NE	1.3	0.425	0.425	J	-	-	0.423	J
Vanadium	mg/kg	39	40.9	17.3	15.9		16.5		17.3	
Zinc	mg/kg	2300	322	67	64		67.4		59.1	

Location Code:					AP2-SB07									
Sample Number:					AP0120		AP0121		AP0122		AP0123		AP0124	
Sample Date:					16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
Sample Type:					Surface		Surface		Surface		Subsurface		Subsurface	
Sample Depth:					0 - 1 Ft		0 - 1 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
Sample Purpose:					REG		FD		FS		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES														
Phenanthrene	mg/kg	NE	NE	0.0798	-	-	-	-	-	-	-	-	0.0798	J
METALS														
Aluminum	mg/kg	7700	15500	8180	7,100	J	8,180	J	7,200		5,250	J	7,150	J
Antimony	mg/kg	3.1	9.3	0.479	0.336	J	0.291	J	-	-	0.269	J	0.479	
Arsenic	mg/kg	0.39	36.5	10.9	6.09		6.04		5.5		6.18		10.9	
Barium	mg/kg	1500	826	57	44.5		56.7		48.6		43.7		20.8	J
Beryllium	mg/kg	16	1	6.41	**6.01**		**6.41**		-	-	**5.46**		**6.31**	J
Calcium	mg/kg	NE	52300	153000	2,100		2,270		1,820	J	1,840		**153,000**	
Chromium	mg/kg	0.29	29	11.8	10.6		11.8		10.4		8.82		11	
Cobalt	mg/kg	2.3	116	11	8.14		8.99		7.7		7.46		11	J
Copper	mg/kg	310	56.2	31.5	18	J	16.5	J	14.6		13.8	J	31.5	J
Iron	mg/kg	5500	234000	55100	17,600	J	19,100	J	16,600		15,500	J	55,100	J
Lead	mg/kg	40	48.6	15.9	12.5		12.8		9.3		9.74		15.9	
Magnesium	mg/kg	NE	10400	9490	2,100	J	2,350	J	1,880		1,730	J	9,490	J
Manganese	mg/kg	180	3506	372	198		226		169		152		372	
Mercury	mg/kg	2.3	0.09	0.0203	0.0203	J	0.0193	J	-	-	0.0112	J	-	-
Nickel	mg/kg	150	55.1	32.5	19.1		20.2		17.9		18.5		32.5	
Potassium	mg/kg	NE	3390	1060	450		470		703	J	323		1,060	
Sodium	mg/kg	NE	NE	116	28.4	B	28	B	-	-	43.3	B	116	
Thallium	mg/kg	NE	1.3	0.316	-	-	-	-	-	-	-	-	0.316	J
Vanadium	mg/kg	39	40.9	17.4	15.4		17.4		14.1		13.6		13.6	
Zinc	mg/kg	2300	322	63	63.2		27.8		51.4		55.4		52.7	

Location Code:					AP2-SB06					
Sample Number:					AP0117		AP0118		AP0119	
Sample Date:					15-Jan-09		15-Jan-09		15-Jan-09	
Sample Type:					Surface		Subsurface		Subsurface	
Sample Depth:					0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
Sample Purpose:					REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES										
Benzoic acid	mg/kg	24000	NE	0.622	0.622		-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0403	-	-	-	-	0.0403	J
METALS										
Aluminum	mg/kg	7700	15500	13200	7,150	J	6,750	J	13,200	J
Antimony	mg/kg	3.1	9.3	0.708	0.708		0.412	J	0.44	J
Arsenic	mg/kg	0.39	36.5	11.4	11.4		6.33		3.55	
Barium	mg/kg	1500	826	99	98.7		58.3		53.4	J
Beryllium	mg/kg	16	1	12.1	**12.1**		**6.9**		**7.73**	J
Cadmium	mg/kg	7	NE	0.423	0.423	J	0.293	J	-	-
Calcium	mg/kg	NE	52300	44000	2,830		2,090		44,000	
Chromium	mg/kg	0.29	29	19.4	7.84		10.1		19.4	
Cobalt	mg/kg	2.3	116	14.6	4.64		8.93		14.6	J
Copper	mg/kg	310	56.2	32.1	22.2	J	12.6	J	32.1	J
Iron	mg/kg	5500	234000	51800	51,800	J	19,900	J	24,000	J
Lead	mg/kg	40	48.6	14.3	12.5		11.2		14.3	
Magnesium	mg/kg	NE	10400	12000	819	J	2,110	J	**12,000**	J
Manganese	mg/kg	180	3506	392	243		234		392	
Mercury	mg/kg	2.3	0.09	0.0688	0.0688		0.0156	J	0.0132	J
Nickel	mg/kg	150	55.1	36.7	13.7		21.8		36.7	
Potassium	mg/kg	NE	3390	1730	616		426		1,730	
Selenium	mg/kg	39	2	0.737	0.737	J	-	-	-	-
Sodium	mg/kg	NE	NE	135	76.3	B	37.1	B	135	
Thallium	mg/kg	NE	1.3	0.312	0.312	J	-	-	0.293	J
Vanadium	mg/kg	39	40.9	23.2	17.3		15.5		23.2	
Zinc	mg/kg	2300	322	73	53.2		63.7		73	

Location Code:					AP2-SB03					
Sample Number:					AP0108		AP0109		AP0110	
Sample Date:					18-Jan-09		18-Jan-09		18-Jan-09	
Sample Type:					Surface		Subsurface		Subsurface	
Sample Depth:					0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
Sample Purpose:					REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
PCBs										
Aroclor 1260	mg/kg	0.22	NE	0.0162	0.0162	J	-	-	-	-
SEMIVOLATILES										
Benzo(a)anthracene	mg/kg	0.15	NE	0.0307	0.0307		-	-	-	-
Fluoranthene	mg/kg	230	NE	0.0599	0.0599	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0667	-	-	-	-	0.0667	J
Pyrene	mg/kg	170	NE	0.044	0.044	J	-	-	-	-
METALS										
Aluminum	mg/kg	7700	15500	15000	8,070		15,000		7,720	
Antimony	mg/kg	3.1	9.3	0.637	0.637		0.257	J	0.329	J
Arsenic	mg/kg	0.39	36.5	12.6	7.71	J	5.27	J	12.6	J
Barium	mg/kg	1500	826	99	69.4	J	98.9	J	18.6	J
Beryllium	mg/kg	16	1	7.43	**6.46**	J	**7.43**	J	**6.35**	J
Cadmium	mg/kg	7	NE	0.558	0.558		-	-	-	-
Calcium	mg/kg	NE	52300	54300	3,430	J	36,500	J	**54,300**	J
Chromium	mg/kg	0.29	29	22.1	12	J	22.1	J	11.8	J
Cobalt	mg/kg	2.3	116	10.8	8.68	J	10.8	J	10.7	J
Copper	mg/kg	310	56.2	29.8	22.5		29.8		29.6	
Iron	mg/kg	5500	234000	24900	19,100		24,900		22,100	
Lead	mg/kg	40	48.6	27.7	27.7	J	16.7	J	15.8	J
Magnesium	mg/kg	NE	10400	10400	2,150	J	10,100	J	**10,400**	J
Manganese	mg/kg	180	3506	436	211		436		414	
Mercury	mg/kg	2.3	0.09	0.0642	0.0642		0.013	J	0.0132	J
Nickel	mg/kg	150	55.1	31.5	21.7	J	31.5	J	27.4	J
Potassium	mg/kg	NE	3390	1570	745		1,570		1,110	
Selenium	mg/kg	39	2	0.928	0.928	J	-	-	-	-
Sodium	mg/kg	NE	NE	120	36.3	B	119		120	
Thallium	mg/kg	NE	1.3	0.47	0.47	J	0.35	J	0.336	J
Vanadium	mg/kg	39	40.9	25.3	18.7		25.3		15.4	
Zinc	mg/kg	2300	322	80	80	J	68.5	J	61.5	J

Location Code:					AP2-SB04					
Sample Number:					AP0111		AP0112		AP0113	
Sample Date:					18-Jan-09		18-Jan-09		19-Jan-09	
Sample Type:					Surface		Subsurface		Subsurface	
Sample Depth:					0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
Sample Purpose:					REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES										
Phenanthrene	mg/kg	NE	NE	0.0453	-	-	-	-	0.0453	J
METALS										
Aluminum	mg/kg	7700	15500	8670	7,130		7,830		8,670	
Antimony	mg/kg	3.1	9.3	0.485	0.485		0.312	J	0.392	J
Arsenic	mg/kg	0.39	36.5	26.8	26.8	J	4.51	J	12.1	J
Barium	mg/kg	1500	826	98	98.4	J	61.5	J	35.6	J
Beryllium	mg/kg	16	1	16.3	**16.3**	J	**6.68**	J	**7.02**	J
Calcium	mg/kg	NE	52300	50700	2,160	J	3,010	J	50,700	J
Chromium	mg/kg	0.29	29	12.7	10.5	J	11.9	J	12.7	J
Cobalt	mg/kg	2.3	116	11	5.96	J	7.88	J	11	J
Copper	mg/kg	310	56.2	38.4	26		20.9		38.4	
Iron	mg/kg	5500	234000	109000	109,000		19,200		24,400	
Lead	mg/kg	40	48.6	18.9	10.1	J	18.9	J	16	J
Magnesium	mg/kg	NE	10400	10800	442	J	2,530	J	**10,800**	J
Manganese	mg/kg	180	3506	522	116		87.4		522	
Mercury	mg/kg	2.3	0.09	0.0352	0.0265		0.0352		0.0147	J
Nickel	mg/kg	150	55.1	28.8	17.1	J	24.8	J	28.8	J
Potassium	mg/kg	NE	3390	1150	827		705		1,150	
Selenium	mg/kg	39	2	0.859	0.678	J	0.859	J	-	-
Sodium	mg/kg	NE	NE	119	55.7	B	43.6	B	119	
Thallium	mg/kg	NE	1.3	0.468	0.468	J	-	-	0.315	J
Vanadium	mg/kg	39	40.9	26.9	26.9		17.8		17.5	
Zinc	mg/kg	2300	322	64	57	J	64.4	J	60.4	J

Location Code:					AP2-SB08									
Sample Number:					AP0125		AP0126		AP0127		AP0128		AP0129	
Sample Date:					16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
Sample Type:					Surface		Subsurface		Subsurface		Subsurface		Subsurface	
Sample Depth:					0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft	
Sample Purpose:					REG		REG		REG		FD		FS	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
METALS														
Aluminum	mg/kg	7700	15500	15100	4,070	J	5,350	J	15,100	J	14,900	J	12,100	
Antimony	mg/kg	3.1	9.3	0.248	-	-	0.227	J	-	-	0.248	J	-	-
Arsenic	mg/kg	0.39	36.5	12.8	12.8		12.6		6.16		6.61		7	
Barium	mg/kg	1500	826	85	73.2	J	56	J	81	J	83.7	J	85	
Beryllium	mg/kg	16	1	16.9	**16.9**	J	**8.48**	J	**8.51**	J	**8.11**	J	-	-
Calcium	mg/kg	NE	52300	45500	1,650		1,860		44,800		45,500		45,000	J
Chromium	mg/kg	0.29	29	22.4	6.13		8.82		22.4		21.9		18.5	
Cobalt	mg/kg	2.3	116	15.6	3.9	J	8.7	J	15.6	J	14.6	J	12.4	
Copper	mg/kg	310	56.2	31.1	21.3	J	11	J	31.1	J	30.1	J	23.9	
Iron	mg/kg	5500	234000	72600	72,600	J	28,000	J	26,600	J	28,500	J	23,900	
Lead	mg/kg	40	48.6	14.1	4.64		9.05		11.6		14.1		10.7	
Magnesium	mg/kg	NE	10400	12200	312	J	1,730	J	**12,200**	J	**11,500**	J	10,100	
Manganese	mg/kg	180	3506	473	98.2		196		473		432		363	
Mercury	mg/kg	2.3	0.09	0.034	0.034		0.0151	J	-	-	-	-	-	-
Nickel	mg/kg	150	55.1	39.7	10.5		22		39.7		38		32.8	
Potassium	mg/kg	NE	3390	2870	477		371		1,980		1,990		2,870	J
Selenium	mg/kg	39	2	0.914	0.914	J	-	-	-	-	-	-	-	-
Sodium	mg/kg	NE	NE	145	36.4	B	27.4	B	145		134		-	-
Thallium	mg/kg	NE	1.3	0.308	0.308	J	-	-	-	-	-	-	-	-
Vanadium	mg/kg	39	40.9	25.4	18.8		15.1		25.4		24.7		20.5	
Zinc	mg/kg	2300	322	77	41.4		58.9		76.6		73.4		61.3	

Location Code:					AP2-SB05					
Sample Number:					AP0114		AP0115		AP0116	
Sample Date:					16-Jan-09		16-Jan-09		16-Jan-09	
Sample Type:					Surface		Subsurface		Subsurface	
Sample Depth:					0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
Sample Purpose:					REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES										
Naphthalene	mg/kg	3.6	NE	0.0444	0.0444	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.0491	-	-	-	-	0.0491	J
METALS										
Aluminum	mg/kg	7700	15500	9300	8,800	J	8,060	J	9,300	J
Antimony	mg/kg	3.1	9.3	0.922	0.922		0.259	J	0.486	
Arsenic	mg/kg	0.39	36.5	24.4	24.4		6.27		11.1	
Barium	mg/kg	1500	826	109	109	J	68.2	J	49	J
Beryllium	mg/kg	16	1	15.5	**15.5**	J	**7.61**	J	**7.53**	J
Cadmium	mg/kg	7	NE	0.716	0.716		-	-	0.276	J
Calcium	mg/kg	NE	52300	42300	4,140		351		42,300	
Chromium	mg/kg	0.29	29	14.4	12.8		11.7		14.4	
Cobalt	mg/kg	2.3	116	14	8.29	J	6.67	J	14	J
Copper	mg/kg	310	56.2	33.6	31.3	J	15.6	J	33.6	J
Iron	mg/kg	5500	234000	61600	61,600	J	22,100	J	24,500	J
Lead	mg/kg	40	48.6	27.4	27.4		12.2		13.4	
Magnesium	mg/kg	NE	10400	8760	1,320	J	1,980	J	8,760	J
Manganese	mg/kg	180	3506	551	319		100		551	
Mercury	mg/kg	2.3	0.09	0.118	**0.118**		0.0242	J	-	-
Nickel	mg/kg	150	55.1	36.8	20.5		18		36.8	
Potassium	mg/kg	NE	3390	990	837		513		990	
Selenium	mg/kg	39	2	1.44	1.44		-	-	0.779	J
Sodium	mg/kg	NE	NE	91	79.2		18.4	B	91.4	
Thallium	mg/kg	NE	1.3	0.939	0.939		-	-	0.347	J
Vanadium	mg/kg	39	40.9	23	23		17		18.2	
Zinc	mg/kg	2300	322	102	102		68.9		85.3	

LEGEND:

- SOIL BORING
- SOIL BORING/PIEZOMETER
- mg/kg MILLIGRAMS PER KILOGRAM
- NE NOT ESTABLISHED (RBSCs), NOT EVALUATED (BSCs)
- NM NOT MEASURED
- \- NOT DETECTED

NOTES:

1. SHADED CELL INDICATES VALUE IS GREATER THAN THE RBSC.
2. BOLD TEXT INDICATES VALUE IS GREATER THAN THE BSC.
3. RBSC VALUES REFLECT AN INCREMENTAL LIFETIME CANCER RISK (ILCR) OF 1E-6 OR A NONCANCER HAZARD QUOTIENT (HQ) OF 0.1. FOR CHEMICALS THAT EXHIBIT BOTH CANCER AND NONCANCER EFFECTS, WHICHEVER TYPE OF EFFECT IN A LOWER CONCENTRATION (USING AN ILCR OF 1E-6 AND AN HQ OF 0.1), THAT CONCENTRATION IS SELECTED AS THE RBSC.
4. BSC IS BACKGROUND SCREENING CONCENTRATION.
5. MDC IS MAXIMUM DETECTED CONCENTRATION FOR THE INVESTIGATION AREA ("B" QUALIFIED DATA NOT INCLUDED).
6. FERROUS IRON MEASURED IN FIELD USING HACH TEST KIT.
7. OXIDATION REDUCTION POTENTIAL - FINAL YSI WATER QUALITY METER FIELD MEASUREMENT PRIOR TO GROUNDWATER SAMPLE COLLECTION.
8. VALIDATION QUALIFIERS (VQ):
   - B - THE ANALYTE WAS NOT DETECTED SIGNIFICANTLY ABOVE THE LEVELS FOUND IN THE ASSOCIATED METHOD BLANK OR FIELD BLANKS.
   - J - THE ANALYTE WAS POSITIVELY IDENTIFIED; THE REPORTED VALUE IS ESTIMATED.

SCALE
0 80 160 FEET

FIGURE 5-6
DETECTED CONSTITUENTS AT POWERHOUSE 2 ASH PITS IN SURFACE AND SUBSURFACE SOIL SAMPLES ABOVE RBSCs AND/OR BSCs (JANUARY AND FEBRUARY 2009)

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw a world of Solutions™

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			Location Code:	AP2-SW01	
			Sample Number:	AP2000	
			Sample Date:	24-May-09	
			Sample Depth:	0 - 0 Ft	
			Sample Purpose:	REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	µg/L	37000	1030	720	
Barium	µg/L	7300	50.9	48.4	J
Calcium	µg/L	NE	80900	79,100	
Iron	µg/L	26000	1060	1,060	
Magnesium	µg/L	NE	22300	21,400	
Manganese	µg/L	880	102	102	
Potassium	µg/L	NE	4400	3,290	J
Sodium	µg/L	NE	40000	32,800	
Vanadium	µg/L	180	3.1	2.6	J
Zinc	µg/L	11000	12.4	12.1	J
GENERAL CHEMISTRY					
Hardness (as $CaCO_3$)	µg/L	NE	286000	286,000	

			Location Code:	AP2-SD01	
			Sample No.:	AP1000	
			Sample Date:	24-May-09	
			Sample Depth:	0 - 0.5 Ft	
			Sample Purpose:	REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	mg/kg	77000	3640	3,640	
Arsenic	mg/kg	3.9	4.1	4.1	
Barium	mg/kg	15000	22.8	22.8	
Beryllium	mg/kg	160	0.36	0.36	
Cadmium	mg/kg	70	0.24	0.24	J
Calcium	mg/kg	NE	7660	7,660	
Chromium	mg/kg	2.9	6.4	6.4	
Cobalt	mg/kg	23	7.4	7.4	
Copper	mg/kg	3100	9.6	9.6	
Iron	mg/kg	55000	10400	10,400	
Lead	mg/kg	400	7.9	7.9	
Magnesium	mg/kg	NE	1950	1,950	
Manganese	mg/kg	1800	127	127	
Nickel	mg/kg	1500	15.7	15.7	
Potassium	mg/kg	NE	498	498	J
Selenium	mg/kg	390	1	1	J
Sodium	mg/kg	NE	85	85.2	J
Vanadium	mg/kg	390	9.4	9.4	
Zinc	mg/kg	23000	34.7	34.7	
GENERAL CHEMISTRY					
Total organic carbon	mg/kg	NE	0.57	0.57	

			Location Code:	AP2-SW02	
			Sample Number:	AP2001	
			Sample Date:	24-May-09	
			Sample Depth:	0 - 0 Ft	
			Sample Purpose:	REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	µg/L	37000	1030	531	
Barium	µg/L	7300	50.9	46.8	J
Calcium	µg/L	NE	80900	78,800	
Iron	µg/L	26000	1060	700	
Magnesium	µg/L	NE	22300	21,200	
Manganese	µg/L	880	102	63	
Potassium	µg/L	NE	4400	3,340	J
Sodium	µg/L	NE	40000	32,700	
Vanadium	µg/L	180	3.1	1.8	J
Zinc	µg/L	11000	12.4	12.4	J

			Location Code:	AP2-SD02	
			Sample No.:	AP1001	
			Sample Date:	24-May-09	
			Sample Depth:	0 - 0.5 Ft	
			Sample Purpose:	REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	mg/kg	77000	6310	6,310	
Arsenic	mg/kg	3.9	5.1	5.1	
Barium	mg/kg	15000	43.5	43.5	
Beryllium	mg/kg	160	0.49	0.49	
Cadmium	mg/kg	70	0.37	0.37	
Calcium	mg/kg	NE	26000	26,000	
Chromium	mg/kg	2.9	10.5	10.5	
Cobalt	mg/kg	23	7.4	7.4	
Copper	mg/kg	3100	14.2	14.2	
Iron	mg/kg	55000	14000	14,000	
Lead	mg/kg	400	7.9	7.9	
Magnesium	mg/kg	NE	7440	7,440	
Manganese	mg/kg	1800	379	379	
Mercury	mg/kg	23	0.018	0.018	J
Nickel	mg/kg	1500	16.1	16.1	
Potassium	mg/kg	NE	1300	1,300	
Selenium	mg/kg	390	0.39	0.39	J
Silver	mg/kg	390	0	-	-
Sodium	mg/kg	NE	157	157	J
Vanadium	mg/kg	390	15.2	15.2	
Zinc	mg/kg	23000	38.9	38.9	

			Location Code:	AP2-SW03					
			Sample Number:	AP2002		AP2003		AP2004	
			Sample Date:	24-May-09		24-May-09		24-May-09	
			Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			Sample Purpose:	REG		FD		FS	
Parameter	Units	RBSC	MDC	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES									
Bis(2-ethylhexyl)phthalate	µg/L	48	2	-	-	2	J	-	-
METALS									
Aluminum	µg/L	37000	1030	357		377		368	
Barium	µg/L	7300	50.9	44.7	J	45.3	J	-	-
Calcium	µg/L	NE	80900	76,400		77,400		80,900	
Iron	µg/L	26000	1060	451		455		546	
Lead	µg/L	15	2.9	2.9	J	-	-	-	-
Magnesium	µg/L	NE	22300	20,500		20,800		22,300	J
Manganese	µg/L	880	102	52.6		52.9		53.4	
Potassium	µg/L	NE	4400	3,150	J	3,190	J	-	-
Sodium	µg/L	NE	40000	32,100		32,800		40,000	
Vanadium	µg/L	180	3.1	1.7	J	1.6	J	-	-
Zinc	µg/L	11000	12.4	-	-	8.1	J	-	-

			Location Code:	AP2-SD03	
			Sample No.:	AP1002	
			Sample Date:	24-May-09	
			Sample Depth:	0 - 0.5 Ft	
			Sample Purpose:	REG	
Parameter	Units	RBSC	MDC	Result	VQ
EXPLOSIVES					
Trinitrotoluene, 2,4,6-	mg/kg	36	0.0647	0.0647	J
SEMIVOLATILES					
Fluoranthene	mg/kg	2300	0.0525	0.0525	J
METALS					
Aluminum	mg/kg	77000	7220	7,220	
Arsenic	mg/kg	3.9	10.1	10.1	J
Barium	mg/kg	15000	67.1	67.1	J
Beryllium	mg/kg	160	0.52	0.52	
Calcium	mg/kg	NE	12900	12,900	J
Chromium	mg/kg	2.9	8.6	8.6	J
Cobalt	mg/kg	23	6.2	6.2	J
Copper	mg/kg	3100	17.2	17.2	
Iron	mg/kg	55000	39100	39,100	J
Lead	mg/kg	400	10.6	10.6	J
Magnesium	mg/kg	NE	7470	7,470	J
Manganese	mg/kg	1800	151	151	J
Mercury	mg/kg	23	0.016	0.016	J
Nickel	mg/kg	1500	16	16	J
Potassium	mg/kg	NE	1060	1,060	J
Selenium	mg/kg	390	0.92	0.92	J
Silver	mg/kg	390	0.083	0.083	J
Sodium	mg/kg	NE	55	54.8	J
Vanadium	mg/kg	390	13.6	13.6	J
Zinc	mg/kg	23000	27	27	J

			Location Code:	AP2-SW04	
			Sample Number:	AP2005	
			Sample Date:	25-May-09	
			Sample Depth:	0 - 0 Ft	
			Sample Purpose:	REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	µg/L	37000	1030	1,030	J
Barium	µg/L	7300	50.9	50.9	J
Calcium	µg/L	NE	80900	80,700	
Cobalt	µg/L	11	1.2	1.2	J
Iron	µg/L	26000	1060	1,020	
Lead	µg/L	15	2.9	2.9	J
Magnesium	µg/L	NE	22300	20,700	
Manganese	µg/L	880	102	83.1	
Nickel	µg/L	730	6.2	6.2	J
Potassium	µg/L	NE	4400	4,400	J
Sodium	µg/L	NE	40000	34,800	
Vanadium	µg/L	180	3.1	3.1	J
Zinc	µg/L	11000	12.4	10.6	J

			Location Code:	AP2-SD04					
			Sample No.:	AP1003		AP1004		AP1005	
			Sample Date:	25-May-09		25-May-09		25-May-09	
			Sample Depth:	0 - 0.5 Ft		0 - 0.5 Ft		0 - 0.5 Ft	
			Sample Purpose:	REG		FD		FS	
Parameter	Units	RBSC	MDC	Result	VQ	Result	VQ	Result	VQ
METALS									
Aluminum	mg/kg	77000	8000	8,000		6,840		6,780	
Arsenic	mg/kg	3.9	9.3	9.3		7.8		8.8	
Barium	mg/kg	15000	59.8	59.8		50		53	
Beryllium	mg/kg	160	0.59	0.59		0.53		-	-
Cadmium	mg/kg	70	0.6	0.6		0.53		-	-
Calcium	mg/kg	NE	37600	28,700		25,200		37,600	
Chromium	mg/kg	2.9	12.8	12.8		10.5		11.6	
Cobalt	mg/kg	23	14.1	14.1		9.8		9.9	
Copper	mg/kg	3100	23.7	23.7		20.4		22.8	
Iron	mg/kg	55000	20700	19,400		17,700		20,700	
Lead	mg/kg	400	15.2	15.2	J	9.1	J	11	
Magnesium	mg/kg	NE	8170	6,110		6,040		8,170	
Manganese	mg/kg	1800	668	668		547		413	
Mercury	mg/kg	23	0.019	0.015	J	0.019	J	-	-
Nickel	mg/kg	1500	27.6	27.6		22.6		27.1	
Potassium	mg/kg	NE	1850	1,850		1,470		1,420	
Selenium	mg/kg	390	0.83	0.83	J	0.48	J	-	-
Sodium	mg/kg	NE	170	170	J	157	J	-	-
Vanadium	mg/kg	390	14.9	14.9		12.5		13.3	
Zinc	mg/kg	23000	62.5	59.7		54.9		62.5	

			Location Code:	AP2-SW05	
			Sample Number:	AP2006	
			Sample Date:	25-May-09	
			Sample Depth:	0 - 0 Ft	
			Sample Purpose:	REG	
Parameter	Units	RBSC	MDC	Result	VQ
METALS					
Aluminum	µg/L	37000	1030	359	
Barium	µg/L	7300	50.9	43.9	J
Calcium	µg/L	NE	80900	75,900	
Iron	µg/L	26000	1060	376	
Magnesium	µg/L	NE	22300	19,800	
Manganese	µg/L	880	102	53.3	
Potassium	µg/L	NE	4400	2,900	J
Sodium	µg/L	NE	40000	30,300	
Vanadium	µg/L	180	3.1	2	J
Zinc	µg/L	11000	12.4	9.9	J

			Location Code:	AP2-SD05	
			Sample No.:	AP1006	
			Sample Date:	25-May-09	
			Sample Depth:	0 - 0.5 Ft	
			Sample Purpose:	REG	
Parameter	Units	RBSC	MDC	Result	VQ
SEMIVOLATILES					
Fluoranthene	mg/kg	2300	0.0547	0.0547	J
METALS					
Aluminum	mg/kg	77000	4690	4,690	
Arsenic	mg/kg	3.9	3.9	3.9	
Barium	mg/kg	15000	43.1	43.1	
Beryllium	mg/kg	160	0.42	0.42	
Cadmium	mg/kg	70	0.26	0.26	J
Calcium	mg/kg	NE	9790	9,790	
Chromium	mg/kg	2.9	7.7	7.7	
Cobalt	mg/kg	23	8	8	
Copper	mg/kg	3100	12.2	12.2	
Iron	mg/kg	55000	10400	10,400	
Lead	mg/kg	400	9.7	9.7	
Magnesium	mg/kg	NE	2450	2,450	
Manganese	mg/kg	1800	187	187	
Mercury	mg/kg	23	0.025	0.025	J
Nickel	mg/kg	1500	17.8	17.8	
Potassium	mg/kg	NE	628	628	J
Selenium	mg/kg	390	0.96	0.96	J
Sodium	mg/kg	NE	123	123	J
Vanadium	mg/kg	390	11.1	11.1	
Zinc	mg/kg	23000	45.1	45.1	

LEGEND:

∇ SURFACE WATER/SEDIMENT SAMPLE
mg/kg MILLIGRAMS PER KILOGRAM
ug/L MICROGRAMS PER LITER
NE NOT ESTABLISHED (RBSCs), NOT EVALUATED (BSCs)
NM NOT MEASURED
\- NOT DETECTED

NOTES:

1. SHADED CELL INDICATES VALUE IS GREATER THAN THE RBSC.
2. RBSC VALUES REFLECT AN INCREMENTAL LIFETIME CANCER RISK (ILCR) OF 1E-6 OR A NONCANCER HAZARD QUOTIENT (HQ) OF 0.1. FOR CHEMICALS THAT EXHIBIT BOTH CANCER AND NONCANCER EFFECTS, WHICHEVER TYPE OF EFFECT IN A LOWER CONCENTRATION (USING AN ILCR OF 1E-6 AND AN HQ OF 0.1), THAT CONCENTRATION IS SELECTED AS THE RBSC.
3. MDC IS MAXIMUM DETECTED CONCENTRATION FOR THE INVESTIGATION AREA ("B" QUALIFIED DATA NOT INCLUDED).
4. VALIDATION QUALIFIERS (VQ):
   B - THE ANALYTE WAS NOT DETECTED SIGNIFICANTLY ABOVE THE LEVELS FOUND IN THE ASSOCIATED METHOD BLANK OR FIELD BLANKS.
   J - THE ANALYTE WAS POSITIVELY IDENTIFIED; THE REPORTED VALUE IS ESTIMATED.

FIGURE 5-7
DETECTED CONSTITUENTS AT POWERHOUSE 2 ASH PITS IN SURFACE WATER AND SEDIMENT SAMPLES ABOVE RBSCs (MAY 2009)

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® a world of Solutions™

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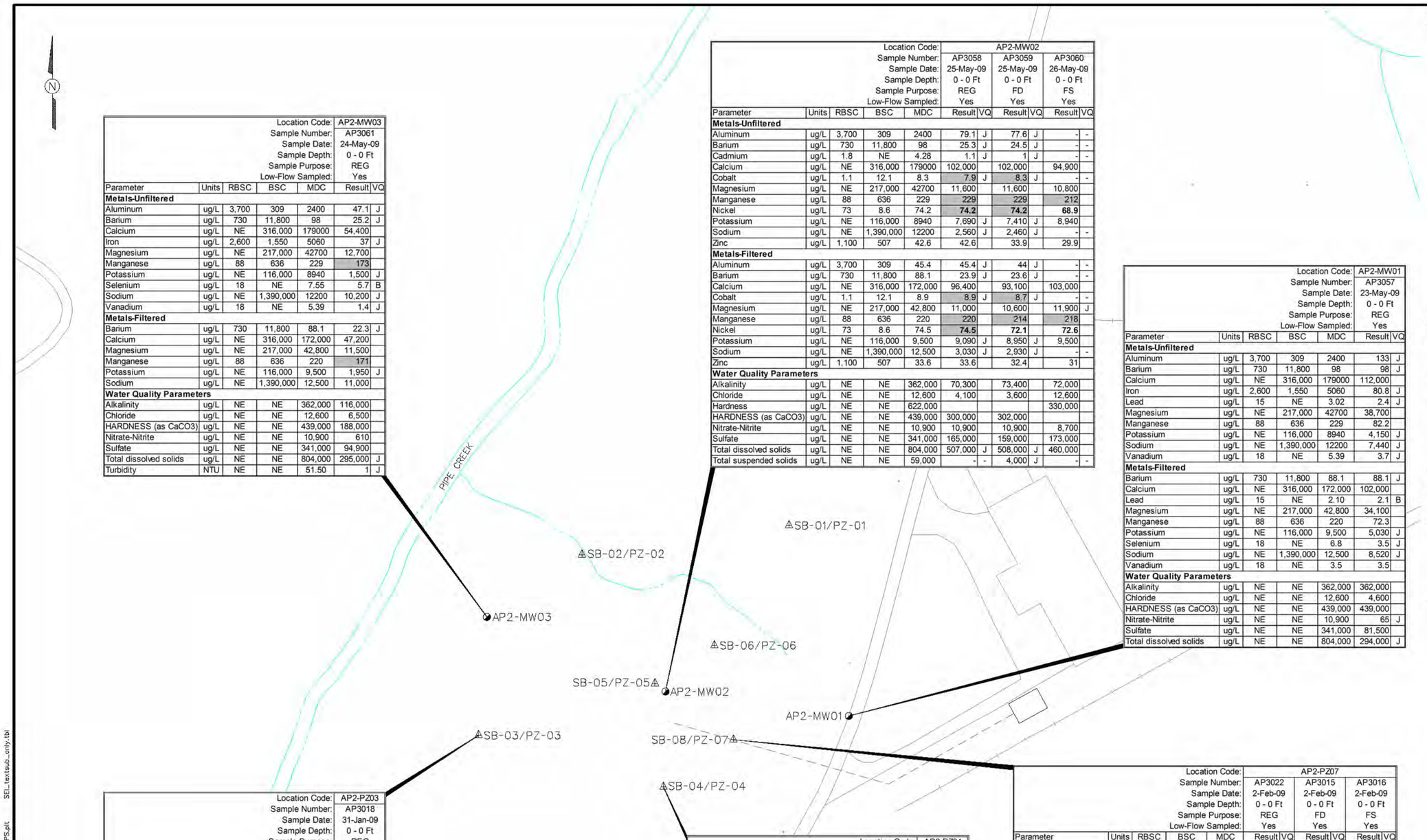

				Location Code:	AP2-MW03	
				Sample Number:	AP3061	
				Sample Date:	24-May-09	
				Sample Depth:	0 - 0 Ft	
				Sample Purpose:	REG	
				Low-Flow Sampled:	Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ
Metals-Unfiltered						
Aluminum	ug/L	3,700	309	2400	47.1	J
Barium	ug/L	730	11,800	98	25.2	J
Calcium	ug/L	NE	316,000	179000	54,400	
Iron	ug/L	2,600	1,550	5060	37	J
Magnesium	ug/L	NE	217,000	42700	12,700	
Manganese	ug/L	88	636	229	173	
Potassium	ug/L	NE	116,000	8940	1,500	J
Selenium	ug/L	18	NE	7.55	5.7	B
Sodium	ug/L	NE	1,390,000	12200	10,200	J
Vanadium	ug/L	18	NE	5.39	1.4	J
Metals-Filtered						
Barium	ug/L	730	11,800	88.1	22.3	J
Calcium	ug/L	NE	316,000	172,000	47,200	
Magnesium	ug/L	NE	217,000	42,800	11,500	
Manganese	ug/L	88	636	220	171	
Potassium	ug/L	NE	116,000	9,500	1,950	J
Sodium	ug/L	NE	1,390,000	12,500	11,000	
Water Quality Parameters						
Alkalinity	ug/L	NE	NE	362,000	116,000	
Chloride	ug/L	NE	NE	12,600	6,500	
HARDNESS (as CaCO3)	ug/L	NE	NE	439,000	188,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	610	
Sulfate	ug/L	NE	NE	341,000	94,900	
Total dissolved solids	ug/L	NE	NE	804,000	295,000	J
Turbidity	NTU	NE	NE	51.50	1	J

				Location Code:	AP2-MW02					
				Sample Number:	AP3058		AP3059		AP3060	
				Sample Date:	25-May-09		25-May-09		26-May-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		FD		FS	
				Low-Flow Sampled:	Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
Metals-Unfiltered										
Aluminum	ug/L	3,700	309	2400	79.1	J	77.6	J	-	-
Barium	ug/L	730	11,800	98	25.3	J	24.5	J	-	-
Cadmium	ug/L	1.8	NE	4.28	1.1	J	1	J	-	-
Calcium	ug/L	NE	316,000	179000	102,000		102,000		94,900	
Cobalt	ug/L	1.1	12.1	8.3	7.9	J	8.3	J	-	-
Magnesium	ug/L	NE	217,000	42700	11,600		11,600		10,800	
Manganese	ug/L	88	636	229	229		229		212	
Nickel	ug/L	73	8.6	74.2	**74.2**		**74.2**		**68.9**	
Potassium	ug/L	NE	116,000	8940	7,690	J	7,410	J	8,940	
Sodium	ug/L	NE	1,390,000	12200	2,560	J	2,460	J	-	-
Zinc	ug/L	1,100	507	42.6	42.6		33.9		29.9	
Metals-Filtered										
Aluminum	ug/L	3,700	309	45.4	45.4	J	44	J	-	-
Barium	ug/L	730	11,800	88.1	23.9	J	23.6	J	-	-
Calcium	ug/L	NE	316,000	172,000	96,400		93,100		103,000	
Cobalt	ug/L	1.1	12.1	8.9	8.9	J	8.7	J	-	-
Magnesium	ug/L	NE	217,000	42,800	11,000		10,600		11,900	J
Manganese	ug/L	88	636	220	220		214		218	
Nickel	ug/L	73	8.6	74.5	**74.5**		**72.1**		**72.6**	
Potassium	ug/L	NE	116,000	9,500	9,090	J	8,950	J	9,500	
Sodium	ug/L	NE	1,390,000	12,500	3,030	J	2,930	J	-	-
Zinc	ug/L	1,100	507	33.6	33.6		32.4		31	
Water Quality Parameters										
Alkalinity	ug/L	NE	NE	362,000	70,300		73,400		72,000	
Chloride	ug/L	NE	NE	12,600	4,100		3,600		12,600	
Hardness	ug/L	NE	NE	622,000					330,000	
HARDNESS (as CaCO3)	ug/L	NE	NE	439,000	300,000		302,000			
Nitrate-Nitrite	ug/L	NE	NE	10,900	10,900		10,900		8,700	
Sulfate	ug/L	NE	NE	341,000	165,000		159,000		173,000	
Total dissolved solids	ug/L	NE	NE	804,000	507,000	J	508,000	J	460,000	
Total suspended solids	ug/L	NE	NE	59,000	-	-	4,000	J	-	-

				Location Code:	AP2-MW01	
				Sample Number:	AP3057	
				Sample Date:	23-May-09	
				Sample Depth:	0 - 0 Ft	
				Sample Purpose:	REG	
				Low-Flow Sampled:	Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ
Metals-Unfiltered						
Aluminum	ug/L	3,700	309	2400	133	J
Barium	ug/L	730	11,800	98	98	J
Calcium	ug/L	NE	316,000	179000	112,000	
Iron	ug/L	2,600	1,550	5060	80.8	J
Lead	ug/L	15	NE	3.02	2.4	J
Magnesium	ug/L	NE	217,000	42700	38,700	
Manganese	ug/L	88	636	229	82.2	
Potassium	ug/L	NE	116,000	8940	4,150	J
Sodium	ug/L	NE	1,390,000	12200	7,440	J
Vanadium	ug/L	18	NE	5.39	3.7	J
Metals-Filtered						
Barium	ug/L	730	11,800	88.1	88.1	J
Calcium	ug/L	NE	316,000	172,000	102,000	
Lead	ug/L	15	NE	2.10	2.1	B
Magnesium	ug/L	NE	217,000	42,800	34,100	
Manganese	ug/L	88	636	220	72.3	
Potassium	ug/L	NE	116,000	9,500	5,030	J
Selenium	ug/L	18	NE	6.8	3.5	J
Sodium	ug/L	NE	1,390,000	12,500	8,520	J
Vanadium	ug/L	18	NE	3.5	3.5	
Water Quality Parameters						
Alkalinity	ug/L	NE	NE	362,000	362,000	
Chloride	ug/L	NE	NE	12,600	4,600	
HARDNESS (as CaCO3)	ug/L	NE	NE	439,000	439,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	65	J
Sulfate	ug/L	NE	NE	341,000	81,500	
Total dissolved solids	ug/L	NE	NE	804,000	294,000	J

				Location Code:	AP2-PZ03	
				Sample Number:	AP3018	
				Sample Date:	31-Jan-09	
				Sample Depth:	0 - 0 Ft	
				Sample Purpose:	REG	
				Low-Flow Sampled:	Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ
Metals-Unfiltered						
Aluminum	ug/L	3,700	309	2400	**2,400**	
Barium	ug/L	730	11,800	98	51.1	
Cadmium	ug/L	1.8	NE	4.28	4.16	J
Calcium	ug/L	NE	316,000	179000	179,000	
Copper	ug/L	150	19.8	12.3	12.3	
Iron	ug/L	2,600	1,550	5060	**5,060**	
Lead	ug/L	15	NE	3.02	3.02	J
Magnesium	ug/L	NE	217,000	42700	42,700	
Manganese	ug/L	88	636	229	51.8	
Nickel	ug/L	73	8.6	74.2	6.28	J
Potassium	ug/L	NE	116,000	8940	1,260	
Selenium	ug/L	18	NE	7.55	7.55	J
Sodium	ug/L	NE	1,390,000	12200	12,200	
Vanadium	ug/L	18	NE	5.39	5.39	
Metals-Filtered						
Barium	ug/L	730	11,800	88.1	34.9	
Cadmium	ug/L	1.8	NE	4.4	4.36	J
Calcium	ug/L	NE	316,000	172,000	172,000	
Copper	ug/L	150	19.8	6.9	6.9	J
Magnesium	ug/L	NE	217,000	42,800	42,800	
Potassium	ug/L	NE	116,000	9,500	510	J
Selenium	ug/L	18	NE	6.8	6.82	J
Sodium	ug/L	NE	1,390,000	12,500	12,500	
Water Quality Parameters						
Alkalinity	ug/L	NE	NE	362,000	231,000	
Chloride	ug/L	NE	NE	12,600	11,600	J
Hardness	ug/L	NE	NE	622,000	622,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	566	J
Sulfate	ug/L	NE	NE	341,000	341,000	
Total dissolved solids	ug/L	NE	NE	804,000	804,000	
Total suspended solids	ug/L	NE	NE	59,000	59,000	
Turbidity	NTU	NE	NE	51.50	51.5	J

				Location Code:	AP2-PZ04	
				Sample Number:	AP3019	
				Sample Date:	1-Feb-09	
				Sample Depth:	0 - 0 Ft	
				Sample Purpose:	REG	
				Low-Flow Sampled:	Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ
Metals-Unfiltered						
Aluminum	ug/L	3,700	309	2400	74.3	J
Barium	ug/L	730	11,800	98	24	
Cadmium	ug/L	1.8	NE	4.28	4.28	J
Calcium	ug/L	NE	316,000	179000	135,000	
Copper	ug/L	150	19.8	12.3	5.63	J
Iron	ug/L	2,600	1,550	5060	203	
Magnesium	ug/L	NE	217,000	42700	39,600	
Manganese	ug/L	88	636	229	22.1	
Nickel	ug/L	73	8.6	74.2	5.36	J
Potassium	ug/L	NE	116,000	8940	405	J
Sodium	ug/L	NE	1,390,000	12200	9,150	
Metals-Filtered						
Barium	ug/L	730	11,800	88.1	22.8	
Cadmium	ug/L	1.8	NE	4.4	4.13	J
Calcium	ug/L	NE	316,000	172,000	135,000	
Magnesium	ug/L	NE	217,000	42,800	40,800	
Manganese	ug/L	88	636	220	16.2	
Potassium	ug/L	NE	116,000	9,500	346	J
Sodium	ug/L	NE	1,390,000	12,500	9,280	
Water Quality Parameters						
Alkalinity	ug/L	NE	NE	362,000	132,000	
Chloride	ug/L	NE	NE	12,600	5,140	J
Hardness	ug/L	NE	NE	622,000	501,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	49	J
Sulfate	ug/L	NE	NE	341,000	236,000	
Total dissolved solids	ug/L	NE	NE	804,000	619,000	
Total suspended solids	ug/L	NE	NE	59,000	3,000	J
Turbidity	NTU	NE	NE	51.50	4.56	J

				Location Code:	AP2-PZ07					
				Sample Number:	AP3022		AP3015		AP3016	
				Sample Date:	2-Feb-09		2-Feb-09		2-Feb-09	
				Sample Depth:	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
				Sample Purpose:	REG		FD		FS	
				Low-Flow Sampled:	Yes		Yes		Yes	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ
Semivolatiles										
Dimethylphenol, 2,4-	ug/L	73	NE	3.38	-	-	3.38	J	-	-
Metals-Unfiltered										
Aluminum	ug/L	3,700	309	2400	147	J	93.3	J	-	-
Barium	ug/L	730	11,800	98	31.9		31.3		-	-
Cadmium	ug/L	1.8	NE	4.28	3.91	J	4.27	J	-	-
Calcium	ug/L	NE	316,000	179000	110,000		110,000		101,000	
Copper	ug/L	150	19.8	12.3	-	-	5.71	J	-	-
Iron	ug/L	2,600	1,550	5060	593	J	325	J	191	
Magnesium	ug/L	NE	217,000	42700	31,900		32,200		29,200	
Manganese	ug/L	88	636	229	24.5		21.6		20.7	
Nickel	ug/L	73	8.6	74.2	-	-	4	J	-	-
Potassium	ug/L	NE	116,000	8940	548	J	521	J	-	-
Sodium	ug/L	NE	1,390,000	12200	6,990		6,860		6,380	
Metals-Filtered										
Barium	ug/L	730	11,800	88.1	28.2		29.3		-	-
Cadmium	ug/L	1.8	NE	4.4	3.9	J	3.98	J	-	-
Calcium	ug/L	NE	316,000	172,000	103,000		108,000		103,000	
Magnesium	ug/L	NE	217,000	42,800	31,400		31,100		29,900	
Manganese	ug/L	88	636	220	19		17.1		30.7	
Potassium	ug/L	NE	116,000	9,500	460	J	445	J	-	-
Sodium	ug/L	NE	1,390,000	12,500	7,000		6,840		6,180	
Water Quality Parameters										
Alkalinity	ug/L	NE	NE	362,000	169,000		222,000		260,000	
Chloride	ug/L	NE	NE	12,600	3,040	J	2,810	J	2,100	
Cyanide, total	ug/L	73	NE	44					44	
Hardness	ug/L	NE	NE	622,000	407,000		408,000		620,000	
Nitrate-Nitrite	ug/L	NE	NE	10,900	28	J	-	-		
Sulfate	ug/L	NE	NE	341,000	80,600		79,600		177,000	
Total dissolved solids	ug/L	NE	NE	804,000	450,000		442,000		450,000	
Total suspended solids	ug/L	NE	NE	59,000	4,000		-	-	-	-
Turbidity	NTU	NE	NE	51.50	4.52		4.93		1.3	

LEGEND:

- OVERBURDEN MONITORING WELL
- SOIL BORING/PIEZOMETER
- ug/L MICROGRAMS PER LITER
- NE NOT ESTABLISHED (RBSCs), NOT EVALUATED (BSCs)
- NM NOT MEASURED
- \- NOT DETECTED

NOTES:

1. SHADED CELL INDICATES VALUE IS GREATER THAN THE RBSC.
2. BOLD TEXT INDICATES VALUE IS GREATER THAN THE BSC.
3. RBSC VALUES REFLECT AN INCREMENTAL LIFETIME CANCER RISK (ILCR) OF 1E-6 OR A NONCANCER HAZARD QUOTIENT (HQ) OF 0.1. FOR CHEMICALS THAT EXHIBIT BOTH CANCER AND NONCANCER EFFECTS, WHICHEVER TYPE OF EFFECT IN A LOWER CONCENTRATION (USING AN ILCR OF 1E-6 AND AN HQ OF 0.1), THAT CONCENTRATION IS SELECTED AS THE RBSC.
4. BSC IS BACKGROUND SCREENING CONCENTRATION.
5. MDC IS MAXIMUM DETECTED CONCENTRATION FOR THE INVESTIGATION AREA ("B" QUALIFIED DATA NOT INCLUDED).
6. VALIDATION QUALIFIERS (VQ):
   B - THE ANALYTE WAS NOT DETECTED SIGNIFICANTLY ABOVE THE LEVELS FOUND IN THE ASSOCIATED METHOD BLANK OR FIELD BLANKS.
   J - THE ANALYTE WAS POSITIVELY IDENTIFIED; THE REPORTED VALUE IS ESTIMATED.
7. ONLY NITROAROMATICS WERE ANALYZED IN GROUNDWATER DURING THE MONTH OF NOVEMBER. NO NITROAROMATICS WERE DETECTED THEREFORE NO DATA IS SHOWN.

FIGURE 5-8
DETECTED CONSTITUENTS AT POWERHOUSE 2 ASH PITS IN OVERBURDEN/SHALE GROUNDWATER SAMPLES ABOVE RBSCs AND/OR BSCs (JAN., FEB., MAY, AND NOV. 2009)

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE
0 80 160 FEET

Shaw® a world of Solutions™

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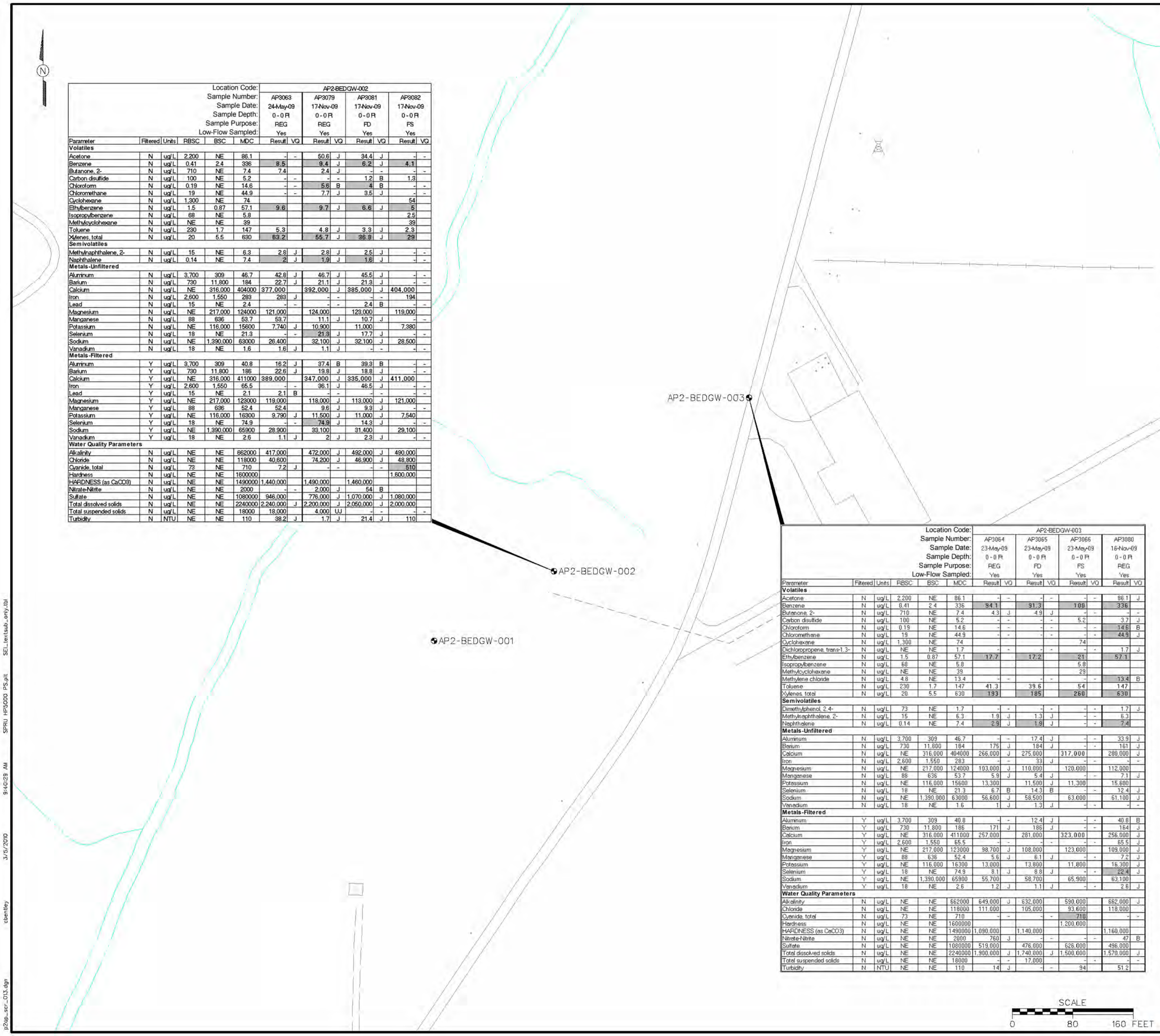

Location Code:						AP2-BEDGW-002							
Sample Number:						AP3063		AP3079		AP3081		AP3082	
Sample Date:						24-May-09		17-Nov-09		17-Nov-09		17-Nov-09	
Sample Depth:						0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
Sample Purpose:						REG		REG		FD		FS	
Low-Flow Sampled:						Yes		Yes		Yes		Yes	
Parameter	Filtered	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatiles													
Acetone	N	ug/L	2,200	NE	86.1	-	-	50.6	J	34.4	J	-	-
Benzene	N	ug/L	0.41	2.4	336	8.5		9.4	J	6.2	J	4.1	
Butanone, 2-	N	ug/L	710	NE	7.4	7.4		2.4	J	-	-	-	-
Carbon disulfide	N	ug/L	100	NE	5.2	-	-	-	-	1.2	B	1.3	
Chloroform	N	ug/L	0.19	NE	14.6	-	-	5.6	B	4	B	-	-
Chloromethane	N	ug/L	19	NE	44.9	-	-	7.7	J	3.5	J	-	-
Cyclohexane	N	ug/L	1,300	NE	74							54	
Ethylbenzene	N	ug/L	1.5	0.87	57.1	9.6		9.7	J	6.6	J	5	
Isopropylbenzene	N	ug/L	68	NE	5.8							2.5	
Methylcyclohexane	N	ug/L	NE	NE	39							39	
Toluene	N	ug/L	230	1.7	147	5.3		4.8	J	3.3	J	2.3	
Xylenes, total	N	ug/L	20	5.5	630	63.2		55.7	J	36.8	J	29	
Semivolatiles													
Methylnaphthalene, 2-	N	ug/L	15	NE	6.3	2.8	J	2.8	J	2.5	J	-	-
Naphthalene	N	ug/L	0.14	NE	7.4	2	J	1.9	J	1.6	J	-	-
Metals-Unfiltered													
Aluminum	N	ug/L	3,700	309	46.7	42.8	J	46.7	J	45.5	J	-	-
Barium	N	ug/L	730	11,800	184	22.7	J	21.1	J	21.3	J	-	-
Calcium	N	ug/L	NE	316,000	404000	377,000		392,000	J	385,000	J	404,000	
Iron	N	ug/L	2,600	1,550	283	283	J	-	-	-	-	194	
Lead	N	ug/L	15	NE	2.4	-	-	-	-	2.4	B	-	-
Magnesium	N	ug/L	NE	217,000	124000	121,000		124,000		123,000		119,000	
Manganese	N	ug/L	88	636	53.7	53.7		11.1	J	10.7	J	-	-
Potassium	N	ug/L	NE	116,000	15600	7,740	J	10,900		11,000		7,380	
Selenium	N	ug/L	18	NE	21.3	-	-	21.3	J	17.7	J	-	-
Sodium	N	ug/L	NE	1,390,000	63000	26,400		32,100	J	32,100	J	28,500	
Vanadium	N	ug/L	18	NE	1.6	1.6	J	1.1	J	-	-	-	-
Metals-Filtered													
Aluminum	Y	ug/L	3,700	309	40.8	16.2	J	37.4	B	39.3	B	-	-
Barium	Y	ug/L	730	11,800	186	22.6	J	19.8	J	18.8	J	-	-
Calcium	Y	ug/L	NE	316,000	411000	389,000		347,000	J	335,000	J	411,000	
Iron	Y	ug/L	2,600	1,550	65.5	-	-	36.1	J	46.5	J	-	-
Lead	Y	ug/L	15	NE	2.1	2.1	B	-	-	-	-	-	-
Magnesium	Y	ug/L	NE	217,000	123000	119,000		118,000	J	113,000	J	121,000	
Manganese	Y	ug/L	88	636	52.4	52.4		9.6	J	9.3	J	-	-
Potassium	Y	ug/L	NE	116,000	16300	9,790	J	11,500	J	11,000	J	7,540	
Selenium	Y	ug/L	18	NE	74.9	-	-	74.9	J	14.3	J	-	-
Sodium	Y	ug/L	NE	1,390,000	65900	28,900		33,100		31,400		29,100	
Vanadium	Y	ug/L	18	NE	2.6	1.1	J	2	J	2.3	J	-	-
Water Quality Parameters													
Alkalinity	N	ug/L	NE	NE	662000	417,000		472,000	J	492,000	J	490,000	
Chloride	N	ug/L	NE	NE	118000	40,600		74,200	J	46,900	J	48,800	
Cyanide, total	N	ug/L	73	NE	710	7.2	J	-	-	-	-	510	
Hardness	N	ug/L	NE	NE	1600000							1,600,000	
HARDNESS (as CaCO3)	N	ug/L	NE	NE	1490000	1,440,000		1,490,000		1,460,000			
Nitrate-Nitrite	N	ug/L	NE	NE	2000	-	-	2,000	J	54	B		
Sulfate	N	ug/L	NE	NE	1080000	946,000		776,000	J	1,070,000	J	1,080,000	
Total dissolved solids	N	ug/L	NE	NE	2240000	2,240,000	J	2,200,000	J	2,050,000	J	2,000,000	
Total suspended solids	N	ug/L	NE	NE	18000	18,000		4,000	UJ	-	-	-	-
Turbidity	N	NTU	NE	NE	110	38.2	J	1.7	J	21.4	J	110	

Location Code:						AP2-BEDGW-003							
Sample Number:						AP3064		AP3065		AP3066		AP3080	
Sample Date:						23-May-09		23-May-09		23-May-09		16-Nov-09	
Sample Depth:						0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
Sample Purpose:						REG		FD		FS		REG	
Low-Flow Sampled:						Yes		Yes		Yes		Yes	
Parameter	Filtered	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatiles													
Acetone	N	ug/L	2,200	NE	86.1	-	-	-	-	-	-	86.1	J
Benzene	N	ug/L	0.41	2.4	336	94.1		91.3		100		336	
Butanone, 2-	N	ug/L	710	NE	7.4	4.3	J	4.9	J	-	-	-	-
Carbon disulfide	N	ug/L	100	NE	5.2	-	-	-	-	5.2		3.7	J
Chloroform	N	ug/L	0.19	NE	14.6	-	-	-	-	-	-	14.6	B
Chloromethane	N	ug/L	19	NE	44.9	-	-	-	-	-	-	44.9	J
Cyclohexane	N	ug/L	1,300	NE	74					74			
Dichloropropene, trans-1,3-	N	ug/L	NE	NE	1.7	-	-	-	-	-	-	1.7	J
Ethylbenzene	N	ug/L	1.5	0.87	57.1	17.7		17.2		21		57.1	
Isopropylbenzene	N	ug/L	68	NE	5.8					5.8			
Methylcyclohexane	N	ug/L	NE	NE	39					29			
Methylene chloride	N	ug/L	4.8	NE	13.4	-	-	-	-	-	-	13.4	B
Toluene	N	ug/L	230	1.7	147	41.3		39.6		54		147	
Xylenes, total	N	ug/L	20	5.5	630	193		185		260		630	
Semivolatiles													
Dimethylphenol, 2,4-	N	ug/L	73	NE	1.7	-	-	-	-	-	-	1.7	J
Methylnaphthalene, 2-	N	ug/L	15	NE	6.3	1.9	J	1.3	J	-	-	6.3	
Naphthalene	N	ug/L	0.14	NE	7.4	2.9	J	1.9	J	-	-	7.4	
Metals-Unfiltered													
Aluminum	N	ug/L	3,700	309	46.7	-	-	17.4	J	-	-	33.9	J
Barium	N	ug/L	730	11,800	184	175	J	184	J	-	-	161	J
Calcium	N	ug/L	NE	316,000	404000	266,000	J	275,000		317,000		289,000	J
Iron	N	ug/L	2,600	1,550	283	-	-	33	J	-	-	-	-
Magnesium	N	ug/L	NE	217,000	124000	103,000	J	110,000		120,000		112,000	
Manganese	N	ug/L	88	636	53.7	5.9	J	5.4	J	-	-	7.1	J
Potassium	N	ug/L	NE	116,000	15600	13,300		11,500	J	11,300		15,600	
Selenium	N	ug/L	18	NE	21.3	6.7	B	14.3	B	-	-	12.4	J
Sodium	N	ug/L	NE	1,390,000	63000	56,600	J	58,500		63,000		61,100	J
Vanadium	N	ug/L	18	NE	1.6	1	J	1.3	J	-	-	-	-
Metals-Filtered													
Aluminum	Y	ug/L	3,700	309	40.8	-	-	12.4	J	-	-	40.8	B
Barium	Y	ug/L	730	11,800	186	171	J	186	J	-	-	164	J
Calcium	Y	ug/L	NE	316,000	411000	257,000		281,000		323,000		256,000	J
Iron	Y	ug/L	2,600	1,550	65.5	-	-	-	-	-	-	65.5	J
Magnesium	Y	ug/L	NE	217,000	123000	98,700	J	108,000		123,000		109,000	J
Manganese	Y	ug/L	88	636	52.4	5.6	J	6.1	J	-	-	7.2	J
Potassium	Y	ug/L	NE	116,000	16300	13,000		13,800		11,800		16,300	J
Selenium	Y	ug/L	18	NE	74.9	8.1	J	8.8	J	-	-	22.4	J
Sodium	Y	ug/L	NE	1,390,000	65900	55,700		58,700		65,900		63,100	
Vanadium	Y	ug/L	18	NE	2.6	1.2	J	1.1	J	-	-	2.6	J
Water Quality Parameters													
Alkalinity	N	ug/L	NE	NE	662000	649,000	J	632,000		590,000		662,000	J
Chloride	N	ug/L	NE	NE	118000	111,000		105,000		93,600		118,000	
Cyanide, total	N	ug/L	73	NE	710	-	-	-	-	710		-	-
Hardness	N	ug/L	NE	NE	1600000					1,200,000			
HARDNESS (as CaCO3)	N	ug/L	NE	NE	1490000	1,090,000		1,140,000				1,160,000	
Nitrate-Nitrite	N	ug/L	NE	NE	2000	760	J	-	-	-	-	47	B
Sulfate	N	ug/L	NE	NE	1080000	519,000		476,000		626,000		496,000	
Total dissolved solids	N	ug/L	NE	NE	2240000	1,900,000	J	1,740,000	J	1,500,000		1,570,000	J
Total suspended solids	N	ug/L	NE	NE	18000	-	-	17,000		-	-	-	-
Turbidity	N	NTU	NE	NE	110	14	J	-	-	94		51.2	

LEGEND:

- BEDROCK MONITORING WELL
- ug/L MICROGRAMS PER LITER
- NE NOT ESTABLISHED (RBSCs), NOT EVALUATED (BSCs)
- NM NOT MEASURED
- \- NOT DETECTED

NOTES:

1. SHADED CELL INDICATES VALUE IS GREATER THAN THE RBSC.
2. BOLD TEXT INDICATES VALUE IS GREATER THAN THE BSC.
3. RBSC VALUES REFLECT AN INCREMENTAL LIFETIME CANCER RISK (ILCR) OF 1E-6 OR A NONCANCER HAZARD QUOTIENT (HQ) OF 0.1. FOR CHEMICALS THAT EXHIBIT BOTH CANCER AND NONCANCER EFFECTS, WHICHEVER TYPE OF EFFECT IN A LOWER CONCENTRATION (USING AN ILCR OF 1E-6 AND AN HQ OF 0.1), THAT CONCENTRATION IS SELECTED AS THE RBSC.
4. BSC IS BACKGROUND SCREENING CONCENTRATION.
5. MDC IS MAXIMUM DETECTED CONCENTRATION FOR THE INVESTIGATION AREA ("B" QUALIFIED DATA NOT INCLUDED).
6. VALIDATION QUALIFIERS (VQ):
   - B - THE ANALYTE WAS NOT DETECTED SIGNIFICANTLY ABOVE THE LEVELS FOUND IN THE ASSOCIATED METHOD BLANK OR FIELD BLANKS.
   - J - THE ANALYTE WAS POSITIVELY IDENTIFIED; THE REPORTED VALUE IS ESTIMATED.

SCALE
0 80 160 FEET

FIGURE 5-9
DETECTED CONSTITUENTS AT POWERHOUSE 2 ASH PITS IN BEDROCK GROUNDWATER SAMPLES ABOVE RBSCs AND/OR BSCs (MAY AND NOVEMBER 2009)

POWERHOUSE 2 ASH PITS SCR
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® a world of Solutions™

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APPENDIX A

DIRECT-PUSH SOIL BORING/PIEZOMETER AND MONITORING WELL HTRW DRILL LOGS AND WELL CONSTRUCTION DIAGRAMS

HTRW DRILLING LOG

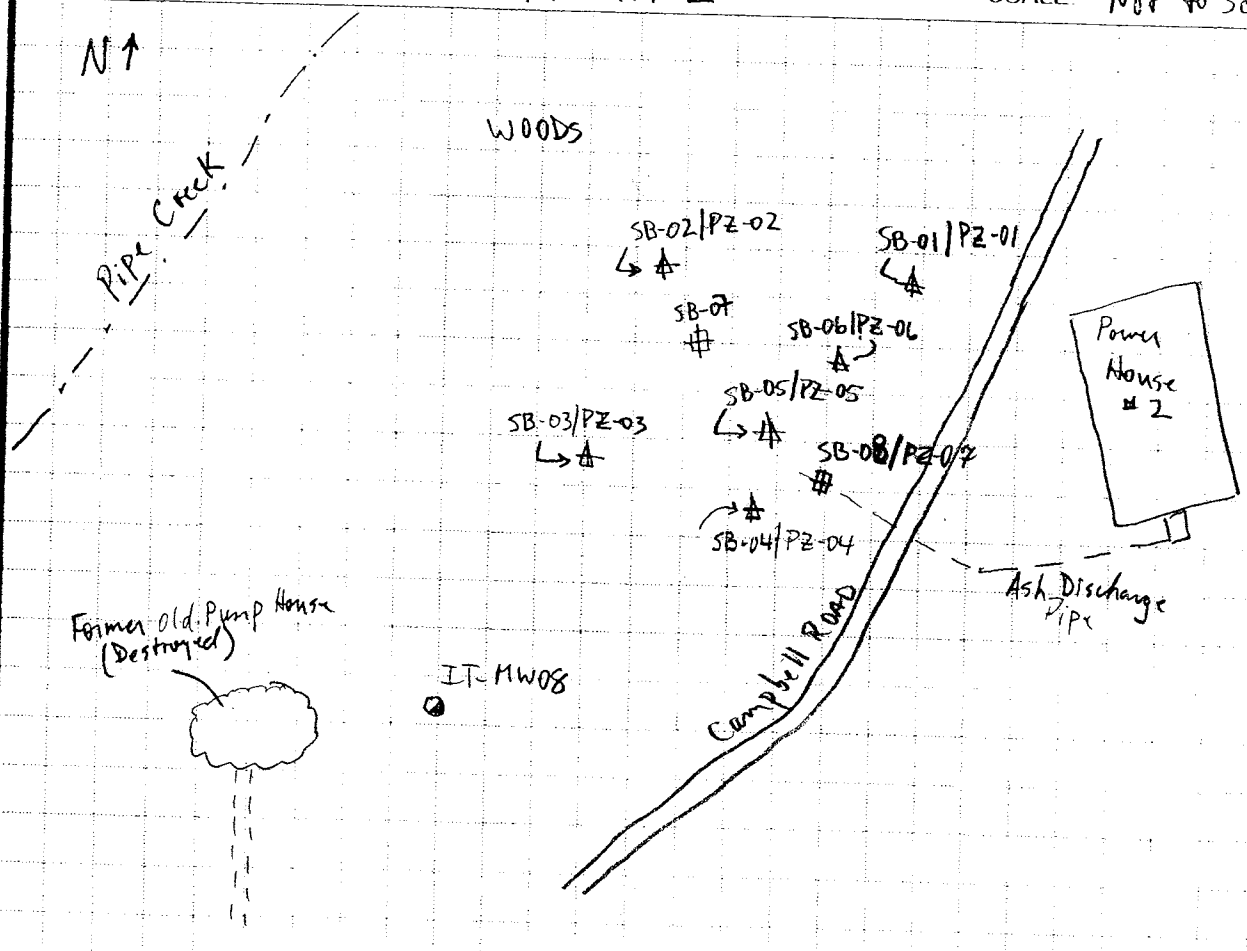
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	SB-01/PZ-01
2. DRILL SUBCONTRACTOR	Tri-State Drilling
SHEET / SHEETS	1 OF 3
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Jimmy Griffith
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe 6610 DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Surface and Subsurface initially cleared with geophysics. Drove 2-inch macrocore with 5-ft long acetate liners.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	Northing: 623073.14 Easting: 1911485.20 Elevation: 631.7
10. DATE STARTED	1/15/09
11. DATE COMPLETED	1/15/09
12. OVERBURDEN THICKNESS	12 Ft
15. DEPTH GROUNDWATER ENCOUNTERED	Not encountered
13. DEPTH DRILLED INTO ROCK	-0-
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	12 Ft
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	✓	Nitros	PCB's	SVOCs	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	NA	NA	1" Piezo	David Kesch

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not to Scale



PROJECT PBOW HOLE NO. SB-01/PZ-01

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-01/PZ-01

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	1	Black (10YR 2/1), black shale fragments, low plasticity, clayey SILT, pebble size gravel 5%, moist, organics (roots), grading to	ml	0.0	NA	AP0100 0830	3.7/ 5.0	Began drilling 1/15/09 S-1 0830 ~~0820~~ (0-5') gravel in silt 0-0.5'
	2	10YR 4/4 dark yellowish brown, mottled dark brown, SILT						Core frozen like rock. Let thaw in bag for homogenization.
	3			0.0		3 AP0101 0835		Done
	4	4.5				3.7		Breathing Air: VOCs = 0.0 ppm O_2 = 20.8 ~~ppm~~ % H_2S = 0 ppm CO = 0 ppm LEL = 0%
	5	color change at 4.5 ft to (2.5Y 4/3) light yellowish brown, 5% mottling (dark yellowish brown) very fine grain, SAND, dry	~~sm~~ SP ~~ml~~					
	6						5/5	S-2 0835 (5-10')
	7	6.5 (10YR 3/3) dark brown, low plasticity, homogeneous, silty CLAY, 10% very coarse grain ~~gravel~~ rock bits, angular to rounded, various colors (brown, white, gray) moist	CL					
	8					8 AP0102		
	9	8.5 (10YR 3/1) very dark gray, low plasticity, SILT, trace clay, very coarse grain rock 10%, moist	ml	0.0				
	10					0840		

Project: PBOW

Hole Number: SB-01/PZ-01

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Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-01/PZ-01

Project: PBOW

Geologist: D. Kessler

Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	(10YR 3/1) very dark gray, low plasticity, SILT, trace clay, very coarse grain Rock, 10%, moist	ML		NA	NA	2/2	S-3 0840 (10-12")
	11							
	12	~~Auger~~ Bit Refusal @ 12ft Total Depth: 12ft SHALE, gray						
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							

Project: PBOW

Hole Number: PZ-01/SB-01

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Temporary Piezometer

Project:	PBOW	Piezometer Number:	PZ-01
Location:	Sandusky, Ohio	Site Location:	Ash Pit 2
Client:	USACE, Nashville, TN	Installation Date	11/15/09
Subcontractor:	Tri-State Drilling	Northing:	623073.14
Driller:	Jimmy Griffith	Easting:	1911485.20
Shaw Field Representative:	DAVID KESSLER	Shaw Project Number:	133422

Top of Casing Elevation (ft): 634.97

Top of Casing Stickup (ft): 3.1

Land Surface Elevation (ft): 631.7

Approximate Diameter of Borehole (in): 3 1/2"

Well Casing Diameter (in): 1"

Depth to Water (ft):

During Drilling: Not encountered

Date: 11/15/09

Post Development: NA TOC

Date: NA

Top of Filter Pack (ft): NA

Top of Screen Interval (ft): 1.90

Bottom of Screen Interval (ft): 11.90

Bottom of Piezometer (ft): 12.15

Bottom of Borehole (ft): 12

Filter Pack Material: None

Manufacturer:

Product Name:

Size:

Installation: Prepacked Screen Filter Sock

Well Casing:

Manufacturer: DSI

Type: PVC

Diameter (in): 1"

Well Screen Casing:

Manufacturer: DSI

Type: PVC

Slot Size (in): 0.010 %Open

Slot Type: Continuous wrap Factory slot

Sump/End Cap: 0.25 ~~0.14~~ Pkr Ft

Backfill Material: None

Abandonment:

Date: 7/6/09

Procedure: Natural fill Grouted Bentonite Casing Removed

Completed as Well NA

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.

All elevations are referenced to MSL (NAVD 88).

If completed as well - see well construction diagram

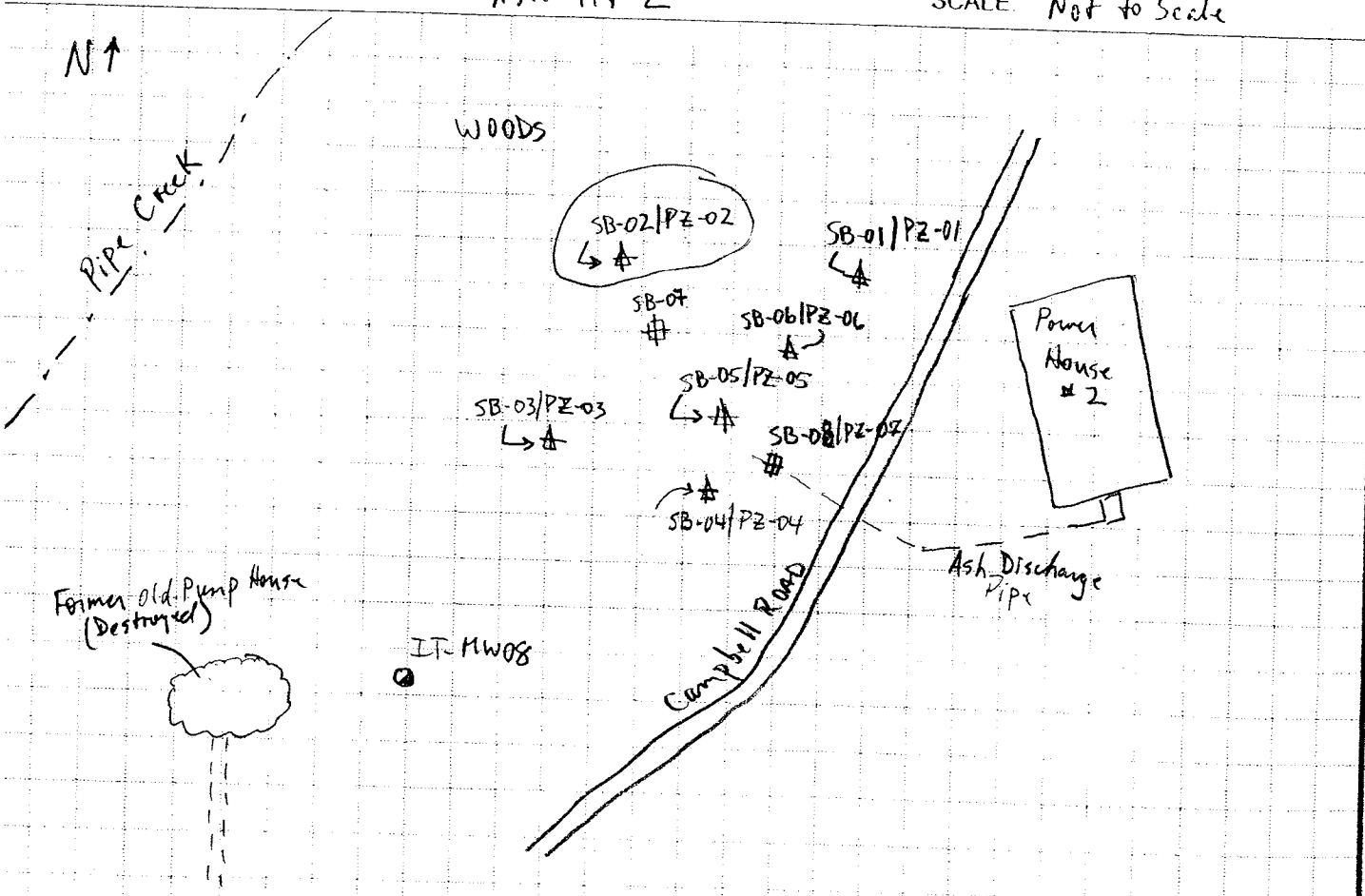
HTRW DRILLING LOG

1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
2. DRILL SUBCONTRACTOR	Tri-State Drilling
HOLE NUMBER	SB02/PZ2
SHEET / OF SHEETS	1 / 3
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Jimmy Griffith
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe 6610 DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Surface and Subsurface initially cleared with geophysics. Drove 2-inch macrocore with 5-ft long acetate liners.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	627.5 Northing: 623041.37 Easting: 1911260.38
10. DATE STARTED	1/16/09
11. DATE COMPLETED	1/16/09
12. OVERBURDEN THICKNESS	10.6 Ft
15. DEPTH GROUNDWATER ENCOUNTERED	Not encountered
13. DEPTH DRILLED INTO ROCK	-0-
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	10.6'
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	Met	Nitros	SVOCs	PCBs	NA %
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	NA	NA	1" Piezo	David Fraser		

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not to Scale



ROJECT PBOW

HOLE NO. SB02/PZ02

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB02/PZ02

Project: PBOW

Geologist: Eric Vearen

Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		Black ASH, very coarse grain, dry, trace organics (roots, leaves) 0.0'		0.3	NA	AP0103 1030	3.7'/5	Begon drilling 1/16/09
	1	Soft (2.5y 3/2) Very dark grayish brown low plasticity, SILT, moist.	ML			1		S-1 (0-5') 1030
	2	Loose (2.5y 4/3) Olive brown, very fine grained SAND, moist grading to (2.5y 5/4) light olive brown	SP					
	3	Stiff to very stiff (10yR 4/3) brown CLAY, moist		0.4		3' AP0104 AP0105 AP0106 1033 3'		
	4		CL					
	5							S-2 (5'-10') 1200
	6							
	7							
	8					8'		
	9							
	10					10'		

Project: PBOW

Hole Number: SB-02/PZ-02

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Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-02/PZ-02

Project: PBOW

Geologist: E. Weaver

Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	(2.5y 3/1) very dark gray, silty CLAY, rock fragments (15%) medium to fine grain moist	CL		NA		0.6/0.6	S-3 (10-10.6) 1205
	11	10.6 Refusal @ 10.6 Ft Total Depth = 10.6 Ft						
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							

Project: PBOW

Hole Number: SB2/PZ2

Temporary Piezometer

Project:	PDOW	Piezometer Number:	PZ-02
Location:	Sandusky, Ohio	Site Location:	Ash Pit 2
Client:	USACE, Nashville, TN	Installation Date	1/16/09
Subcontractor:	Tri-State Drilling	Northing:	623041.37
Driller:	Jimmy Griffith	Easting:	1911260.38
Shaw Field Representative:	DAVID Kessler	Shaw Project Number:	133422

Top of Casing Elevation (ft): 630.32

Top of Casing Stickup (ft): 2

Land Surface Elevation (ft): 627.5

Approximate Diameter of Borehole (in): 3 1/2"

Well Casing Diameter (in): 1"

Depth to Water (ft):

During Drilling: Not encountered

Date: 1/16/09

Post Development: NA TOC

Date: NA

Top of Filter Pack (ft): NA

Top of Screen Interval (ft): 3.5

7' screen slip cap

Bottom of Screen Interval (ft): 10.5

Bottom of Piezometer (ft): 10.6

Bottom of Borehole (ft): 10.6 Ft

Filter Pack Material: None

Manufacturer:

Product Name:

Size:

Installation: Prepacked Screen Filter Sock

Well Casing:

Manufacturer: DSI

Type: PVC

Diameter (in): 1"

Well Screen Casing:

Manufacturer: DSI

Type: PVC

Slot Size (in): 0.010 %Open

Slot Type: Continuous wrap Factory slot

Sump/End Cap: 0.0 ~~0.44 Ft~~ ~~DKK~~

Backfill Material: None

Abandonment:

Date: 7/6/09

Procedure: Natural fill Grouted Bentonite

Casing Removed

Completed as Well NA

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.

All elevations are referenced to MSL (NAVD 88).

If completed as well - see well construction diagram.

HTRW DRILLING LOG

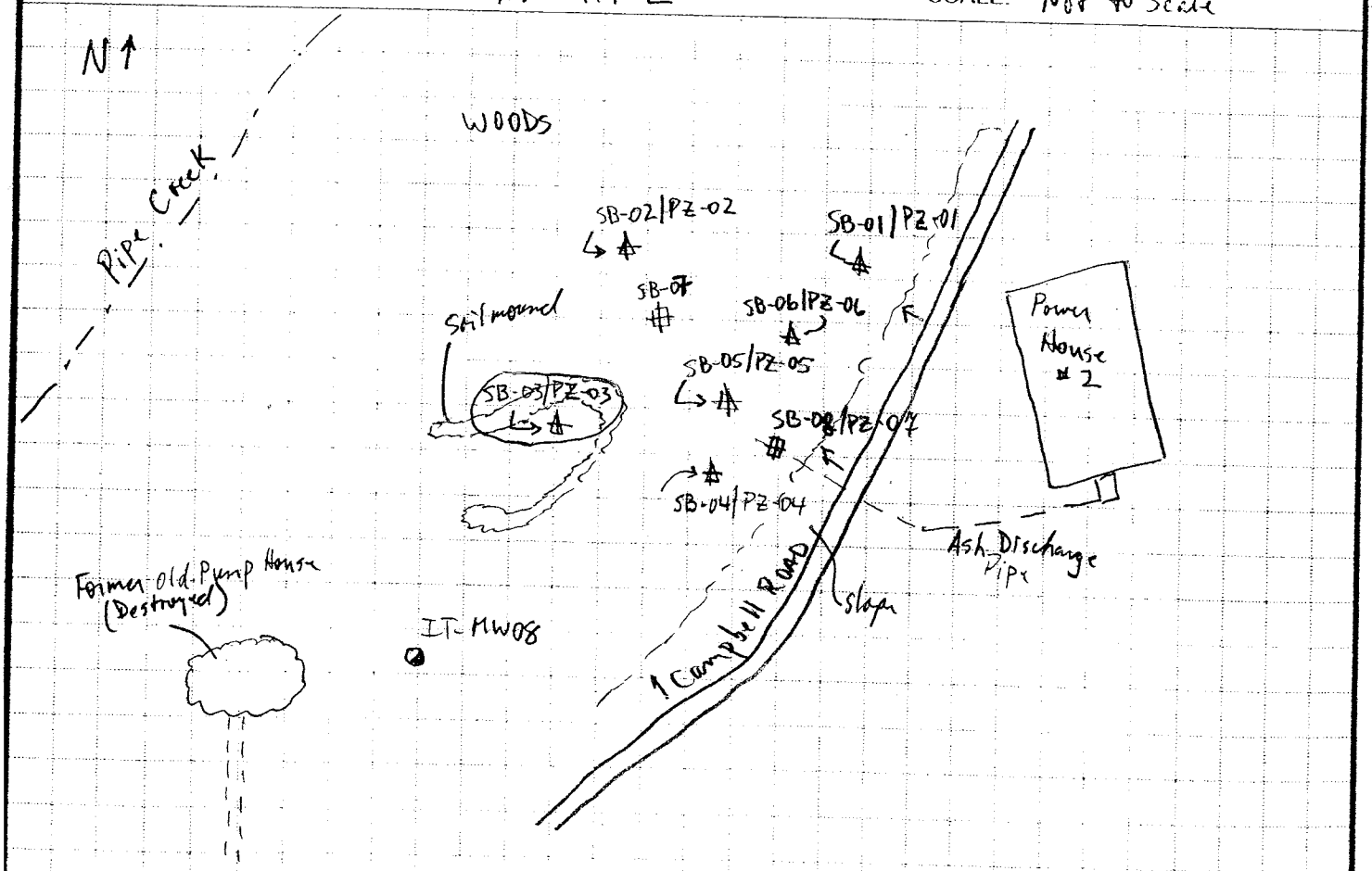
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	SB-03/PZ-03
2. DRILL SUBCONTRACTOR	Tri-State Drilling
SHEET / SHEETS	1 OF 3
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Jimmy Griffith
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe 6610DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Surface and Subsurface initially cleared with geophysics, Drove 2-inch macrocore with 5-ft long acetate liners.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	607.7 Northing: 622845.22 Easting: 1911148.24
10. DATE STARTED	1/18/09
11. DATE COMPLETED	1/18/09
12. OVERBURDEN THICKNESS	11.1 Ft
15. DEPTH GROUNDWATER ENCOUNTERED	1.7 Ft
13. DEPTH DRILLED INTO ROCK	-0-
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	11.1 Ft
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	yes	Nitros	SVOCs	PCBs	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	NA	NA	1" Piezo	David Kessler

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not to Scale



PROJECT	PBOW	HOLE NO.	SB-03/PZ-03

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-03/PZ-03

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		Soft, (10YR 2/2) very dark br, homogeneous, clayey SILT, organics roots, moist grading to (10YR 3/4) dry 1.1	ml		NA	AP0108 0925	3.5/5	Began drilling 1/18/09 S-1 0925 (0-5')
	1							
	2	Loose, (10YR 3/3) dark brown, SAND, little silt (15%), very fine grain, very well sorted, wet silt content increases w/depth clay content begins and increases w/depth 2.8	SP					▽ Encountered gw 1.7 ft
	3	Stiff to very stiff, (10YR 4/1) dark gray, mottled (yellowish brown) (30%-2.8-4'), mottling decreases with depth, high plasticity, CLAY mottled (color SILT-3%), moist to wet.				AP0109 0925		Breathing Air: VOCs = 0.0ppm LEL = 0% O_2 = 21.1% CO = 0.0 ppm H_2S = 0.0 ppm
	4							
	5		ch					
	6						5/5	S-2 0930 (5-10')
	7							
	8					AP0110		
	9	Shale fragments 9.5 ft, friable						
	10					0930		

Project: PBOW

Hole Number: SB-03/PZ-03

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-03/PZ-03

Project: PBOW

Geologist: D. Kessler

Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	very stiff, (10yR 4/1) dark gray, homogeneous, CLAY, high plasticity, shale fragments, limestone fragments, (1cm pebble 11.1 Ft), wet	Ch	0.0	NA	NA	1.1/ 1.1	S-3 0935 (10-11.1')
	11	Refusal @ 11.1 Ft Total Depth = 11.1 Ft						
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							

Project: PBOW

Hole Number: SB-03/PZ-03

Temporary Piezometer

Project:	PBOW	Piezometer Number:	PZ-03
Location:	Sandusky, Ohio	Site Location:	Ash Pit 2
Client:	USACE, Nashville, TN	Installation Date	1/18/09
Subcontractor:	Tri-State Drilling	Northing:	622 845.22
Driller:	Jimmy Griffith	Easting:	1911 148.24
Shaw Field Representative:	David Kessler	Shaw Project Number:	133422

Top of Casing Elevation (ft): 630.69

Top of Casing Stickup (ft): ~~[illegible]~~ 2.9

Land Surface Elevation (ft): 627.7

Approximate Diameter of Borehole (in): 3 1/2"

Well Casing Diameter (in): 1"

Depth to Water (ft):

During Drilling: 1.7 Ft

Date: 1/18/09

Post Development: NA TOC

Date: NA

Top of Filter Pack (ft): NA

Top of Screen Interval (ft): 1.00 ~~[illegible]~~

Bottom of Screen Interval (ft): 11.00

Bottom of Piezometer (ft): 11.25

Bottom of Borehole (ft): 11.1 Ft

Filter Pack Material: None

Manufacturer:

Product Name:

Size:

Installation: Prepacked Screen Filter Sock

Well Casing:

Manufacturer: DSI

Type: PVC

Diameter (in): 1"

Well Screen Casing:

Manufacturer: DSI

Type: PVC

Slot Size (in): 0.010 %Open

Slot Type: Continuous wrap Factory slot

Sump/End Cap: 0.14 Ft

Backfill Material: None

Abandonment:

Date: 7/6/09

Procedure: Natural fill Grouted Bentonite Casing Removed

Completed as Well NA

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.

All elevations are referenced to MSL (NAVD 88)

If completed as well - see well construction diagram.

10+5
screen riser (end 1.1') 2.9 stick up

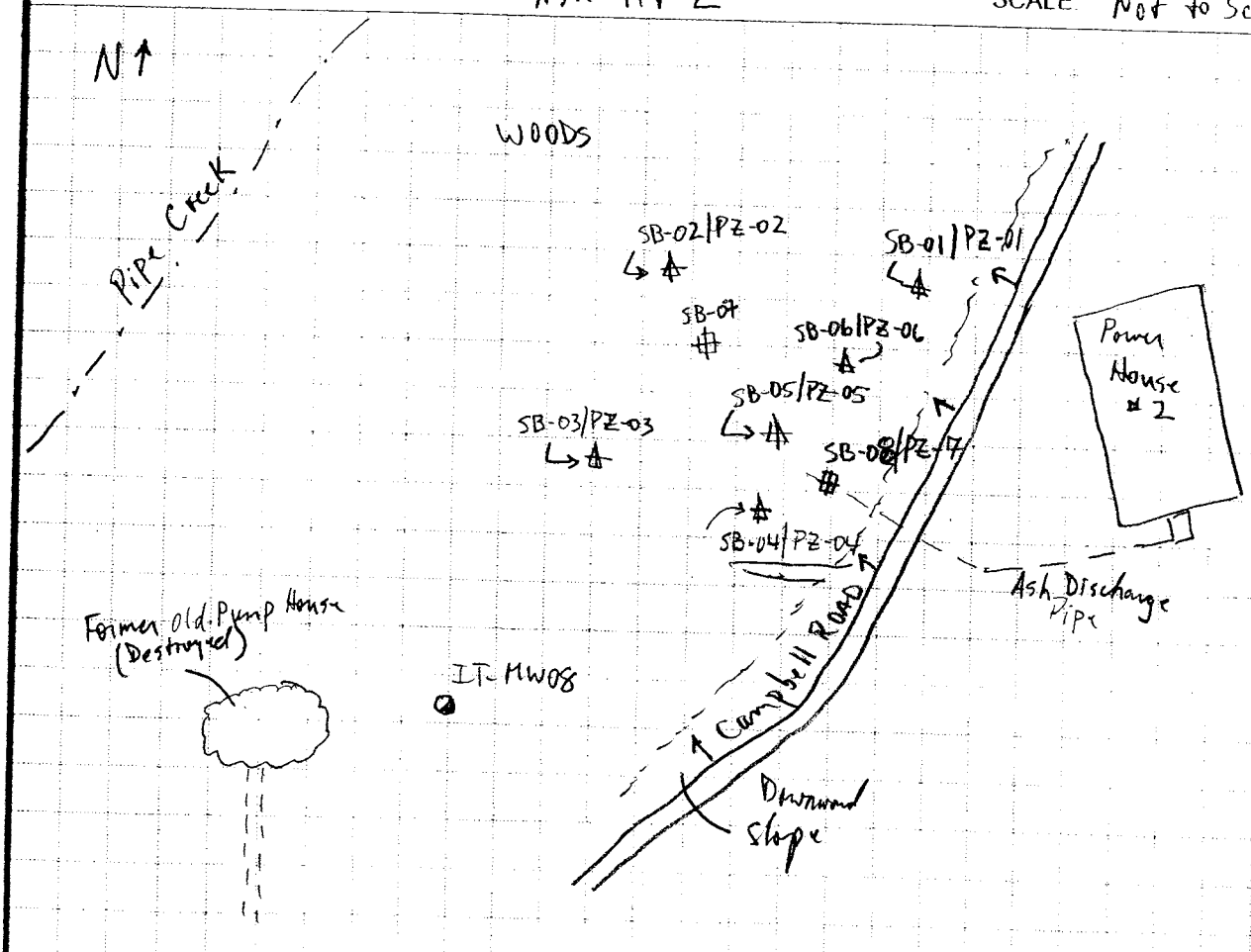
HTRW DRILLING LOG

1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	SB-04/PZ-04
2. DRILL SUBCONTRACTOR	Tri-State Drilling
SHEET / SHEETS	1 OF 3
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Jimmy Griffith
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe 6610 DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Surface and Subsurface initially cleared with geophysics. Drove 2-inch macrocore with 5-ft long acetate liners.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	630.0 Northing: 622789.21 Easting: 1941348.96
10. DATE STARTED	1/18/09
11. DATE COMPLETED	1/18/09
12. OVERBURDEN THICKNESS	11.7 Ft
15. DEPTH GROUNDWATER ENCOUNTERED	~4 Ft
13. DEPTH DRILLED INTO ROCK	-0-
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	11.7 Ft
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	yes	Nitros	PCBs	SVOCs	NA %
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	NA	NA	1" Piezo	David Kessler		

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not to Scale



PROJECT	PBOW	HOLE NO.	SB-04/PZ-04

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-04/PZ-04

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	1	Black, ASH/CINDERS, very loose, mottled (yellowish br), cinders common at base; ~10 mm layers of ASH black/brown, moist organics (roots), 10% white specks		0.0	NA	AP0111 0845	2.7/ 5.0	Began drilling 1/18/09 0845 S-1 (0-5')
	2	2						Attempted 4 sleeves (2 @ 0-5' pushes + 2 discrete 3-5' pushes), best collected 3-3.5'
	3	Soft, (10YR 3/3) dark brown, mottled (very dark brown) (30%), low plasticity, clayey SILT,	ml			3 AP0112 0848 3.5	3 0848 3.5	▽ Encountered gw ~4 ft
	3.3			0.0				
	4	Very loose, (10YR 3/3) dark br, mottled (br yellow), silty SAND, very fine grain, silt (35%), wet	SP					
	5							S-2 0850 (5-10')
	6						5/ 5	
	7	7.2						
	8	Stiff, (10YR 4/2) dark grayish brown, high ~~plasticity~~ plasticity, CLAY, silt 10%, moist color changes to (10YR 4/1) dark gray at 9 ft; very stiff, silt content higher (30%) low plasticity	ch			AP0113		
	9			0.0				
	10					0850		

Project: PBOW

Hole Number: SB-04/PZ-04

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-04/PZ-04

Project: PBOW

Geologist: D. Kessler

Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	Very stiff, (10 yr 4/1) dark gray, low plasticity, silty CLAY, silt content high (40%), wet	Ch	0.0	NA	NA	1.7/ 1.7	S-3 0855
	11							
	12	Refusal @ 11.7 Ft Total Depth = 11.7 Ft						
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							

Project: PBOW

Hole Number: SB-04/PZ-04

Temporary Piezometer

Project:	PBOW	Piezometer Number:	PZ-04
Location:	Sandusky, Ohio	Site Location:	Ash Pit 2
Client:	USACE, Nashville, TN	Installation Date	1/18/09
Subcontractor:	Tri-State Drilling	Northing:	622789.21
Driller:	Jimmy Griffith	Easting:	1911348.96
Shaw Field Representative:	DAVID KESSLER	Shaw Project Number:	133422

Top of Casing Elevation (ft): 633.70

Top of Casing Stickup (ft): 3.35'

Land Surface Elevation (ft): 630.0

Approximate Diameter of Borehole (in): 3 1/2"

Well Casing Diameter (in): 1"

Depth to Water (ft):

During Drilling: ~4 Ft

Date: 1/18/09

Post Development: NA TOC

Date: NA

Top of Filter Pack (ft): NA

Top of Screen Interval (ft): 1.65

Bottom of Screen Interval (ft): 11.65

Bottom of Piezometer (ft): 11.90'

Bottom of Borehole (ft): 11.70'

Filter Pack Material: None

Manufacturer:

Product Name:

Size:

Installation: Prepacked Screen Filter Sock

Well Casing:

Manufacturer: DSI

Type: PVC

Diameter (in): 1"

Well Screen Casing:

Manufacturer: DSI

Type: PVC

Slot Size (in): 0.010 %Open

Slot Type: Continuous wrap Factory slot

Sump/End Cap: 0.14 Ft

Backfill Material: None

Abandonment:

Date: 7/6/09

Procedure: Natural fill Grouted Bentonite

Casing Removed

Completed as Well NA

Shaw

Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.

All elevations are referenced to MSL (NAVD 88).

If completed as well - see well construction diagram.

10' ±5' screen Pitm 3.35' stc

HTRW DRILLING LOG

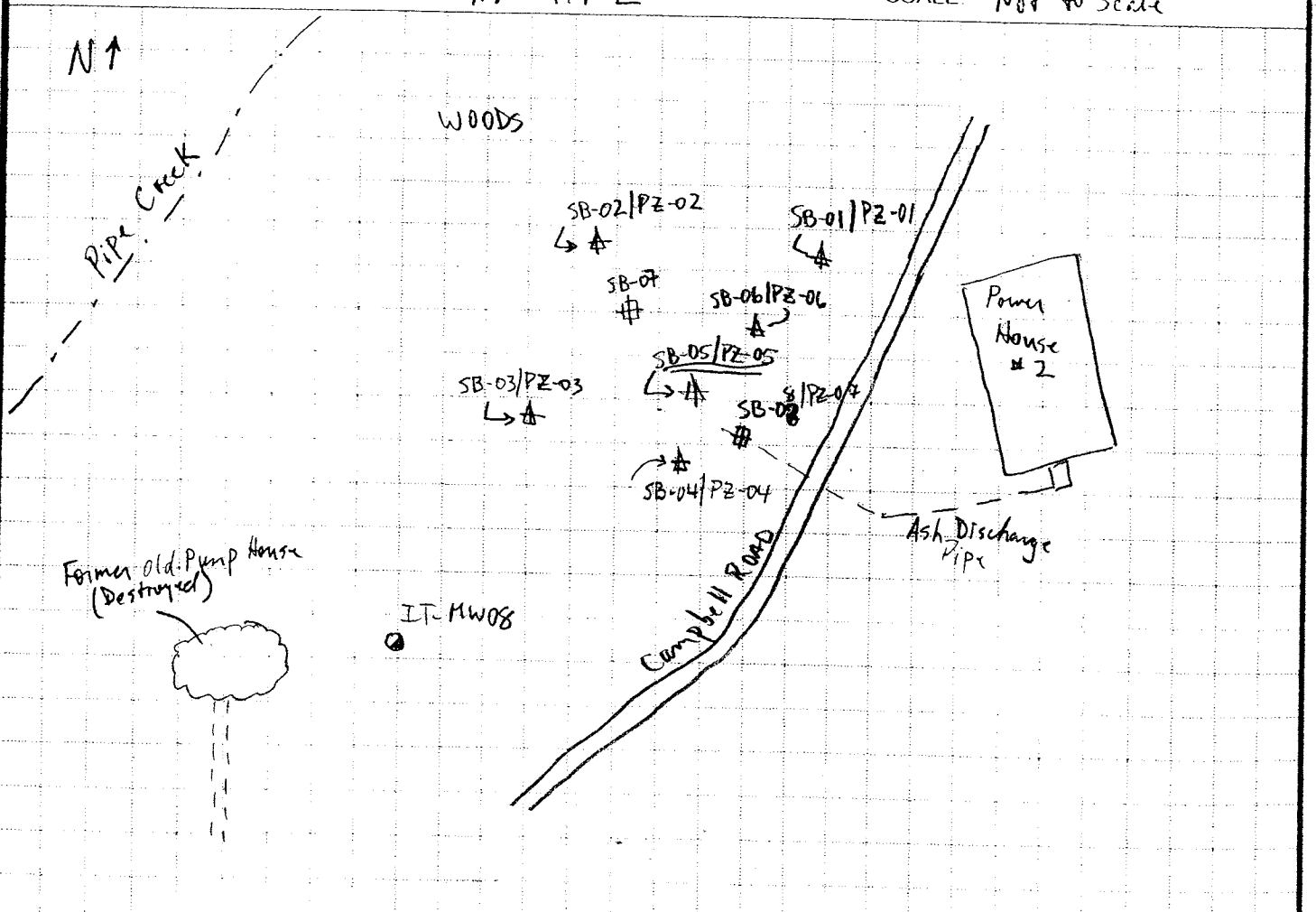
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	SB-05/PZ-05
2. DRILL SUBCONTRACTOR	Tri-State Drilling
SHEET / OF SHEETS	1 OF 2
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Jimmy Griffith
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe 6610DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Surface and Subsurface initially cleared with geophysics. Drove 2-inch macrocore with 5-ft long acetate liners.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	631.8 Northing: 622901.66 Easting: 1911339.77
10. DATE STARTED	1/16/09
11. DATE COMPLETED	1/16/09
12. OVERBURDEN THICKNESS	9.3 Ft
15. DEPTH GROUNDWATER ENCOUNTERED	Not encountered
13. DEPTH DRILLED INTO ROCK	-0-
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	9.3 Ft
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	yes	Nitros	SVOC	PCBs	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	NA	NA	1" Piezo	David Fessler

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not to Scale



PROJECT PBOW HOLE NO. SB-05/PZ-05

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-05/PZ-05

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		ASH, Black, mottled (brown), loose, organics (roots, bugs), dry cinders 5% 1.4			NA	0 AP0114 1225 1	3.3/5	Begon drilling 1/16/09 1225 S-1 (0-5')
	1	(10YR 3/3) Dark brown, no plasticity, SILT, moist 1.8	ml					
	2	Loose (2.5Y 6/4) light yellowish brown, very fine grain, SAND, trace of clay, moist clay content 5-10%	SP	0.0		AP0115 1227 3.3		Pushed 2 @ 0-5 F sleeves, both poor recovery Breathing Air: VOCs = 0.0 ppm H_2S = 0.0 ppm O_2 = 20.8% CO = 0.0 ppm LEL = 0%
	3							
	4							
	5							
	6						5/5	S-2 (5-DKK 9.3) 1235
	7	7.1						
	8	Stiff, (10YR 4/3) brown mottled (gray, light brown, clayey SILT, no-to low plasticity, rock fragments 10% (shale/limestone), dry	ml	0.2		7.3 AP0116 1235 9.3		
	9	Refusal @ 9.3 Ft Total Depth - 9.3 Ft						
	10							

Project: PBOW

Hole Number: SB-05/PZ-05

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Temporary Piezometer

Project:	PBOW	Piezometer Number:	PZ-05
Location:	Sandusky, Ohio	Site Location:	Ash Pit 2
Client:	USACE, Nashville, TN	Installation Date	1/16/09
Subcontractor:	Tri-State Drilling	Northing:	622 901.66
Driller:	Jimmy Griffith	Easting:	1911339.77
Shaw Field Representative:	DAVID Kessler	Shaw Project Number:	133422

Top of Casing Elevation (ft): 633.97

Top of Casing Stickup (ft): 1.9

Land Surface Elevation (ft): 631.8

Approximate Diameter of Borehole (in): 3 1/2"

Well Casing Diameter (in): 1"

Depth to Water (ft):

During Drilling: Not encountered

Date: 1/16/09

Post Development: NA TOC

Date: NA

Top of Filter Pack (ft) NA

Top of Screen Interval (ft): 3.1

6 ft screen
0.1 slip cap

Bottom of Screen Interval (ft): 9.1

Bottom of Piezometer (ft): 9.2

Bottom of Borehole (ft): 9.3

Filter Pack Material: None

Manufacturer:

Product Name:

Size:

Installation: Prepacked Screen Filter Sock

Well Casing:

Manufacturer: DSI

Type: PVC

Diameter (in): 1"

Well Screen Casing:

Manufacturer: DSI

Type: PVC

Slot Size (in): 0.010 %Open

Slot Type: Continuous wrap Factory slot

Sump/End Cap: ~~0.04 Ft~~ ~~0.14 Ft DKK~~ 0.10 Ft

Backfill Material: None

Abandonment:

Date: 7/6/09

Procedure: Natural fill Grouted Bentonite Casing Removed

Completed as Well NA

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.

All elevations are referenced to MSL (NAVD 88).

If completed as well - see well construction diagram.

HTRW DRILLING LOG

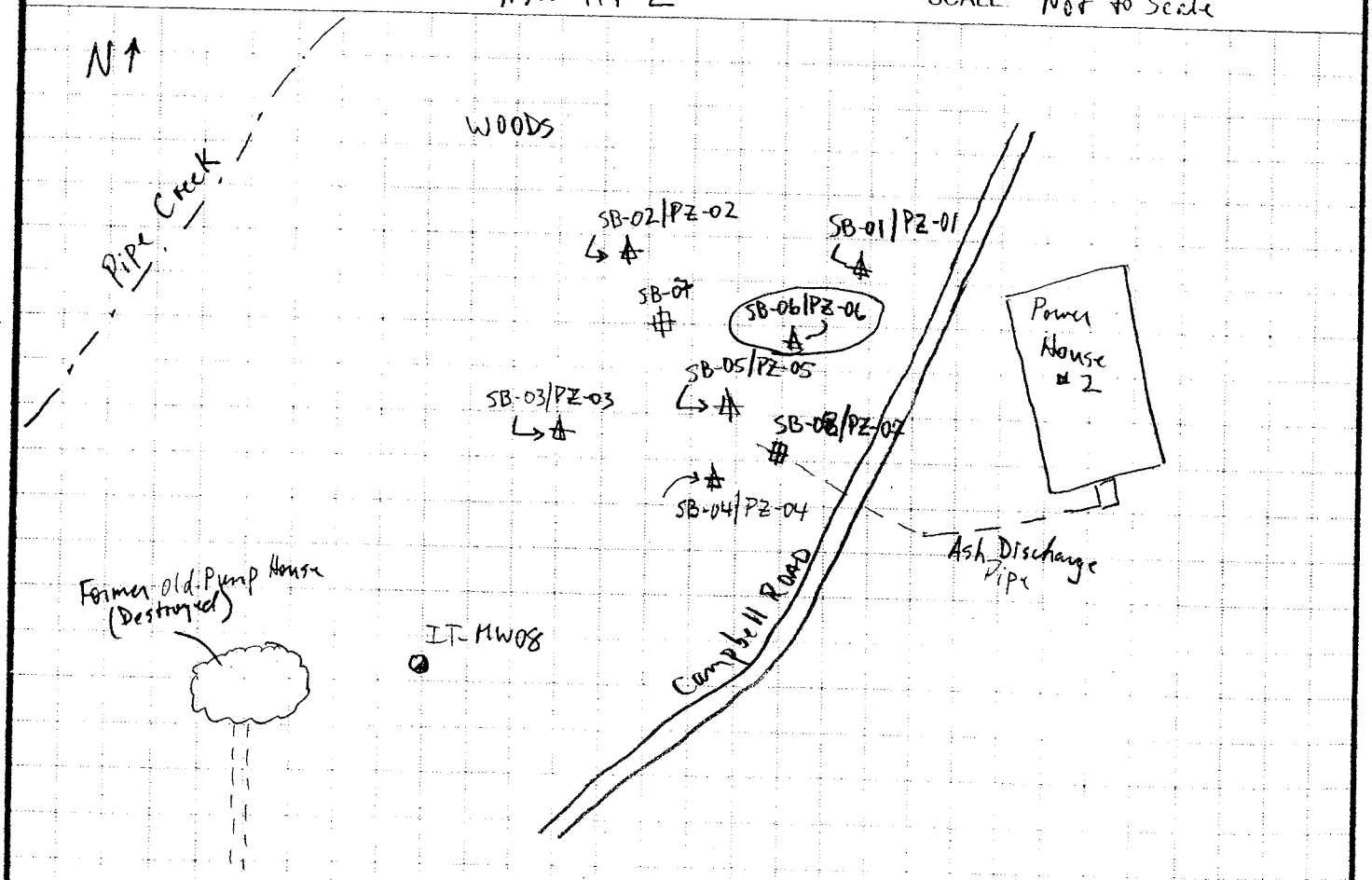
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	SB-06/PZ-06
2. DRILL SUBCONTRACTOR	Tri-State Drilling
SHEET / SHEETS	1 OF 3
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Jimmy Griffith
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe 6610DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Surface and Subsurface initially cleared with geophysics, Drove 2-inch macrocore with 5-ft long acetate liners.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	629.7 Northing: 622942.86 Easting: 1911404.17
10. DATE STARTED	1/15/09
11. DATE COMPLETED	1/15/09
12. OVERBURDEN THICKNESS	11.8
15. DEPTH GROUNDWATER ENCOUNTERED	Not encountered
13. DEPTH DRILLED INTO ROCK	-0-
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	11.8
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	yes	Nitros	PCBs	SVOCs	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	NA	NA	1" Piezo	David Kessler

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not to Scale



PROJECT PBOW HOLE NO SB-06/PZ-06

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-06/PZ-06

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		Black, ASH, very coarse grain, dry, trace organics (roots) 0.9		0.0	NA	AP0117 0920	3.8/5	Began drilling 1/15/09 S-1 0920
	1	soft, (2.5Y 4/3) olive brown, mottled (brown), low plasticity, SILT, moist 3	ml			1		
	2							
	3	Loose, (2.5Y 6/3) light yellowish brown mottled (dark brown - 5%) very fine grain, SAND, moist 6.1	SP	0.0		3 AP0118 0923 3.8		
	4							
	5							
	6	Stiff to very stiff, (10YR 4/3) brown, low plasticity, silty CLAY, 30% silt, moist	cl				5/5	S-2 0925 (5-10')
	7							
	8	color grading to gray (2.5Y 3/1) very dark gray, silt content increases				8 AP0019		
	9			0.0				
	10					0925 10		

Project: PBOW

Hole Number: SB-06/PZ-06

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-06/PZ-06

Project: PBOW

Geologist: D. Kessler

Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	(2.5 Y/3/1) very dark gray, silty CLAY, rock fragments (30%) very coarse gray to pebble size, moist	cl		NA	NA	1.8	S-3 0930 (10-11.8')
	11						1.8	
	12	Refusal @ 11.8 ft Total Depth = 11.8 ft						
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							

Project: PBOW

Hole Number: SB-06/PZ-06

Temporary Piezometer

Project:	PDOW	Piezometer Number:	PZ-06
Location:	Sandusky, Ohio	Site Location:	Ash Pit 2
Client:	USACE, Nashville, TN	Installation Date	1/15/09
Subcontractor:	Tri-State Drilling	Northing:	622942.86
Driller:	Jimmy Griffith	Easting:	1911404.17
Shaw Field Representative:	DAVID KESSLER	Shaw Project Number:	133422

Top of Casing Elevation (ft): 633.42

Top of Casing Stickup (ft): 3.6

Land Surface Elevation (ft): 629.7

Approximate Diameter of Borehole (in): 3 1/2"

Well Casing Diameter (in): 1"

Depth to Water (ft):

During Drilling: Not encountered

Date: 1/15/09

Post Development: NA TOC

Date: NA

Top of Filter Pack (ft): NA

Top of Screen Interval (ft): 1.40

Bottom of Screen Interval (ft): 11.40

Bottom of Piezometer (ft): 11.65

Bottom of Borehole (ft): 11.8

Filter Pack Material: None

Manufacturer:

Product Name:

Size:

Installation: Prepacked Screen Filter Sock

Well Casing:

Manufacturer: DSI

Type: PVC

Diameter (in): 1"

Well Screen Casing:

Manufacturer: DSI

Type: PVC

Slot Size (in): 0.010 %Open

Slot Type: Continuous wrap Factory slot

Sump/End Cap: ~~0.14~~ 0.25 ~~DKK~~ EA

Backfill Material: None

Abandonment:

Date: 7/6/09

Procedure: Natural fill Grouted Bentonite Casing Removed

Completed as Well NA

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.

All elevations are referenced to MSL (NAVD 88).

If completed as well - see well construction diagram.

HTRW DRILLING LOG

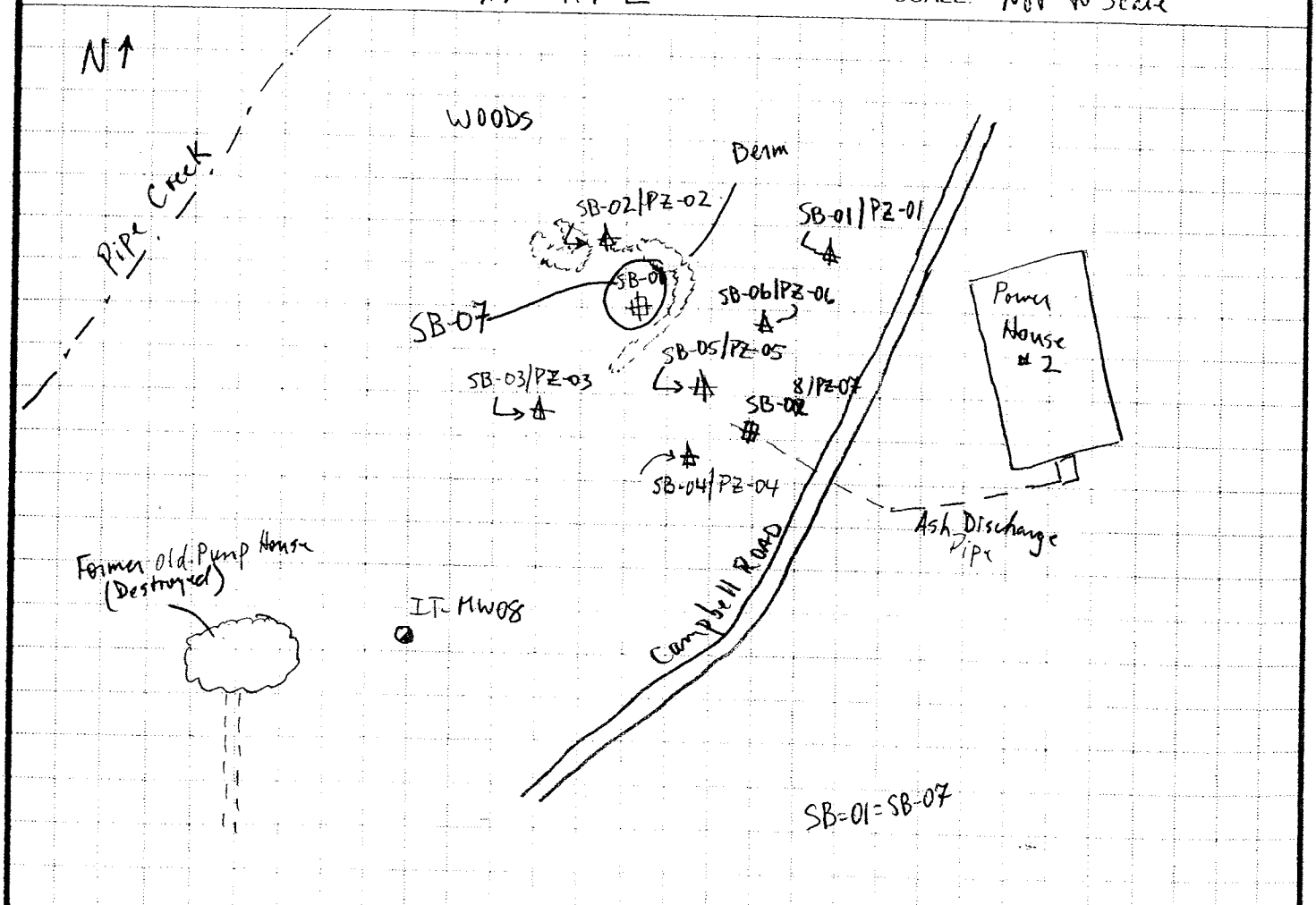
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	SB-07
2. DRILL SUBCONTRACTOR	Tri-State Drilling
SHEET / OF SHEETS	1 OF 2
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Jimmy Griffith
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe 6610 DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Surface and Subsurface initially cleared with geophysics. Drove 2-inch macrocore with 5-ft long acetate liners.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	629.46 Northing: 622955.41 Easting: 1911280.43
10. DATE STARTED	1/16/09
11. DATE COMPLETED	1/16/09
12. OVERBURDEN THICKNESS	unknown
15. DEPTH GROUNDWATER ENCOUNTERED	Not encountered
13. DEPTH DRILLED INTO ROCK	-0-
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	10 ft
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	yes	Nitros	PCB's	SVOC	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	yes	NA	NA	David Kesah

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not to Scale



PROJECT PBOW HOLE NO. SB-07

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-07

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		Soft, (2.5Y 2.5/1) black, low plasticity, SILT, moist 0.4'	ML		NA	AP0120 AP0121 AP0122 1000	4.1'/5'	Begun drilling 1/16/09
	1	Loose (2.5Y 5/4) light olive brown, very fine grained SAND, moist		0.0		1		S-1 (0-5')
	2							
			SP					
	3					3		
						AP0123		
				0.1		1003		
	4					4.1		
	5							
		5.7					5'/5'	S-2 (5-10')
	6	Stiff to very stiff (10YR 3/2) very dark grayish brown, low plasticity SILT, rock fragments (30%) very coarse to fine, moist,						
	7		ml					
	8					8		
						AP0124		
		Color grading to (10YR 3/1) very dark gray		0.2				
	9					1005		
	10	Total Depth = 10 ft				10'		

Project: PBOW

Hole Number: SB-07

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HTRW DRILLING LOG

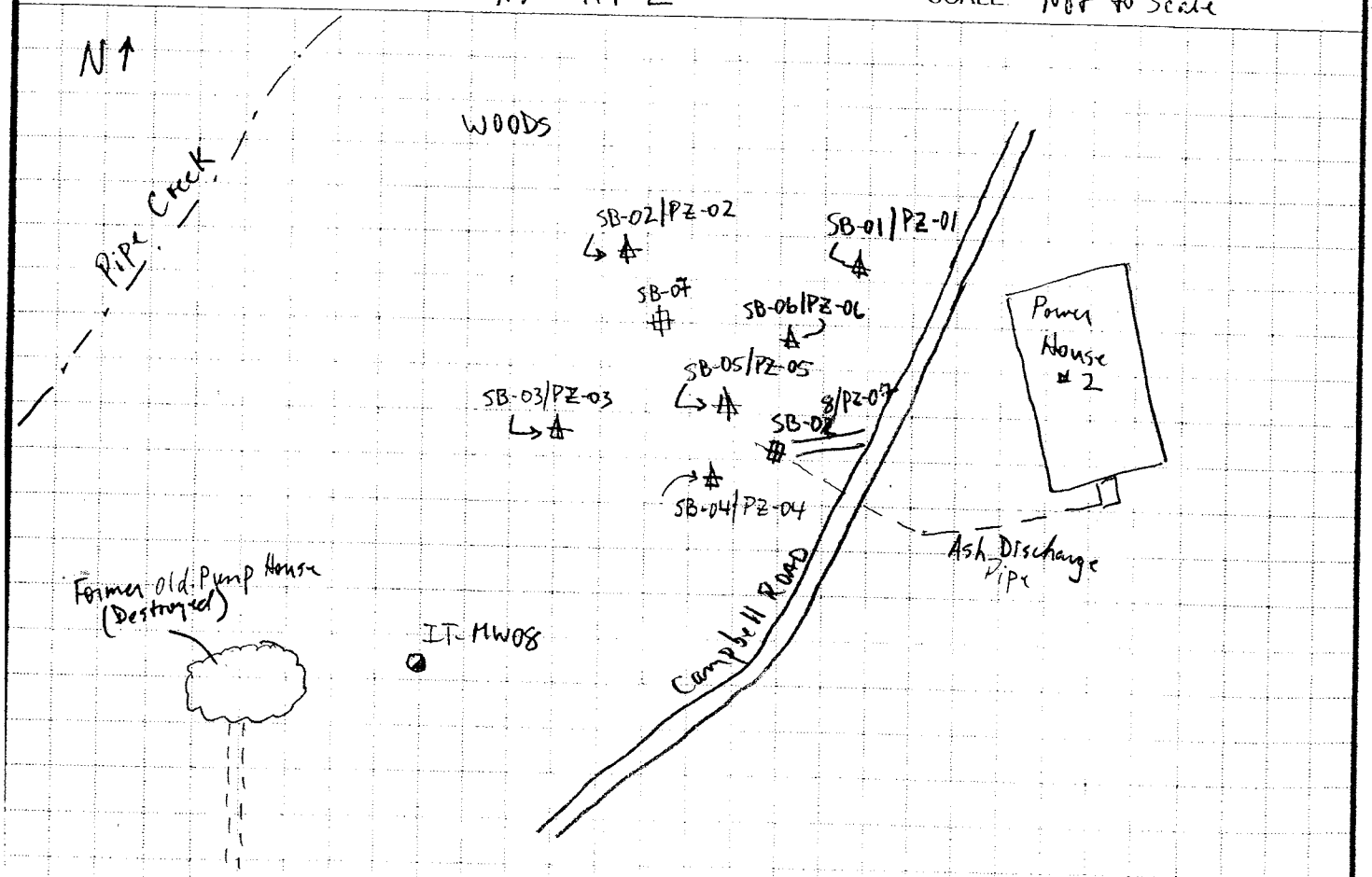
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	SB-08/PZ-07
2. DRILL SUBCONTRACTOR	Tri-State Drilling
SHEET / SHEETS	1 OF 3
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Jimmy Griffith
6. MANUFACTURER'S DESIGNATION OF DRILL	Geoprobe 6610DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Surface and Subsurface initially cleared with geophysics. Drive 2-inch macrocore with 5-ft long acetate liners.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	629.8 Northing: 622840.49 Easting: 1911425.01
10. DATE STARTED	1/16/09
11. DATE COMPLETED	1/16/09
12. OVERBURDEN THICKNESS	12.4 Ft
15. DEPTH GROUNDWATER ENCOUNTERED	5 Ft
13. DEPTH DRILLED INTO ROCK	-0-
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	12.4 Ft
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	Mes	Nitros	SVOCs	PCBs	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	NA	NA	1" Piezo	David Kesch

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not to Scale



PROJECT PBOW HOLE NO. SB-08/PZ-07

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-08/PZ-07

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		ASH, cinders, black, mottled rust colored brown, 10mm layers (black/brown ash) organics, roots in top 0.2ft, dry 10% white specks			NA	AP0125 1305	3.5/5	Began drilling 1/16/09 S-1 1305 (0-5')
	1			0.3				
	2	cinder layer 1.9-2.3, very coarse to pebble size 2.3						
	3	soft, (10YR 4/6) dark yellowish brown, mottled (strong brown - 30%), clayey SILT, low plasticity, moist	ml			3 AP0126 1307 3.5		
	4							
		clay content increases w/depth						
	5							▽ encountered gw 5ft
	6						3.8/5	S-2 1320 ft (5-10')
	7	7						
	7	soft, (10YR 4/1) dark gray, homogeneous, high plasticity, CLAY, little silt (20%), wet rock fragments (5%) (shale, lm)	ch					pushed 2 sleeves
	8			0.0		8 AP0127 AP0128 - FD AP0129 - FS 1320 8.8		
	9	silt content increases consistency increases						
	10							

Project: PBOW

Hole Number: SB-08/PZ-07

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB-08/PZ-07

Project: PBOW

Geologist: D. Kessler

Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	10	Stiff, (10YR 4/1) dark gray, homogeneous, high plasticity, silty CLay, rock fragment (15%), wet	Ch	0.0	NA	NA	2.4/2.4	S-3 1330 (10-12.4')
	11							
	12							
		Refusal @ 12.4 ft Total Depth = 12.4 ft						
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							

Project: PBOW

Hole Number: SB08/PZ-07

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Temporary Piezometer

Project:	PBOW	Piezometer Number:	PZ-07
Location:	Sandusky, Ohio	Site Location:	Ash Pit 2
Client:	USACE, Nashville, TN	Installation Date	1/16/09
Subcontractor:	Tri-State Drilling	Northing:	622840.49
Driller:	Jimmy Griffith	Easting:	1911425.01
Shaw Field Representative:	DAVID Kessler	Shaw Project Number:	133422

Top of Casing Elevation (ft): 632.92

Top of Casing Stickup (ft): 2.4

Land Surface Elevation (ft): 629.8

Approximate Diameter of Borehole (in): 3 1/2"

Well Casing Diameter (in): 1"

Depth to Water (ft):

During Drilling: 5 Ft

Date: 1/16/09

Post Development: NA TOC

Date: NA

Top of Filter Pack (ft): NA

Top of Screen Interval (ft): 2.60

Bottom of Screen Interval (ft): 12.60

Bottom of Piezometer (ft): 12.74

Bottom of Borehole (ft): 12.4

Filter Pack Material: None

Manufacturer:

Product Name:

Size:

Installation: Prepacked Screen Filter Sock

Well Casing:

Manufacturer: DSI

Type: PVC

Diameter (in): 1"

Well Screen Casing:

Manufacturer: DSI

Type: PVC

Slot Size (in): 0.010 %Open

Slot Type: Continuous wrap Factory slot

Sump/End Cap: 0.14 Ft

Backfill Material: None

Abandonment:

Date: 7/6/09

Procedure: Natural fill Grouted Bentonite

Casing Removed

Completed as Well NA

Shaw
Shaw E & I, Inc.

Depths and heights are referenced to ground surface unless specified TOC.

All elevations are referenced to MSL (NAVD 88).

If completed as well - see well construction diagram.

HTRW DRILLING LOG

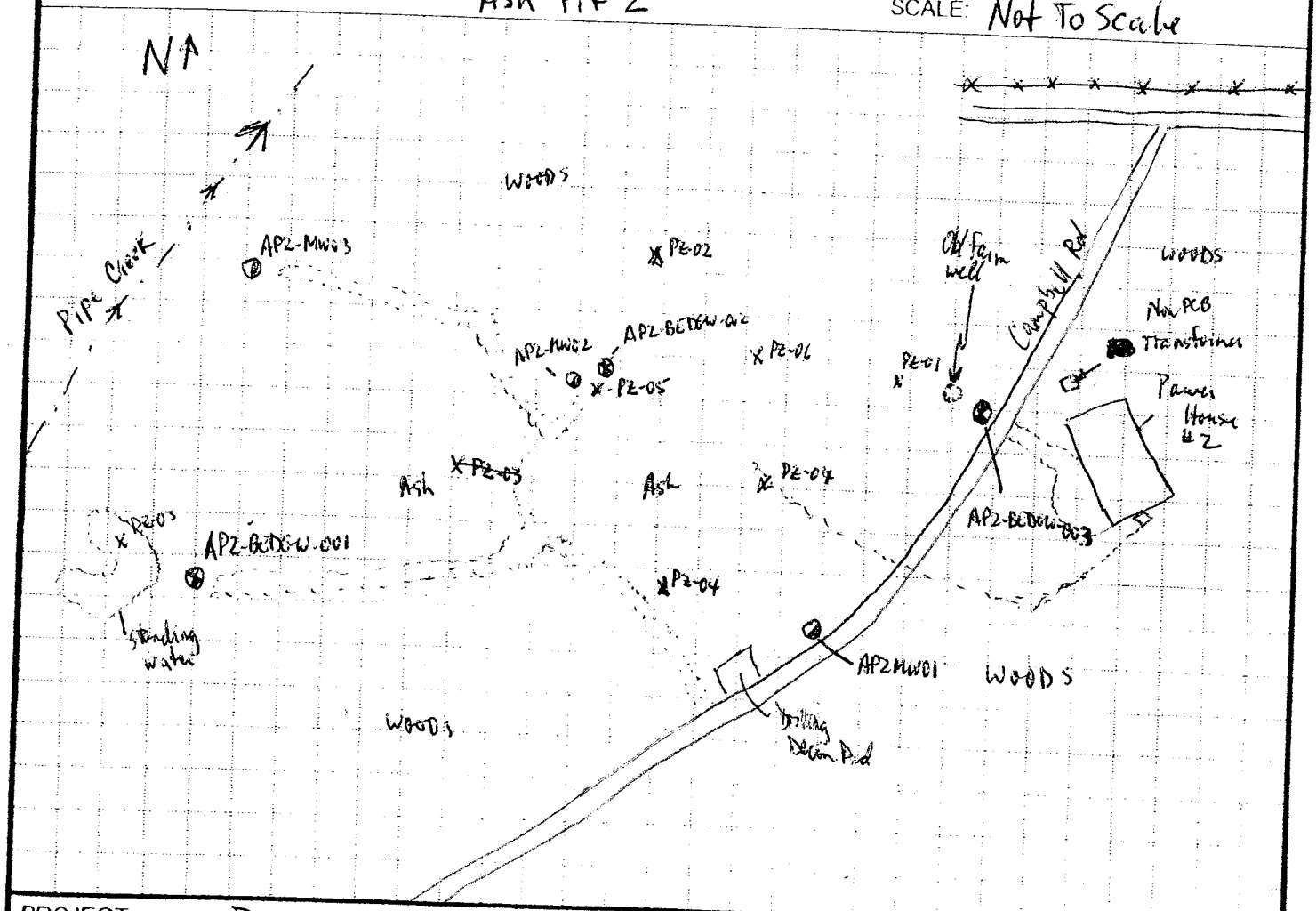
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	APZ-MW01
2. DRILL SUBCONTRACTOR	AE Drilling
SHEET / SHEETS	1 OF 3
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Tom Burnett
6. MANUFACTURER'S DESIGNATION OF DRILL	All Terrain CME-750
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Post-hole dug first 5-feet. Drilled w/ 4¼" ID / 8" OD HSA, and 2" split spoon sampler to 20.0'
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	638.2 ft; Northing: 622866.25; Easting: 1911550.02
10. DATE STARTED	4-15-09
11. DATE COMPLETED	4-15-09
12. OVERBURDEN THICKNESS	~~Unknown~~ 20 ft
15. DEPTH GROUNDWATER ENCOUNTERED	No free water observed
13. DEPTH DRILLED INTO ROCK	0
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	20.0 ft
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	0

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	NA	NA	NA	NA	%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	NA	NA	NA	E. W. Wagner

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not To Scale



PROJECT	PBOW	HOLE NO.	APZ-MW01

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-MW01

Project: PBOW

Geologist: Eckhardt

Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	1	Brown (10YR 4/3) Silty CLAY (FILL) moist-soft, noted grass and roots.	CL					Posthole dig to 5' bgs
	2	Dark yellowish brown (10YR 4/6) Silty CLAY, medium stiff, moist, trace fine sand						
	3							
	4							
	5				3/3	1400	1.0/1.0	Soil Expo-down by 140 lbs mechanical hammer.
	6	-grading to with numerous fine grained sand lenses.			3/3 -		1.2 /	
	7				4/3	1403	2.0	
	8							
	9	Very dark grayish brown (10YR 3/2) SILT, moist, medium stiff with ~~numbers~~ numerous yellowish brown (10 YR 5/6) thin ~~frequently~~ fine sand grain lenses.	ML		3/3 - 3/3	1410	1.2 / 2.0	
	10							

Project: PBOW

Hole Number: AP2-MW01

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Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-MW01

Project: PBOW

Geologist: E. Weaver

Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		Very dark grayish brown (10YR 3/2) SILT moist medium stiff. with numerous yellowish brown (10YR 5/6) thin fine grain sand lenses.	ML		3/4		1.2/2.0	
	11				3/4			
	12	Very dark brown (10YR 2/2) CLAY, with silt, moist, medium stiff.	CL		4/3		1.6/2.0	
	13				3/4			
	14				2/4		0.0/2.0	
	15				3/2			
	16				3/3		1.6/2.0	
	17				4/4			
	18				2/3		1.2/2.0	
	19				4/2			
		- grading to with shale fragments						
	20	Refusal @ 20'						

Project: PBOW

Hole Number: AP2-MW09

Monitoring Well Construction Form

Project:	PBAW	Well Number:	AP2-MW02
Location:	NASA Plum Brook Station, Sandusky, Ohio	Site Location:	Ash Pit #2
Client:	USACE - Nashville, TN	Installation Date	4-15-09
Subcontractor:	A.E. Drilling	Northing:	622866.25
Driller:	Tom Burnett	Easting:	1911550.02
Shaw Field Representative:	Eric Weaver	NAD: 83	NGVD: 1929

Shaw Project # 133422

Protective Cover Elevation (ft): 641.39

Top of Casing Elv. (ft): 640.94

Top of Casing Stickup (ft): 2.64

Land Surface Elv. (ft): 638.2

Approximate Diameter of Borehole (in): 8"

Well Casing Diameter (in): 2"

Depth to Water (ft):

During Drilling: ~8'-10'

Date: 4-15-09

Post Development: — TOC

Date: —

Top of Bentonite Seal (ft): 5.0'

Top of Filter Pack (ft): 7.0'

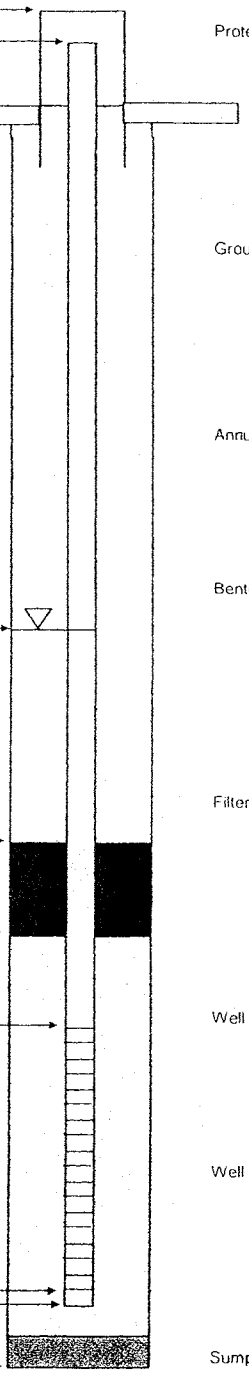
Top of Screen Interval (ft): 9.0'

Bottom of Screen Interval (ft): 19.0'

Bottom of Well (ft): 19.35'

Bottom of Filter Pack (ft): 20.0'

Bottom of Borehole (ft): 20.0'



Protective Casing:

Type: Steel

Dimensions (in): 4"x4"

Length (ft): 5'

Guard Post: 4- concrete filled

Ground Seal (Surface Pad)

Dimensions: 4'x4'x4"

Type: Concrete

Annular Space Seal:

Type: Bentonite-Cement Grout

Installation: (Gravity) Tremie Pumped

Bentonite Seal:

Manufacturer: Haliburton

Type: Pellets Slurry (chips)

Installation: 6-in lifts (One Section)

Gravity Tremie Pumped

Hydration time (hrs): >1 hr.

Filter Pack Material:

Manufacturer: Southern Products

Product Name: Filter Media

Size: Gravel Pack #1

Volume Added (ft^3): 3 ft^3 (6-bags)

Installation: (Gravity) Tremie

Well Casing:

Manufacturer: Campbell Monoflex

Type: PVC

Diameter (in): 2"

Well Screen Casing:

Manufacturer: Campbell Monoflex

Type: PVC

Slot Size (in): .010 %Open

Slot Type: Continuous wrap (Factory slot)

Sump/End Cap: 0.35

Backfill Material: None

Shaw

Shaw E & I, Inc.

All elevations are referenced to the Ohio State Plane (North Zone) NAD 83 and vertical datum NGVD 1929.

Depths and heights are referenced to ground surface unless specified TOC.

HTRW DRILLING LOG

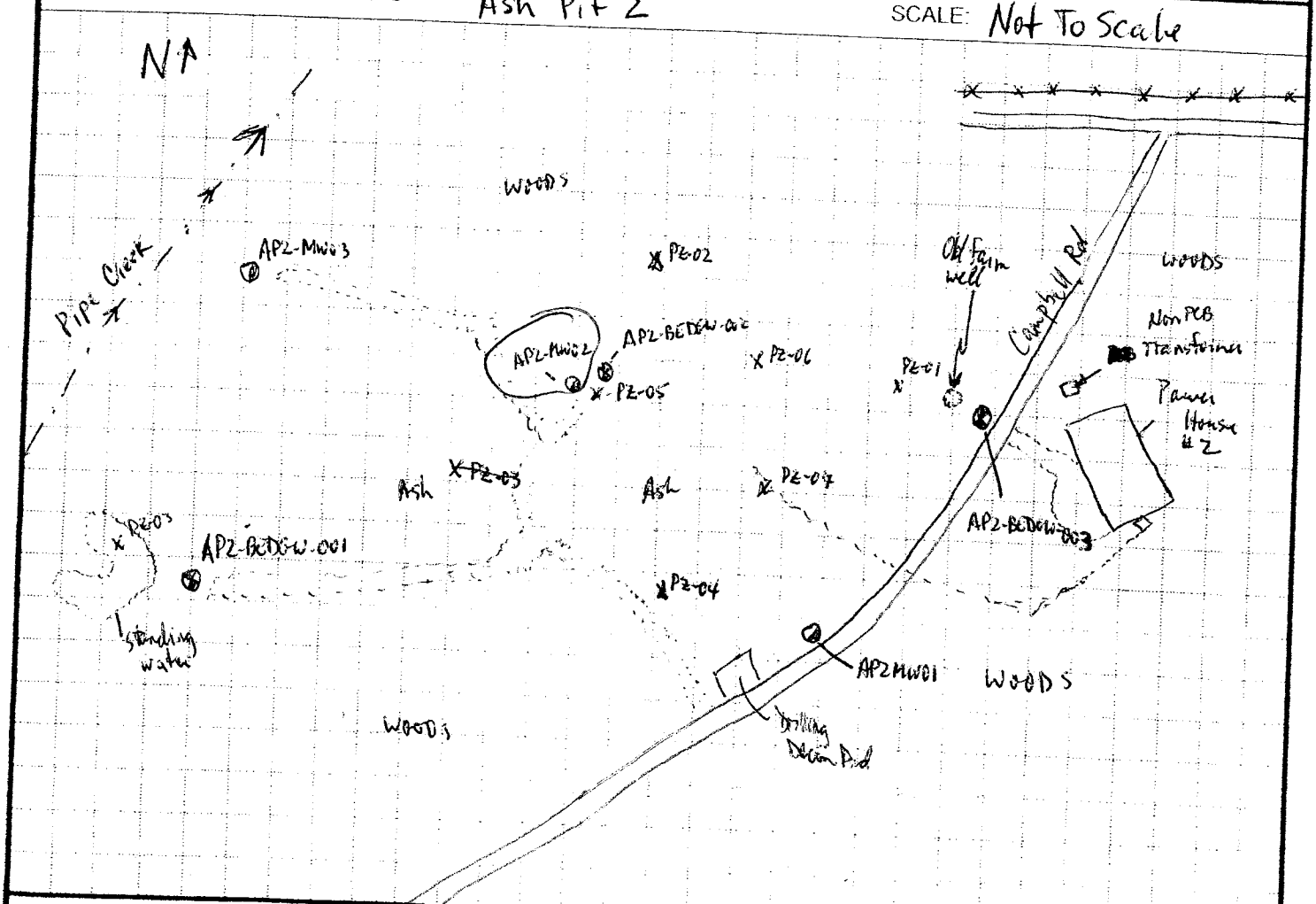
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	AP2-MW02
2. DRILL SUBCONTRACTOR	AE Drilling
SHEET / SHEETS	1 OF 3
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Tom Burnette
6. MANUFACTURER'S DESIGNATION OF DRILL	All Terrain CME-75U
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Post-hole dug first 5-feet. Drilled w/ 4¼" ID / 8" OD HSA. to 16' bgs.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	632.5 (ft) Northing: 622892.79 Easting: 1911351.16
10. DATE STARTED	4-15-09
11. DATE COMPLETED	4-15-09
12. OVERBURDEN THICKNESS	~~16.0' Unknown~~ 16 Ft
13. DEPTH DRILLED INTO ROCK	-0-
14. TOTAL DEPTH OF HOLE	16.0' Ft
15. DEPTH GROUNDWATER ENCOUNTERED	~8 ft
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	—

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	-0-

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	NA	NA	NA	NA	%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
			NA	E.W. Weaver

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not To Scale



PROJECT PBOW HOLE NO. AP2-MW02

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: APZ-MW02

Project: PBOW

Geologist: B. Weaver

Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		See boring log for APZ-BEDGW-002 for soil descriptions.			NA	NA	NA	Posthole dig to 5' bgs
	1			0.0				
	2							
	3							
	4							
	5							Auger with 8.25" O.D. HSA to 16.0' bgs
	6							
	7							
	8	- Cuttings wet						
	9							
	10							

Project: PBOW

Hole Number: APZ-MW02

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Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-MW02

Project: PBOW

Geologist: E. Weaver

Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		See boring log for AP2-BEDGW-002 for soil description.		NA	NA	NA	NA	
	11							
	12							
	13							
	14							
	15							
		16.0						
	16	Auger Refusal = 16 ft						
		Monitor Well set at 15' bgs.						
	17	sand up to 4' bgs. (5.5 bags) 10' screen						
		bentonite up to 2.5' (0.75 bags)						
	18							
	19							
	20							

Project: PBOW

Hole Number: AP2-MW02

Monitoring Well Construction Form

Project:	PBOW	Well Number:	AP2-MW02
Location:	NASA Plum Brook Station, Sandusky, Ohio	Site Location:	Ash Pit #2
Client:	USACE - Nashville, TN	Installation Date	4-15-09
Subcontractor:	A.E. Drilling	Northing:	622892.79
Driller:	Tom Burnett	Easting:	1911351.16
Shaw Field Representative:	Eric Weaver	NAD: 83	NGVD: 1929

Shaw Project #- 133422

Protective Cover Elevation (ft): 635.92

Top of Casing Elv. (ft): 635.53

Top of Casing Stickup (ft): 2.78

Land Surface Elv. (ft): 632.5

Approximate Diameter of Borehole (in): 8"

Well Casing Diameter (in): 2"

Depth to Water (ft):

During Drilling: ~8'

Date: 4-15-09

Post Development: — TOC

Date: —

Top of Bentonite Seal (ft): 2.5'

Top of Filter Pack (ft): 4.0'

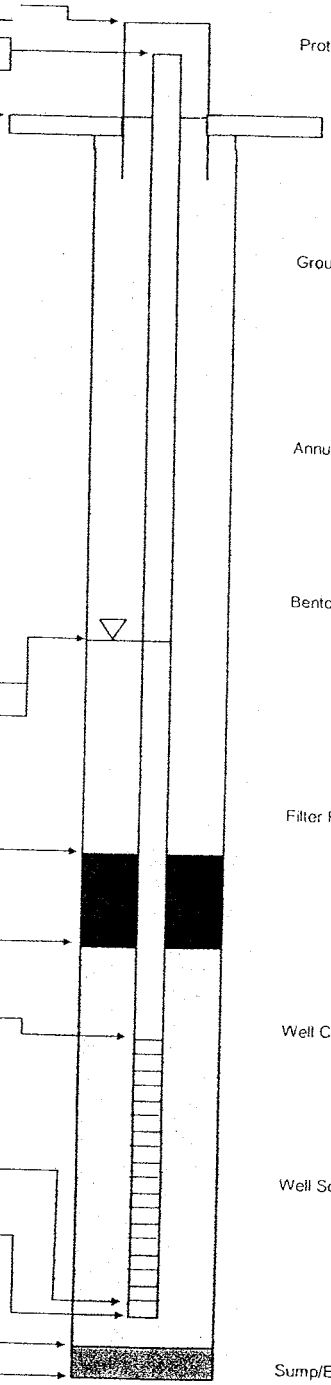
Top of Screen Interval (ft): 5.0'

Bottom of Screen Interval (ft): 15.0'

Bottom of Well (ft): 15.35

Bottom of Filter Pack (ft): 15.50'

Bottom of Borehole (ft): 16.0'



Protective Casing:

Type: Steel

Dimensions (in): 4"x4"

Length (ft): 5'

Guard Post: 4- concrete filled

Ground Seal (Surface Pad)

Dimensions: 4'x4'x4"

Type: Concrete

Annular Space Seal:

Type: Bentonite-Cement Grout

Installation: (Gravity) Tremie Pumped

Bentonite Seal:

Manufacturer: Haliburton

Type: Pellets Slurry (chips)

Installation: 6-in lifts (One Section)

Gravity Tremie Pumped

Hydration time (hrs): >1 hr.

Filter Pack Material:

Manufacturer: Southern Products

Product Name: Filter Media

Size: Gravel Pack #1

Volume Added (ft^3): 2.75 ft^3 (5.5 bags)

Installation: Gravity (Tremie)

Well Casing:

Manufacturer: Campbell Monoflex

Type: PVC

Diameter (in): 2"

Well Screen Casing:

Manufacturer: Campbell Monoflex

Type: PVC

Slot Size (in): .010 %Open

Slot Type: Continuous wrap (factory slot)

Sump/End Cap: 0.35

Backfill Material: None

Shaw

Shaw E & I, Inc.

All elevations are referenced to the Ohio State Plane (North Zone) NAD 83 and vertical datum NGVD 1929.

Depths and heights are referenced to ground surface unless specified TOC.

HTRW DRILLING LOG

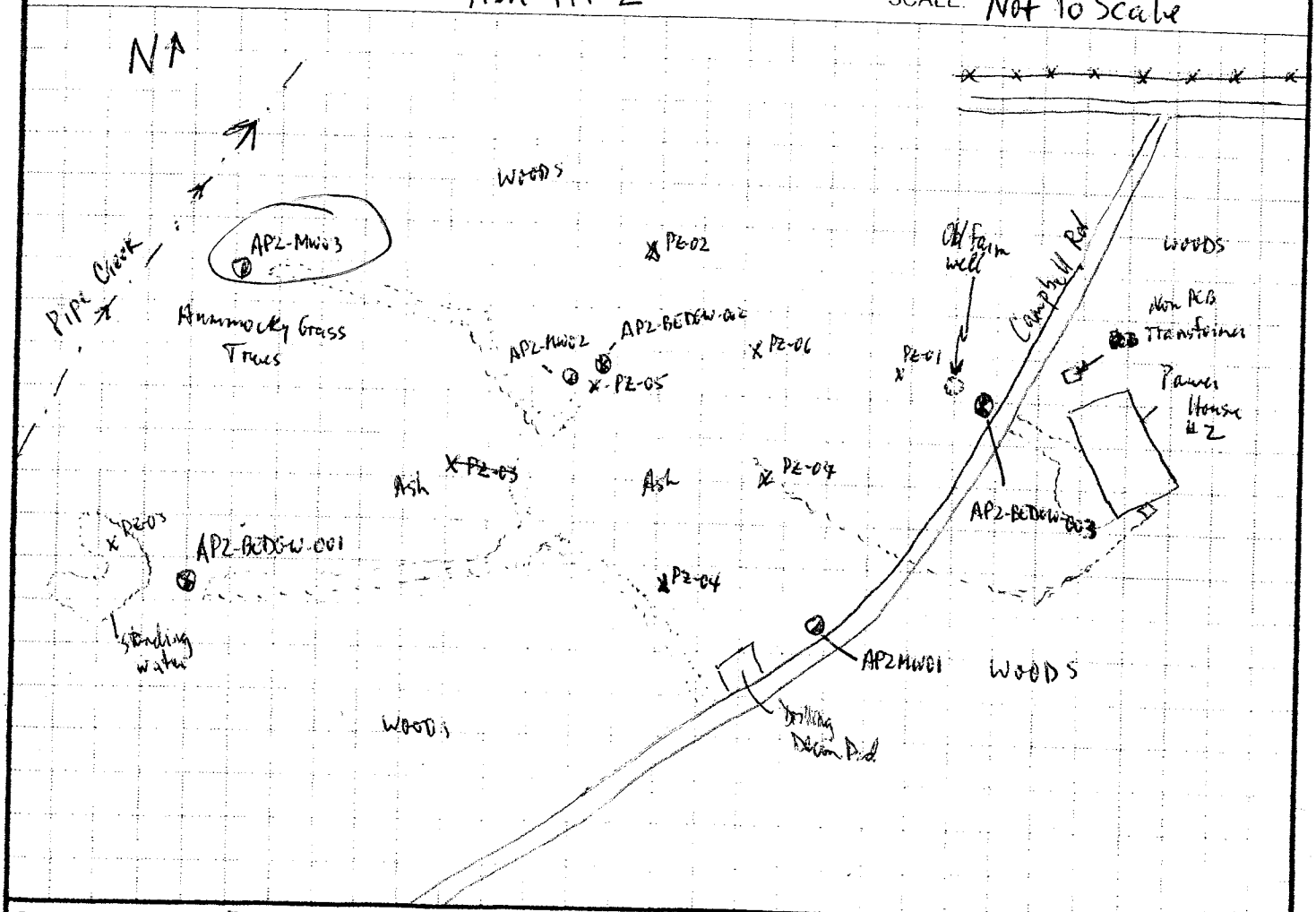
DISTRICT	Nashville, TN
HOLE NUMBER	APZ-MW03
SHEET / SHEETS	1 OF 3
1. COMPANY NAME	Shaw E+I
2. DRILL SUBCONTRACTOR	AE Drilling
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Marcelos Gonzales
6. MANUFACTURER'S DESIGNATION OF DRILL	All Terrain CME-750
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Post-hole dug first 5-feet. Drilled w/ 4¼" ID / 8" OD HSA. Continuously collected soil samples w/ 1.4" ID x 2' length stainless steel split-spoon sampler. Installed 2" PVC monitoring well with 5-ft screen at a depth of 10.08 ft below ground surface.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	629.5 ft — Northing: 622973.78, Easting: 1911157.35
10. DATE STARTED	4/14/09
11. DATE COMPLETED	4/14/09
12. OVERBURDEN THICKNESS	9.8 Ft
13. DEPTH DRILLED INTO ROCK	1.5 Ft
14. TOTAL DEPTH OF HOLE	11.3 Ft
15. DEPTH GROUNDWATER ENCOUNTERED	2.1 Ft over bucket
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	—

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	NA	NA	NA	NA	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	NA	2" PVC	NA	David Kessler

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not To Scale



PROJECT PBOW HOLE NO. APZ-MW03

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-MW03

Project: PBOW | Geologist: D. Kessler | Sheet 2 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical Sample No.~~ Blows	Recovery (ft)	Remarks
		very soft (2.5Y 5/1) black, homogeneous, SILT, trace sand, organics, moist 1	ml		NA			Post-Hole Dug first 5 Feet
	1	Soft, (10YR 5/8) yellowish brown, mottled (gray, light br), low plasticity, clayey SILT, trace sand, moist wet at 2.1 Ft	ml	NM				NM- Not Measured RAIN ▽ Encountered gw @ 2.1 Ft
	2							
	3							
	4							
	5	very loose 5			5			
		Loose, (10YR 6/3) pale br, mottled yellowish br, SAND, silt 20%, fine grading to coarse grain, subangular, wet 6.2	SM	NM		1/2/ 2/4	2/ 2	Began Drilling 4/14/09 1015 S-1
	6							
	7	Soft, (10YR 5/2) grayish br, mottled (dark brown, gray), clayey SILT, trace sand, low plasticity, wet clay content 10-40%, 8.4	ml	NM	7	1015 3/5/ 8/11	2/ 2	S-2
	8							
	9	Soft, (10YR 4/1) dark gray, homogeneous, high plasticity, silty CLAY, silt content (30%), shale / limestone fragments, moist 9.8	Ch	NM	9	1030 3/3/	1.8/	S-3
	10							

Project: PBOW | Hole Number: AP2-MW03

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Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-MW03

Project: PBOW | Geologist: D Kessler | Sheet 3 of 3 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or Core Box No.~~	~~Analytical Sample No.~~ Blows	Recovery (ft)	Remarks
	10	LIMESTONE, very weathered, brown, thinly laminated, broken, shaley texture, weathered brachiopod shell, dry	NA	NM	NA	/10/11	/2	S-3 (cont)
	11			NM	11	50 over 4"	0.3/0.3	S-4
		Spoon Refusal @ 11.3 Ft Total Depth = 11.3 Ft						HSA Refusal at 10 Ft
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							

Project: PBOW | Hole Number: AP2-MW03

Monitoring Well Construction Form

Project:	PBAW	Well Number:	AP2-MW03
Location:	NASA Plum Brook Station, Sandusky, OH	Site Location:	Ash Pit 2
Client:	USACE - Nashville, TN	Installation Date	4/14/09
Subcontractor:	AE Drilling	Northing:	622973.78
Driller:	Marcelos Gonzales	Easting:	1911157.35
Shaw Field Representative:	David Kessler	NAD: 83	NGVD: 1929

Protective Cover Elevation (ft): 632.45

Top of Casing Elv. (ft): 632.16

Top of Casing Stickup (ft): 2.5

Land Surface Elv. (ft): 629.5

Approximate Diameter of Borehole (in): 8

Well Casing Diameter (in): 2

Depth to Water (ft):

During Drilling: 2.1

Date: 4/14/09

Post Development: — TOC

Date: —

Top of Bentonite Seal (ft): 2.5

Top of Filter Pack (ft): 4.5

Top of Screen Interval (ft): 4.90

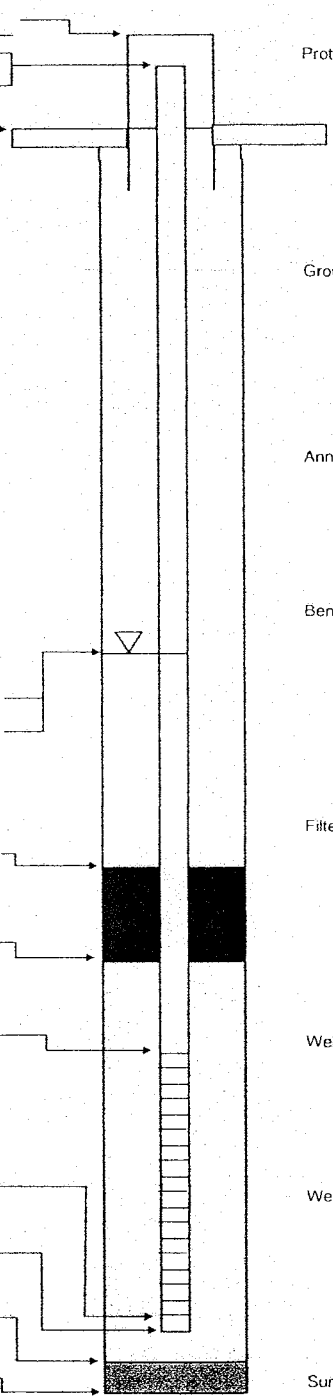
Bottom of Screen Interval (ft): 9.90

Bottom of Well (ft): 10.08

Bottom of Filter Pack (ft): 11.3

Bottom of Borehole (ft): 11.3

Spun



Protective Casing:

Type: Steel

Dimensions (in): 4" x 4"

Length (ft): 5 Ft

Guard Post: 4 @ Concrete filled

Ground Seal (Surface Pad)

Dimensions: 4' x 4' x 4"

Type: Concrete

Annular Space Seal:

Type: Bentonite-Cement Grout

Installation: (Gravity) Tremie Pumped

Bentonite Seal:

Manufacturer: ~~Campbell Mfg~~

Type: (Pellets) Slurry (Chips)

Installation: 6-in lifts (One Section)

(Gravity) Tremie Pumped

Hydration time (hrs):

Filter Pack Material:

Manufacturer: Global

Product Name:

Size: #6

Volume Added (ft^3): 3 bags

Installation: (Gravity) Tremie

Well Casing:

Manufacturer: Campbell, Monoflex

Type: PVC

Diameter (in): 2

Well Screen Casing:

Manufacturer: Campbell - Monoflex

Type: PVC

Slot Size (in): 0.010 %Open

Slot Type: Continuous wrap (Factory slot)

Sump/End Cap: 0.18

Backfill Material: None

Shaw

Shaw E & I, Inc.

All elevations are referenced to the Ohio State Plane (North Zone) NAD 83 and vertical datum NGVD 1929.

Depths and heights are referenced to ground surface unless specified TOC.

HTRW DRILLING LOG

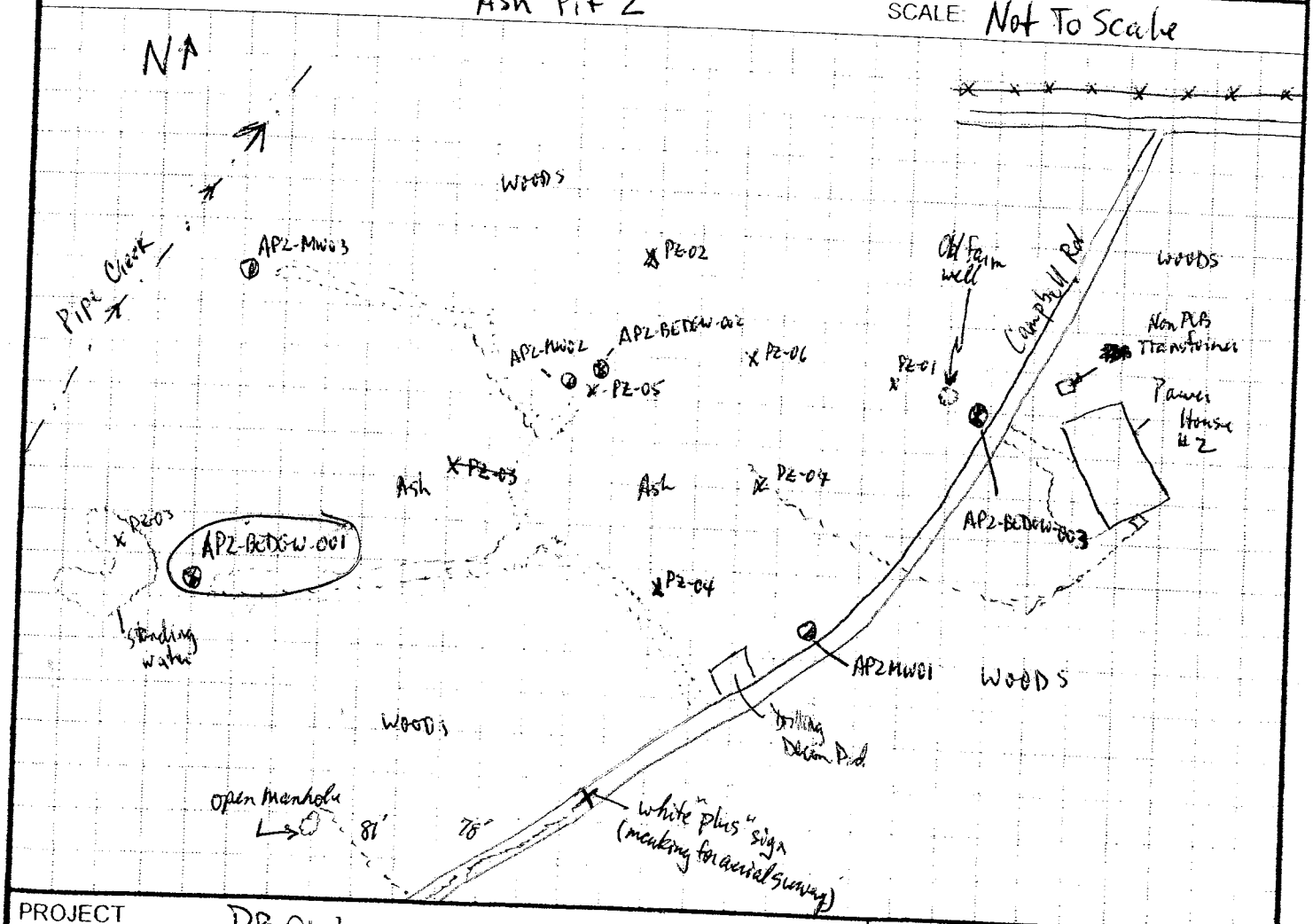
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	APZ-BEDOW-001
2. DRILL SUBCONTRACTOR	AE Drilling
SHEET / SHEETS	1 of 10
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Kevin Warren / Tom Burnett
6. MANUFACTURER'S DESIGNATION OF DRILL	All Terrain CME-75U
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Post-hole dug first 5-feet. Drilled w/ 4¼" ID / 8" OD HSA to 15'. Continuously sampled soil w/ 1.4" ID x 2' length split-spoon. Overdrilled borehole w/ 12" OD HSA to 14.5 ft. Cut bedrock w/ 8" OD rotary bit to 20.5'. Set steel casing at 20.4 ft. Cored rock with 6" OD PQ bit to 87.0'
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	630.4 ft — Northing: 622 795.83, Easting: 1911 202.97
10. DATE STARTED	4/1/09
11. DATE COMPLETED	4-19-09
12. OVERBURDEN THICKNESS	13 Ft
13. DEPTH DRILLED INTO ROCK	74.0'
14. TOTAL DEPTH OF HOLE	87.0
15. DEPTH GROUNDWATER ENCOUNTERED	overburden 2.2 Ft / Bedrock 72.6
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	—

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	80

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	NA	NA	NA	NA	%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
			NA	David Kessler / E. W. Weaver

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not To Scale



PROJECT	HOLE NO.
PBOW	APZ-BEDOW-001

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-001

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical~~ Sample No. Blows	Recovery (ft)	Remarks
	1	very soft, (2.5Y 5/1) black, homogeneous, no plasticity, SILT, trace very fine grain sand, organics, moist 1.5	ml		NA	NA	NA	Post-hole dug first 5-ft
	2	soft, (2.5Y 5/3) light olive br, mottled (yellowish br. gray), low plasticity, clayey SILT, wet	ml	0.0				▽ Encountered gw at 2.2 ft
	3							Blows in spoons by 140lb mechanical hammer.
	4							
	5	soft, (10YR 5/2) grayish brown, mottled (yellowish br), clayey SILT, low plasticity, wet 6		0.0	5	1/2 / 2/1	1.5 / 2	Begin drilling 4/1/09 S-1 Breathing Air/Background. VOC = 0.0 ppm LEL = 0% O_2 = 21.4% H_2S = 0 ppm CO = 0 ppm
	6	Loose, (10YR 5/8) yellowish br, medium to coarse grain, SAND, little silt, (15%), wet 7	sp		7	0850		S-2
	7	soft, (2.5Y 4/2) dark grayish br, homogeneous, low plasticity, SILT, trace clay <10%, wet silty clay lense 7.8-7.9' 9	ml	0.0	9	1/1 / 1/2 / 0905	1.3 / 2	
	9	Medium stiff, (10YR 4/1) dark gray, homogeneous, silty CLAY, moist shale fragments	ch	0.0		1/2	1.6	S-3
	10							

Project: PBOW

Hole Number: AP2-BEDGW-001

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Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-001

Project: PBOW | Geologist: D. Kessler | Sheet 3 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical Sample No.~~ Blows	Recovery (ft)	Remarks
	10	Medium stiff to stiff, (10YR 4/1) dark gray, homogeneous, high plasticity, silty CLAY, shale fragments subangular, very coarse grain to pebble size, gray, moist	CH	0.0	NA	1/3/3	1/2	S-3 (cont)
	11				11	0910		
						4/7/	1.1/	S-4
	12			0.0		9/13	2	
	13	13			13	0913		
		LIMESTONE, gray moderately weathered, 2" tense 13-13.2' hard, then lm is broken, thinnly bedded	NA				1/	S-5
	14			0.0			2	12"OD HSA advanced to 14.5 ft 4 1/4" ID HSA refusal at 15 ft
	15	very broken 15-15.5'		0.0	15	7/50 over 0"	0.5/ 0.5	S-6
		Spoon refusal @ 15.5 ft			15.5			
	16	LIMESTONE, hard, competent, gray fresh weathering	NA					Faint petroleum odor from drill water (air quality indicator 0.0 ppm)
	17		~~OH~~	0.0				chips show signs of iron staining, edges are sharp, fresh
	18							
	19							
	20							

Project: PBOW | Hole Number: AP2-BEDGW-001

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Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BED6W-001

Project: PBOW

Geologist: D. Kessler / E. Wave

Sheet 4 of 9 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or Core Box No.~~	~~Analytical Sample No.~~	Recovery (ft)	Remarks
	20	Start rock coring 4-17-09			NA	NA	NA	8" Rotary Bit Cut to 20.5 ft 6" ID Casing at 20.40 ft 20.5
	21	LIMESTONE, dark gray. massive bedding, fossiliferous (brachs, corals), highly fractured, hard, slightly weathered.			Box #1	21.1		C-1 (20.5-25.8) Run - 5.3 Rec - 5.3 Start - 1345 End - 1352
	22					22.0		
	23					22.8 23.1		
	24					23.6		
	25	- grading to light gray				25.1		
	26	- stylolite, grading to moderately fractured				25.8 26.2		25.8 C-2 (25.8-30.8) Run - 5.0 Rec - 5.0 Start - 1358 End - 1402
	27	- Stylolite - Pyrite nugget						
	28					28.0		
	29	- Stylolite - Pyrite Nugget						
	30				29.9 Box #2	29.9		

Project: PBOW

Hole Number: AP2-BED6W-001

Shaw
Shaw E & I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: APZ-BEDGW-001

Project: PBOW

Geologist: E. Weaver

Sheet 4 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech Sample or~~ Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (brachs, corals), moderately fractured, hard, slightly weathered.			Box #2 Cont			
		- Pyrite nuggets						
	31	- stylolite				30.8		30.8'
		- stylolite						C-3 (30.8-35.8)
	32	- stylolite						Run - 5.0 Rec - 5.0 Start - 1412 End - 1417
	33							
						33.3		Breathing Space Air O_2 - 21.4
	34					34.1		H_2S - 0 CO - 0 LEL - 0 VOC - 0
		- stylolite						
	35							Trip to bottom @ 35.8'
						35.8		35.8
	36					35.9		C-4 (35.8-40.8)
		- stylolite				36.7		Run - 5.0 Rec - 5.0
	37	-						Start - 1636 End - 1641
	38	- stylolite			37.9 Box #3	37.9		
		- stylolite						
	39							
		- Pyrite nugget						
	40							

Project: PBOW

Hole Number: APZ-BEDGW-001

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-001

Project: PBOW

Geologist: E. Weaver

Sheet 5 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample~~ ~~or~~ Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (brachs, coral) moderately fractured, hard, slightly weathered	NA	NA	Box #3 Cont.			
		Coral Reef to 41.5'				40.5		
						40.8		40.8
	41	- stylolite - stylolite						C-5 (40.8-45.8)
						41.4-MB		Run - 5.0 Rec - 5.2
	42							Start - 1648 End - 1659
	43	- stylolite				43.0		Breathing Space Air O_2 - 21.3 H_2S - 0 CO - 0 LEL - 0 VOC - 0
	44							
		- stylolite						
	45							
		- stylolite				45.7		45.8
	46				46.0' Box #4	46.0-MB		C-6 (45.8-50.8)
		- stylolite				46.4		Run - 5.0 Rec - 5.0
	47							Start - 1705 End - 1710
	48	- stylolite				48.0		
	49							
	50							

Project: PBOW

Hole Number: AP2-BEDGW-001

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-001

Project: PBOW

Geologist: E. Weaver

Sheet 7 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or~~ Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous, (bracho, corals), unfractured, hard, slightly weathered.	NA	NA	Box #4 cont.	-50.4-MB		50.8
	51					-51.0-MB		C-7 (50.8-55.8) Run - 5.0 Rec - 4.9 Start - 1740 End - 1745
	52							
	53							
	54							
	55					-55.4-MB		
	56				55.9 Box #5	-55.9-MB		55.8 C-8 (55.8-60.8) Run - 5.0 Rec - 4.8 Start - 1756 End - 1802
	57							
	58							
	59							
	60							

Project: PBOW

Hole Number: AP2-BEDGW-001

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-001

Project: PBOW | Geologist: E. Weaver | Sheet 9 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (brachs, corals) unfractured, hard, slightly weathered			Box #5 Cont.			Tagged bottom @ 60.7
						60.7 - MB		Start 4-18-09 60.8
	61							C-9 (60.8 - 65.8)
						61.7 - MB		Run - 5.0 Rec - 5.0 Start - 1506 End - 1511
	62							
	63							O_2 - 20.8 H_2S - 0 CO - 0 LEL - 0 VOC - 0
	64							
	65							
					65.7	65.7 - MB		65.8
	66	- grading to slightly fractured			Box #6	66.0	~~66.0~~	C-10 (65.8 - 70.8)
	67							Run - 5.0 Rec - ~~Ra~~ 5.2 Start - 1525 End - 1530
	68					68.3	~~68.5~~	
	69							
	70							

Project: PBOW | Hole Number: AP2-BEDGW-001

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-001

Project: PBOW

Geologist: E. Weaver

Sheet 9 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample~~ or Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (brachs, corals) highly fractured, hard, slightly weathered			Box #6 Cont.	70.4		Tagged bottom @ 70.8
						70.8 - MB		70.8
	71					70.9 - MB		C-11 (70.8 - 75.8)
								Run - 5.0
								Rec - 4.9
								Start - 1544
	72							End - 1549
		- potential water bearing fracture				72.6		O_2 - 21.3
	73							H_2S - 0
								CO - 0
		- Potential water bearing fracture				73.5		LEL - 0
								VOC - 0
	74							
		- Potential water bearing fracture to 74.6.				74.4		~~Tagged bottom 75.0~~
						74.6		
	75							
					75.4	75.4 - MB		
		- Potential water bearing fracture			Box #7	75.8		75.8
	76							C-12 (75.8 - 80.8)
								Run - 5.0
		- Potential water bearing fracture				76.6		Rec - 5.1
	77							Start - 1559
						77.2		End - 1604
						77.7		
	78							
						78.2		
	79					79.0		
	80					79.8		
						79.9		

Project: PBOW

Hole Number: AP2-BEDGW-001

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-001

Project: PBOW

Geologist: E. Wenner

Sheet 10 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No. Fracs	Recovery (ft)	Remarks
		LIMESTONE) light gray, massive bedding, fossiliferous (bracks, corals), highly fractured, hard, slightly weathered.			Box #7 Cont'd			80.8
	81					80.9		C-13 (80.8-85.8)
						81.3		Run - 5.0 Rec - 4.8
	82							Start - 1636
						82.2		End - 1642
						82.6		
	83							
						83.5		
	84				Box #8	84.2		
	85					85.0		
						85.7		85.8
	86	- Stylolite						C-14 (85.8-87.0) Run - 1.2 Rec - 1.2 Start - 1655 End - 1659
		87.0'			87.0	87.0		87.0'
	87	Boring Completed Monitor Well Installed @ 85.5' with 15' screen.						
	88							
	89							
	90							

Project: PBOW

Hole Number: AP2-BEDGW-001

Monitoring Well Construction Form (Bedrock)

Project:	PDOW	Well Number:	AP2-BEDGW-001
Location:	NASA Plum Brook Station, Sandusky, Ohio	Site Location:	Ash Pit #2
Client:	USACE - Nashville, TN	Installation Date	4-18-09
Subcontractor:	A. E. Drilling	Northing:	622795.83
Driller:	Kevin Warren / Tom Burnett	Easting:	1911202.97
Shaw Field Representative:	David Kessler / Eric Weaver	Shaw Project Number:	133422

Protective Cover Elevation (ft): 633.8

Top of Casing Elevation (ft): 633.46

Top of Casing Stickup (ft): 3.0'

Land Surface Elevation (ft): 630.4

Approximate Diameter of Section 1 Borehole (in): 12" to 14.5' / 8" to 20.5'

Diameter of Surface Casing (in): 6 5/8" OD / 6" ID

Depth to Bedrock (ft): 13 ft.

Bottom of Surface Casing (ft): 20.40'

Used 5.5 @ 94 lbs bags portland Type I/II cement mixed with bentonite gel to seal casing.

Depth to Water (ft):

During Drilling: ~72.6'

Date: 4-18-09

Post Development: — TOC

Date: —

Approximate Diameter of Section 2 Borehole (in): 6"

Well Casing Diameter (in): 2"

Top of Bentonite Seal (ft): 62.0'

Top of Filter Pack (ft): 66.0'

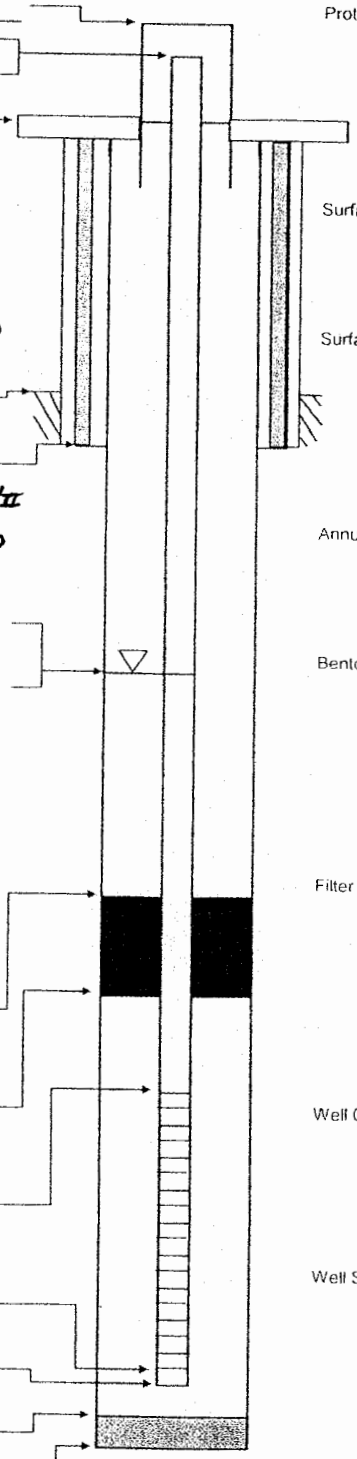
Top of Screen Interval (ft): 70.50'

Bottom of Screen Interval (ft): 85.50'

Bottom of Well (ft): 85.85'

Bottom of Filter Pack (ft): 87.0'

Bottom of Borehole (ft): 87.0'



Protective Casing:
- Type: Steel
- Dimensions (in): 4" x 4"
- Length (ft): 5'
- Guard Post: 4 - concrete filled

Surface Pad:
- Dimensions: 4' x 4' x 4"
- Type: Concrete

Surface Casing:
- Type: Black Steel
- Diameter (in): 6 5/8" OD / 6" ID
- Installation: Tremie / Haliburton / Cementing Plug / ~~Other Plug~~ Johnson Grout shoe

Annular Space Seal:
- Type: Bentonite-Cement Grout
- Installation: Gravity / (Tremie) / Pumped

Bentonite Seal:
- Manufacturer: Haliburton
- Type: (Pellets) / Slurry
- Installation: 6-in lifts / (One Section) / Gravity / (Tremie) / Pumped
- Hydration time (hrs): 14 hrs.

Filter Pack Material:
- Manufacturer: Southern Products
- Product Name: Filter Media
- Size: Gravel Pack #1
- Volume Added (ft^3): 3.5 ft^3 (7-bags)
- Installation: Gravity / (Tremie)

Well Casing:
- Manufacturer: Campbell Monoflex
- Type: PVC
- Diameter (in): 2"

Well Screen Casing:
- Manufacturer: Johnson
- Type: PVC
- Slot Size (in): .010 %Open
- Slot Type: (Continuous wrap) / Factory slot

Sump/End Cap: 0.35'

Backfill Material: None

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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).

HTRW DRILLING LOG

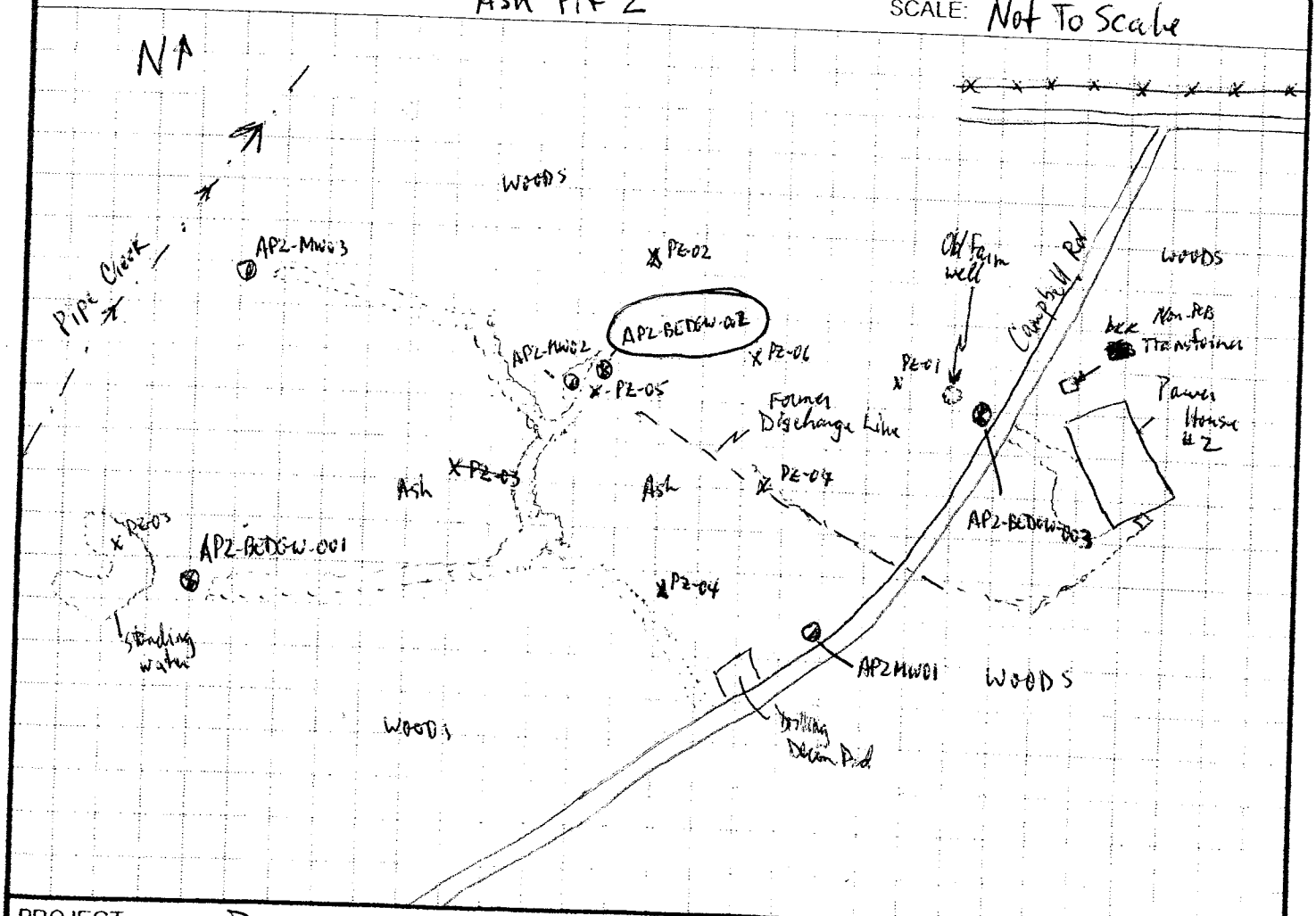
1. COMPANY NAME	Shaw E+I
DISTRICT	Nashville, TN
HOLE NUMBER	AP2-BEDGW-002
2. DRILL SUBCONTRACTOR	AE Drilling
SHEET / SHEETS	1 OF 10
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Kevin Warren / Tom Burnett
6. MANUFACTURER'S DESIGNATION OF DRILL	All Terrain CME-750
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Post-hole dug first 5-feet. Drilled w/ 4¼" ID/8" OD HSA to 16' Continuously sampled soil w/ 1.4" ID x 2' length split spoons. Overdrilled borehole w/ 8¼" ID/12" OD HSA to 15 ft. Drilled bedrock w/ 8" OD rotary bit to 21.1 ft. Set 6⅝" OD/6" ID Steel Casing at 21.1 Ft. Cored rock w/ 6" OD PQ 21.7 to 86.1'.
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	632.4 ft — Northing: 622887.85, Easting: 1911361.47
10. DATE STARTED	4/2/09
11. DATE COMPLETED	4-17-09
12. OVERBURDEN THICKNESS	15.8 Ft
13. DEPTH DRILLED INTO ROCK	70.3'
14. TOTAL DEPTH OF HOLE	86.1'
15. DEPTH GROUNDWATER ENCOUNTERED	6.5 Ft overburden / Bedrock 73.2'
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	4

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	NA	NA	NA	NA	%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
			NA	David Kresh / E.W. Weaver

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not To Scale



PROJECT PBOW HOLE NO. AP2-BEDGW-002

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW | Geologist: D. Kessler | Sheet 2 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical Sample No.~~ Blows	Recovery (ft)	Remarks
		CINDERS/ASH, black, some black silt, organics, moist		NM	NA	NA	NA	Post hole dug first 5-ft.
	1							
	2							
	3	3						Breathing Air/Background VOC = 0.0 (3.7 ppm) LEL = 0% O_2 = 20.8% H_2S = 0 ppm CO = 0 ppm
	4							Blows on spoons by 140lb mechanical hammer
	5	Soft, (10YR 5/3) light olive br, mottled (dark yellowish br), low to medium plasticity, sandy, clayey, SILT, 30% sand, 30% clay, 40% silt, sand very fine grain, moist	ml	0.0	5	2/1/ 2/1	1.5/ 2	Began drilling 4/2/09 0840 S-1
	6							
	7	wet at 7 Ft			7	0840 2/2/ 1/1	1.2/ 2	▽ Believe to encounter gw at 6.5 Ft S-2
	8	8.2		0.0				
	9	Medium stiff, (2.5y 4/4) olive br, mottled (gray), low plasticity silty CLAY, moist	cl		9	0845 1/2/	1.4/	S-3
	10							

Project: PBOW | Hole Number: AP2-BEDGW-002

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW | Geologist: D. Kessler | Sheet 3 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical Sample No.~~ Blows	Recovery (ft)	Remarks
	10	10.4	Cl	0.0	NA	3/4	1/2	S-3 (cont)
		Stiff, (2.5Y 4/1) dark gray, homogeneous, high plasticity, silty CLAY, shale fragments, 15%, very coarse grain to pebble size, subangular to subrounded, saturated			11	0848		
	11					3/4/	2/2	S-4
	12		ch	0.0		6/6		
					13	0855		
	13					3/4/	1.7/	S-5
	14	limestone pebble 14.6', 30 mm		0.0		10/10	2	
					15	0900		
	15	15.8		0.0		9/5/ 50 cm 0"	1/1	S-6 2¼" ID/12" OD HSA advanced to 15 ft
	16	LIMESTONE, gray, moderately weathered, very broken, dry 15.8-16'			16	0905		spoon 1¼" HSA refusal at 16'
						NA	NA	
	17	Competency of bedrock hard, fresh at 16'						
	18	chips light gray, sharp edges.						
	19							
	20							

Project: PBOW | Hole Number: AP2-BEDGW-002

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW

Geologist: D. Kessler / E. Lekeaver

Sheet 4 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or~~ Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	LIMESTONE, gray, hard competent cutting.	NA	0.0	NA	NA	NA	~~8 1/4" OD HSA~~ DKK 8" OD Rotary bit cut to 21.1 ft 6" ID steel casing set at 21.1 ft
	21	Start 4-16-09			21.1	Fracs		21.1
	22	LIMESTONE, dark gray, massive bedding, fossiliferous (brachs, corals), highly fractured, hard, slightly weathered.	NA	NA	Box #1			C-1 (21.1-~~25.9~~ 26.1) Run 5.0 Rec 4.8 Start 0835 End 0842
	23					22.8		Breathing Space Air
	24	- intense fracturing with some clay to 23.9'				23.6 23.9 24.3 24.4		O_2 - 21.4 H_2S - 0 CO - 0 LEL - 0 VOC - 6.0 (?)
	25					25.1		Tagged bottom of hole @ 25.8 Tom said there were some cuttings in bottom.
	26	- grading to light gray and moderately fractured.				25.9		26.1 - 31.1 26.1 C-2 (~~25.9~~ - ~~30.9~~) Run 5.0 Rec 4.9 Start 0851 End 0858
	27							
	28	- stylolite				27.6 28.5		
	29							
	30					29.7		

Project: PBOW

Hole Number: AP2-BEDGW-002

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW | Geologist: E. Weaver | Sheet 5 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech Sample~~ or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	31	LIMESTONE, light gray, massive bedding, fossiliferous (brachs, corals), moderately fractured, hard, slightly weathered.	NA	NA	Box #1 cont. 30.8 Box #2	30.8		Tagged bottom of hole @ 30.5' bgs. Tom said there was still a nub of rock and some material (cuttings) in bottom of hole. 31.1
	32	- stylolite - stylolite				31.8		C-3 (31.1-36.1) Run - 5.0 Rec - 5.3 Start - 0910 End - 0916
	33	- stylolite						Purged hole. No immediate recharge. Tagged bottom after flushing hole. Tagged @ 36.1'.
	34					34.1		
	35					35.0		
	36	- stylolite				36.1		36.1
	37	- stylolite				36.8		C-4 (36.1-41.1) Run - 5.0 Rec - 4.8 Start - 1021 End - 1026
		- stylolite			37.6 Box #3	37.6		
	38	- stylolite - stylolite						Breathing Space Air O_2 - 21.3 H_2S - 0 CO - 0 LEL - 0 VOC - 4.1
	39	- stylolite						
	40	- stylolite						

Project: PBOW | Hole Number: AP2-BEDGW-002

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW

Geologist: E. Weaver

Sheet 6 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or~~ Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (breccia, corals), moderately fractured, hard, slightly weathered,	NA	NA	Box #3 cont.			
	41					40.8 40.9	MB	41.1
		- stylolite				41.4		C-5 (41.1-46.1)
		- stylolite - coral reef to 42.8'						Run - 5.0
	42					42.1		Rec - 5.2 Start - 1036 End - 1043
		- stylolite						
	43							Breathing Space Air O_2 - 21.4 H_2S - 0
		- stylolite				43.8		CO - 0 LEL - 0
	44							VOC - 4.5
	45							
		- stylolite				45.5		
	46				46.1	46.1	MB	46.1
		- stylolite			Box #4			C-6 (46.1-51.1)
		- piece of coral						Run - 5.0
	47	- piece of coral (hydrocarbon seeping from coral)				47.2		Rec - 4.9 Start - 1050 End - 1056
	48	- stylolite						
		- stylolite - stylolite				48.8		
	49							
	50							

Project: PBOW

Hole Number: AP2-BEDGW-002

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW

Geologist: E. Weaver

Sheet 7 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech Sample or~~ Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (bracks, corals), unfractured, hard, slightly weathered.	NA	NA	Box #4 cont.			
						-50.6		Tagged bottom @ 51.0
	51					-51.0 -MB		51.1
								C-7 (51.1-56.1) Run - 5.0 Rec - 5.1 Start - 1350 End - 1354
	52							
	53							Breathing Space Air O_2 ~21.4 H_2S - 0 CO - 0 LEL - 0 VOC - 0
	54							
	55							
					55.5 Box #5	55.5-MB		
	56					-56.1-MB		56.1
		- lighter colored layer in rock to 56.7'						C-8 (56.1-61.1) Run 5.0 Rec 5.1 Start - 1402 End - 1407
	57							
	58							
	59							
	60							

Project: PBOW

Hole Number: AP2-BEDGW-002

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW

Geologist: E. Weaver

Sheet 8 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or~~ Core Box No.	~~Analytical Sample No.~~ Bracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (brachs, corals), unfractured, hard, slightly weathered.			Box #5 Cont.	→ 60.4 - MB		
	61					→ 61.1 - MB		61.1
								C-9 (61.1-66.1) Run - 5.0 Rec - 5.1 Start - 1416 End - 1421
	62	- lighter colored layers in rock to 62.5'						
	63							
	64							Breathing Space Air O_2 - 21.4 H_2S - 0 CO - 0 LEL - 0 VOC - 0
	65				65.3 Box #6	→ 65.3 MB		
	66					→ 66.2 - MB		66.1
								C-10 (66.1-71.1) Run - 5.0 Rec - 5.0 Start - 1429 End - 1435
	67							
	68							
	69	- Angular fracture filled with seeping hydrocarbon				→ 68.9		
	70							

Project: PBOW

Hole Number: AP2-BEDGW-002

Shaw
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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW | Geologist: E. Weaver | Sheet 9 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech Sample or~~ Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (bracks, corals) unfractured, hard, slightly weathered.			Box #6 Cont.	70.3	MB	
	71	- Pyrite nuggets.						71.1
						71.2	MB	C-11 (71.1-76.1) Run - 5.0' Rec - 5.0 Start - 1518 End - 1526
	72							
		- Pyrite nugget						
	73	- potential water bearing fractures grading to moderately fractured				73.2 73.3		Breathing Space Air O_2 - 21.5 H_2S - 0 CO - 0 LEL - 0 VOC - 0
	74				74.5 Box #7	74.5	MB	
	75	- stylolite				75.3		
		- Stylolite						
	76							76.1
						76.2		C-12 (76.1-81.1)
		- stylolite				76.7		Run - 5.0 Rec - 5.1 Start - 1608 End - 1616
	77							
		- Stylolite						
	78							
						78.8		
	79							
	80							

Project: PBOW | Hole Number: AP2-BEDGW-002

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Shaw
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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-002

Project: PBOW

Geologist: E. Weaver

Sheet 10 of 10 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech Sample or~~ Core Box No.	~~Analytical Sample No.~~ Fracs	Recovery (ft)	Remarks
	81	LIMESTONE, light gray, massive bedding, fossiliferous (bryozoans, corals) moderately fractured, hard, slightly weathered.	NA	NA	Box #7 Cont.			81.1
						81.3		C-13 (81.1 - 86.1) Run - 5.0 Rec - 4.8 Start - 1628 End - 1634
	82							
	83							Breathing Space Air
		- Stylolite			83.4 Box #8	83.4		O_2 - 21.5 H_2S - 0 CO - 0 LEL - 0 VOC - 0
	84							
	85							
	86	86.1'			86.1	86.1		Pump hole. Recharging Quickly 86.1
		Boring Completed @ 86.1' Monitor Well Installed with 15' screen						
	87							
	88							
	89							
	90							

Project: PBOW

Hole Number: AP2-BEDGW-002

Monitoring Well Construction Form (Bedrock)

Project:	PBGW	Well Number:	APZ-BEDGW-002
Location:	NASA Plum Brook Station, Sandusky, Ohio	Site Location:	Ash Pit #2
Client:	USACE - Nashville, TN	Installation Date	4-17-09
Subcontractor:	A.E. Drilling	Northing:	622887.85
Driller:	Kevin Warren / Tom Burnett	Easting:	1911361.47
Shaw Field Representative:	David Kessler / Eric Weaver	Shaw Project Number:	133422

Protective Cover Elevation (ft): 636.07

Top of Casing Elevation (ft): 635.58

Top of Casing Stickup (ft): ~~0.49~~ 3.18

Land Surface Elevation (ft): 632.4

Approximate Diameter of Section 1 Borehole (in): 12" to 15' / 8" to 21.1'

Diameter of Surface Casing (in): 6 5/8" OD / 6" ID

Depth to Bedrock (ft): 15.8'

Bottom of Surface Casing (ft): 21.1'

Depth to Water (ft):

During Drilling: ~73.2'

Date: 4-16-09

Post Development: — TOC

Date: —

Approximate Diameter of Section 2 Borehole (in): 6"

Well Casing Diameter (in): 2"

Top of Bentonite Seal (ft): 62.0'

Top of Filter Pack (ft): 66.0'

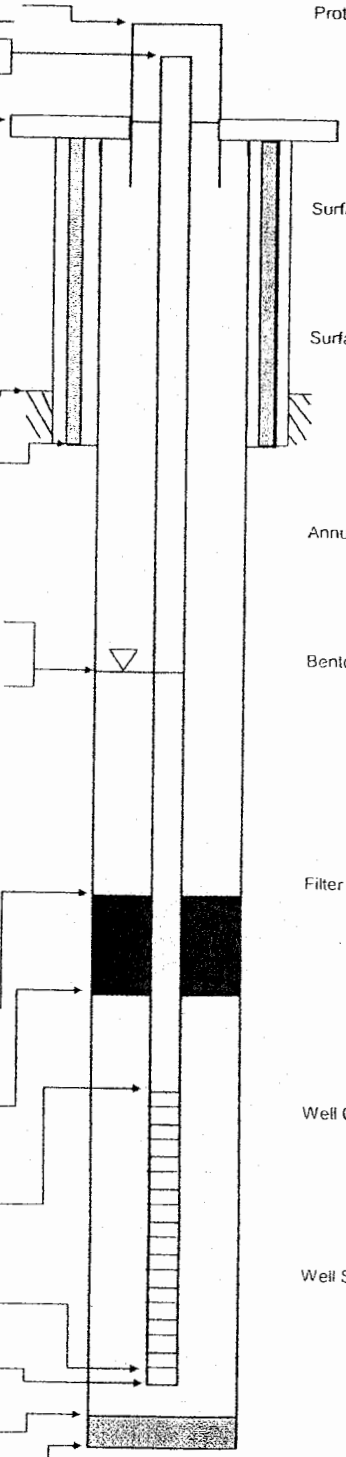
Top of Screen Interval (ft): 70.0'

Bottom of Screen Interval (ft): 85.0'

Bottom of Well (ft): 85.35'

Bottom of Filter Pack (ft): 86.1'

Bottom of Borehole (ft): 86.1'



Protective Casing:
- Type: Steel
- Dimensions (in): 4"x4"
- Length (ft): 5'
- Guard Post: 4 - concrete filled

Surface Pad:
- Dimensions: 4'x4'x4"
- Type: Concrete

Surface Casing:
- Type: Black Steel
- Diameter (in): 6 5/8" OD / 6" ID
- Installation: Tremie / Haliburton / Cementing Plug / ~~Other Plug~~ Johnson Grout shoe

Annular Space Seal:
- Type: Bentonite-Cement Grout
- Installation: Gravity / (Tremie) / Pumped

Bentonite Seal:
- Manufacturer: Haliburton
- Type: (Pellets) / Slurry
- Installation: 6-in lifts / (One Section) / Gravity / (Tremie) / Pumped
- Hydration time (hrs): >1 hr

Filter Pack Material:
- Manufacturer: Southern Products
- Product Name: Filter Media
- Size: Gravel Pack #1
- Volume Added (ft^3): 3 ft^3 (6-bags)
- Installation: Gravity / (Tremie)

Well Casing:
- Manufacturer: Campbell Monoflex
- Type: PVC
- Diameter (in): 2"

Well Screen Casing:
- Manufacturer: Johnson
- Type: PVC
- Slot Size (in): .010 | %Open
- Slot Type: (Continuous wrap) / Factory slot

Sump/End Cap: 0.35'

Backfill Material: None

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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).

HTRW DRILLING LOG

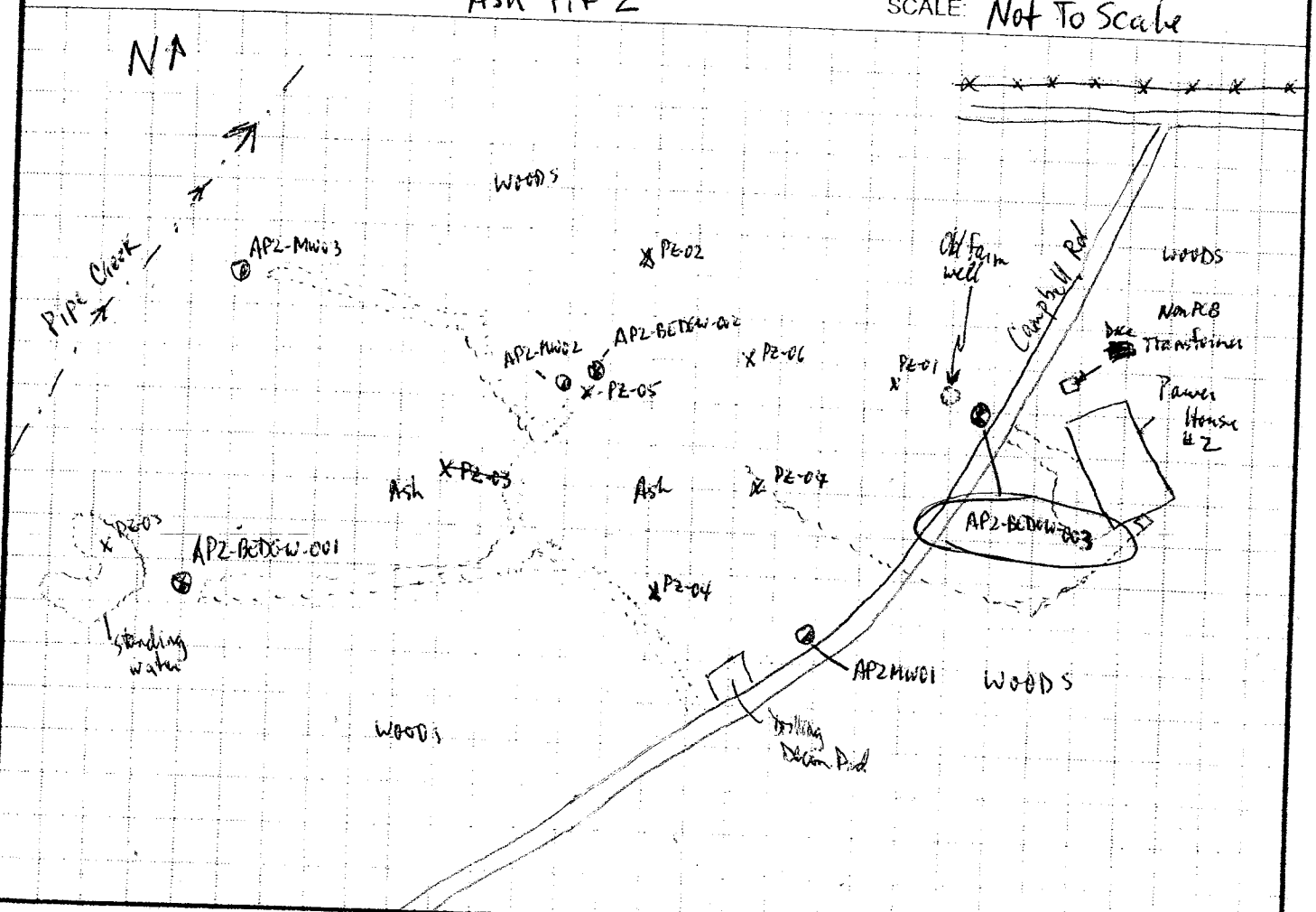
DISTRICT	Nashville, TN
HOLE NUMBER	AP2-BEDGW-003
SHEET / OF SHEETS	1 of 8
1. COMPANY NAME	Shaw E+I
2. DRILL SUBCONTRACTOR	AE Drilling
3. PROJECT	PBOW
4. LOCATION	NASA Plum Brook Station, Sandusky, OH
5. NAME OF DRILLER	Kevin Warren / Tom Burnette
6. MANUFACTURER'S DESIGNATION OF DRILL	All Terrain CME-750
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	Post-hole dug first 5-feet. Drilled w/ 4¼" ID/8" OD HSA. to 19.5 ft. Overdrilled borehole w/ 8¼" ID/12" OD HSA. Continuously soil sampled (thru 4¼" HSA) w/ 1.4" ID x 2 ft length split-spoons. Drilled bedrock w/ 8" OD rotary bit (wet) to 24.5 ft. Steel casing 6⅝" OD set at 24.45'. Cored rock w/ 6" OD PQ bit to 61.0'
8. HOLE LOCATION	See Sketch
9. SURFACE ELEVATION	638.4 ft — Northing: 623117.29, Easting: 1911619.32
10. DATE STARTED	3/30/09
11. DATE COMPLETED	4-15-09
12. OVERBURDEN THICKNESS	19.5 ft
13. DEPTH DRILLED INTO ROCK	41.5
14. TOTAL DEPTH OF HOLE	61.0'
15. DEPTH GROUNDWATER ENCOUNTERED	overburden 6.2 ft / bedrock 46.9 - 50.1
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	—

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	NA	NA	3

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
	NA	NA	NA	NA	NA	%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	NA	NA	NA	David Keseler / Kevin W. Weaver

LOCATION SKETCH/COMMENTS Ash Pit 2 SCALE: Not To Scale



PROJECT	HOLE NO.
PBOW	AP2-BEDGW-003

Shaw
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HTRW DRILLING LOG (continuation sheet)

Hole Number: APZ-BEDG-W-003

Project: PBOW

Geologist: D. Kessler

Sheet 2 of 8 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical Sample No.~~ Blows	Recovery (ft)	Remarks
		Weeds						
	1	Fill: (Soft, (10YR 3/3) dark brown, silty SAND (silt 30%), 10% gravel, sand very fine grain to very coarse grain, poorly sorted, organics (roots), dry) 1.8	SM		NA	NA	NA	Post-hole dug first 5-feet. Old Road Bed base 0-1.8 ft
	2	Soft, (10YR 5/8) yellowish br, mottled (br, gray), low plasticity, clayey SILT,	ML	0.0				Breathing Air/Background: VOC = 0.0 (11.0 ppm) LEL = 0% O_2 = 21.2% H_2S = 0 ppm CO = 0 ppm
	3							
	4							
	5	Soft color grading to (10YR 4/4) dark yellowish brown, mottling (brown/gray - 10% mottles), fine platy structure	ML		5	2/2 1/2	1.9/2	Began drilling 3/30/09 S-1 ▽ 6.2 water encountered (very moist but)
	6			0.0				
	7	Medium stiff, clay content increases w/ depth, pink (oxidized) silt in horizontal fracture			7	1625		S-2
	8	8.5		0.0		3/3 2/3	2/2	
	9	Medium stiff, (10YR 5/2) grayish br, mottled (dark br, yellowish br), silty CLAY, high plasicity, silt content 30-40%, very moist, wet	CH		9	1630		S-3
	10			0.0		3/4/	1.8/	

Project: PBOW

Hole Number: APZ-BEDG-W-003

Shaw
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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-003

Project: PBOW | Geologist: D. Kessler | Sheet 3 of 8 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical Sample No.~~ Blows	Recovery (ft)	Remarks
	10	Medium stiff. (10YR 5/2) grayish brown, mottled (dark br, yellowish br) high plasticity, silty CLAY, silt content varies (30-40%), silt content decreases w/ depth	ch	0.0	NA	4/4	1/2	S-3 (cont)
	11				11	1635		
	12			0.0		2/3 / 5/5	2/2	S-4 11.5' saturated
	13				13	1640		
	14			0.0		2/2 / 3/2	2/2	S-5
	15				15	1645		
	16	At 16.5 ft, silt content 5%, nothing 5%	ch	0.0		2/1 / 2/1	1.4/ 2	S-6
	17				17	1655		
	18	Shale fragments appear 18.3 ft, rounded		0.0		1/2 / 3/3	1.7/ 2	S-7
	19				19	1700		
		19.5 ~~Lime~~ Shaley LIMESTONE, gray, very weathered, dry			19.6	1/50 cm 0"	0.6/ 0.6	S-8 Bedrock @ 19.5 ft; spoon Refusal 19.6 ft
	20							

Project: PBOW | Hole Number: AP-BEDGW-003

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Shaw
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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-003

Project: PBOW

Geologist: D. Kessler/Weaver

Sheet 7/4 of 8 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
	20	LIMESTONE, dark gray, small chips w/ sharp edges, competent	NA		NA	NA	NA	Began drilling w/ 8" OD rotary bit at 19.5' 3/31/09 1010. wet drilling
	21							
	22			0.0				Breathing Air/Background VOC = 0.0 ppm LEL = 0% O_2 = 21.2% H_2S = 0 ppm CO = 0 ppm
	23							
	24							8" OD Rotary bit drilled to 24.5 ft. Black steel casing 6 5/8" OD set at 24.45'
		Start Coring.				Fracs		24.5
	25	LIMESTONE, dark gray, massive bedding, fossiliferous (brachs, corals), highly fractured, hard, slightly weathered.	NA	NA	Box #1		NA	Began Drilling (Coring) 4/14/09
	26					25.9 26.0		C-1 (24.5-25.9) Run - 1.4 Rec - 1.4
						26.6 26.7		Start 1523 End 1526
	27					27.0		C-2 (25.9-30.9)
						27.4 27.5		Run 5.0 Rec 5.0
	28							Start 1534 End 1540
						28.3-MB		Breathing Space Air
	29	grading to light gray						O_2 - 21.3 H_2S 0
						29.3		CO 0
						29.7		LEL 0 VOC [illegible]
	30							

Project: PBOW

Hole Number: AP2-BEDGW-003

Shaw
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HTRW DRILLING LOG (continuation sheet)

Hole Number: APZ-BEDGW-003

Project: PBOW

Geologist: B Weaver

Sheet 5 of 8 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or~~ Core Box No.	~~Analytical Sample No.~~ Fract	Recovery (ft)	Remarks
	30	LIMESTONE, lt, lt gray, massive bedding, fossiliferous (brachs, corals), moderately fractured, hard, slightly weathered.			AA Box #1 Cont.	30.5		
	31					30.9		C-3 (30.9-35.9) Run 5.0 Rec 5.0 Start 1550 End 1555
	32	- Stylolite - Stylolite				32.2		
	33	- Stylolite						
	34				34.0 Box #2	34.0		
	35	- Stylolite - Stylolite				35.0		
	36					35.9		C-4 (35.9-40.9) Run 5.0 Rec 5.0 Start - 1602 End - 1607
	37	- Stylolite				37.3		
	38					38.2		Breathing Space Air O_2 - 21.2 H2S - 0 CO - 0 LEL - 0 VOC - 0
	39	- Stylolite - Stylolite						
	40					39.9		

Project: PBOW

Hole Number: APZ-BEDGW-003

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Shaw
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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BEDGW-003

Project: PBOW

Geologist: E. Weaver

Sheet 6 of 8 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (brachs, corals), highly fractured, hard, slightly weathered.			Box #2 Cont.			
	41					40.8 40.9 41.1		C5 (40.9-45.9)
								Run 5.0
	42	- stylolite						Rec 5.1
					42.A Box #3	42.A		Start - 1655 End - 1701
	43							
	44					44.0		
		- Coral Reef to 45.7' - Stylolite						
	45					44.9		
						45.7		
	46					46.0		C6 (45.9-50.9)
	47	- possible water bearing fracture				46.9		Run 5.0 Rec 5.1
	48							Start 1708 End
		- Stylolite						
	49							
		- Stylolite				49.A		
	50							

Project: PBOW

Hole Number: AP2-BEDGW-003

Shaw
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HTRW DRILLING LOG (continuation sheet)

Hole Number: APZ-BEDGW-003

Project: PBOW

Geologist: E. Weaver

Sheet 7 of 8 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (bracks, corals), moderately fractured, hard, slightly weathered.			Box #3 cont.	50.1		Stained with Bearing fracture
	51				51.1 Box #4	51.1		C7 (50.9-55.9) Run - 5.0 Rec - 5.0 Start - 1721 End - 1726
	52					52.0		
	53							
						53.6		
	54							
	55							
						55.6		Start 4-15-09
	56				56.1 Box #5	56.1		C8 (55.9-60.9)
	57							Run - 5.0 Rec - 4.9 Start 0921 End - 0925
	58							
	59							Breathing Space Air O_2 - 21.1 H_2S - 0 CO - 0 LEL - 0 VOC - 0
	60							

Project: PBOW

Hole Number: APZ-BEDGW-003

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HTRW DRILLING LOG (continuation sheet)

Hole Number: AP2-BOD6W-003

Project: PBOW

Geologist: E. Weaver

Sheet 8 of 8 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	~~Analytical Sample No.~~ Frac's	Recovery (ft)	Remarks
		LIMESTONE, light gray, massive bedding, fossiliferous (branchs, worms) moderately fractured hard, slightly weathered	NA	NA	Box #5 Cont.			
	61		NA		61.0	61.0		61.0
		Boring Completed @ 61.0 ft Monitoring Well Installed Total Depth - 61.0 Ft						
	62							
	63							
	64							
	65							
	66							
	67							
	68							
	69							
	70							

Project: PBOW

Hole Number: AP2-BOD6W-003

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Monitoring Well Construction Form (Bedrock)

Project:	PDOW	Well Number:	AP2-BEDGW-003
Location:	NASA Plum Brook Station, Sandusky, Ohio	Site Location:	Ash Pit #2
Client:	USACE - Nashville, TN	Installation Date	4-15-09
Subcontractor:	A.E. Drilling	Northing:	623117.29
Driller:	Kevin Warren / Tom Burnett	Easting:	1911619.32
Shaw Field Representative:	David Kessler / Eric Weaver	Shaw Project Number:	133422

Protective Cover Elevation (ft): 641.17

Top of Casing Elevation (ft): 640.83

Top of Casing Stickup (ft): 2.43

Land Surface Elevation (ft): 638.4

Approximate Diameter of Section 1 Borehole (in): 12" to 19.5'; 8" to 24.5'

Diameter of Surface Casing (in): 6 5/8" OD / 6" ID

Depth to Bedrock (ft): 19.5'

Bottom of Surface Casing (ft): 24.45'

Used 7@ 94 lbs bags Portland Cement Type I/II mixed with bentonite gel to seal isolation casing.

Depth to Water (ft):

During Drilling: 46.9' or 50.1'

Date: 4-15-09

Post Development: — TOC

Date: —

Approximate Diameter of Section 2 Borehole (in): 6"

Well Casing Diameter (in): 2"

Top of Bentonite Seal (ft): 38.0'

Top of Filter Pack (ft): 41.0'

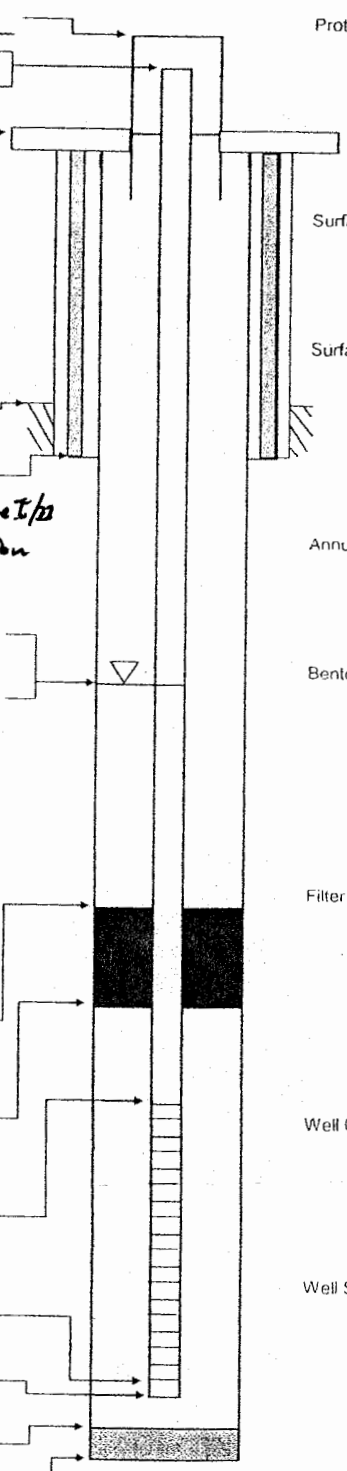
Top of Screen Interval (ft): 45.0'

Bottom of Screen Interval (ft): 60.0'

Bottom of Well (ft): 60.35'

Bottom of Filter Pack (ft): 61.0'

Bottom of Borehole (ft): 61.0'



Protective Casing:

Type: Steel

Dimensions (in): 4" x 4"

Length (ft): 5'

Guard Post: 4 - concrete filled

Surface Pad:

Dimensions: 4' x 4' x 4"

Type: Concrete

Surface Casing:

Type: Black Steel

Diameter (in): 6 5/8" OD / 6" ID

Installation: Tremie Haliburton Cementing Plug ~~Other Plug~~ Johnson Grout shoe

Annular Space Seal:

Type: Bentonite-Cement Grout

Installation: Gravity (Tremie) Pumped

Bentonite Seal:

Manufacturer: Haliburton

Type: (Pellets) Slurry

Installation: 6-in lifts (One Section) Gravity (Tremie) Pumped

Hydration time (hrs): >1 hr.

Filter Pack Material:

Manufacturer: Southern Products

Product Name: Filter Media

Size: Gravel Pack #1

Volume Added (ft^3): 3 ft^3 (6-bags)

Installation: Gravity (Tremie)

Well Casing:

Manufacturer: Campbell Monoflex

Type: PVC

Diameter (in): 2"

Well Screen Casing:

Manufacturer: Johnson

Type: PVC

Slot Size (in): .010 %Open

Slot Type: (Continuous wrap) Factory slot

Sump/End Cap: 0.35'

Backfill Material: None

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Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).

APPENDIX B

DIRECT-PUSH SOIL BORING, DIRECT-PUSH GROUNDWATER, SURFACE WATER, SEDIMENT, AND GROUNDWATER SAMPLE COLLECTION LOGS

Shaw™
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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB01**/PZ 01

Sample Number: **AP0100**

Sample Name: **PBOW-09-SS-ASH PIT 2-SB01-AP0100-(0-1)**

Sampling Method: **DP**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

QC Partners:

(TB) ——— **(ER)** ——— **(FB)** ———

Task: **ASH PIT2**

Collection Date: 1-15-09

Collection Time: 0830

Start Depth: 0' ~~bto~~ mk

End Depth: 1' ~~bto~~ mk

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

ERPIMS Values:

Sacode:

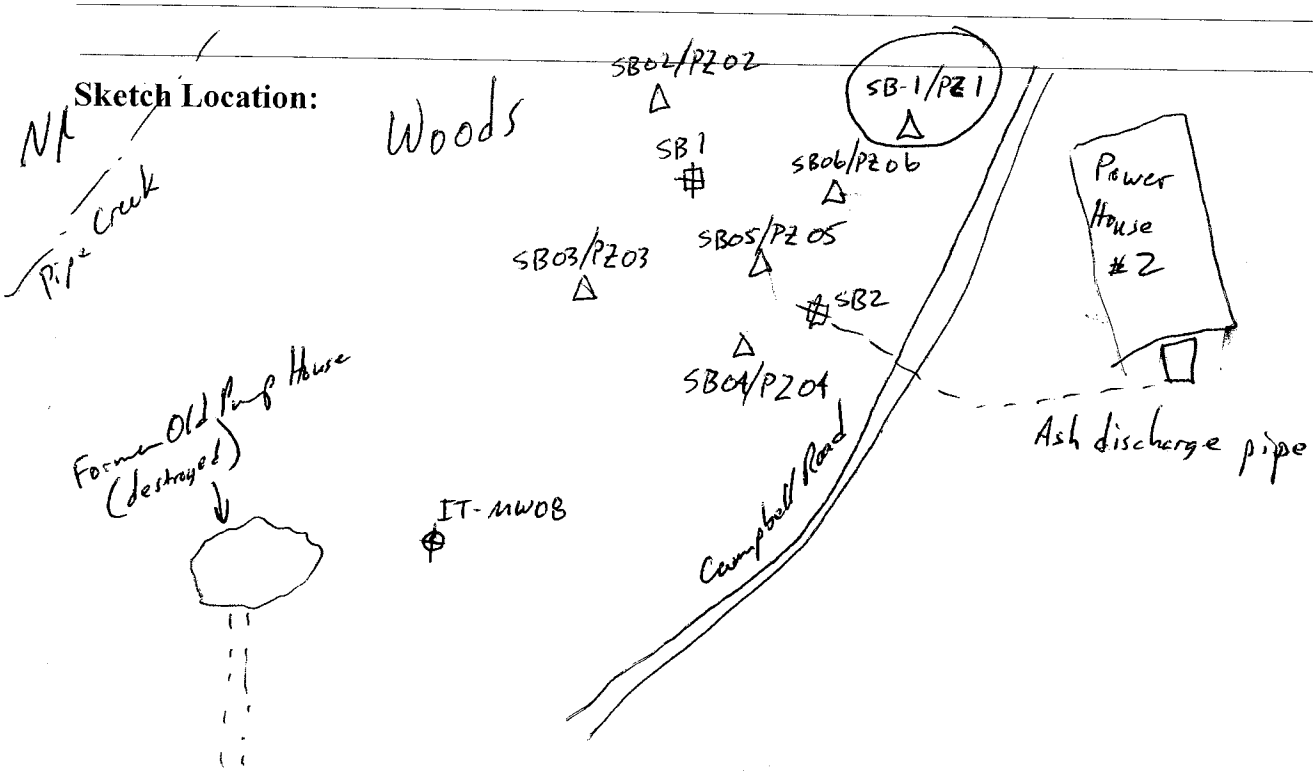
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-15-09

Reviewed BY / Date: Edward W. Weaver 11-8-09

Shaw™
Shaw E & I, Inc.

Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB01/PZ01**
Sample Number: **AP0100MS**
Sample Name: **PBOW-09-SS-ASH PIT 2-SB01-AP0100MS-(**
Sampling Method: **DP**
Sample Type: **SS** *Sample Purpose:* **MS**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-15-09
Collection Time: 0830
Start Depth: 0' ~~bgs~~ mn
End Depth: 1' ~~bgs~~ mn
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) ——— (ER) ——— (FB) ———

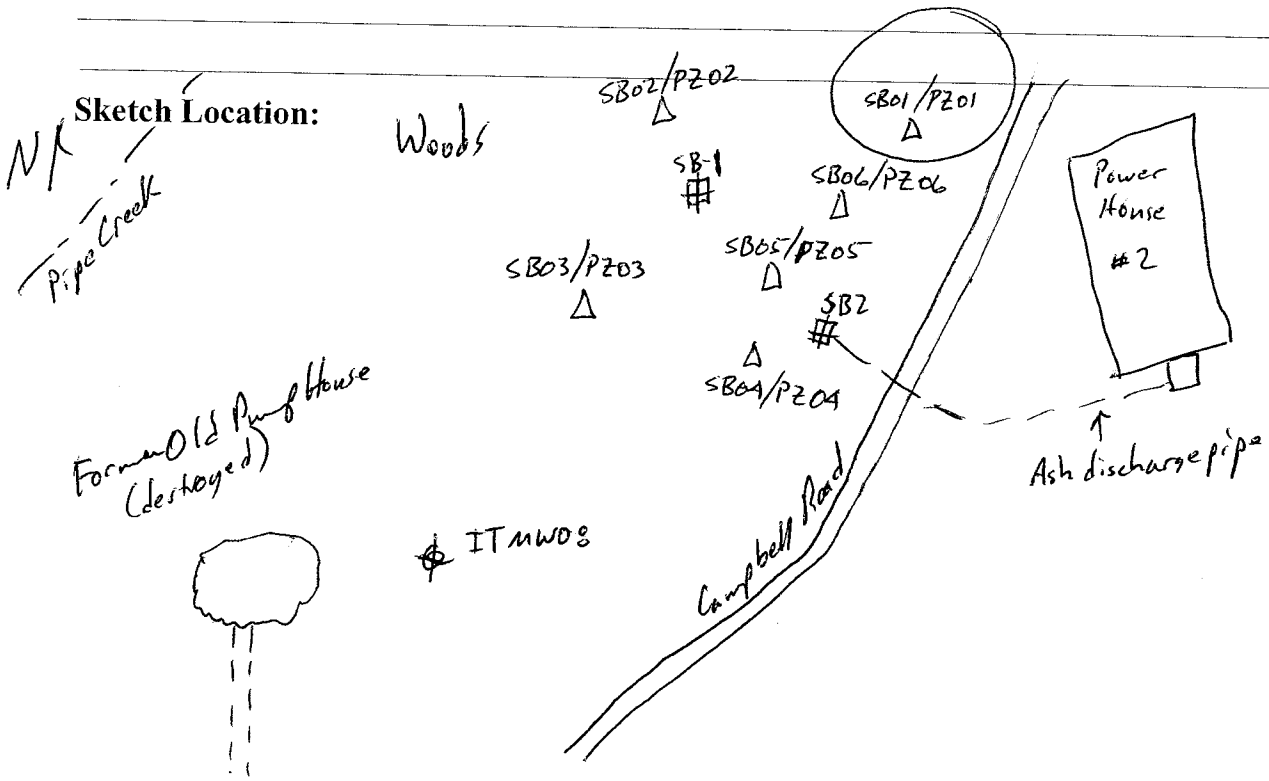
ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID- 0.0

Sketch Location:



Logged BY / Date: Eric W. Weaver 1-15-09

Reviewed BY / Date: Edward L. Kessler 11-8-09

Shaw™
Shaw E & I, Inc.

Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB01**/PZ01
Sample Number: **AP0100MSD**
Sample Name: **PBOW-09-SS-ASH PIT 2-SB01-AP0100MSD-**
Sampling Method: **DP**
Sample Type: **SS** *Sample Purpose:* **MSD**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-15-09
Collection Time: 0830
Start Depth: 0' ~~btoc~~ MR
End Depth: 1' ~~btoc~~ MR
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) —— (ER) —— (FB) ——

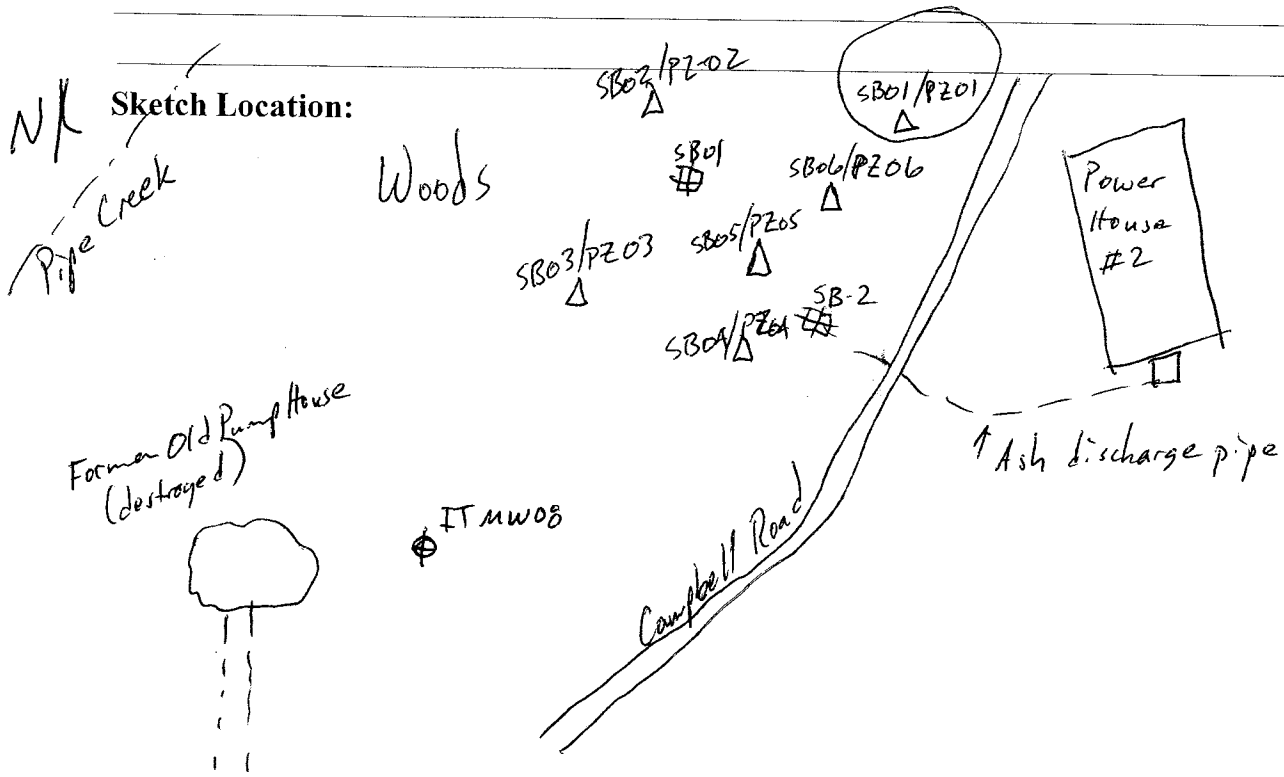
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: Eric W. Weaver 1-15-09 *Reviewed BY / Date:* Edward K. Weaver 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB01**

Sample Number: **AP0101**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB01-AP0101-(3-5)**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

Task: **ASH PIT2**

Collection Date: 1-15-09

Collection Time: 0835

Start Depth: 3' ~~bgs~~ mk

End Depth: ~~3~~ 3.7' ~~bgs~~ mk EW

Sample Matrix: **SOIL**

Sample Team: Kessler / Weaver

QC Partners:

(TB) ——— (ER) ——— (FB) ———

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:

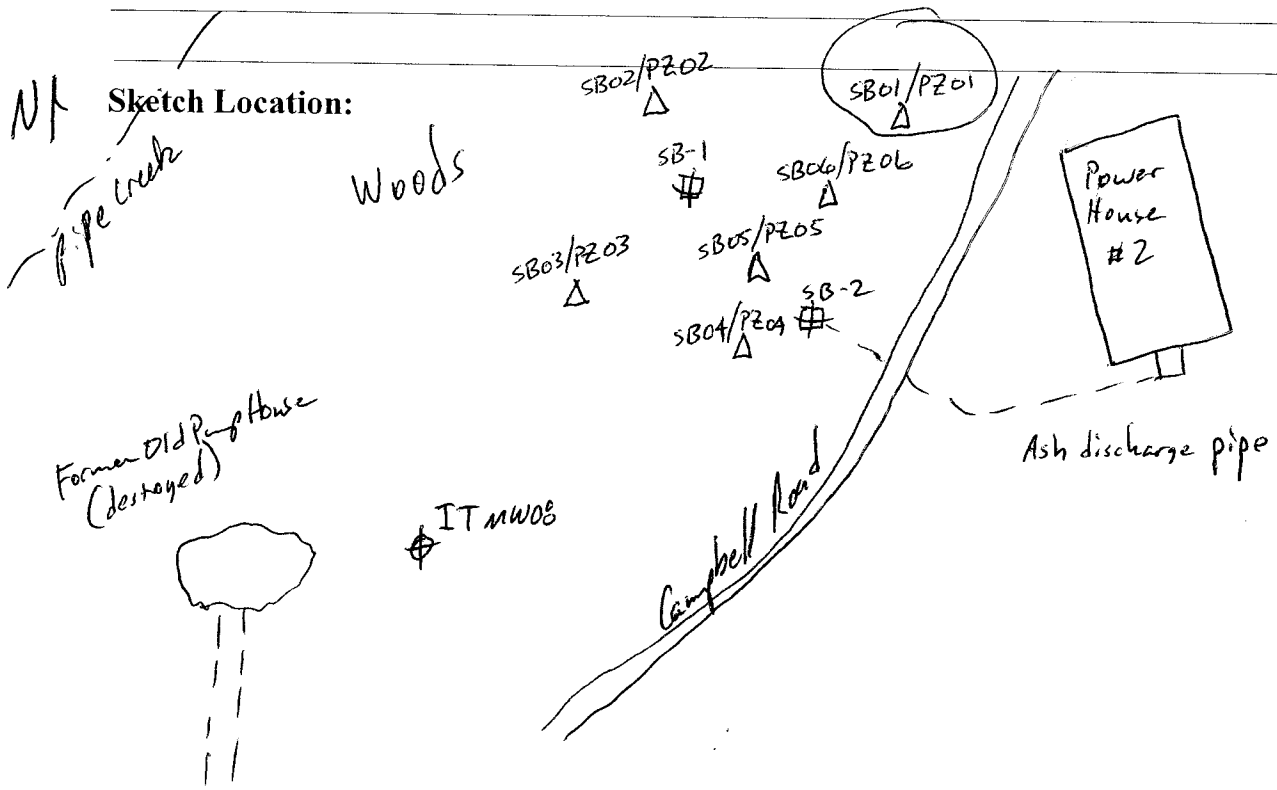
Sacode:

Lot Control#:

Comments: PID - 0.0

NA

Sketch Location:



Logged BY / Date: E. W. Weaver 1-15-09

Reviewed BY / Date: Edward E. Weaver 11-8-09

Shaw E & I, Inc.

Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB01**

Sample Number: **AP0102**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB01-AP0102-(8-1(**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**

Collection Date: 1-15-09

Collection Time: 0840

Start Depth: 8' ~~btoc~~ MR

End Depth: 10' ~~btoc~~ MR

Sample Matrix: **SOIL**

Sample Team: Keeler/Weaver

QC Partners:

(TB) ——— (ER) ——— (FB) ———

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

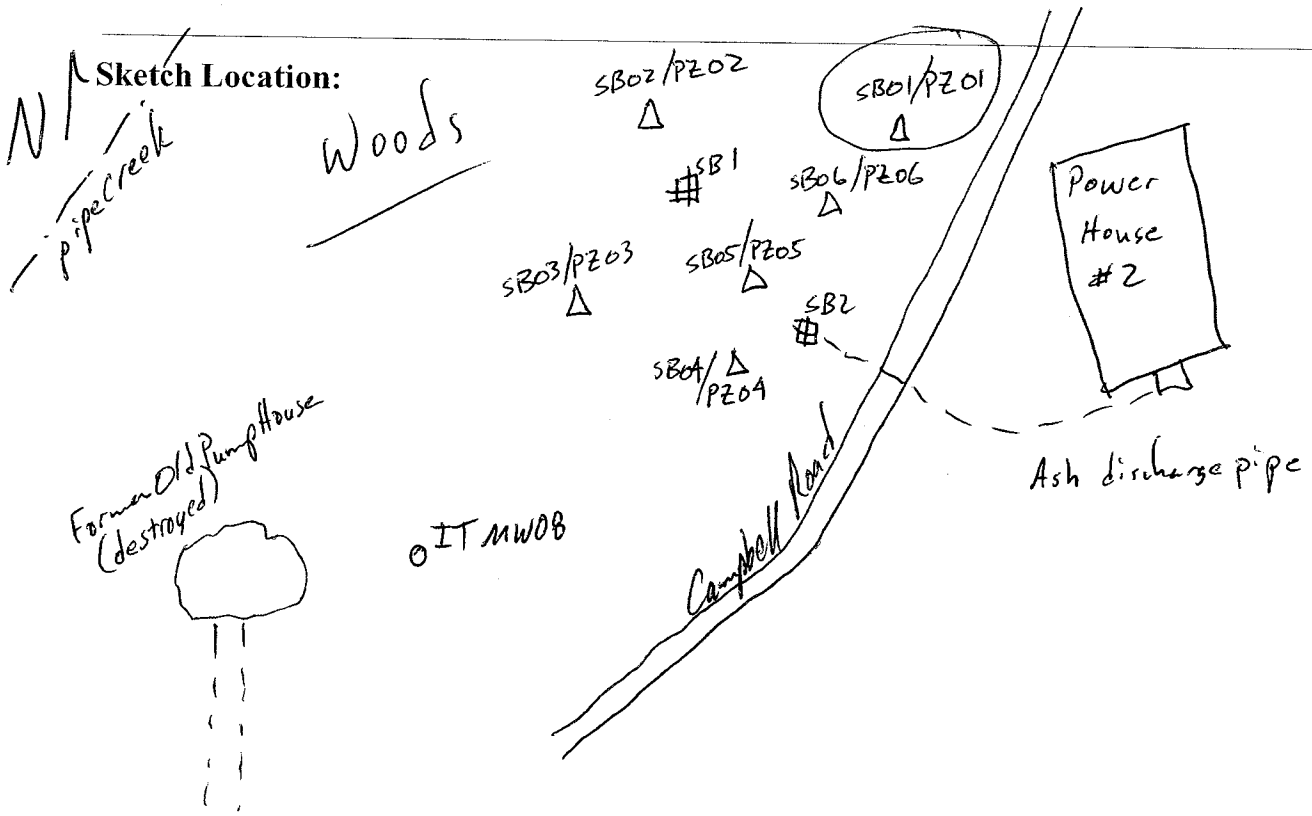
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-15-09

Reviewed BY / Date: Edward G. Weaver 11-8-0

Shaw E & I, Inc.

Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB06**

Sample Number: **AP0117**

Sample Name: **PBOW-09-SS-ASH PIT 2-SB06-AP0117-(0-1)**

Sampling Method: **DP**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

QC Partners:

(TB) ——— **(ER)** ——— **(FB)** ———

Task: **ASH PIT2**

Collection Date: 1-15-09

Collection Time: 0920

Start Depth: 0' ~~bgs~~ mr

End Depth: 1' ~~bgs~~ mr

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

ERPIMS Values:

Sacode:

Lot Control#:

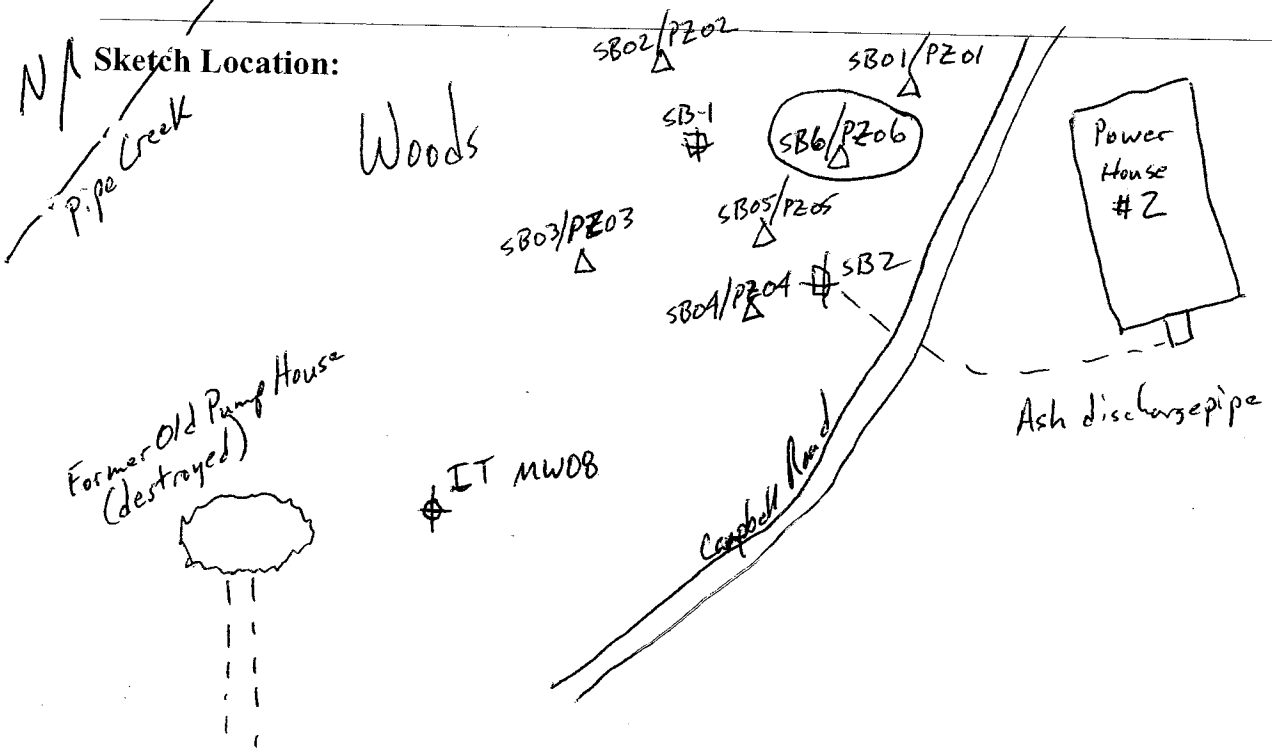
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID 0.0

NA

Sketch Location:



Logged BY / Date: E. W. Weaver 1-15-09 *Reviewed BY / Date:* Edward L. Weaver 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB06**
Sample Number: **AP0118**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB06-AP0118-(3-5)**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-15-09
Collection Time: 0923
Start Depth: 3' ~~bgs~~ na
End Depth: 3.8' ~~bgs~~ na
Sample Matrix: **SOIL**
Sample Team: Keesler/Weaver

QC Partners:
(TB) —— (ER) —— (FB) ——

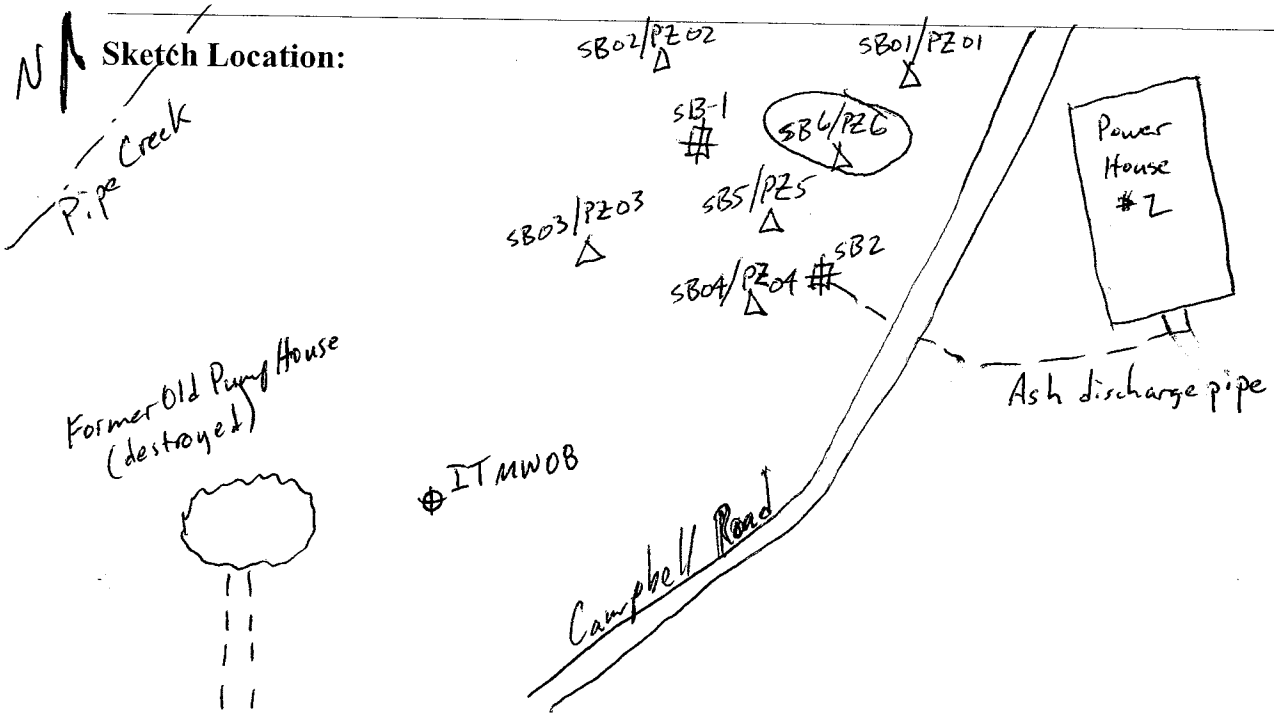
ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-15-09 *Reviewed BY / Date:* Edward G. Weaver 1-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB06**

Sample Number: **AP0119**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB06-AP0119-(8-1(**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable 2 ziplock baggie

Task: **ASH PIT2**

Collection Date: 1-15-09

Collection Time: 0930

Start Depth: 8' ~~bgs~~ MR

End Depth: 10' ~~bgs~~ MR

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

QC Partners:

(TB) —— (ER) —— (FB) ——

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

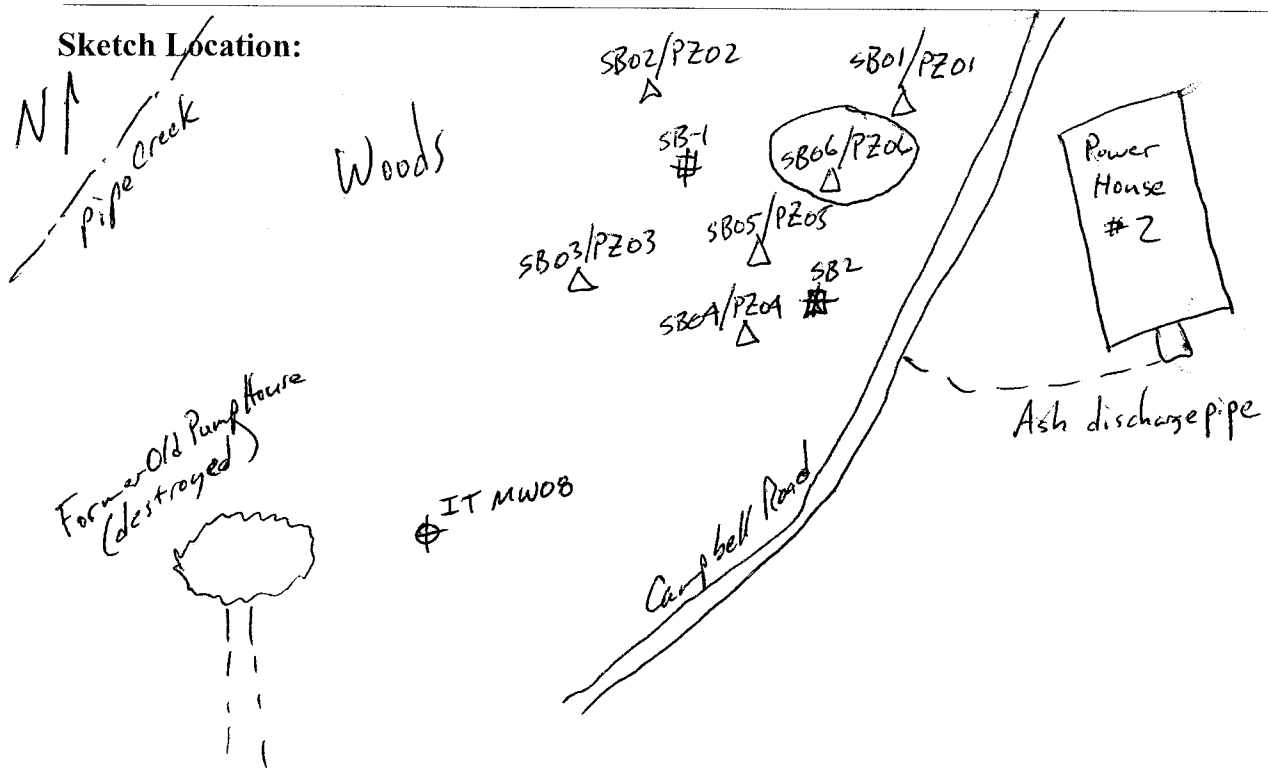
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: Eric W. Weaver 1-15-09 *Reviewed BY / Date:* Edward E. Weaver 1-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB07**

Sample Number: **AP0120**

Sample Name: **PBOW-09-SS-ASH PIT 2-SB07-AP0120-(0-1)**

Sampling Method: **DP**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

QC Partners:

(TB) ——— **(ER)** ——— **(FB)** ———

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1000

Start Depth: 0' ~~bgs~~ nk

End Depth: 1' ~~bgs~~ nk

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

ERPIMS Values:

Sacode:

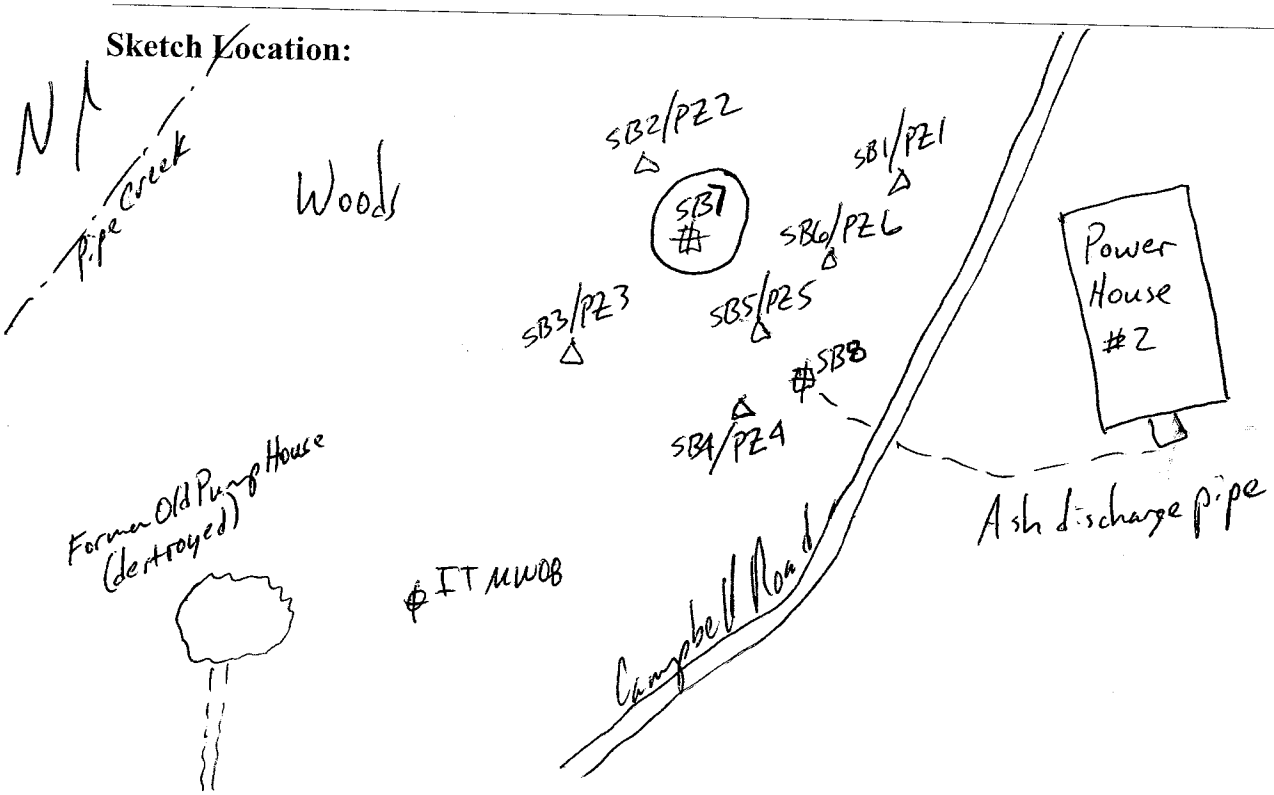
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. Weaver 1-16-09 *Reviewed BY / Date:* Edward K. Weaver 4-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB07**

Sample Number: **AP0121**

Sample Name: **PBOW-09-SS-ASH PIT 2-SB07-AP0121-(0-1)**

Sampling Method: **DP**

Sample Type: **SS** *Sample Purpose:* **FD**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable zip lock baggie

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1000

Start Depth: 0' ~~btoc~~ MR

End Depth: 1' ~~btoc~~ MR

Sample Matrix: **SOIL**

Sample Team: Kercher/Weaver

QC Partners:

(TB) —— (ER) —— (FB) ——

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

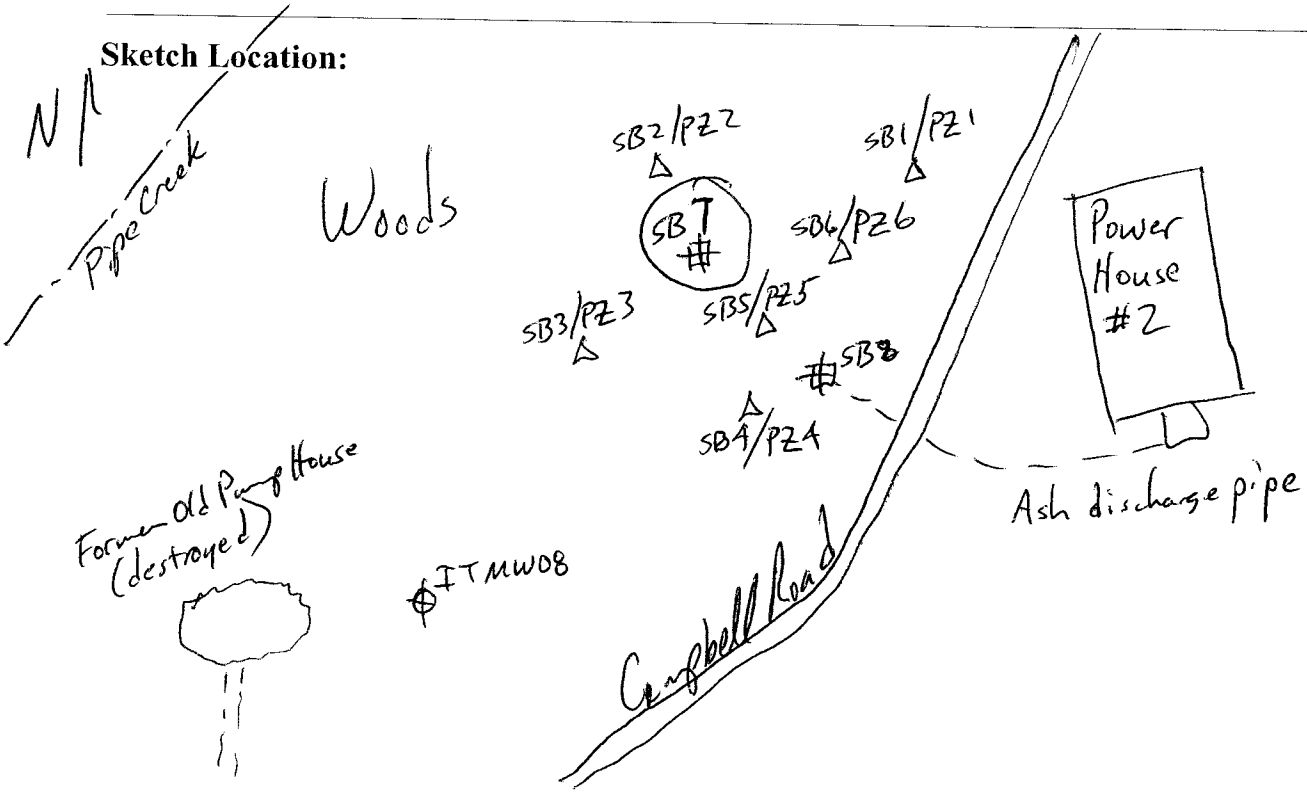
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E.W. Weaver 1-16-09 *Reviewed BY / Date:* Edward E. Weaver 11-8-10

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609TA

Location Code: **ASH PIT 2-SB07**

Sample Number: **AP0122**

Sample Name: **PBOW-09-SS-ASH PIT 2-SB07-AP0122-(0-1)**

Sampling Method: **DP**

Sample Type: **SS** *Sample Purpose:* **FS**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable plastic bag

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1000

Start Depth: 0' ~~bgs~~ uks

End Depth: 1' ~~bgs~~ uks

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

QC Partners:

(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	4	oz	CWM
METALS	N	A	2	4	oz	CWM
PCBS	N	A	2	4	oz	CWM
SEMIVOLATILES	N	A	2	4	oz	CWM

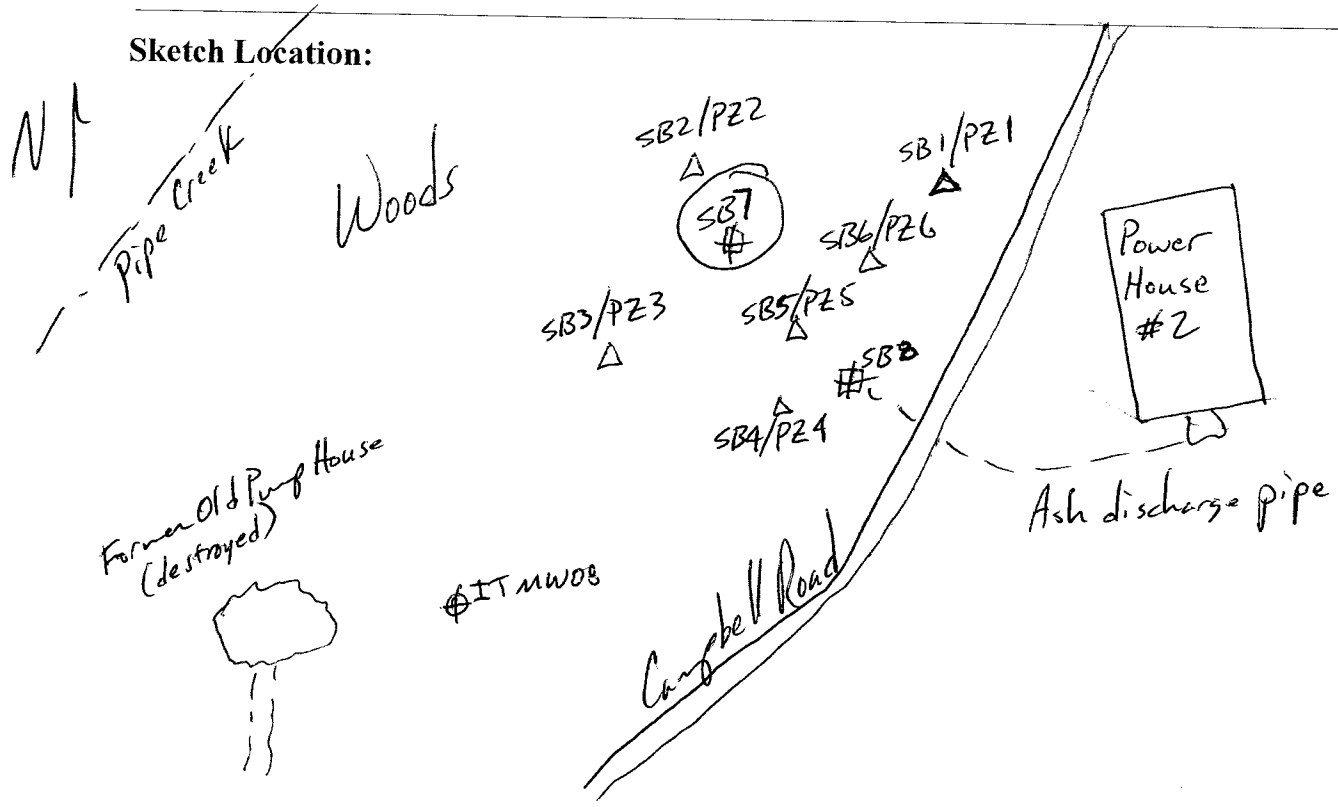
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-16-09

Reviewed BY / Date: Edward E. Weaver 1-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB07**

Sample Number: **AP0123**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB07-AP0123-(3-5)**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable zylock bag

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1003

Start Depth: 3'

End Depth: 4.1'

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

QC Partners:

(TB) — **(ER)** — **(FB)** —

ERPIMS Values:

Sacode:

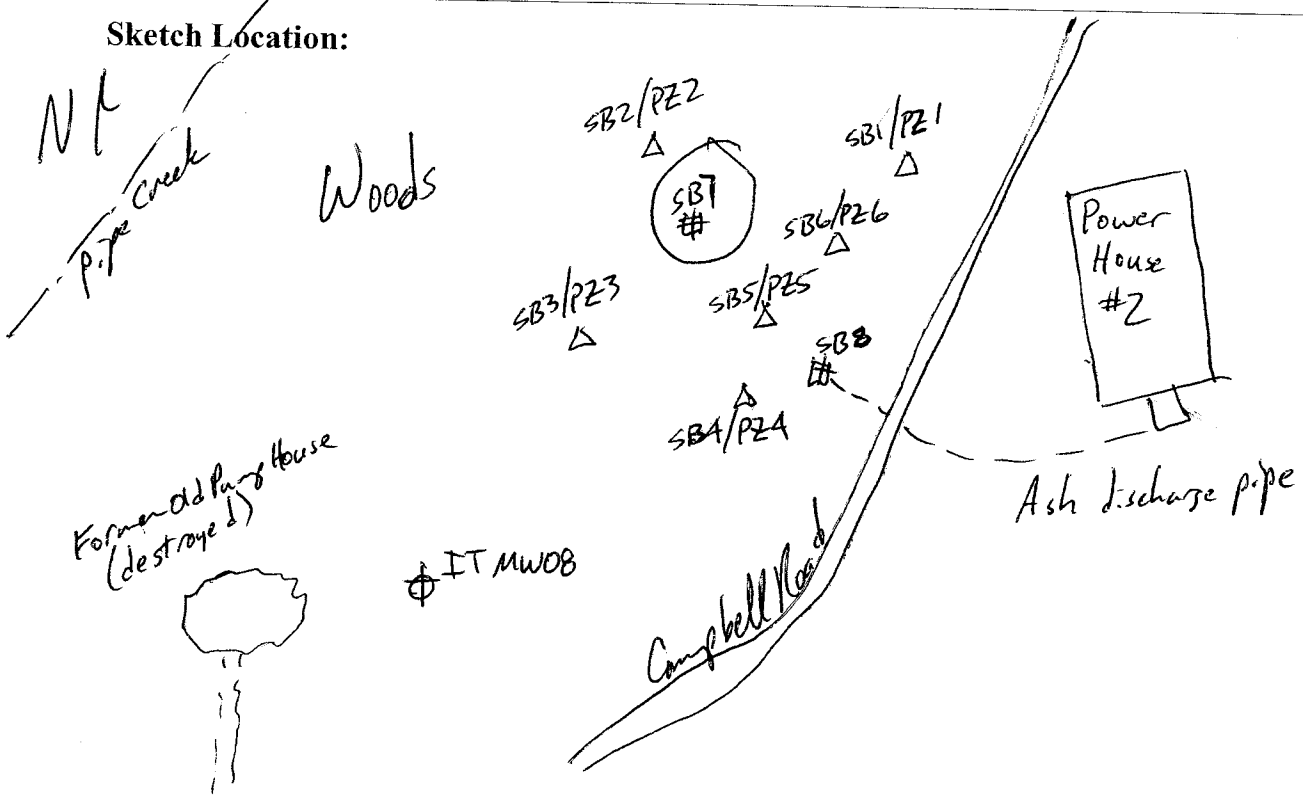
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. Weaver 1-16-09 *Reviewed BY / Date:* Edward G. Weaver 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB07**

Sample Number: **AP0124**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB07-AP0124-(8-1(**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1005

Start Depth: 8'

End Depth: 10'

Sample Matrix: **SOIL**

Sample Team: Keesler/Weaver

QC Partners:

(TB) — (ER) — (FB) —

ERPIMS Values:

Sacode:

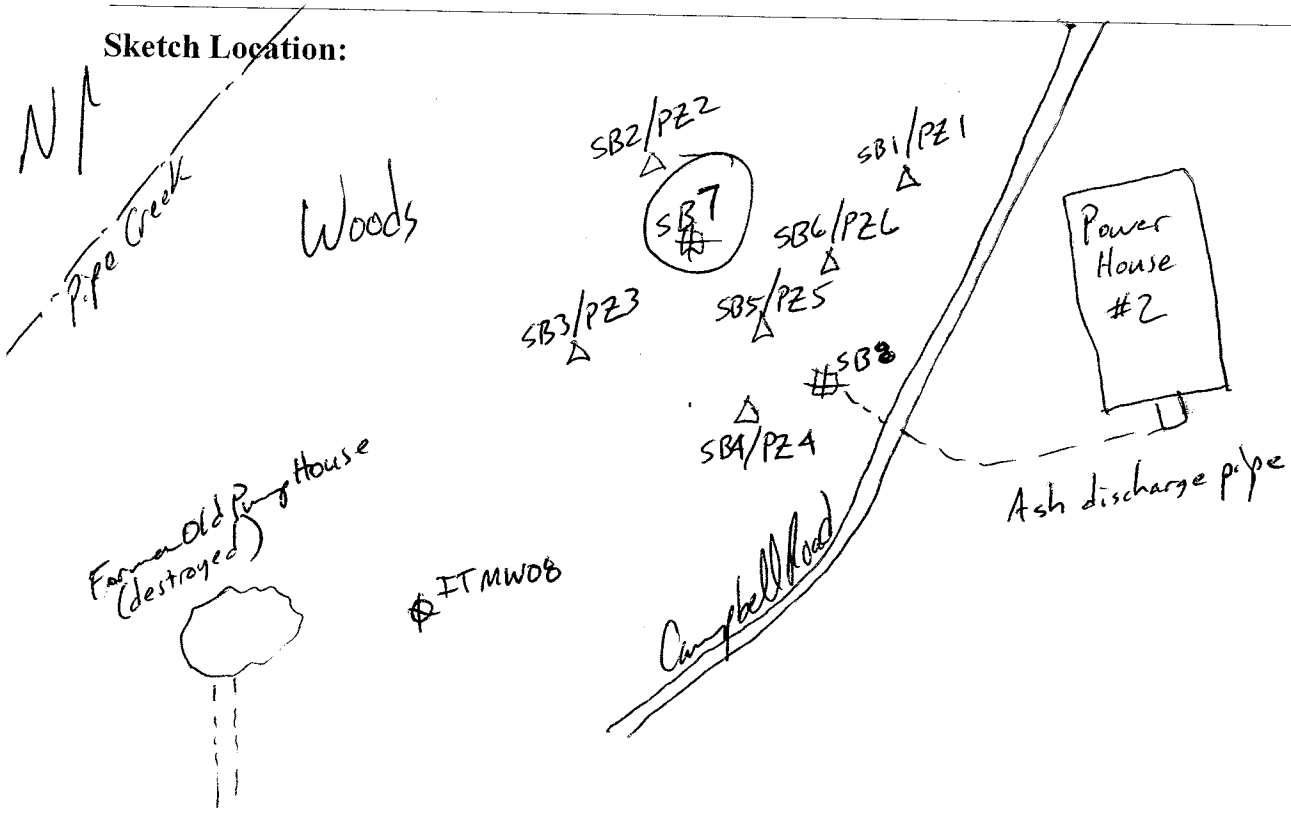
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E.W. Weaver 1-16-09 *Reviewed BY / Date:* Edward E. Howard 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609 AML

Location Code: **ASH PIT 2-SB02**

Sample Number: **AP0103**

Sample Name: **PBOW-09-SS-ASH PIT 2-SB02-AP0103-(0-1)**

Sampling Method: **DP**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

QC Partners:

(TB) — **(ER)** — **(FB)** —

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1030

Start Depth: 0

End Depth: 1'

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

ERPIMS Values:

Sacode:

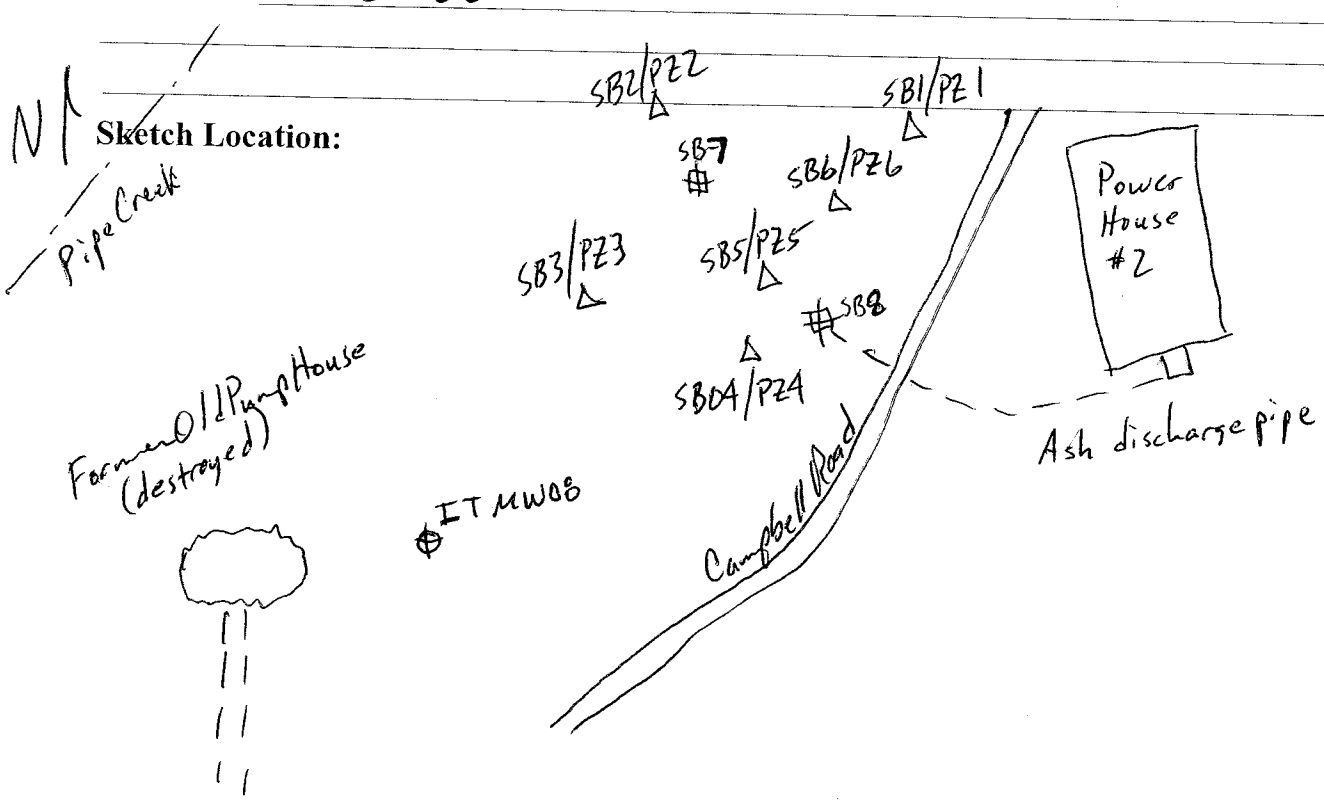
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM
TOC-B	N	B	1	4	oz	CWM

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. Weaver 1-16-09 *Reviewed BY / Date:* Edward E. Weaver 11-8-09

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Shaw E & I, Inc.

Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609 AML

Location Code: **ASH PIT 2-SB02**
Sample Number: **AP0104**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB02-AP0104-(3-5)**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-16-09
Collection Time: 1033
Start Depth: 3'
End Depth: 5'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) —— (ER) —— (FB) ——

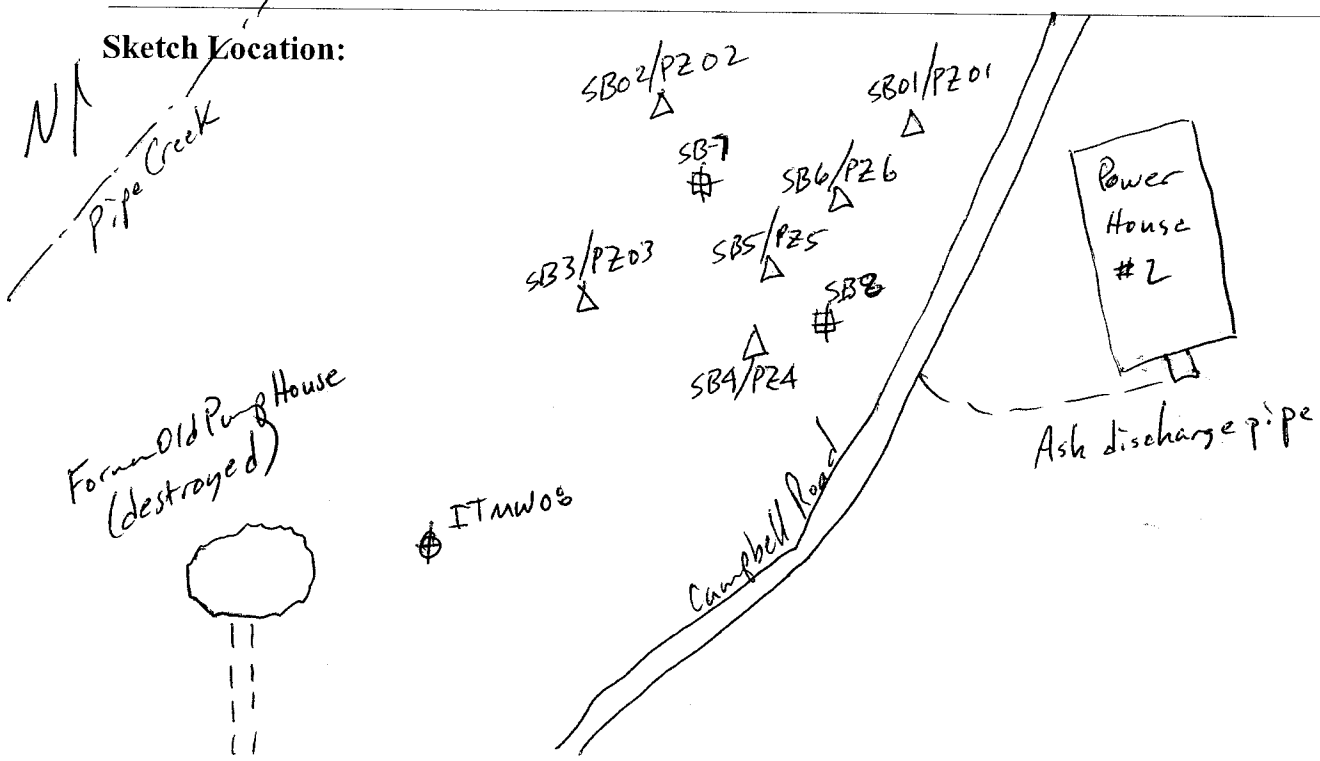
ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID -0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-16-09 *Reviewed BY / Date:* Edward W. Weaver 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS
Manager: Steve Downey

RFA / COC Number: PB011609 AML

Location Code: **ASH PIT 2-SB02**
Sample Number: **AP0105**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB02-AP0105-(3-5)**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **FD**
Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-16-09
Collection Time: 1033
Start Depth: 3'
End Depth: 5'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) — (ER) — (FB) —

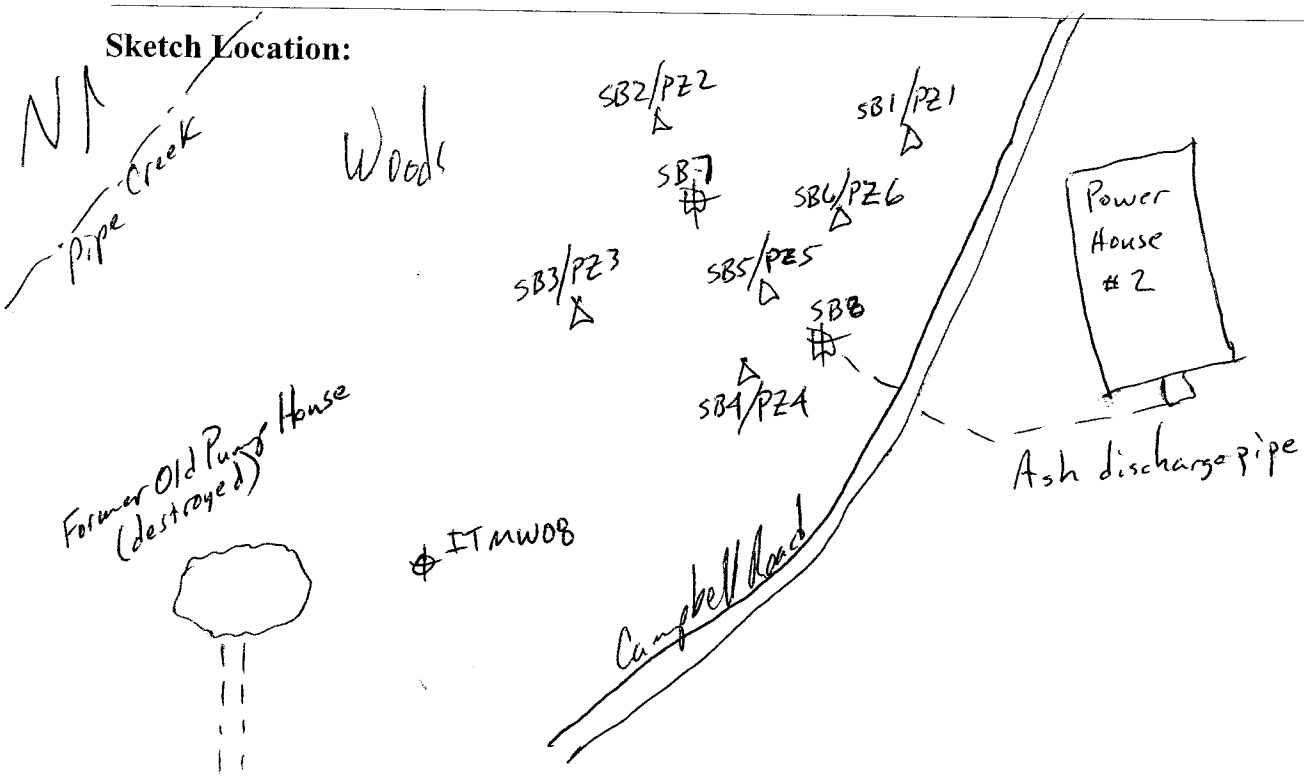
ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID -0.0

Sketch Location:



Logged BY / Date: E. Weaver 1-16-09 *Reviewed BY / Date:* Edward E. Weaver 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609TA

Location Code: **ASH PIT 2-SB02**

Sample Number: **AP0106**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB02-AP0106-(3-5)**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **FS**

Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

QC Partners:

(TB) — (ER) — (FB) —

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1033

Start Depth: 3'

End Depth: 5'

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

ERPIMS Values:

Sacode:

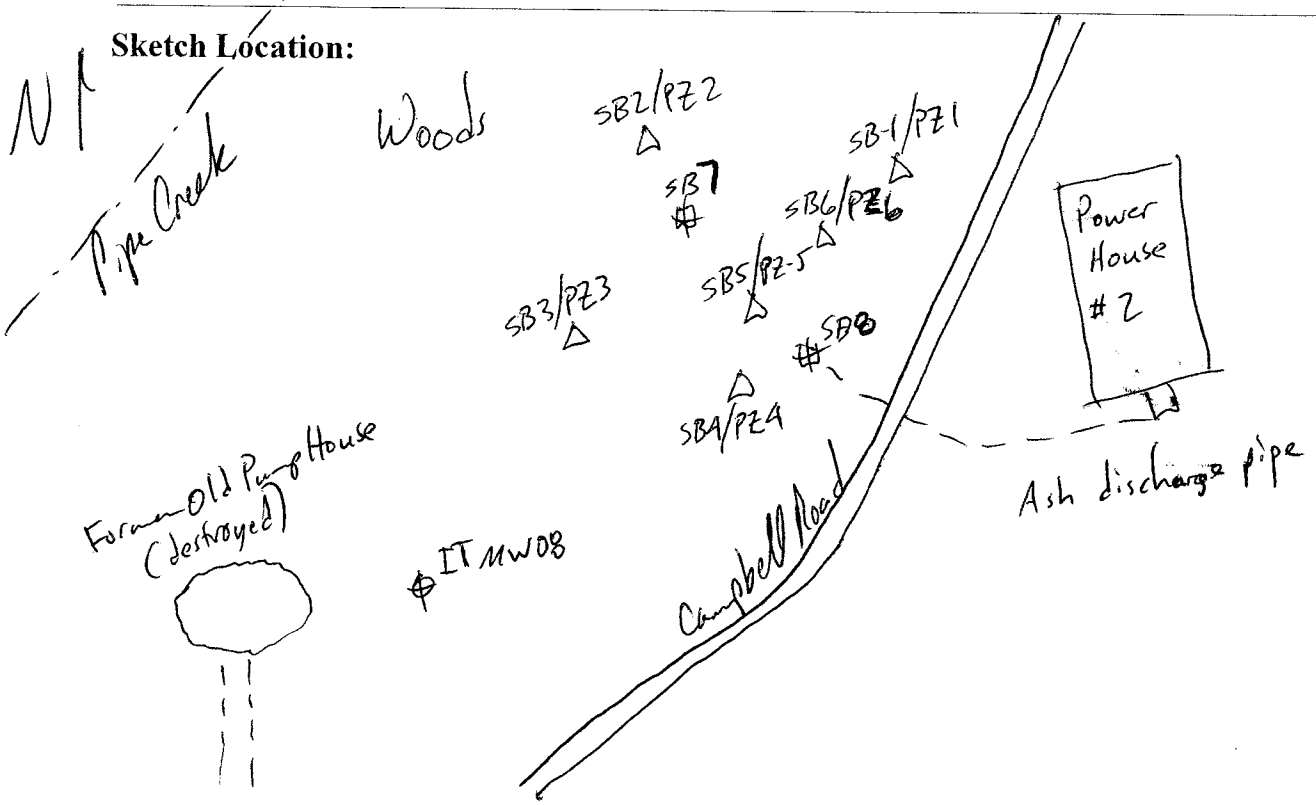
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	4	oz	CWM
METALS	N	A	2	4	oz	CWM
PCBS	N	A	2	4	oz	CWM
SEMIVOLATILES	N	A	2	4	oz	CWM

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. Weaver 1-16-09

Reviewed BY / Date: Edward J. Weaver 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB02**
Sample Number: **AP0107**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB02-AP0107-(8-1(**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-16-09
Collection Time: 1200
Start Depth: 8'
End Depth: 10'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) — (ER) — (FB) —

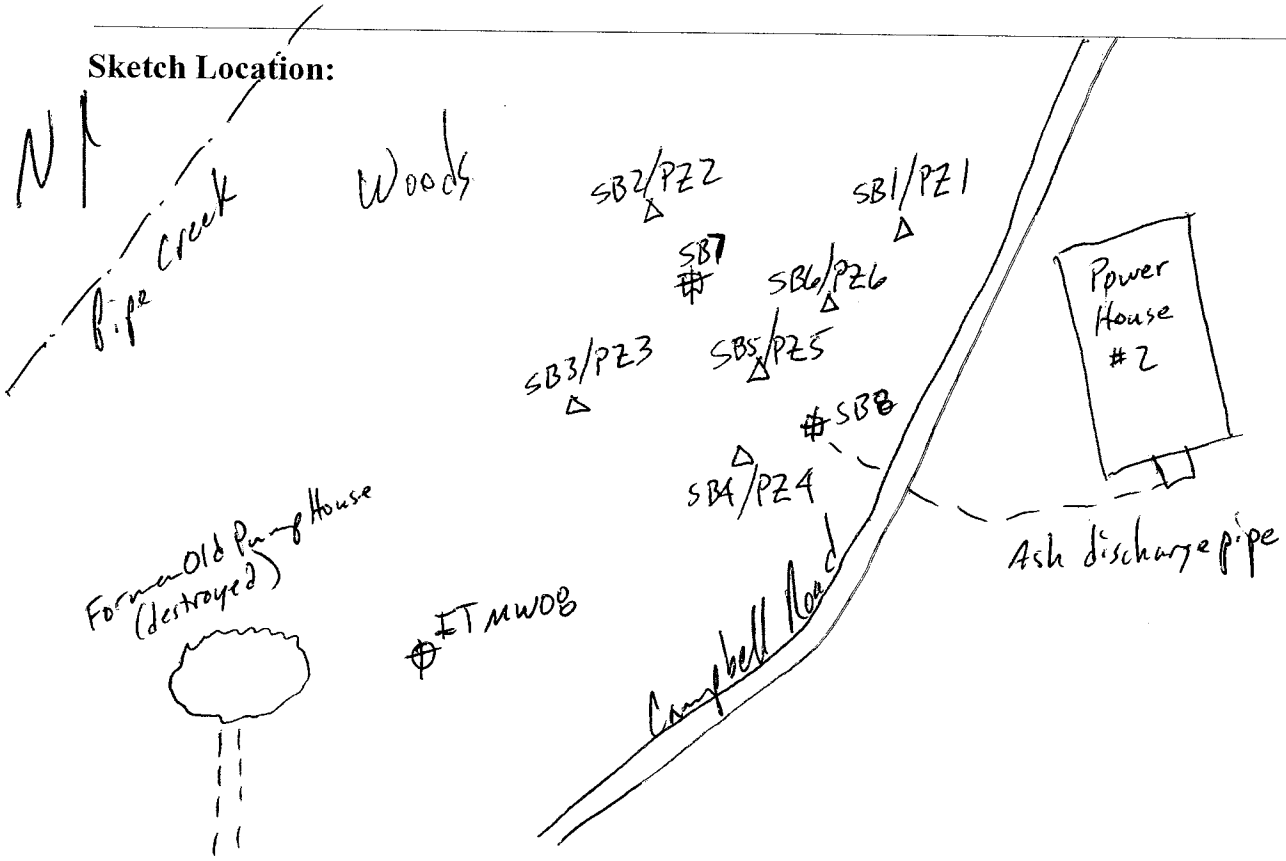
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. Weaver 1-16-09 *Reviewed BY / Date:* Edward K. Weaver 1-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609 AML

Location Code: **ASH PIT 2-SB05**

Sample Number: **AP0114**

Sample Name: **PBOW-09-SS-ASH PIT 2-SB05-AP0114-(0-1)**

Sampling Method: **DP**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggies

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1225

Start Depth: 0

End Depth: 1'

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

QC Partners:

(TB) —— (ER) —— (FB) ——

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

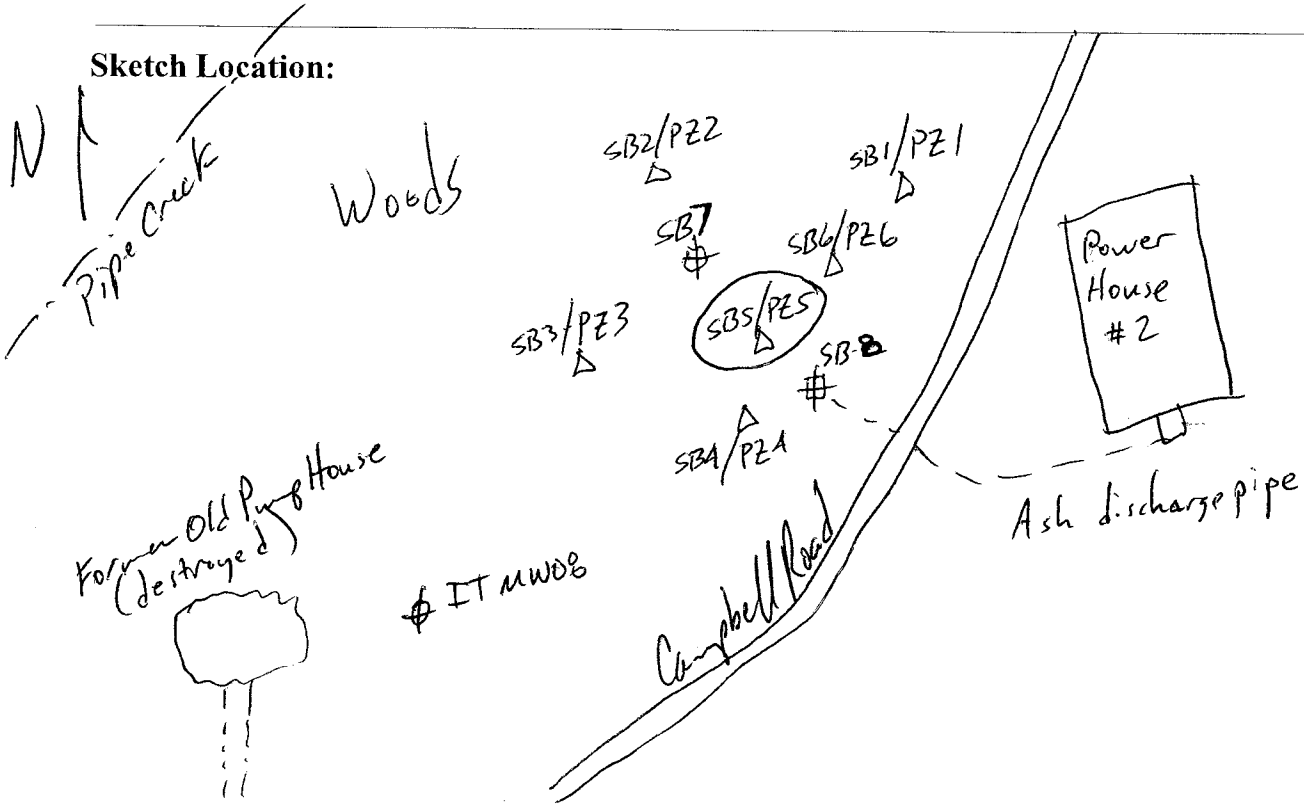
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID 0.0

Sketch Location:



Logged BY / Date: [signature] 1-16-09

Reviewed BY / Date: Edward E. Weaver 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AUL

Location Code: **ASH PIT 2-SB05**

Sample Number: **AP0115**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB05-AP0115-(3-5)**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1227

Start Depth: 3'

End Depth: 3.3'

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

QC Partners:

(TB) — **(ER)** — **(FB)** —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

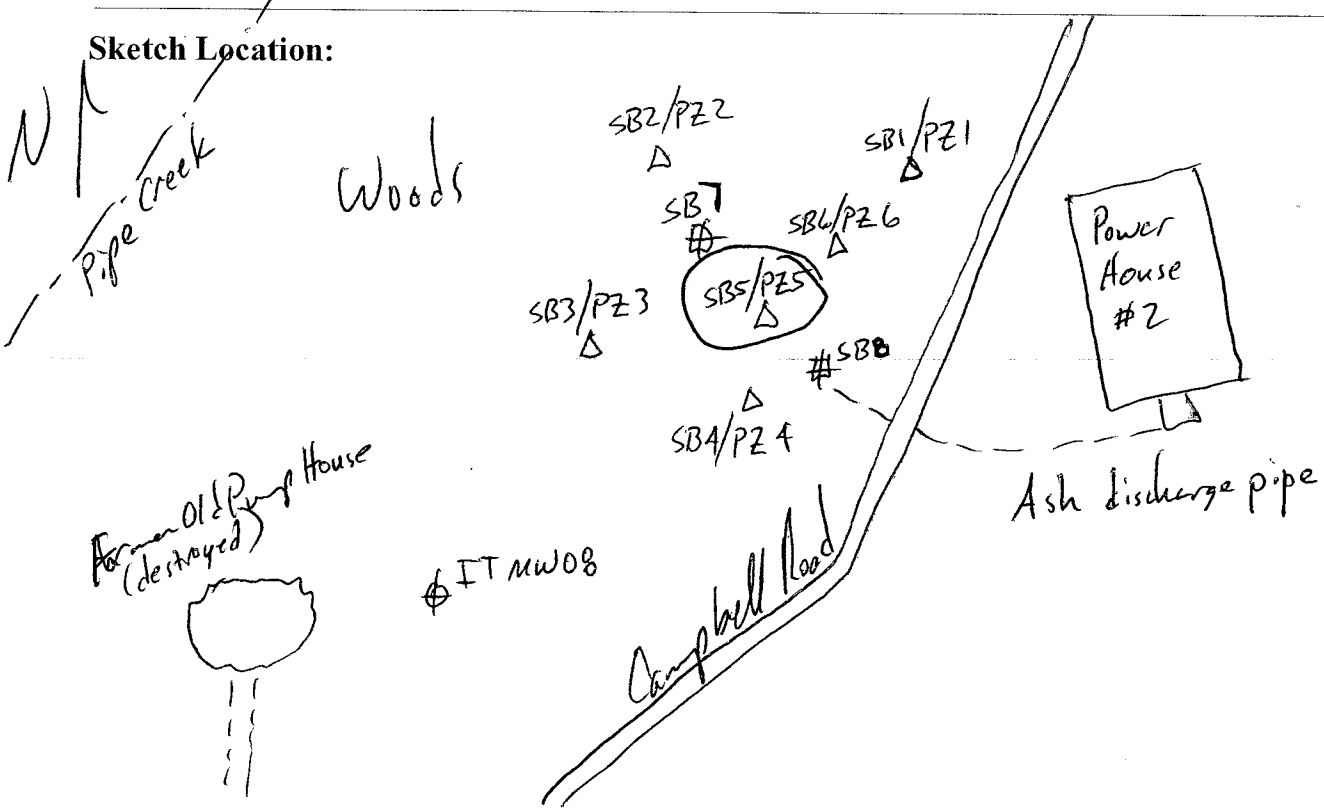
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID - 0.0

Sketch Location:



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Reviewed BY / Date: [signature] 1-16-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB05**
Sample Number: **AP0116**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB05-AP0116-(8-1(**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-16-09
Collection Time: 1235
Start Depth: 7.3'
End Depth: 9.3'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) — (ER) — (FB) —

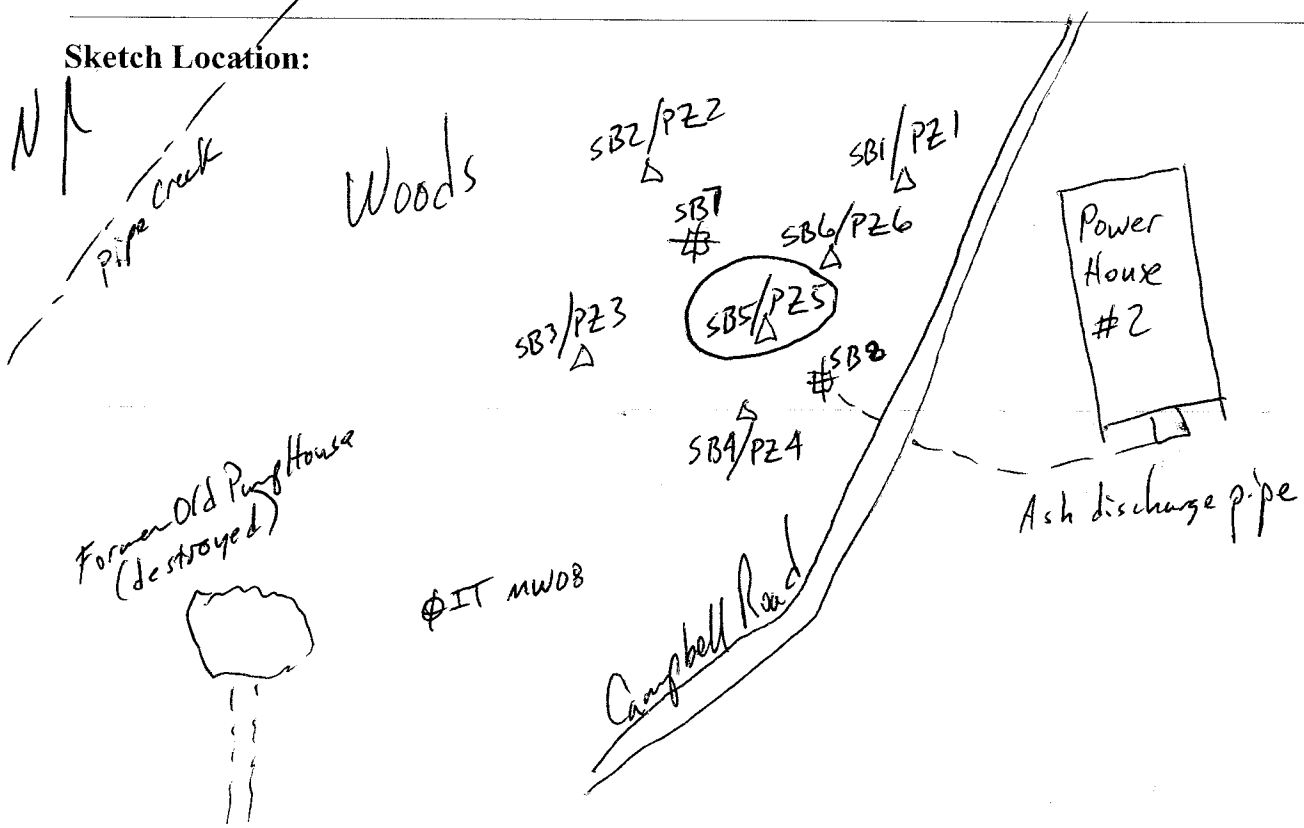
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID - 0.2

Sketch Location:



Logged BY / Date: E. W. Weaver 1-16-09 *Reviewed BY / Date:* Edward G. Weaver 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609 AML

Location Code: **ASH PIT 2-SB08**

Sample Number: **AP0125**

Sample Name: **PBOW-09-SS-ASH PIT 2-SB08-AP0125-(0-1)**

Sampling Method: **DP**

Sample Type: **SS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

QC Partners:

(TB) — **(ER)** — **(FB)** —

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1305

Start Depth: 0

End Depth: 1'

Sample Matrix: **SOIL**

Sample Team: Kessler/Weaver

ERPIMS Values:

Sacode:

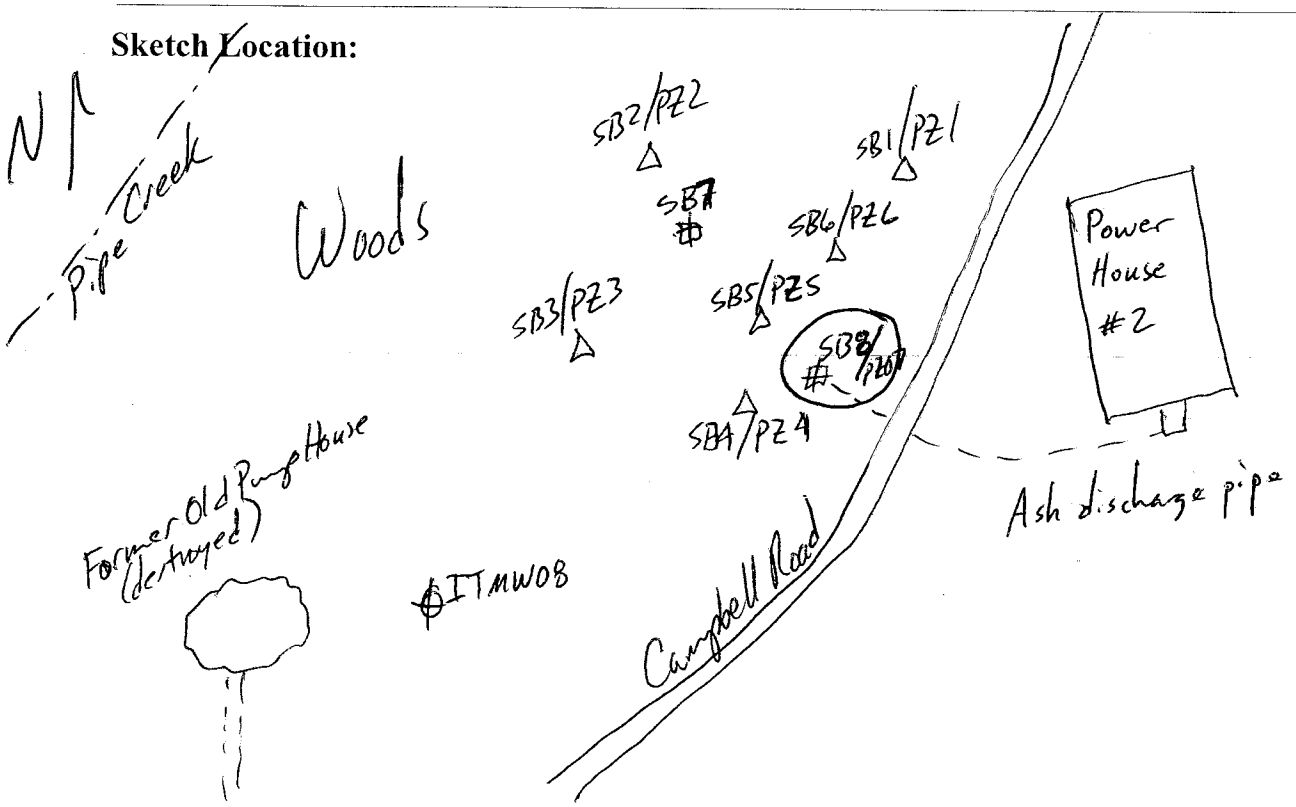
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

Comments: PID 0.3

Sketch Location:



Logged BY / Date: Eric W. Weaver 1-16-09

Reviewed BY / Date: Edward K. Weaver 11-8-10

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB08**
Sample Number: **AP0126**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB08-AP0126-(3-5)**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-16-09
Collection Time: 1307
Start Depth: 3'
End Depth: 3.5'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) — **(ER)** — **(FB)** —

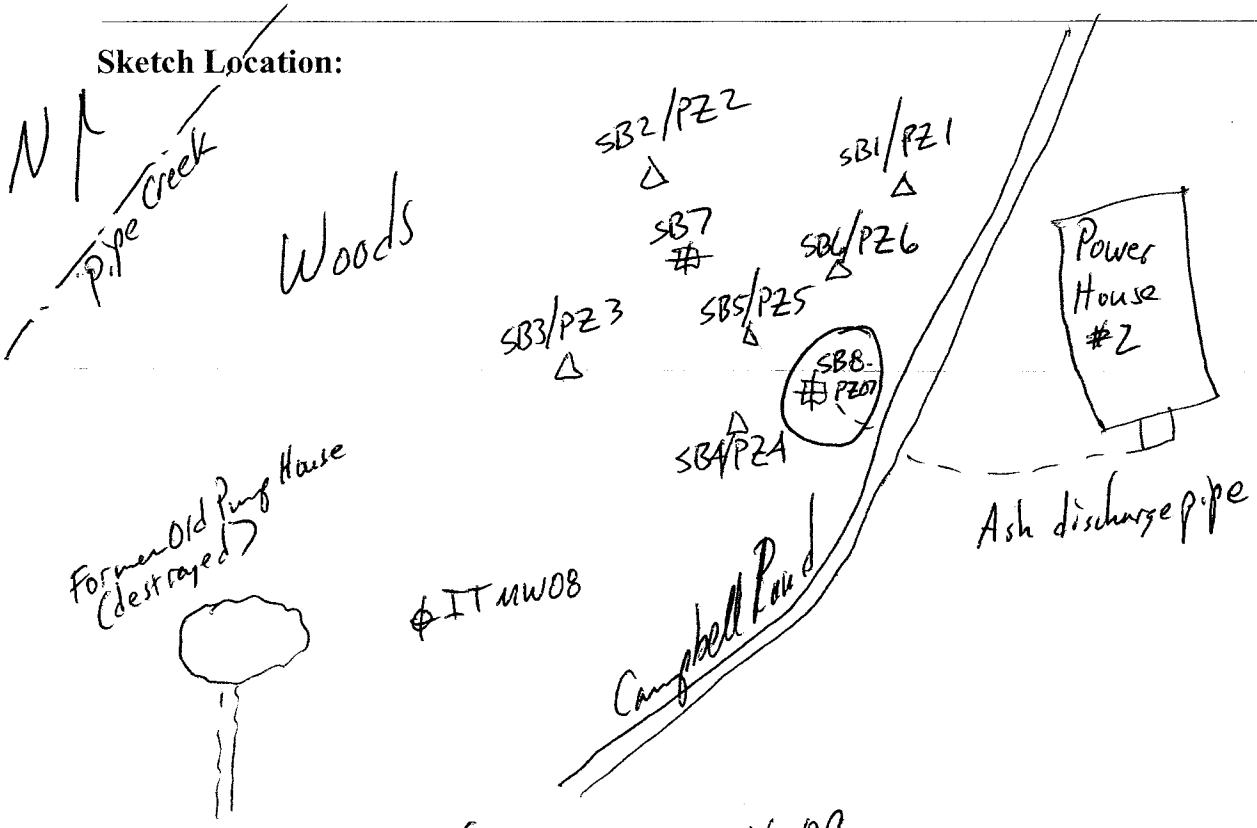
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID 0.0

Sketch Location:



Logged BY / Date: 1-16-09 *Reviewed BY / Date:* 1-8-

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609 AML

Location Code: **ASH PIT 2-SB08**
Sample Number: **AP0127**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB08-AP0127-(8-1(**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate liner disposable/plastic bassie

Task: **ASH PIT2**
Collection Date: 1-16-09
Collection Time: 1320
Start Depth: 8'
End Depth: 8.8'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) — (ER) — (FB) —

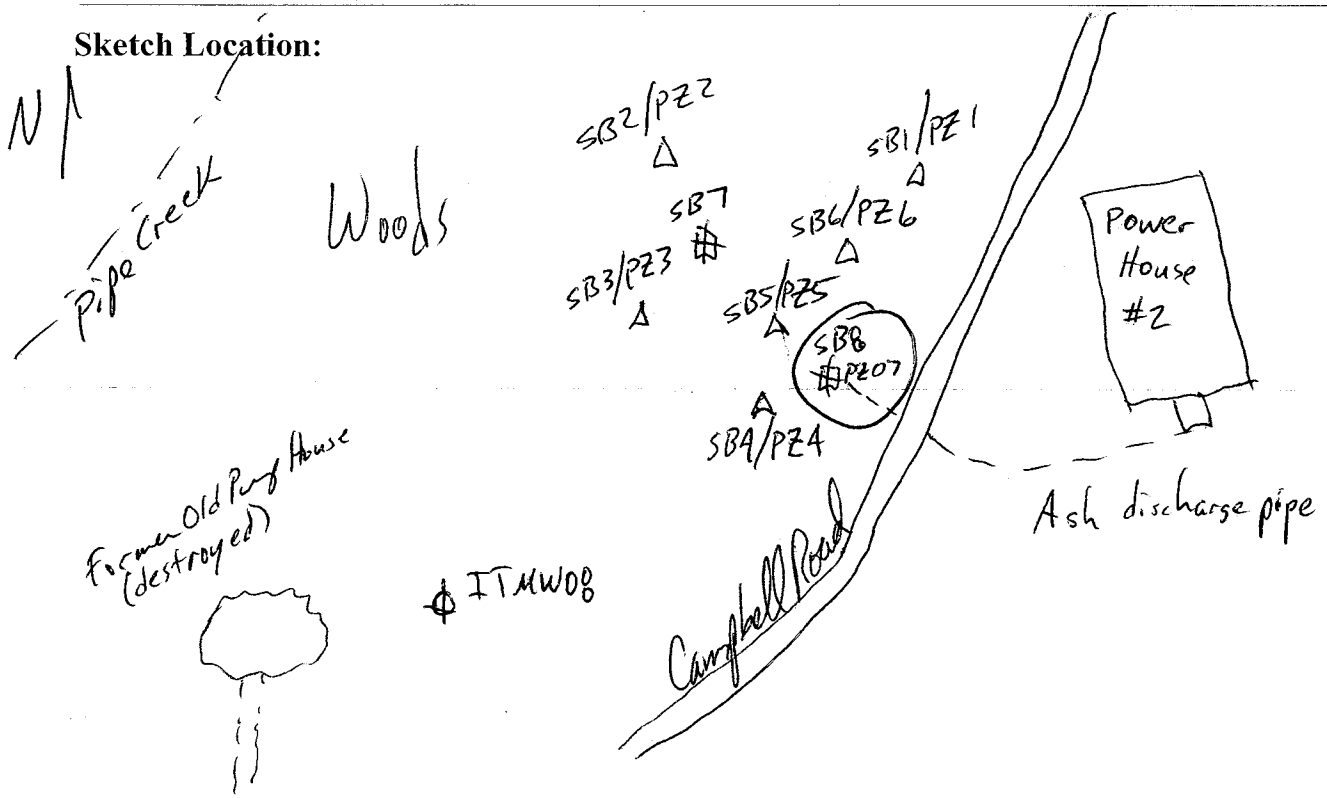
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID 0.0

Sketch Location:



Logged BY / Date: [signature] 1-16-09

Reviewed BY / Date: [signature] 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609AML

Location Code: **ASH PIT 2-SB08**

Sample Number: **AP0128**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB08-AP0128-(8-1(**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **FD**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**

Collection Date: 1-16-09

Collection Time: 1320

Start Depth: 8'

End Depth: 8.0'

Sample Matrix: **SOIL**

Sample Team: Keeler/Weaver

QC Partners:

(TB) —— (ER) —— (FB) ——

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

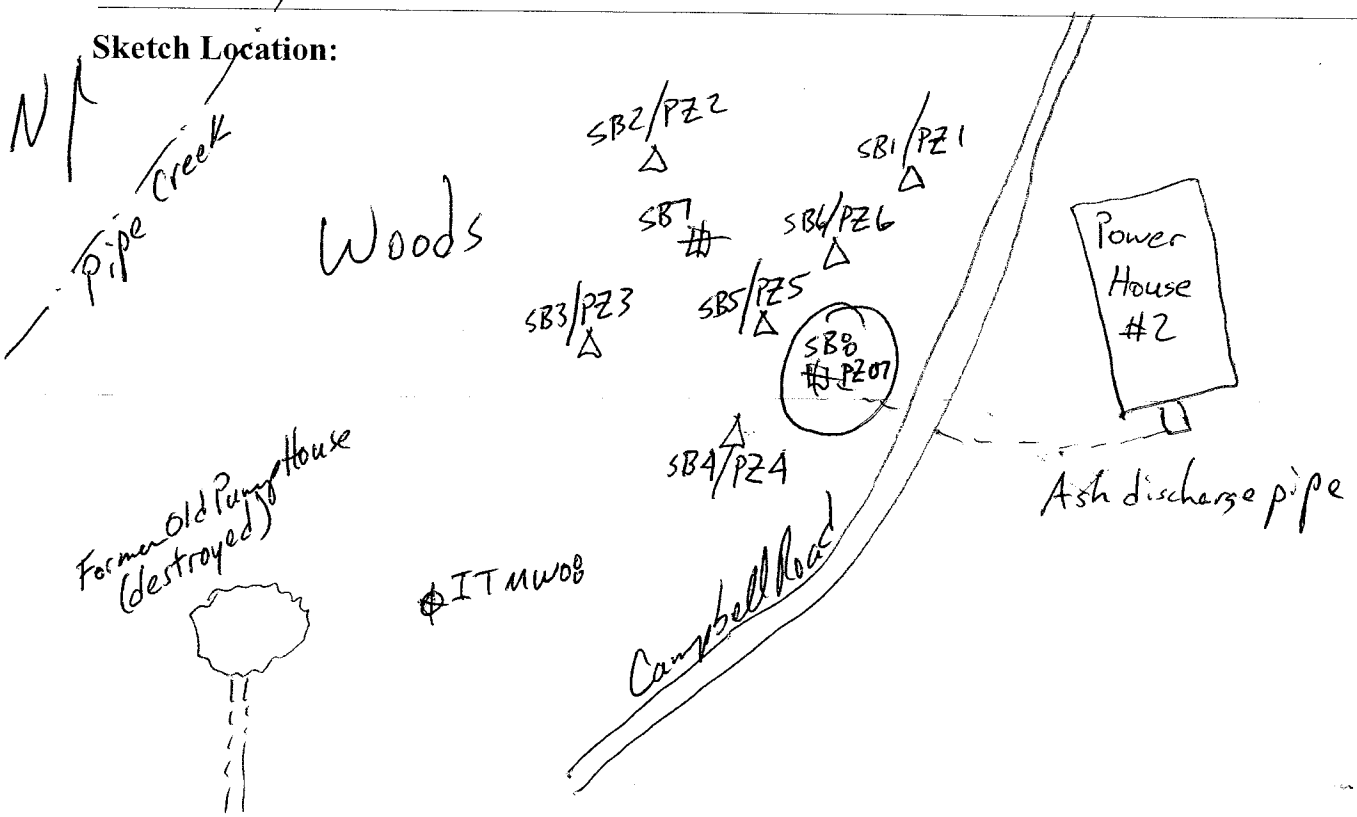
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-16-09

Reviewed BY / Date: Edward A. Weaver 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011609TA

Location Code: **ASH PIT 2-SB08**
Sample Number: **AP0129**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB08-AP0129-(8-1(**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **FS**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-16-09
Collection Time: 1320
Start Depth: 8'
End Depth: 8.8'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) —— (ER) —— (FB) ——

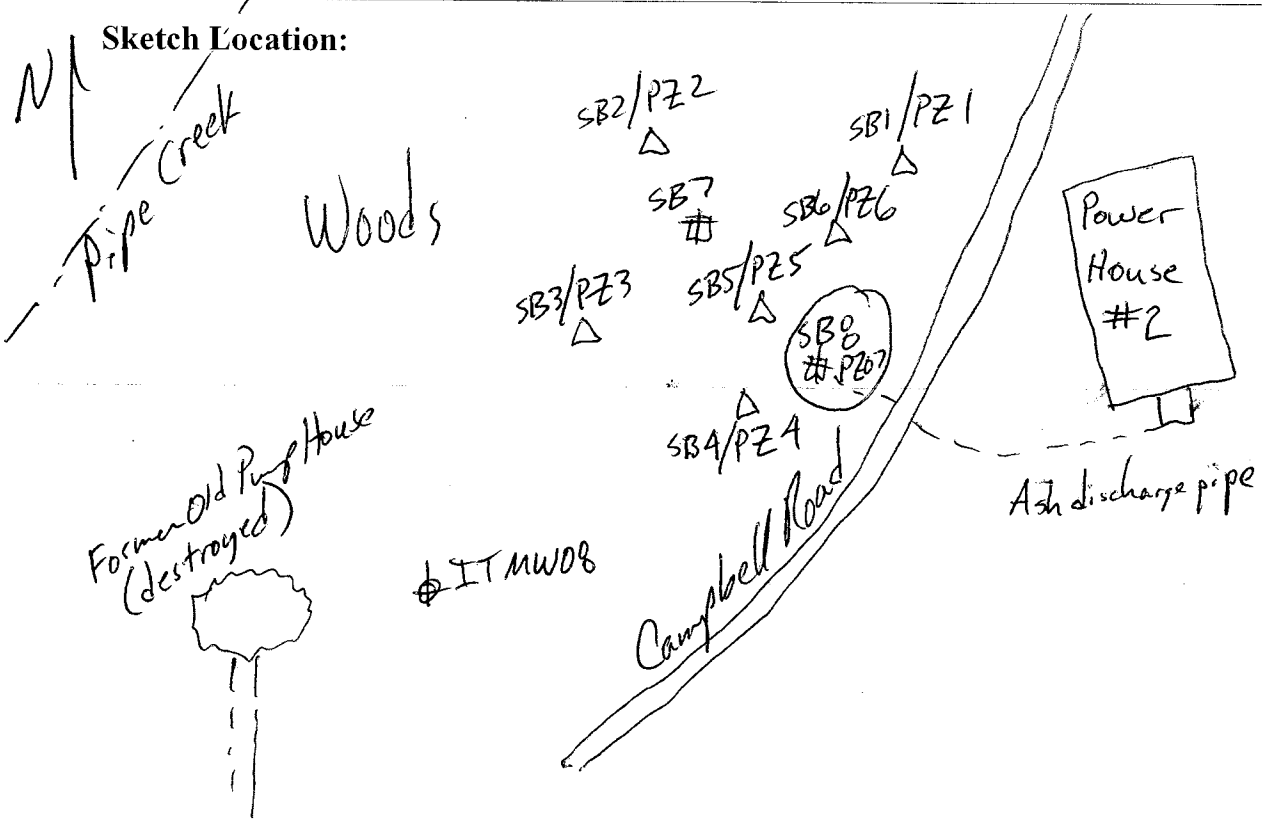
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	4	oz	CWM
METALS	N	A	2	4	oz	CWM
SEMIVOLATILES	N	A	2	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-16-09 *Reviewed BY / Date:* Edward S. Weaver 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011909AML

Location Code: **ASH PIT 2-SB03**
Sample Number: **AP0108**
Sample Name: **PBOW-09-SS-ASH PIT 2-SB03-AP0108-(0-1)**
Sampling Method: **DP**
Sample Type: **SS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-18-09
Collection Time: 0925
Start Depth: 0
End Depth: 1'
Sample Matrix: **SOIL**

QC Partners:
(TB) — (ER) — (FB) —

Sample Team: Keesler/Weaver

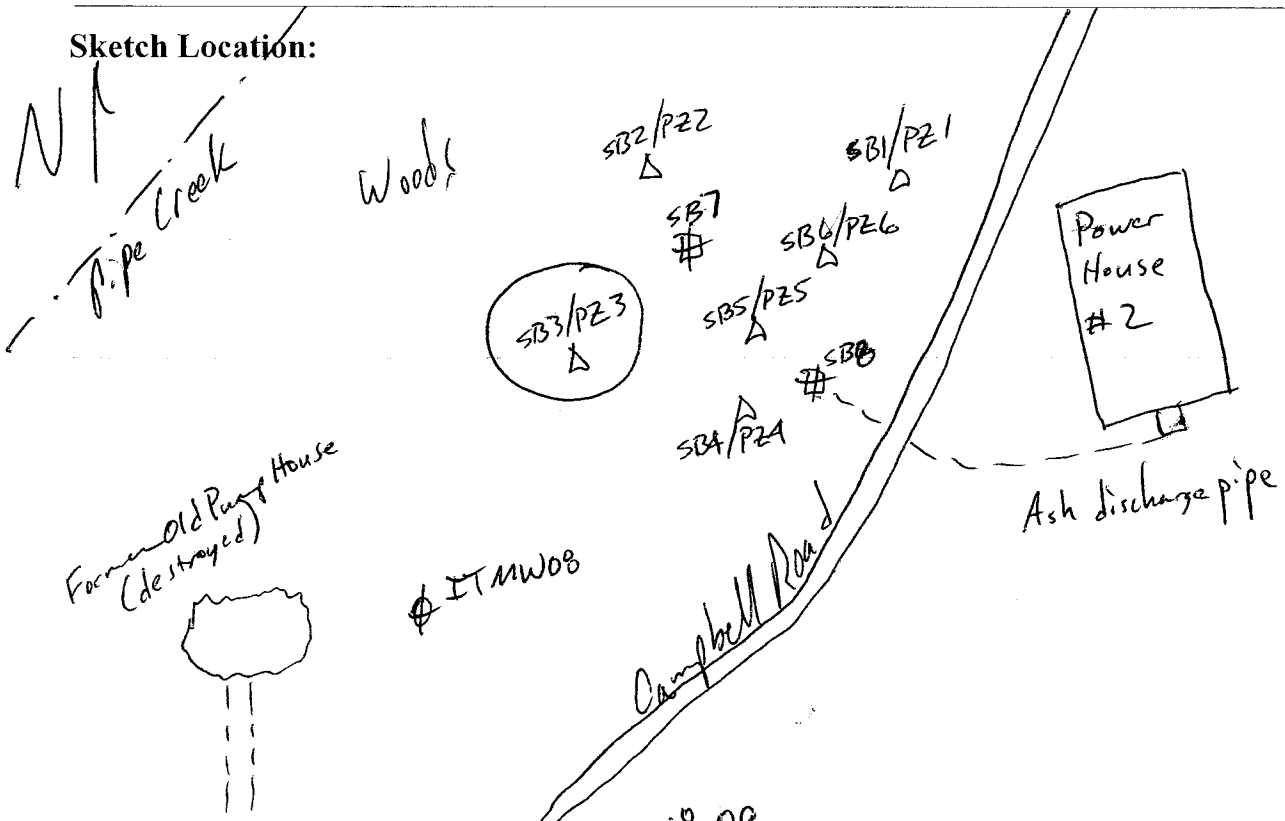
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: 1-18-09

Reviewed BY / Date: 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011909AML

Location Code: **ASH PIT 2-SB03**

Sample Number: **AP0109**

Sample Name: **PBOW-09-DS-ASH PIT 2-SB03-AP0109-(3-5)**

Sampling Method: **DP**

Sample Type: **DS** *Sample Purpose:* **REG**

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**

Collection Date: 1-18-09

Collection Time: ~~930~~ EW 0928

Start Depth: 3'

End Depth: 3.5'

Sample Matrix: **SOIL**

Sample Team: Kessler / Weaver

QC Partners:

(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

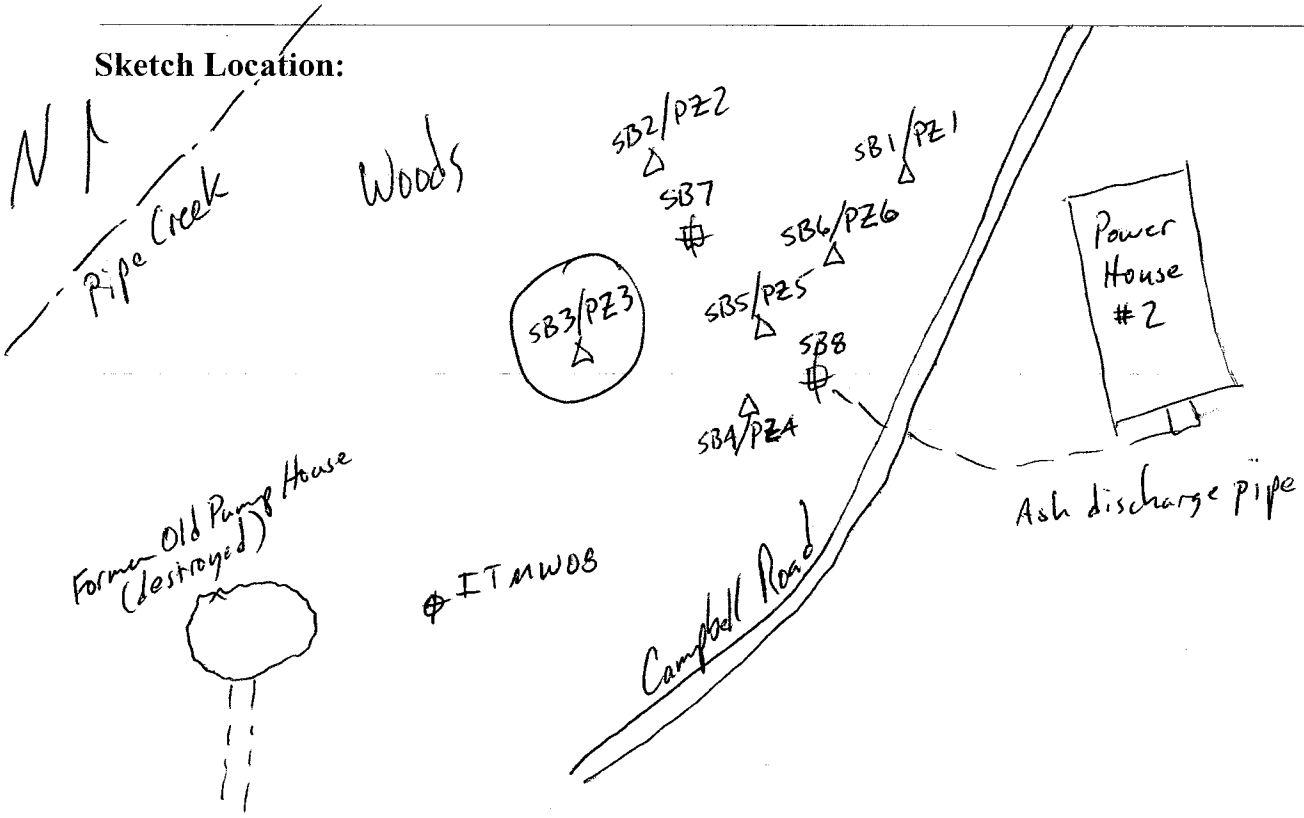
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-18-09

Reviewed BY / Date: Edward E. Weaver 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011909AML

Location Code: **ASH PIT 2-SB03**
Sample Number: **AP0110**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB03-AP0110-(8-1(**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate Liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-18-09
Collection Time: 0930
Start Depth: 8'
End Depth: 10'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) —— (ER) —— (FB) ——

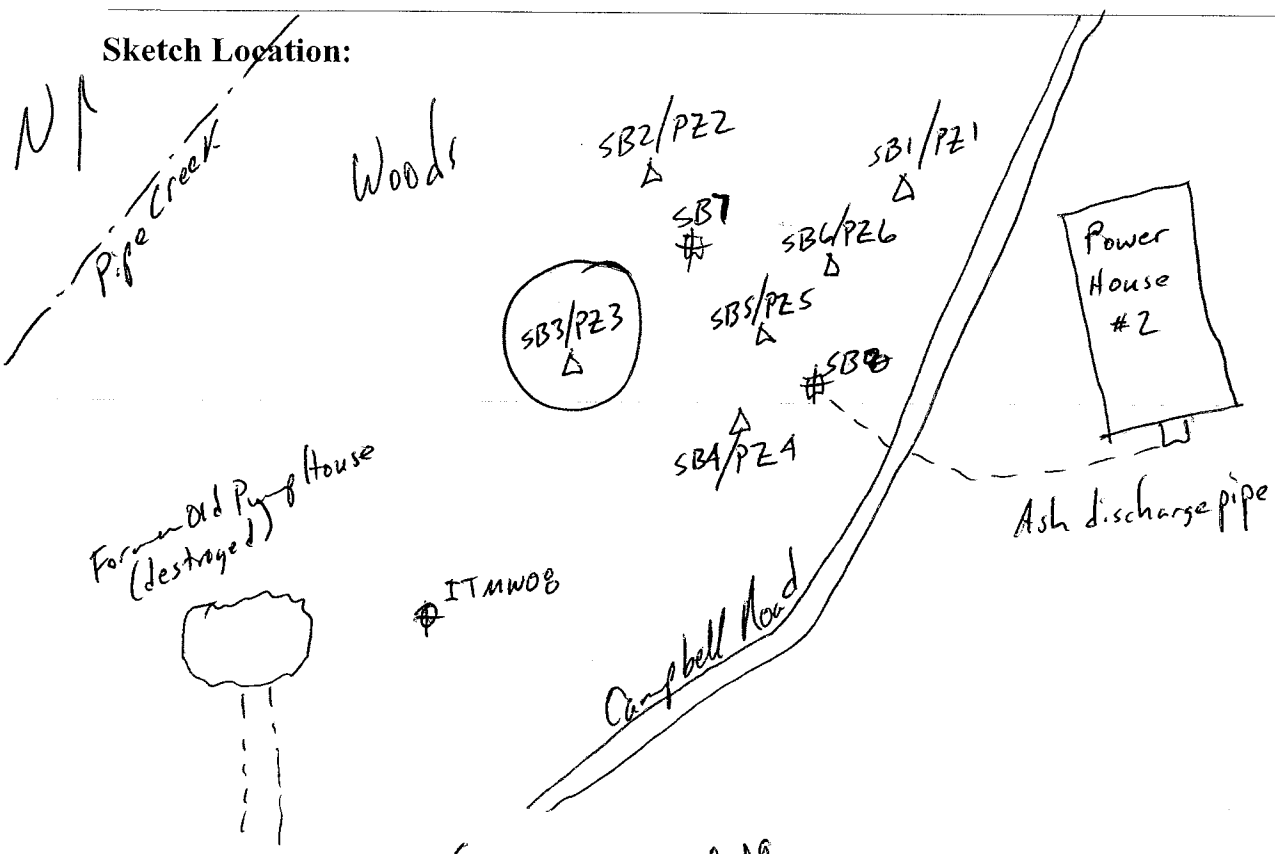
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-18-09

Reviewed BY / Date: Edward K. Weaver 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011909AML

Location Code: **ASH PIT 2-SB04**

Task: **ASH PIT2**

Sample Number: **AP0111**

Collection Date: 1-18-09

Sample Name: **PBOW-09-SS-ASH PIT 2-SB04-AP0111-(0-1)**

Collection Time: 0845

Sampling Method: **DP**

Start Depth: 0

Sample Type: **SS** *Sample Purpose:* **REG**

End Depth: 1'

Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Sample Matrix: **SOIL**

QC Partners:

(TB) — **(ER)** — **(FB)** —

Sample Team: Kessler / Weaver

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

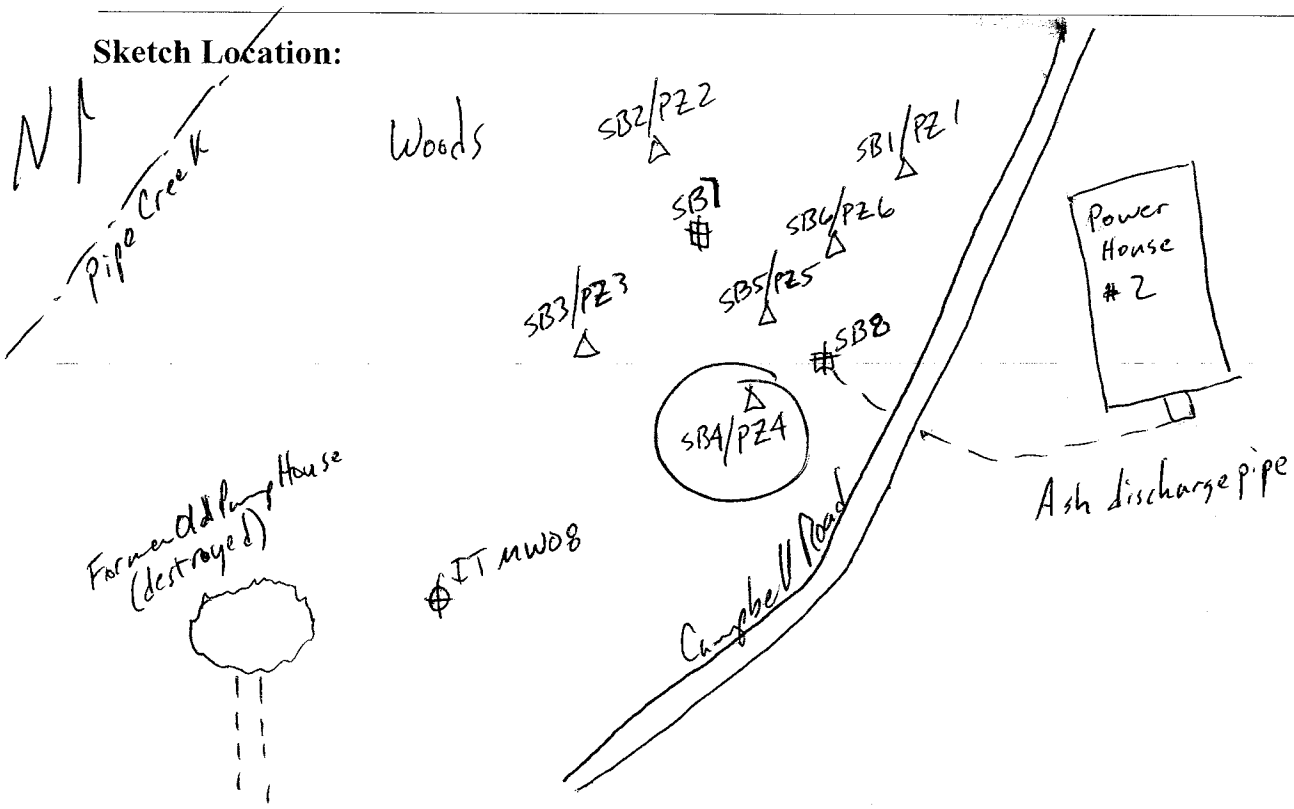
ERPIMS Values:

Sacode:

Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: [signature] 1-18-09

Reviewed BY / Date: [signature] 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB011909 AML

Location Code: **ASH PIT 2-SB04**
Sample Number: **AP0112**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB04-AP0112-(3-5)**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-18-09
Collection Time: 0848
Start Depth: 3'
End Depth: 3.5'
Sample Matrix: **SOIL**
Sample Team: Kessler/Weaver

QC Partners:
(TB) — (ER) — (FB) —

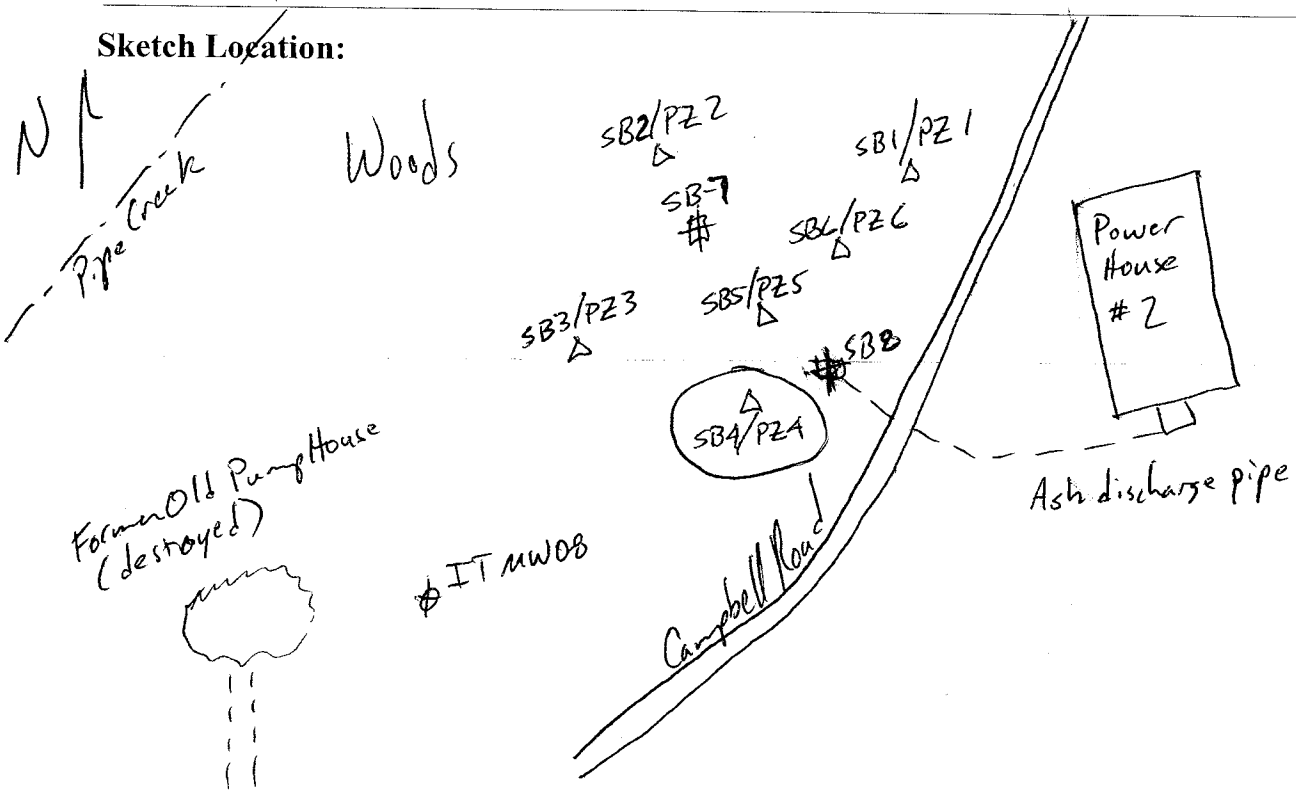
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
PCB3	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID - 0.0

Sketch Location:



Logged BY / Date: E. W. Weaver 1-18-09 *Reviewed BY / Date:* Edward K. Weaver 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB01 1909 AML

Location Code: **ASH PIT 2-SB04**
Sample Number: **AP0113**
Sample Name: **PBOW-09-DS-ASH PIT 2-SB04-AP0113-(8-1(**
Sampling Method: **DP**
Sample Type: **DS** *Sample Purpose:* **REG**
Sampling Equip: Geoprobe, 5' Acetate liner, disposable ziplock baggie

Task: **ASH PIT2**
Collection Date: 1-18-09
Collection Time: 0850
Start Depth: 8'
End Depth: 10'
Sample Matrix: **SOIL**
Sample Team: Kessler / Weaver

QC Partners:
(TB) —— (ER) —— (FB) ——

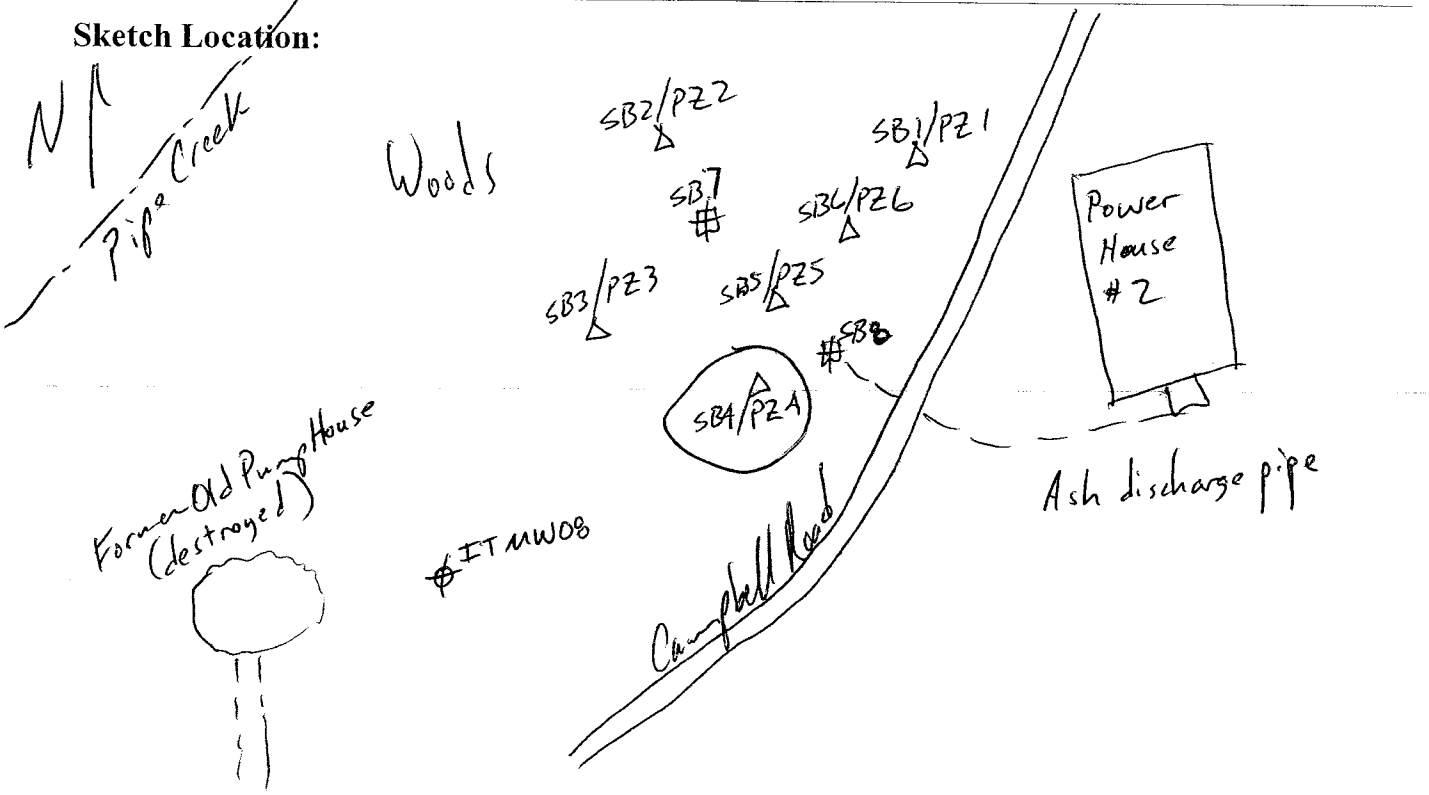
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	8	oz	CWM
METALS	N	A	1	8	oz	CWM
SEMIVOLATILES	N	A	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: PID 0.0

Sketch Location:



Logged BY / Date: Linda W. Weaver 1-18-09 *Reviewed BY / Date:* Edward [illegible] 1-18-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB020209AM2

Location Code: **ASH PIT 2-PZ03**
Sample Number: **AP3018**
Sample Name: **PBOW-09-GW-ASH PIT 2-PZ03-AP3018**
Sampling Method: **SP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Peristaltic pump Teflon lined tubing

Task: **ASH PIT2**
Collection Date: 1-31-09
Collection Time: 1730
Start Depth: 5.39' btoc
End Depth: 5.38' btoc
Sample Matrix: **WATER**
Sample Team: DK/EW/MW

QC Partners:
(TB) — (ER) — (FB) —

Containers

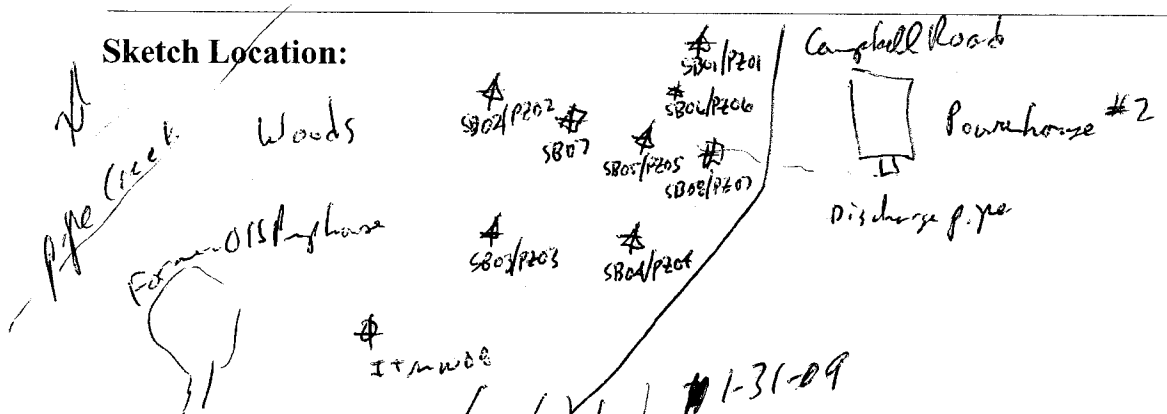
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
ALKALINITY	N	A	1	1	L	HDPE
CHLORIDE	N	A	1	1	L	HDPE
SULFATE	N	A	1	1	L	HDPE
TDS	N	A	1	1	L	HDPE
TSS	N	A	1	1	L	HDPE
TURB 180.1	N	A	1	1	L	HDPE
HARDNESS	N	B	1	500	mL	HDPE
METALS3-W	N	B	1	500	mL	HDPE
METALS3-W-F	Y	C	1	500	mL	HDPE
CYANIDE	N	D	1	500	mL	HDPE
NITRATE	N	E	1	125	mL	HDPE
EXPLOSIVES	N	F	2	1	L	Amb. Glass
SEMIVOLATILES3	N	G	2	1	L	Amb. Glass

ERPIMS Values:
Sacode:
Lot Control#:

Groundwater Information:
Measured Well Depth: 14.15' btoc **Depth To Water:** 5.28' btoc

Comments: NA

Sketch Location:



Logged BY / Date: E. W. Weaver 1-31-09 *Reviewed BY / Date:* Edward E. Nowe 11-8-0

Groundwater Purge Form

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GROUNDWATER PURGE FORM

Sheet 1 of 2

Operable Unit/Site ID: Ash Pit 2
Project Name/#: PBOW
Weather: cloudy ~ 15°F
Purge Equipment: Peristaltic pump, Teflon lined tubing
Sampling Equipment: same

Sampling location ID: Ash Pit 2 - PZ03
Sample ID: AP3018
Collection Time/Date: 1-31-09
Purge Purpose (circle): Sample or Redevelop

Pump Installation

Pump installation crew: DK/EW/MW
PID/FID reading (well head/background): 0
Casing diameter (inches): 1"
Total well Depth (ft. BTOC): 14.15
Initial (pre-installation) DTW/time: 5.27
Final (after pump priming) DTW/time: 5.28
Free product (circle): LNAPL / DNAPL
Depth to free product (ft BTOC): —
Volume of water removed during priming (mL): —
Discharge tube length (ft.): 21

Installation date/beginning time: 1-31-09
Installation date/completion time: 1-31-09
Screen Interval (ft. BTOC): 3.9 to 13.9
Sample Depth/Pump intake depth (ft BTOC): 13.5
Post-installation DTW/time: 5.28
Max. sustainable pump rate (mL/min): —
Appearance of product: —
Discharge tube diameter (3/8" or 1/4"): 1/4" ID
Inlet reducer used (Y/N): N

Pneumatic Controller Tuning: Initial air pressure = H (ft.) X 0.43 = — psi

	Initial	2	3	4	5	6	7	8	Final
Pressure (psi)									
Refill Setting									
Discharge Setting									
Flow rate (mL/min)									

Purging

Purging/sampling crew: DK/EW/MW
Purge date/beginning time: 1-31-09
Initial (pre-purging) DTW (ft. BTOC): 5.27
Calculated tubing + pump volume: 0.21
Unit casing volume: 0.041

PID/FID reading (well head/background): 0
Purge date/completion time: 1-31-09
Final (post-purging) DTW (ft. BTOC): 5.36
Total volume purged: 7.150
Required purge volume: 0.63

Pneumatic Controller Tuning: Initial air pressure = H (ft.) X 0.43 = — psi

	Initial	2	3	4	5	6	7	8	Final
Pressure (psi)									
Refill Setting									
Discharge Setting									
Flow rate (mL/min)									

Water Quality Parameter Measurements

Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (mMhos/cm)	pH	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1635	5.27	—	0	—	—	—	—	—	—
1645	5.31	130	1.300	3.45	2.045	6.52	24.2	2.57	775.2
1650	5.31	130	1.950	3.15	1.854	6.53	23.4	2.37	554.6
1655	5.32	130	2.600	2.58	1.630	6.58	20.9	2.38	365.2
1700	5.33	130	3.250	2.29	1.502	6.64	19.2	2.31	232.0
1705	5.33	130	3.900	2.05	1.409	6.67	17.2	2.24	199.3
1710	5.33	130	4.550	1.77	1.338	6.70	16.4	2.19	157.4
1715	5.34	130	5.200	1.72	1.323	6.70	15.3	2.15	118.1

Groundwater Purge Form

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GROUNDWATER PURGE FORM

Sheet 2 of 2

Water Quality Parameter Measurements (continued)

Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (mMhos/cm)	pH	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1720	5.34	130	5.850	1.67	1.289	6.73	14.4	2.11	85.4
1725	5.34	130	6.500	1.51	1.272	6.75	14.6	2.07	54.3
1730	5.34	130	7.150	1.52	1.251	6.73	14.4	2.02	60.1

1/31/09

Sampling

Sampling beginning time: 1730

Sampling completion time: 1825

Water Quality Parameter Measurements

Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (mMhos/cm)	pH	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1730	5.34	130	7.150	1.52	1.251	6.73	14.4	2.02	60.1

Field Screening Parameters (ferrous iron, sulfide, etc.)

	Result	Units
Ferrous Iron	0.0	

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB020209AML

Location Code: **ASH PIT 2-PZ04**

Sample Number: **AP3019**

Sample Name: **PBOW-09-GW-ASH PIT 2-PZ04-AP3019**

Sampling Method: **SP**

Sample Type: **GW** *Sample Purpose:* **REG**

Sampling Equip: Peristaltic pump, Teflon lined tubing

QC Partners:

(TB) — (ER) — (FB) —

Task: **ASH PIT2**

Collection Date: 2-1-09

Collection Time: 1110

Start Depth: 8.33' btoc

End Depth: 8.38' btoc

Sample Matrix: **WATER**

Sample Team: EW/MW

ERPIMS Values:

Sacode:

Lot Control#:

Containers

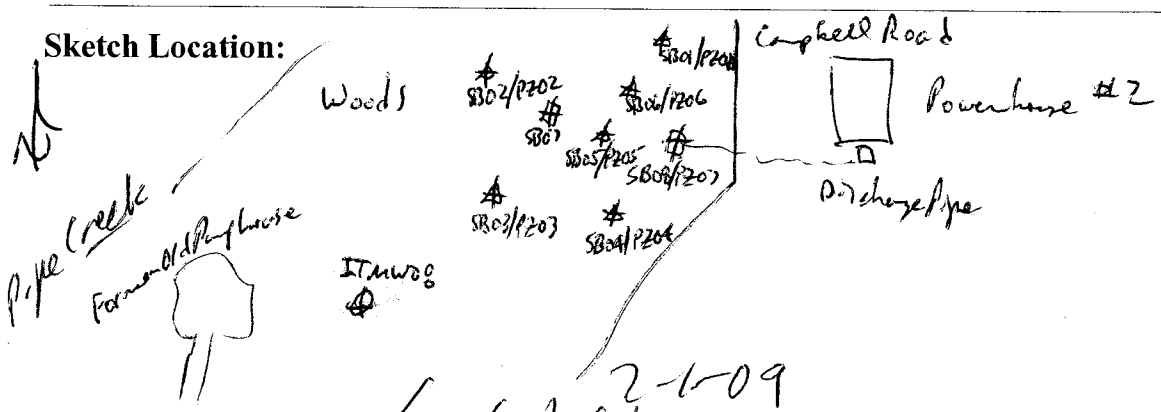
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
ALKALINITY	N	A	1	1	L	HDPE
CHLORIDE	N	A	1	1	L	HDPE
SULFATE	N	A	1	1	L	HDPE
TDS	N	A	1	1	L	HDPE
TSS	N	A	1	1	L	HDPE
TURB 180.1	N	A	1	1	L	HDPE
HARDNESS	N	B	1	500	mL	HDPE
METALS3-W	N	B	1	500	mL	HDPE
METALS3-W-F	Y	C	1	500	mL	HDPE
CYANIDE	N	D	1	500	mL	HDPE
NITRATE	N	E	1	125	mL	HDPE
EXPLOSIVES	N	F	2	1	L	Amb. Glass
SEMIVOLATILES3	N	G	2	1	L	Amb. Glass

Groundwater Information:

Measured Well Depth: 15.25' btoc **Depth To Water:** 7.72' btoc

Comments: Collected MS + MSD at this location

Sketch Location:



Logged BY / Date: E. W. Wilson 2-1-09 *Reviewed BY / Date:* Edward [illegible] 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB020209AML

Location Code: ASH PIT 2-PZ0~~6~~4 OW

Sample Number: AP30~~21MS~~19MS

Sample Name: PBOW-09-GW-ASH PIT 2-PZ06-AP3021MS

Sampling Method: SP

Sample Type: GW *Sample Purpose:* MS

Sampling Equip: Peristaltic pump, Teflon lined tubing

QC Partners:

(TB) — (ER) — (FB) —

Task: ASH PIT2

Collection Date: 2-1-09

Collection Time: 1110

Start Depth: 8.33' btoc

End Depth: 8.38' btoc

Sample Matrix: WATER

Sample Team: EW/MW

ERPIMS Values:

Sacode:

Lot Control#:

Containers

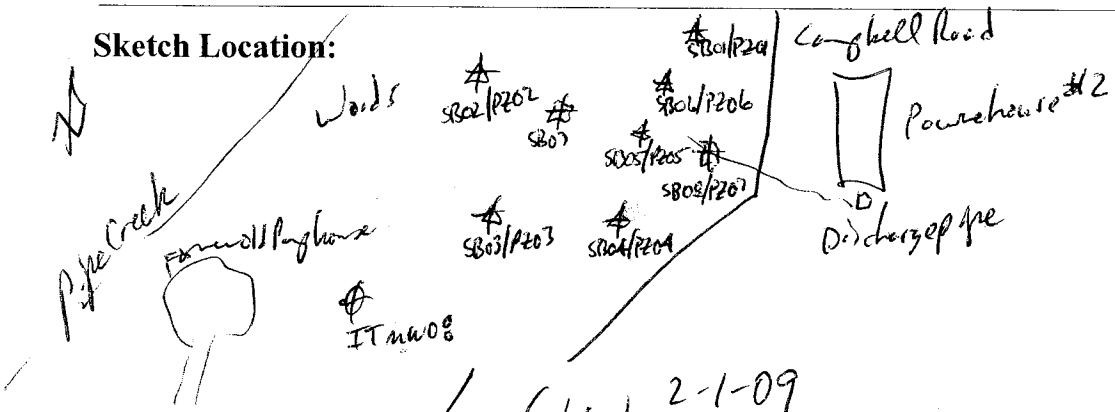
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
ALKALINITY	N	A	1	1	L	HDPE
CHLORIDE	N	A	1	1	L	HDPE
SULFATE	N	A	1	1	L	HDPE
TDS	N	A	1	1	L	HDPE
TSS	N	A	1	1	L	HDPE
TURB 180.1	N	A	1	1	L	HDPE
HARDNESS	N	B	1	500	mL	HDPE
METALS3-W	N	B	1	500	mL	HDPE
METALS3-W-F	N	C	1	500	mL	HDPE
CYANIDE	N	D	1	500	mL	HDPE
NITRATE-W	N	D	1	125	mL	HDPE
EXPLOSIVES	N	F	2	1	L	Amb. Glass
SEMIVOLATILES	N	G	2	1	L	Amb. Glass

Groundwater Information:

Measured Well Depth: 15.25' btoc **Depth To Water:** 7.72' btoc

Comments: Also collected MSD + Regular sample at this location

Sketch Location:



Logged BY / Date: E. W. Weaver 2-1-09

Reviewed BY / Date: Edward M. Weaver 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB020209AML

Location Code: ASH PIT 2-PZ0~~6~~4

Sample Number: AP30~~2~~19MSD

Sample Name: PBOW-09-GW-ASH PIT 2-PZ06-AP3021MSI

Sampling Method: SP

Sample Type: GW *Sample Purpose:* MSD

Sampling Equip: Peristaltic pump, Teflon lined tubing

QC Partners:

(TB) — (ER) — (FB) —

Task: ASH PIT2

Collection Date: 2-1-09

Collection Time: 1110

Start Depth: 8.33' btoc

End Depth: 8.38' btoc

Sample Matrix: WATER

Sample Team: EW/MW

ERPIMS Values:

Sacode:

Lot Control#:

Containers

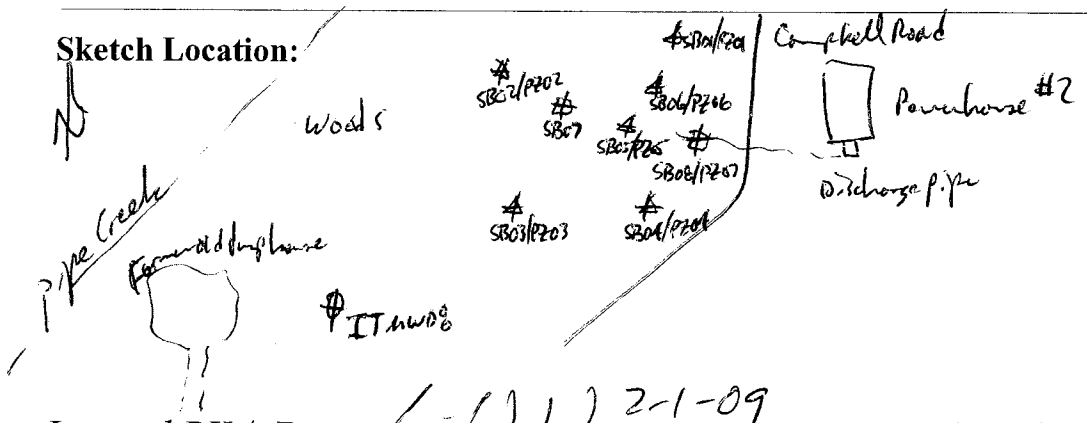
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
ALKALINITY	N	A	1	1	L	HDPE
CHLORIDE	N	A	1	1	L	HDPE
SULFATE	N	A	1	1	L	HDPE
TDS	N	A	1	1	L	HDPE
TSS	N	A	1	1	L	HDPE
TURB 180.1	N	A	1	1	L	HDPE
HARDNESS	N	B	1	500	mL	HDPE
METALS-W	N	B	1	500	mL	HDPE
NITRATE-W	N	B	1	125	mL	HDPE
METALS3-W-F	N	C	1	500	mL	HDPE
CYANIDE	N	D	1	500	mL	HDPE
EXPLOSIVES	N	F	2	1	L	Amb. Glass
SEMIVOLATILES	N	H	2	1	L	Amb. Glass

Groundwater Information:

Measured Well Depth: 15.25' btoc **Depth To Water:** 7.72' btoc

Comments: Also collected regular sample + MS at this location

Sketch Location:



Logged BY / Date: E. W. Weaver 2-1-09 *Reviewed BY / Date:* Edward [illegible] 11-8-09

GROUNDWATER PURGE FORM

Sheet 1 of 2

Sampling location ID: Ash Pit #2
Project Name/#: PBOW
Weather: clear Sunny ≈35°F
Purge Equipment: Peristaltic Pump, Teflon lined tubing, Some

Sampling location ID: Ash Pit 2 – PZ04
Sample ID: AP3019
Collection Time/Date: 2-1-09
Purge Purpose (circle): Sample or Redevelop

Pump Installation

Pump installation crew: EW/MW
PID/FID reading (well head/background): 0
Casing diameter (inches): 1"
Total well Depth (ft. BTOC): 15.25
Initial (pre-installation) DTW/time: 7.75 / 0954
Final (after pump priming) DTW/time: 7.72 / 0959
Free product (circle): LNAPL / DNAPL
Depth to free product (ft BTOC): —
Volume of water removed during priming (mL): —
Discharge tube length (ft.): 23'

Installation date/beginning time: 02-01-09
Installation date/completion time: 02-01-09
Screen Interval (ft. BTOC): 1.65 to 16.65
Sample Depth/Pump intake depth (ft BTOC): 14'
Post-installation DTW/time: 7.72 / 0959
Max. sustainable pump rate (mL/min): —
Appearance of product: —
Discharge tube diameter (3/8" or 1/4"): 1/4" ID
Inlet reducer used (Y/N): N

Pneumatic Controller Tuning: Initial air pressure = H (ft.) X 0.43 = — psi

	Initial	2	3	4	5	6	7	8	Final
Pressure (psi)									
Refill Setting									
Discharge Setting									
Flow rate (mL/min)									

Purging

Purging/sampling crew: EW/MW
Purge date/beginning time: 02-01
Initial (pre-purging) DTW (ft. BTOC): 7.72
Calculated tubing + pump volume: 0.23
Unit casing volume: 0.041

PID/FID reading (well head/background): 0
Purge date/completion time: 02-01-09
Final (post-purging) DTW (ft. BTOC): 8.41
Total volume purged: 7.730 Liters
Required purge volume: 0.69

Pneumatic Controller Tuning: Initial air pressure = H (ft.) X 0.43 = — psi

	Initial	2	3	4	5	6	7	8	Final
Pressure (psi)									
Refill Setting									
Discharge Setting									
Flow rate (mL/min)									

Water Quality Parameter Measurements

Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (mMhos/cm)	pH	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1007	7.72	—	0	—	—	—	—	—	—
1020	8.17	110	1430	7.58	1.134	6.42	29.9	2.39	293.1
1025	8.19	110	1980	7.53	1.197	6.47	27.8	1.42	415.8
1030	8.21	130	2.530	7.38	1.075	6.49	26.6	1.24	327.7
1035	8.23	130	3.180	7.29	1.072	6.51	25.8	1.17	348.9
1040	8.25	130	3.830	7.36	1.057	6.54	24.3	1.12	373.9
1045	8.28	130	4.480	7.26	1.001	6.55	24.1	1.11	256.0
1050	8.29	140	5180	7.31	0.981	6.54	24.0	1.10	137.2

Groundwater Purge Form

2 /2

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Water Quality Parameter Measurements (continued)

Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (mMhos/cm)	pH	Eh (mv)	DO (mg/L)	Turbidity (NTU)
~~1100~~	~~8.31~~								
1100	8.31	140	5.880	7.19	0.962	6.55	23.9	1.09	51.5
1105	8.32	145	6.605	7.21	0.961	6.55	23.9	1.10	52.9
1110	8.33	145	7.330	7.31	0.958	6.55	23.7	1.10	26.6

Sampling time: 1110 Sampling completion time: 1335

Water Quality Parameter Measurements

	(ft. BTOC)	(mL/min)	Volume Purged (L)	(degree C)	(mMhos/cm)		(mv)	(mg/L)	(NTU)
1110	8.33	145	7.330	7.31	0.958	6.55	23.7	1.10	26.6

Field Screening Parameters (ferrous iron, sulfide, etc.)

Parameter	Result	Units
Ferrous Iron	0	

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB020209AML

Location Code: **ASH PIT 2-PZ01**
Sample Number: **AP~~3014~~** 3022 EW
Sample Name: **PBOW-09-GW-ASH PIT 2-PZ01-AP3014**
Sampling Method: **SP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Peristaltic Pump, Teflon/Tubing

Task: **ASH PIT2**
Collection Date: 2-2-09
Collection Time: 1030
Start Depth: 7.18' btoc
End Depth: 7.15' btoc
Sample Matrix: **WATER**
Sample Team: EW/MW

QC Partners:
(TB) — (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

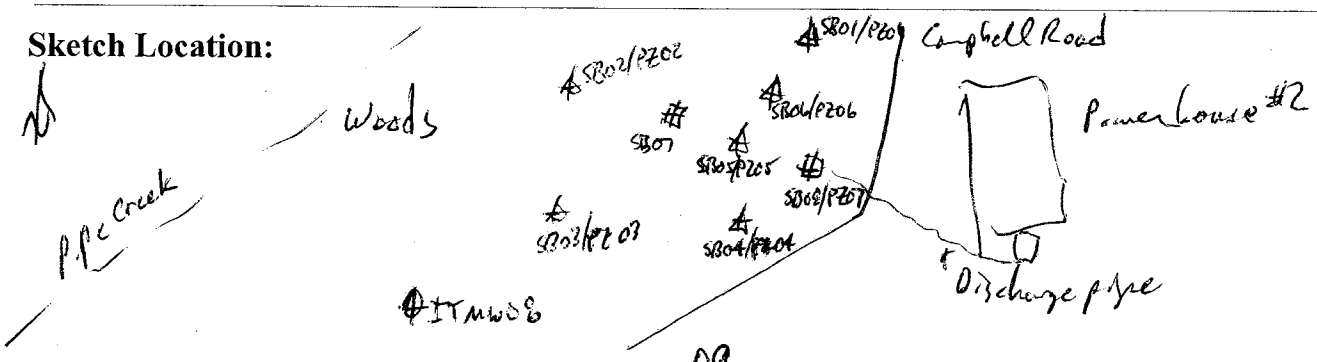
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
ALKALINITY	N	A	1	1	L	HDPE
CHLORIDE	N	A	1	1	L	HDPE
SULFATE	N	A	1	1	L	HDPE
TDS	N	A	1	1	L	HDPE
TSS	N	A	1	1	L	HDPE
TURB 180.1	N	A	1	1	L	HDPE
HARDNESS	N	B	1	500	mL	HDPE
METALS3-W	N	B	1	500	mL	HDPE
METALS3-W-F	Y	C	1	500	mL	HDPE
CYANIDE	N	D	1	500	mL	HDPE
NITRATE	N	E	1	125	mL	HDPE
EXPLOSIVES	N	F	2	1	L	Amb. Glass
SEMIVOLATILES3	N	G	2	1	L	Amb. Glass

Groundwater Information:
Measured Well Depth: 15.14' btoc **Depth To Water:** 7.18' btoc

Comments: Collected FD + FS at this location
~~(AP3015)~~ (AP3016)

Sketch Location:



Logged BY / Date: L. W. Weaver 2-2-09 *Reviewed BY / Date:* Edward [illegible] 11-8-09

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB0208209TA

Location Code: **ASH PIT 2-PZ07**
Sample Number: **AP3016**
Sample Name: **PBOW-09-GW-ASH PIT 2-PZ01-AP3016**
Sampling Method: **SP**
Sample Type: **GW** *Sample Purpose:* **FS**
Sampling Equip: Peristaltic pump, Teflon lined tubing

Task: **ASH PIT2**
Collection Date: 2-2-09
Collection Time: 1030
Start Depth: 7.18 ' btoc
End Depth: 7.15' btoc
Sample Matrix: **WATER**
Sample Team: EW/MW

QC Partners:
(TB) — **(ER)** — **(FB)** —

ERPIMS Values:
Sacode:
Lot Control#:

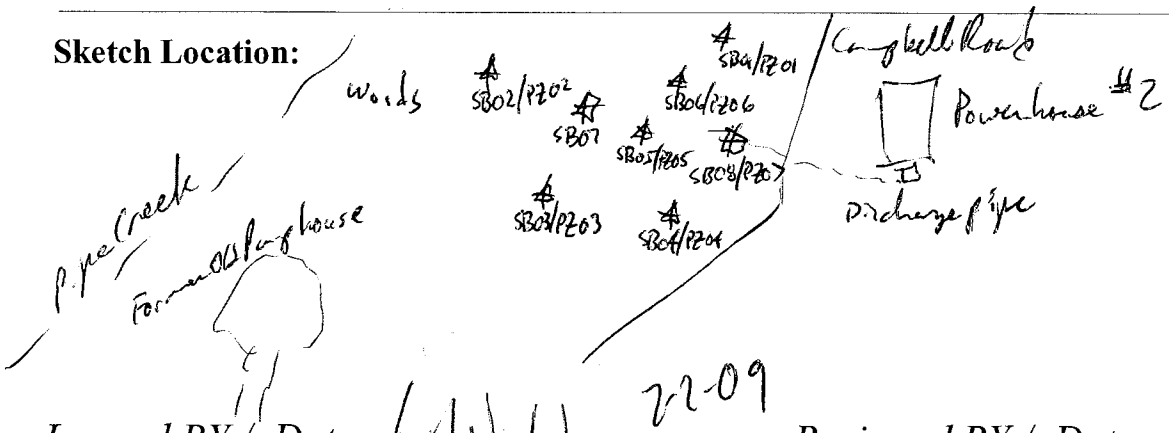
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
ALKALINITY	N	A	1	1	L	HDPE
CHLORIDE	N	A	1	1	L	HDPE
NITRATE-W	N	A	1	1	L	HDPE
SULFATE	N	A	1	1	L	HDPE
TDS	N	A	1	1	L	HDPE
TSS	N	A	1	1	L	HDPE
TURB 180.1	N	A	1	1	L	HDPE
METALS3-W	N	C	1	1	L	HDPE
METALS3-W-F	Y	D	1	1	L	HDPE
CYANIDE	N	E	1	250	mL	HDPE
HARDNESS	N	F	1	250	mL	HDPE
EXPLOSIVES	N	G	2	1	L	Amb. Glass
SEMIVOLATILES	N	H	2	1	L	Amb. Glass

Groundwater Information:
Measured Well Depth: 15.14' btoc **Depth To Water:** 7.18' btoc

Comments: Collected at Ash Pit #2-PZ07. Also collected regular sample (AP3022) + FD. (AP3016)

Sketch Location:



Logged BY / Date: E. W. Weaver 2-2-09 *Reviewed BY / Date:* Edward M. Weaver 11-8-0

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Sample Collection Log

843656 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB020209AML

Location Code: **ASH PIT 2-PZ07**
Sample Number: **AP3015**
Sample Name: **PBOW-09-GW-ASH PIT 2-PZ01-AP3015**
Sampling Method: **SP**
Sample Type: **GW** *Sample Purpose:* **FD**
Sampling Equip: Peristaltic pump, Teflon lined tubing

Task: **ASH PIT2**
Collection Date: 2-2-09
Collection Time: 1030
Start Depth: 7.18' btoc
End Depth: 7.15' btoc
Sample Matrix: **WATER**
Sample Team: EW/MW

QC Partners:
(TB) — (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

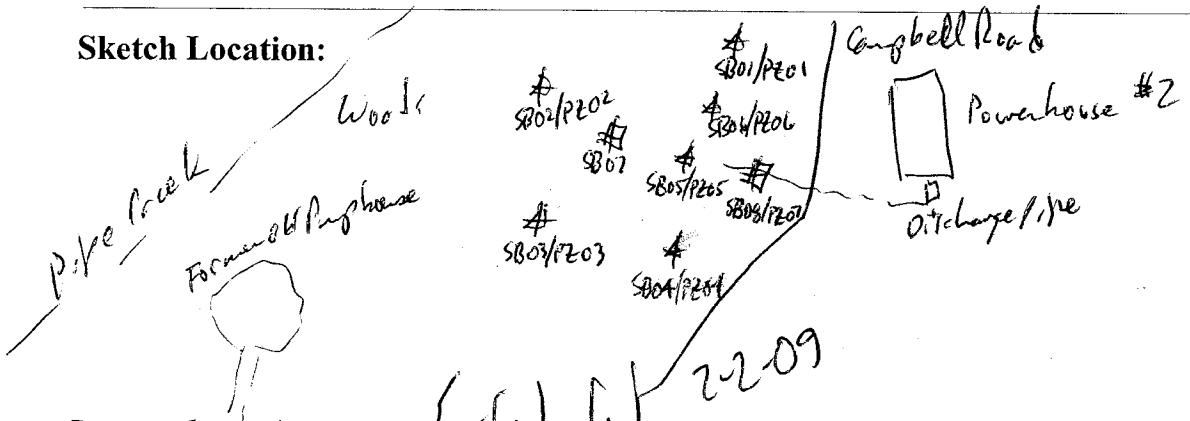
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
ALKALINITY	N	A	1	1	L	HDPE
CHLORIDE	N	A	1	1	L	HDPE
SULFATE	N	A	1	1	L	HDPE
TDS	N	A	1	1	L	HDPE
TSS	N	A	1	1	L	HDPE
TURB 180.1	N	A	1	1	L	HDPE
HARDNESS	N	B	1	500	mL	HDPE
METALS3-W	N	B	1	500	mL	HDPE
METALS3-W-F	Y	C	1	500	mL	HDPE
CYANIDE	N	D	1	500	mL	HDPE
NITRATE-W	N	E	1	125	mL	HDPE
EXPLOSIVES	N	F	2	1	L	Amb. Glass
SEMIVOLATILES	N	G	2	1	L	Amb. Glass

Groundwater Information:
Measured Well Depth: 15.14' btoc **Depth To Water:** 7.18' btoc

Comments: Collected at Ash Pit #2 PZ07. Also collected regular sample (AP3022) + FS. (AP3016)

Sketch Location:



Logged BY / Date: 2-2-09 *Reviewed BY / Date:* 11-8-09

Groundwater Purge Form

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GROUNDWATER PURGE FORM

Sheet 1 of 2

Operable Unit/Site ID: Ash Pit #2
Project Name/#: PBOW
Weather: cloudy but clearing, ~25°F.
Purge Equipment: Peristaltic Pump, Teflon lined tubing
Sampling Equipment: same

Sampling location ID: Ash Pit #2 - PZ07
Sample ID: AP3022
Collection Time/Date: 2-2-09
Purge Purpose (circle): Sample or Redevelop

Pump Installation

Pump installation crew: EW/MW
PID/FID reading (well head/background): 0
Casing diameter (inches): 1"
Total well Depth (ft. BTOC): 15.14
Initial (pre-installation) DTW/time: 6.48 / 900
Final (after pump priming) DTW/time: 6.49 / 905
Free product (circle): LNAPL / DNAPL
Depth to free product (ft BTOC): —
Volume of water removed during priming (mL): —
Discharge tube length (ft.): 22

Installation date/beginning time: 2-2-09 / 903
Installation date/completion time: 2-2-09 / 904
Screen Interval (ft. BTOC): 2-60 to 12.60
Sample Depth/Pump intake depth (ft BTOC): 13.5'
Post-installation DTW/time: 2-2-09 7.15 / 1215
Max. sustainable pump rate (mL/min): —
Appearance of product: —
Discharge tube diameter (3/8" or 1/4"): 1/4" ID
Inlet reducer used (Y/N): N

Pneumatic Controller Tuning: Initial air pressure = H (ft.) X 0.43 = — psi

	Initial	2	3	4	5	6	7	8	Final
Pressure (psi)									
Refill Setting									
Discharge Setting									
Flow rate (mL/min)									

Purging

Purging/sampling crew: EW/MW
Purge date/beginning time: 2-2-09 /
Initial (pre-purging) DTW (ft. BTOC): 6.49
Calculated tubing + pump volume: 0.22 L
Unit casing volume: 0.041

PID/FID reading (well head/background): 0
Purge date/completion time: 2-2-09 /
Final (post-purging) DTW (ft. BTOC): 7.15 / 1215
Total volume purged: 3.5 gallons
Required purge volume: 0.66 L

Pneumatic Controller Tuning: Initial air pressure = H (ft.) X 0.43 = — psi

	Initial	2	3	4	5	6
Pressure (psi)						
Refill Setting						
Discharge Setting						

Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (mMhos/cm)	pH	Eh (mv)	DO (mg/L)	Turbidity (NTU)
0907	6.49	210	0	—	—	—	—	—	—
0915	7.21	210	1.680	4.88	1.192	6.48	21.5	2.19	327.2
0920	7.16	175	2.555	4.84	1.001	6.48	22.0	1.04	172.3
0925	7.13	160	3.355	5.06	0.911	6.49	21.6	0.83	82.1
0930	7.13	160	4.155	5.06	0.892	6.50	21.0	0.65	50.9
0935	7.13	160	4.955	4.99	0.869	6.51	21.5	0.57	33.2
0940	7.14	170	5.805	5.16	0.851	6.52	20.8	0.62	20.9
0945	7.27	170	6.655	5.32	0.872	6.53	19.9	0.59	281.0

water suddenly turned very brown (turbid) for no apparent reason

bailing with bottom flow bailer and allowed turbidity to settle

Groundwater Purge Form

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GROUNDWATER PURGE FORM

Sheet 2 of 2

Water Quality Parameter Measurements (continued)

Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume Purged (L)	Temp. (degree C)	Conductivity (mMhos/cm)	pH	Eh (mv)	DO (mg/L)	Turbidity (NTU)
0950	7.18	170	7.505	5.53	0.894	6.55	19.1	0.53	750.2
0955	7.12	180	8.405	5.54	0.840	6.55	18.9	0.47	859.5
1000	7.11	180	9.305	5.48	0.815	6.54	19.1	0.40	499.3
1005	7.15	180	10.205	5.81	0.793	6.54	19.4	0.44	87.3
1010	7.19	180	11.105	5.91	0.787	6.54	19.6	0.52	138.1
1015	7.22	180	12.005	5.88	0.782	6.53	19.9	0.53	72.6
1020	7.22	180	12.905	6.04	0.785	6.54	19.8	0.47	69.6
1025	7.25	190	13.855	5.80	0.781	6.53	20.2	0.50	61.8
1030	7.18	190	14.805	6.19	0.778	6.53	20.4	0.50	28.2

start sampling ~~0950~~ 1030 1215

Time	DTW (ft. BTOC)	Purge Rate (mL/min)	Cumulative Volume	Temp. (degree C)	Conductivity (mMhos/cm)	pH	Eh (mv)	DO (mg/L)	Turbidity (NTU)
1030	7.18	190	14.805	6.19	0.778	6.53	20.4	0.50	28.2

Field Screening Parameters (ferrous iron, sulfide, etc.)

	Result	Units
Ferrous Iron	0	

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-ACCT

Location Code: **AP2-SW01**
Sample Number: **AP2000**
Sample Name: **PBOW-09-SW-AP2-SW01-AP2000-REG**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **REG**
Sampling Equip: Submerged sample bottles

Task: **AP2-SW**
Collection Date: 5/24/09
Collection Time: 1025
Start Depth: 0.0 ft
End Depth: 0.3 ft
Sample Matrix: **WATER**
Sample Team: DK/BT

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
HARDNESS	N	B	1	500	mL	HDPE
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

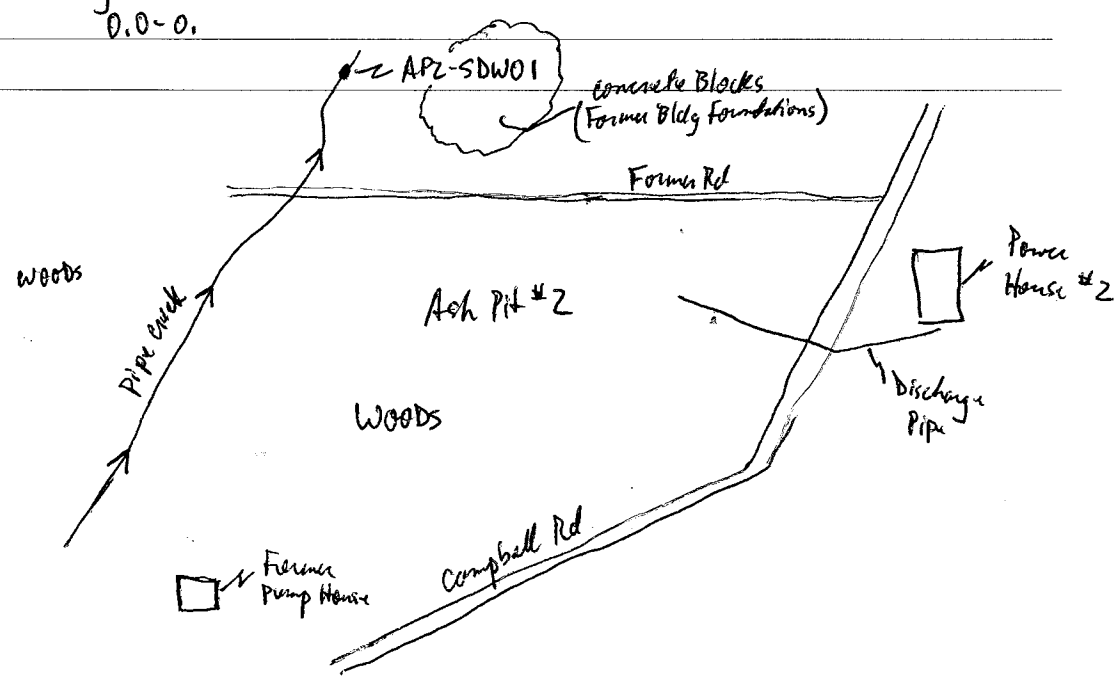
ERPIMS Values:
Sacode:
Lot Control#:

Surface Water Parameters:	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
	163.5	7.28	0.924	12.9	7.55	17.45

Comments: Water Flowing in Pipe Creek
0.0-0.

Sketch Location:

N↑



Logged BY / Date: David Kesh 5/24/09 *Reviewed BY / Date:* Edward [illegible] 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB 052609-ACCT

Location Code: **AP2-SW02**
Sample Number: **AP2001**
Sample Name: **PBOW-09-SW-AP2-SW02-AP2001-REG**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **REG**
Sampling Equip: Submerged sample bottle

Task: **AP2-SW**
Collection Date: 5-24-09
Collection Time: 1350
Start Depth: 0.0'
End Depth: 0.3'
Sample Matrix: **WATER**
Sample Team: DK/BT

QC Partners:
(TB) — (ER) — (FB) —

Containers

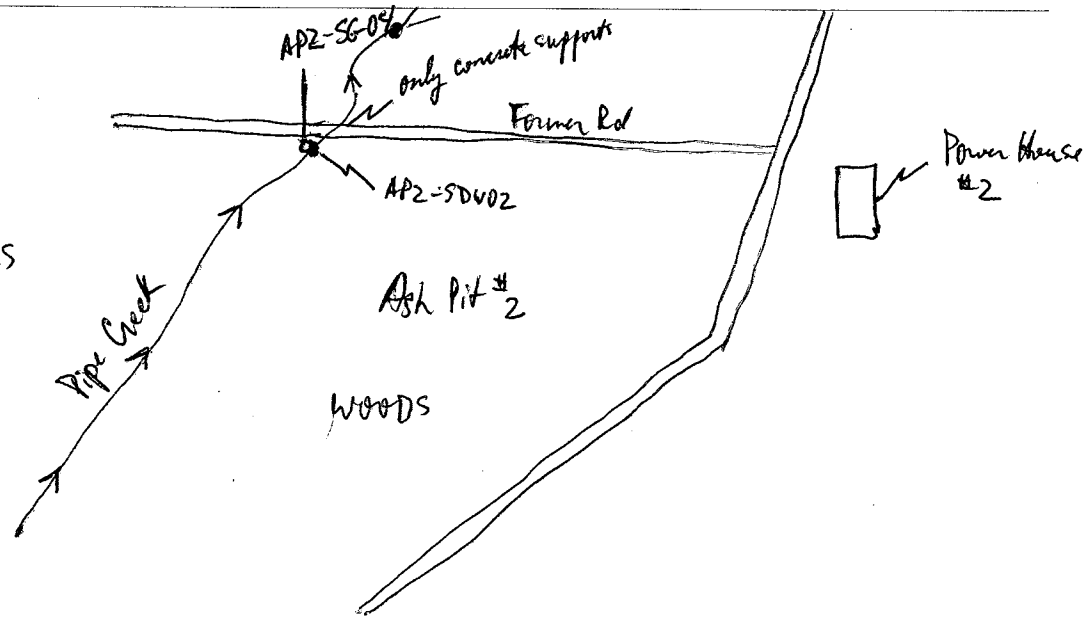
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

ERPIMS Values:
Sacode:
Lot Control#:

Surface Water Parameters:	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
	124.3	7.42	0.912	12.5	7.81	18.94

Comments: NA

Sketch Location:



Logged BY / Date: David Kesh 5/24/09 *Reviewed BY / Date:* Edward E. Wasson 11-8-0

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB 052609-ACCT

Location Code: **AP2-SW03**
Sample Number: **AP2002**
Sample Name: **PBOW-09-SW-AP2-SW03-AP2002-REG**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **REG**
Sampling Equip: Submerged sample Bottles

QC Partners:
(TB) — (ER) — (FB) —

Task: **AP2-SW**
Collection Date: 5/24/09
Collection Time: 1505
Start Depth: 0.0'
End Depth: 0.3'
Sample Matrix: **WATER**
Sample Team: DKBT

ERPIMS Values:
Sacode:
Lot Control#:

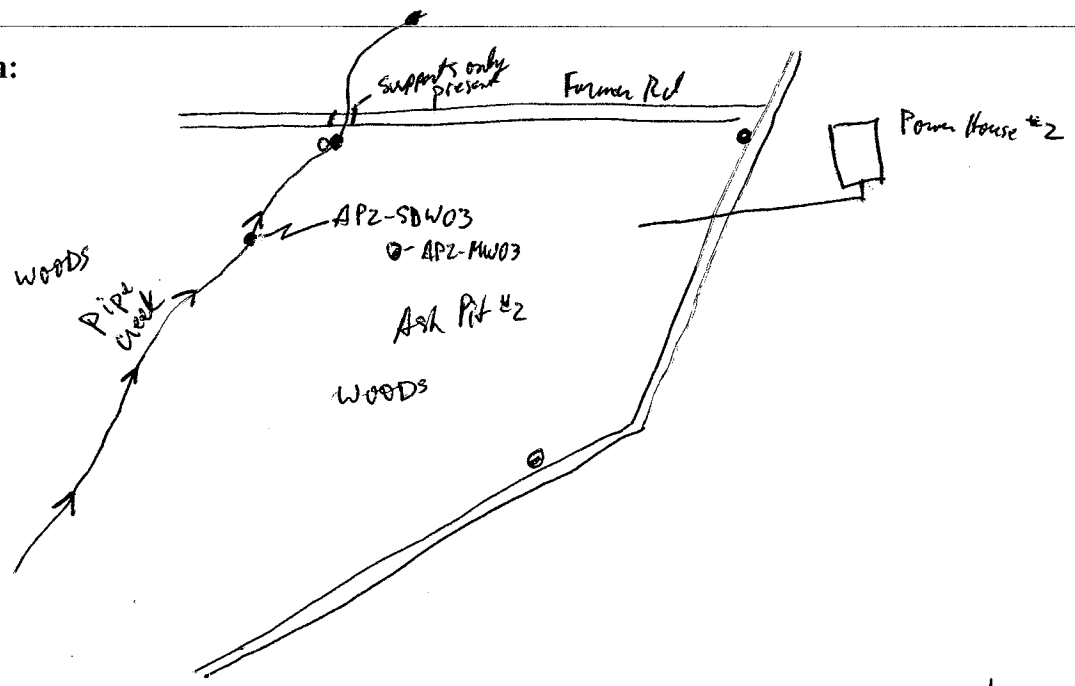
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

Surface Water Parameters:	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
	113.8	7.60	0.908	17.7	7.94	19.16

Comments: Preserved metals bottles filled only by nitro bottle.

Sketch Location:



Logged BY / Date: David Keach 5/24/09 *Reviewed BY / Date:* Edward L. Mann 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-ACCT

Location Code: **AP2-SW03**
Sample Number: **AP2003**
Sample Name: **PBOW-09-SW-AP2-SW03-AP2003-REG**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **FD**
Sampling Equip: Submerged Sample Bottles

Task: **AP2-SW**
Collection Date: 5/24/09
Collection Time: 1505
Start Depth: 0.0'
End Depth: 0.3'
Sample Matrix: **WATER**
Sample Team: DIE/BT

QC Partners:
(TB) — (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

Surface Water Parameters:	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
	113.8	7.60	0.908	17.4	7.94	19.16

Comments: NA

Sketch Location:

See SW SCL AP2002 for sketch

Logged BY / Date: David Kresh 5/24/09 *Reviewed BY / Date:* Edward Kwan 11-6-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-TA

Location Code: **AP2-SW03**
Sample Number: **AP2004**
Sample Name: **PBOW-09-SW-AP2-SW03-AP2004-REG**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **FS**
Sampling Equip: Submerged Sample Bottle

Task: **AP2-SW**
Collection Date: 5-24-09
Collection Time: 1505
Start Depth: 0.0'
End Depth: 0.3'
Sample Matrix: **WATER**
Sample Team: DK/BT

QC Partners:
(TB) — (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

Surface Water Parameters:	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
	113.8	7.60	0.908	17.7	7.94	19.16

Comments: NA

Sketch Location:

See SW SCL AP2002 for sketch

Logged BY / Date: David Kressler 5/24/09 *Reviewed BY / Date:* Edward [illegible] 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-ACCT

Location Code: **AP2-SW04**
Sample Number: **AP2005**
Sample Name: **PBOW-09-SW-AP2-SW04-AP2005-REG**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **REG**
Sampling Equip: Submerged Sample bottle

Task: **AP2-SW**
Collection Date: 5-25-09
Collection Time: 0825
Start Depth: 0.0'
End Depth: 0.3'
Sample Matrix: **WATER**
Sample Team: DK/BT

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

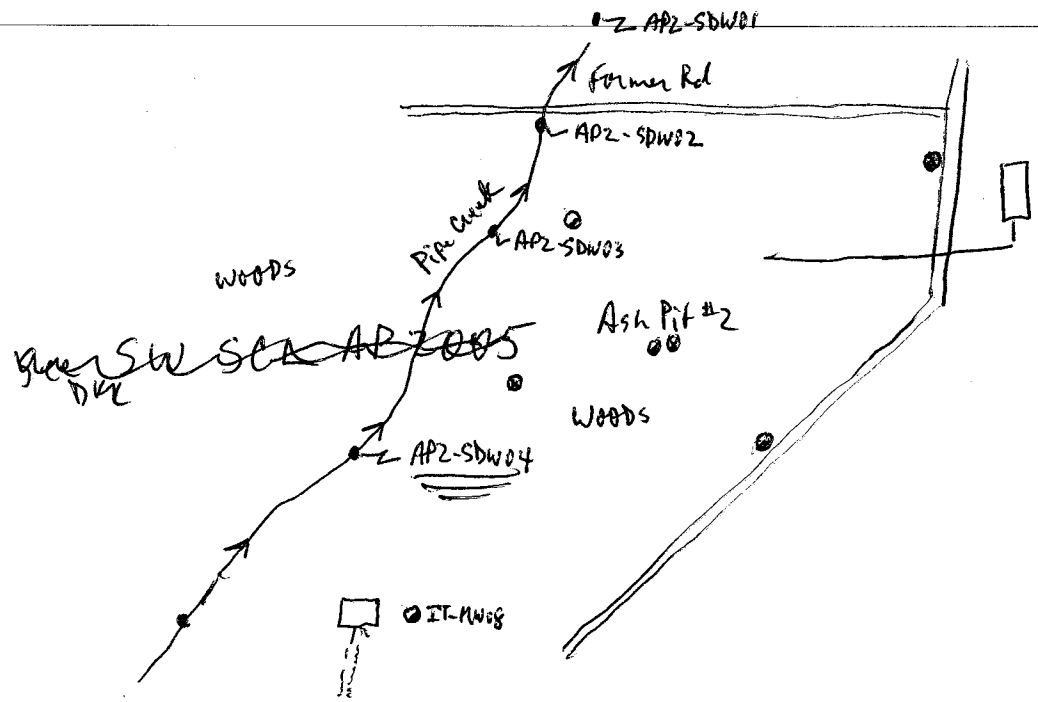
ERPIMS Values:
Sacode:
Lot Control#:

Surface Water Parameters:	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
	193.5	7.43	0.885	24.6	7.40	15.93

Comments: Pre-preserved metals bottle filled w/SVOCs bottle.

Sketch Location:

N ↑



Logged BY / Date: David Kessler 5/25/09 *Reviewed BY / Date:* Edward [illegible] 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB0526 09-ACCT

Location Code: **AP2-SW04**
Sample Number: **AP2005MS**
Sample Name: **PBOW-09-SW-AP2-SW04-AP2005MS-MS**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **MS**
Sampling Equip: Submerged sample bottle

Task: **AP2-SW**
Collection Date: 5-25-09
Collection Time: 0925
Start Depth: 0.0'
End Depth: 0.3'
Sample Matrix: **WATER**
Sample Team: DK/BT

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

ERPIMS Values:
Sacode:
Lot Control#:

Surface Water Parameters:	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
	193.5	7.43	0.885	24.6	7.40	15.93

Comments: NA

Sketch Location:

See SW SCL AP2005 for sketch

Logged BY / Date: David Kussler 5/25/09 *Reviewed BY / Date:* Edward W Lowe 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB0526 09-ACCT

Location Code: **AP2-SW04**
Sample Number: **AP2005MSD**
Sample Name: **PBOW-09-SW-AP2-SW04-AP2005MS-MSD**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **MSD**
Sampling Equip: Submerged sample bottles

Task: **AP2-SW**
Collection Date: 5/25/09
Collection Time: 0925
Start Depth: 0.0'
End Depth: 0.3'
Sample Matrix: **WATER**
Sample Team: BK/BT

QC Partners:
(TB) — (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

Surface Water Parameters:	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
	193.5	7.43	0.885	24.6	7.40	15.93

Comments: NA

Sketch Location:

See SW SCL AP2005 for sketch

Logged BY / Date: David Kresh 5/25/09 *Reviewed BY / Date:* Edward [illegible] 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-ACCT

Location Code: **AP2-SW05**
Sample Number: **AP2006**
Sample Name: **PBOW-09-SW-AP2-SW05-AP2006-REG**
Sampling Method: **GRAB**
Sample Type: **SW** *Sample Purpose:* **REG**
Sampling Equip: Submerged Sample bottles

QC Partners:
(TB) — (ER) — (FB) —

Task: **AP2-SW**
Collection Date: 5/25/09
Collection Time: 1155
Start Depth: 0.0'
End Depth: 0.3'
Sample Matrix: **WATER**
Sample Team: DK/BT

ERPIMS Values:
Sacode:
Lot Control#:

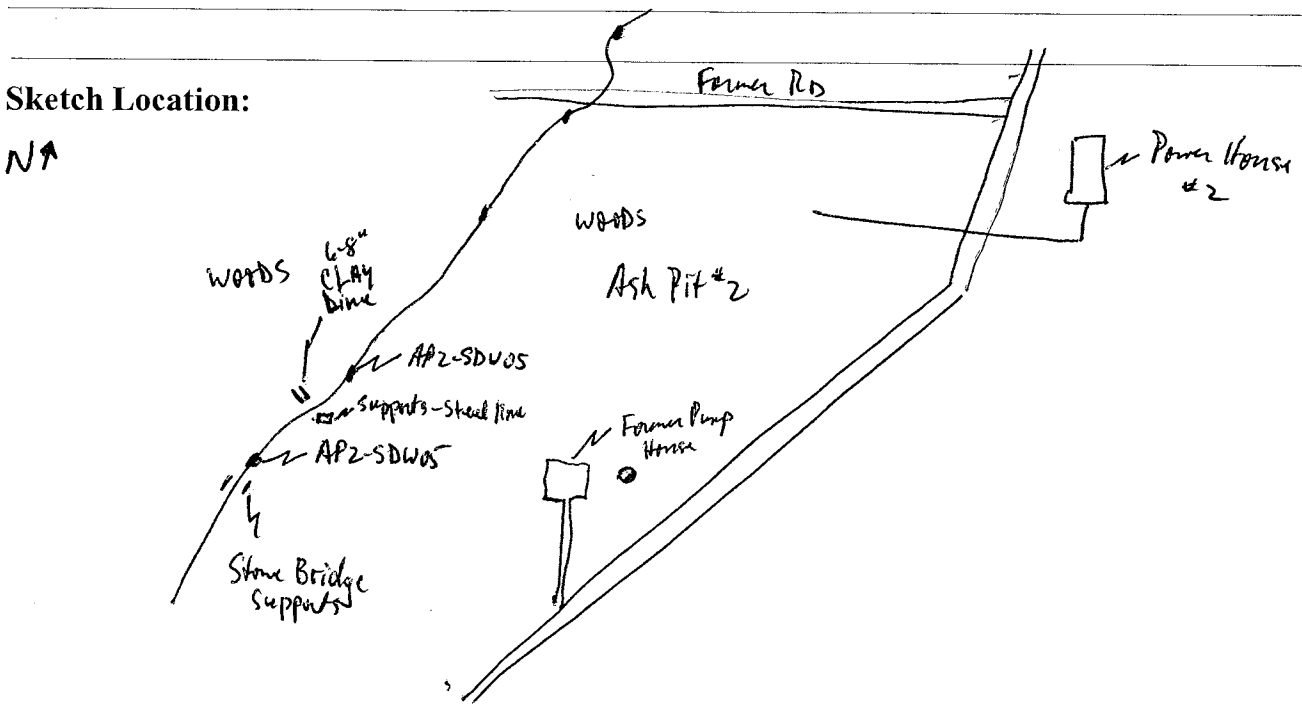
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	2	1	L	Amb. Glass
METALS3-W	N	B	1	500	mL	HDPE
PCB3	N	C	2	1	L	Amb. Glass
EXPLOSIVES	N	D	2	1	L	Amb. Glass

	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)
Surface Water Parameters:	157.8	7.66	0.900	11.7	8.37	16.26

Comments: NA

Sketch Location:



Logged BY / Date: David Kesh 5/25/09 *Reviewed BY / Date:* Edward Weaver 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB 052609-ACCT

Location Code: **ASH PIT 2-SD01**
Sample Number: **AP1000**
Sample Name: **PBOW-09-SD-AP2-SD01-AP1000-(0-0.5)-REG**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **REG**
Sampling Equip: nitrile gloves grab, zip-lock bag composite

Task: **AP2-SED**
Collection Date: 5/24/09
Collection Time: 1050
Start Depth: 0.2'
End Depth: 0.7'
Sample Matrix: **SOIL**
Sample Team: DK/BT

QC Partners:
(TB) — **(ER)** — **(FB)** —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	1	4	oz	CWM
METALS3	N	B	1	4	oz	CWM
PCB3	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	4	oz	CWM
TOC-B	N	E	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments:
0.0-0.2'; decaying leaves, roots
0.2-0.4'; fine grain SAND, trace silt, grayish br, wet
0.4-0.7'; fine grain SAND/gRAVEL, trace silt, wet

Sketch Location:

see SW SCL AP2000 for sketch

Logged BY / Date: David Keesh 5/24/09 *Reviewed BY / Date:* Edward Schweer 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-ACCT

Location Code: **ASH PIT 2-SD02**
Sample Number: **AP1001**
Sample Name: **PBOW-09-SD-AP2-SD02-AP1001-(0-0.5)-REG**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **REG**
Sampling Equip: nitrile glove grab, zip-lock bag composite

Task: **AP2-SED**
Collection Date: 5-24-09
Collection Time: 1415
Start Depth: 0.0'
End Depth: 0.5'
Sample Matrix: **SOIL**
Sample Team: DK/DT

QC Partners:
(TB) — **(ER)** — **(FB)** —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	1	4	oz	CWM
METALS3	N	B	1	4	oz	CWM
PCB3	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: 0.0-0.5': Dark gray, CLAY, trace sand, wet

Sketch Location:

See SW SCL ~~[illegible]~~ DKK AP2001 for sketch

Logged BY / Date: David Kessler 5/24/09 *Reviewed BY / Date:* Edward Kleaver 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-ACCT

Location Code: **ASH PIT 2-SD03**
Sample Number: **AP1002**
Sample Name: **PBOW-09-SD-AP2-SD03-AP1002-(0-0.5)-RE(**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **REG**
Sampling Equip: nitrile gloves grab/zip-lock bag composite

Task: **AP2-SED**
Collection Date: 5/24/09
Collection Time: 1550
Start Depth: 0.0 Ft
End Depth: 0.5 Ft
Sample Matrix: **SOIL**
Sample Team: DK/DT

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	1	4	oz	CWM
METALS3	N	B	1	4	oz	CWM
PCB3	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: NA

Sketch Location:

See SW SCL AP2002 for sketch

Logged BY / Date: David Kesh 5/24/09 *Reviewed BY / Date:* Edward [illegible] 11-8-0

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB 052609-ACCT

Location Code: **ASH PIT 2-SD03**
Sample Number: **AP1002MS**
Sample Name: **PBOW-09-SD-AP2-SD03-AP1002MS-(0-0.5)-I**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **MS**
Sampling Equip: nitrile glove grab, zip-lock bag composite

Task: **AP2-SED**
Collection Date: 5/24/09
Collection Time: 1550
Start Depth: 0.0 Ft
End Depth: ~~0.0~~ 0.5 Ft
Sample Matrix: **SOIL**
Sample Team: DK/BT

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	1	4	oz	CWM
METALS3	N	B	1	4	oz	CWM
PCB3	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: 0.0 - 0.5 Ft: Dark gray, CLAY, little gravel (20%), trace sand (5%), wet

Sketch Location:

See SW SCL AP2002 for sketch

Logged BY / Date: David Kesh 5/24/09 *Reviewed BY / Date:* Edward Kane 11-8-09

Shaw™
Shaw E & I, Inc.

Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB05 26 09-ACCT

Location Code: **ASH PIT 2-SD03**
Sample Number: **AP1002MSD**
Sample Name: **PBOW-09-SD-AP2-SD03-AP1002MSD-(0-0.5)**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **MSD**
Sampling Equip: nitrile glove grab, zip lock bag composite

Task: **AP2-SED**
Collection Date: 5/24/09
Collection Time: 1550
Start Depth: 0.0 ft
End Depth: ~~0.0~~ 0.5 ft
Sample Matrix: **SOIL**
Sample Team: DK/BT

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	1	4	oz	CWM
METALS3	N	B	1	4	oz	CWM
PCB3	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: NA

Sketch Location:

See SW SCL AP2002 for sketch

Logged BY / Date: David Kersh 5/24/09 *Reviewed BY / Date:* Edward E Wade 11-8-0

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB152609-ACCT

Location Code: **ASH PIT 2-SD04**
Sample Number: **AP1003**
Sample Name: **PBOW-09-SD-AP2-SD04-AP1003-(0-0.5)-REG**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **REG**
Sampling Equip: nitrile glove grab/zip lock bag composite

Task: **AP2-SED**
Collection Date: 5/25/09
Collection Time: 1020
Start Depth: 0.0'
End Depth: 0.5'
Sample Matrix: **SOIL**
Sample Team: DKBT

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	1	4	oz	CWM
METALS3	N	B	1	4	oz	CWM
PCB3	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: 0.0-0.5': Brown; silty CLAY, trace sand, wet, stiff

Sketch Location:

See SW SCL AP2005 for collocated sample sketch

Logged BY / Date: David Kersh 5/25/09 *Reviewed BY / Date:* Edward [illegible] 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-ACUT

Location Code: **ASH PIT 2-SD04**
Sample Number: **AP1004**
Sample Name: **PBOW-09-SD-AP2-SD04-AP1004-(0-0.5)-RE(**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **FD**
Sampling Equip: nitrile glove grab/zip-lock bag composite

Task: **AP2-SED**
Collection Date: 5/25/09
Collection Time: 1020
Start Depth: 0.0'
End Depth: 0.5'
Sample Matrix: **SOIL**
Sample Team: DK/BT

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	1	4	oz	CWM
METALS3	N	B	1	4	oz	CWM
PCB3	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: NA

Sketch Location:

See SW SCL AP2005 for collocated sample sketch

Logged BY / Date: David Kessler 5/25/09 *Reviewed BY / Date:* Edward A. Weaver 11-8-09

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB05 26 09-RA

Location Code: **ASH PIT 2-SD04**
Sample Number: **AP1005**
Sample Name: **PBOW-09-SD-AP2-SD04-AP1005-(0-0.5)-RE(**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **FS**
Sampling Equip: nitrile glove grab, zip lock bag composite

Task: **AP2-SED**
Collection Date: 5/25/09
Collection Time: 1020
Start Depth: 0.0'
End Depth: 0.5'
Sample Matrix: **SOIL**
Sample Team: DK/BJ

QC Partners:
(TB) — (ER) — (FB) —

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS	N	A	2	4	oz	CWM
PCBS	N	A	2	4	oz	CWM
SEMIVOLATILES	N	A	2	4	oz	CWM
EXPLOSIVES	N	B	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: NA

Sketch Location:

see SW SCL AP2005 for sketch

Logged BY / Date: David Kessler 5/25/09 *Reviewed BY / Date:* Edward [illegible] 1-8-0

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB052609-ACCT

Location Code: **ASH PIT 2-SD05**
Sample Number: **AP1006**
Sample Name: **PBOW-09-SD-AP2-SD05-AP1006-(0-0.5)-REG**
Sampling Method: **GRAB**
Sample Type: **SD** *Sample Purpose:* **REG**
Sampling Equip: Nitrile glove grab, zip-lock bag composite

Task: **AP2-SED**
Collection Date: 5/25/09
Collection Time: 1215
Start Depth: 0.1 ft
End Depth: 0.6 ft
Sample Matrix: **SOIL**

QC Partners:
(TB) — (ER) — (FB) —

Sample Team: DK/DT

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
SEMIVOLATILES3	N	A	1	4	oz	CWM
METALS3	N	B	1	4	oz	CWM
PCB3	N	C	1	4	oz	CWM
EXPLOSIVES	N	D	1	4	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: 0.0-0.1': leaves, roots
0.1-0.6': Black, very soft, SILT (at 0.5' soft, gray CLAY)
↳ little bit of vfg sand

Sketch Location:

See SW SCL AP2006 for sketch

Logged BY / Date: David Kessler 5/25/09 *Reviewed BY / Date:* Edward G. Wa[illegible] 11-8-09

Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW 052609 - ACCT

Location Code: **AP2-MW01**

Sample Number: **AP3057**

Sample Name: **PBOW-09-GW-AP2-MW01-AP3057-REG**

Sampling Method: **GRAB**

Sample Type: **GW** *Sample Purpose:* **REG**

Sampling Equip: YSI 6820 / Bladder pump

QC Partners:

(TB) 052609-TB (ER) ER 2 (FB) ——

Task: **TPAPLBRC**

Collection Date: 5/23/09

Collection Time: ~~1055~~ MK 1055

Start Depth: 11.20' btoc

End Depth: 11.20' btoc

Sample Matrix: **WATER**

Sample Team: M. Yantin / E. Weaver

ERPIMS Values:

Sacode:

Lot Control#:

Containers

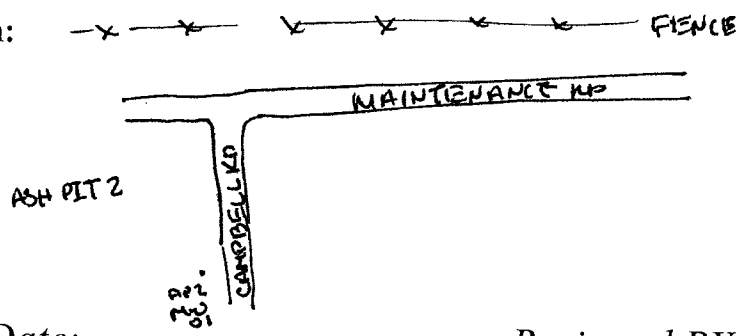
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DNK
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 19.35' btoc **Depth To Water:** 11.20' btoc

Comments: Low flow @ 70 mL/min.
Iron Hach Test: 0.0 mg/L

Sketch Location:



Logged BY / Date: M. Yantin / 05/23/09 *Reviewed BY / Date:* Edward Weaver 11-6-09

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GROUNDWATER SAMPLING FORM

Sheet 1 of 2

Area or Site ID: PBOW
Sample ID: AP3057
Weather: Sunny 70°

Sampling location ID: AP2-MW01
Collection Time/Date: 5/23/09 1055

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other_____ (circle or add one)

Pump installation crew: H. Yantin / E. Weaver ✓
Casing diameter (inches): 2
Total well depth (ft. BTOC): 19.35
Bladder pump settings: CPM 2-2-2-2
Refill (seconds): 28-29-28-29
Discharge (seconds): 2-1-2-1
Throttle (psi): 20-20-20-20
Discharge tube length (ft.): 17

Screen Interval (ft. BTOC): 11.64 to 21.64
Pump intake depth (ft BTOC): 11.7
Max. sustainable pump rate (mL/min):
Appearance of product: clear
Discharge tube diameter: 1/4" ID
Inlet reducer used (Y/N): N
PID: 0 ppm H_2S: 0
LEL: LEL: 0 %; Oxygen: 21.4 %; Carbon: 0 ppm

Purging

Purging/sampling crew: H. Yantin / E. Weaver ✓
Purge date/beginning time: 5/23/09 1015
Initial (pre-purging) DTW (ft. BTOC): 10.83

Purge date/completion time: 5/23/09
Final (post-purging) DTW (ft. BTOC): 11.20

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters
Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube
Tubing length = 17 ft.
Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 17 ft) + 0.3 L = .47 L
No. of tubing volumes purged: 3
Total purge volume: Tubing volume (L) x No. of tubing volumes purged = .47 L x 3 = 1.41 L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = .164 gal/ft
Well volume (gallons) = Water Column (ft) x Gal/ft = 8.52 ft x .164 Gal/ft = 1.39 gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. In inches & d is casing dia. in inches
= 0.041 x ((8)^2 - (2)^2) = 2.46 gal/ft
Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)
= ((Screen Height 10 ft + 8.52 ft) x 2.46 gal/ft) x 0.3 = 1.03 gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = 1.39 gal + 1.03 gal = 2.42 gal X 3.785 L/gal = 9.16 L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume
9.16	18.32	27.49	36.65	45.81

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)	.052	.06	.07						0.70

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
5/23/09	1025	11.19	NA	1L	14.90	0.899	-131.8	6.41	10.49	3.1
"	1030	11.14	.052	1.26	14.30	0.901	-138.7	6.39	10.55	2.8
"	1035	11.22	.060	1.56	13.70	0.900	-141.8	6.35	10.58	2.1
"	1040	11.21	.070	1.81	13.55	0.899	-140.9	6.35	10.49	2.5
"	1045	11.20	.070	2.16	13.60	0.894	-141.1	6.36	10.38	2.7
"	1050	11.20	.070	2.51	13.57	0.895	-141.6	6.36	10.30	2.7
"	1055	11.20	.070	2.86	13.59	0.895	-141.3	6.35	10.27	2.5

HRM 5/23/09

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GROUNDWATER SAMPLING FORM

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

MPM 5/23/09

Sampling

Sampling beginning time: 1055 Sampling completion time: 1240

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
5/23/09	1055	11.20	.070	2.86	13.59	0.895	-141.3	6.35	10.27	2.5

Sample Information

Sample ID: AP 3057 Sample collection date/time: 5/23/09 1055

Duplicate sample collected (Y/N): N Duplicate sample ID: NA

Split sample collected (Y/N): N Split sample ID: NA

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers

MPM 5/23/09

Comments: Low flow @ 70mL/min.

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW 052609-ACCT

Location Code: **AP2-MW02**
Sample Number: **AP3058**
Sample Name: **PBOW-09-GW-AP2-MW02-AP3058-REG**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: YSI 6820/ Bladder pump

Task: **TPAPLBRC**
Collection Date: 5/25/09
Collection Time: 0932
Start Depth: 7.40' btoc
End Depth: 7.40' btoc
Sample Matrix: **WATER**
Sample Team: H. Yantin / E. Weaver

QC Partners:
(TB) 052609-TB (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

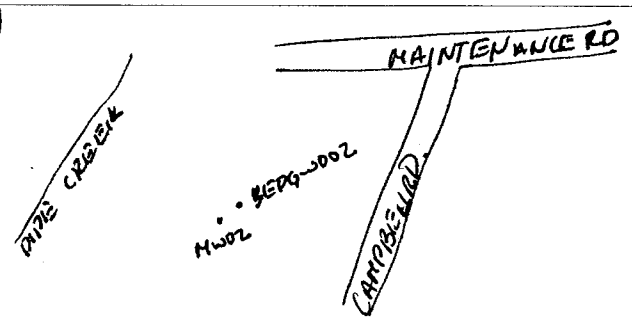
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ BKK
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 15.35' btoc **Depth To Water:** 7.40' btoc

Comments: Sampled @ 130 mL/min
Iron Hach Test: 0.0 mg/L

Sketch Location:



Logged BY / Date: H. Yantin 5/25/09 *Reviewed BY / Date:* Edward Weaver 11-8-09

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW-052609-ACCT

Location Code: **AP2-MW02**
Sample Number: **AP3059**
Sample Name: **PBOW-09-GW-AP2-MW02-AP3059-REG**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **FD**
Sampling Equip: YSI 6820 / Bladder pump

QC Partners:
(TB) 052609-TB (ER) — (FB) —

Task: **TPAPLBRC**
Collection Date: 5/26/09
Collection Time: 0932
Start Depth: 7.40' btoc
End Depth: 7.40' btoc
Sample Matrix: **WATER**
Sample Team: M. Yantin / E. Weaver

ERPIMS Values:
Sacode:
Lot Control#:

Containers

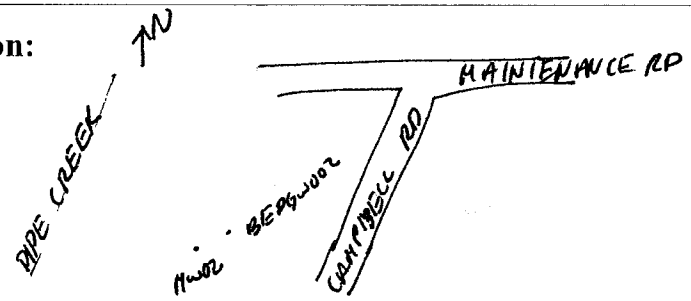
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DKK
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 15.25' btoc **Depth To Water:** 7.40' btoc

Comments: Sampled @ 130 ml/min.
Iron Hach Test: 0.0 mg/L

Sketch Location:



Logged BY / Date: M. Yantin 5/26/09 *Reviewed BY / Date:* Edward [illegible] 11-9-09

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: DHK PW052609-TA

Location Code: **AP2-MW02**

Sample Number: **AP3060**

Sample Name: **PBOW-09-GW-AP2-MW02-AP3060-REG**

Sampling Method: **GRAB**

Sample Type: **GW** *Sample Purpose:* **FS**

Sampling Equip: YSI 6820 / Bladder pump

QC Partners:

(TB) 052609-TB (ER) (FB) —

Task: **TPAPLBRC**

Collection Date: 5/25/09

Collection Time: 0932

Start Depth: 7.40' btoc

End Depth: 7.40' btoc

Sample Matrix: **WATER**

Sample Team: M. Yantin / E. Weaver

ERPIMS Values:

Sacode:

Lot Control#:

Containers

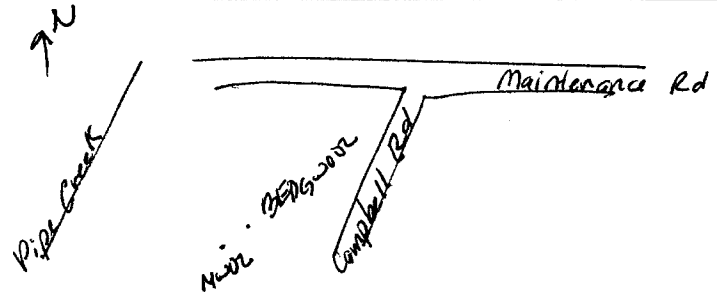
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	1	L	HDPE
METALS3-W-F	Y	E	1	1	L	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
~~PCB3~~	~~N~~	~~G~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DHK
NO2/NO3	N	H	1	250	mL	HDPE
CYANIDE	N	I	1	250	mL	HDPE
HARDNESS	N	J	1	250	mL	HDPE

Groundwater Information:

Measured Well Depth: 15.35' btoc **Depth To Water:** 7.40' btoc

Comments: Sampled @ 130 mL/min
Iron Hach Test: mg/L (0.0)

Sketch Location:



Logged BY / Date: M. Yantin 5/25/09 *Reviewed BY / Date:* Edward Weaver 11-82

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GROUNDWATER SAMPLING FORM

Sheet 1 of 2

Area or Site ID: PBOW
Sample ID: AP3058
Weather: Partly cloudy 65°

Sampling location ID: AP2 MW02
Collection Time/Date: 5/25/09 0932

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other_____ (circle or add one)

Pump installation crew: M. Martin / E. Weaver
Casing diameter (inches): 2
Total well depth (ft. BTOC): 15.35
Bladder pump settings: CPM 2-2
Refill (seconds): 28 - 28
Discharge (seconds): 2-2
Throttle (psi): 20 - 18
Discharge tube length (ft.): 16

Screen Interval (ft. BTOC): 5.35 to 15.35
Pump intake depth (ft BTOC): 8.8
Max. sustainable pump rate (mL/min):
Appearance of product: clear
Discharge tube diameter: 1/4" ID
Inlet reducer used (Y/N): N
PID: 0 ppm H_2S: 0
LEL: LEL: ~~20.7~~ 0 %; Oxygen: 20.8 %; Carbon: 0 ppm

Purging

Purging/sampling crew: M. Martin / E. Weaver
Purge date/beginning time: 5/25/09 0852
Initial (pre-purging) DTW (ft. BTOC): 7.29'

Purge date/completion time: 5/25/09
Final (post-purging) DTW (ft. BTOC): 7.40

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters
Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube
Tubing length = 16 ft.
Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 16 ft) + 0.3 L = .46 L
No. of tubing volumes purged: 3
Total purge volume: Tubing volume (L) x No. of tubing volumes purged = .46 L x 3 = 1.38 L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____ gal/ft
Well volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____ gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches
= 0.041 x ((8)^2 - (2)^2) = 1.27 gal/ft
Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)
= ((Screen Height 10 ft + 5.525 ft) x _____ gal/ft) x 0.3 = _____ gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal X 3.785 L/gal = _____ L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)	.170	.150	.130						

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
5/25/09	0902	7.37	.170	1.7	12.31	0.809	1073.1	5.55	3.57	3.8
"	0907	7.38	.170	2.55	11.95	0.829	1361.8	5.66	2.66	2.8
"	0912	7.40	.150	3.30	11.84	0.842	693.8	5.70	2.29	3.3
"	0917	7.39	.130	3.95	11.72	0.853	630.2	5.75	2.00	2.0
"	0922	7.40	.130	4.6	11.72	0.854	625.2	5.74	1.91	2.0
"	0927	7.40	.130	5.25	11.69	0.855	624.1	5.72	1.91	1.9
"	0932	7.40	.130	5.90	11.69	0.856	623.8	5.72	1.92	1.7
					MDM 5/25/09					

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GROUNDWATER SAMPLING FORM

Sheet 2 of 2

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

HMM 5/25/09

Sampling

Sampling beginning time: 0932

Sampling completion time: 1200

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
5/25/09	0932	7.40	.130	5.90	11.69	0.856	623.8	5.72	1.92	1.7

Sample Information

Sample ID: AP3058

Sample collection date/time: 5/25/09 0932

Duplicate sample collected (Y/N): Y

Duplicate sample ID: AP3059

Split sample collected (Y/N): Y

Split sample ID: AP 3060

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers

HMM 5/25/09

Comments: Low flow @ 130 mL/min

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW 052609 - ACCT

Location Code: **AP2-MW03**
Sample Number: **AP3061**
Sample Name: **PBOW-09-GW-AP2-MW03-AP3061-REG**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Bladder pump 1451 6820

Task: **TPAPLBRC**
Collection Date: 5/24/09
Collection Time: 1058
Start Depth: 6.21' btoc
End Depth: 6.21 btoc
Sample Matrix: **WATER**
Sample Team: M. Yantin / E. Weaver

QC Partners:
(TB) 052609-TB (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DKK
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 12.45' btoc **Depth To Water:** 6.21' btoc

Comments: Sampled @ 40 mL/min
Iron Hach Test: 0.0 mg/L

Sketch Location:

Logged BY / Date: M. Yantin / 5/24/09 *Reviewed BY / Date:* Edward Weaver 11-8-09

Shaw Shaw Environmental, Inc.

GROUNDWATER SAMPLING FORM

Sheet 1 of 2

Area or Site ID: PBOW
Sample ID: AP 3061
Weather: Partly cloudy 65°

Sampling location ID: AP2-MW03
Collection Time/Date: 5/24/09 1058

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other_____ (circle or add one)

Pump installation crew: M. Martin / E. Weaver
Casing diameter (inches): 2
Total well depth (ft. BTOC): 12.45
Bladder pump settings: CPM 2-2
Refill (seconds): 28-29
Discharge (seconds): 2-1
Throttle (psi): 20-20
Discharge tube length (ft.): 15

Screen Interval (ft. BTOC): 7.4 to 12.4
Pump intake depth (ft BTOC): 9.9
Max. sustainable pump rate (mL/min): 40
Appearance of product: clear
Discharge tube diameter: 1/4" ID
Inlet reducer used (Y/N): N
PID: 0 ppm
LEL: LEL: 0 %; Oxygen: 20.8%; Carbon: 0 ppm

Purging

Purging/sampling crew: M. Martin / E. Weaver
Purge date/beginning time: 5/24/09 1008
Initial (pre-purging) DTW (ft. BTOC): 4.81

Purge date/completion time: 5/24/09
Final (post-purging) DTW (ft. BTOC): 6.21 btoc

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters
Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube
Tubing length = 15 ft.
Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 15 ft) + 0.3 L = .45 L
No. of tubing volumes purged: 3
Total purge volume: Tubing volume (L) x No. of tubing volumes purged = .45 L x 3 = 1.35 L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = .164 gal/ft
Well volume (gallons) = Water Column (ft) x Gal/ft = 7.64 ft x .164 Gal/ft = 1.25 gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches
= 0.041 x ((8)^2 - (2)^2) = 2.46 gal/ft
Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)
= ((Screen Height 5 ft + 2.5 ft) x 2.46 gal/ft) x 0.3 = 5.166 gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = 1.25 gal + 5.166 gal = 6.42 gal X 3.785 L/gal = 24.28

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume
24.28	48.56	72.84	97.12	121.4

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)	.120	.068	.058	.044					0.044

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
5/24/09	1018	6.0	.120	1.20	13.04	1.416	-385.9	6.30	6.28	10.6
"	1023	6.12	.068	1.37	12.86	1.456	-540.8	6.29	5.20	13.7
"	1028	6.15	.068	1.71	12.98	1.432	-395.8	6.29	5.36	15.0
"	1033	6.20	.058	2.00	13.11	1.382	-398.4	6.30	5.60	14.7
"	1038	6.22	.044	2.22	13.14	1.371	-399.6	6.31	5.61	14.5
"	1043	6.23	.050	2.47	13.15	1.369	-398.2	6.31	5.63	14.9
"	1048	6.22	.045	2.92	13.18	1.367	-394.6	6.31	5.62	12.8
"	1053	6.21	.040	3.32	13.20	1.367	-393.1	6.30	5.58	11.6
"	1058	6.21	.040	3.72	13.20	1.368	-394.8	6.29	5.60	10.1

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GROUNDWATER SAMPLING FORM

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

NM 5/24/09

Sampling

Sampling beginning time: 1058

Sampling completion time: 1300

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
5/24/09	1058	6.21	.040	3.72	13.20	1.368	-394.8	6.29	5.60	10.1

Sample Information

Sample ID: AP3061

Sample collection date/time: 5/24/09 1058

Duplicate sample collected (Y/N): N

Duplicate sample ID: NA

Split sample collected (Y/N): N

Split sample ID: NA

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers

NM 5/24/09

Comments: Low-flow @ 40 mL/min

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: NA

Location Code: **AP2-BEDGW-001**
Sample Number: **AP3062**
Sample Name: **PBOW-09-GW-AP2-BEDGW-001-AP3062-R1**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: NA

Task: **TPAPLBRC**
Collection Date:
Collection Time: NA
Start Depth:
End Depth:
Sample Matrix: **WATER**
Sample Team: M. Yantin/E. Weaver

QC Partners:
(TB) NA (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DKK
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 88.50' btoc **Depth To Water:** 87.17' btoc

Comments:

DRY WELL

Sketch Location:

See bore log.

Logged BY / Date: M. Yantin 5/23/09 *Reviewed BY / Date:* Edward Weaver 6-8

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GROUNDWATER SAMPLING FORM

Sheet 1 of 2

Area or Site ID: PBOW
Sample ID: DP3062
Weather: Sunny 70°

Sampling location ID: AP2-BIDGW001
Collection Time/Date: NA

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other NA (circle or add one)

Pump installation crew: E. Weaver / M. Yantin
Casing diameter (inches): 2
Total well depth (ft. BTOC): 88.53
Bladder pump settings: CPM NA
Refill (seconds): NA
Discharge (seconds): NA
Throttle (psi): NA
Discharge tube length (ft.): NA

Screen Interval (ft. BTOC): 73.50 to 88.50
Pump intake depth (ft BTOC): NA
Max. sustainable pump rate (mL/min): NA
Appearance of product: NA
Discharge tube diameter: 1/4" ID
Inlet reducer used (Y/N): N
PID : _____ ppm
LEL: LEL: %; Oxygen: %; Carbon: ppm

Purging

Purging/sampling crew: M. Yantin / E. Weaver
Purge date/beginning time: NA
Initial (pre-purging) DTW (ft. BTOC): 87.17

Purge date/completion time: NA
Final (post-purging) DTW (ft. BTOC): NA

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters
Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube
Tubing length = _____ ft.
Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x ____ ft) + 0.3 L = _____ L
No. of tubing volumes purged: _____
Total purge volume: Tubing volume (L) x No. of tubing volumes purged = _____ L x _____ = _____ L

MPM 5/23/09

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____ gal/ft
Well volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____ gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches
= 0.041 x ((_____)^2 - (_____)^2) = _____ gal/ft
Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)
= ((Screen Height _____ ft + _____ ft) x _____ gal/ft) x 0.3 = _____ gallons

MPM 5/23/09

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal X 3.785 L/gal = _____ L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)				MPM	05/23/09				

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)

MPM 5/23/09

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GROUNDWATER SAMPLING FORM

Sheet 2 of 2

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

HMM 5/23/09

Sampling

Sampling beginning time: _____ Sampling completion time: VMK

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

HMM 5/23/09

Sample Information

Sample ID: AP3062

Sample collection date/time: NA

Duplicate sample collected (Y/N): N

Duplicate sample ID: NA

Split sample collected (Y/N): N

Split sample ID: NA

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers

HMM 5/23/09

Comments:

Well is dry.

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW 052609-ACCT

Location Code: **AP2-BEDGW-002**
Sample Number: **AP3063**
Sample Name: **PBOW-09-GW-AP2-BEDGW-002-AP3063-RI**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: YSI 6820 / Bladder pump

QC Partners:
(TB) 052609TB (ER) — (FB) —

Task: **TPAPLBRC**
Collection Date: 5/24/09
Collection Time: 1531
Start Depth: 23.1' btoc
End Depth: 23.1' btoc
Sample Matrix: **WATER**
Sample Team: H. Yantin / E. Weaver

ERPIMS Values:
Sacode:
Lot Control#:

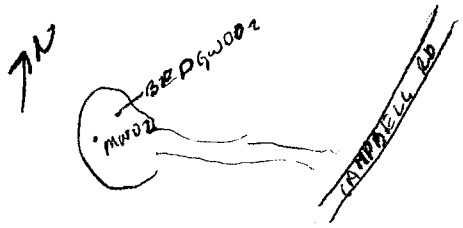
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DKE
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:
Measured Well Depth: 85.35' btoc **Depth To Water:** 23.1' btoc

Comments: Low flow @ 92 mL/min

Sketch Location:



Logged BY / Date: H. Yantin 5/26/09 *Reviewed BY / Date:* Edward Weaver 1/28/10

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GROUNDWATER SAMPLING FORM

Sheet 1 of 2

Area or Site ID: PBOW
Sample ID: AB3063
Weather: Sunny 70°

Sampling location ID: AP2-BEDGW002
Collection Time/Date: 5/24/09 1531

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other_____ (circle or add one)

Pump installation crew: M. Yantin / E. Weaver
Casing diameter (inches): 2
Total well depth (ft. BTOC): ~~77.23~~ 85.35
Bladder pump settings: CPM 2
Refill (seconds): 25
Discharge (seconds): 5
Throttle (psi): 40
Discharge tube length (ft.): 80

Screen Interval (ft. BTOC): 70 to 85.0
Pump intake depth (ft BTOC): 75.7
Max. sustainable pump rate (mL/min):
Appearance of product: clear
Discharge tube diameter: 1/4" ID
Inlet reducer used (Y/N): N
PID: 2.5 ppm H_2S: 5
LEL: LEL: 0 %; Oxygen: 20.8 %; Carbon: 0 ppm

Purging

Purging/sampling crew: M. Yantin / E. Weaver
Purge date/beginning time: 5/24/09 1441
Initial (pre-purging) DTW (ft. BTOC): 23.05

Purge date/completion time: 5/24/09 1531
Final (post-purging) DTW (ft. BTOC): 23.1

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters
Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube
Tubing length = 80 ft.
Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 80 ft) + 0.3 L = 1.1 L
No. of tubing volumes purged: 3
Total purge volume: Tubing volume (L) x No. of tubing volumes purged = 1.1 L x 3 = 3.3 L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = .164 gal/ft
Well volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____ gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches
= 0.041 x ((6)^2 - (2)^2) = _____ gal/ft
Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)
= ((Screen Height _____ ft + _____ ft) x _____ gal/ft) x 0.3 = _____ gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal X 3.785 L/gal = _____ L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)	.092	—	—	—	—	—	—	—	0.092

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min) 0.092	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
5/24/09	1501	23.1	~~0.0874~~	1.84	16.95	0.746	-396.9	6.27	1.80	54.4
"	1506	"	0.092	2.30	16.88	2.905	-168.7	6.21	1.10	33.6
"	1511	"	0.092	2.76	16.91	2.930	-154.4	6.21	1.79	30.1
"	1516	"	0.092	3.22	16.88	2.957	-148.9	6.20	1.70	24.2
"	1521	"	0.092	3.68	16.92	2.965	-142.8	6.20	1.68	20.1
"	1526	"	0.092	4.14	16.98	2.964	-144.6	6.20	1.65	18.8
"	1531	"	0.092	4.60	17.00	2.968	-144.8	6.20	1.64	16.2

5/24/09

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GROUNDWATER SAMPLING FORM

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

HPM
5/24/09

Sampling

Sampling beginning time: 1531

Sampling completion time: 1640

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
5/24/09	1531	23.1	0.092	4.60	17.00	2.968	-144.8	6.20	1.64	16.2

Sample Information

Sample ID: AP 3063

Sample collection date/time: 5/24/09

Duplicate sample collected (Y/N): N

Duplicate sample ID: NA

Split sample collected (Y/N): N

Split sample ID: NA

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers

HPM
5/24/09.

Comments: water level stable @ 92 mL/min.

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW-052609-ACCT

Location Code: **AP2-BEDGW-003**
Sample Number: **AP3064**
Sample Name: **PBOW-09-GW-AP2-BEDGW-003-AP3064-R1**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: YSI 6820 / Bladder pump

Task: **TPAPLBRC**
Collection Date: 5/23/09
Collection Time: 1550
Start Depth: 27.85' btoc
End Depth: 27.85' btoc
Sample Matrix: **WATER**
Sample Team: M. Yantin / E. Weaver

QC Partners:
(TB) 052609-TB (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

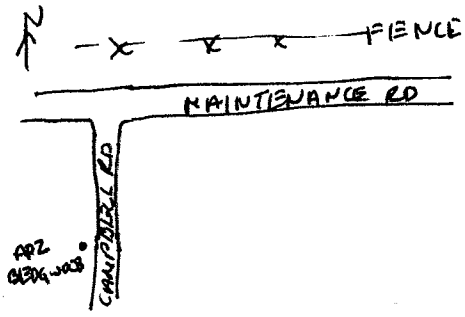
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 62.65' btoc **Depth To Water:** 27.85' btoc

Comments: Well sampled @ 114 mL/min
Iron Hach Test: 0.0 mg/L

Sketch Location:



Logged BY / Date: M. Yantin 5/23/09 *Reviewed BY / Date:* Edward Weaver 11-8-09

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: RW-052609-ACCT

Location Code: **AP2-BEDGW-003**
Sample Number: **AP3064MS**
Sample Name: **PBOW-09-GW-AP2-BEDGW-003-AP3064MS**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **MS**
Sampling Equip: YSI 6820 / Bladder Pump
QC Partners: 052909-TB
(TB) ~~052609-TB~~ MR **(ER)** — **(FB)** —

Task: **TPAPLBRC**
Collection Date: 5/23/09
Collection Time: 1550
Start Depth: 27.85' btoc
End Depth: 27.85' btoc
Sample Matrix: **WATER**
Sample Team: M. Yantin / E. Weaver

ERPIMS Values:
Sacode:
Lot Control#:

Containers

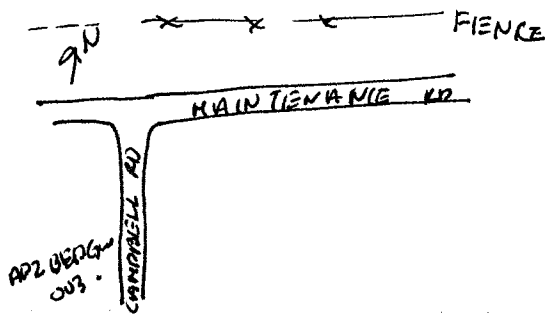
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DKK
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 62.65' btoc **Depth To Water:** 27.85' btoc

Comments: Well sampled @ 114 mL/min
Iron Hach Test: mg/L (0.0)

Sketch Location:



Logged BY / Date: M. Yantin 5/23/09 *Reviewed BY / Date:* Edward Weaver 1-8-0

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW052609 -ACCT

Location Code: **AP2-BEDGW-003**
Sample Number: **AP3064MSD**
Sample Name: **PBOW-09-GW-AP2-BEDGW-003-AP3064MS**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **MSD**
Sampling Equip: YSI 6820 / Bladder Pump

Task: **TPAPLBRC**
Collection Date: 5/23/09
Collection Time: 1550
Start Depth: 27.85' btoc
End Depth: 27.85' btoc
Sample Matrix: **WATER**
Sample Team: M. Yantin / E. Weaver

QC Partners:
(TB) 052609 -TB (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

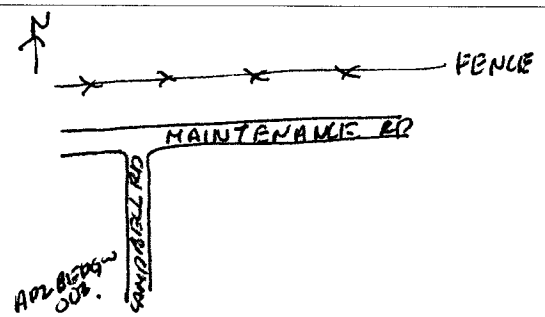
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DKK
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information:
Measured Well Depth: 62.65' btoc **Depth To Water:** 27.85' btoc

Comments: Well sampled @ 114 mL/min
Iron Hach Test: 0.0 mg/L

Sketch Location:



Logged BY / Date: M. Yantin 5/23/09 *Reviewed BY / Date:* Edward G. Weaver 11-8-09

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW 052609-ACCT

Location Code: **AP2-BEDGW-003**
Sample Number: **AP3065**
Sample Name: **PBOW-09-GW-AP2-BEDGW-003-AP3065-R1**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **FD**
Sampling Equip: YSI 6920 / Bladder pump

QC Partners:
(TB) 052609-TB (ER) — (FB) —

Task: **TPAPLBRC**
Collection Date: 5/23/09
Collection Time: 1550
Start Depth: 27.85' btoc
End Depth: 27.85' btoc
Sample Matrix: **WATER**
Sample Team: M. Yantin / E. Weaver

ERPIMS Values:
Sacode:
Lot Control#:

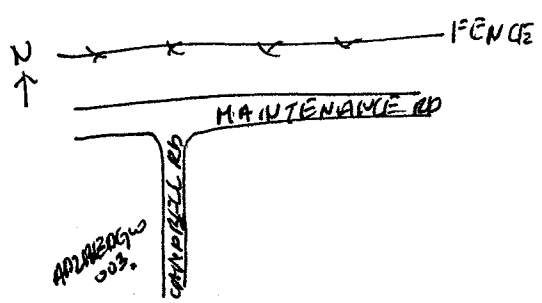
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
~~PCB3~~	~~N~~	~~H~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DKK
CYANIDE	N	I	1	500	mL	HDPE
HARDNESS	N	J	1	500	mL	HDPE

Groundwater Information: 62.65' btoc
Measured Well Depth: ~~bto~~ btoc **Depth To Water:** 27.85' btoc

Comments: well sampled @ 114 mL/min.
Iron Hach Test: 0.0 mg/L

Sketch Location:



Logged BY / Date: M. Yantin 5/23/09 *Reviewed BY / Date:* Edward Weaver 11-8-09

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW-052609-TA

Location Code: **AP2-BEDGW-003**
Sample Number: **AP3066**
Sample Name: **PBOW-09-GW-AP2-BEDGW-003-AP3066-R1**
Sampling Method: **GRAB**
Sample Type: **GW** *Sample Purpose:* **FS**
Sampling Equip: YSI 6820 / Bladder pump

Task: **TPAPLBRC**
Collection Date: 5/23/09
Collection Time: 1550
Start Depth: 27.85' btoc
End Depth: 27.85' btoc
Sample Matrix: **WATER**
Sample Team: H. Yantin / E. Weaver

QC Partners:
(TB) 052609-TB (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

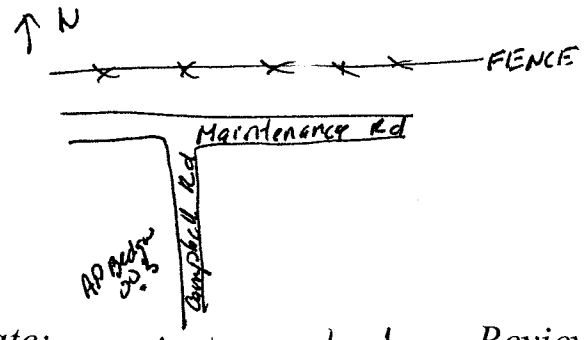
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
METALS3-W	N	D	1	1	L	HDPE
METALS3-W-F	Y	E	1	1	L	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
~~PCB3~~	~~N~~	~~G~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~ DKK
NO2/NO3	N	H	1	250	mL	HDPE
CYANIDE	N	I	1	250	mL	HDPE
HARDNESS	N	J	1	250	mL	HDPE

Groundwater Information:

Measured Well Depth: 62.65' btoc **Depth To Water:** 27.85' btoc

Comments: well sampled @ 114 mL/min.
Iron Hach Test: 0.0 mg/L

Sketch Location:



Logged BY / Date: H. Yantin 5/23/09 *Reviewed BY / Date:* Edward Weaver 11-8-09

Shaw Shaw Environmental, Inc.

GROUNDWATER SAMPLING FORM

Sheet 1 of 2

Area or Site ID: PBOW
Sample ID:
Weather: Sunny 80°

Sampling location ID: AP2 BLDG 003
Collection Time/Date: 5/23/09 1550

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other_____ (circle or add one)

Pump installation crew: M. Yantin / E. Weaver
Casing diameter (inches): 2
Total well depth (ft. BTOC): 62.65
Bladder pump settings: CPM 22-2
Refill (seconds): 28-27-27
Discharge (seconds): 2-3-3
Throttle (psi): 30-30-35
Discharge tube length (ft.): 56

Screen Interval (ft. BTOC): _____ to _____
Pump intake depth (ft BTOC): 51.0
Max. sustainable pump rate (mL/min): _____
Appearance of product: clear
Discharge tube diameter: 1/4" ID
Inlet reducer used (Y/N): N
PID: 25.3 ppm 128.0
LEL: LEL: 3 %; Oxygen: 20.8%; Carbon: 0 ppm

Purging

Purging/sampling crew: M. Yantin / E. Weaver
Purge date/beginning time: 5/23/09 1430
Initial (pre-purging) DTW (ft. BTOC): 27.55

Purge date/completion time: _____
Final (post-purging) DTW (ft. BTOC): _____

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters
Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube
Tubing length = 56 ft.
Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 56 ft) + 0.3 L = .86 L
No. of tubing volumes purged: 3
Total purge volume: Tubing volume (L) x No. of tubing volumes purged = .86 L x 3 = 2.58 L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____ gal/ft
Well volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____ gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches
= 0.041 x ((_____)^2 - (_____)^2) = _____ gal/ft
Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)
= ((Screen Height _____ ft + _____ ft) x _____ gal/ft) x 0.3 = _____ gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal X 3.785 L/gal = _____ L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)	.036	.086	.114						.114

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
5/23/09	1450	27.65	.036	.72	26.78	1.201	-344.8	6.30	0.78	15.9
"	1500	27.65	"	1.08	26.06	2.099	-407.6	6.25	0.26	15.6
"	1510	27.65	"	1.44	25.90	2.122	-323.8	6.23	0.24	15.8
"	1515	27.70	.086	1.87	25.86	2.131	-319.6	6.21	0.24	13.8
"	1520	27.77	.086	2.30	25.80	2.140	-316.9	6.21	0.23	11.8
"	1525	27.75	.086	2.73	25.78	2.142	-320.6	6.20	0.23	9.1
"	1530	27.81	.114	3.3	25.61	2.139	-319.8	6.18	0.23	7.9
"	1535	27.85	.114	3.87	25.60	2.140	-315.6	6.16	0.22	7.5
"	1540	27.85	.114	4.44	25.60	2.141	-312.8	6.15	0.22	7.1

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GROUNDWATER SAMPLING FORM

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
5/23/09	1545	27.85	.114	5.01	25.59	2.143	-313.6	6.15	0.22	6.1
"	1550	27.85	.114	5.58	25.59	2.141	-315.1	6.15	0.22	5.9

MM 5/23/09

Sampling

Sampling beginning time: 1550 Sampling completion time: 1605

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
5/23/09	1550	27.85	.114	5.58	25.59	2.141	-315.1	6.15	0.22	5.9

Sample Information

Sample ID: AP 3064

Duplicate sample collected (Y/N): Y

Split sample collected (Y/N): Y

Sample collection date/time: 5/23/09 1550

Duplicate sample ID: MS+MSD AP3065

Split sample ID: AP3066

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers

MM 5/23/09

Comments:
- Low flow is possible @ 36 mL/min.
- Well recharged @ 114 mL/min.

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

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Sample Collection Log

133422 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW 052609-ACCT

Location Code: **FIELDQC-AP2**
Sample Number: **ER2**
Sample Name: **FIELDQC-AP2-ER2**
Sampling Method: **QC**
Sample Type: **BW** *Sample Purpose:* **ER**
Sampling Equip: NA

Task: **MW-RINSATES**
Collection Date: 5/23/09
Collection Time: 1400
Start Depth: NA
End Depth: NA
Sample Matrix: **WATER**

QC Partners:
(TB) 052609-TB (ER) — (FB) —

Sample Team: H. Yantin/E. Weaver

ERPIMS Values:
Sacode:
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	500	mL	HDPE
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
CYANIDE	N	H	1	500	mL	HDPE

Comments: Sample collected after decontamination of bladder pump from well number: AP2 MW01. Lot number of DI water is 012809A and was distributed by VWR International.

Sketch Location:

NA

Logged BY / Date: H. Yantin 5/23/09

Reviewed BY / Date: Edward Weav 11-8-0

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW111309ACCT

Location Code: **AP2-MW01**
Sample Number: **AP3075**
Sample Name: **PBOW-09-GW-AP2-MW01-AP3075-REG**
Sampling Method: **BP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: bailer

Task: **OCT09-GW**
Collection Date: 11/13/09
Collection Time: 0900
Start Depth: —
End Depth: —
Sample Matrix: **WATER**
Sample Team: JAB, CPS

QC Partners:
(TB) — (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

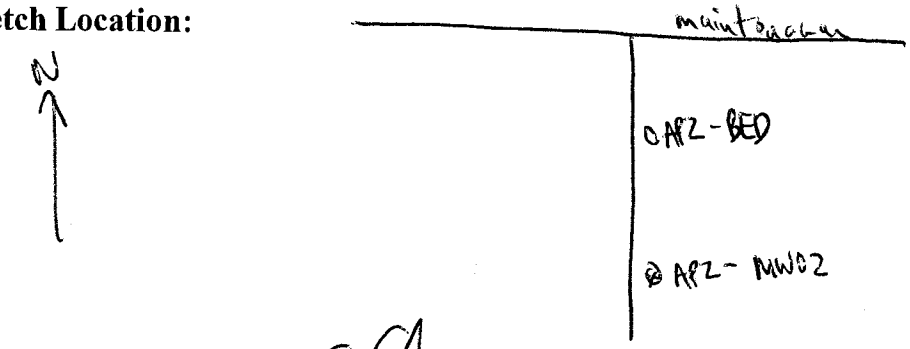
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
~~VOLATILES~~	~~N~~	~~A~~	~~3~~	~~40~~	~~mL~~	~~VOA VIAL~~
~~SEMIVOLATILES3~~	~~N~~	~~B~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~
EXPLOSIVES	N	C	2	1	L	Amb. Glass
~~HARDNESS~~	~~N~~	~~D~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~
~~METALS3-W~~	~~N~~	~~D~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~
~~METALS3-W-F~~	~~Y~~	~~E~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~
~~ALKALINITY~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~
~~CHLORIDE~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~
~~SULFATE~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~
~~TDS~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~
~~TSS~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~
~~TURB 180.1~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~
~~NO2/NO3~~	~~N~~	~~G~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~
~~CYANIDE~~	~~N~~	~~H~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~

CPS

Groundwater Information:
Measured Well Depth: 22.22 **Depth To Water:** 17.00

Comments: Well did not recharge. could only collect 2 1L ambers for explosives analysis.

Sketch Location:



Logged BY / Date: 11/13/09 *Reviewed BY / Date:* 2/18/10

ROUNDWATER SAMPLING FORM

Sheet 1 of 2

Shaw Environmental, Inc.

Area or Site ID: AP2

Sample ID: AP3075

Weather: clear, 50°, slight breeze

Sampling location ID: AP2-MW01

Collection Time/Date: 11/12/09 1300

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other Bailer (circle or add one)

Pump installation crew: JAB, CPS

Casing diameter (inches): 2

Total well depth (ft. BTOC): 22.22

Bladder pump settings: CPM ____

Refill (seconds): ____

Discharge (seconds): ____

Throttle (psi): ____

Discharge tube length (ft.): 25

Screen Interval (ft. BTOC): 11.64 to 21.64

Pump intake depth (ft BTOC): —

Max. sustainable pump rate (mL/min): —

Appearance of product: —

Discharge tube diameter: 1/4" ID

Inlet reducer used (Y/N): —

PID: — ppm H_2S: 0 ppm

LEL: LEL: 0 %; Oxygen: 20.9 %; Carbon: 0 ppm

Purging

Purging/sampling crew: JAB

Purge date/beginning time: 11/12/09 1315

Initial (pre-purging) DTW (ft. BTOC): 17.00

Purge date/completion time: 11/12/09 1430

Final (post-purging) DTW (ft. BTOC): ~~21.6~~ dry

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters

Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube

Tubing length = 25 ft.

Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 25 ft) + 0.3 L = 0.55 L

No. of tubing volumes purged: 3

Total purge volume: Tubing volume (L) x No. of tubing volumes purged = 0.55 L x 3 = 1.65 L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft

Well volume (gallons) = Water Column (ft) x Gal/ft = 5.22 ft x 0.164 Gal/ft = 0.86 gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. In inches & d is casing dia. in inches

= 0.041 x ((8)^2 - (2)^2) = 2.46 gal/ft

Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)

= ((Screen Height 10 ft + 0 ft) x 2.46 gal/ft) x 0.3 = 7.38 gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = 7.38 gal + 0.86 gal = 8.24 gal X 3.785 L/gal = 31.2 L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)									
				±1	±3	±10	±0.1	±10	3 < 100

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
11/12/09	1329	17.31	42	1L	12.82	0.958	-10.7	7.04	2.24	22.2
		~~17~~ 17.40	40		13.34	0.970	-10.3	7.03	1.72	24.0
	1347	17.51	32	1.65L	13.76	0.979	-10.0	7.02	1.45	13.7
	1353	17.60	42	1.98L	13.90	0.979	-9.6	7.01	1.43	8.8
	1402	17.62	32		14.45	0.983	-8.3	~~7.00~~ 6.99	1.41	7.3
	1409	17.70	32	2.41L	14.59	0.990	-8.3	6.99	1.32	7.8
			Low Flow Not possible							

GROUNDWATER SAMPLING FORM

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
			AP2-MW04							

Sampling

Shaw™ Shaw Environmental, Inc. _____ Sampling completion time: _____

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
11/13/09	0900	20.62								

Sample Information

Sample ID: AP3075

Duplicate sample collected (Y/N): N

Split sample collected (Y/N): N

Sample collection date/time: 11/13/09 0900

Duplicate sample ID: N

Split sample ID: N

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers
Explosive	8330				

Comments:

Well did not recharge. Only 2 1L ambers could be collected for explosive analysis.

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: ~~PWACCT~~ CPS PW111309 ACCT

Location Code: **AP2-MW02**

Sample Number: **AP3076**

Sample Name: **PBOW-09-GW-AP2-MW02-AP3076-REG**

Sampling Method: **BP**

Sample Type: **GW** *Sample Purpose:* **REG**

Sampling Equip: bladder purge / bailer - sample

QC Partners:

(TB) N (ER) N (FB) N

Task: **OCT09-GW**

Collection Date: 11/13/09

Collection Time: 0830

Start Depth: —

End Depth: —

Sample Matrix: **WATER**

Sample Team: JAB, CPS

ERPIMS Values:

Sacode:

Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type	
~~VOLATILES~~	~~N~~	~~A~~	~~3~~	~~40~~	~~mL~~	~~VOA VIAL~~	CPS
~~SEMIVOLATILES3~~	~~N~~	~~B~~	~~2~~	~~1~~	~~L~~	~~Amb. Glass~~	CPS
EXPLOSIVES	N	C	2	1	L	Amb. Glass	
~~HARDNESS~~	~~N~~	~~D~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~	
~~METALS3-W~~	~~N~~	~~D~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~	
~~METALS3-W-F~~	~~Y~~	~~E~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~	
~~ALKALINITY~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~	
~~CHLORIDE~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~	
~~SULFATE~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~	
~~TDS~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~	
~~TSS~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~	
~~TURB 180.I~~	~~N~~	~~F~~	~~1~~	~~1~~	~~L~~	~~HDPE~~	
~~NO2/NO3~~	~~N~~	~~G~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~	
~~CYANIDE~~	~~N~~	~~H~~	~~1~~	~~500~~	~~mL~~	~~HDPE~~	

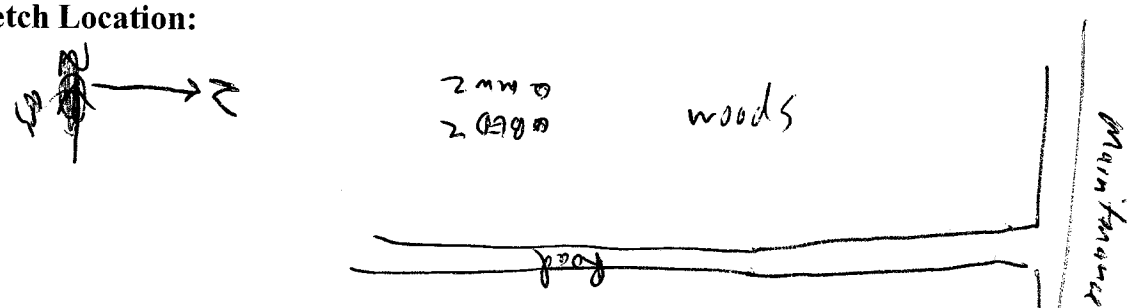
CPS

Groundwater Information:

Measured Well Depth: 18.52 **Depth To Water:** 14.08

Comments: Well did not recharge. Only Explosives could be collected. Well water was highly turbid and high sediment content.

Sketch Location:



Logged BY / Date: 11/13/09 *Reviewed BY / Date:* 2/18/10

ROUNDWATER SAMPLING FORM

Sheet 1 of 2

Shaw Environmental, Inc.

Area or Site ID: AP2

Sample ID: AP3076

Weather: clear 45° slight breeze

Sampling location ID: AP2-MW02

Collection Time/Date: 11/12/09 1100

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other_____ (circle or add one)

Pump installation crew: JAB, CPS

Casing diameter (inches): 2

Total well depth (ft. BTOC): 18.52

Bladder pump settings: CPM

Refill (seconds):

Discharge (seconds):

Throttle (psi):

Discharge tube length (ft.): 25

Screen Interval (ft. BTOC): 5.35 to 15.35

Pump intake depth (ft BTOC): 10.35

Max. sustainable pump rate (mL/min): —

Appearance of product: —

Discharge tube diameter: 1/4" ID

Inlet reducer used (Y/N): —

PID: ppm H_2S: 0 ppm

LEL: LEL: 0 %; Oxygen: 20.8%; Carbon: 0 ppm

Purging

Purging/sampling crew: JAB, CPS

Purge date/beginning time: 11/12/09 1120

Initial (pre-purging) DTW (ft. BTOC): 14.08

Purge date/completion time: 11/12/09 1242

Final (post-purging) DTW (ft. BTOC): dry

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters

Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube

Tubing length = 25 ft.

Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 25 ft) + 0.3 L = 0.55 L

No. of tubing volumes purged: 3

Total purge volume: Tubing volume (L) x No. of tubing volumes purged = 0.55 L x 3 = 1.65 L

No Low Flow

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft

Well volume (gallons) = Water Column (ft) x Gal/ft = 4.44 ft x 0.164 Gal/ft = 0.728 gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. In inches & d is casing dia. in inches

= 0.041 x ((8)^2 - (2)^2) = 2.46 gal/ft

Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)

= ((Screen Height 10 ft + 0 ft) x 2.46 gal/ft) x 0.3 = 7.38 gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = 7.38 gal + 0.73 gal = 8.11 gal X 3.785 L/gal = 30.1 L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume
30	60	90		

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)									
				±1	±3	±10	±0.1	±10	3<100

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
11/12/09	1141	14.40	44	1L	10.55	1.43	-9.1	7.01	2.56	124.2
11/12/09	1151	14.53	38	—	10.84	1.46	-8.7	7.00	2.86	189.2
11/12/09	1206	14.74	50	—	10.74	1.41	-8.0	6.99	2.63	363.2
11/12/09	1218	14.95	50	—	10.59	1.40	-7.7	6.98	2.56	356.4
11/12/09	1223	15.10	50	3.1L	10.69	1.39	-7.2	6.98	2.15	72.1
				No Low Flow						

GROUNDWATER SAMPLING FORM

Sheet 2 of 2

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

AR2 - MW02

Sampling

Shaw Environmental, Inc.

Sampling completion time: _____

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
11/13/09	0830	16.99								

Sample Information

Sample ID: AR3076

Sample collection date/time: 11/13/09 0830

Duplicate sample collected (Y/N): N

Duplicate sample ID: _____

Split sample collected (Y/N): N

Split sample ID: _____

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers
Explosives	8330				

Comments: Only 2 1L ambers were collected because well would not recharge. High sediment & Turbidity

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

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Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: —

Location Code: **AP2-MW03**
Sample Number: **AP3077**
Sample Name: **PBOW-09-GW-AP2-MW03-AP3077-REG**
Sampling Method: **BP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: —

Task: **OCT09-GW**
Collection Date: —
Collection Time: —
Start Depth: —
End Depth: —
Sample Matrix: **WATER**
Sample Team: JAB / CPS

QC Partners:
(TB) — (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

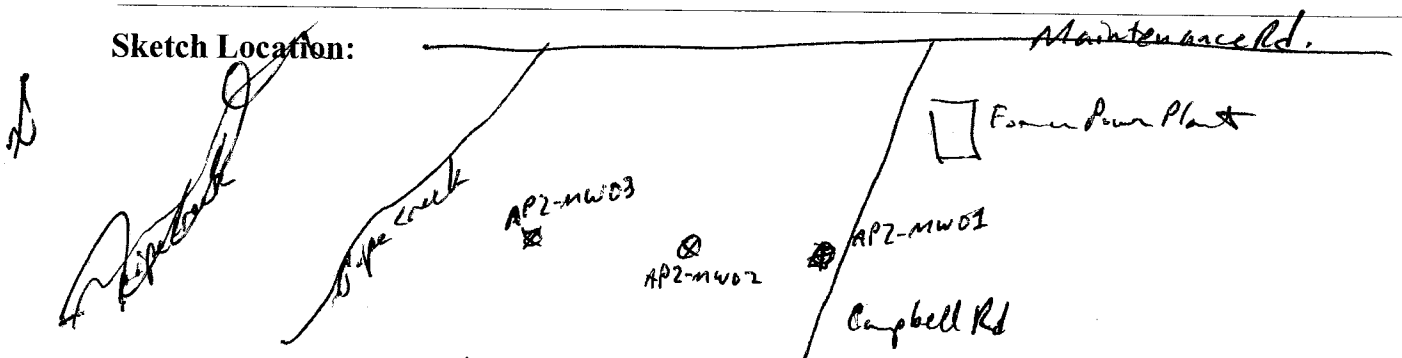
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	500	mL	HDPE
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
CYANIDE	N	H	1	500	mL	HDPE

Groundwater Information:
Measured Well Depth: 12.45 **Depth To Water:** —

Comments: Dry Well

Sketch Location:



Logged BY / Date: E. W. Weaver 11-12-09 *Reviewed BY / Date:* Edward Gowan 2/18/10

ROUNDWATER SAMPLING FORM

Sheet 1 of 2

Shaw Environmental, Inc.

Area or Site ID: PBOW

Sample ID: —

Weather: —

Sampling location ID: APZ-MW03

Collection Time/Date: —

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other — (circle or add one)

Pump installation crew: —

Casing diameter (inches): 2"

Total well depth (ft. BTOC): 12.45'

Bladder pump settings: CPM —

Refill (seconds): —

Discharge (seconds): —

Throttle (psi): —

Discharge tube length (ft.): —

Screen Interval (ft. BTOC): ____ to ____

Pump intake depth (ft BTOC): —

Max. sustainable pump rate (mL/min): —

Appearance of product: —

Discharge tube diameter: 1/4" ID

Inlet reducer used (Y/N): —

PID: 0 ppm

H_2S: 0 ppm

LEL: LEL: 0 %; Oxygen: 20.9 %; Carbon: 0 ppm

Purging

Purging/sampling crew: ____

Purge date/beginning time: ____

Initial (pre-purging) DTW (ft. BTOC): ____

Purge date/completion time: ____

Final (post-purging) DTW (ft. BTOC): ____

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters

Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft.

0.02 L for a 3/8" I.D. tube

Tubing length = ____ ft.

Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x ____ ft) + 0.3 L = ____ L

No. of tubing volumes purged: ____

Total purge volume: Tubing volume (L) x No. of tubing volumes purged = ____ L x ____ = ____ L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (____)^2) = ____ gal/ft

Well volume (gallons) = Water Column (ft) x Gal/ft = ____ ft x ____ Gal/ft = ____ gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. In inches & d is casing dia. in inches

= 0.041 x ((____)^2 - (____)^2) = ____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)

= ((Screen Height ____ ft + ____ ft) x ____ gal/ft) x 0.3 = ____ gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = ____ gal + ____ gal = ____ gal X 3.785 L/gal = ____ L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)									

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)

Dry Well

GROUNDWATER SAMPLING FORM

Sheet 2 of 2

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

Dry Well

Sampling

No Sample Collected

Sampling completion time:

Shaw™ Shaw Environmental, Inc.

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

Sample Information

Sample ID:

Sample collection date/time:

Duplicate sample collected (Y/N):

Duplicate sample ID:

Split sample collected (Y/N):

Split sample ID:

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers

Comments:

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: —

Location Code: **AP2-BEDGW-001**
Sample Number: **AP3078**
Sample Name: **PBOW-09-GW-AP2-BEDGW-001-AP3078-RI**
Sampling Method: **BP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Bailer to purge

Task: **OCT09-GW**
Collection Date: —
Collection Time: —
Start Depth: —
End Depth: —
Sample Matrix: **WATER**
Sample Team: JAB, CPS

QC Partners:
(TB) N (ER) N (FB) N

ERPIMS Values:
Sacode:
Lot Control#:

Containers

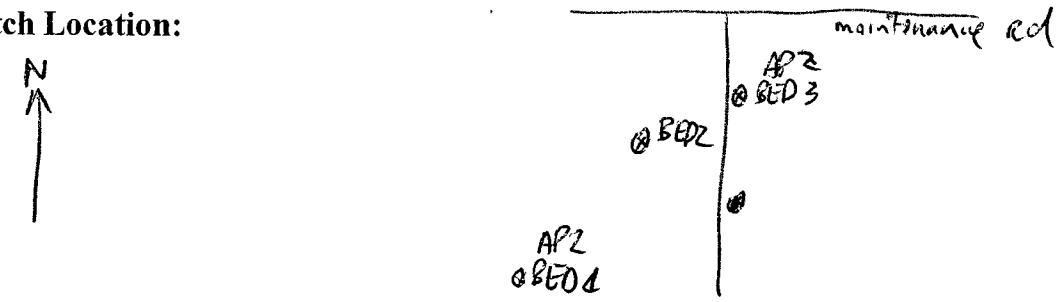
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	500	mL	HDPE
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
CYANIDE	N	H	1	500	mL	HDPE

CPS

Groundwater Information:
Measured Well Depth: 95.53 **Depth To Water:** 95.52

Comments: Sample not collected. Well does not recharge after removing ~ < 1 gallon of water.

Sketch Location:



Logged BY / Date: CJA 11/12/09 *Reviewed BY / Date:* Edward Gohlen 2/18/10

ROUNDWATER SAMPLING FORM

Sheet 1 of 2

Shaw Environmental, Inc.

Area or Site ID: AP2

Sample ID: AP3079

Weather: Sunny 50°

Sampling location ID: AP2 - BEDGW001

Collection Time/Date: 11/12/09 1600

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other bailer (circle or add one)

Pump installation crew: JAB, CPS

Casing diameter (inches): 2

Total well depth (ft. BTOC): 88.53

Bladder pump settings: CPM —

Refill (seconds): —

Discharge (seconds): —

Throttle (psi): —

Discharge tube length (ft.): —

Screen Interval (ft. BTOC): 73.50 to 88.53

Pump intake depth (ft BTOC): —

Max. sustainable pump rate (mL/min): —

Appearance of product: None

Discharge tube diameter: 1/4" ID

Inlet reducer used (Y/N):

PID : — ppm H_2S: 0 ppm

LEL: LEL: 0 %; Oxygen: 20.9 %; Carbon: 0 ppm

Purging

Purging/sampling crew:

Purge date/beginning time: 11/12/09 1557

Initial (pre-purging) DTW (ft. BTOC): 85.52

Purge date/completion time:

Final (post-purging) DTW (ft. BTOC):

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters

Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube

Tubing length = _____ ft.

Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x ____ ft) + 0.3 L = _____ L

No. of tubing volumes purged: _____

Total purge volume: Tubing volume (L) x No. of tubing volumes purged = _____ L x _____ = _____ L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft

Well volume (gallons) = Water Column (ft) x Gal/ft = 3.01 ft x 0.164 Gal/ft = 0.49 gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. In inches & d is casing dia. in inches

= 0.041 x ((8)^2 - (2)^2) = 2.46 gal/ft

Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)

= ((Screen Height 10 ft + 8 ft) x 2.46 gal/ft) x 0.3 = 7.38 gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = 0.49 gal + gal = 7.88 gal X 3.785 L/gal = 29.7 L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume

well purging dry w/ < 1 gallon

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)									

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
Not enough water to collect a water quality parameter										

GROUNDWATER SAMPLING FORM

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
			APZ - BGPGW001							

Sampling

Shaw™ Shaw Environmental, Inc. _____ Sampling completion time: _____

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

Sample Information

Sample ID: _____ Sample collection date/time: _____

Duplicate sample collected (Y/N): _____ Duplicate sample ID: _____

Split sample collected (Y/N): _____ Split sample ID: _____

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers

Comments: Well Not Sampled due to inadequate recharge.

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

Shaw
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW111809 ACCT

Location Code: **AP2-BEDGW-002**
Sample Number: **AP3079**
Sample Name: **PBOW-09-GW-AP2-BEDGW-002-AP3079-R1**
Sampling Method: **BP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Bladder pump, tubing

Task: **OCT09-GW**
Collection Date: 11-17-09
Collection Time: 0945
Start Depth: 28.20'
End Depth: 28.20'
Sample Matrix: **WATER**
Sample Team: EW/BT

QC Partners:
(TB) ____ (ER) AP2- ____ (FB) ____

ERPIMS Values:
Sacode: ____
Lot Control#: ____

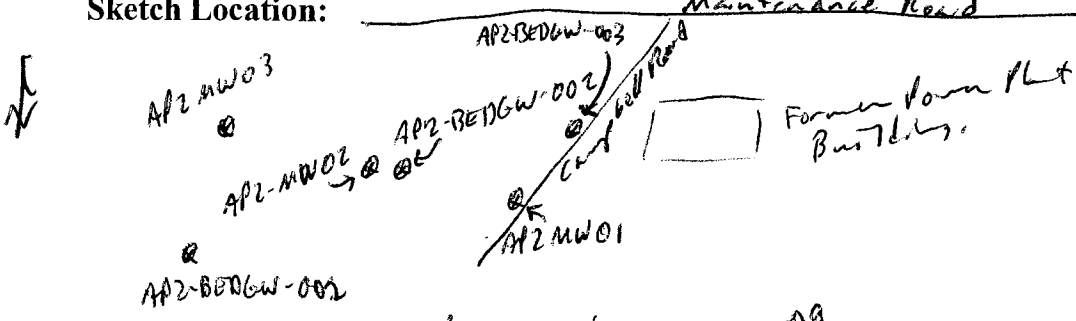
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	500	mL	HDPE
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
CYANIDE	N	H	1	500	mL	HDPE

Groundwater Information:
Measured Well Depth: 85.35' **Depth To Water:** 28.20'

Comments: Fe^{2+} 0.0 mg/L. Also collected ~~[illegible]~~ AP3079MS, AP3079MSD, AP3081 (FD), and AP3082 (FS) at this location. Equipment Rinsate sample collected after decontamination of pump used at this location

Sketch Location:



Logged BY / Date: [signature] 11-17-09 *Reviewed BY / Date:* [signature] 2/18/10

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW11809 ACCT

Location Code: **AP2-BEDGW-002**

Sample Number: **AP3079-MS**

Sample Name: **PBOW-09-GW-AP2-BEDGW-002-AP3079-M**

Sampling Method: **BP**

Sample Type: **GW** *Sample Purpose:* **MS**

Sampling Equip: Bladder pump tubing

Task: **OCT09-GW**

Collection Date: 11-17-09

Collection Time: 0945

Start Depth: 28.20'

End Depth: 28.20'

Sample Matrix: **WATER**

Sample Team: EW/BT

QC Partners:

(TB) _____ (ER) AP2- _____ (FB) —

ERPIMS Values:

Sacode:

Lot Control#:

Containers

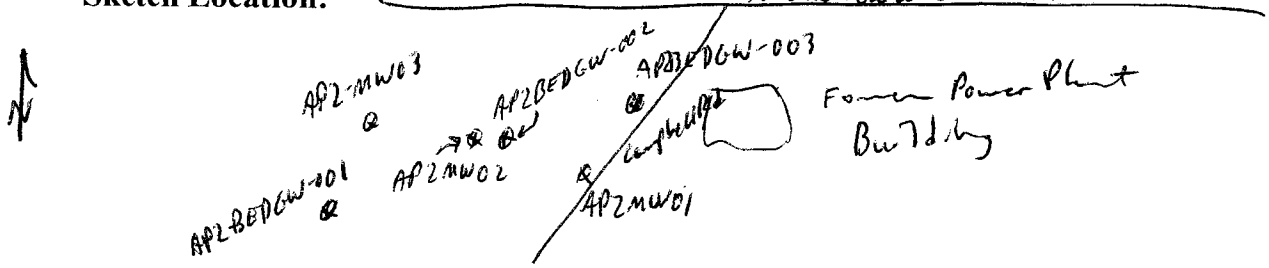
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	500	mL	HDPE
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
CYANIDE	N	H	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 85.35' **Depth To Water:** 28.20'

Comments: Fe^{2+} 0.0 mg/L. Also collected AP3079, AP3079 MSD, AP3081 (FD) and AP3082 (FS) at this location.

Sketch Location:



Logged BY / Date: E W Weaver 11-17-09 *Reviewed BY / Date:* Edward A Weaver 2/18/10

Shaw™
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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW118809 ACCT

Location Code: AP2-BEDGW-002

Sample Number: AP3079-MSD

Sample Name: PBOW-09-GW-AP2-BEDGW-002-AP3079-M

Sampling Method: BP

Sample Type: GW *Sample Purpose:* MSD

Sampling Equip: Bladder pump, tubing

Task: OCT09-GW

Collection Date: 11-17-09

Collection Time: 0945

Start Depth: 28.20

End Depth: 28.20

Sample Matrix: WATER

Sample Team: EW/BT

QC Partners:

(TB) _____ (ER) AP2- (FB) –

ERPIMS Values:

Sacode:

Lot Control#:

Containers

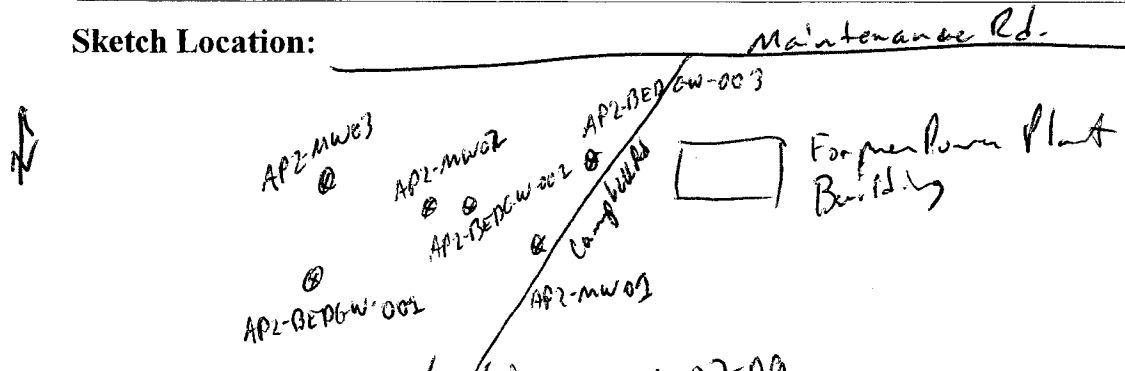
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	500	mL	HDPE
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
CYANIDE	N	H	1	500	mL	HDPE

Groundwater Information:

Measured Well Depth: 85.35' **Depth To Water:** 28.20'

Comments: Fe^{2+} 0.0 mg/L. Also collected AP3079, AP3079MS, AP3081 (FD) and AP3082 (FS) at this location.

Sketch Location:



Logged BY / Date: [signature] 11-17-09 *Reviewed BY / Date:* [signature] 2/18/12

Shaw™
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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW111809 ACCT

Location Code: **AP2-BEDGW-002**
Sample Number: **AP3081**
Sample Name: **PBOW-09-GW-AP2-BEDGW-002-AP3081-FI**
Sampling Method: **BP**
Sample Type: **GW** *Sample Purpose:* **FD**
Sampling Equip: Bladder pump, tubing

Task: **OCT09-GW**
Collection Date: 11-17-09
Collection Time: 0945
Start Depth: 28.20'
End Depth: 28.20
Sample Matrix: **WATER**
Sample Team: EW/BT

QC Partners:
(TB) _____ (ER) AP2- _____ (FB) –

ERPIMS Values:
Sacode:
Lot Control#:

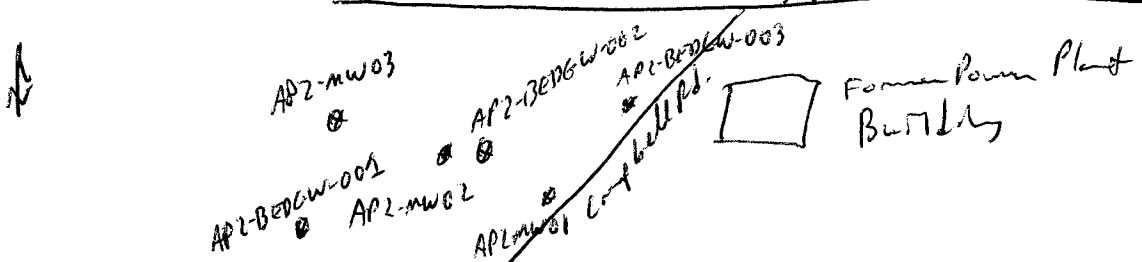
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	500	mL	HDPE
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
CYANIDE	N	H	1	500	mL	HDPE

Groundwater Information:
Measured Well Depth: 85.35' **Depth To Water:** 28.20'

Comments: Fe^{2+} 0.0 mg/L. Also collected AP3079, AP3079MS, AP3079MSD, and AP3082(FS) at this location.

Sketch Location: Maintenance Road



Logged BY / Date: E. W. Weaver 11-17-09 *Reviewed BY / Date:* Edward E. Weaver 2/18/10

Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW111009TA

Location Code: AP2-BEDGW-00~~1~~2

Sample Number: AP3082

Sample Name: PBOW-09-GW-AP2-BEDGW-00~~1~~2-AP3082

Sampling Method: BP

Sample Type: GW *Sample Purpose:* FS

Sampling Equip: Bladder pump, tubing

QC Partners:

(TB) (ER) AP2- (FB) —

Task: OCT09-GW

Collection Date: 11-17-09

Collection Time: 0945

Start Depth: 28.20'

End Depth: 28.20'

Sample Matrix: WATER

Sample Team: EW/BT

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	250	mL	HDPE
METALS3-W	N	D	1	1	L	HDPE
METALS3-W-F	Y	E	1	1	L	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	250	mL	HDPE
CYANIDE	N	H	1	250	mL	HDPE

ERPIMS Values:

Sacode:

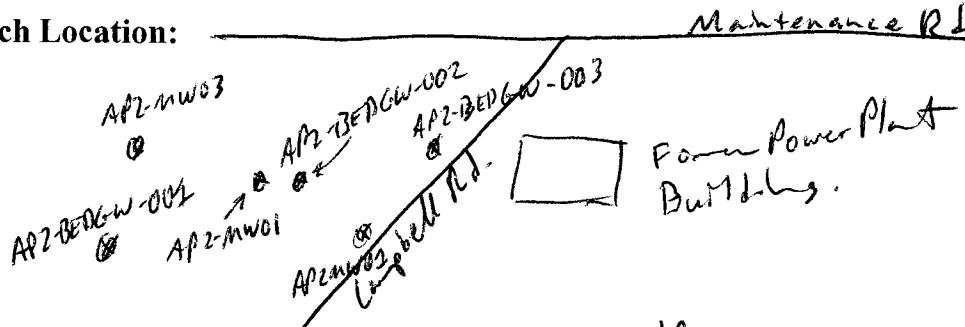
Lot Control#:

Groundwater Information:

Measured Well Depth: 85.35' **Depth To Water:** 28.20'

Comments: Fe^{2+} 0.0 mg/L. Also collected AP3079, AP3079 MS, AP3079 MSD, and AP3081 (FD) at this location

Sketch Location: Maintenance Rd



Logged BY / Date: EW Weaver 11-17-09 *Reviewed BY / Date:* Edward S. Weaver 2/16/10

ROUNDWATER SAMPLING FORM

Sheet 1 of 2

Shaw® Shaw Environmental, Inc.

Area or Site ID: PB OW
Sample ID: AP3079
Weather: Clear, Sunny ≈ 45°F

Sampling location ID: APZ-BEDGW-002
Collection Time/Date: 11-17-09 / 0945

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other_____ (circle or add one)

Pump installation crew: EW/BT
Casing diameter (inches): 2"
Total well depth (ft. BTOC): 85.35
Bladder pump settings: CPM 2
Refill (seconds): 27/26
Discharge (seconds): 3/4
Throttle (psi): 40/50
Discharge tube length (ft.): 90'

Screen Interval (ft. BTOC): 70 to 85
Pump intake depth (ft BTOC): 75.7
Max. sustainable pump rate (mL/min): 150
Appearance of product: None
Discharge tube diameter: 1/4" ID
Inlet reducer used (Y/N): N
PID: 0 ppm H_2S: 0 ppm
LEL: LEL: 0 %; Oxygen: 20.8 %; Carbon: 0 ppm

Purging

Purging/sampling crew: EW/BT
Purge date/beginning time: 11-17-09 / 0908
Initial (pre-purging) DTW (ft. BTOC): 28.13

Purge date/completion time: 11-17-09 / 0943
Final (post-purging) DTW (ft. BTOC): 28.20

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters
Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube
Tubing length = 90 ft.
Tubing volume (Liters)= (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 90 ft) + 0.3 L = 1.2 L
No. of tubing volumes purged: 4
Total purge volume: Tubing volume (L) x No. of tubing volumes purged = 1.2 L x 4 = 4.8 L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft
Well volume (gallons) = Water Column (ft) x Gal/ft = 57.22 ft x 0.164 Gal/ft = 9.38 gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. In inches & d is casing dia. in inches
= 0.041 x ((6)^2 - (2)^2) = 1.31 gal/ft
Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)
= ((Screen Height 15 ft + 3 ft) x 1.31 gal/ft) x 0.3 = 7.07 gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = 7.07 gal + 9.38 gal = 16.45 gal X 3.785 L/gal = 62.26 L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)									

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
11-17-09	0908	28.13	1.29	0	—	—	—	—	—	—
11-17-09	0928	28.20	~~1.29~~ .150	2.58	9.66	2.484	-15.5	6.92	2.08	15.7
11-17-09	0933	28.20	.150	3.33	9.60	2.578	-11.4	6.84	0.66	8.0
11-17-09	0938	28.20	.150	4.08	9.62	2.621	-8.5	6.79	0.28	5.9
11-17-09	0943	28.20	.150	4.83	9.67	2.635	-6.9	6.78	1.01	3.6

GROUNDWATER SAMPLING FORM

Sheet 2 of 2

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

EW

Sampling

Shaw Environmental, Inc.

Sampling completion time: 1330

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
11-17-09	0945	28.20	.150	4.83	9.67	2.635	-6.9	6.78	1.01	3.6

Sample Information

Sample ID: AP3079

Duplicate sample collected (Y/N): Y

Split sample collected (Y/N): Y

Sample collection date/time: 11-17-09 / 0945

Duplicate sample ID: AP3081

Split sample ID: AP3082

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers
TCL VOC	8260	3x 40ml vials	Turb, Alk, TDS, TSS, Sulfate, Chloride	Various	1x1L HDPE
Explosives	8330	2x1L Amber			
TCL SVOC	8270	2x1L Amber	Cyanide	9010/9012	1x 500ml HDPE
Total TAL Metals	6010/7470	1x 500ml HDPE	Nitrate	-	1x 500ml HDPE
Dissolved TAL Metals	6010/7470	1x 500ml HDPE			

Comments: Fe^{2+} 0.0 mg/L - Also collected AP3079MS, AP3079MSD, AP3081 (FD) and AP3082 (PS) at this location.

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PW 11 18 09 ACCT

Location Code: **AP2-BEDGW-003**
Sample Number: **AP3080**
Sample Name: **PBOW-09-GW-AP2-BEDGW-003-AP3080-R1**
Sampling Method: **BP**
Sample Type: **GW** *Sample Purpose:* **REG**
Sampling Equip: Bladder pump, tubing

Task: **OCT09-GW**
Collection Date: 11-16-09
Collection Time: 1400
Start Depth: 33.92
End Depth: 33.95
Sample Matrix: **WATER**
Sample Team: CW / BT

QC Partners:
(TB) – (ER) – (FB) –

ERPIMS Values:
Sacode:
Lot Control#:

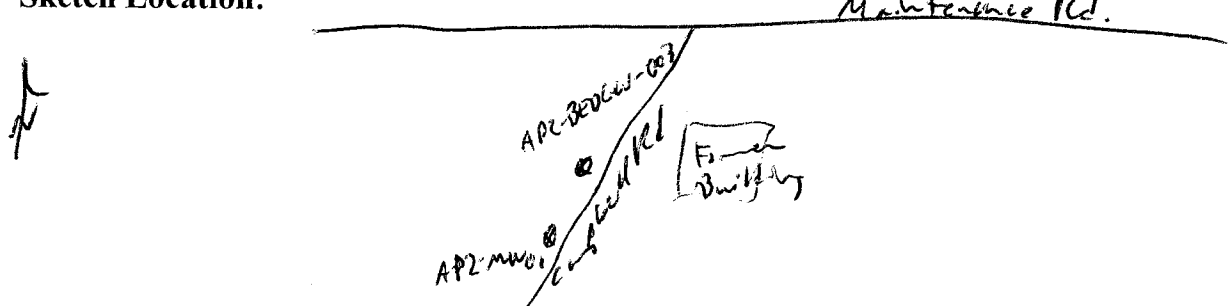
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
VOLATILES	N	A	3	40	mL	VOA VIAL
SEMIVOLATILES3	N	B	2	1	L	Amb. Glass
EXPLOSIVES	N	C	2	1	L	Amb. Glass
HARDNESS	N	D	1	500	mL	HDPE
METALS3-W	N	D	1	500	mL	HDPE
METALS3-W-F	Y	E	1	500	mL	HDPE
ALKALINITY	N	F	1	1	L	HDPE
CHLORIDE	N	F	1	1	L	HDPE
SULFATE	N	F	1	1	L	HDPE
TDS	N	F	1	1	L	HDPE
TSS	N	F	1	1	L	HDPE
TURB 180.1	N	F	1	1	L	HDPE
NO2/NO3	N	G	1	500	mL	HDPE
CYANIDE	N	H	1	500	mL	HDPE

Groundwater Information:
Measured Well Depth: 62.65' **Depth To Water:** 33.92'

Comments: Fe^{2+} 0.0 mg/L

Sketch Location:



Logged BY / Date: L.W. Jones 11-16-09 *Reviewed BY / Date:* Edward [illegible] 2/26/10

ROUNDWATER SAMPLING FORM

Sheet 1 of ___

Shaw™ Shaw Environmental, Inc.

Area or Site ID: PBOW

Sample ID: AP3080

Weather: Cloudy Sprinkles ~48°F

Sampling location ID: AP2-BEDGW-003

Collection Time/Date: 11-16-09/1400

Pump Installation (Bladder/Fultz/Peristaltic/Grundfos/Other_____ (circle or add one)

Pump installation crew: EW/BT

Casing diameter (inches): 2"

Total well depth (ft. BTOC): 62.65

Bladder pump settings: CPM 2

Refill (seconds): 27/28

Discharge (seconds): 3/2

Throttle (psi): 30/32

Discharge tube length (ft.): 67'

Screen Interval (ft. BTOC): 42.5 to 62.5

Pump intake depth (ft BTOC): 51.0'

Max. sustainable pump rate (mL/min): ___

Appearance of product: None

Discharge tube diameter: 1/4" ID

Inlet reducer used (Y/N): N

PID: ___ ppm H_2S: ___ ppm

LEL: LEL: ___ %; Oxygen: ___ %; Carbon: ___ ppm

Purging

Purging/sampling crew: EW/BT

Purge date/beginning time: 11-16-09

Initial (pre-purging) DTW (ft. BTOC): 32.92

Purge date/completion time: 11-16-09/1610

Final (post-purging) DTW (ft. BTOC): 33.95

Low Flow purge tubing volume calculations

Volume of Water in Tubing:

Bladder pump volume = 0.3 Liters

Tubing Liters/ft. (1/4" ID tubing) = 0.01 Liters/ft. 0.02 L for a 3/8" I.D. tube

Tubing length = 67 ft.

OK was able to low flow. EW

Tubing volume (Liters) = (Tubing Liters/ft. x Tubing length) + Pump volume = (0.01 L/ft x 67 ft) + 0.3 L = 0.97 L

No. of tubing volumes purged: 4.34

Total purge volume: Tubing volume (L) x No. of tubing volumes purged = 0.97 L x 4.34 = 4.25 L

Monitoring well purge volume calculations

Volume of Water in Casing:

Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft

Well volume (gallons) = Water Column (ft) x Gal/ft = 29.73 ft x 0.164 Gal/ft = 4.88 gallons

Volume of Water in Filter Pack:

Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. In inches & d is casing dia. in inches

= 0.041 x ((6)^2 - (2)^2) = 1.31 gal/ft

Filter Pack Volume (gal) = ((Screen Height + water column above screen to below bent.) x gal/ft) x porosity (0.3)

= ((Screen Height 15 ft + 3 ft) x 1.31 gal/ft) x 0.3 = 7.07 gallons

Well Purge Volume:

Well Purge Volume = Filter Pack Volume + Well Volume = 7.07 gal + 4.88 gal = 11.95 gal X 3.785 L/gal = 45.23 L

1 x Well Purge Volume	2 x Well Purge Volume	3 x Well Purge Volume	4 x Well Purge Volume	5 x Well Purge Volume
45.23	90.46	135.69	180.92	226.15

Purge Rate

	Initial	2	3	4	5	6	7	8	Final
Flow rate (L/min)									

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidiy (NTU)
11-16-09	1248	32.92	.106	0	—	—	—	—	—	—
11-16-09	1303	33.80	.046	1.59	9.36	1.728	-27.6	7.20	2.57	7.1
11-16-09	1313	33.70	.066	2.05	9.14	1.864	-18.6	7.04	1.18	0.1
11-16-09	1323	33.80	.050	2.71	8.93	2.080	-8.5	6.85	0.88	0.0
11-16-09	1333	33.91	.050	3.21	8.92	2.203	-2.0	6.72	3.82	0.0
11-16-09	1343	34.00	.050	3.71	8.86	2.241	-1.6	6.71	4.54	0.0
11-16-09	1353	33.95	.050	4.21	8.87	2.202	-1.8	6.72	4.51	0.0

GROUNDWATER SAMPLING FORM

Sheet 2 of 2

Water Quality Parameter Measurements (continued)

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)

Sampling

Shaw Shaw Environmental, Inc.

Sampling completion time: 1610

Water Quality Parameter Measurements

Date	Time	DTW (ft. BTOC)	Purge Rate (L/min)	Purge Volume (L)	Temp. (C)	Electrical Conductivity (mS/cm)	ORP (mV)	pH (std units)	DO (mg/L)	Turbidity (NTU)
11-16-09	1400	33.92	0.050	4.25	8.87	2.202	-1.8	6.72	4.51	0.0

Sample Information

Sample ID: AP3080

Sample collection date/time: 11-16-09/1400

Duplicate sample collected (Y/N): –

Duplicate sample ID: –

Split sample collected (Y/N): –

Split sample ID: –

Requested Analysis	Method	Containers	Requested Analysis	Method	Containers
TCL VOC	8260	3 x 40 ml vials	Alk, Total, TDS, TSS, Sulfate, Chloride		1 x 1L HDPE
Explosives	8330	2 x 1L Amber	Nitrate	–	1 x 500 ml HDPE
TCL SVOC	8270	2 x 1L Amber	Cyanide	9010/9012	1 x 500 ml HDPE
Total TAL Metals	6010/7470	1 x 500 ml HDPE			
Dissolved TAL Metals	6010/7470	1 x 500 ml HDPE			

Comments: Fe^{2+} 0.0 mg/L

Abbreviations: BTOC - Below top of casing; DTW - Depth to water; H - head above pump intake; mL - milliliter; L - Liter;

APPENDIX C

ROCK CORE PHOTOGRAPHS

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

1 of 8

Depth:

20.5' to 29.9'

Comments:

Photo 1: View of entire box.

Boring:

AP2-BEDGW-001

Box:

1 of 8

Depth:

20.5' to 29.9'

Comments:

Photo 2: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE | **Project Number: 133422**

Site Name: Former Plum Brook Works | **Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

1 of 8

Depth:

20.5' to 29.9'

Comments:

Photo 3: Close-up view of right portion of box.

Boring:

AP2-BEDGW-001

Box:

2 of 8

Depth:

29.9' to 37.9'

Comments:

Photo 4: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE | **Project Number: 133422**

Site Name: Former Plum Brook Works | **Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

2 of 8

Depth:

29.9' to 37.9'

Comments:

Photo 5: Close-up view of left portion of box.

Boring:

AP2-BEDGW-001

Box:

2 of 8

Depth:

29.9' to 37.9'

Comments:

Photo 6: Close-up view of right portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

3 of 8

Depth:

37.9' to 46.0'

Comments:

Photo 7: View of entire box.

Note: Box is marked 46.8 but should be 46.0

Boring:

AP2-BEDGW-001

Box:

3 of 8

Depth:

37.9' to 46.0'

Comments:
Photo 8: Close-up view of left portion of box.

Note: Box is marked 46.8 but should be 46.0

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

3 of 8

Depth:

37.9' to 46.0'

Comments:
Photo 9: Close-up view of right portion of box.
Note: Box is marked 46.8 but should be 46.0

Boring:

AP2-BEDGW-001

Box:

4 of 8

Depth:

46.0' to 55.9'

Comments:

Photo 10: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

4 of 8

Depth:

46.0’ to 55.9’

Comments:

Photo 11: Close-up view of left portion of box.

Boring:

AP2-BEDGW-001

Box:

4 of 8

Depth:

46.0’ to 55.9’

Comments:

Photo 12: Close-up view of right portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

5 of 8

Depth:

55.9' to 65.7'

Comments:

Photo 13: View of entire box.

Boring:

AP2-BEDGW-001

Box:

5 of 8

Depth:

55.9' to 65.7'

Comments:

Photo 14: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE **Project Number: 133422**

Boring:

AP2-BEDGW-001

Box:

5 of 8

Depth:

55.9' to 65.7'

Comments:

Photo 15: Close-up view of right portion of box.

Boring:

AP2-BEDGW-001

Box:

6 of 8

Depth:

65.7' to 75.4'

Comments:

Photo 16: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE | **Project Number: 133422**

Site Name: Former Plum Brook Works | **Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

6 of 8

Depth:

65.7' to 75.4'

Comments:

Photo 17: Close-up view of left portion of box.

Boring:

AP2-BEDGW-001

Box:

6 of 8

Depth:

65.7' to 75.4'

Comments:

Photo 18: Close-up view of right portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Cient: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

7 of 8

Depth:

75.4' to 84.2'

Comments:

Photo 19: View of entire box.

Boring:

AP2-BEDGW-001

Box:

7 of 8

Depth:

75.4' to 84.2'

Comments:

Photo 20: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

7 of 8

Depth:

75.4' to 84.2'

Comments:

Photo 21: Close-up view of right portion of box.

Boring:

AP2-BEDGW-001

Box:

8 of 8

Depth:

84.2' to 87.0'

Comments:

Photo 22: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-001

Box:

8 of 8

Depth:

84.2' to 87.0'

Comments:

Photo 23: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

1 of 8

Depth:

21.1' to 30.8'

Comments:

Photo 1: View of entire box.

Boring:

AP2-BEDGW-002

Box:

1 of 8

Depth:

21.1' to 30.8'

Comments:

Photo 2: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE | **Project Number: 133422**

Site Name: Former Plum Brook Works | **Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

1 of 8

Depth:

21.1' to 30.8'

Comments:

Photo 3: Close-up view of right portion of box.

Boring:

AP2-BEDGW-002

Box:

2 of 8

Depth:

30.8' to 37.6'

Comments:

Photo 4: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE | **Project Number: 133422**

Site Name: Former Plum Brook Works | **Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

2 of 8

Depth:

30.8' to 37.6'

Comments:

Photo 5: Close-up view of left portion of box.

Boring:

AP2-BEDGW-002

Box:

2 of 8

Depth:

30.8' to 37.6'

Comments:

Photo 6: Close-up view of right portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

3 of 8

Depth:

37.6' to 46.1'

Comments:

Photo 7: View of entire box.

Boring:

AP2-BEDGW-002

Box:

3 of 8

Depth:

37.6' to 46.1'

Comments:
Photo 8: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

3 of 8

Depth:

37.6' to 46.1'

Comments:
Photo 9: Close-up view of right portion of box.

Boring:

AP2-BEDGW-002

Box:

4 of 8

Depth:

46.1' to 55.5'

Comments:

Photo 10: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

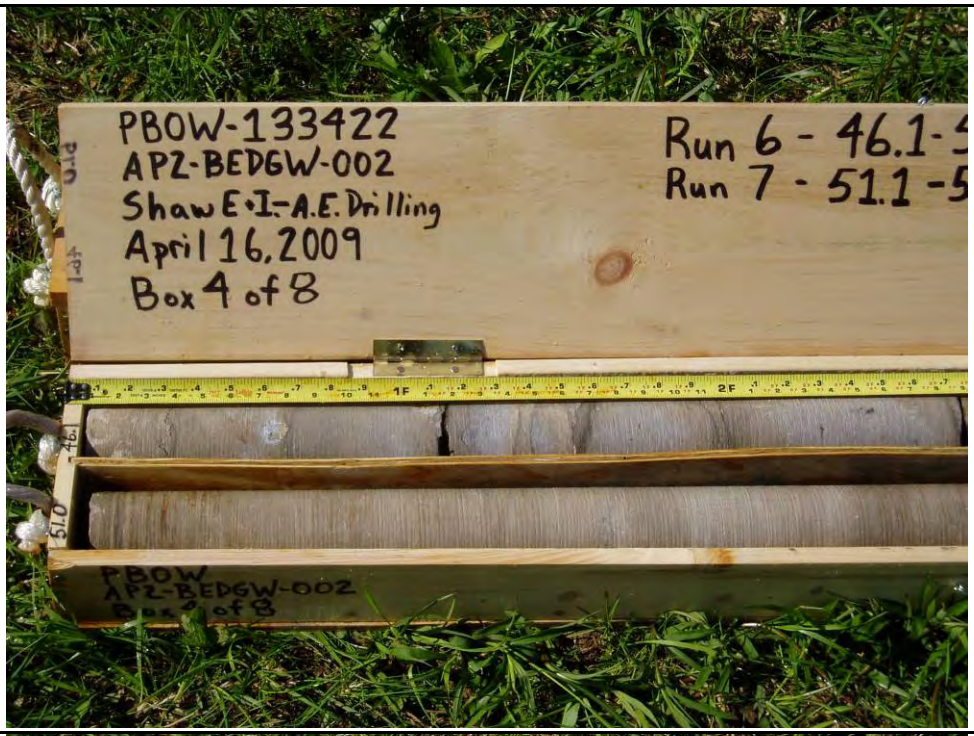
4 of 8

Depth:

46.1' to 55.5'

Comments:

Photo 11: Close-up view of left portion of box.



Boring:

AP2-BEDGW-002

Box:

4 of 8

Depth:

46.1' to 55.5'

Comments:

Photo 12: Close-up view of right portion of box.

Shaw
Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

5 of 8

Depth:

55.5' to 65.3'

Comments:

Photo 13: View of entire box.

Boring:

AP2-BEDGW-002

Box:

5 of 8

Depth:

55.5' to 65.3'

Comments:

Photo 14: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

5 of 8

Depth:

55.5’ to 65.3’

Comments:

Photo 15: Close-up view of right portion of box.

Boring:

AP2-BEDGW-002

Box:

6 of 8

Depth:

65.3’ to 74.5’

Comments:

Photo 16: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

6 of 8

Depth:

65.3' to 74.5'

Comments:

Photo 17: Close-up view of left portion of box.

Boring:

AP2-BEDGW-002

Box:

6 of 8

Depth:

65.3' to 74.5'

Comments:

Photo 18: Close-up view of right portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

7 of 8

Depth:

74.5' to 83.4'

Comments:

Photo 19: View of entire box.

Boring:

AP2-BEDGW-002

Box:

7 of 8

Depth:

74.5' to 83.4'

Comments:

Photo 20: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE | **Project Number: 133422**

Site Name: Former Plum Brook Works | **Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

7 of 8

Depth:

74.5' to 83.4'

Comments:

Photo 21: Close-up view of right portion of box.

Boring:

AP2-BEDGW-002

Box:

8 of 8

Depth:

83.4' to 86.1'

Comments:

Photo 22: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-002

Box:

8 of 8

Depth:

83.4' to 86.1'

Comments:

Photo 23: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-003

Box:

1 of 5

Depth:

24.5' to 34.0'

Comments:

Photo 1: View of entire box.

Boring:

AP2-BEDGW-003

Box:

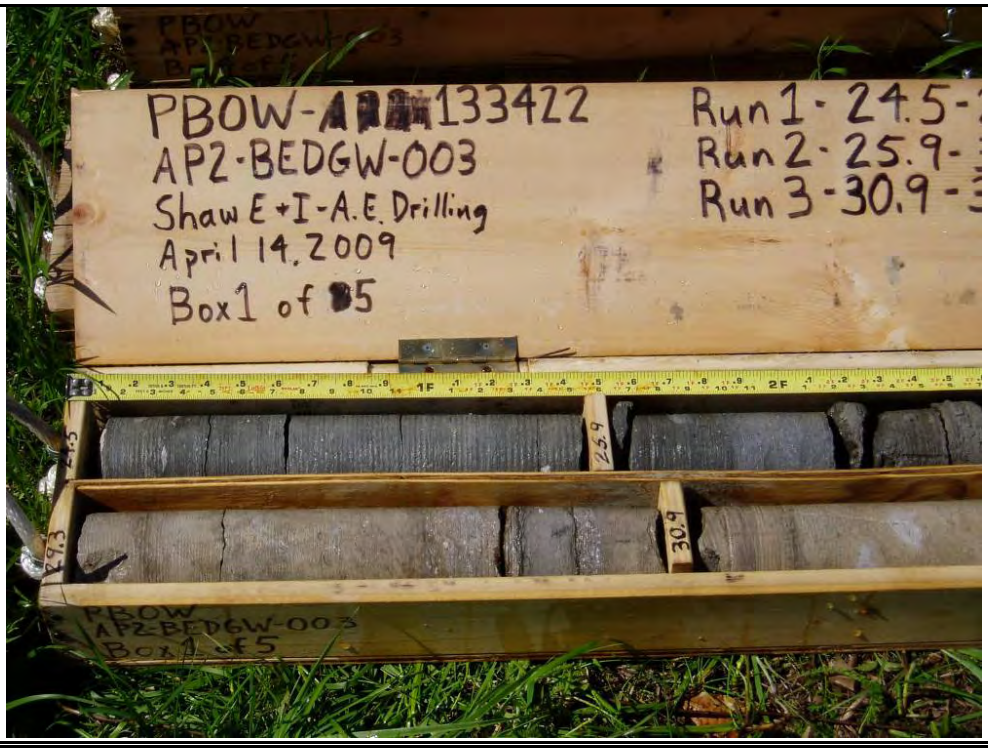
1 of 5

Depth:

24.5' to 34.0'

Comments:

Photo 2: Close-up view of left portion of box.



Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE | **Project Number: 133422**

Site Name: Former Plum Brook Works | **Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-003

Box:

1 of 5

Depth:

24.5' to 34.0'

Comments:

Photo 3: Close-up view of right portion of box.

Boring:

AP2-BEDGW-003

Box:

2 of 5

Depth:

34.0' to 42.4'

Comments:

Photo 4: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE | **Project Number: 133422**

Site Name: Former Plum Brook Works | **Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-003

Box:

2 of 5

Depth:

34.0' to 42.4'

Comments:

Photo 5: Close-up view of left portion of box.

Boring:

AP2-BEDGW-003

Box:

2 of 5

Depth:

34.0' to 42.4'

Comments:

Photo 6: Close-up view of right portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-003

Box:

3 of 5

Depth:

42.4' to 51.1'

Comments:

Photo 7: View of entire box.

Boring:

AP2-BEDGW-003

Box:

3 of 5

Depth:

42.4' to 51.1'

Comments:
Photo 8: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-003

Box:

3 of 5

Depth:

42.4' to 51.1'

Comments:
Photo 9: Close-up view of right portion of box.

Boring:

AP2-BEDGW-003

Box:

4 of 5

Depth:

51.1' to 56.1'

Comments:

Photo 10: View of entire box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-003

Box:

4 of 5

Depth:

51.1' to 56.1'

Comments:

Photo 11: Close-up view of left portion of box.

Boring:

AP2-BEDGW-003

Box:

4 of 5

Depth:

51.1' to 56.1'

Comments:

Photo 12: Close-up view of right portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-003

Box:

5 of 5

Depth:

56.1' to 61.0'

Comments:

Photo 13: View of entire box.

Boring:

AP2-BEDGW-003

Box:

5 of 5

Depth:

56.1' to 61.0'

Comments:

Photo 14: Close-up view of left portion of box.

Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Boring:

AP2-BEDGW-003

Box:

5 of 5

Depth:

56.1' to 61.0'

Comments:

Photo 15: Close-up view of right portion of box.

Shaw E & I, Inc.

APPENDIX D

WELL DEVELOPMENT LOGS AND WELL DEVELOP WATER PHOTOGRAPHS

Stickup 2.54

Shaw
Shaw E & I, Inc.

Well Development Log

Project Number: 133422
Project Name: PBGW
Form Completed by: David Kessler / B. Tiell
Well Developed by/firm: David Kessler / Shaw
B. Tiell

Site ID: Ash Pit #2
Location ID: AP2-MW01
Date Started: 4/21/09

Monitoring Well Information

Development Method: Pump / Surge
Development Equipment: Waterra Pump
w/ 1/2" OD x 5/8" OD HDPE tubing and YSI 6820

Screen Height (ft): 10
Filter pack length (ft): 13
Casing Diameter (in): 2

Begining Measurements (BTOC)
Depth to Water (ft): 11.03
Total depth of Well (ft): 22.20
water column = 11.17'

Monitoring Well Purge Calculations

Volume of Water in Casing:
Gallons/foot = 0.041 x d^2, where casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft.
Well Volume (gallons) = Water Column (ft) x Gal/ft = 11.17 ft x 0.164 gal/ft = 1.83 gallons

Volume of Water in Filter Pack:
Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole diameter in inches & d is casing diameter in inches = 0.041 x ((8.25)^2 - (2)^2) = 2.6 gal/ft.
Filter Pack Volume (gal) = (the less of the filter pack lenght or water column) x gal/ft x porosity (0.3) = (11.17)ft x (2.6) gal/ft x 0.3 = 8.71 gal

Purge Well Volume: Purge well Volume = Filter pack volume + Well Volume = 1.83 gal + 8.71 gal = 10.54 gal.

1 x Purge Well Volume	2 x Purge Well Volume	3 x Purge Well Volume	4 x Purge Well Volume	5 x Purge Well Volume
10.54	21.08	31.62	42.16	52.70

Development Record

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
4/21/09 1135	0	11.03	—	—	—	—	—	—	—	Began Pumping (Manually Surged Screen Inv.)
1145	2.5	14.28	193.8	Gray	10.14	7.32	0.702	9.61	-50.0	Pumping at rate of 970 ml/min
1155	5	16.69	327.3	DK br	8.96	6.92	0.740	8.99	-19.6	
1210	7.5	20.87	190.5	light gray	8.84	6.98	0.648	9.07	-10.0	
stopped 1215	11	>21.5	—	—	—	—	—	—	—	Well will not dry. Recharging at 100 ml/min
1320	11	20.10	—	—	—	—	—	—	—	Began pumping
1355	12	—	37.4	clear	10.84	7.18	0.663	9.61	-32.1	Pumping recharge water.
stopped 4/22/09 1438	—	11.06								start purge
1500	13.00	12.50	17.3	clear	10.97	7.47	0.675	13.08	-33.6	flow rate @ 200 ml/min

Shaw
Shaw E & I, Inc.

Well Development Log (Continuation)

Site ID: Ash Pit #2
Location ID: AP2-MW9
Date Started: 4/21/09

Development Record (continuation)

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
1511	13.5	13.10	15.1	clear	10.14	7.35	0.669	12.93	-23.6	continue @ 200 ml/min
1540	15.0	14.25	6.3	clear	9.29	7.29	0.696	14.13	-25.4	increase flow
1550		15.00	6.8	clear	9.55	7.32	0.705	13.33	-27.5	flow rate @ 250 ml/min
1635	21.0	20.80	6.8	clear	Development		complete			SHUT DOWN / DRY

Water Added: type None volume — (gal.)
Chemical Added: type None volume — (gal.)
Range and Average Discharge Rate: —
Maximum Drawdown during Development: Dry >22.6 at — gpm.
Disposition of Development Water: (Drums) Baker Tank Other
Number of Containers for Development Water: 1

Comments:

Final Measurements (BTOC)

Total depth of Well (ft): 22.20

Date Completed: 4-22-2009

Hours Developed: 3 Hr. 12 min

Stick-up 2.78.

Shaw
Shaw E & I, Inc.

Well Development Log

Project Number: 133422
Project Name: PBOW
Form Completed by: David Kessler
Well Developed by/firm: David Kessler/Shaw

Site ID: Ash Pit #2
Location ID: AP2-MW02
Date Started: 4/21/09

Monitoring Well Information

Development Method: Pump/Surge
Development Equipment: Waterra Pump w/ 1/2" ID x 5/8" OD HDPE tubing and 1/2" 6820

Screen Height (ft): 10
Filter pack length (ft): 11.50
Casing Diameter (in): 2

Begining Measurements (BTOC)
Depth to Water (ft): 5.92
Total depth of Well (ft): 18.50
water column 12.58 ft

Monitoring Well Purge Calculations

Volume of Water in Casing:
Gallons/foot = 0.041 x d^2, where casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft.
Well Volume (gallons) = Water Column (ft) x Gal/ft = 12.58 ft x 0.164 gal/ft = 2.07 gallons

Volume of Water in Filter Pack:
Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole diameter in inches & d is casing diameter in inches = 0.041 x ((8.25)^2 - (2)^2) = 2.63 gal/ft.
Filter Pack Volume (gal) = (the less of the filter pack lenght or water column) x gal/ft x porosity (0.3) = (11.50)ft x (2.63) gal/ft x 0.3 = 9.08 gal

Purge Well Volume: Purge well Volume = Filter pack volume + Well Volume = 9.08 gal + 2.07 gal = 11.15 gal.

1 x Purge Well Volume	2 x Purge Well Volume	3 x Purge Well Volume	4 x Purge Well Volume	5 x Purge Well Volume
11.15	22.30	33.45	44.60	55.75

Development Record

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
1430	0	5.92	—	—	—	—	—	—	—	Began Manually surged screen interval
1450	10	7.10	1671.1	Drk Br	8.76	6.70	0.777	5.78	50.8	Pumping 1940 ml/min, making water
1515	20	7.36	1662.2	Drk Br	8.12	6.57	0.747	6.38	66.3	Pumping at same rate.
1540	30	7.37	1461.2	" "	8.01	6.46	0.731	6.66	78.5	Rate decreased on own.
1600	40	7.30	1602.1	Clayey Br	8.32	6.51	0.724	7.30	80.6	Rate 1280 ml/min. Decreased further
1630	45	6.71	1067.3	Clayey Br	8.43	6.51	0.734	7.72	82.7	Slowed to 650 ml/min
1705	50	6.68	670.1	Clayey Br	8.67	6.83	0.731	7.43	72.6	" "
1720	52.5	6.67	570.4	" "	8.29	6.61	0.713	8.35	75.2	" "
1740	56	6.65	463.0	" "	8.45	6.53	0.707	7.74	80.7	" "

>1000 NTU

Shaw decreased rate

Stopped for day

Shaw
Shaw E & I, Inc.

Well Development Log (Continuation)

Site ID: Ash Pit #2
Location ID: AP2-MW02
Date Started: 4/21/09

Development Record (continuation)

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
Start 4/22 1050		5.97	—	—	—	—	—	—	—	Started pump on 4-22-09
1105	57.5	6.27	465	lightbrown	9.23	6.22	0.835	7.55	25.4	Pumping at ~~[illegible]~~ 520 ml/min
1120	59.0	6.35	386.6	lightbrown	8.92	6.79	0.789	8.42	-0.3	Pumping at 730 ml/min
1135	~~[illegible]~~ 65.0	6.45	276.9	very lightbrown	8.57	6.70	0.755	8.02	4.2	Pumping at 760 ml/min
1150	68.5	6.50	249.9	very lightbrown	8.44	6.53	0.742	8.03	13.6	Pumping @ 760 ml/min

Water Added: type None volume — (gal.)
Chemical Added: type None volume — (gal.)
Range and Average Discharge Rate: —
Maximum Drawdown during Development: at gpm.
Disposition of Development Water: (Drums) Baker Tank Other
Number of Containers for Development Water: 1

Comments:

Final Measurements (BTOC)

Total depth of Well (ft):

Date Completed: 4-22-09

Hours Developed: 4 hrs.

~~stickup 2.5~~ TD = 12.55 (should be)

Shaw
Shaw E & I, Inc.

Well Development Log

Project Number: 133422
Project Name: PBOW
Form Completed by: David Keissler / Eric Weaver
Well Developed by/firm: /Shaw

Site ID: Ash Pit #2
Location ID: AP2-MW03
Date Started: 4/22/09

Monitoring Well Information

Development Method: Waterra Pump/Surge
Development Equipment: Waterra Pump w/ 1/2" ID x 5/8" OD HDPE tubing and YSI 6820

Screen Height (ft): 5
Filter pack length (ft): 6.8
Casing Diameter (in): 2

Begining Measurements (BTOC)
Depth to Water (ft): 6.19
Total depth of Well (ft): 12.45
water column

Monitoring Well Purge Calculations

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft.
Well Volume (gallons) = Water Column (ft) x Gal/ft = 6.26 ft x 0.164 gal/ft = 1.03 gallons

Volume of Water in Filter Pack:
Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole diameter in inches & d is casing diameter in inches = 0.041 x ((8.25)^2 - (2)^2) = 2.63 gal/ft. (8.25 → 68.06; 2 → 4)
Filter Pack Volume (gal) = (the less of the filter pack lenght or water column) x gal/ft x porosity (0.3) = (6.26)ft x (0.164) gal/ft x 0.3 = 0.31 gal

Purge Well Volume: Purge well Volume = Filter pack volume + Well Volume = 0.31 gal + 1.03 gal = 1.34 gal.

1 x Purge Well Volume	2 x Purge Well Volume	3 x Purge Well Volume	4 x Purge Well Volume	5 x Purge Well Volume
1.34	2.68	4.02	5.36	6.7

Development Record

4/22/09

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments 5.0
1410	Start	6.19	—	—	—	—	—	—	—	Purged + Surged by hand for 10 minutes
1420	Start Pump	9.90	~~1701.2~~	~~brown~~	~~8.81~~	~~6.74~~	~~1.339~~	~~7.21~~	~~-1.5~~	Pumping at 220 ml/min
1450	4 gal	9.90	1701.2	brown	8.81	6.74	1.339	7.21	-1.5	Pumping at 220 ml/min
1500	4.5 dry	dry	—	—	—	—	—	—	—	Shut down 20 min.
1520	Restart	10.90	—	—	—	—	—	—	—	Pumping @ 380 ml/min
1540	Dry	—								
1600	5.5	10.9	963.4	brown	8.07	7.47	0.969	11.23	-38.7	Pumping @ 370 ml/min
1625	6.0	>12.0	112.7	~~brown~~ gray	8.49	7.35	0.950	11.42	121.5	Pumping @ 250 ml/min
1630	~~Dry~~ Shutoff	>12.0'	—	—	—	—	—	—	—	

Shaw
Shaw E & I, Inc.

Well Development Log (Continuation)

Site ID: Ash Pit #2
Location ID: AP2-MW03
Date Started: 4-22-09

Development Record (continuation)

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
1650	6	11.0'	—	—	—	—	—	—	—	Start Pump again
1720	7.0'	>12.0'	—	—	—	—	—	—	—	Raining Put YSI away
Start 4/23 0810	start		—							
0815	7.25	5.0'	138.3	lightgray	6.75	6.04	0.358	11.23	34.7	Pumping @ 300 ml/min
0830	8.0	7.41	565.2	brown	6.28	6.46	0.365	11.33	13.4	Pumping at 160 ml/min
0845	8.5	7.65	496.5	brown	6.42	6.57	0.387	11.55	6.0	Pumping at 140 ml/min
0900	9.0	7.87	303.1	lightbrn	6.56	6.67	0.385	11.14	2.5	Pumping at 140 ml/min
0915	9.5	7.97	178.4	lightbrown	6.81	6.66	0.379	11.18	2.3	130 ml/min
0930	10.0	8.13	117.8	lightgray	6.95	6.64	0.385	11.61	3.6	120 ml/min
0940	10.25	8.17	106.1	very light gray	6.77	6.63	0.391	11.52	4.1	120 ml/min
0950	10.5	8.23	97.5	lightgray	6.87	6.69	0.394	11.66	0.7	110 ml/min
1000	10.75	8.23	81.1	very light gray	6.96	6.69	0.390	11.38	0.1	110 ml/min
1010	11.0	8.24	68.8	very light gray	6.96	6.73	0.397	11.23	-1.5	110 ml/min

Water Added: type — volume — (gal.)
Chemical Added: type — volume — (gal.)
Range and Average Discharge Rate: —
Maximum Drawdown during Development: — at — gpm.
Disposition of Development Water: Drums Baker Tank Other
Number of Containers for Development Water: 1

Comments:

Final Measurements (BTOC)

Total depth of Well (ft): 12.45'

Date Completed: 4-23-09

Hours Developed: 4

Shaw
Shaw E & I, Inc.

Well Development Log

Project Number: 133422
Project Name: PBOW
Form Completed by: BRIAN TIEW
Well Developed by/firm: Shaw E+I / A+E Drilling

Site ID: AP2
Location ID: AP2-BEDGW-001
Date Started: 04-21-2009

Monitoring Well Information

Development Method: Surge & Purge
Development Equipment: Waterra pump, Honda 2000W generator, YSI 6820 water quality meter, 5/8 OD x 1/2 ID hdpe tubing, Huron WL indicator

Screen Height (ft): 15
Filter pack length (ft): 21
Casing Diameter (in): 2

Begining Measurements (BTOC)
Depth to Water (ft): 4.94
Total depth of Well (ft): 88.06
WC = 83.12

Monitoring Well Purge Calculations

Volume of Water in Casing:
Gallons/foot = 0.041 x d^2, where casing diameter in inches = (0.041 x (4)^2) = 0.164 gal/ft.
Well Volume (gallons) = Water Column (ft) x Gal/ft = 83.12 ft x 0.164 gal/ft = 13.63 gallons

Volume of Water in Filter Pack:
Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole diameter in inches & d is casing diameter in inches = 0.041 x ((68.06)^2 - (4)^2) = 2.62 gal/ft.
Filter Pack Volume (gal) = (the less of the filter pack lenght or water column) x gal/ft x porosity (0.3) = (21)ft x (2.62) gal/ft x 0.3 = 16.50 gal

Purge Well Volume: Purge well Volume = Filter pack volume + Well Volume = 16.50 gal + 13.63 gal = 30.13 gal.

1 x Purge Well Volume	2 x Purge Well Volume	3 x Purge Well Volume	4 x Purge Well Volume	5 x Purge Well Volume
30.13	60.26	90.39	120.52	150.65

Development Record

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
4/21 1004	2.0	2.33	high	light Brown	—	—	—	—	—	surge by hand e 2' intervals
1006	3.5	16.86	513.6	light Brown	11.38	7.51	0.434	10.34	-46.3	START purge (waterra 800 ml/min)
1016	4.0	24.60	64.3	cloudy	11.44	8.00	0.413	11.00	-67.7	flow now @ 800 ml/min
1040	6.0	35.50	55.4	clear	11.58	8.12	0.398	12.09	-74.3	readjust flow to 800 ml/min
1054	—	47.90	32.0	clear	11.40	8.16	0.212	12.64	-76.8	—
1105	9.0	53.60	—	clear	Turn pump up full speed					continue purging
1120	15.0	79.80	—	clear	—	—	—	—	—	readjust flow to 800 ml/min
1128	18.0	81.4	22.5	clear	11.12	7.79	0.462	11.26	-55.5	—
1146	23.0	85.1	13.6	clear	11.30	7.75	0.470	12.18	-54.4	continue flowrate 800 ml/min

Shaw
Shaw E & I, Inc.

Well Development Log (Continuation)

Site ID: AP2
Location ID: AP2 - BedGW-001
Date Started: 04-21-2009

Development Record (continuation)

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
cont.. 4/21 1150	25.0	86.10	—	SHUT DOWN Surge well bottom by hand						Then pump aggressively
1310	—	84.46	—	Recharge level after lunch				—	—	—
1320	—	85.40	12.9	clear ~~tint~~	11.22	7.77	0.480	10.90	-55.5	RESTART Purge 1000 ml/min
3 hrs. 39 min 1325	25.5	86.10	18.4	clear	11.25	7.75	0.491	11.77	-54.8	continue @ 1000 ml/min
1335	27.0	87.98	13.5	clear	11.23	7.82	0.493	12.02	-58.0	SHUT DOWN/Dry sample collected

Water Added: type NO volume — (gal.)
Chemical Added: type NA volume — (gal.)
Range and Average Discharge Rate: —
Maximum Drawdown during Development: — at — gpm.
Disposition of Development Water: (Drums) Baker Tank Other
Number of Containers for Development Water: 1

Comments:

Final Measurements (BTOC)

Total depth of Well (ft): 88.53

Date Completed: 04-21-2009

Hours Developed: 3.65

Shaw
Shaw E & I, Inc.

Well Development Log

Project Number: 133422
Project Name: PBOW
Form Completed by: Brian Tiew
Well Developed by/firm: Shaw E+I A+E drilling

Site ID: AP2
Location ID: AP2 - Bed GW-002
Date Started: 04-21-2009

Monitoring Well Information

Development Method: surge + purge
Development Equipment: waterra pump, 2000 Honda Generator, YSI 6820 water quality meter, 5/8 OD x 1/2 ID HDPE tubing, Huron WL indicator.

Screen Height (ft): 15
Filter pack length (ft): 20.1
Casing Diameter (in): 2

Begining Measurements (BTOC)
Depth to Water (ft): 22.47
Total depth of Well (ft): 77.23
WC = 54.76

Monitoring Well Purge Calculations

Volume of Water in Casing:
Gallons/foot = 0.041 x d^2, where casing diameter in inches = (0.041 x (4)^2) = 0.164 gal/ft.
Well Volume (gallons) = Water Column (ft) x Gal/ft = 54.76 ft x 0.164 gal/ft = 8.98 gallons

Volume of Water in Filter Pack:
Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole diameter in inches & d is casing diameter in inches = 0.041 x ((6.06)^2 - (4)^2) = 2.62 gal/ft.
Filter Pack Volume (gal) = (the less of the filter pack lenght or water column) x gal/ft x porosity (0.3) = (20.10)ft x (2.62) gal/ft x 0.3 = 15.79 gal

Purge Well Volume: Purge well Volume = Filter pack volume + Well Volume = 15.79 gal + 8.98 gal = 24.77 gal.

1 x Purge Well Volume	2 x Purge Well Volume	3 x Purge Well Volume	4 x Purge Well Volume	5 x Purge Well Volume
24.77	49.54	74.31	99.08	123.85

Development Record

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
4/21 ↓ 1430	3.0	22.52	—	water	lower	after	surging	by hand		—
1435	—	22.52	High	black	—	—	—	—	—	start purge @ 2430 ml/min
1447	10.0	23.60	34.7	clear	11.42	6.81	2.789	3.51	-4.2	flow rate 2400 ml/min
1458	15.0	24.80	10.4	clear	11.20	6.78	2.797	0.25	-2.4	flow rate now 2200 ml/min
1501	20.0	23.90	11.9	clear	11.06	6.76	2.764	2.40	-1.7	—
1515	25.0	24.00	—	clear	—	—	—	—	—	flowrate 2320 ml/min
1520	30.0	24.10	8.1	clear	11.06	6.71	2.813	3.88	0.8	—
1528	35.0	24.08	—	clear	raise	tubing	up 7' and	increase		flowrate to 2040 ml/min
1533	40.0	24.58	7.9	clear	11.13	6.72	2.815	3.65	0.5	—

Shaw
Shaw E & I, Inc.

Well Development Log (Continuation)

Site ID: AP2
Location ID: AP2-BCPGW-002
Date Started: 04-21-2009

Development Record (continuation)

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
cont.— 4/21 ↓ 1540	45.0	24.55	17.5	clear	10.91	6.73	2.808	4.02	0.2	continue 7' up from bottom
1550	50.0	24.70	2.9	clear	11.04	6.71	2.822	4.52	0.9	—
he. 31 min. 1554	55.0	22.70	—	clear	lower	tubing	back	to	bottom	—
1601	60.0	24.10	5.4	clear	11.65	6.75	1.502	5.67	-1.1	SHUT DOWN / collect sample

Water Added: type 0-NA volume — (gal.)
Chemical Added: type NA volume — (gal.)
Range and Average Discharge Rate: —
Maximum Drawdown during Development: — at — gpm.
Disposition of Development Water: Drums Baker Tank Other
Number of Containers for Development Water: 1

Comments:

Final Measurements (BTOC)

Total depth of Well (ft): 77.23

Date Completed: 04-21-2009

Hours Developed: 1.51

Shaw
Shaw E & I, Inc.

Well Development Log

Project Number: 133422
Project Name: PBOW
Form Completed by: E. Weaver
Well Developed by/firm: ~~[illegible]~~ / Shaw
David Kessler / E Weaver

Site ID: Ash Pit #2
Location ID: AP2-BEDGW-003
Date Started: 4-20-09

Monitoring Well Information

Development Method: Pump / Surge
Development Equipment: Watera Pump
check valve, tubing (1/2" ID/5/8" OD), containers for water
YSI meter, H2O Level indicator

Screen Height (ft): 15'
Filter pack length (ft): 20'
Casing Diameter (in): 2"

Begining Measurements (BTOC)
Depth to Water (ft): 27.14
Total depth of Well (ft): 62.63
water column 35.49

Monitoring Well Purge Calculations

Volume of Water in Casing:
Gallons/foot = 0.041 x d^2, where casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft.
Well Volume (gallons) = Water Column (ft) x Gal/ft = 35.49 ft x 0.164 gal/ft = 5.82 gallons

Volume of Water in Filter Pack:
Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole diameter in inches & d is casing diameter in inches = 0.041 x ((6)^2 - (2)^2) = 1.39 gal/ft.
Filter Pack Volume (gal) = (the less of the filter pack lenght or water column) x gal/ft x porosity (0.3) = (20)ft x (1.39) gal/ft x 0.3 = 8.34 gal

Purge Well Volume: Purge well Volume = Filter pack volume + Well Volume = 8.34 gal + 5.82 gal = 14.16 gal.

1 x Purge Well Volume	2 x Purge Well Volume	3 x Purge Well Volume	4 x Purge Well Volume	5 x Purge Well Volume
14.16	28.32	42.48	56.64	70.80

Began 1630

Development Record

Manually surged screen interval.

	Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments
4/20/09	1640	5	32.10	206.5	gray	11.78	6.98	1.332	8.40	-10.3	Pumping @ 840 ml/min / [illegible] water
	1705	~~8~~ 13	35.40	63.8	clear	11.53	6.78	2.017	8.8/8.93	-0.3	1650 increased pump rate >1000 ml/min/minute
	1715	18	52.95	82.4	clear	11.50	6.87	1.438	2.30	-5.1	
	1740	23	56.5	98.6	gray	11.51	7.10	1.387	2.70	-17.8	Level dropped to 61'
4/21/09	0900	~~[illegible]~~ 31	27.20	—	—	—	—	—	—	—	Began. No YSI available.
	0910	~~[illegible]~~ 33	34.75	—	clear	—	—	—	—	—	pumping 720 ml/min → reduced rate
	0940	38	39.40	—	clear	—	—	—	—	—	Making water at flow of 320 ml/min → increased rate
	1005	43	46.25	—							Stopped - ended development
	1050	43	46.25	1.3	clear	13.71	6.49	1.992	3.72	-335.6	yellow tint to water

L.

Shaw
Shaw E & I, Inc.

Well Development Log (Continuation)

Site ID: Ash Pit #2
Location ID: AP2-BEDGW-003
Date Started: 4/20/09

Development Record (continuation)

Time (24 hrs)	Volume Removed (gal)	Water Level (ft) (TOC)	Turbidity (NTU)	Clarity (color)	Temp. (C)	pH (Std Units)	Conductivity (mS/cm)	D.O. (mg/L)	Redox (mV)	Comments

DHR 4/21/09

Water Added: type None volume — (gal.)
Chemical Added: type None volume — (gal.)
Range and Average Discharge Rate: ~840 ml/min
Maximum Drawdown during Development: 61' at >1100 ml/min ~~spm~~.
Disposition of Development Water: (Drums) Baker Tank Other
Number of Containers for Development Water: 1

Comments: No YSI available 4/21/09. Down due to malfunction
H_2S ~ >200 ppm, VOC = 21.5 ppm from water being pumped.

Final Measurements (BTOC)

Total depth of Well (ft): 62.65

Date Completed: 4/21/09

Hours Developed: 2 HR 5 min

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Well:

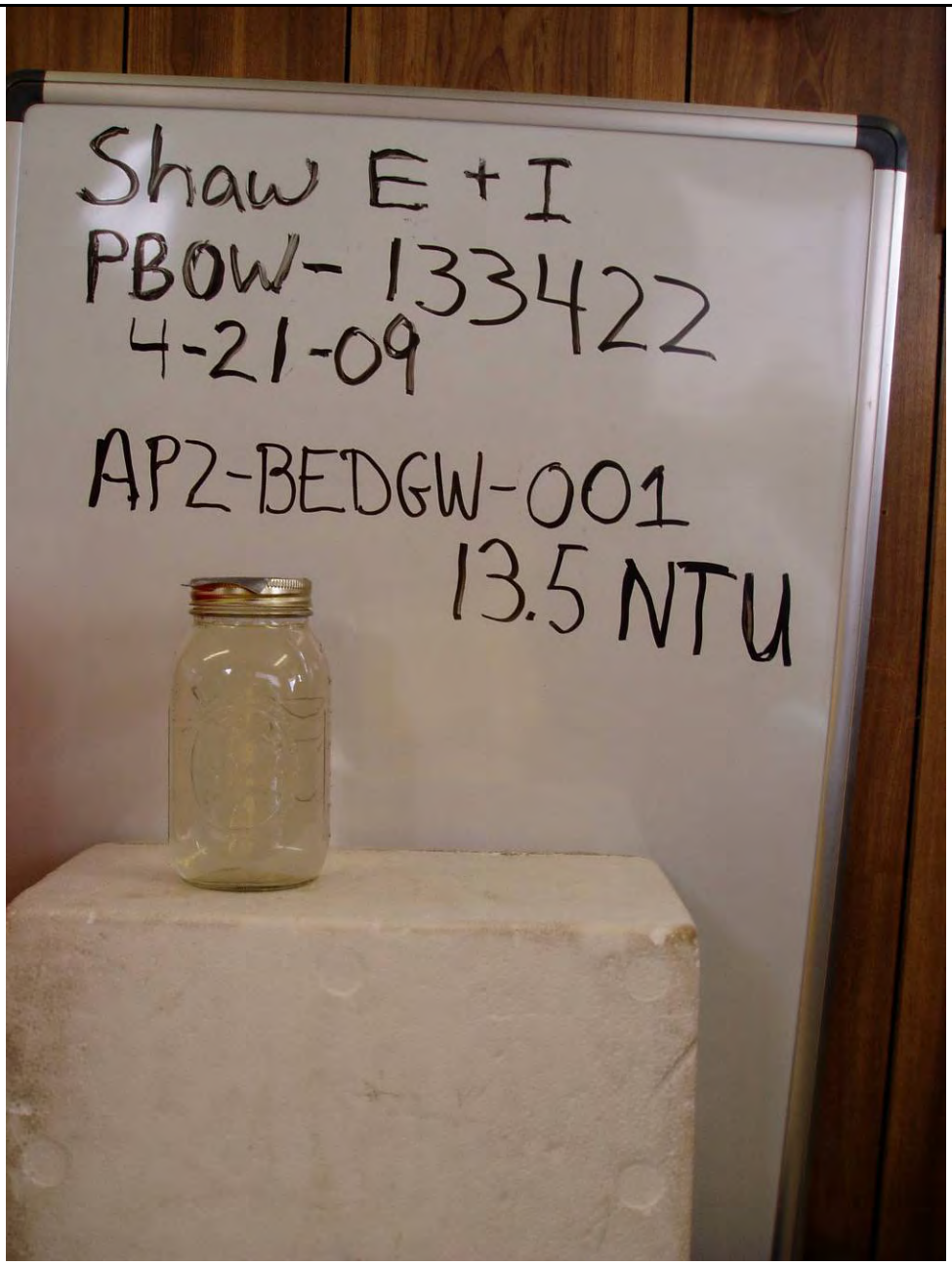
AP2-BEDGW-001

Date:

April 21, 2009

Final reading:

13.5 NTU



Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Well:

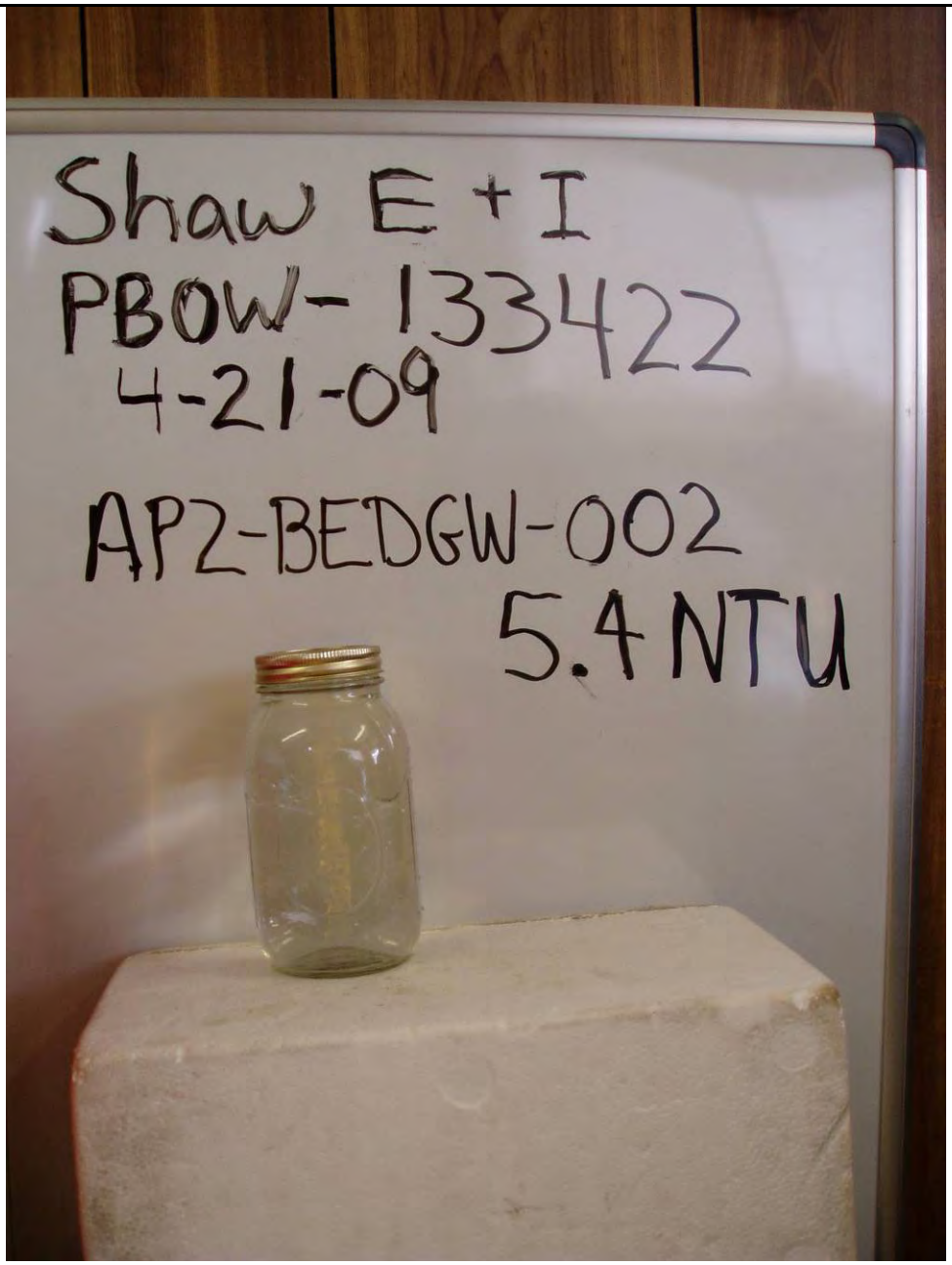
AP2-BEDGW-002

Date:

April 21, 2009

Final Reading:

5.4 NTU



Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Well:

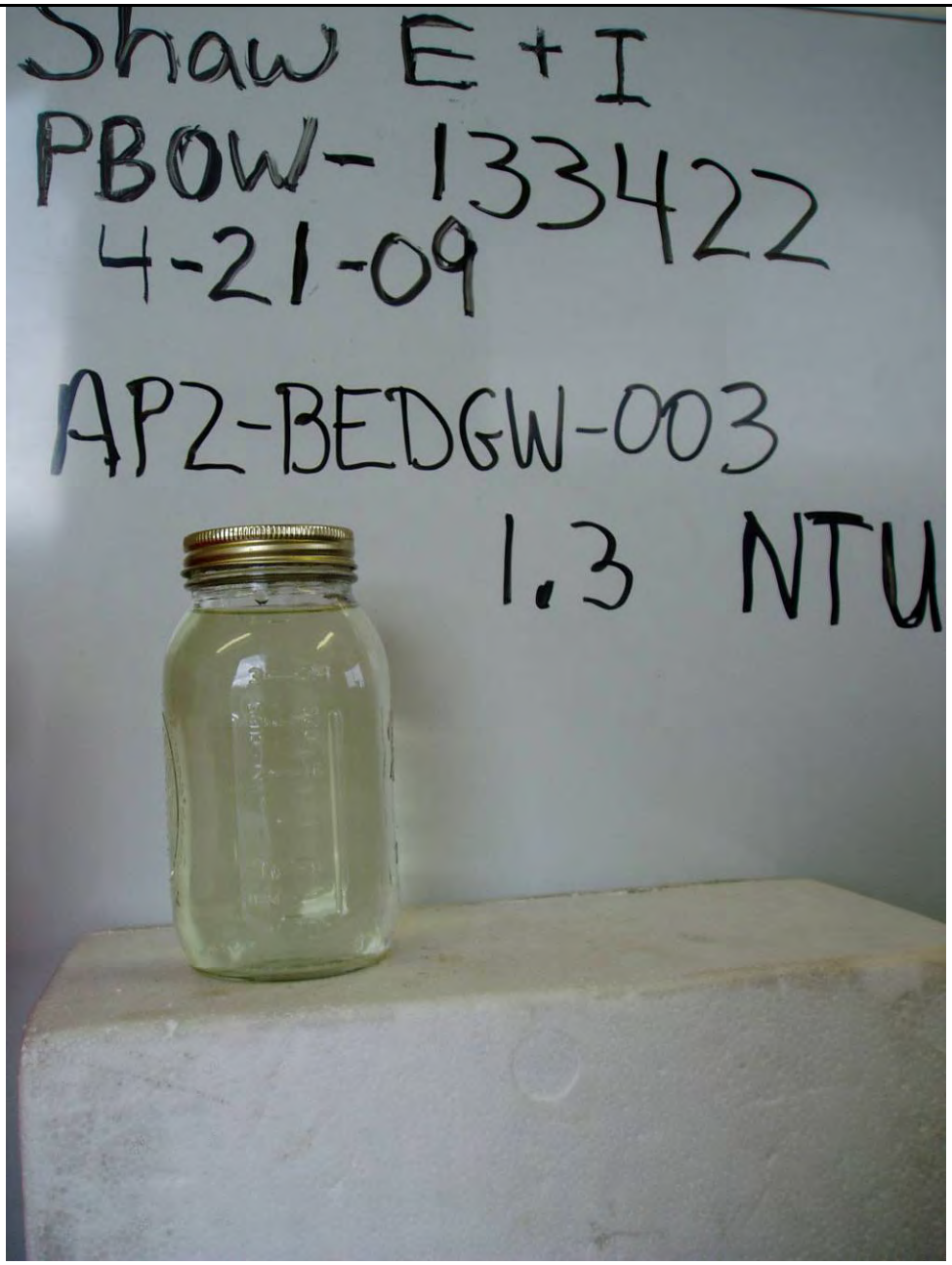
AP2-BEDGW-003

Date:

April 21, 2009

Final Reading:

1.3 NTU



Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Well:

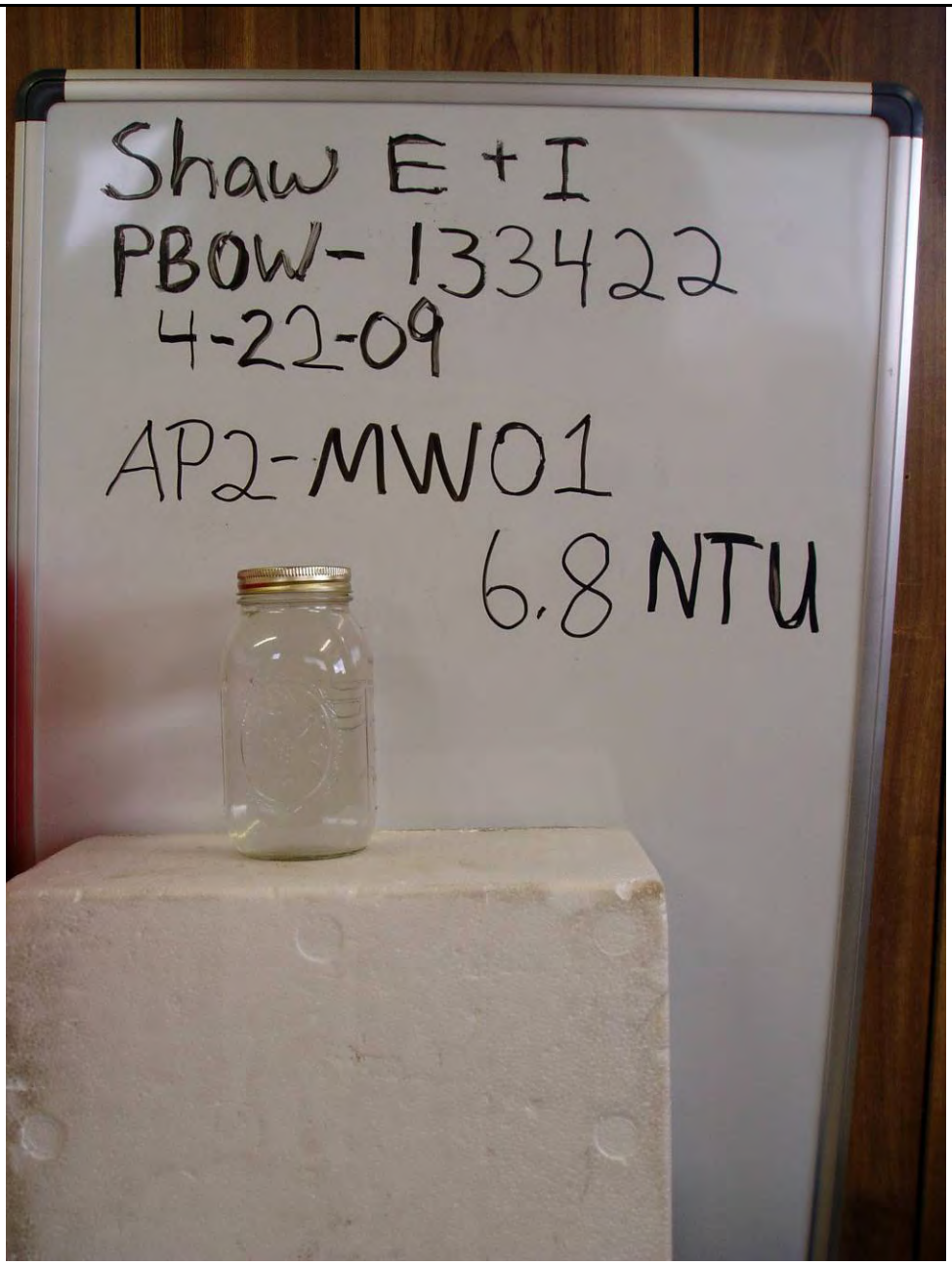
AP2-MW01

Date:

April 22, 2009

Final Reading:

6.8 NTU



Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Well:

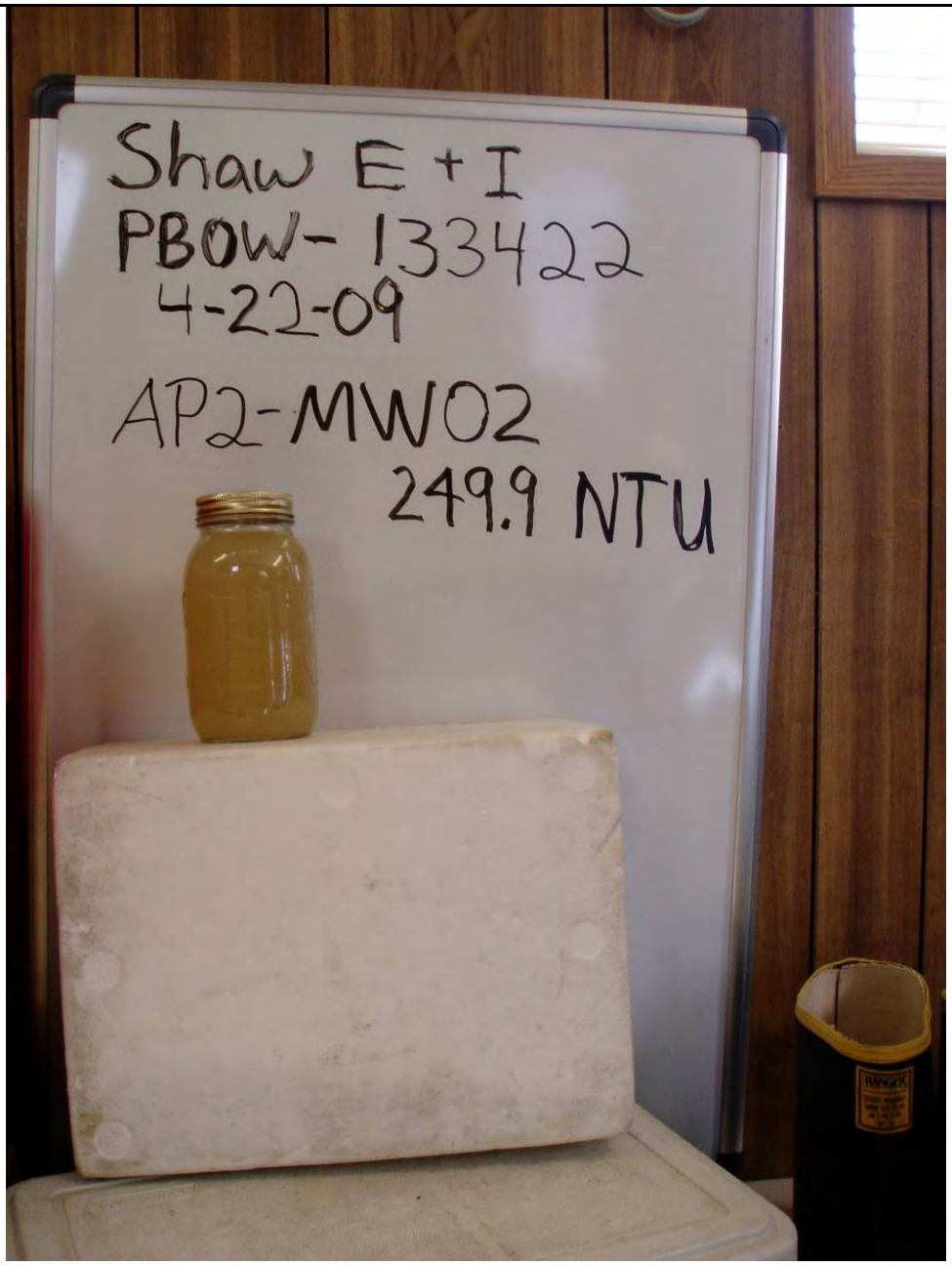
AP2-MW02

Date:

April 22, 2009

Final Reading:

249.9 NTU



Shaw E & I, Inc.

Shaw Environmental, Inc.
Photographic Record

Client: USACE	**Project Number: 133422**
Site Name: Former Plum Brook Works	**Site Location: Sandusky, Erie County, Ohio**

Well:

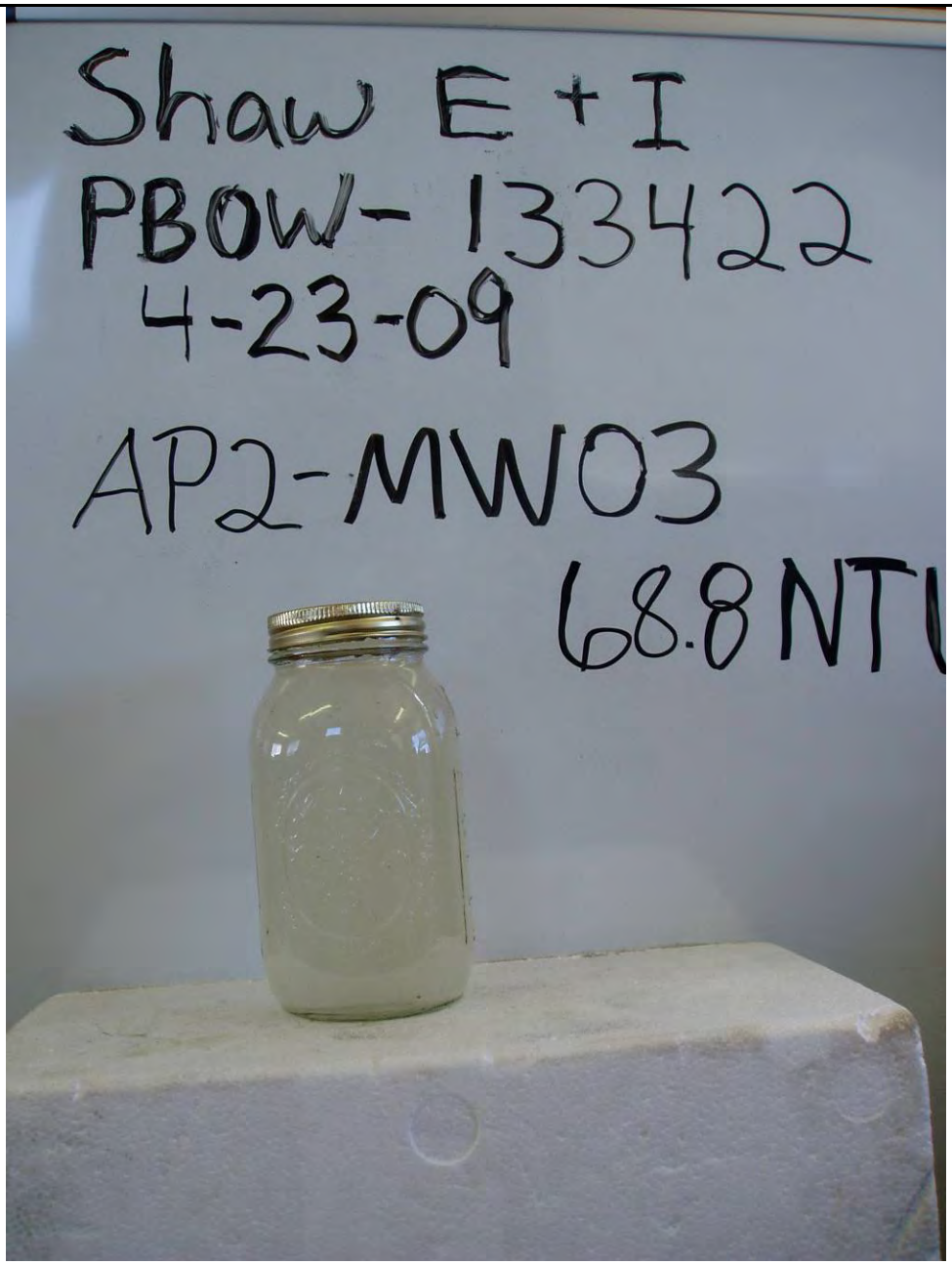
AP2-MW03

Date:

April 23, 2009

Final Reading:

68.8 NTU



Shaw E & I, Inc.

APPENDIX E

LAND SURVEY DATA

FINAL REPORT
of
SURVEYING SERVICES PERFORMED
by
SACKS SURVEYING & MAPPING, P.C. / KUSMER & ASSOCIATES J.V.
at the
PLUMBROOK ORDNANCE WORKS, SANDUSKY, OH
for
SHAW E & I (CONTRACT #W912QR-08-D-0013, D.O. DX03)
JANUARY, 2009

SUMMARY OF WORK PERFORMED

Sacks Surveying & Mapping, PC, in joint venture with Kusmer & Associates, Inc., located 42 soil sample and test pit locations and 43 piezometer locations at seven sites within the Plumbrook Ordnance Works site (Waste Water Treatment Plant #1, Ash Pit #1, Ash Pit #2, Wastewater Treatment Plant #2, Railcar Wash Area, Locomotive Area, and Waste Water Treatment Plant #1 Sewer Line). Work was performed on-site between 27 January, 2009 and 30 January, 2009 in accordance with Shaw E & I R.F.P. 2008-037 under purchase order #470434 OP in support of Shaw E & I contract W912QR-08-D-0013, D.O. DX03.

KEY PERSONNEL

W. Robert Kusmer – Ohio Land Surveyor S-6754
Stanley Robert Sacks – North Carolina Surveyor L-2913
Michael A. McKibbin – North Carolina Surveyor L-4519, Hazmat Project Manager
Jeff Bucholtz – On-site Party Chief *
Steven Chris Shelton – Survey Technician *
* all on-site personnel for this project are OSHA 29 CFR 1910.120 40-hour trained and medically monitored in accordance with Shaw E & I requirements.

FIELD PROCEDURES

All soil sample and piezometer locations reported below were surveyed with a Topcon GTS-235W Total Station using conventional angle and distance measurements to determine the horizontal and vertical position thereof. The survey control points used in this operation were established at each site by direct static differential GPS observation using three Ashtech Promark III GPS receivers. GPS vectors were adjusted holding fixed station "PB 06" using Ashtech post-processing software, producing a least squares adjustment of the WGS 84 positions. A loop using the unadjusted vectors passing the fixed and derived control positions yields a loop precision exceeding 1 part in 100,000. Horizontal and vertical values of Sacks Surveying & Mapping control station "PB 06" were derived by GPS survey in 1996 from NGS Monuments "Skyway RM 2" and "J-318" (a first order benchmark). The horizontal datum is NAD 83. The vertical datum is NGVD 29. Values were scaled to the Ohio State Plane Coordinate System (North Zone) using a combined scale and ellipsoid factor of 0.9999270034. Values for Sacks Surveying & Mapping monument "PB 06" are:

Northing (y) 189,438.4289 m
Easting (x) 585,685.6292 m
Orthometric Elevation 200.5985 m
Geoid Height -35.167 m (Geoid 99)

SAMPLE LOCATIONS

Waste Water Treatment Plant #1

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
3	623,838.916	1,920,186.361	635.762	GPS Pt 2-100
4	624,061.542	1,920,188.546	634.731	GPS Pt 2-101
206	624,221.21	1,919,718.65	639.33 Riser	PZ-01
207			638.0 Ground	
205	624,224.51	1,919,868.74	636.86 Riser	PZ-02
204			635.4 Ground	
210	624,097.22	1,919,768.37	639.67 Riser	SB-01/PZ-06
209			637.3 Ground	
208	624,087.98	1,919,683.02	637.18	SB-02
211	624,057.52	1,919,720.80	636.61	SB-03
213	623,995.17	1,919,709.85	639.26 Riser	SB-04/PZ04
212			638.1 Ground	
214	623,971.71	1,919,679.01	638.50	SB-05
218	623,987.84	1,919,772.77	637.56	SB-06
217	623,963.70	1,919,752.47	638.94 Riser	SB-07/PZ-03
216			638.0 Ground	
215	623,869.76	1,919,685.96	639.94 Riser	SB-08/PZ-05
**			638.8 Ground	

** = measure down from riser to ground supplied by Shaw E & I

Ash Pit #1

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
1	623,657.242	1,919,113.236	639.873	GPS Pt. 1-100
2	623,667.454	1,918,690.125	638.297	GPS Pt. 1-101
122	623,632.54	1,918,680.82	636.00	SB-01 *
111	623,561.23	1,918,686.10	635.92	SB-02
112	623,475.30	1,918,685.16	638.41	SB-03
113	623,463.46	1,918,828.82	638.81	SB-04
116	623,455.17	1,918,962.03	638.35	SB-05
119	623,620.51	1,918,930.44	635.23	SB-06 *

* = Stake missing; field location as directed by Shaw E & I personnel

108	623,724.22	1,918,737.52	637.65 Riser	PZ-01
109			636.8 Ground	

Ash Pit #1 <cont.>

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
107	623,728.76	1,918,855.35	639.11 Riser	PZ-02
106			637.7 Ground	
104	623,715.50	1,919,025.14	640.79 Riser	PZ-03
105			638.7 Ground	
118	623,368.95	1,918,792.10	641.23 Riser	PZ-04
117			640.9 Ground	
115	623,521.04	1,918,801.67	638.30 Riser	SB-08/PZ-05
114			637.5 Ground	
121	623,585.48	1,918,735.41	635.15 Riser	SB-09/PZ-06
120			634.5 Ground	

Ash Pit #2

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
9	622,858.595	1,911,566.119	639.400	GPS Pt 5-100
10	623,115.362	1,911,626.581	638.679	GPS Pt. 5-101
516	622,819.31	1,911,245.10	632.55	SS&M Nail 516
505	623,073.14	1,911,485.20	634.97 Riser	SB-01/PZ-01
504			631.7 Ground	
520	623,041.37	1,911,260.38	630.32 Riser	SB-02/PZ-02
521			627.5 Ground	
519	622,845.22	1,911,148.24	630.69 Riser	SB-03/PZ-03
518			627.7 Ground	
512	622,789.21	1,911,348.96	633.70 Riser	SB-04/PZ-04
511			630.0 Ground	
513	622,901.66	1,911,339.77	633.97 Riser	SB-05/PZ-05
514			631.8 Ground	
508	622,942.86	1,911,404.17	633.42 Riser	SB-06/PZ-06
507	629.7 Ground			
515	622,955.41	1,911,280.43	629.46	SB-07
509	622,840.49	1,911,425.01	632.92 Riser	SB-08/PZ-07
510			629.8 Ground	

Ash Pit #3 not sampled as of this date

Waste Water Treatment Plant #3

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
7	623,379.091	1,914,915.675	637.382	GPS Pt. 4-100
8	623,522.259	1,914,911.296	637.616	GPS Pt. 4-102
401	623,646.21	1,914,907.54		SS&M Nail 401
416	623,616.33	1,914,460.24	639.66 Riser	PZ-01
417			637.2 Ground	
415	623,575.37	1,914,357.85	638.43 Riser	PZ-02
414			636.3 Ground	
413	623,442.78	1,914,322.61	637.56	SB-01
412	623,389.04	1,914,335.44	639.36 Riser	SB-02/PZ-03
411	623,388.62	1,914,335.56	637.2 Ground	
410	623,416.20	1,914,391.06	637.63	SB-03
409	623,455.74	1,914,416.30	640.12 Riser	SB-0~~4~~/PZ-06
408			637.3 Ground	9 DKL
407	623,438.28	1,914,458.72	637.54 Riser	SB-05/PZ-05
**			636.9 Ground	
406	623,406.06	1,914,452.39	637.54	SB-06
405	623,377.78	1,914,453.57	639.72 Riser	SB-07/PZ-04
404			637.3 Ground	

** = measure up from ground to riser supplied by Shaw E & I

Railcar Wash Area (Acid Area)

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
1	623,657.242	1,919,113.236	639.873	GPS Pt. 1-100
2	623,667.454	1,918,690.125	638.297	GPS Pt. 1-101
130	623,882.09	1,918,943.02	638.10 Riser	PZ-01
131			635.4 Ground	
124	623,757.23	1,918,888.90	641.18 Riser	PZ-02
123			638.1 Ground	
127	623,812.43	1,918,868.73	639.85 Riser	PZ-03
126			636.5 Ground	
133	623,890.97	1,918,863.20	636.24 Riser	PZ-04
132			634.4 Ground	
125	623,800.27	1,918,892.60	637.58	SB-10
128	623,790.87	1,918,845.66	637.46	SB-12
129	623,823.32	1,918,836.69	635.39	SB-11

Locomotive Area

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
1	623,657.242	1,919,113.236	639.873	GPS Pt. 1-100
2	623,667.454	1,918,690.125	638.297	GPS Pt. 1-101
135	623,861.73	1,918,349.65	636.41	SS&M Nail 135
142	623,907.99	1,918,641.61	637.93 Riser	PZ-01
141			636.3 Ground	
148	623,862.16	1,918,467.96	640.67 Riser	PZ-02
147			637.0 Ground	
139	623,848.15	1,918,624.77	639.46 Riser	PZ-03
140			636.1 Ground	
138	623,794.37	1,918,550.21	637.50 Riser	SB-03/PZ-04
137			635.6 Ground	
149	623,880.78	1,918,509.04	640.20 Riser	PZ-05
150			637.3 Ground	
151	623,872.89	1,918,595.27	636.69	SB-04
136	623,799.16	1,918,471.15	636.35	SB-05
144	623,853.27	1,918,497.75	636.79	SB-07
145	623,852.71	1,918,515.02	636.82	SB-08
146	623,851.97	1,918,541.10	636.80	SB-09

Waste Water Treatment Plant #1 Sewer Line

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
5	624,284.373	1,923,674.317	635.700	GPS Pt. 3-100
6	624,608.356	1,923,501.823	631.977	GPS Pt. 3-102
301	624,567.58	1,923,502.38		SS&M Nail 301
336	624,601.08	1,921,712.32	628.78	~~SB-01~~ SB-09 DKL
337	624,623.89	1,921,715.45	628.65	~~SB-02~~ SB-10
304	624,517.72	1,923,563.59	632.31	Sth. Line, E. of road
306	624,515.71	1,923,522.82	632.20	Sth. Line, W. of road
305	624,522.75	1,923,560.31	632.08	Nth. Line, E. of road
307	624,568.23	1,923,492.44	632.09	Nth Line, W. of road
341	624,573.46	1,923,373.40	630.32	TP-03
326	624,577.93	1,923,102.28	631.96	TP-04
325	623,998.14	1,920,748.90	637.01	TP-21
324	624,049.00	1,921,018.16	635.54	TP-22
323	624,115.38	1,921,376.89	629.71	TP-23
322	624,170.76	1,921,675.58	632.49	TP-24
321	624,224.10	1,921,958.30	631.21	TP-25

Waste Water Treatment Plant #1 Sewer Line <cont.>

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
320	624,273.74	1,922,226.54	631.87	TP-26
316	624,335.37	1,922,550.74	633.80 Riser	TP-27/PZ-07
317			630.6 Ground	
313	624,383.06	1,922,811.74	630.29	TP-28
312	624,437.18	1,923,095.69	632.12	TP-29
309	624,484.42	1,923,339.45	632.11 Riser	TP-30/PZ-10
308			630.4 Ground	
340	624,616.65	1,921,456.57	628.93	TP-32
334	624,612.42	1,921,713.34	632.08 Riser	TP-33/PZ-03
335			629.0 Ground	
331	624,605.23	1,921,993.22	635.42	TP-34
330	624,595.15	1,922,271.99	636.48	TP-35
329	624,592.56	1,922,545.31	639.03 Riser	TP-36/PZ-05
328			635.7 Ground	
327	624,587.05	1,922,819.39	633.67	TP-37
PZ-01 not recovered at this date				
339	624,614.47	1,921,581.00	632.10 Riser	PZ-02
338			629.4 Ground	
333	624,609.33	1,921,832.45	631.01 Riser	PZ-04
332	624,609.09	1,921,832.50	629.8 Ground	
319	624,306.47	1,922,397.79	634.08 Riser	PZ-06
318	624,306.31	1,922,397.80	631.3 Ground	
315	624,360.52	1,922,687.65	633.93 Riser	PZ-08
314	624,360.83	1,922,687.71	630.9 Ground	
310	624,464.54	1,923,237.32	633.84 Riser	PZ-09
311	624,464.55	1,923,237.28	631.2 Ground	

CERTIFICATION

I, Warren Robert Kusmer, Ohio Professional Surveyor #S-6754, hereby certify that the information in this survey report is true to the best of my knowledge and belief.

W Robert Kusmer

Warren Robert Kusmer,
Ohio Professional Surveyor #S-6754

March 2, 2009
Date

FINAL REPORT
of
SURVEYING SERVICES PERFORMED
by
SACKS SURVEYING & MAPPING, P.C. / KUSMER & ASSOCIATES J.V.
at the
PLUMBROOK ORDNANCE WORKS, SANDUSKY, OH
for
SHAW E & I (CONTRACT #W912QR-08-D-0013, LTMP)
MAY, 2009

SUMMARY OF WORK PERFORMED

Sacks Surveying & Mapping, PC, in joint venture with Kusmer & Associates, Inc., located 39 monitoring wells, 1 bore hole, 4 staff gauges, and 24 surface water/sediment sample locations at seven sites within the Plumbrook Ordnance Works site (Waste Water Treatment Plant #1, Ash Pit #1, Ash Pit #2, Wastewater Treatment Plant #3, Railcar Wash Area, Locomotive Area, and Waste Water Treatment Plant #1 Sewer Line). Work was performed on-site between 18 May, 2009 and 21 May, 2009 in accordance with Shaw E & I R.F.P. 2008-037 under purchase order #499335 OP in support of Shaw E & I contract W912QR-08-D-0013, LTMP.

KEY PERSONNEL

W. Robert Kusmer – Ohio Land Surveyor S-6754
Stanley Robert Sacks – North Carolina Surveyor L-2913
Michael A. McKibbin – North Carolina Surveyor L-4519, Hazmat Project Manager
Jeff Bucholtz – On-site Party Chief *
Steven Chris Shelton – Survey Technician *
* all on-site personnel for this project are OSHA 29 CFR 1910.120 40-hour trained and medically monitored in accordance with Shaw E & I requirements.

FIELD PROCEDURES

All monitoring well and sampling locations reported below were surveyed with a Topcon GTS-235W Total Station using conventional angle and distance measurements to determine the horizontal and vertical position thereof. The survey control points used in this operation were previously established (January, 2009) at each site by direct static differential GPS observation using three Ashtech Promark III GPS receivers. GPS vectors were adjusted holding fixed station "PB 06" using Ashtech post-processing software, producing a least squares adjustment of the WGS 84 positions. A loop using the unadjusted vectors passing the fixed and derived control positions yields a loop precision exceeding 1 part in 100,000. Horizontal and vertical values of Sacks Surveying & Mapping control station "PB 06" were derived by GPS survey in 1996 from NGS Monuments "Sky D" and "J-318" (a first order benchmark). The horizontal datum is NAD 83. The vertical datum is NGVD 29. Values were scaled to the Ohio State Plane Coordinate System (North Zone) using a combined scale and ellipsoid factor of 0.9999270034. Values for Sacks Surveying & Mapping monument "PB 06" are:

Northing (y) 189,438.4289 m
Easting (x) 585,685.6292 m
Orthometric Elevation 200.5985 m
Geoid Height -35.167 m (Geoid 99)

SAMPLE LOCATIONS

Waste Water Treatment Plant #1

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
3	623,838.916	1,920,186.361	635.762	GPS Pt 2-100
4	624,061.542	1,920,188.546	634.731	GPS Pt 2-101
2047	624,015.57	1,919,560.22	639.40 Riser	WTP1-MW01
2048			639.90 Casing	
2046			637.16 Concrete Pad	
2045			636.6 Ground	
2037	623,971.13	1,919,757.79	640.24 Riser	WTP1-MW02
2036			640.64 Casing	
2035			638.02 Concrete Pad	
2034			638.6 Ground	
2029	623,975.45	1,919,998.27	639.68 Riser	WTP1-MW03
2028			640.19 Casing	
2027			637.46 Concrete Pad	
2026			637.0 Ground	
2053	624,011.89	1,919,564.07	636.8	Borehole at proposed WTP1-BEDGW-001
2041	623,957.54	1,919,747.58	640.35 Riser	WTP1-BEDGW-002
2040			640.72 Casing	
2039			638.18 Concrete Pad	
2038			637.8 Ground	
2033	623,962.13	1,919,998.14	639.93 Riser	WTP1-BEDGW-003
2032			640.41 Casing	
2031			637.56 Concrete Pad	
2030			637.1 Ground	
2052	624,243.79	1,919,831.93	631.8	WTP1-SDW01
2049	624,248.32	1,919,717.17	631.8	WTP1-SDW02
2056	624,006.22	1,919,446.79	633.4	WTP1-SDW03
2059	623,929.66	1,919,432.72	634.2	WTP1-SDW04
2051	624,250.91	1,919,716.51	636.11 Top/Pipe	WTP1-SG01
2050			631.7 Creek Bottom	

Ash Pit #1

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
1	623,657.242	1,919,113.236	639.873	GPS Pt. 1-100
2	623,667.454	1,918,690.125	638.297	GPS Pt. 1-101
2150	623,372.09	1,918,800.20	642.93 Riser	AP1-MW01
2149			643.42 Casing	
2148			640.69 Concrete Pad	
2147			640.3 Ground	
2081	623,622.45	1,918,730.13	638.01 Riser	AP1-MW02
2080			638.45 Casing	
2079			635.02 Concrete Pad	
2078			634.7 Ground	
2072	623,723.44	1,918,747.06	639.06 Riser	AP1-MW03
2071			639.54 Casing	
2070			636.65 Concrete Pad	
2069			636.5 Ground	
2145	623,369.01	1,918,892.38	644.28 Riser	AP1-BEDGW-001
2144			644.62 Casing	
2143			641.95 Concrete Pad	
2142			641.8 Ground	
2077	623,620.90	1,918,741.22	637.16 Riser	AP1-BEDGW-002
2076			637.52 Casing	
2075			634.63 Concrete Pad	
2074			634.5 Ground	
2088	623,399.02	1,918,443.98	627.5	AP1-SDW01
2087	623,471.38	1,918,494.34	627.8	AP1-SDW02
2084	623,612.61	1,918,583.19	627.1	AP1-SDW03
2073	623,617.03	1,918,760.43	633.6	AP1-SDW04

Ash Pit #2

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
9	622,858.595	1,911,566.119	639.400	GPS Pt 5-100
10	623,115.362	1,911,626.581	638.679	GPS Pt. 5-101
516	622,819.31	1,911,245.10	632.55	SS&M Nail 516
2159	622,866.25	1,911,550.02	640.94 Riser	AP2-MW01
2158			641.39 Casing	
2157			638.41 Concrete Pad	
2156			638.2 Ground	
2167	622,892.79	1,911,351.16	635.53 Riser	AP2-MW02
2166			635.92 Casing	
2165			632.75 Concrete Pad	
2164			632.5 Ground	
2177	622,973.78	1,911,157.35	632.16 Riser	AP2-MW03
2176			632.45 Casing	
2175			629.84 Concrete Pad	
2174			629.5 Ground	
2173	622,795.83	1,911,202.97	633.46 Riser	AP2-BEDGW-001
2172			633.88 Casing	
2171			630.50 Concrete Pad	
2170			630.4 Ground	
2163	622,887.85	1,911,361.47	635.58 Riser	AP2-BEDGW-002
2162			636.07 Casing	
2161			632.77 Concrete Pad	
2160			632.4 Ground	
2155	623,117.29	1,911,619.32	640.83 Riser	AP2-BEDGW-003
2154			641.17 Casing	
2153			638.57 Concrete Pad	
2152			638.4 Ground	
2190	623,503.16	1,911,303.54	621.2	AP2-SDW01
2187	623,268.84	1,911,230.43	621.8	AP2-SDW02
2184	623,145.14	1,911,134.90	621.8	AP2-SDW03
2193	622,772.78	1,910,936.54	623.1	AP2-SDW04
2194	622,484.96	1,910,811.50	623.0	AP2-SDW05
2189	623,270.04	1,911,226.61	625.46 Top/pipe	AP2-SG04
2188			621.1 Creek Bottom	

Ash Pit #3 not sampled as of this date

Waste Water Treatment Plant #3

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
7	623,379.091	1,914,915.675	637.382	GPS Pt. 4-100
8	623,522.259	1,914,911.296	637.616	GPS Pt. 4-102
401	623,646.21	1,914,907.54		SS&M Nail 401
2215	623,391.43	1,914,527.69	640.00 Riser	WTP3-MW01
2214			640.39 Casing	
2213			637.21 Concrete Pad	
2212			637.0 Ground	
2203	623,447.80	1,914,416.55	640.91 Riser	WTP3-MW02
2202			641.36 Casing	
2201			638.04 Concrete Pad	
2200			637.7 Ground	
2207	623,501.39	1,914,372.79	637.90 Riser	WTP3-MW03
2206			638.40 Casing	
2205			635.72 Concrete Pad	
2204			635.6 Ground	
2218	623,382.22	1,914,531.86	640.15 Riser	WTP3-BEDGW-001
2219			640.64 Casing	
2217			637.30 Concrete Pad	
2216			637.1 Ground	
2199	623,453.92	1,914,407.33	640.9 Riser	WTP3-BEDGW-002
2198			641.38 Casing	
2197			638.02 Concrete Pad	
2196			637.6 Ground	
2222	623,532.48	1,914,302.59	640.21 Riser	WTP3-BEDGW-003
2223			640.66 Casing	
2221			637.43 Concrete Pad	
2220			637.1 Ground	
2225	623,513.33	1,914,357.28	630.6	WTP3-SDW01
2224	623,415.50	1,914,298.15	632.5	WTP3-SDW02
2226	623,667.10	1,914,369.86	629.76	WTP3-SDW03
2211	623,748.43	1,914,383.75	631.00 Top/Pipe	WTP3-SG03
2210			627.3 Creek Bottom	

Railcar Wash Area (Acid Area)

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
1	623,657.242	1,919,113.236	639.873	GPS Pt. 1-100
2	623,667.454	1,918,690.125	638.297	GPS Pt. 1-101
2064	623,724.69	1,919,029.45	641.01 Riser	RCA-MW01
2063			641.44 Casing	
2062			638.63 Concrete Pad	
2061			638.4 Ground	
2124	623,826.40	1,918,834.02	638.15 Riser	RCA-MW02
2123			638.59 Casing	
2122			635.52 Concrete Pad	
2121			635.3 Ground	
2128	623,865.52	1,918,827.90	638.16 Riser	RCA-MW03
2127			638.53 Casing	
2126			635.71 Concrete Pad	
2125			635.3 Ground	
2068	623,709.77	1,919,022.35	641.02 Riser	RCA-BEDGW-001
2067			641.38 Casing	
2066			638.83 Concrete Pad	
2065		638.5 Ground		
2120	623,832.46	1,918,842.57	638.03 Riser	RCA-BEDMW-002
2119			638.42 Casing	
2118			635.71 Concrete Pad	
2117			635.5 Ground	
2108	623,916.92	1,918,767.69	637.00 Riser	RCA-BEDGW-003
2107			637.46 Casing	
2106			634.80 Concrete Pad	
2105			634.3 Ground	

Locomotive Area

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
1	623,657.242	1,919,113.236	639.873	GPS Pt. 1-100
2	623,667.454	1,918,690.125	638.297	GPS Pt. 1-101
135	623,861.73	1,918,349.65	636.41	SS&M Nail 135
2112	623,937.12	1,918,462.09	639.86 Riser	LBA-MW01
2111			640.35 Casing	
2110			637.61 Concrete Pad	
2109			637.2 Ground	
2098	623,827.44	1,918,628.33	639.25 Riser	LBA-MW02
2097			639.71 Casing	
2096			636.39 Concrete Pad	
2095			635.9 Ground	
2104	623,788.63	1,918,684.59	638.18 Riser	LBA-MW03
2103			638.70 Casing	
2102			635.71 Concrete Pad	
2101			635.5 Ground	
2116	623,937.80	1,918,452.89	639.74 Riser	LBA-BEDGW-001
2115			640.23 Casing	
2114			637.65 Concrete Pad	
2113			637.3 Ground	
2094	623,827.05	1,918,614.64	638.62 Riser	LBA-BEDGW-002
2093			639.00 Casing	
2092			636.39 Concrete Pad	
2091			636.3 Ground	
2140	624,006.50	1,918,888.18	626.4	LBA-SDW01
2136	623,880.05	1,918,796.17	627.4	LBA-SDW02
2129	623,829.34	1,918,766.27	626.9	LBA-SDW03
2133	623,782.26	1,918,733.17	627.0	LBA-SDW04
2083	623,719.16	1,918,654.72	627.8	LBA-SDW05
2082	623,716.02	1,918,803.56	630.4	LBA-SDW06
2132	623,815.14	1,918,768.04	632.1 Water level	LBA-SW07
2131			631.1 Pipe invert	
2137	623,939.77	1,918,834.41	627.7	WSD-5
2138	623,781.72	1,918,728.51	630.65 Top/Pipe	LBA-SG05
2139			626.3 Creek Bottom	

Waste Water Treatment Plant #1 Sewer Line

SS&M ID#	Northing (y)	Easting (x)	Elevation	Shaw Designation
5	624,284.373	1,923,674.317	635.700	GPS Pt. 3-100
6	624,608.356	1,923,501.823	631.977	GPS Pt. 3-102
301	624,567.58	1,923,502.38		SS&M Nail 301
2004	624,190.42	1,922,785.52	634.66 Riser	1SLA-MW01
2003			635.11 Casing	
2002			631.85 Concrete Pad	
2001			631.7 Ground	
2012	624,354.65	1,922,688.56	633.93 Riser	1SLA-MW02
2011			634.57 Casing	
2010			630.92 Concrete Pad	
2009			630.8 Ground	
2020	624,654.19	1,922,564.69	639.71 Riser	1SLA-MW03
2019			640.10 Casing	
2018			636.92 Concrete Pad	
2017			636.7 Ground	
2008	624,129.03	1,922,624.33	636.14 Riser	1SLA-BEDGW-001
2007			636.59 Casing	
2006			633.41 Concrete Pad	
2005			633.0 Ground	
2016	624,368.22	1,922,687.20	634.16 Riser	1SLA-BEDGW-002
2015			634.56 Casing	
2014			631.21 Concrete Pad	
2013			630.9 Ground	
2024	624,696.73	1,922,811.24	636.74 Riser	1SLA-BEDGW-003
2023			637.16 Casing	
2022			634.41 Concrete Pad	
2021			634.0 Ground	

CERTIFICATION

I, Warren Robert Kusmer, Ohio Professional Surveyor #S-6754, hereby certify that the information in this survey report is true to the best of my knowledge and belief.

W Robert Kusmer

Warren Robert Kusmer,
Ohio Professional Surveyor #S-6754

June 22, 2009

Date

STATE OF OHIO
W. ROBERT KUSMER
6754
REGISTERED
SURVEYOR

APPENDIX F

IDW WASTE MANIFESTS
(APRIL, MAY, JUNE, SEPTEMBER, DECEMBER 2009)

** ALL MANIFESTS MAY OR MAY NOT BE APPROPRIATE FOR DISPOSAL OF WASTES AT POWERHOUSE 2 ASH PITS. DOCUMENTATION OF THE WASTE GENERATION LOCATION WAS NOT MADE, ONLY THE GROSS WEIGHT. THEREFORE, ALL MANIFESTS GENERATED ARE INCLUDED TO DOCUMENT ALL DISPOSAL ACTIVITIES.

006184141JJK

Form Approved. OMB No 2050-0039

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH3 800 015 379
2. Page 1 of 1
3. Emergency Response Phone: 800424 9300
4. Manifest Tracking Number: 006184141 JJK

5. Generator's Name and Mailing Address: NASA - PLUMBROOK STATION, 6100 COLUMBUS AVE, SANDUSKY OH 44870

Generator's Site Address (if different than mailing address): 6100 COLUMBUS AVE, SANDUSKY OH 44870

Generator's Phone: ~~(216) 642 0800~~ 419-621-3234

6. Transporter 1 Company Name: Triad Transport, Inc. — U.S. EPA ID Number: OKD981588791

7. Transporter 2 Company Name — U.S. EPA ID Number:

8. Designated Facility Name and Site Address: EQ DETROIT, INC, 1923 FREDERICK, DETROIT, MI 48211 — U.S. EPA ID Number: MID 980 991 662

Facility's Phone: (313) 947 1300

9a. HM	9b. U.S. DOT Description (Including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1. UN, NON DOT HAZARDOUS, NON RCRA REGULATED WATER	71	DM	35,500	~~600~~ P	D006
	2. UN, NON DOT HAZARDOUS, NON RCRA REGULATED SOIL	8	DM	4800	~~600~~ P	NONE
	3.					
	4.					

14. Special Handling Instructions and Additional Information
01 D098220DET / NON HAZARDOUS IDW WATER 02 D098221DET / NON HAZARDOUS SOIL
24 HOUR EMERGENCY RESPONSE NUMBER 1-800-424-9300 PROVIDED BY SHAW E & I VIA CONTRACT WITH CHEMTREC. NASA Manifest tracking number N09031

15. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Amy L. Bower — Signature: Amy L. Bower — Month 04 Day 29 Year 09

16. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit: Date leaving U.S.:
Transporter signature (for exports only):

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: DAVE GALL — Signature: Dave Gall — Month 04 Day 29 Year 09
Transporter 2 Printed/Typed Name — Signature — Month Day Year

18. Discrepancy
18a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number: U.S. EPA ID Number
18b. Alternate Facility (or Generator)
Facility's Phone: Month Day Year
18c. Signature of Alternate Facility (or Generator)

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H111 2. H111 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Tonya L. Howard — Signature — Month 04 Day 29 Year 09

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

EQ Detroit, Inc.

1923 FREDERICK STREET • DETROIT, MICHIGAN 48211 • tel 313-923-0080 • fax 313-923-3375 • www.eqonline.com

CERTIFICATE OF RECEIPT

This certificate is to verify that the wastes specified on manifest # 006184141551K have been properly received at EQ Detroit and will be properly managed to meet all applicable local, state and federal standards.

FACILITY NAME:	EQ Detroit, Inc. EPA ID # MID 980991566
ADDRESS:	1923 Frederick Street Detroit, MI 48211
PHONE NUMBER:	313-923-0080 800-495-6059
FAX NUMBER:	313-923-3375

Authorized Signature: _____

On behalf of EQ Detroit, Inc.

006184137JJK

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH3 800 015 379
2. Page 1 of 1
3. Emergency Response Phone: 800 424-9300
4. Manifest Tracking Number: 006184137 JJK

5. Generator's Name and Mailing Address: NASA - PLUMBROOK STATION
6100 COLUMBUS AVE
SANDUSKY OH 44870
Generator's Phone: ~~[illegible]~~ 419-621-3294

Generator's Site Address (if different than mailing address):
6100 COLUMBUS AVE
SANDUSKY, OH 44870

6. Transporter 1 Company Name: Triad Transport Inc.
U.S. EPA ID Number: OKD 981588791

7. Transporter 2 Company Name
U.S. EPA ID Number:

8. Designated Facility Name and Site Address: EQ DETROIT, INC
1923 FREDERICK
DETROIT, MI 48211
Facility's Phone: (313) 347-1300
U.S. EPA ID Number: MID 980 991 556

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt/Vol	13. Waste Codes
	1 UN, NON DOT HAZARDOUS, NON RCRA REGULATED Water	63	DM	32,720	P	D029L D.G.
	2 UN NON DOT HAZARDOUS NON RCRA REGULATED Soil	17	DM	10,200	P	NONE D.G.
	3					
	4.					

14. Special Handling Instructions and Additional Information:
01 D098220DET / NON HAZARDOUS IDW WATER 02 D098221DET / NON HAZARDOUS SOIL
24 HOUR EMERGENCY RESPONSE NUMBER 1-800-424-9300 PROVIDED BY SHAW E & I VIA CONTRACT WITH CHEMTREC. NASA Tracking number N09032

15 **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Amy L. Bower
Signature: Amy L. Bower
Month 04 Day 30 Year 09

GENERATOR

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Dave Gall
Signature: Dave Gall
Month 4 Day 30 Year 09
Transporter 2 Printed/Typed Name
Signature
Month Day Year

DESIGNATED FACILITY

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator)
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H111 2. H111 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Tonya Stewart
Signature
Month Day Year 04 30 09

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

EQ Detroit, Inc.

1923 FREDERICK STREET • DETROIT, MICHIGAN 48211 • *tel* 313-923-0080 • *fax 313-923-3375* • *www.eqonline.com*

CERTIFICATE OF RECEIPT

This certificate is to verify that the wastes specified on manifest # 006184137 have been properly received at EQ Detroit and will be properly managed to meet all applicable local, state and federal standards.

FACILITY NAME:	EQ Detroit, Inc. EPA ID # MID 980991566
ADDRESS:	1923 Frederick Street Detroit, MI 48211
PHONE NUMBER:	313-923-0080 800-495-6059
FAX NUMBER:	313-923-3375

Authorized Signature: Mark Hudson

On behalf of EQ Detroit, Inc.

006184138JJK

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH3 800 015 379
2. Page 1 of 1
3. Emergency Response Phone: 8004249300
4. Manifest Tracking Number: 006184138 JJK

5. Generator's Name and Mailing Address: NASA - PLUMBROOK STATION
6100 COLUMBUS AVE
SANDUSKY, OH 44870
Generator's Phone: ~~(218) 842-0891~~ After 419-621-3234 ab

Generator's Site Address (if different than mailing address):
6100 COLUMBUS AVE
SANDUSKY, OH 44870

6. Transporter 1 Company Name: Triad Transport, Inc.
U.S. EPA ID Number: OKD981588791

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address: EQ DETROIT, INC
1923 FREDERICK
DETROIT, MI 48211
Facility's Phone: (313) 347-1300
U.S. EPA ID Number: MID 980 991 566

9a HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes		
	1 UN, NON DOT HAZARDOUS, NON RCRA REGULATED Water	60	DM	23,500	P	D29L		
	2 UN, NON DOT HAZARDOUS, NON RCRA REGULATED Soil	20	DM	18,000	P	NONE		
	3							
	4							

14. Special Handling Instructions and Additional Information:
01 D098220DET / NON HAZARDOUS IDW WATER 02. D098221DET / NON HAZARDOUS SOIL
24 HOUR EMERGENCY RESPONSE NUMBER: 1-800-424-9300 PROVIDED BY SHAW E & I VIA CONTRACT WITH CHEMTREC. NASA tracking number N09033

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Amy L. Bower
Signature: Amy L. Bower
Month Day Year: 05 01 09

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Dave Gall
Signature: Dave Gall
Month Day Year: 05 01 09
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year:

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

18b. Alternate Facility (or Generator)
U.S. EPA ID Number:
Facility's Phone:

18c. Signature of Alternate Facility (or Generator)
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H111 2. H111 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Tony Stewart
Signature:
Month Day Year: 05 01 09

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete

DESIGNATED FACILITY TO GENERATOR STATE (IF REQUIRED)

EQ Detroit, Inc.

1923 FREDERICK STREET • DETROIT, MICHIGAN 48211 • tel 313-923-0080 • fax 313-923-3375 • www.eqonline.com

CERTIFICATE OF RECEIPT

This certificate is to verify that the wastes specified on manifest # 006184138 have been properly received at EQ Detroit and will be properly managed to meet all applicable local, state and federal standards.

FACILITY NAME:	EQ Detroit, Inc. EPA ID # MID 980991566
ADDRESS:	1923 Frederick Street Detroit, MI 48211
PHONE NUMBER:	313-923-0080 800-495-6059
FAX NUMBER:	313-923-3375

Authorized Signature: _____
On behalf of EQ Detroit, Inc.

006184139JJK

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH3 800 015 379
2. Page 1 of: 1
3. Emergency Response Phone: 800-424-9300
4. Manifest Tracking Number: 006184139 JJK

5. Generator's Name and Mailing Address: NASA - PLUMBROOK STATION
6100 COLUMBUS AVE
SANDUSKY, OH 44870
Generator's Phone: ~~(810) 948-8891~~ 419-621-3234

Generator's Site Address (if different than mailing address):
6100 COLUMBUS AVE
SANDUSKY, OH 44870

6. Transporter 1 Company Name: Triad Trucking Company — U.S. EPA ID Number:
7. Transporter 2 Company Name: — U.S. EPA ID Number:

8. Designated Facility Name and Site Address: EQ DETROIT, INC.
1923 FREDERICK
DETROIT, MI 48211
Facility's Phone: (313) 347-1300
U.S. EPA ID Number: MID 980 991 566

9a. HM	9b. U.S. DOT Description (Including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes		
	1. UN, NON DOT HAZARDOUS, NON RCRA REGULATED Water	56	DM	28,000 Est	lbs	D29L		
	2. UN, NON DOT HAZARDOUS, NON RCRA REGULATED Soil	29	DM	14,500 Est	lbs	NONE		
	3.							
	4.							

14. Special Handling Instructions and Additional Information
01. D098220DET / NON HAZARDOUS IDW WATER 02. D098221DET / NON HAZARDOUS SOIL
24 HOUR EMERGENCY RESPONSE NUMBER: 1-800-424-9300 PROVIDED BY SHAW E & I VIA CONTRACT WITH CHEMTREC. NASA - N09034

15. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Robert F. Lallier Jr. — Signature: Robert F. Lallier on behalf of Director, GRC — Month 5 Day 5 Year 09

16. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: DAVE BALL — Signature: Dave Ball — Month 05 Day 05 Year 09
Transporter 2 Printed/Typed Name: — Signature: — Month Day Year

18. Discrepancy
18a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

18b. Alternate Facility (or Generator) — Manifest Reference Number: — U.S. EPA ID Number:
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H111 2. H111 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Danielle Edwards — Signature: Danielle Edwards — Month 05 Day 05 Year 09

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO GENERATOR STATE (IF REQUIRED)

EQ Detroit, Inc.

1923 FREDERICK STREET • DETROIT, MICHIGAN 48211 • tel 313-923-0080 • fax 313-923-3375 • www.eqonline.com

CERTIFICATE OF RECEIPT

This certificate is to verify that the wastes specified on manifest # 006184139 have been properly received at EQ Detroit and will be properly managed to meet all applicable local, state and federal standards.

FACILITY NAME:	EQ Detroit, Inc. EPA ID # MID 980991566
ADDRESS:	1923 Frederick Street Detroit, MI 48211
PHONE NUMBER:	313-923-0080 800-495-6059
FAX NUMBER:	313-923-3375

Authorized Signature: _____

On behalf of EQ Detroit, Inc.

000310559FLE

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH3800015379
2. Page 1 of: 1
3. Emergency Response Phone: 1-800-424-9300
4. Manifest Tracking Number: 000310559 FLE

5. Generator's Name and Mailing Address
NASA-Plumbrook Station
6100 Columbus Ave.
Sandusky, OH 44870
Generator's Phone: 216-642-0891

Generator's Site Address (if different than mailing address)
6100 Columbus Ave.
Sandusky, OH 44870

6. Transporter 1 Company Name: Triad Transport, Inc.
U.S. EPA ID Number: OKD981588791

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
EQ Detroit, Inc.
1923 Frederick
Detroit, MI 48211
Facility's Phone: 313-347-1300
U.S. EPA ID Number: MID980991566

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1. UN, Non Dot Hazardous, Non RCRA Regulated	19	DM	15,200	lbs	None
	2. UN, Non Dot Hazardous, Non RCRA Regulated	59	DM	23,600	lbs	029L
	3.					
	4.					

14. Special Handling Instructions and Additional Information
1. D098221DET/ Non Hazardous Soil 2. D098220DET/ Non Hazardous IDW Water
24hr Emergency Response: 1-800-424-9300 provided by Shaw E&I via contract with Chemtrec

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Robert F. Lallier Jr.
Signature: Robert F. Lallier on behalf of Director, SRC
Month 06 Day 16 Year 09

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Benjamin D. Rhoads Sr.
Signature: Benjamin D. Rhoads Sr.
Month 06 Day 16 Year 09
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
OK to change see 12 line 1 & 2 per Beth Crawford 6/16/09
Manifest Reference Number:
18b. Alternate Facility (or Generator)
U.S. EPA ID Number:
Facility's Phone:
18c. Signature of Alternate Facility (or Generator)
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H111 2. H111 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Tonya C. Stewart
Signature:
Month 06 Day 16 Year 09

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

000310584FLE

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH3800015379
2. Page 1 of 1
3. Emergency Response Phone: 1-800-424-9300
4. Manifest Tracking Number: 000310584 FLE

5. Generator's Name and Mailing Address
NASA-Plumbrook Station
6100 Columbus Ave.
Sandusky, OH 44870
Generator's Phone: 216-642-0891

Generator's Site Address (if different than mailing address)
6100 Columbus Ave.
Sandusky, OH 44870

6. Transporter 1 Company Name: Triad Transport, Inc.
U.S. EPA ID Number: OKD981588791

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
EQ Detroit, Inc.
1923 Frederick
Detroit, MI 48211
Facility's Phone: 313-347-1300
U.S. EPA ID Number: MID980991566

9a HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1 UN, Non Dot Hazardous, Non RCRA Regulated		DM			
	2. UN, Non Dot Hazardous, Non RCRA Regulated	56	DM	22,400	lbs P	D029L
	3.					
	4.					

14. Special Handling Instructions and Additional Information
1. D098221DET/Non Hazardous Soil 2. D098220DET/ Non Hazardous IDW Water
24hr Emergency Response: 1-800-424-9300 provided by Shaw E&I via contract with Chemtrec

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Robert F. Lallier Jr.
Signature: Robert F. Lallier on behalf of Director, GRC
Month Day Year: 06 17 09

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Benjamin D. Rhoads Sr.
Signature: Benjamin D. Rhoads Sr.
Month Day Year: 06 17 09
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year:

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

18b. Alternate Facility (or Generator) U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. 2. H111 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Tonya C. Stewart
Signature:
Month Day Year: 06 17 09

GENERATOR / TRANSPORTER (INT'L) / DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete. DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

EQ Detroit, Inc.

1923 FREDERICK STREET • DETROIT, MICHIGAN 48211 • tel 313-923-0080 • fax 313-923-3375 • www.eqonline.com

CERTIFICATE OF RECEIPT

000316559FLE

This certificate is to verify that the wastes specified on manifest # _____ _ have been properly received at EQ Detroit and will be properly managed to meet all applicable local, state and federal standards.

FACILITY NAME:	EQ Detroit, Inc. EPA ID # MID 980991566
ADDRESS:	1923 Frederick Street Detroit, MI 48211
PHONE NUMBER:	313-923-0080 800-495-6059
FAX NUMBER:	313-923-3375

Authorized Signature: _____

On behalf of EQ Detroit, Inc.

000310583FLE

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH380001537 9
2. Page 1 of: 1
3. Emergency Response Phone: 1-800-424-9300
4. Manifest Tracking Number: 000310583 FLE

5. Generator's Name and Mailing Address
NASA-Plumbrook Station
6100 Columbus Ave.
Sandusky, OH 44870
Generator's Phone: 216-642-0891

Generator's Site Address (if different than mailing address)
6100 Columbus Ave.
Sandusky, OH 44870

6. Transporter 1 Company Name: Triad Transport, Inc.
U.S. EPA ID Number: OKD981588791

7. Transporter 2 Company Name
U.S. EPA ID Number

8. Designated Facility Name and Site Address
EQ, Detroit, Inc.
1923 Frederick
Detroit, MI 48211
Facility's Phone: 313-347-1300
U.S. EPA ID Number: MID980991566

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No	10. Containers Type	11. Total Quantity	12. Unit Wt/Vol	13. Waste Codes
	1. UN, Non Dot Hazardous, Non RCRA Regulated	22	DM	17,600	P	
	2. UN, Non Dot Hazardous, Non RCRA Regulated	20	DM	8,000	P	029L
	3.					
	4.					

14. Special Handling Instructions and Additional Information
1. D098221DET/ Non-Hazardous Soil 2. D098220DET/ Non Hazardous IDW Water
XX 24hr Emergency Response: 1-800-424-9300 provided by Shaw E&I via contract with Chemtrec

15. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Robert F. Lallier Jr.
Signature: Robert F. Lallier Jr. on behalf of Director, GRC
Month 6 Day 18 Year 09

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Benjamin D. Rhoads Sr.
Signature: Benjamin D. Rhoads Sr.
Month 06 Day 18 Year 09
Transporter 2 Printed/Typed Name
Signature
Month Day Year

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number

18b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:

18c. Signature of Alternate Facility (or Generator)
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H111 2. H111 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Corey C. Howard
Signature
Month 06 Day 18 Year 09

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete. DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

EQ Detroit, Inc.

1923 FREDERICK STREET • DETROIT, MICHIGAN 48211 • tel 313-923-0080 • fax 313-923-3375 • www.eqonline.com

CERTIFICATE OF RECEIPT

This certificate is to verify that the wastes specified on manifest # 000310583FLE have been properly received at EQ Detroit and will be properly managed to meet all applicable local, state and federal standards.

FACILITY NAME:	EQ Detroit, Inc. EPA ID # MID 980991566
ADDRESS:	1923 Frederick Street Detroit, MI 48211
PHONE NUMBER:	313-923-0080 800-495-6059
FAX NUMBER:	313-923-3375

Authorized Signature: _____

On behalf of EQ Detroit, Inc.

000310538FLE

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: O H 3 8 0 0 0 1 5 3 7 9
2. Page 1 of 1
3. Emergency Response Phone: 1-800-424-9300
4. Manifest Tracking Number: 000310538 FLE

5. Generator's Name and Mailing Address
Nasa-Plumbrook Station
6100 Columbus Ave.
Sandusky, OH 44870

Generator's Site Address (if different than mailing address)
6100 Columbus Ave.
Sandusky, OH 44870

Generator's Phone: ~~216-642-0891~~ 419.621-3234

6. Transporter 1 Company Name: EQ Industrial Services — U.S. EPA ID Number: MID 000 263 871

7. Transporter 2 Company Name — U.S. EPA ID Number:

8. Designated Facility Name and Site Address
EQ, Detroit, Inc.,
1923 Frederick
Detroit, MI 48211
Facility's Phone: 313-347-1300
U.S. EPA ID Number: MID 980991566

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number and Packing Group (if any))	10. Containers No.	Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1. UN, Non DOT Hazardous, Non-RCRA Regulated	~~X~~ 3 CCS	D M	1,000 ~~150~~ CCS est.	P	None
	2. UN, Non Dot Hazardous, Non-RCRA Regulated	~~X~~ 4	D M	210 est.	G	029L
	3.					
	4.					

14. Special Handling Instructions and Additional Information
9a1) D098221DET/ Non-Hazardous Soil 9a2) D098220DET/ Non-Hazardous IDW Water
24hr Emergency Response: 1-800-424-9300 provided by Shaw E&I via contract with Chemtrec

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Robert F. Lallier Jr. — Signature: Robert F. Lallier Jr. — Month 9 Day 10 Year 09

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Raymond Root — Signature: Raymond Root — Month 09 Day 10 Year 09
Transporter 2 Printed/Typed Name: — Signature: — Month Day Year

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) — U.S. EPA ID Number:
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H111 2. H111 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18b.
Printed/Typed Name: David Patton — Signature: — Month 09 Day 10 Year 09

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

EQ Detroit, Inc.

1923 FREDERICK STREET • DETROIT, MICHIGAN 48211 • tel 313-923-0080 • fax 313-923-3375 • www.eqonline.com

CERTIFICATE OF RECEIPT

This certificate is to verify that the wastes specified on manifest # 000310538FLE have been properly received at EQ Detroit and will be properly managed to meet all applicable local, state and federal standards.

FACILITY NAME:	EQ Detroit, Inc. EPA ID # MID 980991566
ADDRESS:	1923 Frederick Street Detroit, MI 48211
PHONE NUMBER:	313-923-0080 800-495-6059
FAX NUMBER:	313-923-3375

Authorized Signature: _____
On behalf of EQ Detroit, Inc.

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: O H 3 8 0 0 0 1 5 3 7 9
2. Page 1 of: 1
3. Emergency Response Phone: 1-800-424-9300
4. Manifest Tracking Number: 000310647 FLE

5. Generator's Name and Mailing Address
Nasa-Plumbrook Station
6100 Columbus Ave.
Sandusky, OH 44870
Generator's Phone: 216-642-0891

Generator's Site Address (if different than mailing address)
6100 Columbus Ave.
Sandusky, OH 44870

6. Transporter 1 Company Name: EQ Industrial Services
U.S. EPA ID Number: M I 0 0 0 0 2 6 3 8 7 1

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Wayne Disposal, Inc.
49350 North I-94 Service Drive.
Belleville, MI 48111
Facility's Phone: 1-800-592-5489
U.S. EPA ID Number: M I D 0 4 8 0 9 0 6 3 3

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes		
X	1. NA3077, Hazardous Waste Solid, n.o.s. (2,4-Dinitrotoluene) 9, PG III	4	D M	2400	P	D030		
	2.							
	3.							
	4.							

14. Special Handling Instructions and Additional Information
9a1) Approval #: L098097WDI-OTS ERG #: 171
24hr Emergency Response: 1-800-424-9300 provided by Shaw E&I via contract with Chemtrec
NASA# 09012

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Robert F. Lallier Jr.
Signature: Robert F. Lallier on behalf of Director, GKC
Month 12 Day 17 Year 09

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: DAYLE BLAIR
Signature: Dayle Blair
Month 12 Day 17 Year 09
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator)
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name
Signature
Month Day Year

GENERATOR | INT'L | TRANSPORTER | DESIGNATED FACILITY

Land Disposal Restriction & Certification Form

Please check the appropriate facility:

☐ **Michigan Disposal Waste Treatment Plant**	49350 N. I-94 Service Drive, Belleville, MI 48111	EPA ID # MID 000 724 831
☒ **Wayne Disposal, Inc. Site #2 Landfill**	49350 N. I-94 Service Drive, Belleville, MI 48111	EPA ID # MID 048 090 633
☐ **EQ Detroit, Inc.**	1923 Frederick Street, Detroit, MI 48211	EPA ID # MID 980 991 566
☐ **EQ Resource Recovery, Inc.**	36345 Van Born Road, Romulus, MI 48174	EPA ID # MID 060 975 844
☐ **EQ North Carolina**	1005 Investment Blvd, Apex, NC 27502	EPA ID # NCD 982 170 292
☐ **EQ Florida, Inc.**	7202 East 8th Ave, Tampa, FL 33619	EPA ID # FLD 981 932 494

Generator Name: Nasa - Plumbrook **U.S. EPA ID No.:** OH3800015379

Generator Address: 6100 Columbus Ave Sandusky, OH 44870

State Manifest No.: _____ **Manifest Doc. No.:** C003101047 FLE

Instructions

Column 1: Identify all U.S. EPA hazardous waste codes that apply to this waste shipment.
Column 2: Choose the appropriate treatability group: Non-Wastewater (NWW) or Wastewater (WW).
Column 3: Enter the appropriate Subcategory, if applicable. Also enter "Contaminated Soil" or "Debris" if the waste will be treated using one of the alternative treatment technologies provided by 40 CFR 268.49 (c) – soil, or 40 CFR 268.45 – debris.
Column 4: Enter the letter of the appropriate paragraph from pages 1-2 of this form.
Column 5: For F001 – F005, F039, D001 – D043, Debris and Contaminated Soil: please enter the Reference Number(s) for any constituents in your waste stream subject to treatment. The Reference Number(s) can be found in the EQ Resource Guide, LDR/UHC Constituent Table.

Manifest Line Item	U.S. EPA Hazardous Waste Code (s)	NWW or WW	Subcategory	How Must the Waste be Managed?	Reference Number(s) of Hazardous Constituents contained in the waste. Complete for F001-F005, F039, D001-D043, Soil and Debris wastes.
9a ~~11A~~	D030	NWW	—	D	D030
11B					
11C					
11D					

I hereby certify that all information submitted on this and all associated documents is complete and accurate to the best of my knowledge and information.

Generator Signature: Robert F. Lallier **Title:** Env Manager

Printed Name: Robert F. Lallier Jr. **Date:** 12/17/09

How Must the Waste Be Managed?

S. THIS CONTAMINATED SOIL *DOES* / *DOES NOT* (CIRCLE ONE) CONTAIN LISTED HAZARDOUS WASTE AND *DOES* / *DOES NOT* (CIRCLE ONE) EXHIBIT A CHARACTERISTIC OF HAZARDOUS WASTE AND *IS SUBJECT TO* / *COMPLIES WITH* (CIRCLE ONE) THE SOIL TREATMENT STANDARDS AS PROVIDED BY 268.49(c) OR THE UNIVERSAL TREATMENT STANDARDS. I certify under penalty of law that I have personally examined and am familiar with the treatment technology and operation of the treatment process used to support this certification and believe that it has been maintained and operated properly so as to comply with treatment standards specified in 40 CFR 268.49 without impermissible dilution of the prohibited wastes. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine and imprisonment.

000310647 FLE

Land Disposal Restriction & Certification Form

A. THIS RESTRICTED WASTE REQUIRES TREATMENT TO THE APPLICABLE STANDARD. This waste must be treated to the applicable performance based treatment standard set forth in 40CFR Part 268 Subpart C and Subpart D, 268.40 or RCRA Section 3004(d) prior to land disposal.

B. THIS HAZARDOUS DEBRIS IS SUBJECT TO THE ALTERNATIVE TREATMENT STANDARDS OF 40 CFR 268.45.

C. THIS RESTRICTED WASTE HAS BEEN TREATED TO THE PERFORMANCE STANDARDS. I certify under penalty of law that I have personally examined and am familiar with the treatment technology and operation of the treatment process used to support this certification. Based on my inquiry of those individuals immediately responsible for obtaining this information, I believe that the treatment process has been operated and maintained properly so as to comply with the treatment standards specified in 40 CFR 268.40 without impermissible dilution of the prohibited waste. I am aware there are significant penalties for submitting a false certification, including the possibility of fine and imprisonment.

D. THIS RESTRICTED WASTE CAN BE LAND DISPOSED WITHOUT TREATMENT. I certify under penalty of law that I personally have examined and am familiar with the waste through analysis and testing or through knowledge of the waste to support this certification that the waste complies with the treatment standards specified in 40 CFR part 268 subpart D. I believe that the information I submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting a false certification, including the possibility of a fine and imprisonment.

E. THIS LAB PACK DOES NOT CONTAIN ANY WASTES IDENTIFIED AT APPENDIX IV TO PART 268. I certify under penalty of law that I personally have examined and am familiar with the waste and that the lab pack contains only wastes that have not been excluded under appendix IV to 40 CFR part 268 and that this lab pack will be sent to a combustion facility in compliance with the alternative treatment standards for lab packs at 40 CFR 268.42(c). I am aware that there are significant penalties for submitting a false certification, including the possibility of fine or imprisonment.

F. THIS RESTRICTED WASTE HAS BEEN TREATED TO REMOVE THE HAZARDOUS CHARACTERISTIC AND CONTAINS UNDERLYING HAZARDOUS CONSTITUENTS THAT REQUIRE FURTHER TREATMENT TO MEET THE UNIVERSAL TREATMENT STANDARDS. I certify under penalty of law that the waste has been treated in accordance with the requirements of 40 CFR 268.40 or 268.49 to remove the hazardous characteristic. This decharacterized waste contains underlying hazardous constituents that require further treatment to meet treatment standards. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine and imprisonment.

G. THIS RESTRICTED WASTE HAS BEEN TREATED TO REMOVE THE HAZARDOUS CHARACTERISTIC AND BEEN TREATED FOR UNDERLYING HAZARDOUS CONSTITUENTS. I certify under penalty of law that the waste has been treated in accordance with the requirements of 40 CFR 268.40 to remove the hazardous characteristic and that underlying hazardous constituents, as defined in §268.2(i) have been treated on-site to meet the §268.48 Universal Treatment Standards. I am aware that there are significant penalties for submitting a false certification, including the possibility of fine and imprisonment..

H. THIS RESTRICTED WASTE IS SUBJECT TO AN EXEMPTION FROM LAND DISPOSAL. *(Please include the date the waste is subject to the prohibitions in Column 5)* This waste is subject to an exemption from a prohibition on the type of land disposal method utilized for the waste (such as, but not limited to, a case-by-case extension under 40 CFR Part 268.5, an exemption under 40 CFR 268.6, or a nationwide capacity variance under 40 CFR 269 Subpart C)

I. THIS RESTRICTED WASTE WITH TREATMENT STANDARDS EXPRESSED AS CONCENTRATIONS IN THE WASTE PURSUANT TO 268.43, IF COMPLIANCE WITH THE TREATMENT STANDARDS IN SUBPART D OF THIS PART IS BASED IN PART OR IN WHOLE ON THE ANALYTICAL DETECTION LIMIT ALTERNATIVE IN 268.439(c). I certify under penalty of law that I have personally examined and am familiar with the treatment technology and operation of the treatment process used to support this certification. Based on my inquiry of those individuals immediately responsible for obtaining this information, I believe that the nonwastewater organic constituents have been treated by combustion units as specified in 268.42, Table 1. I have been unable to detect the nonwastewater organic constituents, despite having used best good-faith efforts to analyze for such constituents. I am aware there are significant penalties for submitting a false certifications, including the possibility of fine and imprisonment.

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH380001537 9
2. Page 1 of 1
3. Emergency Response Phone: 1-800-424-9300
4. Manifest Tracking Number: 000310535 FLE

GENERATOR

5. Generator's Name and Mailing Address
Nasa-Plumbrook Station
6100 Columbus Ave.
Sandusky, OH 44870
Generator's Phone: 216-642-0891

Generator's Site Address (if different than mailing address)
6100 Columbus Ave.
Sandusky, OH 44870

6. Transporter 1 Company Name: EQ Industrial Services
U.S. EPA ID Number: MI0000263871

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
EQ Detroit Inc.
1923 Frederick
Detroit, MI 48211
Facility's Phone: 313-347-1300
U.S. EPA ID Number: MID980991566

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1. UN, Non-DOT Hazardous, Non-RCRA Regulated Liquids	7	DM	300	G	029L
	2. UN, Non-DOT Hazardous, Non-RCRA Regulated Solids	1	DM	200	P	
	3.					
	4.					

14. Special Handling Instructions and Additional Information
NASA # N09103
9a1) D098220DET/Non-Hazardous IDW Water 9a2) D098221DET/Non-Hazardous Soil
24hr Emergency Response: 1-800-424-9300 provided by Shaw E&I via contract with Chemtrec

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Robert F. Lallier Jr. Signature: Robert F. Lallier on behalf of Director GRC Month 12 Day 17 Year 09

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: DAVE BLAIR Signature: Dave Blair Month 12 Day 17 Year 09
Transporter 2 Printed/Typed Name: Signature: Month Day Year

DESIGNATED FACILITY

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) Month Day Year
19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. 2. 3. 4.
20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name Signature Month Day Year

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete. DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

APPENDIX G

DATA VALIDATION SUMMARIES

Data Validation Summary Report
Powerhouse 2 Ash Pits Sampling January – November 2009
Former Plum Brook Ordnance Works
Sandusky, Ohio

1.0 Introduction

Level IV data validation was performed on 100 percent of the environmental samples collected for the January 2009 through November 2009 sampling events. The analytical data consisted of nine sample delivery groups (0901026, 0901027, 0902003, F65476, F65479, F65480, F69338, F69502 and F69607), which were analyzed by AML Scientific of Olathe, Kansas and Accutest of Orlando, Florida. In addition, validation of the field-split data, four SDGs (A9A170114, A9B030206, A9E270266 and A9K190539), which were analyzed by Test America of North Canton, Ohio, was performed and findings are discussed in section 5.0 of this report. Water and soil matrices were validated.

The following samples were validated for this investigation:

SDG Number	Sample Number
0901026	AP0100, AP0101, AP0102, AP0103, AP0104, AP0105, AP0107, AP0114, AP0115, AP0116, AP0117, AP0118, AP0119, AP0120, AP0121, AP0123, AP0124, AP0125, AP0126, AP0127, AP0128
0901027	AP0108, AP0109, AP0110, AP0111, AP0112, AP0113
0902003	AP3015, AP3018, AP3019, AP3022
F65476	AP1000, AP1001, AP1002, AP1003, AP1004, AP1006
F65479	AP2000, AP2001, AP2002, AP2003, AP2005, AP2006
F65480	AP3063, AP3064, AP3065, AP3057, AP3058, AP3059, AP3061
F69338	AP3070
F69502	AP3076
F69607	AP3079, AP3080, AP3081
A9A170114	AP0106, AP0122, AP0129
A9B030206	AP3016
A9E270266	AP1005, AP3066, AP3060, AP2004
A9K190539	AP3082

The chemical parameters, for which the samples were analyzed, are identified below:

Parameter (Prep/Analytical Method)
Volatile Organics by GC/MS SW846 5030/8260B
Semivolatile Organics by GC/MS SW846 3510C/8270C
Total and Dissolved Metals by SW846 3005A/6010B and 7470A/7471
Nitroaromatic and Nitramine Explosives by SW846 8330M
PCBs by SW846 8082
Wet Chemistry (TOC, Sulfate, Nitrate, Chloride, Alkalinity, Turbidity, TDS, TSS, Hardness, Cyanide)

GC/MS – Gas chromatography/mass spectrometry.
TDS - Total dissolved solids.
TOC - Total organic carbon.
TSS – Total suspended solids.

2.0 Procedures

The sample data were validated following the logic identified in the EPA Contract Laboratory Program (CLP) National Functional Guidelines for Inorganic Data Review (October 2004) and the EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (June 2008) for all areas except blanks. EPA Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses (April 1993) and Region III Modifications to National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration (September 1994) were applied to the areas associated with blank contamination. Specific quality control (QC) criteria as identified in the quality assurance plan (QAP), analytical methods, and laboratory standard operating procedures (SOP) were applied to all sample results. As a result of the use of Update III SW846 test methods for the analytical data and the application of the Contract Laboratory Program (CLP) guidelines during the validation process, there were instances where the specific QC requirements for all target compounds were not defined. This primarily occurred in the organic, GC/MS calibration areas and is due to the fact that the analytical methods are performance-based and allow the use of average calibration responses in lieu of individual responses, which are defined by CLP protocol. In light of applying CLP guidelines to SW846 methods and evaluating the usability of the data during the validation process, specific QC criteria were determined to address all target compounds and are identified in this report for each parameter, as well as in the validation checklists, which function as worksheets. For those analytical methods not addressed by the CLP and Region III guidelines, the validation was based on the method requirements (i.e., SW846, Code of Federal Regulations, SOPs) and technical judgment, following the logic of the CLP validation guidelines. Lab-specific criteria may be found in Attachment A.

3.0 Summary of Data Validation Findings

The overall quality of the data was determined to be acceptable with minimal qualifications. The only rejected volatile organic data ("R" qualified) was due to "poor performing" volatile compounds (ketones, some halogenated hydrocarbons, etc.), which experienced poor calibration responses in the associated calibration data. For the Explosive analysis, surrogate recoveries for samples AP0114 and AP0125 and the MS/MSD recoveries for sample AP3079 for Tetryl resulted in those data being rejected. The poor recoveries appear to be associated with matrix interference. Reanalysis of these samples yield the same results. The "R" qualifier was assigned to the samples with more than one set of results to indicate that a given result should not be used to characterize a particular constituent or an analysis for a given sample.

Individual validation reports have been prepared for each parameter, and the overall results of the validation findings are summarized in this report. A listing of the validation qualifiers and the reason codes, along with their definitions, is found in Attachment A. The following section highlights the key findings of the data validation for each analysis.

4.0 Analysis-Specific Data Validation Summaries

4.1 Volatile Organics by GC/MS SW846 8260B

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times
Technical holding time criteria were met for all samples.

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria with the following exception(s):

- The following exhibited individual ICAL/CCAL relative response factor (RRF) <0.1:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
F65480	AP3057, AP3058, AP3059, AP3061, AP3063, AP3064, AP3065	Acetone	R
F69338	AP3070	Acetone	R

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable with the following exception(s):

SDG Number	Samples Affected	Compounds	Blank Contaminant	Validation Qualifier
F69607	AP3079, AP3080, AP3081	Chloroform	Equipment	B
	AP3080	Methylene Chloride	Trip	B
	AP3081	Carbon Disulfide	Equipment	B

Surrogate Recoveries
All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
F65480	AP3064	Cis-1,3-Dichloropropene, trans-1,3-Dichloropropene	UJ
F69607	AP3079	trans-1,3-Dichloropropene, Methyl bromide, Methyl chloride, Vinyl chloride	J/UJ

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Field Duplicates
Original and field duplicate results were evaluated and no problems were identified with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
F69607	AP3079(original), AP3081(FD)	Chloroform, Chloromethane, Acetone, Benzene, Ethylbenzene, Toluene, Xylene (total)	J

Internal Standards
All internal standards met QC criteria.

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.2 Semivolatile Organics by GC/MS SW846 8270C
Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following;

Holding Times
Technical holding time criteria were met for all samples, with the following exception(s):

SDG Number	Samples Affected	Analysis	Validation Qualifier
F65480	AP3057	Semivolatiles	UJ

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria with the following exception(s):

The following exhibited individual ICAL percent relative standard deviation > 30% and/or CCAL percent difference > 20%:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
0901026	AP0102, AP0104, AP0107, AP0116, AP0119, AP0121, AP0123, AP0124, AP0127, AP0128	Benzoic Acid	UJ
	AP0105, AP0114, AP0115,	2,4-Dinitrophenol	UJ
0902003	AP3015, AP3018, AP3019, AP3022	Hexachlorocyclopentadiene	UJ
F65476	AP1002, AP1003, AP1004, AP1006	2,4-Dinitrophenol	UJ

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
0901026	AP1000	Hexachlorocyclopentadiene*	UJ

*Hexachlorocyclopentadiene was qualified for %RPD outside QC limits for the MS/MSD analysis.

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Field Duplicates
Original and field duplicate results were evaluated and no problems were identified with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
F65480	AP3064(original), AP3065(FD)	2-Methylnaphthalene, Naphthalene	J

Internal Standards
All internal standards met QC criteria.

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.3 Total and Dissolved Metals by SW846 6010B/7470A/7471
Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following;

Holding Times
Technical holding time criteria were met for all samples.

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria.

Blanks

The 5X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable, with the following exception(s):

SDG Number	Samples Affected	Analytes	Blank Contaminant	Validation Qualifier
F65480	AP3057, AP3063	Pb (Filtered)	Equipment	B
	AP3061, AP3064, AP3065	Se (Total)	Equipment	B
F69338	AP3070, AP3071, AP3072	Pb (Total)	Method	B
	AP3070, AP3072, AP3073	Zn (Total)	Method	B
F69607	AP3081	Pb (Total)	Equipment	B
	AP3079, AP3080, AP3081	Al (Filtered)	Equipment	B

Matrix Spike/Matrix Spike Duplicate

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Analyte(s)	Validation Qualifier
0901026	AP0100, AP0101, AP0102, AP0117, AP0118, AP0120, AP0121, AP0123	(Total) Al, Cu, Fe, Mg	J/UJ
	AP0103, AP0104, AP0105, AP0107, AP0114, AP0115, AP0116, AP0119, AP0124, AP0125, AP0126, AP0127, AP0128	(Total) Al, Ba, Co*, Cu, Mg	J/UJ
0901027	AP0108, AP0109, AP0110, AP0111, AP0112, AP0113	(Total) As, Ba*, Co*, Mg, Ni, Se, Ag*	J/UJ
F65480	AP3064	Se (Total and Filtered), Mg (Filtered)	B/J
F69607	AP3079, AP3080, AP3081	Se (Total and Filtered)	J

*Analytes were qualified for %RPD outside QC limits for the MS/MSD analysis.

Laboratory Duplicate Sample Analysis

A Laboratory Duplicate Sample analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Analyte(s)	Validation Qualifier
F65476	AP1001, AP1002, AP1003, AP1004, AP1006	(Total) Hg	J
	AP1002	(Total) Sb, Zn, As, Ba, Ca, Fe, Mg, Mn, K, Ag, Na	J
F65479	AP2005	(Total) Al, Co, V	J
F65480	AP3064	Se (Total and Filtered)	B/J
F69338	AP3070, AP3071, AP3072	(Total) Lead	B
	AP3071, AP3072	(Total) Selenium	J
F69607	AP3079, AP3080, AP3081	Se (Total and Filtered), V (Total)	J/UJ

Laboratory Control Sample

Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Interference Check Sample

All Interference Check Sample (ICS) percent recoveries were met the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
F69607	AP3079, AP3080, AP3081	Ca (Filtered)	J

Inductively Coupled Plasma Serial Dilutions

All QC criteria were met for the serial dilutions associated with the project samples with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
0901026	AP0100	(Total) Al, Fe, Mg, Ba, Ca, Mn, Ni, K	J
	AP0103, AP0104, AP0105, AP0107, AP0114, AP0115, AP0116, AP0119, AP0124, AP0125, AP0126, AP0127, AP0128	(Total) Be, Fe	J
0901027	Total: AP0108, AP0109, AP0110, AP0111, AP0112, AP0113	Ba, Co, Mg, Ni, Be, Ca, Cr, Pb, Zn	J
F65476	AP1002	(Total) Ca, Fe, Mg, Mn, Cr, Co, Pb, Ni, V, Zn	J
F65479	AP2005	(Total) Al	J
F69607	AP3079, AP3080, AP3081	Ca (Total and Filtered), Na (Total), Mg, K (Filtered)	J

Field Duplicates

Original and field duplicate results were evaluated and no problems were identified with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
0901026	AP0104(original), AP0105(FD)	(Total) Magnesium, Arsenic, Manganese	J
0902003	AP3022(original), AP3015(FD)	(Total) Aluminum, Iron	J
F65476	AP1003(original), AP1004(FD)	(Total) Se, Pb	J

SDG	Samples Affected	Compound(s)	Validation Qualifier
F65480	AP3064(original), AP3065(FD)	(Total) Se	J
F69607	AP3079(original), AP3081(FD)	(Filtered) Se	J

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "B", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.4 Nitroaromatic and Nitroamine Explosives by SW846 8330
Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following;

Holding Times
Technical holding time criteria were met for all samples.

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria.

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits, with the following exceptions:

SDG Number	Samples Affected	Surrogate	Validation Qualifier
0901026	AP0103, AP0114, AP0117, AP0125	1-Chloro-3-nitrobenzene	UJ/R
0901027	AP0111	1-Chloro-3-nitrobenzene	UJ
F69338	AP3073	1-Chloro-3-nitrobenzene	UJ

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
0901026	AP1000	4-Amino-2,6-dinitrotoluene, 2-Amino-4,6-dinitrotoluene, 1,3-Dinitrobenzene, 2,4-Dinitrotoluene, 3-Nitrotoluene	UJ
	AP0117	4-Amino-2,6-dinitrotoluene, 2-Amino-4,6-dinitrotoluene, 1,3-Dinitrobenzene, 2,4-Dinitrotoluene, Nitrobenzene, 2- Nitrobenzene, 3- Nitrobenzene, 4- Nitrobenzene,	UJ

		1,3,5-Trinitrobenzene	
	AP0127	2-Amino-4,6-dinitrotoluene, 2,4-Dinitrotoluene, 1,3,5-Trinitrobenzene, 2,4,6-Trinitrotoluene	UJ
F65476	AP1002	2-Amino-4,6-dinitrotoluene	UJ
F65479	AP2005	4-Amino-2,6-dinitrotoluene	UJ
F65480	AP3064	Tetryl, 1,3,5-Trinitrobenzene, 2,4,6-Trinitrotoluene	UJ
F69607	AP3079	Tetryl	R

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Field Duplicates
Original and field duplicate results were evaluated and no problems were identified.

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.5 Polychlorinated Biphenyls (PCBs) by SW846 8082
Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following;

Holding Times
Technical holding time criteria were met for all samples.

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria.

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits, with the following exceptions.

SDG Number	Samples Affected	Surrogate	Validation Qualifier
0901026	AP0125	DCB	UJ

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Field Duplicates
Original and field duplicate results were evaluated and no problems were identified.

Second Column Confirmation
Samples having analytes with positive detects were verified on a second confirmation column; QC criteria (40% RPD) were met with the following exception(s):

SDG Number	Samples Affected	Analyte	Validation Qualifier
0901026	AP0103	Aroclor 1016	J
0901027	AP0108	Aroclor 1260	J

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.6 Wet Chemistry (TOC, Sulfate, Nitrate, Chloride, Alkalinity, Turbidity, TDS, TSS, Hardness, Cyanide

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Preservation
Preservation criteria were met for all samples.

Holding Times
Technical holding time criteria were met for all samples with the following exception(s):

SDG Number	Samples Affected	Analysis	Validation Qualifier
0902003	AP3018, AP3019	Turbidity	J
F65480	AP3057, AP3058, AP3059, AP3061, AP3063, AP3064, AP3065	Turbidity	J/UJ

Initial and Continuing Calibration
All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks
The 5X rule for contaminants found in the associated equipment rinses and method blanks was applied to all sample results. All were found acceptable with the following exception(s):

SDG Number	Samples Affected	Compounds	Blank Contaminant	Validation Qualifier
F69607	AP3080, AP3081	Nitrate-Nitrite	Equipment	B

Matrix Spike/Matrix Spike Duplicate

MS/MSD analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Analytes(s)	Validation Qualifier
0902003	AP3015, AP3018, AP3019, AP3022	Chloride, Nitrate-Nitrite	J/UJ
F65480	AP3057, AP3058, AP3059, AP3061, AP3063, AP3064, AP3065,	Cyanide	J/UJ
	AP3064	Alkalinity	J
F69338	AP3070, AP3071, AP3073	Nitrate-Nitrite, Sulfate	J/UJ
F69607	AP3079, AP3080, AP3081	Alkalinity, Cyanide	J/UJ

Laboratory Duplicate Sample Analysis

A Laboratory Duplicate Sample analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Analytes(s)	Validation Qualifier
F65480	AP3057, AP3058, AP3059, AP3061, AP3063, AP3064, AP3065	TDS	J
F69607	AP3079, AP3080, AP3081	TDS, TSS	J/UJ

Laboratory Control Sample

LCS analysis was performed for the project samples, and all QC criteria were met.

Field Duplicates

Original and field duplicate results were evaluated and no problems were identified with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
F69607	AP3079(original), AP3081(FD)	Chloride, Nitrate-Nitrite, Sulfate, Turbidity	J

Quantitation

Results quantified between the MDL and RL which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.0 Quality Assurance Field Split Sample Data Evaluation

Data from the quality assurance split samples, (SDGs: A9A170114, A9B030206, A9E270266 and A9K190539), were validated. The field split (FS) samples were analyzed for Volatiles by SW846 8260B, Semivolatiles by SW846 8270C, Explosives by SW846 8330, Polychlorinated Biphenyls (PCBs) by SW846 8280, Total and Dissolved Metals by SW 846 6010B and 7471A, and Wet Chemistry Analyses (TOC, Sulfate, Nitrate, Chloride, Alkalinity, Turbidity, TDS, TSS, Hardness, Cyanide). The following section highlights the key findings of the data validation for each analysis.

The following samples were validated for this site investigation:

SDG Number	Sample Number
A9A170114	AP0106, AP0122, AP0129
A9B030206	AP3016
A9E270266	AP1005, AP3066, AP3060, AP2004
A9K190539	AP3082

5.1 Volatile Organics by GC/MS SW846 8260B

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples.

Initial and Continuing Calibration

The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria with the following exception(s):

- The following exhibited individual ICAL/CCAL relative response factor (RRF) <0.1:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
A9E270266	AP3060, AP3066	2-Butanone, Chloroethane, 1,2-Dibromo-3-chloropropane	R

The following exhibited individual ICAL percent relative standard deviation > 30% and/or CCAL percent difference > 20%:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
A9E270266	AP3060, AP3066	2-Butanone, Chloroethane, Acetone, Chloromethane, 4-Methyl-2-pentanone	UJ/R
A9K190539	AP3082	Bromoform, 1,2-Dibromo-3-chloropropane, cis-1,3-Dichloropropene, trans-1,3-Dichloropropene	UJ

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Internal Standards
All internal standards met QC criteria.

Field Split/Original Sample Comparison
Table 2 shows the Regular/Field Duplicate/Field Split comparison of the data. A Relative Percent Difference is calculated for the analytes that were positive detects. Volatile analysis was performed on the field splits listed below.

Sample/FD/FS
AP3058 (Original) / AP3059 (FD) / AP3060(FS)
AP3064 (Original) / AP3065 (FD) / AP3066(FS)
AP3079 (Original) / AP3081 (FD) / AP3082(FS)

Quantitation
Results quantitated between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.2 Semivolatile Organics by GC/MS SW846 8270C

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following;

Holding Times
Technical holding time criteria were met for all samples.

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria with the following exception(s):

The following exhibited individual ICAL percent relative standard deviation > 30% and/or CCAL percent difference > 20%:

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
A9B030206	AP3016	Bis(2-Chloroethyl)ether	UJ

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Internal Standards
All internal standards met QC criteria.

Field Splits
The following table lists the Original/Field Duplicate/Field Split samples that were analyzed for semivolatiles. All analytes were non-detect in the field split samples; Naphthalene and 2-Methylnaphthalene were detected in original samples AP3064 and AP3079 at values less than the reporting limit.

Sample/FD/FS
AP0104 (Original) / AP0105 (FD) / AP0106 (FS)
AP0120 (Original) / AP0121 (FD) / AP0122 (FS)
AP0127 (Original) / AP0128 (FD) / AP0129 (FS)
AP3022 (Original) / AP3015 (FD / AP3016 (FS)
AP1003 (Original) / AP1004 (FD) / AP1005 (FS)
AP2002 (Original) / AP2003 (FD) / AP2004 (FS)
AP3058 (Original) / AP3059 (FD) / AP3060 (FS)
AP3064 (Original) / AP3065 (FD / AP3066 (FS)
AP3079 (Original / AP3081 (FD) / AP3082 (FS)

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.3 Total and Dissolved Metals by SW846 6010B/7470A/7471

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following;

Holding Times
Technical holding time criteria were met for all samples.

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria with the following exception(s):

The following exhibited individual ICAL percent relative standard deviation > 10% and/or CCAL percent difference > 10% (±20% for mercury):

SDG Number	Samples Affected	Compound(s)	Validation Qualifier
A9E270266	AP2004 (Total), AP3060 (Filtered)	Magnesium	J

Blanks
The 5X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Analyte(s)	Validation Qualifier
A9E270266	AP1005	Sb*	UJ

*Analyte was qualified for %RPD outside QC limits for the MS/MSD analysis.

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Interference Check Sample
All Interference Check Sample (ICS) percent recoveries were acceptable. All QC criteria were met.

Inductively Coupled Plasma Serial Dilutions
All QC criteria were met for the serial dilutions associated with the project samples with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
A9A170114	AP0106, AP0122, AP0129	(Total) Ca, K	J

Field Splits
Table 2 shows the Regular/Field Duplicate/Field Split comparison of the data. A Relative Percent Difference is calculated for the analytes that were positive detects. The samples (Original/FD/FS) that had a metal analysis performed are listed below:

Sample/FD/FS
AP0104 (Original) / AP0105 (FD) / AP0106 (FS)
AP0120 (Original) / AP0121 (FD) / AP0122 (FS)
AP0127 (Original) / AP0128 (FD) / AP0129 (FS)
AP3022 (Original) / AP3015 (FD / AP3016 (FS)
AP1003 (Original) / AP1004 (FD) / AP1005 (FS)
AP2002 (Original) / AP2003 (FD) / AP2004 (FS)
AP3058 (Original) / AP3059 (FD) / AP3060 (FS)
AP3064 (Original) / AP3065 (FD / AP3066 (FS)
AP3079 (Original / AP3081 (FD) / AP3082 (FS)

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "B", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.4 Nitroaromatic and Nitroamine Explosives by SW846 8330

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following;

Holding Times
Technical holding time criteria were met for all samples.

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria.

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Field Splits
Original and field split results were evaluated and no problems were identified. All analytes were non-detect in the original and field split samples. Explosives by SW846 8330 analysis was performed on the original and field split samples listed below.

Original/Field Split Pair
AP0104 (Original) / AP0106 (FS)
AP0120 (Original) / AP0122 (FS)
AP0127 (Original) / AP0129 (FS)
AP3022 (Original) / AP3016 (FS)
AP1003 (Original) / AP1005 (FS)
AP2002 (Original) / AP2004 (FS)
AP3058 (Original) / AP3060 (FS)
AP3064 (Original) / AP3066 (FS)
AP3079 (Original) / AP3082 (FS)

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.5 Polychlorinated Biphenyls (PCBs) by SW846 8082

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following;

Holding Times
Technical holding time criteria were met for all samples.

Initial and Continuing Calibration
The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria.

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Second Column Confirmation
Samples having analytes with positive detects were verified on a second confirmation column; QC criteria (40% RPD) were met.

Field Splits
Original and field split results were evaluated and no problems were identified. All analytes were non-detect in the original and field split samples. A PCB analysis was performed on the original and field split samples listed below.

Original/Field Split Pair
AP0104 (Original) / AP0106 (FS)
AP0120 (Original) / AP0122 (FS)
AP1003 (Original) / AP1005 (FS)
AP2002 (Original) / AP2004 (FS)
AP3058 (Original) / AP3060 (FS)
AP3064 (Original) / AP3066 (FS)

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.6 Wet Chemistry (TOC, Sulfate, Nitrate, Chloride, Alkalinity, Turbidity, TDS, TSS, Hardness, Cyanide

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Preservation
Preservation criteria were met for all samples.

Holding Times
Technical holding time criteria were met for all samples with the following exception(s):

SDG Number	Samples Affected	Analysis	Validation Qualifier
A9K190539	AP3082(FS)	Nitrate	UJ

Initial and Continuing Calibration
All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks
The 5X rule for contaminants found in the associated equipment rinses and method blanks was applied to all sample results. All were found acceptable.

Matrix Spike/Matrix Spike Duplicate
MS/MSD analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
LCS analysis was performed for the project samples, and all QC criteria were met.

Field Splits
The original, field duplicate and field splits are listed in the below. Table 2 shows the comparison for original, field duplicate and field split samples that has positive detects.

Sample/FD/FS
AP3022 (Original) / AP3015 (FD / AP3016 (FS)
AP3058 (Original) / AP3059 (FD) / AP3060(FS)
AP3064 (Original) / AP3065 (FD / AP3066(FS)
AP3079 (Original / AP3081 (FD) / AP3082(FS)

Quantitation
Results quantified between the MDL and RL which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

Laboratory and Validation Qualifier Definitions
Former Plum Brook Ordnance Works
Sandusky, Ohio

Qualifier	Definition
Laboratory	
B (metals)	The analyte was detected; the concentration is below the reporting limit.
B (organics)	Indicates analyte is found in associated method blank.
J (metals)	The compound was detected in the blank.
J (organics)	The compound was positively identified; the reported value is below the reporting limit.
U	Not detected. The compound was analyzed for, but not detected above the associated reporting limit.
E	Indicates that the result is above the maximum calibration range.
N	Indicates presumptive evidence of a compound.
P	RPD > 40% between the primary and confirmation column results for dual column chromatographic method (e.g. GC and HPLC methods).
*	Exceeds QC limit.
Q1	The %D or %Drift for the associated CCV is outside the method QC limit.
ME	Marginal Exceedence of the 3-sigma QC limits.
ME*	Exceedence of the 4-sigma QC limits.
Validation	
B	The compound/analyte was detected in a lab or field blank.
J	The compound/analyte was positively identified; the reported value is an estimated concentration.
U	Not detected. The compound/analyte was analyzed for, but not detected above the associated reporting limit.
UJ	The analyte is not detected; the result is an estimated value.
R	Analyte is rejected.

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Reason Code	Description
01	Sample received outside of 4+/-2 degrees Celsius
01A	Improper sample preservation
02	Holding Time Exceeded
02A	Extraction
02B	Analysis
03	Instrument Performance - Outside Criteria
03A	BFB
03B	DFTPP
03C	DDT and/or Endrin % breakdown exceeds criteria
03D	retention time windows
03E	Resolution
04	Initial Calibration results outside specified criteria
04A	Compound mean RRF<0.05
04B	Compound %RSD>30
04C	Correlation Coefficient<0.995
05	Continuing Calibration results outside specified criteria
05A	Compound mean RRF<0.05
05B	Compound %D>25
06	Result qualified as a result of the 5x/10x blank correction
06A	Method or Preparation Blank
06B	ICB or CCB
06C	ER
06D	TB
06E	FB
07	Surrogate Recoveries outside control limits
07A	Sample
07B	Associated method blank or LCS
08	MS/MSD/Duplicate results outside criteria
08A	MS and/or MSD recovery not within control limits (accuracy)
08B	%RPD outside acceptance criteria (precision)
09	Post Digestion Spike outside criteria (GFAA)
10	Internal Standards outside specified control limits
10A	Recovery
10B	Retention Time
11	Laboratory Control Sample recoveries outside specified control limits
11A	Recovery
11B	%RPD (if run in duplicate)
12	Interference Check Standard
13	Serial Dilution
14	Tentatively Identified Compounds
15	Quantitation
16	Multiple results available; alternate analysis preferred
17	Field duplicate RPD criteria exceeded
18	Percent difference between original and second column > 25%
19	Professional judgement was used to qualify the data
20	Pesticide clean-up checks
21	Target compound identification
22	Radiological calibration
23	Radiological quantitation
24	Reported result and/or lab qualifier revised to reflect validation findings
999	See hard copy for details.

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML Scientific, LLC			Test America		
	Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
Volatile Organic Compounds, SW846 8260B									
Acetone	61 - 144	61 - 144	29	20 - 160	20 - 160	30	N/A	N/A	N/A
Acrolein	N/A	N/A	N/A	64 - 130	64 - 130	30	N/A	N/A	N/A
Acrylonitrile	N/A	N/A	N/A	72 - 129	72 - 129	30	N/A	N/A	N/A
Benzene	78 - 130	78 - 130	25	75 - 125	75 - 125	30	75 - 129	75 - 129	N/A
Bromobenzene	N/A	N/A	N/A	65 - 120	65 - 120	30	N/A	N/A	N/A
Bromochloromethane	N/A	N/A	N/A	70 - 125	70 - 125	30	N/A	N/A	N/A
Bromodichloromethane	73 - 122	73 - 122	25	70 - 130	70 - 130	30	N/A	N/A	N/A
Bromoform	70 - 139	70 - 139	26	55 - 135	55 - 135	30	N/A	N/A	N/A
Bromomethane	N/A	N/A	N/A	30 - 160	30 - 160	30	N/A	N/A	N/A
2-Butanone	N/A	N/A	N/A	30 - 160	30 - 160	30	N/A	N/A	N/A
Chlorobenzene	83 - 122	83 - 122	23	75 - 125	75 - 125	30	75 - 127	75 - 127	N/A
Chloroethane	61 - 153	61 - 153	31	40 - 155	40 - 155	30	N/A	N/A	N/A
Chloromethane	N/A	N/A	N/A	50 - 130	50 - 130	30	N/A	N/A	N/A
Chloroform	79 - 129	79 - 129	27	70 - 125	70 - 125	30	N/A	N/A	N/A
2-Chlorotoluene	N/A	N/A	N/A	70 - 130	70 - 130	30	N/A	N/A	N/A
4-Chlorotoluene	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
Carbon disulfide	61 - 142	61 - 142	27	45 - 160	45 - 160	30	N/A	N/A	N/A
Carbon tetrachloride	79 - 135	79 - 135	29	65 - 135	65 - 135	30	N/A	N/A	N/A
1,2-Dibromoethane	N/A	N/A	N/A	70 - 125	70 - 125	30	N/A	N/A	N/A
1,2-Dibromo-3-chloropropane	N/A	N/A	N/A	40 - 135	40 - 135	30	N/A	N/A	N/A
1,1-Dichloroethane	77 - 132	77 - 132	26	75 - 125	75 - 125	30	N/A	N/A	N/A
1,1-Dichloroethylene	66 - 132	66 - 132	27	65 - 135	65 - 135	30	55 - 142	55 - 142	N/A
1,2-Dichloroethane	78 - 129	78 - 129	24	70 - 135	70 - 135	30	N/A	N/A	N/A
1,2-Dichloropropane	74 - 127	74 - 127	27	70 - 120	70 - 120	30	N/A	N/A	N/A
1,3-Dichloropropane	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
2,2-Dichloropropane	N/A	N/A	N/A	65 - 135	65 - 135	30	N/A	N/A	N/A
1,1-Dichloropropene	N/A	N/A	N/A	70 - 135	70 - 135	30	N/A	N/A	N/A
1,2-Dichlorobenzene	N/A	N/A	N/A	75 - 120	75 - 120	30	N/A	N/A	N/A
1,3-Dichlorobenzene	N/A	N/A	N/A	70 - 125	70 - 125	30	N/A	N/A	N/A
1,4-Dichlorobenzene	N/A	N/A	N/A	70 - 125	70 - 125	30	N/A	N/A	N/A
Dibromochloromethane	78 - 117	78 - 117	27	65 - 130	65 - 130	30	N/A	N/A	N/A
Dibromomethane	N/A	N/A	N/A	75 - 130	75 - 130	30	N/A	N/A	N/A
Dichlorodifluoromethane	N/A	N/A	N/A	35 - 135	35 - 135	30	N/A	N/A	N/A
cis-1,2-Dichloroethylene	74 - 123	74 - 123	26	65 - 125	65 - 125	30	N/A	N/A	N/A
cis-1,3-Dichloropropene	79 - 130	79 - 130	23	70 - 125	70 - 125	30	N/A	N/A	N/A
trans-1,2-Dichloroethylene	77 - 129	77 - 129	27	65 - 135	65 - 135	30	N/A	N/A	N/A
trans-1,3-Dichloropropene	87 - 131	87 - 131	27	65 - 125	65 - 125	30	N/A	N/A	N/A
Ethylbenzene	82 - 124	82 - 124	25	75 - 125	75 - 125	30	N/A	N/A	N/A

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML Scientific, LLC			Test America		
	Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
2-Hexanone	67 - 130	67 - 130	29	45 - 145	45 - 145	30	N/A	N/A	N/A
Hexachlorobutadiene	N/A	N/A	N/A	55 - 140	55 - 140	30	N/A	N/A	N/A
Isopropylbenzene	N/A	N/A	N/A	75 - 130	75 - 130	30	N/A	N/A	N/A
4-Isopropyltoluene	N/A	N/A	N/A	75 - 135	75 - 135	30	N/A	N/A	N/A
4-Methyl-2-pentanone	69 - 125	69 - 125	24	45 - 145	45 - 145	30	N/A	N/A	N/A
Methyl bromide	60 - 146	60 - 146	31	N/A	N/A	N/A	N/A	N/A	N/A
Methyl chloride	58 - 163	58 - 163	26	N/A	N/A	N/A	N/A	N/A	N/A
Methylene chloride	62 - 140	62 - 140	25	55 - 140	55 - 140	30	N/A	N/A	N/A
Methyl ethyl ketone	66 - 134	66 - 134	23	N/A	N/A	N/A	N/A	N/A	N/A
Methyl tert-Butyl ether	N/A	N/A	N/A	81 - 126	81 - 126	30	N/A	N/A	N/A
Naphthalene	N/A	N/A	N/A	40 - 125	40 - 125	30	N/A	N/A	N/A
n-Butylbenzene	N/A	N/A	N/A	65 - 140	65 - 140	30	N/A	N/A	N/A
n-Propylbenzene	N/A	N/A	N/A	65 - 135	65 - 135	30	N/A	N/A	N/A
Styrene	79 - 123	79 - 123	28	75 - 125	75 - 125	30	N/A	N/A	N/A
sec-Butylbenzene	N/A	N/A	N/A	65 - 130	65 - 130	30	N/A	N/A	N/A
1,1,1-Trichloroethane	80 - 133	80 - 133	27	70 - 135	70 - 135	30	N/A	N/A	N/A
1,2,3-Trichloropropane	N/A	N/A	N/A	65 - 130	65 - 130	30	N/A	N/A	N/A
1,1,1,2-Tetrachloroethane	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
1,1,2,2-Tetrachloroethane	70 - 128	70 - 128	30	55 - 130	55 - 130	30	N/A	N/A	N/A
1,1,2-Trichloroethane	76 - 118	76 - 118	28	60 - 125	60 - 125	30	N/A	N/A	N/A
1,3,5-Trimethylbenzene	N/A	N/A	N/A	65 - 135	65 - 135	30	N/A	N/A	N/A
1,2,3-Trichlorobenzene	N/A	N/A	N/A	60 - 135	60 - 135	30	N/A	N/A	N/A
1,2,4-Trichlorobenzene	N/A	N/A	N/A	65 - 130	65 - 130	30	N/A	N/A	N/A
1,2,4-Trimethylbenzene	N/A	N/A	N/A	65 - 135	65 - 135	30	N/A	N/A	N/A
tert-Butylbenzene	N/A	N/A	N/A	65 - 130	65 - 130	30	N/A	N/A	N/A
Tetrachloroethylene	79 - 132	79 - 132	27	65 - 140	65 - 140	30	N/A	N/A	N/A
Toluene	80 - 123	80 - 123	26	70 - 125	70 - 125	30	71 - 130	71 - 130	N/A
Trichloroethylene	78 - 132	78 - 132	28	75 - 125	75 - 125	30	70 - 131	70 - 131	N/A
Trichlorofluoromethane	N/A	N/A	N/A	25 - 185	25 - 185	30	N/A	N/A	N/A
Vinyl acetate	N/A	N/A	N/A	71 - 126	71 - 126	30	N/A	N/A	N/A
Vinyl chloride	60 - 145	60 - 145	29	60 - 125	60 - 125	30	N/A	N/A	N/A
m-Xylene/p-Xylene	N/A	N/A	N/A	80 - 125	80 - 125	30	N/A	N/A	N/A
o-Xylene	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
Xylene (total)	83 - 127	83 - 127	24	N/A	N/A	N/A	N/A	N/A	N/A
Semivolatile Organic Compounds, SW-846 8270C									
Benzoic Acid	44 - 116	44 - 116	36	0 - 110	0 - 110	25	N/A	N/A	N/A
2-Chlorophenol	54 - 97	54 - 97	31	45 - 105	45 - 105	25	32 - 110	32 - 110	30
4-Chloro-3-methyl phenol	59 - 102	59 - 102	27	45 - 115	45 - 115	25	32 - 117	32 - 117	30
2,4-Dichlorophenol	60 - 101	60 - 101	30	45 - 110	45 - 110	25	N/A	N/A	N/A

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML Scientific, LLC			Test America		
	Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
2,4-Dimethylphenol	49 - 89	49 - 89	31	30 - 105	30 - 105	25	N/A	N/A	N/A
2,4-Dinitrophenol	39 - 107	39 - 107	40	15 - 130	15 - 130	25	N/A	N/A	N/A
4,6-Dinitro-o-cresol	58 - 109	58 - 109	37	30 - 135	30 - 135	25	N/A	N/A	N/A
2-Methylphenol	53 - 94	53 - 94	29	40 - 105	40 - 105	25	N/A	N/A	N/A
3&4-Methylphenol	54 - 95	54 - 95	31	N/A	N/A	25	N/A	N/A	N/A
4-Methylphenol	N/A	N/A	N/A	40 - 105	40 - 105	25	N/A	N/A	N/A
2-Nitrophenol	55 - 96	55 - 96	30	40 - 110	40 - 110	25	N/A	N/A	N/A
4-Nitrophenol	56 - 106	56 - 106	29	15 - 140	15 - 140	25	10 - 125	10 - 125	30
Pentachlorophenol	50 - 115	50 - 115	33	25 - 120	25 - 120	25	10 - 182	10 - 182	30
Phenol	55 - 99	55 - 99	28	40 - 100	40 - 100	25	10 - 144	10 - 144	30
2,4,5-Trichlorophenol	60 - 101	60 - 101	28	50 - 110	50 - 110	25	N/A	N/A	N/A
2,4,6-Trichlorophenol	60 - 100	60 - 100	27	45 - 110	45 - 110	25	N/A	N/A	N/A
Acenaphthene	59 - 97	59 - 97	29	45 - 110	45 - 110	25	10 - 200	10 - 200	30
Acenaphthylene	58 - 98	58 - 98	30	45 - 105	45 - 105	25	N/A	N/A	N/A
Anthracene	61 - 104	61 - 104	29	55 - 105	55 - 105	25	N/A	N/A	N/A
Benzo(a)anthracene	60 - 106	60 - 106	31	50 - 110	50 - 110	25	N/A	N/A	N/A
Benzo(a)pyrene	59 - 102	59 - 102	32	50 - 110	50 - 110	25	N/A	N/A	N/A
Benzo(b)fluoranthene	60 - 107	60 - 107	31	45 - 115	45 - 115	25	N/A	N/A	N/A
Benzo(g,h,i)perylene	56 - 103	56 - 103	32	40 - 125	40 - 125	25	N/A	N/A	N/A
Benzo(k)fluoranthene	61 - 107	61 - 107	30	45 - 125	45 - 125	25	N/A	N/A	N/A
4-Bromophenol phenyl ether	60 - 104	60 - 104	26	45 - 115	45 - 115	25	N/A	N/A	N/A
Butyl benzyl phthalate	57 - 110	57 - 110	28	50 - 125	50 - 125	25	N/A	N/A	N/A
Benzyl Alcohol	N/A	N/A	N/A	20 - 125	20 - 125	25	N/A	N/A	N/A
Butyl Alcohol	51 - 102	51 - 102	34	N/A	N/A	N/A	N/A	N/A	N/A
2-Chloronaphthalene	57 - 95	57 - 95	28	45 - 105	45 - 105	25	N/A	N/A	N/A
4-Chloroaniline	19 - 85	19 - 85	34	10 - 95	10 - 95	25	N/A	N/A	N/A
Carbazole	60 - 106	60 - 106	30	45 - 115	45 - 115	25	N/A	N/A	N/A
Chrysene	60 - 107	60 - 107	31	55 - 110	55 - 110	25	N/A	N/A	N/A
bis(2-Chloroethyoxy)methane	51 - 89	51 - 89	30	45 - 110	45 - 110	25	N/A	N/A	N/A
bis(2-Chloroethyl)ether	50 - 96	50 - 96	33	40 - 105	40 - 105	25	N/A	N/A	N/A
bis(2-Chloroisopropyl)ether	44 - 94	44 - 94	32	20 - 115	20 - 115	25	N/A	N/A	N/A
4-Chlorophenyl phenyl ether	60 - 101	60 - 101	26	45 - 110	45 - 110	25	N/A	N/A	N/A
1,2-Dichlorobenzene	47 - 91	47 - 91	35	45 - 95	45 - 95	25	N/A	N/A	N/A
1,3-Dichlorobenzene	45 - 86	45 - 86	36	40 - 100	40 - 100	25	N/A	N/A	N/A
1,4-Dichlorobenzene	45 - 88	45 - 88	36	35 - 105	35 - 105	25	26 - 110	26 - 110	30
2,4-Dinitrotoluene	59 - 103	59 - 103	30	50 - 115	50 - 115	25	42 - 118	42 - 118	30
2,6-Dinitrotoluene	57 - 99	57 - 99	30	50 - 110	50 - 110	25	N/A	N/A	N/A
3,3'-Dichlorobenzidine	34 - 88	34 - 88	31	10 - 130	10 - 130	25	N/A	N/A	N/A
Dibenzo(a,h)antracene	57 - 105	57 - 105	29	40 - 125	40 - 125	25	N/A	N/A	N/A

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML Scientific, LLC			Test America		
	Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
Dibenzofuran	58 - 103	58 - 103	27	50 - 105	50 - 105	25	N/A	N/A	N/A
Di-n-butyl phthalate	59 - 105	59 - 105	27	55 - 110	55 - 110	25	N/A	N/A	N/A
Di-n-octyl phthalate	59 - 117	59 - 117	28	40 - 130	40 - 130	25	N/A	N/A	N/A
Diethyl phthalate	59 - 106	59 - 106	27	50 - 115	50 - 115	25	N/A	N/A	N/A
Dimethyl phthalate	60 - 100	60 - 100	26	50 - 110	50 - 110	25	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	57 - 111	57 - 111	29	45 - 125	45 - 125	25	N/A	N/A	N/A
Fluoranthene	60 - 110	60 - 110	32	55 - 115	55 - 115	25	N/A	N/A	N/A
Fluorene	60 - 99	60 - 99	30	50 - 110	50 - 110	25	N/A	N/A	N/A
Hexachlorobenzene	58 - 103	58 - 103	27	45 - 120	45 - 120	25	N/A	N/A	N/A
Hexachlorobutadiene	49 - 95	49 - 95	33	40 - 115	40 - 115	25	N/A	N/A	N/A
Hexachlorocyclopentadiene	36 - 94	36 - 94	41	45 - 135	45 - 135	25	N/A	N/A	N/A
Hexachloroethane	44 - 89	44 - 89	38	35 - 110	35 - 110	25	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	57 - 104	57 - 104	33	40 - 120	40 - 120	25	N/A	N/A	N/A
Isophorone	58 - 97	58 - 97	30	45 - 110	45 - 110	25	N/A	N/A	N/A
2-Methylnaphthalene	57 - 103	57 - 103	32	45 - 105	45 - 105	25	N/A	N/A	N/A
2-Nitroaniline	53 - 106	53 - 106	29	45 - 120	45 - 120	25	N/A	N/A	N/A
3-Nitroaniline	29 - 85	29 - 85	31	25 - 110	25 - 110	25	N/A	N/A	N/A
4-Nitroaniline	49 - 104	49 - 104	31	35 - 115	35 - 115	25	N/A	N/A	N/A
Naphthalene	54 - 93	54 - 93	32	40 - 105	40 - 105	25	N/A	N/A	N/A
Nitrobenzene	53 - 92	53 - 92	32	40 - 115	40 - 115	25	N/A	N/A	N/A
N-Nitroso-di-n-propylamine	49 - 94	49 - 94	28	40 - 115	40 - 115	25	30 - 121	30 - 121	30
N-Nitrosodimethylamine	N/A	N/A	N/A	20 - 115	20 - 115	25	N/A	N/A	N/A
N-Nitrosodiphenylamine	53 - 107	53 - 107	28	50 - 115	50 - 115	25	N/A	N/A	N/A
Phenanthrene	61 - 103	61 - 103	32	50 - 110	50 - 110	25	N/A	N/A	N/A
Pyrene	58 - 109	58 - 109	33	45 - 125	45 - 125	25	10 - 200	10 - 200	30
Diphenylamine	N/A	N/A	N/A	45 - 135	45 - 135	25	N/A	N/A	N/A
1,2,4-Trichlorobenzene	52 - 93	52 - 93	32	45 - 110	45 - 110	25	33 - 110	33 - 110	30
Nitroaromatics and Nitroamines, SW-846 8330									
HMX	75 - 156	75 - 156	27	75 - 125	75 - 125	50	75 - 125	75 - 125	N/A
RDX	77 - 131	77 - 131	28	70 - 135	70 - 135	50	70 - 135	70 - 135	N/A
1,3-Dinitrobenzene	82 - 134	82 - 134	20	80 - 125	80 - 125	50	80 - 125	80 - 125	N/A
2,6-Dinitrotoluene	86 - 142	86 - 142	17	80 - 120	80 - 120	50	80 - 120	80 - 120	N/A
2,4-Dinitrotoluene	74 - 129	74 - 129	18	80 - 125	80 - 125	50	80 - 125	80 - 125	N/A
2-amino-4,6-Dinitrotoluene	83 - 123	83 - 123	22	80 - 125	80 - 125	50	80 - 125	80 - 125	N/A
4-amino-2,6-Dinitrotoluene	85 - 137	85 - 137	18	80 - 125	80 - 125	50	80 - 125	80 - 125	N/A
Nitrobenzene	82 - 138	82 - 138	19	75 - 125	75 - 125	50	75 - 125	75 - 125	N/A
o-Nitrotoluene	85 - 129	85 - 129	21	75 - 120	75 - 120	50	75 - 120	75 - 120	N/A
m-Nitrotoluene	85 - 136	85 - 136	22	80 - 125	80 - 125	50	80 - 125	80 - 125	N/A
p-Nitrotoluene	86 - 133	86 - 133	19	75 - 125	75 - 125	50	75 - 125	75 - 125	N/A

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML Scientific, LLC			Test America		
	Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
Tetryl	53 - 124	53 - 124	22	10 - 150	10 - 150	50	10 - 150	10 - 150	N/A
1,3,5-Trinitrobenzene	81 - 138	81 - 138	24	75 - 125	75 - 125	50	75 - 125	75 - 125	N/A
2,4,6-Trinitrotoluene	70 - 137	70 - 137	29	55 - 140	55 - 140	50	55 - 140	55 - 140	N/A
PCBs, SW-846 8082									
Aroclor-1016	69 - 117	69 - 117	26	40 - 140	40 - 140	20	10 - 199	10 - 199	30
Aroclor-1260	71 - 121	71 - 121	30	60 - 130	60 - 130	20	10 - 199	10 - 199	30
Metals, SW-846 6010B/7470A									
Aluminum	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Antimony	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Arsenic	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Barium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Beryllium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Cadmium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Calcium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Chromium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Cobalt	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Copper	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Iron	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Lead	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Magnesium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Manganese	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Nickel	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Potassium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Selenium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Silver	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Sodium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Thallium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Vanadium	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Zinc	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Mercury	80 - 120	80 - 120	20	75 - 125	75 - 125	35	80 - 120	75 - 125	20
Total Organic Carbon (TOC) SW-846 9060									
TOC			25	70 - 130					

LCS - Laboratory Control Sample
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
N/A - Not Applicable

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML			Test America Laboratories, Inc.		
	Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
Volatile Organic Compounds, SW846 8260B									
Acetone	59 - 134	59 - 134	14	40 - 140	40 - 140	30	N/A	N/A	N/A
Acrolein	N/A	N/A	N/A	54 - 142	54 - 142	30	N/A	N/A	N/A
Acrylonitrile	N/A	N/A	N/A	40 - 140	40 - 140	30	N/A	N/A	N/A
Benzene	83 - 124	83 - 124	11	80 - 120	80 - 120	30	78 - 118	78 - 118	N/A
Bromobenzene	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
Bromochloromethane	N/A	N/A	N/A	65 - 130	65 - 130	30	N/A	N/A	N/A
Bromodichloromethane	76 - 116	76 - 116	10	75 - 120	75 - 120	30	N/A	N/A	N/A
Bromomethane	N/A	N/A	N/A	30 - 145	30 - 145	30	N/A	N/A	N/A
Bromoform	68 - 128	68 - 128	11	70 - 130	70 - 130	30	N/A	N/A	N/A
2-Butanone	N/A	N/A	N/A	30 - 150	30 - 150	30	N/A	N/A	N/A
Chlorobenzene	87 - 115	87 - 115	9	80 - 120	80 - 120	30	76 - 117	76 - 117	N/A
Chloroethane	54 - 166	54 - 166	20	60 - 135	60 - 135	30	N/A	N/A	N/A
Chloromethane	N/A	N/A	N/A	40 - 125	40 - 125	30	N/A	N/A	N/A
Chloroform	85 - 123	85 - 123	10	65 - 135	65 - 135	30	N/A	N/A	N/A
2-Chlorotoluene	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
4-Chlorotoluene	N/A	N/A	N/A	75 - 130	75 - 130	30	N/A	N/A	N/A
Carbon disulfide	67 - 147	67 - 147	12	35 - 160	35 - 160	30	N/A	N/A	N/A
Carbon tetrachloride	74 - 139	74 - 139	13	65 - 140	65 - 140	30	N/A	N/A	N/A
1,2-Dibromoethane	N/A	N/A	N/A	80 - 120	80 - 120	30	N/A	N/A	N/A
1,1-Dichloroethane	82 - 127	82 - 127	10	70 - 135	70 - 135	30	N/A	N/A	N/A
1,1-Dichloroethylene	75 - 133	75 - 133	13	70 - 130	70 - 130	30	62 - 130	62 - 130	N/A
1,1-Dichloropropene	N/A	N/A	N/A	75 - 130	75 - 130	30	N/A	N/A	N/A
1,2-Dichloroethane	76 - 122	76 - 122	11	70 - 130	70 - 130	30	N/A	N/A	N/A
1,2-Dichloropropane	81 - 120	81 - 120	11	75 - 125	75 - 125	30	N/A	N/A	N/A
1,2-Dichlorobenzene	N/A	N/A	N/A	70 - 120	70 - 120	30	N/A	N/A	N/A
1,3-Dichlorobenzene	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
1,4-Dichlorobenzene	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
1,3-Dichloropropane	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
2,2-Dichloropropane	N/A	N/A	N/A	70 - 135	70 - 135	30	N/A	N/A	N/A
Dibromochloromethane	74 - 116	74 - 116	11	60 - 135	60 - 135	30	N/A	N/A	N/A
Dibromomethane	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
Dichlorodifluoromethane	N/A	N/A	N/A	30 - 155	30 - 155	30	N/A	N/A	N/A
1,2-Dibromo-3-chloropropane	N/A	N/A	N/A	50 - 130	50 - 130	30	N/A	N/A	N/A
cis-1,2-Dichloroethylene	81 - 114	81 - 114	10	70 - 125	70 - 125	30	N/A	N/A	N/A
cis-1,3-Dichloropropene	83 - 119	83 - 119	10	70 - 130	70 - 130	30	N/A	N/A	N/A
trans-1,2-Dichloroethylene	82 - 126	82 - 126	10	60 - 140	60 - 140	30	N/A	N/A	N/A
trans-1,3-Dichloropropene	87 - 123	87 - 123	10	55 - 140	55 - 140	30	N/A	N/A	N/A

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML			Test America Laboratories, Inc.		
	Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
Ethylbenzene	87 - 118	87 - 118	10	75 - 125	75 - 125	30	N/A	N/A	N/A
Hexachlorobutadiene	N/A	N/A	N/A	50 - 140	50 - 140	30	N/A	N/A	N/A
2-Hexanone	58 - 125	58 - 125	14	55 - 130	55 - 130	30	N/A	N/A	N/A
Isopropylbenzene	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
4-Isopropyltoluene	N/A	N/A	N/A	75 - 130	75 - 130	30	N/A	N/A	N/A
4-Methyl-2-pentanone	62 - 125	62 - 125	13	60 - 135	60 - 135	30	N/A	N/A	N/A
Methyl bromide	55 - 151	55 - 151	21	N/A	N/A	N/A	N/A	N/A	N/A
Methyl chloride	55 - 173	55 - 173	22	N/A	N/A	N/A	N/A	N/A	N/A
Methylene chloride	69 - 125	69 - 125	11	55 - 140	55 - 140	30	N/A	N/A	N/A
Methyl ethyl ketone	61 - 127	61 - 127	13	N/A	N/A	N/A	N/A	N/A	N/A
Methyl tert-Butyl Ether	N/A	N/A	N/A	65 - 125	65 - 125	30	N/A	N/A	N/A
n-Butylbenzene	N/A	N/A	N/A	70 - 135	70 - 135	30	N/A	N/A	N/A
Naphthalene	N/A	N/A	N/A	55 - 140	55 - 140	30	N/A	N/A	N/A
n- Propylbenzene	N/A	N/A	N/A	70 - 130	70 - 130	30	N/A	N/A	N/A
sec-Butylbenzene	N/A	N/A	N/A	70 - 125	70 - 125	30	N/A	N/A	N/A
Styrene	78 - 118	78 - 118	11	65 - 135	65 - 135	30	N/A	N/A	N/A
1,1,1-Trichloroethane	79 - 133	79 - 133	11	65 - 130	65 - 130	30	N/A	N/A	N/A
1,1.1,2-Tetrachloroethane	N/A	N/A	N/A	80 - 130	80 - 130	30	N/A	N/A	N/A
1,1,2,2-Tetrachloroethane	71 - 120	71 - 120	11	65 - 130	65 - 130	30	N/A	N/A	N/A
1,1,2-Trichloroethane	80 - 114	80 - 114	11	75 - 125	75 - 125	30	N/A	N/A	N/A
1,2,3-Trichlorobenzene	N/A	N/A	N/A	55 - 140	55 - 140	30	N/A	N/A	N/A
1,2,3-Trichloropropane	N/A	N/A	N/A	75 - 125	75 - 125	30	N/A	N/A	N/A
1,3,5-Trimethylbenzene	N/A	N/A	N/A	75 - 130	75 - 130	30	N/A	N/A	N/A
1,2,4-Trichlorobenzene	N/A	N/A	N/A	65 - 135	65 - 135	30	N/A	N/A	N/A
1,2,4-Trimethylbenzene	N/A	N/A	N/A	75 - 130	75 - 130	30	N/A	N/A	N/A
Tetrachloroethylene	80 - 131	80 - 131	12	45 - 150	45 - 150	30	N/A	N/A	N/A
tert-Butylbenzene	N/A	N/A	N/A	70 - 130	70 - 130	30	N/A	N/A	N/A
Toluene	86 - 116	86 - 116	10	75 - 120	75 - 120	30	70 - 119	70 - 119	N/A
Trichloroethylene	85 - 124	85 - 124	10	70 - 125	70 - 125	30	62 - 130	62 - 130	N/A
Trichlorofluoromethane	N/A	N/A	N/A	60 - 145	60 - 145	30	N/A	N/A	N/A
Vinyl chloride	57 - 153	57 - 153	22	50 - 145	50 - 145	30	N/A	N/A	N/A
Vinyl acetate	N/A	N/A	N/A	72 - 121	72 - 121	30	N/A	N/A	N/A
m-Xylene/p-Xylene	N/A	N/A	N/A	75 - 130	75 - 130	30	N/A	N/A	N/A
o-Xylene	N/A	N/A	N/A	80 - 120	80 - 120	30	N/A	N/A	N/A
Xylene (total)	86 - 120	86 - 120	10	N/A	N/A	N/A	N/A	N/A	N/A
Semivolatile Organic Compounds, SW-846 8270C									
Benzoic Acid	10 - 50	10 - 50	40	20 - 145	20 - 145	50	N/A	N/A	N/A
2-Chlorophenol	44 - 103	44 - 103	29	35 - 105	35 - 105	50	27 - 110	27 - 110	30

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML			Test America Laboratories, Inc.		
	Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
4-Chloro-3-methyl phenol	53 - 105	53 - 105	24	45 - 110	45 - 110	50	39 - 110	39 - 110	30
2,4-Dichlorophenol	53 - 108	53 - 108	26	50 - 105	50 - 105	50	N/A	N/A	N/A
2,4-Dimethylphenol	37 - 91	37 - 91	28	30 - 110	30 - 110	50	N/A	N/A	N/A
2,4-Dinitrophenol	37 - 111	37 - 111	30	15 - 140	15 - 140	50	N/A	N/A	N/A
4,6-Dinitro-o-cresol	62 - 115	62 - 115	26	N/A	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	35 - 91	35 - 91	30	40 - 110	40 - 110	50	N/A	N/A	N/A
4-Methylphenol	N/A	N/A	N/A	45 - 135	45 - 135	50	N/A	N/A	N/A
3&4-Methylphenol	32 - 85	32 - 85	29	N/A	N/A	N/A	N/A	N/A	N/A
2-Nitrophenol	49 - 111	49 - 111	30	40 - 115	40 - 115	50	N/A	N/A	N/A
4-Nitrophenol	13 - 55	13 - 55	31	10 - 85	10 - 85	50	12 - 130	12 - 130	30
Pentachlorophenol	57 118	57 118	26	40 - 115	40 - 115	50	26 - 110	26 - 110	30
Phenol	13 - 54	13 - 54	34	21 - 50	21 - 50	50	14 - 112	14 - 112	30
2,4,5-Trichlorophenol	59 - 106	59 - 106	23	50 - 110	50 - 110	50	N/A	N/A	N/A
2,4,6-Trichlorophenol	58 - 107	58 - 107	24	50 - 115	50 - 115	50	N/A	N/A	N/A
Acenaphthene	58 - 106	58 - 106	21	45 - 110	45 - 110	50	40 - 110	40 - 110	30
Acenaphthylene	58 - 105	58 - 105	21	50 - 105	50 - 105	50	N/A	N/A	N/A
Anthracene	65 - 108	65 - 108	19	55 - 110	55 - 110	50	N/A	N/A	N/A
Benzo(a)anthracene	63 - 111	63 - 111	19	55 - 110	55 - 110	50	N/A	N/A	N/A
Benzo(a)pyrene	62 - 106	62 - 106	20	55 - 110	55 - 110	50	N/A	N/A	N/A
Benzo(b)fluoranthene	63 - 109	63 - 109	20	45 - 120	45 - 120	50	N/A	N/A	N/A
Benzo(g,h,i)perylene	61 - 111	61 - 111	21	40 - 125	40 - 125	50	N/A	N/A	N/A
Benzo(k)fluoranthene	64 - 111	64 - 111	20	45 - 125	45 - 125	50	N/A	N/A	N/A
4-Bromophenol phenyl ether	64 - 107	64 - 107	20	50 - 115	50 - 115	50	N/A	N/A	N/A
Butyl benzyl phthalate	59 - 114	59 - 114	20	45 - 115	45 - 115	50	N/A	N/A	N/A
Benzyl Alcohol	34 - 98	34 - 98	27	45 - 135	45 - 135	50	N/A	N/A	N/A
2-Chloronaphthalene	54 - 105	54 - 105	24	50 - 105	50 - 105	50	N/A	N/A	N/A
4-Chloroaniline	53 - 103	53 - 103	22	15 - 110	15 - 110	50	N/A	N/A	N/A
Carbazole	66 - 109	66 - 109	20	50 - 115	50 - 115	50	N/A	N/A	N/A
Chrysene	64 - 111	64 - 111	19	55 - 110	55 - 110	50	N/A	N/A	N/A
bis(2-Chloroethyoxy)methane	48 - 101	48 - 101	28	45 - 105	45 - 105	50	N/A	N/A	N/A
bis(2-Chloroethyl)ether	51 - 108	51 - 108	27	35 - 110	35 - 110	50	N/A	N/A	N/A
bis(2-Chloroisopropyl)ether	43 - 106	43 - 106	27	25 - 130	25 - 130	50	N/A	N/A	N/A
4-Chlorophenyl pheny ether	61 - 107	61 - 107	20	50 - 110	50 - 110	50	N/A	N/A	N/A
1,2-Dichlorobenzene	41 - 102	41 - 102	28	35 - 100	35 - 100	50	N/A	N/A	N/A
1,3-Dichlorobenzene	38 - 100	38 - 100	28	30 - 100	30 - 100	50	N/A	N/A	N/A
1,4-Dichlorobenzene	40 - 100	40 - 100	28	30 - 100	30 - 100	50	19 - 110	19 - 110	30
2,4-Dinitrotoluene	60 - 109	60 - 109	20	50 - 120	50 - 120	50	52 - 123	52 - 123	30
2,6-Dinitrotoluene	58 - 104	58 - 104	21	50 - 115	50 - 115	50	N/A	N/A	N/A
3,3'-Dichlorobenzidine	57 - 105	57 - 105	25	20 - 110	20 - 110	50	N/A	N/A	N/A

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML			Test America Laboratories, Inc.		
	Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
Dibenzo(a,h)antracene	62 - 112	62 - 112	20	40 - 125	40 - 125	50	N/A	N/A	N/A
Dibenzofuran	61 - 108	61 - 108	20	55 - 105	55 - 105	50	N/A	N/A	N/A
Di-n-butyl phthalate	62 - 109	62 - 109	20	55 - 115	55 - 115	50	N/A	N/A	N/A
Di-n-octyl phthalate	60 - 120	60 - 120	24	35 - 135	35 - 135	50	N/A	N/A	N/A
Diethyl phthalate	62 - 109	62 - 109	19	40 - 120	40 - 120	50	N/A	N/A	N/A
Dimethyl phthalate	63 - 106	63 - 106	19	25 - 125	25 - 125	50	N/A	N/A	N/A
Diphenylamine	N/A	N/A	N/A	45 - 135	45 - 135	50	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	59 - 116	59 - 116	21	40 - 125	40 - 125	50	N/A	N/A	N/A
Fluoranthene	65 - 114	65 - 114	21	55 - 115	55 - 115	50	N/A	N/A	N/A
Fluorene	61 - 106	61 - 106	19	50 - 110	50 - 110	50	N/A	N/A	N/A
Hexachlorobenzene	62 - 107	62 - 107	20	50 - 110	50 - 110	50	N/A	N/A	N/A
Hexachlorobutadiene	38 - 107	38 - 107	30	25 - 105	25 - 105	50	N/A	N/A	N/A
Hexachlorocyclopentadiene	19 - 84	19 - 84	35	30 - 145	30 - 145	50	N/A	N/A	N/A
Hexachloroethane	35 - 101	30 - 101	29	30 - 95	30 - 95	50	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	61 - 113	61 - 113	20	45 - 125	45 - 125	50	N/A	N/A	N/A
Isophorone	56 - 111	56 - 111	26	50 - 110	50 - 110	50	N/A	N/A	N/A
2-Metlhyl-4,6-dinitrophenol	N/A	N/A	N/A	45 - 135	45 - 135	50	N/A	N/A	N/A
2-Methylnaphthalene	56 - 112	56 - 112	26	45 - 105	45 - 105	50	N/A	N/A	N/A
2-Nitroaniline	60 - 109	60 - 109	20	50 - 115	50 - 115	50	N/A	N/A	N/A
3-Nitroaniline	52 - 107	52 - 107	21	20 - 125	20 - 125	50	N/A	N/A	N/A
4-Nitroaniline	59 - 111	59 - 111	21	35 - 120	35 - 120	50	N/A	N/A	N/A
Naphthalene	50 - 104	50 - 104	28	40 - 100	40 - 100	50	N/A	N/A	N/A
Nitrobenzene	52 - 105	52 - 105	28	45 - 110	45 - 110	50	N/A	N/A	N/A
N-Nitroso-di-n-propylamine	51 - 104	51 - 104	28	35 - 130	35 - 130	50	37 - 121	37 - 121	30
N-Nitrosodimethylamine	N/A	N/A	N/A	20 - 115	20 - 115	50	N/A	N/A	N/A
N-Nitrosodiphenylamine	57 - 110	57 - 110	19	50 - 110	50 - 110	50	N/A	N/A	N/A
Phenanthrene	65 - 108	65 - 108	20	50 - 115	50 - 115	50	N/A	N/A	N/A
Pyrene	60 - 113	60 - 113	20	50 - 130	50 - 130	50	55 - 120	55 - 120	30
1,2,4-Trichlorobenzene	45 - 104	45 - 104	28	35 - 105	35 - 105	50	25 - 110	25 - 110	30
Nitroaromatics and Nitroamines, SW-846 8330									
HMX	74 - 152	74 - 152	21	80 - 115	80 - 115	30	80 - 115	80 - 115	30
RDX	80 - 124	80 - 124	20	50 - 160	50 - 160	30	50 - 160	50 - 160	30
1,3-Dinitrobenzene	84 - 123	84 - 123	23	45 - 160	45 - 160	30	45 - 160	45 - 160	30
2,6-Dinitrotoluene	84 - 133	84 - 133	23	60 - 135	60 - 135	30	60 - 135	60 - 135	30
2,4-Dinitrotoluene	77 - 116	77 - 116	26	60 - 135	60 - 135	30	60 - 135	60 - 135	30
2-amino-4,6-Dinitrotoluene	78 - 117	78 - 117	28	55 - 155	55 - 155	30	55 - 155	55 - 155	30
4-amino-2,6-Dinitrotoluene	84 - 123	84 - 123	27	55 - 155	55 - 155	30	55 - 155	55 - 155	30
Nitrobenzene	76 - 128	76 - 128	28	50 - 140	50 - 140	30	50 - 140	50 - 140	30

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML			Test America Laboratories, Inc.		
	Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
o-Nitrotoluene	76 - 120	76 - 120	30	50 - 130	50 - 130	30	50 - 130	50 - 130	30
m-Nitrotoluene	74 - 124	74 - 124	32	45 - 135	45 - 135	30	45 - 135	45 - 135	30
p-Nitrotoluene	81 - 125	81 - 125	34	50 - 130	50 - 130	30	50 - 130	50 - 130	30
Tetryl	62 - 117	62 - 117	28	20 - 175	20 - 175	30	20 - 175	20 - 175	30
1,3,5-Trinitrobenzene	85 - 127	85 - 127	21	65 - 140	65 - 140	30	65 - 140	65 - 140	30
2,4,6-Trinitrotoluene	71 - 128	71 - 128	21	50 - 145	50 - 145	30	50 - 145	50 - 145	30
Nitroglycerin	N/A	N/A	N/A	N/A	N/A	N/A	76 - 116	76 - 116	30
PETN	N/A	N/A	N/A	N/A	N/A	N/A	69 - 117	69 - 117	30
PCBs, SW-846 8082									
Aroclor-1016	76 - 117	76 - 117	16	N/A	N/A	N/A	44 - 119	10 - 199	30
Aroclor-1260	65 - 117	65 - 117	23	N/A	N/A	N/A	41 - 118	10 - 199	30
Metals, SW-846 6010B/6020A/7470A									
Aluminum	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Antimony	80 - 120	80 - 120	20	80 - 120	75 - 125	20	80 - 120	75 - 125	20
Arsenic	80 - 120	80 - 120	20	80 - 120	75 - 125	20	80 - 120	75 - 125	20
Barium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Beryllium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Cadmium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Calcium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Chromium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Cobalt	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Copper	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Iron	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Lead	80 - 120	80 - 120	20	80 - 120	75 - 125	20	80 - 120	75 - 125	20
Magnesium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Manganese	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Nickel	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Potassium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Selenium	80 - 120	80 - 120	20	80 - 120	75 - 125	20	80 - 120	75 - 125	20
Silver	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Sodium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Thallium	80 - 120	80 - 120	20	80 - 120	75 - 125	20	80 - 120	75 - 125	20
Vanadium	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Zinc	80 - 120	80 - 120	20	80 - 120	80 - 120	25	80 - 120	75 - 125	20
Mercury	80 - 120	80 - 120	20	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Water Quality									
Chloride	90 - 110	90 - 110	20	90 - 110	90 - 110	20	90 - 110	80 - 120	20
Hardness as CaCO3	N/A	N/A	N/A	N/A	N/A	N/A	88 - 110	87 - 114	20

Laboratory Control Limits for QC Samples
Plum Brook Ordnance Works

Spiked Compound	Accutest			AML			Test America Laboratories, Inc.		
	Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD		Water - LCS	Water - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
Nitrate	90 - 110	90 - 110	20	80 - 120	80 - 120	20	90 - 110	34 - 125	20
Sulfate	90 - 110	90 - 110	20	90 - 110	90 - 110	20	90 - 110	80 - 120	20
Total Alkalinity	90 - 113	90 - 113	20	70 - 130	N/A	N/A	90 - 127	10 - 160	24
Total Cyanide	90 - 110	90 - 110	20	75 - 125	75 - 125	25	69 - 118	42 - 140	20
Total Dissolved Solids	N/A	N/A	5	75 - 125	N/A	N/A	88 - 110	N/A	20
Total Suspended Solids	N/A	N/A	5	75 - 125	N/A	N/A	73 - 113	N/A	20
Turbidity	N/A	N/A	8	N/A	N/A	N/A	75 - 125	N/A	20

LCS - Laboratory Control Sample
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
N/A - Not Applicable

APPENDIX H

CHEMICAL ANALYTICAL DATA SUMMARY

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB01		ASH PIT 2-SB01		ASH PIT 2-SB01		ASH PIT 2-SB02		ASH PIT 2-SB02		ASH PIT 2-SB02	
			SAMPLE_NO	AP0100		AP0101		AP0102		AP0103		AP0104		AP0105	
			SAMPLE_DATE	15-Jan-09		15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		3 - 5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		REG		FD	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	mg/kg	0.147	UJ	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	mg/kg	0.147	UJ	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Dinitrobenzene, 1,3-	N	mg/kg	0.147	UJ	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Dinitrotoluene, 2,4-	N	mg/kg	0.147	UJ	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Dinitrotoluene, 2,6-	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	HMX	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Nitrobenzene	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Nitrotoluene, 2-	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Nitrotoluene, 3-	N	mg/kg	0.147	UJ	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Nitrotoluene, 4-	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	RDX	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Tetryl	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Trinitrobenzene, 1,3,5-	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Explosives	Trinitrotoluene, 2,4,6-	N	mg/kg	0.147	U	0.149	U	0.144	U	0.149	UJ	0.148	U	0.146	U
Semivolatiles	Acenaphthene	N	mg/kg	0.00737	U	0.00709	U	0.00675	U	0.00899	U	0.00754	U	0.00748	U
Semivolatiles	Acenaphthylene	N	mg/kg	0.00491	U	0.00472	U	0.0045	U	0.00599	U	0.00502	U	0.00498	U
Semivolatiles	ACETOPHENONE	N	mg/kg												
Semivolatiles	Anthracene	N	mg/kg	0.00884	U	0.0085	U	0.0081	U	0.0108	U	0.00904	U	0.00897	U
Semivolatiles	Atrazine	N	mg/kg												
Semivolatiles	Benzaldehyde	N	mg/kg												
Semivolatiles	Benzo(a)anthracene	N	mg/kg	0.0827	J	0.0259	U	0.0246	U	0.0464	J	0.0275	U	0.0273	U
Semivolatiles	Benzo(a)pyrene	N	mg/kg	0.0844	J	0.0259	U	0.0246	U	0.0328	U	0.0275	U	0.0273	U
Semivolatiles	Benzo(b)fluoranthene	N	mg/kg	0.13	J	0.0655	U	0.0624	U	0.0831	U	0.0697	U	0.0692	U
Semivolatiles	Benzo(ghi)perylene	N	mg/kg	0.0997	U	0.0959	U	0.0914	U	0.122	U	0.102	U	0.101	U
Semivolatiles	Benzo(k)fluoranthene	N	mg/kg	0.124	U	0.119	U	0.114	U	0.151	U	0.127	U	0.126	U
Semivolatiles	Benzoic acid	N	mg/kg	0.0997	U	0.0959	U	0.0914	UJ	1.43		0.102	UJ	0.101	U
Semivolatiles	Benzyl alcohol	N	mg/kg	0.0997	U	0.0959	U	0.0914	U	0.122	U	0.102	U	0.101	U
Semivolatiles	BIBENZENE	N	mg/kg												
Semivolatiles	Bis(2-chloroethoxy)methane	N	mg/kg	0.0086	U	0.00827	U	0.00788	U	0.0105	U	0.00879	U	0.00872	U
Semivolatiles	Bis(2-chloroethyl)ether	N	mg/kg	0.0104	U	0.01	U	0.00956	U	0.0127	U	0.0107	U	0.0106	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	mg/kg	0.0178	U	0.0171	U	0.0163	U	0.0217	U	0.0182	U	0.0181	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	mg/kg	0.0378	U	0.0364	U	0.0347	U	0.0461	U	0.0387	U	0.0384	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	mg/kg	0.0146	U	0.0141	U	0.0134	U	0.0178	U	0.0149	U	0.0148	U
Semivolatiles	Butyl benzyl phthalate	N	mg/kg	0.0166	U	0.0159	U	0.0152	U	0.0202	U	0.017	U	0.0168	U
Semivolatiles	Caprolactam	N	mg/kg												
Semivolatiles	Carbazole	N	mg/kg	0.0409	U	0.0393	U	0.0375	U	0.0499	U	0.0418	U	0.0415	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	mg/kg	0.0101	U	0.00968	U	0.00923	U	0.0123	U	0.0103	U	0.0102	U
Semivolatiles	Chloroaniline, 4-	N	mg/kg	0.0355	U	0.0341	U	0.0325	U	0.0433	U	0.0363	U	0.036	U
Semivolatiles	Chloronaphthalene, 2-	N	mg/kg	0.00651	U	0.00626	U	0.00596	U	0.00794	U	0.00666	U	0.0066	U
Semivolatiles	Chlorophenol, 2-	N	mg/kg	0.00504	U	0.00484	U	0.00461	U	0.00614	U	0.00515	U	0.00511	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	mg/kg	0.0313	U	0.0301	U	0.0287	U	0.0382	U	0.032	U	0.0318	U
Semivolatiles	Chrysene	N	mg/kg	0.0979	J	0.0156	U	0.0149	U	0.0639	J	0.0166	U	0.0164	U
Semivolatiles	Dibenz(a,h)anthracene	N	mg/kg	0.0925	U	0.0889	U	0.0847	U	0.113	U	0.0946	U	0.0938	U
Semivolatiles	Dibenzofuran	N	mg/kg	0.00688	U	0.00661	U	0.0063	U	0.00839	U	0.00703	U	0.00698	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB01		ASH PIT 2-SB01		ASH PIT 2-SB01		ASH PIT 2-SB02		ASH PIT 2-SB02		ASH PIT 2-SB02	
			SAMPLE_NO	AP0100		AP0101		AP0102		AP0103		AP0104		AP0105	
			SAMPLE_DATE	15-Jan-09		15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		3 - 5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		REG		FD	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Dichlorobenzene, 1,2-	N	mg/kg	0.00946	U	0.00909	U	0.00866	U	0.0115	U	0.00967	U	0.00959	U
Semivolatiles	Dichlorobenzene, 1,3-	N	mg/kg	0.0149	U	0.0143	U	0.0136	U	0.0181	U	0.0152	U	0.0151	U
Semivolatiles	Dichlorobenzene, 1,4-	N	mg/kg	0.00798	U	0.00768	U	0.00731	U	0.00974	U	0.00816	U	0.0081	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	mg/kg	0.0405	U	0.039	U	0.0371	U	0.0494	U	0.0415	U	0.0411	U
Semivolatiles	Dichlorophenol, 2,4-	N	mg/kg	0.0146	U	0.0141	U	0.0134	U	0.0178	U	0.0149	U	0.0148	U
Semivolatiles	Diethyl phthalate	N	mg/kg	0.0166	U	0.0159	U	0.0152	U	0.0202	U	0.017	U	0.0168	U
Semivolatiles	Dimethyl phthalate	N	mg/kg	0.0125	U	0.012	U	0.0115	U	0.0153	U	0.0128	U	0.0127	U
Semivolatiles	Dimethylphenol, 2,4-	N	mg/kg	0.0108	U	0.0104	U	0.0099	U	0.0132	U	0.0111	U	0.011	U
Semivolatiles	Di-n-butyl phthalate	N	mg/kg	0.00884	U	0.0085	U	0.0081	U	0.0108	U	0.00904	U	0.00897	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	mg/kg	0.0412	U	0.0396	U	0.0377	U	0.0502	U	0.0421	U	0.0417	U
Semivolatiles	Dinitrophenol, 2,4-	N	mg/kg	0.0652	U	0.0627	U	0.0597	U	0.0795	U	0.0667	U	0.0662	UJ
Semivolatiles	Dinitrotoluene, 2,4-	N	mg/kg	0.0144	U	0.0138	U	0.0132	U	0.0175	U	0.0147	U	0.0146	U
Semivolatiles	Dinitrotoluene, 2,6-	N	mg/kg	0.00983	U	0.00945	U	0.009	U	0.012	U	0.01	U	0.00997	U
Semivolatiles	Di-n-octyl phthalate	N	mg/kg	0.077	U	0.074	U	0.0705	U	0.0939	U	0.0788	U	0.0781	U
Semivolatiles	DIPHENYLAMINE	N	mg/kg	0.0405	U	0.039	U	0.0371	U	0.0494	U	0.0415	U	0.0411	U
Semivolatiles	Fluoranthene	N	mg/kg	0.132	J	0.0085	U	0.0081	U	0.131	J	0.00904	U	0.00897	U
Semivolatiles	Fluorene	N	mg/kg	0.0173	U	0.0167	U	0.0159	U	0.0211	U	0.0177	U	0.0176	U
Semivolatiles	Hexachlorobenzene	N	mg/kg	0.0254	U	0.0244	U	0.0233	U	0.031	U	0.026	U	0.0258	U
Semivolatiles	Hexachlorobutadiene	N	mg/kg	0.0388	U	0.0373	U	0.0356	U	0.0473	U	0.0397	U	0.0394	U
Semivolatiles	Hexachlorocyclopentadiene	N	mg/kg	0.013	UJ	0.0125	U	0.0119	U	0.0159	U	0.0133	U	0.0132	U
Semivolatiles	Hexachloroethane	N	mg/kg	0.0125	U	0.012	U	0.0115	U	0.0153	U	0.0128	U	0.0127	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	mg/kg	0.133	U	0.128	U	0.122	U	0.162	U	0.136	U	0.135	U
Semivolatiles	Isophorone	N	mg/kg	0.00491	U	0.00472	U	0.0045	U	0.00599	U	0.00502	U	0.00498	U
Semivolatiles	Methylnaphthalene, 2-	N	mg/kg	0.107	U	0.103	U	0.0983	U	0.131	U	0.11	U	0.109	U
Semivolatiles	Methylphenol, 2-	N	mg/kg	0.00614	U	0.0059	U	0.00563	U	0.00749	U	0.00628	U	0.00623	U
Semivolatiles	Methylphenol, 4-	N	mg/kg	0.0128	U	0.0123	U	0.0117	U	0.0156	U	0.0131	U	0.013	U
Semivolatiles	Naphthalene	N	mg/kg	0.0446	J	0.00933	U	0.00889	U	0.0559	J	0.00992	U	0.00984	U
Semivolatiles	Nitroaniline, 2-	N	mg/kg	0.0177	U	0.017	U	0.0162	U	0.0216	U	0.0181	U	0.0179	U
Semivolatiles	Nitroaniline, 3-	N	mg/kg	0.0139	U	0.0133	U	0.0127	U	0.0169	U	0.0142	U	0.0141	U
Semivolatiles	Nitroaniline, 4-	N	mg/kg	0.145	U	0.139	U	0.133	U	0.177	U	0.148	U	0.147	U
Semivolatiles	Nitrobenzene	N	mg/kg	0.0134	U	0.0129	U	0.0123	U	0.0163	U	0.0137	U	0.0136	U
Semivolatiles	Nitrophenol, 2-	N	mg/kg	0.0145	U	0.0139	U	0.0133	U	0.0177	U	0.0148	U	0.0147	U
Semivolatiles	Nitrophenol, 4-	N	mg/kg	0.0332	U	0.0319	U	0.0304	U	0.0404	U	0.0339	U	0.0336	U
Semivolatiles	n-Nitrosodimethylamine	N	mg/kg	0.0123	U	0.0118	U	0.0113	U	0.015	U	0.0126	U	0.0125	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	mg/kg	0.0146	U	0.0141	U	0.0134	U	0.0178	U	0.0149	U	0.0148	U
Semivolatiles	n-Nitrosodiphenylamine	N	mg/kg	0.00577	U	0.00555	U	0.00529	U	0.00704	U	0.0059	U	0.00586	U
Semivolatiles	Pentachlorophenol	N	mg/kg	0.0367	U	0.0353	U	0.0336	U	0.0448	U	0.0376	U	0.0373	U
Semivolatiles	Phenanthrene	N	mg/kg	0.0733	J	0.00957	U	0.0855	J	0.0964	J	0.0102	U	0.0101	U
Semivolatiles	Phenol	N	mg/kg	0.00491	U	0.00472	U	0.0045	U	0.00599	U	0.00502	U	0.00498	U
Semivolatiles	Pyrene	N	mg/kg	0.111	J	0.0157	U	0.015	U	0.0894	J	0.0167	U	0.0166	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	mg/kg	0.0101	U	0.00968	U	0.00923	U	0.0123	U	0.0103	U	0.0102	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	mg/kg	0.0351	U	0.0338	U	0.0322	U	0.0428	U	0.0359	U	0.0356	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	mg/kg	0.0276	U	0.0266	U	0.0253	U	0.0337	U	0.0283	U	0.028	U
Pesticides/PCBs	Aroclor 1016	N	mg/kg	0.00825	U	0.00788	U			0.525	J	0.00838	U	0.0082	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB01		ASH PIT 2-SB01		ASH PIT 2-SB01		ASH PIT 2-SB02		ASH PIT 2-SB02		ASH PIT 2-SB02	
			SAMPLE_NO	AP0100		AP0101		AP0102		AP0103		AP0104		AP0105	
			SAMPLE_DATE	15-Jan-09		15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		3 - 5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		REG		FD	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1221	N	mg/kg	0.00825	U	0.00788	U			0.00999	U	0.00838	U	0.0082	U
Pesticides/PCBs	Aroclor 1232	N	mg/kg	0.00825	U	0.00788	U			0.00999	U	0.00838	U	0.0082	U
Pesticides/PCBs	Aroclor 1242	N	mg/kg	0.00825	U	0.00788	U			0.00999	U	0.00838	U	0.0082	U
Pesticides/PCBs	Aroclor 1248	N	mg/kg	0.00825	U	0.00788	U			0.00999	U	0.00838	U	0.0082	U
Pesticides/PCBs	Aroclor 1254	N	mg/kg	0.00825	U	0.00788	U			0.00999	U	0.00838	U	0.0082	U
Pesticides/PCBs	Aroclor 1260	N	mg/kg	0.00825	U	0.00788	U			0.00999	U	0.00838	U	0.0082	U
Metals - Unfiltered	Aluminum	N	mg/kg	6460	J	6420	J	8750	J	9310	J	12700	J	8930	J
Metals - Unfiltered	Antimony	N	mg/kg	0.81		0.269	J	0.355	J	0.958		0.362	J	0.287	J
Metals - Unfiltered	Arsenic	N	mg/kg	11.6		4.93		11.3		15.3		15.7	J	8.31	J
Metals - Unfiltered	Barium	N	mg/kg	55.7	J	45.6		26.8		84.4	J	85.3	J	59.4	J
Metals - Unfiltered	Beryllium	N	mg/kg	4.74		5.97		6.72		15.3	J	9.06	J	6.76	J
Metals - Unfiltered	Cadmium	N	mg/kg	0.436	J	0.229	U	0.227	U	0.381	J	0.255	U	0.238	U
Metals - Unfiltered	Calcium	N	mg/kg	47200	J	4310		47400		7110		23300		16100	
Metals - Unfiltered	Chromium	N	mg/kg	8.64		11.5		13		11.1		19.8		13.7	
Metals - Unfiltered	Cobalt	N	mg/kg	7.74		8.32		11.9		14.6	J	13.4	J	10.9	J
Metals - Unfiltered	Copper	N	mg/kg	23.6	J	18.3	J	32	J	33.7	J	28.9	J	20.9	J
Metals - Unfiltered	Iron	N	mg/kg	14300	J	16500	J	23100	J	61300	J	30500	J	19400	J
Metals - Unfiltered	Lead	N	mg/kg	50.7		8.39		13		22.5		13.8		11.9	
Metals - Unfiltered	Magnesium	N	mg/kg	8960	J	2350	J	11400	J	1560	J	8640	J	4940	J
Metals - Unfiltered	Manganese	N	mg/kg	354	J	172		386		546		726	J	351	J
Metals - Unfiltered	Mercury	N	mg/kg	0.0959		0.0245		0.0128	J	0.0539		0.0162	J	0.0164	J
Metals - Unfiltered	Nickel	N	mg/kg	18.3	J	20.2		32.6		35.5		35.6		26.9	
Metals - Unfiltered	Potassium	N	mg/kg	893	J	589		1160		587		1170		803	
Metals - Unfiltered	Selenium	N	mg/kg	0.727	J	0.458	U	0.455	U	1.36		0.511	U	0.476	U
Metals - Unfiltered	Silver	N	mg/kg	0.254	U	0.229	U	0.231	U	0.3	U	0.255	U	0.238	U
Metals - Unfiltered	Sodium	N	mg/kg	55.1		68.7		107		60.4		93.9		64.9	
Metals - Unfiltered	Thallium	N	mg/kg	0.425	J	0.229	U	0.423	J	0.416	J	0.3	J	0.238	U
Metals - Unfiltered	Vanadium	N	mg/kg	15.9		16.5		17.3		21.4		26.2		18.1	
Metals - Unfiltered	Zinc	N	mg/kg	64		67.4		59.1		88.6		74.6		66.2	
Water Quality Parameters	% Solids	N	Percent												
Water Quality Parameters	Total organic carbon	N	mg/kg							11400					

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB02		ASH PIT 2-SB02		ASH PIT 2-SB03		ASH PIT 2-SB03		ASH PIT 2-SB03		ASH PIT 2-SB04	
			SAMPLE_NO	AP0106		AP0107		AP0108		AP0109		AP0110		AP0111	
			SAMPLE_DATE	16-Jan-09		16-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft	
			SAMPLE_PURPOSE	FS		REG		REG		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Amino-4,6-dinitrotoluene, 2-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Dinitrobenzene, 1,3-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Dinitrotoluene, 2,4-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Dinitrotoluene, 2,6-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	HMX	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Nitrobenzene	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Nitrotoluene, 2-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Nitrotoluene, 3-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Nitrotoluene, 4-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	RDX	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Tetryl	N	mg/kg	0.3	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Trinitrobenzene, 1,3,5-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Explosives	Trinitrotoluene, 2,4,6-	N	mg/kg	0.2	U	0.147	U	0.148	U	0.149	U	0.144	U	0.15	UJ
Semivolatiles	Acenaphthene	N	mg/kg	0.4	U	0.00705	U	0.00842	U	0.00805	U	0.00682	U	0.00796	U
Semivolatiles	Acenaphthylene	N	mg/kg	0.4	U	0.0047	U	0.00562	U	0.00537	U	0.00455	U	0.00531	U
Semivolatiles	ACETOPHENONE	N	mg/kg	0.081	U										
Semivolatiles	Anthracene	N	mg/kg	0.4	U	0.00846	U	0.0101	U	0.00966	U	0.00818	U	0.00956	U
Semivolatiles	Atrazine	N	mg/kg	0.4	U										
Semivolatiles	Benzaldehyde	N	mg/kg	0.4	U										
Semivolatiles	Benzo(a)anthracene	N	mg/kg	0.4	U	0.0257	U	0.0307		0.0294	U	0.0249	U	0.0291	U
Semivolatiles	Benzo(a)pyrene	N	mg/kg	0.4	U	0.0257	U	0.0307	U	0.0294	U	0.0249	U	0.0291	U
Semivolatiles	Benzo(b)fluoranthene	N	mg/kg	0.4	U	0.0652	U	0.0779	U	0.0745	U	0.0631	U	0.0737	U
Semivolatiles	Benzo(ghi)perylene	N	mg/kg	0.4	U	0.0954	U	0.114	U	0.109	U	0.0923	U	0.108	U
Semivolatiles	Benzo(k)fluoranthene	N	mg/kg	0.4	U	0.119	U	0.142	U	0.135	U	0.115	U	0.134	U
Semivolatiles	Benzoic acid	N	mg/kg			0.0954	UJ	0.114	U	0.109	U	0.0923	U	0.108	U
Semivolatiles	Benzyl alcohol	N	mg/kg			0.0954	U	0.114	U	0.109	U	0.0923	U	0.108	U
Semivolatiles	BIBENZENE	N	mg/kg	0.4	U										
Semivolatiles	Bis(2-chloroethoxy)methane	N	mg/kg	0.4	U	0.00822	U	0.00983	U	0.00939	U	0.00795	U	0.00929	U
Semivolatiles	Bis(2-chloroethyl)ether	N	mg/kg	0.4	U	0.00999	U	0.0119	U	0.0114	U	0.00966	U	0.0113	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	mg/kg	0.4	U	0.017	U	0.0204	U	0.0195	U	0.0165	U	0.0192	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	mg/kg	0.4	U	0.0362	U	0.0432	U	0.0413	U	0.035	U	0.0409	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	mg/kg	0.4	U	0.014	U	0.0167	U	0.016	U	0.0135	U	0.0158	U
Semivolatiles	Butyl benzyl phthalate	N	mg/kg	0.4	U	0.0159	U	0.019	U	0.0181	U	0.0153	U	0.0179	U
Semivolatiles	Caprolactam	N	mg/kg	0.4	U										
Semivolatiles	Carbazole	N	mg/kg	0.4	U	0.0391	U	0.0468	U	0.0447	U	0.0378	U	0.0442	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	mg/kg	0.4	U	0.00963	U	0.0115	U	0.011	U	0.00932	U	0.0109	U
Semivolatiles	Chloroaniline, 4-	N	mg/kg	0.4	U	0.034	U	0.0406	U	0.0388	U	0.0328	U	0.0384	U
Semivolatiles	Chloronaphthalene, 2-	N	mg/kg	0.4	U	0.00623	U	0.00744	U	0.00711	U	0.00602	U	0.00703	U
Semivolatiles	Chlorophenol, 2-	N	mg/kg	0.4	U	0.00482	U	0.00576	U	0.0055	U	0.00466	U	0.00544	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	mg/kg	0.4	U	0.03	U	0.0358	U	0.0342	U	0.029	U	0.0338	U
Semivolatiles	Chrysene	N	mg/kg	0.4	U	0.0155	U	0.0185	U	0.0177	U	0.015	U	0.0175	U
Semivolatiles	Dibenz(a,h)anthracene	N	mg/kg	0.4	U	0.0885	U	0.106	U	0.101	U	0.0856	U	0.0999	U
Semivolatiles	Dibenzofuran	N	mg/kg	0.4	U	0.00658	U	0.00786	U	0.00751	U	0.00636	U	0.00743	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB02		ASH PIT 2-SB02		ASH PIT 2-SB03		ASH PIT 2-SB03		ASH PIT 2-SB03		ASH PIT 2-SB04	
			SAMPLE_NO	AP0106		AP0107		AP0108		AP0109		AP0110		AP0111	
			SAMPLE_DATE	16-Jan-09		16-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft	
			SAMPLE_PURPOSE	FS		REG		REG		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Dichlorobenzene, 1,2-	N	mg/kg			0.00905	U	0.0108	U	0.0103	U	0.00875	U	0.0102	U
Semivolatiles	Dichlorobenzene, 1,3-	N	mg/kg			0.0142	U	0.017	U	0.0162	U	0.0138	U	0.0161	U
Semivolatiles	Dichlorobenzene, 1,4-	N	mg/kg			0.00764	U	0.00913	U	0.00872	U	0.00739	U	0.00863	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	mg/kg	1.9	U	0.0388	U	0.0463	U	0.0443	U	0.0375	U	0.0438	U
Semivolatiles	Dichlorophenol, 2,4-	N	mg/kg	0.4	U	0.014	U	0.0167	U	0.016	U	0.0135	U	0.0158	U
Semivolatiles	Diethyl phthalate	N	mg/kg	0.4	U	0.0159	U	0.019	U	0.0181	U	0.0153	U	0.0179	U
Semivolatiles	Dimethyl phthalate	N	mg/kg	0.4	U	0.012	U	0.0143	U	0.0137	U	0.0116	U	0.0135	U
Semivolatiles	Dimethylphenol, 2,4-	N	mg/kg	0.4	U	0.0103	U	0.0124	U	0.0118	U	0.01	U	0.0117	U
Semivolatiles	Di-n-butyl phthalate	N	mg/kg	0.4	U	0.00846	U	0.0101	U	0.00966	U	0.00818	U	0.00956	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	mg/kg	1.9	U	0.0394	U	0.047	U	0.0449	U	0.0381	U	0.0445	U
Semivolatiles	Dinitrophenol, 2,4-	N	mg/kg	1.9	U	0.0624	U	0.0746	U	0.0712	U	0.0603	U	0.0705	U
Semivolatiles	Dinitrotoluene, 2,4-	N	mg/kg	0.4	U	0.0137	U	0.0164	U	0.0157	U	0.0133	U	0.0155	U
Semivolatiles	Dinitrotoluene, 2,6-	N	mg/kg	0.4	U	0.0094	U	0.0112	U	0.0107	U	0.00909	U	0.0106	U
Semivolatiles	Di-n-octyl phthalate	N	mg/kg	0.4	U	0.0737	U	0.088	U	0.0841	U	0.0712	U	0.0832	U
Semivolatiles	DIPHENYLAMINE	N	mg/kg			0.0388	U	0.0463	U	0.0443	U	0.0375	U	0.0438	U
Semivolatiles	Fluoranthene	N	mg/kg	0.4	U	0.00846	U	0.0599	J	0.00966	U	0.00818	U	0.00956	U
Semivolatiles	Fluorene	N	mg/kg	0.4	U	0.0166	U	0.0198	U	0.0189	U	0.016	U	0.0187	U
Semivolatiles	Hexachlorobenzene	N	mg/kg	0.4	U	0.0243	U	0.0291	U	0.0278	U	0.0235	U	0.0275	U
Semivolatiles	Hexachlorobutadiene	N	mg/kg	0.4	U	0.0371	U	0.0444	U	0.0424	U	0.0359	U	0.0419	U
Semivolatiles	Hexachlorocyclopentadiene	N	mg/kg	1.9	U	0.0125	U	0.0149	U	0.0142	U	0.012	U	0.0141	U
Semivolatiles	Hexachloroethane	N	mg/kg	0.4	U	0.012	U	0.0143	U	0.0137	U	0.0116	U	0.0135	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	mg/kg	0.4	U	0.127	U	0.152	U	0.145	U	0.123	U	0.143	U
Semivolatiles	Isophorone	N	mg/kg	0.4	U	0.0047	U	0.00562	U	0.00537	U	0.00455	U	0.00531	U
Semivolatiles	Methylnaphthalene, 2-	N	mg/kg	0.4	U	0.103	U	0.123	U	0.117	U	0.0993	U	0.116	U
Semivolatiles	Methylphenol, 2-	N	mg/kg	0.4	U	0.00587	U	0.00702	U	0.00671	U	0.00568	U	0.00664	U
Semivolatiles	Methylphenol, 4-	N	mg/kg	0.4	U	0.0122	U	0.0146	U	0.014	U	0.0118	U	0.0138	U
Semivolatiles	Naphthalene	N	mg/kg	0.4	U	0.00928	U	0.0111	U	0.0106	U	0.00898	U	0.0105	U
Semivolatiles	Nitroaniline, 2-	N	mg/kg	1.9	U	0.0169	U	0.0202	U	0.0193	U	0.0164	U	0.0191	U
Semivolatiles	Nitroaniline, 3-	N	mg/kg	1.9	U	0.0133	U	0.0159	U	0.0152	U	0.0128	U	0.015	U
Semivolatiles	Nitroaniline, 4-	N	mg/kg	1.9	U	0.139	U	0.166	U	0.158	U	0.134	U	0.157	U
Semivolatiles	Nitrobenzene	N	mg/kg	0.4	U	0.0128	U	0.0153	U	0.0146	U	0.0124	U	0.0145	U
Semivolatiles	Nitrophenol, 2-	N	mg/kg	0.4	U	0.0139	U	0.0166	U	0.0158	U	0.0134	U	0.0157	U
Semivolatiles	Nitrophenol, 4-	N	mg/kg	1.9	U	0.0317	U	0.0379	U	0.0362	U	0.0307	U	0.0358	U
Semivolatiles	n-Nitrosodimethylamine	N	mg/kg			0.0117	U	0.014	U	0.0134	U	0.0114	U	0.0133	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	mg/kg	0.4	U	0.014	U	0.0167	U	0.016	U	0.0135	U	0.0158	U
Semivolatiles	n-Nitrosodiphenylamine	N	mg/kg	0.4	U	0.00552	U	0.0066	U	0.00631	U	0.00534	U	0.00624	U
Semivolatiles	Pentachlorophenol	N	mg/kg	0.4	U	0.0351	U	0.042	U	0.0401	U	0.034	U	0.0397	U
Semivolatiles	Phenanthrene	N	mg/kg	0.4	U	0.0544	J	0.0114	U	0.0109	U	0.0667	J	0.0107	U
Semivolatiles	Phenol	N	mg/kg	0.4	U	0.0047	U	0.00562	U	0.00537	U	0.00455	U	0.00531	U
Semivolatiles	Pyrene	N	mg/kg	0.4	U	0.0156	U	0.044	J	0.0178	U	0.0151	U	0.0177	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	mg/kg			0.00963	U	0.0115	U	0.011	U	0.00932	U	0.0109	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	mg/kg	0.4	U	0.0336	U	0.0402	U	0.0384	U	0.0325	U	0.038	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	mg/kg	0.4	U	0.0264	U	0.0316	U	0.0302	U	0.0256	U	0.0299	U
Pesticides/PCBs	Aroclor 1016	N	mg/kg	0.04	U			0.00937	U	0.00886	U			0.00891	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB02		ASH PIT 2-SB02		ASH PIT 2-SB03		ASH PIT 2-SB03		ASH PIT 2-SB03		ASH PIT 2-SB04	
			SAMPLE_NO	AP0106		AP0107		AP0108		AP0109		AP0110		AP0111	
			SAMPLE_DATE	16-Jan-09		16-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09		18-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft	
			SAMPLE_PURPOSE	FS		REG		REG		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1221	N	mg/kg	0.04	U			0.00937	U	0.00886	U			0.00891	U
Pesticides/PCBs	Aroclor 1232	N	mg/kg	0.04	U			0.00937	U	0.00886	U			0.00891	U
Pesticides/PCBs	Aroclor 1242	N	mg/kg	0.04	U			0.00937	U	0.00886	U			0.00891	U
Pesticides/PCBs	Aroclor 1248	N	mg/kg	0.04	U			0.00937	U	0.00886	U			0.00891	U
Pesticides/PCBs	Aroclor 1254	N	mg/kg	0.04	U			0.00937	U	0.00886	U			0.00891	U
Pesticides/PCBs	Aroclor 1260	N	mg/kg	0.04	U			0.0162	J	0.00886	U			0.00891	U
Metals - Unfiltered	Aluminum	N	mg/kg	6930		10700	J	8070		15000		7720		7130	
Metals - Unfiltered	Antimony	N	mg/kg	7.3	U	0.626		0.637		0.257	J	0.329	J	0.485	
Metals - Unfiltered	Arsenic	N	mg/kg	4		12.1		7.71	J	5.27	J	12.6	J	26.8	J
Metals - Unfiltered	Barium	N	mg/kg	54.4		41.2	J	69.4	J	98.9	J	18.6	J	98.4	J
Metals - Unfiltered	Beryllium	N	mg/kg	0.61	U	7.06	J	6.46	J	7.43	J	6.35	J	16.3	J
Metals - Unfiltered	Cadmium	N	mg/kg	0.61	U	0.224	U	0.558		0.23	U	0.214	U	0.237	U
Metals - Unfiltered	Calcium	N	mg/kg	7170	J	46600		3430	J	36500	J	54300	J	2160	J
Metals - Unfiltered	Chromium	N	mg/kg	10.6		16		12	J	22.1	J	11.8	J	10.5	J
Metals - Unfiltered	Cobalt	N	mg/kg	8.3		11.7	J	8.68	J	10.8	J	10.7	J	5.96	J
Metals - Unfiltered	Copper	N	mg/kg	13.4		27.8	J	22.5		29.8		29.6		26	
Metals - Unfiltered	Iron	N	mg/kg	13300		23200	J	19100		24900		22100		109000	
Metals - Unfiltered	Lead	N	mg/kg	7.5		18.9		27.7	J	16.7	J	15.8	J	10.1	J
Metals - Unfiltered	Magnesium	N	mg/kg	3340		10800	J	2150	J	10100	J	10400	J	442	J
Metals - Unfiltered	Manganese	N	mg/kg	320		431		211		436		414		116	
Metals - Unfiltered	Mercury	N	mg/kg	0.12	U	0.0101	U	0.0642		0.013	J	0.0132	J	0.0265	
Metals - Unfiltered	Nickel	N	mg/kg	18.7		30.8		21.7	J	31.5	J	27.4	J	17.1	J
Metals - Unfiltered	Potassium	N	mg/kg	1070	J	1450		745		1570		1110		827	
Metals - Unfiltered	Selenium	N	mg/kg	0.61	U	0.448	U	0.928	J	0.459	UJ	0.427	UJ	0.678	J
Metals - Unfiltered	Silver	N	mg/kg	1.2	U	0.224	U	0.24	UJ	0.23	UJ	0.214	UJ	0.237	UJ
Metals - Unfiltered	Sodium	N	mg/kg	609	U	152		36.3		119		120		55.7	
Metals - Unfiltered	Thallium	N	mg/kg	1.2	U	0.343	J	0.47	J	0.35	J	0.336	J	0.468	J
Metals - Unfiltered	Vanadium	N	mg/kg	13		20.2		18.7		25.3		15.4		26.9	
Metals - Unfiltered	Zinc	N	mg/kg	43.5		62.9		80	J	68.5	J	61.5	J	57	J
Water Quality Parameters	% Solids	N	Percent	82.2											
Water Quality Parameters	Total organic carbon	N	mg/kg												

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB04		ASH PIT 2-SB04		ASH PIT 2-SB05		ASH PIT 2-SB05		ASH PIT 2-SB05		ASH PIT 2-SB06	
			SAMPLE_NO	AP0112		AP0113		AP0114		AP0115		AP0116		AP0117	
			SAMPLE_DATE	18-Jan-09		19-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		15-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Amino-4,6-dinitrotoluene, 2-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Dinitrobenzene, 1,3-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Dinitrotoluene, 2,4-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Dinitrotoluene, 2,6-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	HMX	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Nitrobenzene	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Nitrotoluene, 2-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Nitrotoluene, 3-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Nitrotoluene, 4-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	RDX	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Tetryl	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Trinitrobenzene, 1,3,5-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Explosives	Trinitrotoluene, 2,4,6-	N	mg/kg	0.146	U	0.146	U	0.15	R	0.148	U	0.145	U	0.149	UJ
Semivolatiles	Acenaphthene	N	mg/kg	0.00812	U	0.00715	U	0.00879	U	0.00775	U	0.00691	U	0.00752	U
Semivolatiles	Acenaphthylene	N	mg/kg	0.00541	U	0.00477	U	0.00586	U	0.00517	U	0.0046	U	0.00501	U
Semivolatiles	ACETOPHENONE	N	mg/kg												
Semivolatiles	Anthracene	N	mg/kg	0.00975	U	0.00858	U	0.0105	U	0.0093	U	0.00829	U	0.00902	U
Semivolatiles	Atrazine	N	mg/kg												
Semivolatiles	Benzaldehyde	N	mg/kg												
Semivolatiles	Benzo(a)anthracene	N	mg/kg	0.0296	U	0.0261	U	0.0321	U	0.0283	U	0.0252	U	0.0274	U
Semivolatiles	Benzo(a)pyrene	N	mg/kg	0.0296	U	0.0261	U	0.0321	U	0.0283	U	0.0252	U	0.0274	U
Semivolatiles	Benzo(b)fluoranthene	N	mg/kg	0.0751	U	0.0662	U	0.0813	U	0.0717	U	0.0639	U	0.0695	U
Semivolatiles	Benzo(ghi)perylene	N	mg/kg	0.11	U	0.0968	U	0.119	U	0.105	U	0.0935	U	0.102	U
Semivolatiles	Benzo(k)fluoranthene	N	mg/kg	0.137	U	0.12	U	0.148	U	0.13	U	0.116	U	0.127	U
Semivolatiles	Benzoic acid	N	mg/kg	0.11	U	0.0968	U	0.119	U	0.105	U	0.0935	UJ	0.622	
Semivolatiles	Benzyl alcohol	N	mg/kg	0.11	U	0.0968	U	0.119	U	0.105	U	0.0935	U	0.102	U
Semivolatiles	BIBENZENE	N	mg/kg												
Semivolatiles	Bis(2-chloroethoxy)methane	N	mg/kg	0.00948	U	0.00834	U	0.0103	U	0.00904	U	0.00806	U	0.00877	U
Semivolatiles	Bis(2-chloroethyl)ether	N	mg/kg	0.0115	U	0.0101	U	0.0124	U	0.011	U	0.00978	U	0.0107	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	mg/kg	0.0196	U	0.0173	U	0.0212	U	0.0187	U	0.0167	U	0.0182	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	mg/kg	0.0417	U	0.0367	U	0.0451	U	0.0398	U	0.0355	U	0.0386	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	mg/kg	0.0161	U	0.0142	U	0.0174	U	0.0154	U	0.0137	U	0.0149	U
Semivolatiles	Butyl benzyl phthalate	N	mg/kg	0.0183	U	0.0161	U	0.0198	U	0.0174	U	0.0155	U	0.0169	U
Semivolatiles	Caprolactam	N	mg/kg												
Semivolatiles	Carbazole	N	mg/kg	0.0451	U	0.0397	U	0.0488	U	0.043	U	0.0383	U	0.0417	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	mg/kg	0.0111	U	0.00977	U	0.012	U	0.0106	U	0.00944	U	0.0103	U
Semivolatiles	Chloroaniline, 4-	N	mg/kg	0.0391	U	0.0345	U	0.0423	U	0.0373	U	0.00333	U	0.0362	U
Semivolatiles	Chloronaphthalene, 2-	N	mg/kg	0.00717	U	0.00632	U	0.00776	U	0.00684	U	0.0061	U	0.00664	U
Semivolatiles	Chlorophenol, 2-	N	mg/kg	0.00555	U	0.00489	U	0.006	U	0.00529	U	0.00472	U	0.00514	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	mg/kg	0.0345	U	0.0304	U	0.0373	U	0.0329	U	0.0294	U	0.032	U
Semivolatiles	Chrysene	N	mg/kg	0.0179	U	0.0157	U	0.0193	U	0.017	U	0.0152	U	0.0165	U
Semivolatiles	Dibenz(a,h)anthracene	N	mg/kg	0.102	U	0.0898	U	0.11	U	0.0972	U	0.0867	U	0.0944	U
Semivolatiles	Dibenzofuran	N	mg/kg	0.00758	U	0.00668	U	0.0082	U	0.00723	U	0.00645	U	0.00702	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB04		ASH PIT 2-SB04		ASH PIT 2-SB05		ASH PIT 2-SB05		ASH PIT 2-SB05		ASH PIT 2-SB06	
			SAMPLE_NO	AP0112		AP0113		AP0114		AP0115		AP0116		AP0117	
			SAMPLE_DATE	18-Jan-09		19-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		15-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Dichlorobenzene, 1,2-	N	mg/kg	0.0104	U	0.00918	U	0.0113	U	0.00994	U	0.00886	U	0.00965	U
Semivolatiles	Dichlorobenzene, 1,3-	N	mg/kg	0.0164	U	0.0144	U	0.0177	U	0.0156	U	0.0139	U	0.0152	U
Semivolatiles	Dichlorobenzene, 1,4-	N	mg/kg	0.0088	U	0.00775	U	0.00952	U	0.00839	U	0.00748	U	0.00815	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	mg/kg	0.0447	U	0.0393	U	0.0483	U	0.0426	U	0.038	U	0.0414	U
Semivolatiles	Dichlorophenol, 2,4-	N	mg/kg	0.0161	U	0.0142	U	0.0174	U	0.0154	U	0.0137	U	0.0149	U
Semivolatiles	Diethyl phthalate	N	mg/kg	0.0183	U	0.0161	U	0.0198	U	0.0174	U	0.0155	U	0.0169	U
Semivolatiles	Dimethyl phthalate	N	mg/kg	0.0138	U	0.0122	U	0.0149	U	0.0132	U	0.0117	U	0.0128	U
Semivolatiles	Dimethylphenol, 2,4-	N	mg/kg	0.0119	U	0.0105	U	0.0129	U	0.0114	U	0.0101	U	0.011	U
Semivolatiles	Di-n-butyl phthalate	N	mg/kg	0.00975	U	0.00858	U	0.0105	U	0.0093	U	0.00829	U	0.00902	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	mg/kg	0.0453	U	0.0399	U	0.0491	U	0.0433	U	0.0386	U	0.042	U
Semivolatiles	Dinitrophenol, 2,4-	N	mg/kg	0.0719	U	0.0633	U	0.0778	UJ	0.0686	UJ	0.0611	U	0.0665	U
Semivolatiles	Dinitrotoluene, 2,4-	N	mg/kg	0.0158	U	0.0139	U	0.0171	U	0.0151	U	0.0135	U	0.0147	U
Semivolatiles	Dinitrotoluene, 2,6-	N	mg/kg	0.0108	U	0.00954	U	0.0117	U	0.0103	U	0.00921	U	0.01	U
Semivolatiles	Di-n-octyl phthalate	N	mg/kg	0.0849	U	0.0747	U	0.0918	U	0.081	U	0.0722	U	0.0786	U
Semivolatiles	DIPHENYLAMINE	N	mg/kg	0.0447	U	0.0393	U	0.0483	U	0.0426	U	0.038	U	0.0414	U
Semivolatiles	Fluoranthene	N	mg/kg	0.00975	U	0.00858	U	0.0105	U	0.0093	U	0.00829	U	0.00902	U
Semivolatiles	Fluorene	N	mg/kg	0.0191	U	0.0168	U	0.0206	U	0.0182	U	0.0162	U	0.0177	U
Semivolatiles	Hexachlorobenzene	N	mg/kg	0.028	U	0.0247	U	0.0303	U	0.0267	U	0.0238	U	0.0259	U
Semivolatiles	Hexachlorobutadiene	N	mg/kg	0.0428	U	0.0377	U	0.0463	U	0.0408	U	0.0364	U	0.0396	U
Semivolatiles	Hexachlorocyclopentadiene	N	mg/kg	0.0143	U	0.0126	U	0.0155	U	0.0137	U	0.0122	U	0.0133	U
Semivolatiles	Hexachloroethane	N	mg/kg	0.0138	U	0.0122	U	0.0149	U	0.0132	U	0.0117	U	0.0128	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	mg/kg	0.146	U	0.129	U	0.158	U	0.139	U	0.124	U	0.135	U
Semivolatiles	Isophorone	N	mg/kg	0.00541	U	0.00477	U	0.00586	U	0.00517	U	0.0046	U	0.00501	U
Semivolatiles	Methylnaphthalene, 2-	N	mg/kg	0.118	U	0.104	U	0.128	U	0.113	U	0.101	U	0.11	U
Semivolatiles	Methylphenol, 2-	N	mg/kg	0.00677	U	0.00596	U	0.00732	U	0.00646	U	0.00576	U	0.00627	U
Semivolatiles	Methylphenol, 4-	N	mg/kg	0.0141	U	0.0124	U	0.0152	U	0.0134	U	0.012	U	0.013	U
Semivolatiles	Naphthalene	N	mg/kg	0.0107	U	0.00942	U	0.0444	J	0.0102	U	0.00909	U	0.0099	U
Semivolatiles	Nitroaniline, 2-	N	mg/kg	0.0195	U	0.0172	U	0.0211	U	0.0186	U	0.0166	U	0.018	U
Semivolatiles	Nitroaniline, 3-	N	mg/kg	0.0153	U	0.0135	U	0.0165	U	0.0146	U	0.013	U	0.0142	U
Semivolatiles	Nitroaniline, 4-	N	mg/kg	0.16	U	0.141	U	0.173	U	0.152	U	0.136	U	0.148	U
Semivolatiles	Nitrobenzene	N	mg/kg	0.0148	U	0.013	U	0.016	U	0.0141	U	0.0125	U	0.0137	U
Semivolatiles	Nitrophenol, 2-	N	mg/kg	0.016	U	0.0141	U	0.0173	U	0.0152	U	0.0136	U	0.0148	U
Semivolatiles	Nitrophenol, 4-	N	mg/kg	0.0366	U	0.0322	U	0.0395	U	0.0349	U	0.0311	U	0.0338	U
Semivolatiles	n-Nitrosodimethylamine	N	mg/kg	0.0135	U	0.0119	U	0.0146	U	0.0129	U	0.0115	U	0.0125	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	mg/kg	0.0161	U	0.0142	U	0.0174	U	0.0154	U	0.0137	U	0.0149	U
Semivolatiles	n-Nitrosodiphenylamine	N	mg/kg	0.00636	U	0.0056	U	0.00688	U	0.00607	U	0.00541	U	0.00589	U
Semivolatiles	Pentachlorophenol	N	mg/kg	0.0405	U	0.0356	U	0.0438	U	0.0386	U	0.0344	U	0.0375	U
Semivolatiles	Phenanthrene	N	mg/kg	0.011	U	0.0453	J	0.0119	U	0.0105	U	0.0491	J	0.0102	U
Semivolatiles	Phenol	N	mg/kg	0.00541	U	0.00477	U	0.00586	U	0.00517	U	0.0046	U	0.00501	U
Semivolatiles	Pyrene	N	mg/kg	0.018	U	0.0159	U	0.0195	U	0.0172	U	0.0153	U	0.0167	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	mg/kg	0.0111	U	0.00977	U	0.012	U	0.0106	U	0.00944	U	0.0103	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	mg/kg	0.0387	U	0.0341	U	0.0419	U	0.0369	U	0.0329	U	0.0358	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	mg/kg	0.0305	U	0.0268	U	0.0329	U	0.0291	U	0.0259	U	0.0282	U
Pesticides/PCBs	Aroclor 1016	N	mg/kg	0.00897	U			0.00964	U	0.00861	U			0.00825	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB04		ASH PIT 2-SB04		ASH PIT 2-SB05		ASH PIT 2-SB05		ASH PIT 2-SB05		ASH PIT 2-SB06	
			SAMPLE_NO	AP0112		AP0113		AP0114		AP0115		AP0116		AP0117	
			SAMPLE_DATE	18-Jan-09		19-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		15-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1221	N	mg/kg	0.00897	U			0.00964	U	0.00861	U			0.00825	U
Pesticides/PCBs	Aroclor 1232	N	mg/kg	0.00897	U			0.00964	U	0.00861	U			0.00825	U
Pesticides/PCBs	Aroclor 1242	N	mg/kg	0.00897	U			0.00964	U	0.00861	U			0.00825	U
Pesticides/PCBs	Aroclor 1248	N	mg/kg	0.00897	U			0.00964	U	0.00861	U			0.00825	U
Pesticides/PCBs	Aroclor 1254	N	mg/kg	0.00897	U			0.00964	U	0.00861	U			0.00825	U
Pesticides/PCBs	Aroclor 1260	N	mg/kg	0.00897	U			0.00964	U	0.00861	U			0.00825	U
Metals - Unfiltered	Aluminum	N	mg/kg	7830		8670		8800	J	8060	J	9300	J	7150	J
Metals - Unfiltered	Antimony	N	mg/kg	0.312	J	0.392	J	0.922		0.259	J	0.486		0.708	
Metals - Unfiltered	Arsenic	N	mg/kg	4.51	J	12.1	J	24.4		6.27		11.1		11.4	
Metals - Unfiltered	Barium	N	mg/kg	61.5	J	35.6	J	109	J	68.2	J	49	J	98.7	
Metals - Unfiltered	Beryllium	N	mg/kg	6.68	J	7.02	J	15.5	J	7.61	J	7.53	J	12.1	
Metals - Unfiltered	Cadmium	N	mg/kg	0.271	U	0.245	U	0.716		0.241	U	0.276	J	0.423	J
Metals - Unfiltered	Calcium	N	mg/kg	3010	J	50700	J	4140		351		42300		2830	
Metals - Unfiltered	Chromium	N	mg/kg	11.9	J	12.7	J	12.8		11.7		14.4		7.84	
Metals - Unfiltered	Cobalt	N	mg/kg	7.88	J	11	J	8.29	J	6.67	J	14	J	4.64	
Metals - Unfiltered	Copper	N	mg/kg	20.9		38.4		31.3	J	15.6	J	33.6	J	22.2	J
Metals - Unfiltered	Iron	N	mg/kg	19200		24400		61600	J	22100	J	24500	J	51800	J
Metals - Unfiltered	Lead	N	mg/kg	18.9	J	16	J	27.4		12.2		13.4		12.5	
Metals - Unfiltered	Magnesium	N	mg/kg	2530	J	10800	J	1320	J	1980	J	8760	J	819	J
Metals - Unfiltered	Manganese	N	mg/kg	87.4		522		319		100		551		243	
Metals - Unfiltered	Mercury	N	mg/kg	0.0352		0.0147	J	0.118		0.0242	J	0.011	U	0.0688	
Metals - Unfiltered	Nickel	N	mg/kg	24.8	J	28.8	J	20.5		18		36.8		13.7	
Metals - Unfiltered	Potassium	N	mg/kg	705		1150		837		513		990		616	
Metals - Unfiltered	Selenium	N	mg/kg	0.859	J	0.49	UJ	1.44		0.482	U	0.779	J	0.737	J
Metals - Unfiltered	Silver	N	mg/kg	0.271	UJ	0.245	UJ	0.284	U	0.241	U	0.238	U	0.227	U
Metals - Unfiltered	Sodium	N	mg/kg	43.6		119		79.2		18.4		91.4		76.3	
Metals - Unfiltered	Thallium	N	mg/kg	0.271	U	0.315	J	0.939		0.241	U	0.347	J	0.312	J
Metals - Unfiltered	Vanadium	N	mg/kg	17.8		17.5		23		17		18.2		17.3	
Metals - Unfiltered	Zinc	N	mg/kg	64.4	J	60.4	J	102		68.9		85.3		53.2	
Water Quality Parameters	% Solids	N	Percent												
Water Quality Parameters	Total organic carbon	N	mg/kg												

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB06		ASH PIT 2-SB06		ASH PIT 2-SB07		ASH PIT 2-SB07		ASH PIT 2-SB07		ASH PIT 2-SB07	
			SAMPLE_NO	AP0118		AP0119		AP0120		AP0121		AP0122		AP0123	
			SAMPLE_DATE	15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		0 - 1 Ft		0 - 1 Ft		3 - 5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Dinitrobenzene, 1,3-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Dinitrotoluene, 2,4-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Dinitrotoluene, 2,6-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	HMX	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Nitrobenzene	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Nitrotoluene, 2-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Nitrotoluene, 3-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Nitrotoluene, 4-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	RDX	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Tetryl	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.3	U	0.149	U
Explosives	Trinitrobenzene, 1,3,5-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Explosives	Trinitrotoluene, 2,4,6-	N	mg/kg	0.146	U	0.149	U	0.148	U	0.149	U	0.2	U	0.149	U
Semivolatiles	Acenaphthene	N	mg/kg	0.0071	U	0.00771	U	0.00739	U	0.00719	U	0.41	U	0.00684	U
Semivolatiles	Acenaphthylene	N	mg/kg	0.00474	U	0.00514	U	0.00493	U	0.00479	U	0.41	U	0.00456	U
Semivolatiles	ACETOPHENONE	N	mg/kg									0.083	U		
Semivolatiles	Anthracene	N	mg/kg	0.00852	U	0.00925	U	0.00887	U	0.00862	U	0.41	U	0.00821	U
Semivolatiles	Atrazine	N	mg/kg									0.41	U		
Semivolatiles	Benzaldehyde	N	mg/kg									0.41	U		
Semivolatiles	Benzo(a)anthracene	N	mg/kg	0.0259	U	0.0281	U	0.027	U	0.0262	U	0.41	U	0.025	U
Semivolatiles	Benzo(a)pyrene	N	mg/kg	0.0259	U	0.0281	U	0.027	U	0.0262	U	0.41	U	0.025	U
Semivolatiles	Benzo(b)fluoranthene	N	mg/kg	0.0657	U	0.0713	U	0.0683	U	0.0665	U	0.41	U	0.0633	U
Semivolatiles	Benzo(ghi)perylene	N	mg/kg	0.0961	U	0.104	U	0.1	U	0.0973	U	0.41	U	0.0926	U
Semivolatiles	Benzo(k)fluoranthene	N	mg/kg	0.12	U	0.13	U	0.124	U	0.121	U	0.41	U	0.115	U
Semivolatiles	Benzoic acid	N	mg/kg	0.0961	U	0.104	UJ	0.1	U	0.0973	UJ			0.0926	UJ
Semivolatiles	Benzyl alcohol	N	mg/kg	0.0961	U	0.104	U	0.1	U	0.0973	U			0.0926	U
Semivolatiles	BIBENZENE	N	mg/kg									0.41	U		
Semivolatiles	Bis(2-chloroethoxy)methane	N	mg/kg	0.00829	U	0.009	U	0.00862	U	0.00838	U	0.41	U	0.00798	U
Semivolatiles	Bis(2-chloroethyl)ether	N	mg/kg	0.0101	U	0.0109	U	0.0105	U	0.0102	U	0.41	U	0.00969	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	mg/kg	0.0172	U	0.0186	U	0.0179	U	0.0174	U	0.41	U	0.0165	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	mg/kg	0.0365	U	0.0396	U	0.0379	U	0.0369	U	0.41	U	0.0351	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	mg/kg	0.0141	U	0.0153	U	0.0147	U	0.0143	U	0.41	U	0.0136	U
Semivolatiles	Butyl benzyl phthalate	N	mg/kg	0.016	U	0.0173	U	0.0166	U	0.0162	U	0.41	U	0.0154	U
Semivolatiles	Caprolactam	N	mg/kg									0.41	U		
Semivolatiles	Carbazole	N	mg/kg	0.0394	U	0.0428	U	0.041	U	0.0399	U	0.41	U	0.038	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	mg/kg	0.00971	U	0.0105	U	0.0101	U	0.00982	U	0.41	U	0.00935	U
Semivolatiles	Chloroaniline, 4-	N	mg/kg	0.0342	U	0.0371	U	0.0356	U	0.0346	U	0.41	U	0.0329	U
Semivolatiles	Chloronaphthalene, 2-	N	mg/kg	0.00627	U	0.00681	U	0.00653	U	0.00635	U	0.41	U	0.00604	U
Semivolatiles	Chlorophenol, 2-	N	mg/kg	0.00485	U	0.00527	U	0.00505	U	0.00491	U	0.41	U	0.00467	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	mg/kg	0.0302	U	0.0328	U	0.0314	U	0.0305	U	0.41	U	0.0291	U
Semivolatiles	Chrysene	N	mg/kg	0.0156	U	0.017	U	0.0163	U	0.0158	U	0.41	U	0.015	U
Semivolatiles	Dibenz(a,h)anthracene	N	mg/kg	0.0891	U	0.0968	U	0.0927	U	0.0902	U	0.41	U	0.0859	U
Semivolatiles	Dibenzofuran	N	mg/kg	0.00663	U	0.0072	U	0.0069	U	0.00671	U	0.41	U	0.00638	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB06		ASH PIT 2-SB06		ASH PIT 2-SB07		ASH PIT 2-SB07		ASH PIT 2-SB07		ASH PIT 2-SB07	
			SAMPLE_NO	AP0118		AP0119		AP0120		AP0121		AP0122		AP0123	
			SAMPLE_DATE	15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		0 - 1 Ft		0 - 1 Ft		3 - 5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Dichlorobenzene, 1,2-	N	mg/kg	0.00912	U	0.0099	U	0.00948	U	0.00922	U			0.00878	U
Semivolatiles	Dichlorobenzene, 1,3-	N	mg/kg	0.0143	U	0.0156	U	0.0149	U	0.0145	U			0.0138	U
Semivolatiles	Dichlorobenzene, 1,4-	N	mg/kg	0.0077	U	0.00835	U	0.008	U	0.00779	U			0.00741	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	mg/kg	0.0391	U	0.0424	U	0.0406	U	0.0395	U	2	U	0.0376	U
Semivolatiles	Dichlorophenol, 2,4-	N	mg/kg	0.0141	U	0.0153	U	0.0147	U	0.0143	U	0.41	U	0.0136	U
Semivolatiles	Diethyl phthalate	N	mg/kg	0.016	U	0.0173	U	0.0166	U	0.0162	U	0.41	U	0.0154	U
Semivolatiles	Dimethyl phthalate	N	mg/kg	0.0121	U	0.0131	U	0.0126	U	0.0122	U	0.41	U	0.0116	U
Semivolatiles	Dimethylphenol, 2,4-	N	mg/kg	0.0104	U	0.0113	U	0.0108	U	0.0105	U	0.41	U	0.01	U
Semivolatiles	Di-n-butyl phthalate	N	mg/kg	0.00852	U	0.00925	U	0.00887	U	0.00862	U	0.41	U	0.00821	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	mg/kg	0.0397	U	0.0431	U	0.0413	U	0.0401	U	2	U	0.0382	U
Semivolatiles	Dinitrophenol, 2,4-	N	mg/kg	0.0629	U	0.0682	U	0.0654	U	0.0636	U	2	U	0.0605	U
Semivolatiles	Dinitrotoluene, 2,4-	N	mg/kg	0.0139	U	0.015	U	0.0144	U	0.014	U	0.41	U	0.0133	U
Semivolatiles	Dinitrotoluene, 2,6-	N	mg/kg	0.00947	U	0.0103	U	0.00985	U	0.00958	U	0.41	U	0.00912	U
Semivolatiles	Di-n-octyl phthalate	N	mg/kg	0.0742	U	0.0806	U	0.0772	U	0.0751	U	0.41	U	0.0715	U
Semivolatiles	DIPHENYLAMINE	N	mg/kg	0.0391	U	0.0424	U	0.0406	U	0.0395	U			0.0376	U
Semivolatiles	Fluoranthene	N	mg/kg	0.00852	U	0.00925	U	0.00887	U	0.00862	U	0.41	U	0.00821	U
Semivolatiles	Fluorene	N	mg/kg	0.0167	U	0.0181	U	0.0174	U	0.0169	U	0.41	U	0.0161	U
Semivolatiles	Hexachlorobenzene	N	mg/kg	0.0245	U	0.0266	U	0.0255	U	0.0248	U	0.41	U	0.0236	U
Semivolatiles	Hexachlorobutadiene	N	mg/kg	0.0374	U	0.0406	U	0.0389	U	0.0378	U	0.41	U	0.036	U
Semivolatiles	Hexachlorocyclopentadiene	N	mg/kg	0.0125	U	0.0136	U	0.0131	U	0.0127	U	2	U	0.0121	U
Semivolatiles	Hexachloroethane	N	mg/kg	0.0121	U	0.0131	U	0.0126	U	0.0122	U	0.41	U	0.0116	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	mg/kg	0.128	U	0.139	U	0.133	U	0.129	U	0.41	U	0.123	U
Semivolatiles	Isophorone	N	mg/kg	0.00474	U	0.00514	U	0.00493	U	0.00479	U	0.41	U	0.00456	U
Semivolatiles	Methylnaphthalene, 2-	N	mg/kg	0.103	U	0.112	U	0.108	U	0.105	U	0.41	U	0.0996	U
Semivolatiles	Methylphenol, 2-	N	mg/kg	0.00592	U	0.00643	U	0.00616	U	0.00599	U	0.41	U	0.0057	U
Semivolatiles	Methylphenol, 4-	N	mg/kg	0.0123	U	0.0134	U	0.0128	U	0.0125	U	0.41	U	0.0119	U
Semivolatiles	Naphthalene	N	mg/kg	0.00935	U	0.0102	U	0.00973	U	0.00946	U	0.41	U	0.00901	U
Semivolatiles	Nitroaniline, 2-	N	mg/kg	0.017	U	0.0185	U	0.0177	U	0.0172	U	2	U	0.0164	U
Semivolatiles	Nitroaniline, 3-	N	mg/kg	0.0134	U	0.0145	U	0.0139	U	0.0135	U	2	U	0.0129	U
Semivolatiles	Nitroaniline, 4-	N	mg/kg	0.14	U	0.152	U	0.145	U	0.141	U	2	U	0.135	U
Semivolatiles	Nitrobenzene	N	mg/kg	0.0129	U	0.014	U	0.0134	U	0.0131	U	0.41	U	0.0124	U
Semivolatiles	Nitrophenol, 2-	N	mg/kg	0.014	U	0.0152	U	0.0145	U	0.0141	U	0.41	U	0.0135	U
Semivolatiles	Nitrophenol, 4-	N	mg/kg	0.032	U	0.0347	U	0.0332	U	0.0324	U	2	U	0.0308	U
Semivolatiles	n-Nitrosodimethylamine	N	mg/kg	0.0118	U	0.0129	U	0.0123	U	0.012	U			0.0114	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	mg/kg	0.0141	U	0.0153	U	0.0147	U	0.0143	U	0.41	U	0.0136	U
Semivolatiles	n-Nitrosodiphenylamine	N	mg/kg	0.00556	U	0.00604	U	0.00579	U	0.00563	U	0.41	U	0.00536	U
Semivolatiles	Pentachlorophenol	N	mg/kg	0.0354	U	0.0384	U	0.0368	U	0.0358	U	0.41	U	0.0341	U
Semivolatiles	Phenanthrene	N	mg/kg	0.00959	U	0.0403	J	0.00997	U	0.0097	U	0.41	U	0.00923	U
Semivolatiles	Phenol	N	mg/kg	0.00474	U	0.00514	U	0.00493	U	0.00479	U	0.41	U	0.00456	U
Semivolatiles	Pyrene	N	mg/kg	0.0157	U	0.0171	U	0.0164	U	0.0159	U	0.41	U	0.0152	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	mg/kg	0.00971	U	0.0105	U	0.0101	U	0.00982	U			0.00935	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	mg/kg	0.0339	U	0.0368	U	0.0352	U	0.0343	U	0.41	U	0.0326	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	mg/kg	0.0266	U	0.0289	U	0.0277	U	0.0269	U	0.41	U	0.0257	U
Pesticides/PCBs	Aroclor 1016	N	mg/kg	0.00782	U			0.00821	U	0.00799	U	0.041	U	0.00748	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB06		ASH PIT 2-SB06		ASH PIT 2-SB07		ASH PIT 2-SB07		ASH PIT 2-SB07		ASH PIT 2-SB07	
			SAMPLE_NO	AP0118		AP0119		AP0120		AP0121		AP0122		AP0123	
			SAMPLE_DATE	15-Jan-09		15-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		0 - 1 Ft		0 - 1 Ft		3 - 5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1221	N	mg/kg	0.00782	U			0.00821	U	0.00799	U	0.041	U	0.00748	U
Pesticides/PCBs	Aroclor 1232	N	mg/kg	0.00782	U			0.00821	U	0.00799	U	0.041	U	0.00748	U
Pesticides/PCBs	Aroclor 1242	N	mg/kg	0.00782	U			0.00821	U	0.00799	U	0.041	U	0.00748	U
Pesticides/PCBs	Aroclor 1248	N	mg/kg	0.00782	U			0.00821	U	0.00799	U	0.041	U	0.00748	U
Pesticides/PCBs	Aroclor 1254	N	mg/kg	0.00782	U			0.00821	U	0.00799	U	0.041	U	0.00748	U
Pesticides/PCBs	Aroclor 1260	N	mg/kg	0.00782	U			0.00821	U	0.00799	U	0.041	U	0.00748	U
Metals - Unfiltered	Aluminum	N	mg/kg	6750	J	13200	J	7100	J	8180	J	7200		5250	J
Metals - Unfiltered	Antimony	N	mg/kg	0.412	J	0.44	J	0.336	J	0.291	J	7.5	U	0.269	J
Metals - Unfiltered	Arsenic	N	mg/kg	6.33		3.55		6.09		6.04		5.5		6.18	
Metals - Unfiltered	Barium	N	mg/kg	58.3		53.4	J	44.5		56.7		48.6		43.7	
Metals - Unfiltered	Beryllium	N	mg/kg	6.9		7.73	J	6.01		6.41		0.63	U	5.46	
Metals - Unfiltered	Cadmium	N	mg/kg	0.293	J	0.247	U	0.226	U	0.232	U	0.63	U	0.219	U
Metals - Unfiltered	Calcium	N	mg/kg	2090		44000		2100		2270		1820	J	1840	
Metals - Unfiltered	Chromium	N	mg/kg	10.1		19.4		10.6		11.8		10.4		8.82	
Metals - Unfiltered	Cobalt	N	mg/kg	8.93		14.6	J	8.14		8.99		7.7		7.46	
Metals - Unfiltered	Copper	N	mg/kg	12.6	J	32.1	J	18	J	16.5	J	14.6		13.8	J
Metals - Unfiltered	Iron	N	mg/kg	19900	J	24000	J	17600	J	19100	J	16600		15500	J
Metals - Unfiltered	Lead	N	mg/kg	11.2		14.3		12.5		12.8		9.3		9.74	
Metals - Unfiltered	Magnesium	N	mg/kg	2110	J	12000	J	2100	J	2350	J	1880		1730	J
Metals - Unfiltered	Manganese	N	mg/kg	234		392		198		226		169		152	
Metals - Unfiltered	Mercury	N	mg/kg	0.0156	J	0.0132	J	0.0203	J	0.0193	J	0.13	U	0.0112	J
Metals - Unfiltered	Nickel	N	mg/kg	21.8		36.7		19.1		20.2		17.9		18.5	
Metals - Unfiltered	Potassium	N	mg/kg	426		1730		450		470		703	J	323	
Metals - Unfiltered	Selenium	N	mg/kg	0.497	U	0.494	U	0.453	U	0.464	U	0.63	U	0.439	U
Metals - Unfiltered	Silver	N	mg/kg	0.249	U	0.263	U	0.226	U	0.232	U	1.3	U	0.219	U
Metals - Unfiltered	Sodium	N	mg/kg	37.1		135		28.4		28		626	U	43.3	
Metals - Unfiltered	Thallium	N	mg/kg	0.249	U	0.293	J	0.226	U	0.232	U	1.3	U	0.219	U
Metals - Unfiltered	Vanadium	N	mg/kg	15.5		23.2		15.4		17.4		14.1		13.6	
Metals - Unfiltered	Zinc	N	mg/kg	63.7		73		63.2		27.8		51.4		55.4	
Water Quality Parameters	% Solids	N	Percent									79.9			
Water Quality Parameters	Total organic carbon	N	mg/kg												

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB07		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08	
			SAMPLE_NO	AP0124		AP0125		AP0126		AP0127		AP0128		AP0129	
			SAMPLE_DATE	16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	UJ	0.146	U	0.2	U
Explosives	Dinitrobenzene, 1,3-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	Dinitrotoluene, 2,4-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	UJ	0.146	U	0.2	U
Explosives	Dinitrotoluene, 2,6-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	HMX	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	Nitrobenzene	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	Nitrotoluene, 2-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	Nitrotoluene, 3-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	Nitrotoluene, 4-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	RDX	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.2	U
Explosives	Tetryl	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	U	0.146	U	0.3	U
Explosives	Trinitrobenzene, 1,3,5-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	UJ	0.146	U	0.2	U
Explosives	Trinitrotoluene, 2,4,6-	N	mg/kg	0.144	U	0.149	R	0.145	U	0.149	UJ	0.146	U	0.2	U
Semivolatiles	Acenaphthene	N	mg/kg	0.00684	U	0.00779	U	0.00714	U	0.00805	U	0.00813	U	0.45	U
Semivolatiles	Acenaphthylene	N	mg/kg	0.00456	U	0.00519	U	0.00476	U	0.00536	U	0.00542	U	0.45	U
Semivolatiles	ACETOPHENONE	N	mg/kg											0.091	U
Semivolatiles	Anthracene	N	mg/kg	0.00821	U	0.00934	U	0.00857	U	0.00966	U	0.00975	U	0.45	U
Semivolatiles	Atrazine	N	mg/kg											0.45	U
Semivolatiles	Benzaldehyde	N	mg/kg											0.45	U
Semivolatiles	Benzo(a)anthracene	N	mg/kg	0.025	U	0.0284	U	0.0261	U	0.0294	U	0.0297	U	0.45	U
Semivolatiles	Benzo(a)pyrene	N	mg/kg	0.025	U	0.0284	U	0.0261	U	0.0294	U	0.0297	U	0.45	U
Semivolatiles	Benzo(b)fluoranthene	N	mg/kg	0.0633	U	0.072	U	0.0661	U	0.0744	U	0.0752	U	0.45	U
Semivolatiles	Benzo(ghi)perylene	N	mg/kg	0.0926	U	0.105	U	0.0967	U	0.109	U	0.11	U	0.45	U
Semivolatiles	Benzo(k)fluoranthene	N	mg/kg	0.115	U	0.131	U	0.12	U	0.135	U	0.137	U	0.45	U
Semivolatiles	Benzoic acid	N	mg/kg	0.0926	UJ	0.105	U	0.0967	U	0.109	UJ	0.11	UJ		
Semivolatiles	Benzyl alcohol	N	mg/kg	0.0926	U	0.105	U	0.0967	U	0.109	U	0.11	U		
Semivolatiles	BIBENZENE	N	mg/kg											0.45	U
Semivolatiles	Bis(2-chloroethoxy)methane	N	mg/kg	0.00798	U	0.00908	U	0.00833	U	0.00939	U	0.00948	U	0.45	U
Semivolatiles	Bis(2-chloroethyl)ether	N	mg/kg	0.0097	U	0.011	U	0.0101	U	0.0114	U	0.0115	U	0.45	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	mg/kg	0.0165	U	0.0188	U	0.0173	U	0.0194	U	0.0196	U	0.45	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	mg/kg	0.0351	U	0.04	U	0.0367	U	0.0413	U	0.0417	U	0.45	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	mg/kg	0.0136	U	0.0154	U	0.0142	U	0.016	U	0.0161	U	0.45	U
Semivolatiles	Butyl benzyl phthalate	N	mg/kg	0.0154	U	0.0175	U	0.0161	U	0.0181	U	0.0183	U	0.45	U
Semivolatiles	Caprolactam	N	mg/kg											0.45	U
Semivolatiles	Carbazole	N	mg/kg	0.038	U	0.0432	U	0.0396	U	0.0447	U	0.0451	U	0.45	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	mg/kg	0.00935	U	0.0106	U	0.00976	U	0.011	U	0.0111	U	0.45	U
Semivolatiles	Chloroaniline, 4-	N	mg/kg	0.033	U	0.0375	U	0.0344	U	0.0388	U	0.0391	U	0.45	U
Semivolatiles	Chloronaphthalene, 2-	N	mg/kg	0.00605	U	0.00688	U	0.00631	U	0.00711	U	0.00718	U	0.45	U
Semivolatiles	Chlorophenol, 2-	N	mg/kg	0.00468	U	0.00532	U	0.00488	U	0.0055	U	0.00555	U	0.45	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	mg/kg	0.0291	U	0.0331	U	0.0304	U	0.0342	U	0.0345	U	0.45	U
Semivolatiles	Chrysene	N	mg/kg	0.0151	U	0.0171	U	0.0157	U	0.0177	U	0.0179	U	0.45	U
Semivolatiles	Dibenz(a,h)anthracene	N	mg/kg	0.0859	U	0.0977	U	0.0897	U	0.101	U	0.102	U	0.45	U
Semivolatiles	Dibenzofuran	N	mg/kg	0.00639	U	0.00727	U	0.00667	U	0.00751	U	0.00758	U	0.45	U

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB07		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08	
			SAMPLE_NO	AP0124		AP0125		AP0126		AP0127		AP0128		AP0129	
			SAMPLE_DATE	16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Dichlorobenzene, 1,2-	N	mg/kg	0.00878	U	0.00999	U	0.00917	U	0.0103	U	0.0104	U		
Semivolatiles	Dichlorobenzene, 1,3-	N	mg/kg	0.0138	U	0.0157	U	0.0144	U	0.0162	U	0.0164	U		
Semivolatiles	Dichlorobenzene, 1,4-	N	mg/kg	0.00741	U	0.00843	U	0.00774	U	0.00872	U	0.0088	U		
Semivolatiles	Dichlorobenzidine, 3,3'-	N	mg/kg	0.0376	U	0.0428	U	0.0393	U	0.0443	U	0.0447	U	2.2	U
Semivolatiles	Dichlorophenol, 2,4-	N	mg/kg	0.0136	U	0.0154	U	0.0142	U	0.016	U	0.0161	U	0.45	U
Semivolatiles	Diethyl phthalate	N	mg/kg	0.0154	U	0.0175	U	0.0161	U	0.0181	U	0.0183	U	0.45	U
Semivolatiles	Dimethyl phthalate	N	mg/kg	0.0116	U	0.0132	U	0.0121	U	0.0137	U	0.0138	U	0.45	U
Semivolatiles	Dimethylphenol, 2,4-	N	mg/kg	0.01	U	0.0114	U	0.0105	U	0.0118	U	0.0119	U	0.45	U
Semivolatiles	Di-n-butyl phthalate	N	mg/kg	0.00821	U	0.00934	U	0.00857	U	0.00966	U	0.00975	U	0.45	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	mg/kg	0.0382	U	0.0435	U	0.0399	U	0.0449	U	0.0454	U	2.2	U
Semivolatiles	Dinitrophenol, 2,4-	N	mg/kg	0.0606	U	0.0689	U	0.0632	U	0.0712	U	0.0719	U	2.2	U
Semivolatiles	Dinitrotoluene, 2,4-	N	mg/kg	0.0133	U	0.0152	U	0.0139	U	0.0157	U	0.0158	U	0.45	U
Semivolatiles	Dinitrotoluene, 2,6-	N	mg/kg	0.00913	U	0.0104	U	0.00952	U	0.0107	U	0.0108	U	0.45	U
Semivolatiles	Di-n-octyl phthalate	N	mg/kg	0.0715	U	0.0814	U	0.0747	U	0.0841	U	0.0849	U	0.45	U
Semivolatiles	DIPHENYLAMINE	N	mg/kg	0.0376	U	0.0428	U	0.0393	U	0.0443	U	0.0447	U		
Semivolatiles	Fluoranthene	N	mg/kg	0.00821	U	0.00934	U	0.00857	U	0.00966	U	0.00975	U	0.45	U
Semivolatiles	Fluorene	N	mg/kg	0.0161	U	0.0183	U	0.0168	U	0.0189	U	0.0191	U	0.45	U
Semivolatiles	Hexachlorobenzene	N	mg/kg	0.0236	U	0.0269	U	0.0246	U	0.0278	U	0.028	U	0.45	U
Semivolatiles	Hexachlorobutadiene	N	mg/kg	0.036	U	0.041	U	0.0376	U	0.0424	U	0.0428	U	0.45	U
Semivolatiles	Hexachlorocyclopentadiene	N	mg/kg	0.0121	U	0.0138	U	0.0126	U	0.0142	U	0.0144	U	2.2	U
Semivolatiles	Hexachloroethane	N	mg/kg	0.0116	U	0.0132	U	0.0121	U	0.0137	U	0.0138	U	0.45	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	mg/kg	0.123	U	0.14	U	0.129	U	0.145	U	0.146	U	0.45	U
Semivolatiles	Isophorone	N	mg/kg	0.00456	U	0.00519	U	0.00476	U	0.00536	U	0.00542	U	0.45	U
Semivolatiles	Methylnaphthalene, 2-	N	mg/kg	0.0997	U	0.113	U	0.104	U	0.117	U	0.118	U	0.45	U
Semivolatiles	Methylphenol, 2-	N	mg/kg	0.0057	U	0.00649	U	0.00595	U	0.00671	U	0.00677	U	0.45	U
Semivolatiles	Methylphenol, 4-	N	mg/kg	0.0119	U	0.0135	U	0.0124	U	0.0139	U	0.0141	U	0.45	U
Semivolatiles	Naphthalene	N	mg/kg	0.00901	U	0.0103	U	0.00941	U	0.0106	U	0.0107	U	0.45	U
Semivolatiles	Nitroaniline, 2-	N	mg/kg	0.0164	U	0.0187	U	0.0171	U	0.0193	U	0.0195	U	2.2	U
Semivolatiles	Nitroaniline, 3-	N	mg/kg	0.0129	U	0.0147	U	0.0135	U	0.0152	U	0.0153	U	2.2	U
Semivolatiles	Nitroaniline, 4-	N	mg/kg	0.135	U	0.153	U	0.14	U	0.158	U	0.16	U	2.2	U
Semivolatiles	Nitrobenzene	N	mg/kg	0.0124	U	0.0141	U	0.013	U	0.0146	U	0.0148	U	0.45	U
Semivolatiles	Nitrophenol, 2-	N	mg/kg	0.0135	U	0.0153	U	0.014	U	0.0158	U	0.016	U	0.45	U
Semivolatiles	Nitrophenol, 4-	N	mg/kg	0.0308	U	0.035	U	0.0321	U	0.0362	U	0.0366	U	2.2	U
Semivolatiles	n-Nitrosodimethylamine	N	mg/kg	0.0114	U	0.013	U	0.0119	U	0.0134	U	0.0135	U		
Semivolatiles	n-Nitroso-di-n-propylamine	N	mg/kg	0.0136	U	0.0154	U	0.0142	U	0.016	U	0.0161	U	0.45	U
Semivolatiles	n-Nitrosodiphenylamine	N	mg/kg	0.00536	U	0.0061	U	0.0056	U	0.0063	U	0.00637	U	0.45	U
Semivolatiles	Pentachlorophenol	N	mg/kg	0.0341	U	0.0388	U	0.0356	U	0.0401	U	0.0405	U	0.45	U
Semivolatiles	Phenanthrene	N	mg/kg	0.0798	J	0.0105	U	0.00964	U	0.0109	U	0.011	U	0.45	U
Semivolatiles	Phenol	N	mg/kg	0.00456	U	0.00519	U	0.00476	U	0.00536	U	0.00542	U	0.45	U
Semivolatiles	Pyrene	N	mg/kg	0.0152	U	0.0173	U	0.0158	U	0.0178	U	0.018	U	0.45	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	mg/kg	0.00935	U	0.0106	U	0.00976	U	0.011	U	0.0111	U		
Semivolatiles	Trichlorophenol, 2,4,5-	N	mg/kg	0.0326	U	0.0371	U	0.0341	U	0.0384	U	0.0387	U	0.45	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	mg/kg	0.0257	U	0.0292	U	0.0268	U	0.0302	U	0.0305	U	0.45	U
Pesticides/PCBs	Aroclor 1016	N	mg/kg			0.00848	UJ	0.00794	U						

Appendix H

Chemical Analytical Data Summary
Soil
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SB07		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08		ASH PIT 2-SB08	
			SAMPLE_NO	AP0124		AP0125		AP0126		AP0127		AP0128		AP0129	
			SAMPLE_DATE	16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09		16-Jan-09	
			FK_DEPTH	8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1221	N	mg/kg			0.00848	UJ	0.00794	U						
Pesticides/PCBs	Aroclor 1232	N	mg/kg			0.00848	UJ	0.00794	U						
Pesticides/PCBs	Aroclor 1242	N	mg/kg			0.00848	UJ	0.00794	U						
Pesticides/PCBs	Aroclor 1248	N	mg/kg			0.00848	UJ	0.00794	U						
Pesticides/PCBs	Aroclor 1254	N	mg/kg			0.00848	UJ	0.00794	U						
Pesticides/PCBs	Aroclor 1260	N	mg/kg			0.00848	UJ	0.00794	U						
Metals - Unfiltered	Aluminum	N	mg/kg	7150	J	4070	J	5350	J	15100	J	14900	J	12100	
Metals - Unfiltered	Antimony	N	mg/kg	0.479		0.27	U	0.227	J	0.254	U	0.248	J	8.2	U
Metals - Unfiltered	Arsenic	N	mg/kg	10.9		12.8		12.6		6.16		6.61		7	
Metals - Unfiltered	Barium	N	mg/kg	20.8	J	73.2	J	56	J	81	J	83.7	J	85	
Metals - Unfiltered	Beryllium	N	mg/kg	6.31	J	16.9	J	8.48	J	8.51	J	8.11	J	0.69	U
Metals - Unfiltered	Cadmium	N	mg/kg	0.207	U	0.27	U	0.222	U	0.254	U	0.248	U	0.69	U
Metals - Unfiltered	Calcium	N	mg/kg	153000		1650		1860		44800		45500		45000	J
Metals - Unfiltered	Chromium	N	mg/kg	11		6.13		8.82		22.4		21.9		18.5	
Metals - Unfiltered	Cobalt	N	mg/kg	11	J	3.9	J	8.7	J	15.6	J	14.6	J	12.4	
Metals - Unfiltered	Copper	N	mg/kg	31.5	J	21.3	J	11	J	31.1	J	30.1	J	23.9	
Metals - Unfiltered	Iron	N	mg/kg	55100	J	72600	J	28000	J	26600	J	28500	J	23900	
Metals - Unfiltered	Lead	N	mg/kg	15.9		4.64		9.05		11.6		14.1		10.7	
Metals - Unfiltered	Magnesium	N	mg/kg	9490	J	312	J	1730	J	12200	J	11500	J	10100	
Metals - Unfiltered	Manganese	N	mg/kg	372		98.2		196		473		432		363	
Metals - Unfiltered	Mercury	N	mg/kg	0.00984	U	0.034		0.0151	J	0.0123	U	0.0127	U	0.14	U
Metals - Unfiltered	Nickel	N	mg/kg	32.5		10.5		22		39.7		38		32.8	
Metals - Unfiltered	Potassium	N	mg/kg	1060		477		371		1980		1990		2870	J
Metals - Unfiltered	Selenium	N	mg/kg	0.413	U	0.914	J	0.444	U	0.508	U	0.495	U	0.69	U
Metals - Unfiltered	Silver	N	mg/kg	0.207	U	0.27	U	0.222	U	0.254	U	0.248	U	1.4	U
Metals - Unfiltered	Sodium	N	mg/kg	116		36.4		27.4		145		134		686	U
Metals - Unfiltered	Thallium	N	mg/kg	0.316	J	0.308	J	0.222	U	0.254	U	0.248	U	1.4	U
Metals - Unfiltered	Vanadium	N	mg/kg	13.6		18.8		15.1		25.4		24.7		20.5	
Metals - Unfiltered	Zinc	N	mg/kg	52.7		41.4		58.9		76.6		73.4		61.3	
Water Quality Parameters	% Solids	N	Percent											72.9	
Water Quality Parameters	Total organic carbon	N	mg/kg												

Appendix H

Chemical Analytical Data Summary
Surface Water
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-SW01		AP2-SW02		AP2-SW03		AP2-SW03		AP2-SW03	
			SAMPLE_NO	AP2000		AP2001		AP2002		AP2003		AP2004	
			SAMPLE_DATE	24-May-09		24-May-09		24-May-09		24-May-09		24-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Dinitrobenzene, 1,3-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Dinitrotoluene, 2,4-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Dinitrotoluene, 2,6-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	HMX	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.5	U
Explosives	Nitrobenzene	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Nitrotoluene, 2-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Nitrotoluene, 3-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Nitrotoluene, 4-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	RDX	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.5	U
Explosives	Tetryl	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Trinitrobenzene, 1,3,5-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Trinitrotoluene, 2,4,6-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Semivolatiles	3-Methylphenol and 4-Methylphenol	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Acenaphthene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Acenaphthylene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	ACETOPHENONE	N	µg/L									10	U
Semivolatiles	Anthracene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Atrazine	N	µg/L									10	U
Semivolatiles	Benzaldehyde	N	µg/L									10	U
Semivolatiles	Benzo(a)anthracene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzo(a)pyrene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzo(b)fluoranthene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzo(ghi)perylene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzo(k)fluoranthene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzoic acid	N	µg/L	24	U	24	U	24	U	24	U		
Semivolatiles	Benzyl alcohol	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	BIBENZENE	N	µg/L									10	U
Semivolatiles	Bis(2-chloroethoxy)methane	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Bis(2-chloroethyl)ether	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	2	J	10	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Butyl benzyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Caprolactam	N	µg/L									10	U
Semivolatiles	Carbazole	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chloroaniline, 4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chloronaphthalene, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chlorophenol, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chrysene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U

Appendix H

Chemical Analytical Data Summary
Surface Water
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-SW01		AP2-SW02		AP2-SW03		AP2-SW03		AP2-SW03	
			SAMPLE_NO	AP2000		AP2001		AP2002		AP2003		AP2004	
			SAMPLE_DATE	24-May-09		24-May-09		24-May-09		24-May-09		24-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Dibenz(a,h)anthracene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dibenzofuran	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dichlorobenzene, 1,2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Dichlorobenzene, 1,3-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Dichlorobenzene, 1,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Dichlorobenzidine, 3,3'-	N	µg/L	9.6	U	9.6	U	9.6	U	9.6	U	50	U
Semivolatiles	Dichlorophenol, 2,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Diethyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dimethyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dimethylphenol, 2,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Di-n-butyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	µg/L	9.6	U	9.6	U	9.6	U	9.6	U	50	U
Semivolatiles	Dinitrophenol, 2,4-	N	µg/L	24	U	24	U	24	U	24	U	50	U
Semivolatiles	Dinitrotoluene, 2,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dinitrotoluene, 2,6-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Di-n-octyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Fluoranthene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Fluorene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Hexachlorobenzene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Hexachlorobutadiene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Hexachlorocyclopentadiene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Hexachloroethane	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Isophorone	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Methylnaphthalene, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Methylphenol, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Methylphenol, 4-	N	µg/L									10	U
Semivolatiles	Naphthalene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Nitroaniline, 2-	N	µg/L	9.6	U	9.6	U	9.6	U	9.6	U	50	U
Semivolatiles	Nitroaniline, 3-	N	µg/L	9.6	U	9.6	U	9.6	U	9.6	U	50	U
Semivolatiles	Nitroaniline, 4-	N	µg/L	9.6	U	9.6	U	9.6	U	9.6	U	50	U
Semivolatiles	Nitrobenzene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Nitrophenol, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Nitrophenol, 4-	N	µg/L	24	U	24	U	24	U	24	U	50	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	n-Nitrosodiphenylamine	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Pentachlorophenol	N	µg/L	24	U	24	U	24	U	24	U	10	U
Semivolatiles	Phenanthrene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Phenol	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Pyrene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Trichlorophenol, 2,4,5-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U

Appendix H

Chemical Analytical Data Summary
Surface Water
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-SW01		AP2-SW02		AP2-SW03		AP2-SW03		AP2-SW03	
			SAMPLE_NO	AP2000		AP2001		AP2002		AP2003		AP2004	
			SAMPLE_DATE	24-May-09		24-May-09		24-May-09		24-May-09		24-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1016	N	µg/L	0.48	U	0.48	U	0.48	U	0.48	U	1	U
Pesticides/PCBs	Aroclor 1221	N	µg/L	0.48	U	0.48	U	0.48	U	0.48	U	1	U
Pesticides/PCBs	Aroclor 1232	N	µg/L	0.48	U	0.48	U	0.48	U	0.48	U	1	U
Pesticides/PCBs	Aroclor 1242	N	µg/L	0.48	U	0.48	U	0.48	U	0.48	U	1	U
Pesticides/PCBs	Aroclor 1248	N	µg/L	0.48	U	0.48	U	0.48	U	0.48	U	1	U
Pesticides/PCBs	Aroclor 1254	N	µg/L	0.48	U	0.48	U	0.48	U	0.48	U	1	U
Pesticides/PCBs	Aroclor 1260	N	µg/L	0.48	U	0.48	U	0.48	U	0.48	U	1	U
Metals - Unfiltered	Aluminum	N	µg/L	720		531		357		377		368	
Metals - Unfiltered	Antimony	N	µg/L	6	U	6	U	6	U	6	U	60	U
Metals - Unfiltered	Arsenic	N	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Unfiltered	Barium	N	µg/L	48.4	J	46.8	J	44.7	J	45.3	J	200	U
Metals - Unfiltered	Beryllium	N	µg/L	4	U	4	U	4	U	4	U	5	U
Metals - Unfiltered	Cadmium	N	µg/L	5	U	5	U	5	U	5	U	5	U
Metals - Unfiltered	Calcium	N	µg/L	79100		78800		76400		77400		80900	
Metals - Unfiltered	Chromium	N	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Unfiltered	Cobalt	N	µg/L	50	U	50	U	50	U	50	U	50	U
Metals - Unfiltered	Copper	N	µg/L	25	U	25	U	25	U	25	U	25	U
Metals - Unfiltered	Iron	N	µg/L	1060		700		451		455		546	
Metals - Unfiltered	Lead	N	µg/L	5	U	5	U	2.9	J	5	U	3	U
Metals - Unfiltered	Magnesium	N	µg/L	21400		21200		20500		20800		22300	J
Metals - Unfiltered	Manganese	N	µg/L	102		63		52.6		52.9		53.4	
Metals - Unfiltered	Mercury	N	µg/L	1	U	1	U	1	U	1	U	0.2	U
Metals - Unfiltered	Nickel	N	µg/L	40	U	40	U	40	U	40	U	40	U
Metals - Unfiltered	Potassium	N	µg/L	3290	J	3340	J	3150	J	3190	J	5000	U
Metals - Unfiltered	Selenium	N	µg/L	10	U	10	U	10	U	10	U	5	U
Metals - Unfiltered	Silver	N	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Unfiltered	Sodium	N	µg/L	32800		32700		32100		32800		40000	
Metals - Unfiltered	Thallium	N	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Unfiltered	Vanadium	N	µg/L	2.6	J	1.8	J	1.7	J	1.6	J	50	U
Metals - Unfiltered	Zinc	N	µg/L	12.1	J	12.4	J	20	U	8.1	J	20	U
Water Quality Parameters	HARDNESS (as CaCO3)	N	ppm	286									

Appendix H

Chemical Analytical Data Summary
Surface Water
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-SW04		AP2-SW05	
			SAMPLE_NO	AP2005		AP2006	
			SAMPLE_DATE	25-May-09		25-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.19	UJ	0.19	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.19	U	0.19	U
Explosives	Dinitrobenzene, 1,3-	N	µg/L	0.19	U	0.19	U
Explosives	Dinitrotoluene, 2,4-	N	µg/L	0.19	U	0.19	U
Explosives	Dinitrotoluene, 2,6-	N	µg/L	0.19	U	0.19	U
Explosives	HMX	N	µg/L	0.19	U	0.19	U
Explosives	Nitrobenzene	N	µg/L	0.19	U	0.19	U
Explosives	Nitrotoluene, 2-	N	µg/L	0.19	U	0.19	U
Explosives	Nitrotoluene, 3-	N	µg/L	0.19	U	0.19	U
Explosives	Nitrotoluene, 4-	N	µg/L	0.19	U	0.19	U
Explosives	RDX	N	µg/L	0.19	U	0.19	U
Explosives	Tetryl	N	µg/L	0.19	U	0.19	U
Explosives	Trinitrobenzene, 1,3,5-	N	µg/L	0.19	U	0.19	U
Explosives	Trinitrotoluene, 2,4,6-	N	µg/L	0.19	U	0.19	U
Semivolatiles	3-Methylphenol and 4-Methylphenol	N	µg/L	4.8	U	4.8	U
Semivolatiles	Acenaphthene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Acenaphthylene	N	µg/L	4.8	U	4.8	U
Semivolatiles	ACETOPHENONE	N	µg/L				
Semivolatiles	Anthracene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Atrazine	N	µg/L				
Semivolatiles	Benzaldehyde	N	µg/L				
Semivolatiles	Benzo(a)anthracene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Benzo(a)pyrene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Benzo(b)fluoranthene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Benzo(ghi)perylene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Benzo(k)fluoranthene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Benzoic acid	N	µg/L	24	U	24	U
Semivolatiles	Benzyl alcohol	N	µg/L	4.8	U	4.8	U
Semivolatiles	BIBENZENE	N	µg/L				
Semivolatiles	Bis(2-chloroethoxy)methane	N	µg/L	4.8	U	4.8	U
Semivolatiles	Bis(2-chloroethyl)ether	N	µg/L	4.8	U	4.8	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	µg/L	4.8	U	4.8	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	µg/L	4.8	U	4.8	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Butyl benzyl phthalate	N	µg/L	4.8	U	4.8	U
Semivolatiles	Caprolactam	N	µg/L				
Semivolatiles	Carbazole	N	µg/L	4.8	U	4.8	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Chloroaniline, 4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Chloronaphthalene, 2-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Chlorophenol, 2-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Chrysene	N	µg/L	4.8	U	4.8	U

Appendix H

Chemical Analytical Data Summary
Surface Water
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-SW04		AP2-SW05	
			SAMPLE_NO	AP2005		AP2006	
			SAMPLE_DATE	25-May-09		25-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual
Semivolatiles	Dibenz(a,h)anthracene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dibenzofuran	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dichlorobenzene, 1,2-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dichlorobenzene, 1,3-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dichlorobenzene, 1,4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	µg/L	9.6	U	9.6	U
Semivolatiles	Dichlorophenol, 2,4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Diethyl phthalate	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dimethyl phthalate	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dimethylphenol, 2,4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Di-n-butyl phthalate	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	µg/L	9.6	U	9.6	U
Semivolatiles	Dinitrophenol, 2,4-	N	µg/L	24	U	24	U
Semivolatiles	Dinitrotoluene, 2,4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Dinitrotoluene, 2,6-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Di-n-octyl phthalate	N	µg/L	4.8	U	4.8	U
Semivolatiles	Fluoranthene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Fluorene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Hexachlorobenzene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Hexachlorobutadiene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Hexachlorocyclopentadiene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Hexachloroethane	N	µg/L	4.8	U	4.8	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Isophorone	N	µg/L	4.8	U	4.8	U
Semivolatiles	Methylnaphthalene, 2-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Methylphenol, 2-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Methylphenol, 4-	N	µg/L				
Semivolatiles	Naphthalene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Nitroaniline, 2-	N	µg/L	9.6	U	9.6	U
Semivolatiles	Nitroaniline, 3-	N	µg/L	9.6	U	9.6	U
Semivolatiles	Nitroaniline, 4-	N	µg/L	9.6	U	9.6	U
Semivolatiles	Nitrobenzene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Nitrophenol, 2-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Nitrophenol, 4-	N	µg/L	24	U	24	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	µg/L	4.8	U	4.8	U
Semivolatiles	n-Nitrosodiphenylamine	N	µg/L	4.8	U	4.8	U
Semivolatiles	Pentachlorophenol	N	µg/L	24	U	24	U
Semivolatiles	Phenanthrene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Phenol	N	µg/L	4.8	U	4.8	U
Semivolatiles	Pyrene	N	µg/L	4.8	U	4.8	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	µg/L	4.8	U	4.8	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	µg/L	4.8	U	4.8	U

Appendix H

Chemical Analytical Data Summary
Surface Water
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-SW04		AP2-SW05	
			SAMPLE_NO	AP2005		AP2006	
			SAMPLE_DATE	25-May-09		25-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1016	N	µg/L	0.48	U	0.48	U
Pesticides/PCBs	Aroclor 1221	N	µg/L	0.48	U	0.48	U
Pesticides/PCBs	Aroclor 1232	N	µg/L	0.48	U	0.48	U
Pesticides/PCBs	Aroclor 1242	N	µg/L	0.48	U	0.48	U
Pesticides/PCBs	Aroclor 1248	N	µg/L	0.48	U	0.48	U
Pesticides/PCBs	Aroclor 1254	N	µg/L	0.48	U	0.48	U
Pesticides/PCBs	Aroclor 1260	N	µg/L	0.48	U	0.48	U
Metals - Unfiltered	Aluminum	N	µg/L	1030	J	359	
Metals - Unfiltered	Antimony	N	µg/L	6	U	6	U
Metals - Unfiltered	Arsenic	N	µg/L	10	U	10	U
Metals - Unfiltered	Barium	N	µg/L	50.9	J	43.9	
Metals - Unfiltered	Beryllium	N	µg/L	4	U	4	U
Metals - Unfiltered	Cadmium	N	µg/L	5	U	5	U
Metals - Unfiltered	Calcium	N	µg/L	80700		75900	
Metals - Unfiltered	Chromium	N	µg/L	10	U	10	U
Metals - Unfiltered	Cobalt	N	µg/L	1.2	J	50	U
Metals - Unfiltered	Copper	N	µg/L	25	U	25	U
Metals - Unfiltered	Iron	N	µg/L	1020		376	
Metals - Unfiltered	Lead	N	µg/L	2.9	J	5	U
Metals - Unfiltered	Magnesium	N	µg/L	20700		19800	
Metals - Unfiltered	Manganese	N	µg/L	83.1		53.3	
Metals - Unfiltered	Mercury	N	µg/L	1	U	1	U
Metals - Unfiltered	Nickel	N	µg/L	6.2	J	40	U
Metals - Unfiltered	Potassium	N	µg/L	4400	J	2900	
Metals - Unfiltered	Selenium	N	µg/L	10	U	10	U
Metals - Unfiltered	Silver	N	µg/L	10	U	10	U
Metals - Unfiltered	Sodium	N	µg/L	34800		30300	
Metals - Unfiltered	Thallium	N	µg/L	10	U	10	U
Metals - Unfiltered	Vanadium	N	µg/L	3.1	J	2	
Metals - Unfiltered	Zinc	N	µg/L	10.6	J	9.9	
Water Quality Parameters	HARDNESS (as CaCO3)	N	ppm				

Appendix H

Chemical Analytical Data Summary
Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SD01		ASH PIT 2-SD02		ASH PIT 2-SD03		ASH PIT 2-SD04		ASH PIT 2-SD04	
			SAMPLE_NO	AP1000		AP1001		AP1002		AP1003		AP1004	
			SAMPLE_DATE	24-May-09		24-May-09		24-May-09		25-May-09		25-May-09	
			FK_DEPTH	0 - _5 Ft		0 - _5 Ft		0 - _5 Ft		0 - _5 Ft		0 - _5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		FD	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	mg/kg	0.17	U	0.17	U	0.17	UJ	0.16	U	0.15	U
Explosives	Dinitrobenzene, 1,3-	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Dinitrotoluene, 2,4-	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Dinitrotoluene, 2,6-	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	HMX	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Nitrobenzene	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Nitrotoluene, 2-	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Nitrotoluene, 3-	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Nitrotoluene, 4-	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	RDX	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Tetryl	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Trinitrobenzene, 1,3,5-	N	mg/kg	0.17	U	0.17	U	0.17	U	0.16	U	0.15	U
Explosives	Trinitrotoluene, 2,4,6-	N	mg/kg	0.17	U	0.17	U	0.0647	J	0.16	U	0.15	U
Semivolatiles	3-Methylphenol and 4-Methylphenol	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Acenaphthene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Acenaphthylene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	ACETOPHENONE	N	mg/kg										
Semivolatiles	Anthracene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Atrazine	N	mg/kg										
Semivolatiles	Benzaldehyde	N	mg/kg										
Semivolatiles	Benzo(a)anthracene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Benzo(a)pyrene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Benzo(b)fluoranthene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Benzo(ghi)perylene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Benzo(k)fluoranthene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Benzoic acid	N	mg/kg	1.1	U	1.1	U	1	U	1	U	1	U
Semivolatiles	Benzyl alcohol	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	BIBENZENE	N	mg/kg										
Semivolatiles	Bis(2-chloroethoxy)methane	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Bis(2-chloroethyl)ether	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Butyl benzyl phthalate	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Caprolactam	N	mg/kg										
Semivolatiles	Carbazole	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Chloroaniline, 4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Chloronaphthalene, 2-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Chlorophenol, 2-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Chrysene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U

Appendix H

Chemical Analytical Data Summary
Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SD01		ASH PIT 2-SD02		ASH PIT 2-SD03		ASH PIT 2-SD04		ASH PIT 2-SD04	
			SAMPLE_NO	AP1000		AP1001		AP1002		AP1003		AP1004	
			SAMPLE_DATE	24-May-09		24-May-09		24-May-09		25-May-09		25-May-09	
			FK_DEPTH	0 - _5 Ft		0 - _5 Ft		0 - _5 Ft		0 - _5 Ft		0 - _5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		FD	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Dibenz(a,h)anthracene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Dibenzofuran	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Dichlorobenzene, 1,2-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Dichlorobenzene, 1,3-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Dichlorobenzene, 1,4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Dichlorophenol, 2,4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Diethyl phthalate	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Dimethyl phthalate	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Dimethylphenol, 2,4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Di-n-butyl phthalate	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Dinitrophenol, 2,4-	N	mg/kg	1.1	U	1.1	U	1	UJ	1	UJ	1	UJ
Semivolatiles	Dinitrotoluene, 2,4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Dinitrotoluene, 2,6-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Di-n-octyl phthalate	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Fluoranthene	N	mg/kg	0.22	U	0.21	U	0.0525	J	0.2	U	0.21	U
Semivolatiles	Fluorene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Hexachlorobenzene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Hexachlorobutadiene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Hexachlorocyclopentadiene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Hexachloroethane	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Isophorone	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Methylnaphthalene, 2-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Methylphenol, 2-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Methylphenol, 4-	N	mg/kg										
Semivolatiles	Naphthalene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Nitroaniline, 2-	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Nitroaniline, 3-	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Nitroaniline, 4-	N	mg/kg	0.44	U	0.43	U	0.41	U	0.41	U	0.42	U
Semivolatiles	Nitrobenzene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Nitrophenol, 2-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Nitrophenol, 4-	N	mg/kg	1.1	U	1.1	U	1	U	1	U	1	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	n-Nitrosodiphenylamine	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Pentachlorophenol	N	mg/kg	1.1	U	1.1	U	1	U	1	U	1	U
Semivolatiles	Phenanthrene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Phenol	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Pyrene	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	mg/kg	0.22	U	0.21	U	0.21	U	0.2	U	0.21	U

Appendix H

Chemical Analytical Data Summary
Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SD01		ASH PIT 2-SD02		ASH PIT 2-SD03		ASH PIT 2-SD04		ASH PIT 2-SD04	
			SAMPLE_NO	AP1000		AP1001		AP1002		AP1003		AP1004	
			SAMPLE_DATE	24-May-09		24-May-09		24-May-09		25-May-09		25-May-09	
			FK_DEPTH	0 - _5 Ft		0 - _5 Ft		0 - _5 Ft		0 - _5 Ft		0 - _5 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		REG		FD	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1016	N	mg/kg	0.023	U	0.021	U	0.021	U	0.02	U	0.021	U
Pesticides/PCBs	Aroclor 1221	N	mg/kg	0.023	U	0.021	U	0.021	U	0.02	U	0.021	U
Pesticides/PCBs	Aroclor 1232	N	mg/kg	0.023	U	0.021	U	0.021	U	0.02	U	0.021	U
Pesticides/PCBs	Aroclor 1242	N	mg/kg	0.023	U	0.021	U	0.021	U	0.02	U	0.021	U
Pesticides/PCBs	Aroclor 1248	N	mg/kg	0.023	U	0.021	U	0.021	U	0.02	U	0.021	U
Pesticides/PCBs	Aroclor 1254	N	mg/kg	0.023	U	0.021	U	0.021	U	0.02	U	0.021	U
Pesticides/PCBs	Aroclor 1260	N	mg/kg	0.023	U	0.021	U	0.021	U	0.02	U	0.021	U
Metals - Unfiltered	Aluminum	N	mg/kg	3640		6310		7220		8000		6840	
Metals - Unfiltered	Antimony	N	mg/kg	4	U	3.9	U	7.2	UJ	3.5	U	3.6	U
Metals - Unfiltered	Arsenic	N	mg/kg	4.1		5.1		10.1	J	9.3		7.8	
Metals - Unfiltered	Barium	N	mg/kg	22.8		43.5		67.1	J	59.8		50	
Metals - Unfiltered	Beryllium	N	mg/kg	0.36		0.49		0.52		0.59		0.53	
Metals - Unfiltered	Cadmium	N	mg/kg	0.24	J	0.37		0.48	U	0.6		0.53	
Metals - Unfiltered	Calcium	N	mg/kg	7660		26000		12900	J	28700		25200	
Metals - Unfiltered	Chromium	N	mg/kg	6.4		10.5		8.6	J	12.8		10.5	
Metals - Unfiltered	Cobalt	N	mg/kg	7.4		7.4		6.2	J	14.1		9.8	
Metals - Unfiltered	Copper	N	mg/kg	9.6		14.2		17.2		23.7		20.4	
Metals - Unfiltered	Iron	N	mg/kg	10400		14000		39100	J	19400		17700	
Metals - Unfiltered	Lead	N	mg/kg	7.9		7.9		10.6	J	15.2	J	9.1	J
Metals - Unfiltered	Magnesium	N	mg/kg	1950		7440		7470	J	6110		6040	
Metals - Unfiltered	Manganese	N	mg/kg	127		379		151	J	668		547	
Metals - Unfiltered	Mercury	N	mg/kg	0.11	U	0.018	J	0.016	J	0.015	J	0.019	J
Metals - Unfiltered	Nickel	N	mg/kg	15.7		16.1		16	J	27.6		22.6	
Metals - Unfiltered	Potassium	N	mg/kg	498	J	1300		1060	J	1850		1470	
Metals - Unfiltered	Selenium	N	mg/kg	1	J	0.39	J	0.92	J	0.83	J	0.48	J
Metals - Unfiltered	Silver	N	mg/kg	0.66	U	0.64	U	0.083	J	0.59	U	0.6	U
Metals - Unfiltered	Sodium	N	mg/kg	85.2	J	157	J	54.8	J	170	J	157	J
Metals - Unfiltered	Thallium	N	mg/kg	0.66	U	0.64	U	6	U	3	U	3	U
Metals - Unfiltered	Vanadium	N	mg/kg	9.4		15.2		13.6	J	14.9		12.5	
Metals - Unfiltered	Zinc	N	mg/kg	34.7		38.9		27	J	59.7		54.9	
Water Quality Parameters	% Solids	N	Percent	74.2		77.9		79.9		80.5		79.7	
Water Quality Parameters	Total organic carbon	N	mg/kg	0.57									

Appendix H

Chemical Analytical Data Summary
Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SD04		ASH PIT 2-SD05	
			SAMPLE_NO	AP1005		AP1006	
			SAMPLE_DATE	25-May-09		25-May-09	
			FK_DEPTH	0 - _5 Ft		0 - _5 Ft	
			SAMPLE_PURPOSE	FS		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	mg/kg	0.2	U	0.19	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	mg/kg	0.2	U	0.19	U
Explosives	Dinitrobenzene, 1,3-	N	mg/kg	0.2	U	0.19	U
Explosives	Dinitrotoluene, 2,4-	N	mg/kg	0.2	U	0.19	U
Explosives	Dinitrotoluene, 2,6-	N	mg/kg	0.2	U	0.19	U
Explosives	HMX	N	mg/kg	0.2	U	0.19	U
Explosives	Nitrobenzene	N	mg/kg	0.2	U	0.19	U
Explosives	Nitrotoluene, 2-	N	mg/kg	0.2	U	0.19	U
Explosives	Nitrotoluene, 3-	N	mg/kg	0.2	U	0.19	U
Explosives	Nitrotoluene, 4-	N	mg/kg	0.2	U	0.19	U
Explosives	RDX	N	mg/kg	0.2	U	0.19	U
Explosives	Tetryl	N	mg/kg	0.3	U	0.19	U
Explosives	Trinitrobenzene, 1,3,5-	N	mg/kg	0.2	U	0.19	U
Explosives	Trinitrotoluene, 2,4,6-	N	mg/kg	0.2	U	0.19	U
Semivolatiles	3-Methylphenol and 4-Methylphenol	N	mg/kg			0.26	U
Semivolatiles	Acenaphthene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Acenaphthylene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	ACETOPHENONE	N	mg/kg	0.083	U		
Semivolatiles	Anthracene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Atrazine	N	mg/kg	0.41	U		
Semivolatiles	Benzaldehyde	N	mg/kg	0.41	U		
Semivolatiles	Benzo(a)anthracene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Benzo(a)pyrene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Benzo(b)fluoranthene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Benzo(ghi)perylene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Benzo(k)fluoranthene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Benzoic acid	N	mg/kg			1.3	U
Semivolatiles	Benzyl alcohol	N	mg/kg			0.26	U
Semivolatiles	BIBENZENE	N	mg/kg	0.41	U		
Semivolatiles	Bis(2-chloroethoxy)methane	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Bis(2-chloroethyl)ether	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	mg/kg	0.41	U	0.51	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Butyl benzyl phthalate	N	mg/kg	0.41	U	0.51	U
Semivolatiles	Caprolactam	N	mg/kg	0.41	U		
Semivolatiles	Carbazole	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Chloroaniline, 4-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Chloronaphthalene, 2-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Chlorophenol, 2-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Chrysene	N	mg/kg	0.41	U	0.26	U

Appendix H

Chemical Analytical Data Summary
Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SD04		ASH PIT 2-SD05	
			SAMPLE_NO	AP1005		AP1006	
			SAMPLE_DATE	25-May-09		25-May-09	
			FK_DEPTH	0 - _5 Ft		0 - _5 Ft	
			SAMPLE_PURPOSE	FS		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual
Semivolatiles	Dibenz(a,h)anthracene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Dibenzofuran	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Dichlorobenzene, 1,2-	N	mg/kg			0.26	U
Semivolatiles	Dichlorobenzene, 1,3-	N	mg/kg			0.26	U
Semivolatiles	Dichlorobenzene, 1,4-	N	mg/kg			0.26	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	mg/kg	2	U	0.51	U
Semivolatiles	Dichlorophenol, 2,4-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Diethyl phthalate	N	mg/kg	0.41	U	0.51	U
Semivolatiles	Dimethyl phthalate	N	mg/kg	0.41	U	0.51	U
Semivolatiles	Dimethylphenol, 2,4-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Di-n-butyl phthalate	N	mg/kg	0.41	U	0.51	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	mg/kg	2	U	0.51	U
Semivolatiles	Dinitrophenol, 2,4-	N	mg/kg	2	U	1.3	UJ
Semivolatiles	Dinitrotoluene, 2,4-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Dinitrotoluene, 2,6-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Di-n-octyl phthalate	N	mg/kg	0.41	U	0.51	U
Semivolatiles	Fluoranthene	N	mg/kg	0.41	U	0.0547	J
Semivolatiles	Fluorene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Hexachlorobenzene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Hexachlorobutadiene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Hexachlorocyclopentadiene	N	mg/kg	2	U	0.26	U
Semivolatiles	Hexachloroethane	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Isophorone	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Methylnaphthalene, 2-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Methylphenol, 2-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Methylphenol, 4-	N	mg/kg	0.41	U		
Semivolatiles	Naphthalene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Nitroaniline, 2-	N	mg/kg	2	U	0.51	U
Semivolatiles	Nitroaniline, 3-	N	mg/kg	2	U	0.51	U
Semivolatiles	Nitroaniline, 4-	N	mg/kg	2	U	0.51	U
Semivolatiles	Nitrobenzene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Nitrophenol, 2-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Nitrophenol, 4-	N	mg/kg	2	U	1.3	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	mg/kg	0.41	U	0.26	U
Semivolatiles	n-Nitrosodiphenylamine	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Pentachlorophenol	N	mg/kg	0.41	U	1.3	U
Semivolatiles	Phenanthrene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Phenol	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Pyrene	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	mg/kg			0.26	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	mg/kg	0.41	U	0.26	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	mg/kg	0.41	U	0.26	U

Appendix H

Chemical Analytical Data Summary
Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-SD04		ASH PIT 2-SD05	
			SAMPLE_NO	AP1005		AP1006	
			SAMPLE_DATE	25-May-09		25-May-09	
			FK_DEPTH	0 - _5 Ft		0 - _5 Ft	
			SAMPLE_PURPOSE	FS		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual
Pesticides/PCBs	Aroclor 1016	N	mg/kg	0.041	U	0.025	U
Pesticides/PCBs	Aroclor 1221	N	mg/kg	0.041	U	0.025	U
Pesticides/PCBs	Aroclor 1232	N	mg/kg	0.041	U	0.025	U
Pesticides/PCBs	Aroclor 1242	N	mg/kg	0.041	U	0.025	U
Pesticides/PCBs	Aroclor 1248	N	mg/kg	0.041	U	0.025	U
Pesticides/PCBs	Aroclor 1254	N	mg/kg	0.041	U	0.025	U
Pesticides/PCBs	Aroclor 1260	N	mg/kg	0.041	U	0.025	U
Metals - Unfiltered	Aluminum	N	mg/kg	6780		4690	
Metals - Unfiltered	Antimony	N	mg/kg	7.5	UJ	4.4	U
Metals - Unfiltered	Arsenic	N	mg/kg	8.8		3.9	
Metals - Unfiltered	Barium	N	mg/kg	53		43.1	
Metals - Unfiltered	Beryllium	N	mg/kg	0.62	U	0.42	
Metals - Unfiltered	Cadmium	N	mg/kg	0.62	U	0.26	J
Metals - Unfiltered	Calcium	N	mg/kg	37600		9790	
Metals - Unfiltered	Chromium	N	mg/kg	11.6		7.7	
Metals - Unfiltered	Cobalt	N	mg/kg	9.9		8	
Metals - Unfiltered	Copper	N	mg/kg	22.8		12.2	
Metals - Unfiltered	Iron	N	mg/kg	20700		10400	
Metals - Unfiltered	Lead	N	mg/kg	11		9.7	
Metals - Unfiltered	Magnesium	N	mg/kg	8170		2450	
Metals - Unfiltered	Manganese	N	mg/kg	413		187	
Metals - Unfiltered	Mercury	N	mg/kg	0.12	U	0.025	J
Metals - Unfiltered	Nickel	N	mg/kg	27.1		17.8	
Metals - Unfiltered	Potassium	N	mg/kg	1420		628	J
Metals - Unfiltered	Selenium	N	mg/kg	0.62	U	0.96	J
Metals - Unfiltered	Silver	N	mg/kg	1.2	U	0.73	U
Metals - Unfiltered	Sodium	N	mg/kg	625	U	123	J
Metals - Unfiltered	Thallium	N	mg/kg	1.2	U	0.73	U
Metals - Unfiltered	Vanadium	N	mg/kg	13.3		11.1	
Metals - Unfiltered	Zinc	N	mg/kg	62.5		45.1	
Water Quality Parameters	% Solids	N	Percent	80		65.4	
Water Quality Parameters	Total organic carbon	N	mg/kg				

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-002		AP2-BEDGW-002		AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003	
			SAMPLE_NO	AP3063		AP3079		AP3064		AP3065		AP3066	
			SAMPLE_DATE	24-May-09		17-Nov-09		23-May-09		23-May-09		23-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Dinitrobenzene, 1,3-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Dinitrotoluene, 2,4-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Dinitrotoluene, 2,6-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	HMX	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.5	U
Explosives	Nitrobenzene	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Nitrotoluene, 2-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Nitrotoluene, 3-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	Nitrotoluene, 4-	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.2	U
Explosives	RDX	N	µg/L	0.19	U	0.19	U	0.19	U	0.19	U	0.5	U
Explosives	Tetryl	N	µg/L	0.19	U	0.19	R	0.19	UJ	0.19	U	0.41	
Explosives	Trinitrobenzene, 1,3,5-	N	µg/L	0.19	U	0.19	U	0.19	UJ	0.19	U	0.2	U
Explosives	Trinitrotoluene, 2,4,6-	N	µg/L	0.19	U	0.19	U	0.19	UJ	0.19	U	0.2	U
Volatiles	Acetone	N	µg/L	25	R	50.6	J	25	R	25	R	50	UJ
Volatiles	Benzene	N	µg/L	8.5		9.4	J	94.1		91.3		100	
Volatiles	Bromodichloromethane	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Bromoform	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Bromomethane	N	µg/L	2	U	2	UJ	2	U	2	U	5	U
Volatiles	Butanone, 2-	N	µg/L	7.4		2.4	J	4.3	J	4.9	J	50	R
Volatiles	Carbon disulfide	N	µg/L	2	U	2	U	2	U	2	U	5.2	
Volatiles	Carbon tetrachloride	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Chlorobenzene	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Chloroethane	N	µg/L	2	U	2	U	2	U	2	U	5	R
Volatiles	Chloroform	N	µg/L	1	U	5.6	B	1	U	1	U	5	U
Volatiles	Chloromethane	N	µg/L	2	U	7.7	J	2	U	2	U	5	UJ
Volatiles	Cyclohexane	N	µg/L									74	
Volatiles	Dibromo-3-chloropropane, 1,2-	N	µg/L									10	R
Volatiles	Dibromochloromethane	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Dibromoethane, 1,2-	N	µg/L									5	U
Volatiles	Dichlorobenzene, 1,2-	N	µg/L									5	U
Volatiles	Dichlorobenzene, 1,3-	N	µg/L									5	U
Volatiles	Dichlorobenzene, 1,4-	N	µg/L									5	U
Volatiles	Dichlorodifluoromethane	N	µg/L									5	U
Volatiles	Dichloroethane, 1,1-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Dichloroethane, 1,2-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Dichloroethene, 1,1-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Dichloroethene, cis-1,2-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Dichloroethene, trans-1,2-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Dichloropropane, 1,2-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Dichloropropene, cis-1,3-	N	µg/L	1	U	1	U	1	UJ	1	U	5	U
Volatiles	Dichloropropene, trans-1,3-	N	µg/L	1	U	1	UJ	1	UJ	1	U	5	U
Volatiles	Ethylbenzene	N	µg/L	9.6		9.7	J	17.7		17.2		21	

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-002		AP2-BEDGW-002		AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003	
			SAMPLE_NO	AP3063		AP3079		AP3064		AP3065		AP3066	
			SAMPLE_DATE	24-May-09		17-Nov-09		23-May-09		23-May-09		23-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Volatiles	Hexanone, 2-	N	µg/L	10	U	10	U	10	U	10	U	50	U
Volatiles	Isopropylbenzene	N	µg/L									5.8	
Volatiles	METHYL ACETATE	N	µg/L									50	U
Volatiles	Methyl Tertiary Butyl Ether	N	µg/L									25	U
Volatiles	Methyl-2-pentanone, 4-	N	µg/L	5	U	5	U	5	U	5	U	50	UJ
Volatiles	Methylcyclohexane	N	µg/L									29	
Volatiles	Methylene chloride	N	µg/L	5	U	5	U	5	U	5	U	5	U
Volatiles	Styrene	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Tetrachloroethane, 1,1,2,2-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Tetrachloroethene	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Toluene	N	µg/L	5.3		4.8	J	41.3		39.6		54	
Volatiles	Trichlorobenzene, 1,2,4-	N	µg/L									5	U
Volatiles	Trichloroethane, 1,1,1-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Trichloroethane, 1,1,2-	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Trichloroethene	N	µg/L	1	U	1	U	1	U	1	U	5	U
Volatiles	Trichlorofluoromethane	N	µg/L									5	U
Volatiles	Trichlorotrifluoroethane	N	µg/L									5	U
Volatiles	Vinyl chloride	N	µg/L	1	U	1	UJ	1	U	1	U	5	U
Volatiles	Xylenes, total	N	µg/L	63.2		55.7	J	193		185		260	
Semivolatiles	3-Methylphenol and 4-Methylphenol	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Acenaphthene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Acenaphthylene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	ACETOPHENONE	N	µg/L									10	U
Semivolatiles	Anthracene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Atrazine	N	µg/L									10	U
Semivolatiles	Benzaldehyde	N	µg/L									10	U
Semivolatiles	Benzo(a)anthracene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzo(a)pyrene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzo(b)fluoranthene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzo(ghi)perylene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzo(k)fluoranthene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Benzoic acid	N	µg/L	24	U	24	U	24	U	24	U		
Semivolatiles	Benzyl alcohol	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	BIBENZENE	N	µg/L									10	U
Semivolatiles	Bis(2-chloroethoxy)methane	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Bis(2-chloroethyl)ether	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Butyl benzyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Caprolactam	N	µg/L									10	U
Semivolatiles	Carbazole	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-002		AP2-BEDGW-002		AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003	
			SAMPLE_NO	AP3063		AP3079		AP3064		AP3065		AP3066	
			SAMPLE_DATE	24-May-09		17-Nov-09		23-May-09		23-May-09		23-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Chloroaniline, 4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chloronaphthalene, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chlorophenol, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Chrysene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dibenz(a,h)anthracene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dibenzofuran	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dichlorobenzene, 1,2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Dichlorobenzene, 1,3-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Dichlorobenzene, 1,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Dichlorobenzidine, 3,3'-	N	µg/L	9.6	U	9.5	U	9.6	U	9.6	U	50	U
Semivolatiles	Dichlorophenol, 2,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Diethyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dimethyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dimethylphenol, 2,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Di-n-butyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	µg/L	9.6	U	9.5	U	9.6	U	9.6	U	50	U
Semivolatiles	Dinitrophenol, 2,4-	N	µg/L	24	U	24	U	24	U	24	U	50	U
Semivolatiles	Dinitrotoluene, 2,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Dinitrotoluene, 2,6-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Di-n-octyl phthalate	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	DIPHENYLAMINE	N	µg/L										
Semivolatiles	Fluoranthene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Fluorene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Hexachlorobenzene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Hexachlorobutadiene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Hexachlorocyclopentadiene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Hexachloroethane	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Isophorone	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Methylnaphthalene, 2-	N	µg/L	2.8	J	2.8	J	1.9	J	1.3	J	10	U
Semivolatiles	Methylphenol, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Methylphenol, 4-	N	µg/L									10	U
Semivolatiles	Naphthalene	N	µg/L	2	J	1.9	J	2.9	J	1.9	J	10	U
Semivolatiles	Nitroaniline, 2-	N	µg/L	9.6	U	9.5	U	9.6	U	9.6	U	50	U
Semivolatiles	Nitroaniline, 3-	N	µg/L	9.6	U	9.5	U	9.6	U	9.6	U	50	U
Semivolatiles	Nitroaniline, 4-	N	µg/L	9.6	U	9.5	U	9.6	U	9.6	U	50	U
Semivolatiles	Nitrobenzene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Nitrophenol, 2-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Nitrophenol, 4-	N	µg/L	24	U	24	U	24	U	24	U	50	U
Semivolatiles	n-Nitrosodimethylamine	N	µg/L										
Semivolatiles	n-Nitroso-di-n-propylamine	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	n-Nitrosodiphenylamine	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-002		AP2-BEDGW-002		AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003	
			SAMPLE_NO	AP3063		AP3079		AP3064		AP3065		AP3066	
			SAMPLE_DATE	24-May-09		17-Nov-09		23-May-09		23-May-09		23-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Pentachlorophenol	N	µg/L	24	U	24	U	24	U	24	U	10	U
Semivolatiles	Phenanthrene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Phenol	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Pyrene	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U		
Semivolatiles	Trichlorophenol, 2,4,5-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	µg/L	4.8	U	4.8	U	4.8	U	4.8	U	10	U
Pesticides/PCBs	Aroclor 1016	N	µg/L	0.48	U			0.5	U	0.48	U	10	U
Pesticides/PCBs	Aroclor 1221	N	µg/L	0.48	U			0.5	U	0.48	U	10	U
Pesticides/PCBs	Aroclor 1232	N	µg/L	0.48	U			0.5	U	0.48	U	10	U
Pesticides/PCBs	Aroclor 1242	N	µg/L	0.48	U			0.5	U	0.48	U	10	U
Pesticides/PCBs	Aroclor 1248	N	µg/L	0.48	U			0.5	U	0.48	U	10	U
Pesticides/PCBs	Aroclor 1254	N	µg/L	0.48	U			0.5	U	0.48	U	10	U
Pesticides/PCBs	Aroclor 1260	N	µg/L	0.48	U			0.5	U	0.48	U	10	U
Metals - Unfiltered	Aluminum	N	µg/L	42.8	J	46.7	J	200	U	17.4	J	200	U
Metals - Unfiltered	Antimony	N	µg/L	6	U	6	U	6	U	6	U	60	U
Metals - Unfiltered	Arsenic	N	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Unfiltered	Barium	N	µg/L	22.7	J	21.1	J	175	J	184	J	200	U
Metals - Unfiltered	Beryllium	N	µg/L	4	U	4	U	4	U	4	U	5	U
Metals - Unfiltered	Cadmium	N	µg/L	5	U	5	U	5	U	5	U	5	U
Metals - Unfiltered	Calcium	N	µg/L	377000		392000	J	266000	J	275000		317000	
Metals - Unfiltered	Chromium	N	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Unfiltered	Cobalt	N	µg/L	50	U	50	U	50	U	50	U	50	U
Metals - Unfiltered	Copper	N	µg/L	25	U	25	U	25	U	25	U	25	U
Metals - Unfiltered	Iron	N	µg/L	283	J	300	U	600	U	33	J	100	U
Metals - Unfiltered	Lead	N	µg/L	5	U	10	U	10	U	5	U	3	U
Metals - Unfiltered	Magnesium	N	µg/L	121000		124000		103000	J	110000		120000	
Metals - Unfiltered	Manganese	N	µg/L	53.7		11.1	J	5.9	J	5.4	J	15	U
Metals - Unfiltered	Mercury	N	µg/L	1	U	1	U	1	U	1	U	0.2	U
Metals - Unfiltered	Nickel	N	µg/L	40	U	40	U	40	U	40	U	40	U
Metals - Unfiltered	Potassium	N	µg/L	7740	J	10900		13300		11500	J	11300	
Metals - Unfiltered	Selenium	N	µg/L	10	U	21.3	J	6.7	B	14.3	B	5	U
Metals - Unfiltered	Silver	N	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Unfiltered	Sodium	N	µg/L	26400		32100	J	56600	J	58500		63000	
Metals - Unfiltered	Thallium	N	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Unfiltered	Vanadium	N	µg/L	1.6	J	1.1	J	1	J	1.3	J	50	U
Metals - Unfiltered	Zinc	N	µg/L	20	U	20	U	20	U	20	U	20	U
Metals - Filtered	Aluminum	Y	µg/L	16.2	J	37.4	B	200	U	12.4	J	200	U
Metals - Filtered	Antimony	Y	µg/L	6	U	6	U	6	U	6	U	60	U
Metals - Filtered	Arsenic	Y	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Filtered	Barium	Y	µg/L	22.6	J	19.8	J	171	J	186	J	200	U
Metals - Filtered	Beryllium	Y	µg/L	4	U	4	U	4	U	4	U	5	U
Metals - Filtered	Cadmium	Y	µg/L	5	U	5	U	5	U	5	U	5	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-002		AP2-BEDGW-002		AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003	
			SAMPLE_NO	AP3063		AP3079		AP3064		AP3065		AP3066	
			SAMPLE_DATE	24-May-09		17-Nov-09		23-May-09		23-May-09		23-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		REG		REG		FD		FS	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Metals - Filtered	Calcium	Y	µg/L	389000		347000	J	257000		281000		323000	
Metals - Filtered	Chromium	Y	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Filtered	Cobalt	Y	µg/L	50	U	50	U	50	U	50	U	50	U
Metals - Filtered	Copper	Y	µg/L	25	U	25	U	25	U	25	U	25	U
Metals - Filtered	Iron	Y	µg/L	600	U	36.1	J	600	U	300	U	100	U
Metals - Filtered	Lead	Y	µg/L	2.1	B	10	U	10	U	10	U	3	U
Metals - Filtered	Magnesium	Y	µg/L	119000		118000	J	98700	J	108000		123000	
Metals - Filtered	Manganese	Y	µg/L	52.4		9.6	J	5.6	J	6.1	J	15	U
Metals - Filtered	Mercury	Y	µg/L	1	U	1	U	1	U	1	U	0.2	U
Metals - Filtered	Nickel	Y	µg/L	40	U	40	U	40	U	40	U	40	U
Metals - Filtered	Potassium	Y	µg/L	9790	J	11500	J	13000		13800		11800	
Metals - Filtered	Selenium	Y	µg/L	10	U	74.9	J	8.1	J	8.8	J	5	U
Metals - Filtered	Silver	Y	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Filtered	Sodium	Y	µg/L	28900		33100		55700		58700		65900	
Metals - Filtered	Thallium	Y	µg/L	10	U	10	U	10	U	10	U	10	U
Metals - Filtered	Vanadium	Y	µg/L	1.1	J	2	J	1.2	J	1.1	J	50	U
Metals - Filtered	Zinc	Y	µg/L	20	U	20	U	20	U	20	U	20	U
Cyanide	Cyanide, total	N	ppm										
Water Quality Parameters	Alkalinity	N	ppm	417		472	J	649	J	632		590	
Water Quality Parameters	Chloride	N	ppm	40.6		74.2	J	111		105		93.6	
Water Quality Parameters	Cyanide, total	N	ppm	0.0072	J	0.01	UJ	0.01	UJ	0.01	UJ	0.71	
Water Quality Parameters	Hardness	N	ppm									1200	
Water Quality Parameters	HARDNESS (as CaCO3)	N	ppm	1440		1490		1090		1140			
Water Quality Parameters	Nitrate	N	ppm										
Water Quality Parameters	Nitrate-Nitrite	N	ppm	2	U	2	J	0.76	J	2	U	0.1	U
Water Quality Parameters	Sulfate	N	ppm	946		776	J	519		476		626	
Water Quality Parameters	Total dissolved solids	N	ppm	2240	J	2200	J	1900	J	1740	J	1500	
Water Quality Parameters	Total suspended solids	N	ppm	18		4	UJ	10	U	17		4	U
Water Quality Parameters	Turbidity	N	NTU	38.2	J	1.7	J	14	J	1	UJ	94	

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003		AP2-MW01		AP2-MW01	
			SAMPLE_NO	AP3080		AP3081		AP3082		AP3057		AP3075	
			SAMPLE_DATE	16-Nov-09		17-Nov-09		17-Nov-09		23-May-09		13-Nov-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Dinitrobenzene, 1,3-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Dinitrotoluene, 2,4-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Dinitrotoluene, 2,6-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	HMX	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Nitrobenzene	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Nitrotoluene, 2-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Nitrotoluene, 3-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Nitrotoluene, 4-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	RDX	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Tetryl	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Trinitrobenzene, 1,3,5-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Explosives	Trinitrotoluene, 2,4,6-	N	µg/L	0.2	U	0.19	U			0.19	U	0.19	U
Volatiles	Acetone	N	µg/L	86.1	J	34.4	J	10	U	25	R		
Volatiles	Benzene	N	µg/L	336		6.2	J	4.1		1	U		
Volatiles	Bromodichloromethane	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Bromoform	N	µg/L	5	U	1	U	1	UJ	1	U		
Volatiles	Bromomethane	N	µg/L	10	U	2	U	1	U	2	U		
Volatiles	Butanone, 2-	N	µg/L	25	U	5	U	10	U	5	U		
Volatiles	Carbon disulfide	N	µg/L	3.7	J	1.2	B	1.3		2	U		
Volatiles	Carbon tetrachloride	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Chlorobenzene	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Chloroethane	N	µg/L	10	U	2	U	1	U	2	U		
Volatiles	Chloroform	N	µg/L	14.6	B	4	B	1	U	1	U		
Volatiles	Chloromethane	N	µg/L	44.9	J	3.5	J	1	U	2	U		
Volatiles	Cyclohexane	N	µg/L					54					
Volatiles	Dibromo-3-chloropropane, 1,2-	N	µg/L					2	UJ				
Volatiles	Dibromochloromethane	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Dibromoethane, 1,2-	N	µg/L					1	U				
Volatiles	Dichlorobenzene, 1,2-	N	µg/L					1	U				
Volatiles	Dichlorobenzene, 1,3-	N	µg/L					1	U				
Volatiles	Dichlorobenzene, 1,4-	N	µg/L					1	U				
Volatiles	Dichlorodifluoromethane	N	µg/L					1	U				
Volatiles	Dichloroethane, 1,1-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Dichloroethane, 1,2-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Dichloroethene, 1,1-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Dichloroethene, cis-1,2-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Dichloroethene, trans-1,2-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Dichloropropane, 1,2-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Dichloropropene, cis-1,3-	N	µg/L	5	U	1	U	1	UJ	1	U		
Volatiles	Dichloropropene, trans-1,3-	N	µg/L	1.7	J	1	U	1	UJ	1	U		
Volatiles	Ethylbenzene	N	µg/L	57.1		6.6	J	5		1	U		

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003		AP2-MW01		AP2-MW01	
			SAMPLE_NO	AP3080		AP3081		AP3082		AP3057		AP3075	
			SAMPLE_DATE	16-Nov-09		17-Nov-09		17-Nov-09		23-May-09		13-Nov-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Volatiles	Hexanone, 2-	N	µg/L	50	U	10	U	10	U	10	U		
Volatiles	Isopropylbenzene	N	µg/L					2.5					
Volatiles	METHYL ACETATE	N	µg/L					10	U				
Volatiles	Methyl Tertiary Butyl Ether	N	µg/L					5	U				
Volatiles	Methyl-2-pentanone, 4-	N	µg/L	25	U	5	U	10	U	5	U		
Volatiles	Methylcyclohexane	N	µg/L					39					
Volatiles	Methylene chloride	N	µg/L	13.4	B	5	U	1	U	5	U		
Volatiles	Styrene	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Tetrachloroethane, 1,1,2,2-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Tetrachloroethene	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Toluene	N	µg/L	147		3.3	J	2.3		1	U		
Volatiles	Trichlorobenzene, 1,2,4-	N	µg/L					1	U				
Volatiles	Trichloroethane, 1,1,1-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Trichloroethane, 1,1,2-	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Trichloroethene	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Trichlorofluoromethane	N	µg/L					1	U				
Volatiles	Trichlorotrifluoroethane	N	µg/L					1	U				
Volatiles	Vinyl chloride	N	µg/L	5	U	1	U	1	U	1	U		
Volatiles	Xylenes, total	N	µg/L	630		36.8	J	29		3	U		
Semivolatiles	3-Methylphenol and 4-Methylphenol	N	µg/L	4.8	U	4.8	U			4.8	UJ		
Semivolatiles	Acenaphthene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Acenaphthylene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	ACETOPHENONE	N	µg/L					10	U				
Semivolatiles	Anthracene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Atrazine	N	µg/L					10	U				
Semivolatiles	Benzaldehyde	N	µg/L					10	U				
Semivolatiles	Benzo(a)anthracene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Benzo(a)pyrene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Benzo(b)fluoranthene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Benzo(ghi)perylene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Benzo(k)fluoranthene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Benzoic acid	N	µg/L	24	U	24	U			24	UJ		
Semivolatiles	Benzyl alcohol	N	µg/L	4.8	U	4.8	U			4.8	UJ		
Semivolatiles	BIBENZENE	N	µg/L					10	U				
Semivolatiles	Bis(2-chloroethoxy)methane	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Bis(2-chloroethyl)ether	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Bis(2-chloroisopropyl)ether	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Bromophenyl phenyl ether, 4-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Butyl benzyl phthalate	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Caprolactam	N	µg/L					10	U				
Semivolatiles	Carbazole	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Chloro-3-methylphenol, 4-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003		AP2-MW01		AP2-MW01	
			SAMPLE_NO	AP3080		AP3081		AP3082		AP3057		AP3075	
			SAMPLE_DATE	16-Nov-09		17-Nov-09		17-Nov-09		23-May-09		13-Nov-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Chloroaniline, 4-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Chloronaphthalene, 2-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Chlorophenol, 2-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Chrysene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Dibenz(a,h)anthracene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Dibenzofuran	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Dichlorobenzene, 1,2-	N	µg/L	4.8	U	4.8	U			4.8	UJ		
Semivolatiles	Dichlorobenzene, 1,3-	N	µg/L	4.8	U	4.8	U			4.8	UJ		
Semivolatiles	Dichlorobenzene, 1,4-	N	µg/L	4.8	U	4.8	U			4.8	UJ		
Semivolatiles	Dichlorobenzidine, 3,3'-	N	µg/L	9.5	U	9.5	U	50	U	9.6	UJ		
Semivolatiles	Dichlorophenol, 2,4-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Diethyl phthalate	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Dimethyl phthalate	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Dimethylphenol, 2,4-	N	µg/L	1.7	J	4.8	U	10	U	4.8	UJ		
Semivolatiles	Di-n-butyl phthalate	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	µg/L	9.5	U	9.5	U	50	U	9.6	UJ		
Semivolatiles	Dinitrophenol, 2,4-	N	µg/L	24	U	24	U	50	U	24	UJ		
Semivolatiles	Dinitrotoluene, 2,4-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Dinitrotoluene, 2,6-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Di-n-octyl phthalate	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	DIPHENYLAMINE	N	µg/L										
Semivolatiles	Fluoranthene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Fluorene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Hexachlorobenzene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Hexachlorobutadiene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Hexachlorocyclopentadiene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Hexachloroethane	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Isophorone	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Methylnaphthalene, 2-	N	µg/L	6.3		2.5	J	10	U	4.8	UJ		
Semivolatiles	Methylphenol, 2-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Methylphenol, 4-	N	µg/L					10	U				
Semivolatiles	Naphthalene	N	µg/L	7.4		1.6	J	10	U	4.8	UJ		
Semivolatiles	Nitroaniline, 2-	N	µg/L	9.5	U	9.5	U	50	U	9.6	UJ		
Semivolatiles	Nitroaniline, 3-	N	µg/L	9.5	U	9.5	U	50	U	9.6	UJ		
Semivolatiles	Nitroaniline, 4-	N	µg/L	9.5	U	9.5	U	50	U	9.6	UJ		
Semivolatiles	Nitrobenzene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Nitrophenol, 2-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Nitrophenol, 4-	N	µg/L	24	U	24	U	50	U	24	UJ		
Semivolatiles	n-Nitrosodimethylamine	N	µg/L										
Semivolatiles	n-Nitroso-di-n-propylamine	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	n-Nitrosodiphenylamine	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003		AP2-MW01		AP2-MW01	
			SAMPLE_NO	AP3080		AP3081		AP3082		AP3057		AP3075	
			SAMPLE_DATE	16-Nov-09		17-Nov-09		17-Nov-09		23-May-09		13-Nov-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Pentachlorophenol	N	µg/L	24	U	24	U	10	U	24	UJ		
Semivolatiles	Phenanthrene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Phenol	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Pyrene	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Trichlorobenzene, 1,2,4-	N	µg/L	4.8	U	4.8	U			4.8	UJ		
Semivolatiles	Trichlorophenol, 2,4,5-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Semivolatiles	Trichlorophenol, 2,4,6-	N	µg/L	4.8	U	4.8	U	10	U	4.8	UJ		
Pesticides/PCBs	Aroclor 1016	N	µg/L							0.48	U		
Pesticides/PCBs	Aroclor 1221	N	µg/L							0.48	U		
Pesticides/PCBs	Aroclor 1232	N	µg/L							0.48	U		
Pesticides/PCBs	Aroclor 1242	N	µg/L							0.48	U		
Pesticides/PCBs	Aroclor 1248	N	µg/L							0.48	U		
Pesticides/PCBs	Aroclor 1254	N	µg/L							0.48	U		
Pesticides/PCBs	Aroclor 1260	N	µg/L							0.48	U		
Metals - Unfiltered	Aluminum	N	µg/L	33.9	J	45.5	J	200	U	133	J		
Metals - Unfiltered	Antimony	N	µg/L	6	U	6	U	60	U	6	U		
Metals - Unfiltered	Arsenic	N	µg/L	10	U	10	U	10	U	10	U		
Metals - Unfiltered	Barium	N	µg/L	161	J	21.3	J	200	U	98	J		
Metals - Unfiltered	Beryllium	N	µg/L	4	U	4	U	5	U	4	U		
Metals - Unfiltered	Cadmium	N	µg/L	5	U	5	U	5	U	5	U		
Metals - Unfiltered	Calcium	N	µg/L	280000	J	385000	J	404000		112000			
Metals - Unfiltered	Chromium	N	µg/L	10	U	10	U	10	U	10	U		
Metals - Unfiltered	Cobalt	N	µg/L	50	U	50	U	50	U	50	U		
Metals - Unfiltered	Copper	N	µg/L	25	U	25	U	25	U	25	U		
Metals - Unfiltered	Iron	N	µg/L	300	U	300	U	194		80.8	J		
Metals - Unfiltered	Lead	N	µg/L	10	U	2.4	B	3	U	2.4	J		
Metals - Unfiltered	Magnesium	N	µg/L	112000		123000		119000		38700			
Metals - Unfiltered	Manganese	N	µg/L	7.1	J	10.7	J	15	U	82.2			
Metals - Unfiltered	Mercury	N	µg/L	1	U	1	U	0.2	U	1	U		
Metals - Unfiltered	Nickel	N	µg/L	40	U	40	U	40	U	40	U		
Metals - Unfiltered	Potassium	N	µg/L	15600		11000		7380		4150	J		
Metals - Unfiltered	Selenium	N	µg/L	12.4	J	17.7	J	5	U	10	U		
Metals - Unfiltered	Silver	N	µg/L	10	U	10	U	10	U	10	U		
Metals - Unfiltered	Sodium	N	µg/L	61100	J	32100	J	28500		7440	J		
Metals - Unfiltered	Thallium	N	µg/L	10	U	10	U	10	U	10	U		
Metals - Unfiltered	Vanadium	N	µg/L	50	UJ	50	UJ	50	U	3.7	J		
Metals - Unfiltered	Zinc	N	µg/L	20	U	20	U	20	U	20	U		
Metals - Filtered	Aluminum	Y	µg/L	40.8	B	39.3	B	200	U	200	U		
Metals - Filtered	Antimony	Y	µg/L	6	U	6	U	60	U	6	U		
Metals - Filtered	Arsenic	Y	µg/L	10	U	10	U	10	U	10	U		
Metals - Filtered	Barium	Y	µg/L	164	J	18.8	J	200	U	88.1	J		
Metals - Filtered	Beryllium	Y	µg/L	4	U	4	U	5	U	4	U		
Metals - Filtered	Cadmium	Y	µg/L	5	U	5	U	5	U	5	U		

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003		AP2-MW01		AP2-MW01	
			SAMPLE_NO	AP3080		AP3081		AP3082		AP3057		AP3075	
			SAMPLE_DATE	16-Nov-09		17-Nov-09		17-Nov-09		23-May-09		13-Nov-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Metals - Filtered	Calcium	Y	µg/L	256000	J	335000	J	411000		102000			
Metals - Filtered	Chromium	Y	µg/L	10	U	10	U	10	U	10	U		
Metals - Filtered	Cobalt	Y	µg/L	50	U	50	U	50	U	50	U		
Metals - Filtered	Copper	Y	µg/L	25	U	25	U	25	U	25	U		
Metals - Filtered	Iron	Y	µg/L	65.5	J	46.5	J	100	U	300	U		
Metals - Filtered	Lead	Y	µg/L	10	U	10	U	3	U	2.1	B		
Metals - Filtered	Magnesium	Y	µg/L	109000	J	113000	J	121000		34100			
Metals - Filtered	Manganese	Y	µg/L	7.2	J	9.3	J	15	U	72.3			
Metals - Filtered	Mercury	Y	µg/L	1	U	1	U	0.2	U	1	U		
Metals - Filtered	Nickel	Y	µg/L	40	U	40	U	40	U	40	U		
Metals - Filtered	Potassium	Y	µg/L	16300	J	11000	J	7540		5030	J		
Metals - Filtered	Selenium	Y	µg/L	22.4	J	14.3	J	5	U	3.5	J		
Metals - Filtered	Silver	Y	µg/L	10	U	10	U	10	U	10	U		
Metals - Filtered	Sodium	Y	µg/L	63100		31400		29100		8520	J		
Metals - Filtered	Thallium	Y	µg/L	10	U	10	U	10	U	10	U		
Metals - Filtered	Vanadium	Y	µg/L	2.6	J	2.3	J	50	U	3.5			
Metals - Filtered	Zinc	Y	µg/L	20	U	20	U	20	U	20	U		
Cyanide	Cyanide, total	N	ppm										
Water Quality Parameters	Alkalinity	N	ppm	662	J	492	J	490		362			
Water Quality Parameters	Chloride	N	ppm	118		46.9	J	48.8		4.6			
Water Quality Parameters	Cyanide, total	N	ppm	0.01	UJ	0.01	UJ	0.51		0.01	UJ		
Water Quality Parameters	Hardness	N	ppm					1600					
Water Quality Parameters	HARDNESS (as CaCO3)	N	ppm	1160		1460				439			
Water Quality Parameters	Nitrate	N	ppm					0.1	UJ				
Water Quality Parameters	Nitrate-Nitrite	N	ppm	0.047	B	0.054	B			0.065	J		
Water Quality Parameters	Sulfate	N	ppm	496		1070	J	1080		81.5			
Water Quality Parameters	Total dissolved solids	N	ppm	1570	J	2050	J	2000		294	J		
Water Quality Parameters	Total suspended solids	N	ppm	10	UJ	10	UJ	4	U	10	U		
Water Quality Parameters	Turbidity	N	NTU	51.2		21.4	J	110		1	UJ		

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW03	
			SAMPLE_NO	AP3058		AP3059		AP3060		AP3076		AP3061	
			SAMPLE_DATE	25-May-09		25-May-09		26-May-09		13-Nov-09		24-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Dinitrobenzene, 1,3-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Dinitrotoluene, 2,4-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Dinitrotoluene, 2,6-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	HMX	N	µg/L	0.19	U	0.19	U	0.5	U	0.2	U	0.19	U
Explosives	Nitrobenzene	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Nitrotoluene, 2-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Nitrotoluene, 3-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Nitrotoluene, 4-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	RDX	N	µg/L	0.19	U	0.19	U	0.5	U	0.2	U	0.19	U
Explosives	Tetryl	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Trinitrobenzene, 1,3,5-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Explosives	Trinitrotoluene, 2,4,6-	N	µg/L	0.19	U	0.19	U	0.2	U	0.2	U	0.19	U
Volatiles	Acetone	N	µg/L	25	R	25	R	10	UJ			25	R
Volatiles	Benzene	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Bromodichloromethane	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Bromoform	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Bromomethane	N	µg/L	2	U	2	U	1	U			2	U
Volatiles	Butanone, 2-	N	µg/L	5	U	5	U	10	R			5	U
Volatiles	Carbon disulfide	N	µg/L	2	U	2	U	1	U			2	U
Volatiles	Carbon tetrachloride	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Chlorobenzene	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Chloroethane	N	µg/L	2	U	2	U	1	R			2	U
Volatiles	Chloroform	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Chloromethane	N	µg/L	2	U	2	U	1	UJ			2	U
Volatiles	Cyclohexane	N	µg/L					1	U				
Volatiles	Dibromo-3-chloropropane, 1,2-	N	µg/L					2	R				
Volatiles	Dibromochloromethane	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Dibromoethane, 1,2-	N	µg/L					1	U				
Volatiles	Dichlorobenzene, 1,2-	N	µg/L					1	U				
Volatiles	Dichlorobenzene, 1,3-	N	µg/L					1	U				
Volatiles	Dichlorobenzene, 1,4-	N	µg/L					1	U				
Volatiles	Dichlorodifluoromethane	N	µg/L					1	U				
Volatiles	Dichloroethane, 1,1-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Dichloroethane, 1,2-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Dichloroethene, 1,1-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Dichloroethene, cis-1,2-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Dichloroethene, trans-1,2-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Dichloropropane, 1,2-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Dichloropropene, cis-1,3-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Dichloropropene, trans-1,3-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Ethylbenzene	N	µg/L	1	U	1	U	1	U			1	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW03	
			SAMPLE_NO	AP3058		AP3059		AP3060		AP3076		AP3061	
			SAMPLE_DATE	25-May-09		25-May-09		26-May-09		13-Nov-09		24-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Volatiles	Hexanone, 2-	N	µg/L	10	U	10	U	10	U			10	U
Volatiles	Isopropylbenzene	N	µg/L					1	U				
Volatiles	METHYL ACETATE	N	µg/L					10	U				
Volatiles	Methyl Tertiary Butyl Ether	N	µg/L					5	U				
Volatiles	Methyl-2-pentanone, 4-	N	µg/L	5	U	5	U	10	UJ			5	U
Volatiles	Methylcyclohexane	N	µg/L					1	U				
Volatiles	Methylene chloride	N	µg/L	5	U	5	U	1	U			5	U
Volatiles	Styrene	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Tetrachloroethane, 1,1,2,2-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Tetrachloroethene	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Toluene	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Trichlorobenzene, 1,2,4-	N	µg/L					1	U				
Volatiles	Trichloroethane, 1,1,1-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Trichloroethane, 1,1,2-	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Trichloroethene	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Trichlorofluoromethane	N	µg/L					1	U				
Volatiles	Trichlorotrifluoroethane	N	µg/L					1	U				
Volatiles	Vinyl chloride	N	µg/L	1	U	1	U	1	U			1	U
Volatiles	Xylenes, total	N	µg/L	3	U	3	U	2	U			3	U
Semivolatiles	3-Methylphenol and 4-Methylphenol	N	µg/L	5	U	5	U					5	U
Semivolatiles	Acenaphthene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Acenaphthylene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	ACETOPHENONE	N	µg/L					10	U				
Semivolatiles	Anthracene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Atrazine	N	µg/L					10	U				
Semivolatiles	Benzaldehyde	N	µg/L					10	U				
Semivolatiles	Benzo(a)anthracene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Benzo(a)pyrene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Benzo(b)fluoranthene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Benzo(ghi)perylene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Benzo(k)fluoranthene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Benzoic acid	N	µg/L	25	U	25	U					25	U
Semivolatiles	Benzyl alcohol	N	µg/L	5	U	5	U					5	U
Semivolatiles	BIBENZENE	N	µg/L					10	U				
Semivolatiles	Bis(2-chloroethoxy)methane	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Bis(2-chloroethyl)ether	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Butyl benzyl phthalate	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Caprolactam	N	µg/L					10	U				
Semivolatiles	Carbazole	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	µg/L	5	U	5	U	10	U			5	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW03	
			SAMPLE_NO	AP3058		AP3059		AP3060		AP3076		AP3061	
			SAMPLE_DATE	25-May-09		25-May-09		26-May-09		13-Nov-09		24-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Chloroaniline, 4-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Chloronaphthalene, 2-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Chlorophenol, 2-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Chrysene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Dibenz(a,h)anthracene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Dibenzofuran	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Dichlorobenzene, 1,2-	N	µg/L	5	U	5	U					5	U
Semivolatiles	Dichlorobenzene, 1,3-	N	µg/L	5	U	5	U					5	U
Semivolatiles	Dichlorobenzene, 1,4-	N	µg/L	5	U	5	U					5	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	µg/L	10	U	10	U	50	U			10	U
Semivolatiles	Dichlorophenol, 2,4-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Diethyl phthalate	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Dimethyl phthalate	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Dimethylphenol, 2,4-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Di-n-butyl phthalate	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	µg/L	10	U	10	U	50	U			10	U
Semivolatiles	Dinitrophenol, 2,4-	N	µg/L	25	U	25	U	50	U			25	U
Semivolatiles	Dinitrotoluene, 2,4-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Dinitrotoluene, 2,6-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Di-n-octyl phthalate	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	DIPHENYLAMINE	N	µg/L										
Semivolatiles	Fluoranthene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Fluorene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Hexachlorobenzene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Hexachlorobutadiene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Hexachlorocyclopentadiene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Hexachloroethane	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Isophorone	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Methylnaphthalene, 2-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Methylphenol, 2-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Methylphenol, 4-	N	µg/L					10	U				
Semivolatiles	Naphthalene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Nitroaniline, 2-	N	µg/L	10	U	10	U	50	U			10	U
Semivolatiles	Nitroaniline, 3-	N	µg/L	10	U	10	U	50	U			10	U
Semivolatiles	Nitroaniline, 4-	N	µg/L	10	U	10	U	50	U			10	U
Semivolatiles	Nitrobenzene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Nitrophenol, 2-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Nitrophenol, 4-	N	µg/L	25	U	25	U	50	U			25	U
Semivolatiles	n-Nitrosodimethylamine	N	µg/L										
Semivolatiles	n-Nitroso-di-n-propylamine	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	n-Nitrosodiphenylamine	N	µg/L	5	U	5	U	10	U			5	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW03	
			SAMPLE_NO	AP3058		AP3059		AP3060		AP3076		AP3061	
			SAMPLE_DATE	25-May-09		25-May-09		26-May-09		13-Nov-09		24-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Pentachlorophenol	N	µg/L	25	U	25	U	10	U			25	U
Semivolatiles	Phenanthrene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Phenol	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Pyrene	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	µg/L	5	U	5	U					5	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	µg/L	5	U	5	U	10	U			5	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	µg/L	5	U	5	U	10	U			5	U
Pesticides/PCBs	Aroclor 1016	N	µg/L	0.48	U	0.48	U	1	U			0.48	U
Pesticides/PCBs	Aroclor 1221	N	µg/L	0.48	U	0.48	U	1	U			0.48	U
Pesticides/PCBs	Aroclor 1232	N	µg/L	0.48	U	0.48	U	1	U			0.48	U
Pesticides/PCBs	Aroclor 1242	N	µg/L	0.48	U	0.48	U	1	U			0.48	U
Pesticides/PCBs	Aroclor 1248	N	µg/L	0.48	U	0.48	U	1	U			0.48	U
Pesticides/PCBs	Aroclor 1254	N	µg/L	0.48	U	0.48	U	1	U			0.48	U
Pesticides/PCBs	Aroclor 1260	N	µg/L	0.48	U	0.48	U	1	U			0.48	U
Metals - Unfiltered	Aluminum	N	µg/L	79.1	J	77.6	J	200	U			47.1	J
Metals - Unfiltered	Antimony	N	µg/L	6	U	6	U	60	U			6	U
Metals - Unfiltered	Arsenic	N	µg/L	10	U	10	U	10	U			10	U
Metals - Unfiltered	Barium	N	µg/L	25.3	J	24.5	J	200	U			25.2	J
Metals - Unfiltered	Beryllium	N	µg/L	4	U	4	U	5	U			4	U
Metals - Unfiltered	Cadmium	N	µg/L	1.1	J	1	J	5	U			5	U
Metals - Unfiltered	Calcium	N	µg/L	102000		102000		94900				54400	
Metals - Unfiltered	Chromium	N	µg/L	10	U	10	U	10	U			10	U
Metals - Unfiltered	Cobalt	N	µg/L	7.9	J	8.3	J	50	U			50	U
Metals - Unfiltered	Copper	N	µg/L	25	U	25	U	25	U			25	U
Metals - Unfiltered	Iron	N	µg/L	300	U	300	U	100	U			37	J
Metals - Unfiltered	Lead	N	µg/L	5	U	5	U	3	U			5	U
Metals - Unfiltered	Magnesium	N	µg/L	11600		11600		10800				12700	
Metals - Unfiltered	Manganese	N	µg/L	229		229		212				173	
Metals - Unfiltered	Mercury	N	µg/L	1	U	1	U	0.2	U			1	U
Metals - Unfiltered	Nickel	N	µg/L	74.2		74.2		68.9				40	U
Metals - Unfiltered	Potassium	N	µg/L	7690	J	7410	J	8940				1500	J
Metals - Unfiltered	Selenium	N	µg/L	10	U	10	U	5	U			5.7	B
Metals - Unfiltered	Silver	N	µg/L	10	U	10	U	10	U			10	U
Metals - Unfiltered	Sodium	N	µg/L	2560	J	2460	J	5000	U			10200	J
Metals - Unfiltered	Thallium	N	µg/L	10	U	10	U	10	U			10	U
Metals - Unfiltered	Vanadium	N	µg/L	50	U	50	U	50	U			1.4	J
Metals - Unfiltered	Zinc	N	µg/L	42.6		33.9		29.9				20	U
Metals - Filtered	Aluminum	Y	µg/L	45.4	J	44	J	200	U			200	U
Metals - Filtered	Antimony	Y	µg/L	6	U	6	U	60	U			6	U
Metals - Filtered	Arsenic	Y	µg/L	10	U	10	U	10	U			10	U
Metals - Filtered	Barium	Y	µg/L	23.9	J	23.6	J	200	U			22.3	J
Metals - Filtered	Beryllium	Y	µg/L	4	U	4	U	5	U			4	U
Metals - Filtered	Cadmium	Y	µg/L	5	U	5	U	5	U			5	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW02		AP2-MW03	
			SAMPLE_NO	AP3058		AP3059		AP3060		AP3076		AP3061	
			SAMPLE_DATE	25-May-09		25-May-09		26-May-09		13-Nov-09		24-May-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	REG		FD		FS		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Metals - Filtered	Calcium	Y	µg/L	96400		93100		103000				47200	
Metals - Filtered	Chromium	Y	µg/L	10	U	10	U	10	U			10	U
Metals - Filtered	Cobalt	Y	µg/L	8.9	J	8.7	J	50	U			50	U
Metals - Filtered	Copper	Y	µg/L	25	U	25	U	25	U			25	U
Metals - Filtered	Iron	Y	µg/L	300	U	300	U	100	U			300	U
Metals - Filtered	Lead	Y	µg/L	10	U	10	U	3	U			10	U
Metals - Filtered	Magnesium	Y	µg/L	11000		10600		11900	J			11500	
Metals - Filtered	Manganese	Y	µg/L	220		214		218				171	
Metals - Filtered	Mercury	Y	µg/L	1	U	1	U	0.2	U			1	U
Metals - Filtered	Nickel	Y	µg/L	74.5		72.1		72.6				40	U
Metals - Filtered	Potassium	Y	µg/L	9090	J	8950	J	9500				1950	J
Metals - Filtered	Selenium	Y	µg/L	10	U	10	U	5	U			10	U
Metals - Filtered	Silver	Y	µg/L	10	U	10	U	10	U			10	U
Metals - Filtered	Sodium	Y	µg/L	3030	J	2930	J	5000	U			11000	
Metals - Filtered	Thallium	Y	µg/L	10	U	10	U	10	U			10	U
Metals - Filtered	Vanadium	Y	µg/L	50	U	50	U	50	U			50	U
Metals - Filtered	Zinc	Y	µg/L	33.6		32.4		31				20	U
Cyanide	Cyanide, total	N	ppm										
Water Quality Parameters	Alkalinity	N	ppm	70.3		73.4		72				116	
Water Quality Parameters	Chloride	N	ppm	4.1		3.6		12.6				6.5	
Water Quality Parameters	Cyanide, total	N	ppm	0.01	UJ	0.01	UJ	0.01	U			0.01	UJ
Water Quality Parameters	Hardness	N	ppm					330					
Water Quality Parameters	HARDNESS (as CaCO3)	N	ppm	300		302						188	
Water Quality Parameters	Nitrate	N	ppm										
Water Quality Parameters	Nitrate-Nitrite	N	ppm	10.9		10.9		8.7				0.61	
Water Quality Parameters	Sulfate	N	ppm	165		159		173				94.9	
Water Quality Parameters	Total dissolved solids	N	ppm	507	J	508	J	460				295	J
Water Quality Parameters	Total suspended solids	N	ppm	10	U	4	J	4	U			10	U
Water Quality Parameters	Turbidity	N	NTU	1	UJ	1	UJ	0.5	U			1	J

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ03		ASH PIT 2-PZ04	
			SAMPLE_NO	AP3015		AP3016		AP3022		AP3018		AP3019	
			SAMPLE_DATE	2-Feb-09		2-Feb-09		2-Feb-09		31-Jan-09		1-Feb-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	FD		FS		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Explosives	Amino-2,6-dinitrotoluene, 4-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Amino-4,6-dinitrotoluene, 2-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Dinitrobenzene, 1,3-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Dinitrotoluene, 2,4-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Dinitrotoluene, 2,6-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	HMX	N	µg/L	0.316	U	0.5	U	0.324	U	0.333	U	0.333	U
Explosives	Nitrobenzene	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Nitrotoluene, 2-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Nitrotoluene, 3-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Nitrotoluene, 4-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	RDX	N	µg/L	0.316	U	0.5	U	0.324	U	0.333	U	0.333	U
Explosives	Tetryl	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Trinitrobenzene, 1,3,5-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Explosives	Trinitrotoluene, 2,4,6-	N	µg/L	0.316	U	0.2	U	0.324	U	0.333	U	0.333	U
Volatiles	Acetone	N	µg/L										
Volatiles	Benzene	N	µg/L										
Volatiles	Bromodichloromethane	N	µg/L										
Volatiles	Bromoform	N	µg/L										
Volatiles	Bromomethane	N	µg/L										
Volatiles	Butanone, 2-	N	µg/L										
Volatiles	Carbon disulfide	N	µg/L										
Volatiles	Carbon tetrachloride	N	µg/L										
Volatiles	Chlorobenzene	N	µg/L										
Volatiles	Chloroethane	N	µg/L										
Volatiles	Chloroform	N	µg/L										
Volatiles	Chloromethane	N	µg/L										
Volatiles	Cyclohexane	N	µg/L										
Volatiles	Dibromo-3-chloropropane, 1,2-	N	µg/L										
Volatiles	Dibromochloromethane	N	µg/L										
Volatiles	Dibromoethane, 1,2-	N	µg/L										
Volatiles	Dichlorobenzene, 1,2-	N	µg/L										
Volatiles	Dichlorobenzene, 1,3-	N	µg/L										
Volatiles	Dichlorobenzene, 1,4-	N	µg/L										
Volatiles	Dichlorodifluoromethane	N	µg/L										
Volatiles	Dichloroethane, 1,1-	N	µg/L										
Volatiles	Dichloroethane, 1,2-	N	µg/L										
Volatiles	Dichloroethene, 1,1-	N	µg/L										
Volatiles	Dichloroethene, cis-1,2-	N	µg/L										
Volatiles	Dichloroethene, trans-1,2-	N	µg/L										
Volatiles	Dichloropropane, 1,2-	N	µg/L										
Volatiles	Dichloropropene, cis-1,3-	N	µg/L										
Volatiles	Dichloropropene, trans-1,3-	N	µg/L										
Volatiles	Ethylbenzene	N	µg/L										

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ03		ASH PIT 2-PZ04	
			SAMPLE_NO	AP3015		AP3016		AP3022		AP3018		AP3019	
			SAMPLE_DATE	2-Feb-09		2-Feb-09		2-Feb-09		31-Jan-09		1-Feb-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	FD		FS		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Volatiles	Hexanone, 2-	N	µg/L										
Volatiles	Isopropylbenzene	N	µg/L										
Volatiles	METHYL ACETATE	N	µg/L										
Volatiles	Methyl Tertiary Butyl Ether	N	µg/L										
Volatiles	Methyl-2-pentanone, 4-	N	µg/L										
Volatiles	Methylcyclohexane	N	µg/L										
Volatiles	Methylene chloride	N	µg/L										
Volatiles	Styrene	N	µg/L										
Volatiles	Tetrachloroethane, 1,1,2,2-	N	µg/L										
Volatiles	Tetrachloroethene	N	µg/L										
Volatiles	Toluene	N	µg/L										
Volatiles	Trichlorobenzene, 1,2,4-	N	µg/L										
Volatiles	Trichloroethane, 1,1,1-	N	µg/L										
Volatiles	Trichloroethane, 1,1,2-	N	µg/L										
Volatiles	Trichloroethene	N	µg/L										
Volatiles	Trichlorofluoromethane	N	µg/L										
Volatiles	Trichlorotrifluoroethane	N	µg/L										
Volatiles	Vinyl chloride	N	µg/L										
Volatiles	Xylenes, total	N	µg/L										
Semivolatiles	3-Methylphenol and 4-Methylphenol	N	µg/L										
Semivolatiles	Acenaphthene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Acenaphthylene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	ACETOPHENONE	N	µg/L			10	U						
Semivolatiles	Anthracene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Atrazine	N	µg/L			10	U						
Semivolatiles	Benzaldehyde	N	µg/L			10	U						
Semivolatiles	Benzo(a)anthracene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Benzo(a)pyrene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Benzo(b)fluoranthene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Benzo(ghi)perylene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Benzo(k)fluoranthene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Benzoic acid	N	µg/L	10.3	U			10.1	U	10.1	U	10	U
Semivolatiles	Benzyl alcohol	N	µg/L	10.3	U			10.1	U	10.1	U	10	U
Semivolatiles	BIBENZENE	N	µg/L			10	U						
Semivolatiles	Bis(2-chloroethoxy)methane	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Bis(2-chloroethyl)ether	N	µg/L	10.3	U	10	UJ	10.1	U	10.1	U	10	U
Semivolatiles	Bis(2-chloroisopropyl)ether	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Bis(2-ethylhexyl)phthalate	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Bromophenyl phenyl ether, 4-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Butyl benzyl phthalate	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Caprolactam	N	µg/L			10	U						
Semivolatiles	Carbazole	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Chloro-3-methylphenol, 4-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ03		ASH PIT 2-PZ04	
			SAMPLE_NO	AP3015		AP3016		AP3022		AP3018		AP3019	
			SAMPLE_DATE	2-Feb-09		2-Feb-09		2-Feb-09		31-Jan-09		1-Feb-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	FD		FS		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Chloroaniline, 4-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Chloronaphthalene, 2-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Chlorophenol, 2-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Chlorophenyl phenyl ether, 4-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Chrysene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Dibenz(a,h)anthracene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Dibenzofuran	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Dichlorobenzene, 1,2-	N	µg/L	10.3	U			10.1	U	10.1	U	10	U
Semivolatiles	Dichlorobenzene, 1,3-	N	µg/L	10.3	U			10.1	U	10.1	U	10	U
Semivolatiles	Dichlorobenzene, 1,4-	N	µg/L	10.3	U			10.1	U	10.1	U	10	U
Semivolatiles	Dichlorobenzidine, 3,3'-	N	µg/L	10.3	U	50	U	10.1	U	10.1	U	10	U
Semivolatiles	Dichlorophenol, 2,4-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Diethyl phthalate	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Dimethyl phthalate	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Dimethylphenol, 2,4-	N	µg/L	3.38	J	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Di-n-butyl phthalate	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Dinitro-2-methylphenol, 4,6-	N	µg/L	10.3	U	50	U	10.1	U	10.1	U	10	U
Semivolatiles	Dinitrophenol, 2,4-	N	µg/L	20.6	U	50	U	20.2	U	20.2	U	20	U
Semivolatiles	Dinitrotoluene, 2,4-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Dinitrotoluene, 2,6-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Di-n-octyl phthalate	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	DIPHENYLAMINE	N	µg/L	10.3	U			10.1	U	10.1	U	10	U
Semivolatiles	Fluoranthene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Fluorene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Hexachlorobenzene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Hexachlorobutadiene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Hexachlorocyclopentadiene	N	µg/L	10.3	UJ	10	U	10.1	UJ	10.1	UJ	10	UJ
Semivolatiles	Hexachloroethane	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Indeno(1,2,3-cd)pyrene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Isophorone	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Methylnaphthalene, 2-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Methylphenol, 2-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Methylphenol, 4-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Naphthalene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Nitroaniline, 2-	N	µg/L	10.3	U	50	U	10.1	U	10.1	U	10	U
Semivolatiles	Nitroaniline, 3-	N	µg/L	10.3	U	50	U	10.1	U	10.1	U	10	U
Semivolatiles	Nitroaniline, 4-	N	µg/L	10.3	U	50	U	10.1	U	10.1	U	10	U
Semivolatiles	Nitrobenzene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Nitrophenol, 2-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Nitrophenol, 4-	N	µg/L	10.3	U	50	U	10.1	U	10.1	U	10	U
Semivolatiles	n-Nitrosodimethylamine	N	µg/L	10.3	U			10.1	U	10.1	U	10	U
Semivolatiles	n-Nitroso-di-n-propylamine	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	n-Nitrosodiphenylamine	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ03		ASH PIT 2-PZ04	
			SAMPLE_NO	AP3015		AP3016		AP3022		AP3018		AP3019	
			SAMPLE_DATE	2-Feb-09		2-Feb-09		2-Feb-09		31-Jan-09		1-Feb-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	FD		FS		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Semivolatiles	Pentachlorophenol	N	µg/L	20.6	U	10	U	20.2	U	20.2	U	20	U
Semivolatiles	Phenanthrene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Phenol	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Pyrene	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Trichlorobenzene, 1,2,4-	N	µg/L	10.3	U			10.1	U	10.1	U	10	U
Semivolatiles	Trichlorophenol, 2,4,5-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Semivolatiles	Trichlorophenol, 2,4,6-	N	µg/L	10.3	U	10	U	10.1	U	10.1	U	10	U
Pesticides/PCBs	Aroclor 1016	N	µg/L										
Pesticides/PCBs	Aroclor 1221	N	µg/L										
Pesticides/PCBs	Aroclor 1232	N	µg/L										
Pesticides/PCBs	Aroclor 1242	N	µg/L										
Pesticides/PCBs	Aroclor 1248	N	µg/L										
Pesticides/PCBs	Aroclor 1254	N	µg/L										
Pesticides/PCBs	Aroclor 1260	N	µg/L										
Metals - Unfiltered	Aluminum	N	µg/L	93.3	J	200	U	147	J	2400		74.3	j
Metals - Unfiltered	Antimony	N	µg/L	5.56	U	60	U	5.56	U	5.56	U	5.56	U
Metals - Unfiltered	Arsenic	N	µg/L	11.1	U	10	U	11.1	U	11.1	U	11.1	U
Metals - Unfiltered	Barium	N	µg/L	31.3		200	U	31.9		51.1		24	
Metals - Unfiltered	Beryllium	N	µg/L	4.44	U	5	U	4.44	U	4.44	U	4.44	U
Metals - Unfiltered	Cadmium	N	µg/L	4.27	J	5	U	3.91	J	4.16	J	4.28	J
Metals - Unfiltered	Calcium	N	µg/L	110000		101000		110000		179000		135000	
Metals - Unfiltered	Chromium	N	µg/L	11.1	U	10	U	11.1	U	11.1	U	11.1	U
Metals - Unfiltered	Cobalt	N	µg/L	8.89	U	50	U	8.89	U	8.89	U	8.89	U
Metals - Unfiltered	Copper	N	µg/L	5.71	J	25	U	11.1	U	12.3		5.63	J
Metals - Unfiltered	Iron	N	µg/L	325	J	191		593	J	5060		203	
Metals - Unfiltered	Lead	N	µg/L	5.56	U	3	U	5.56	U	3.02	J	5.56	U
Metals - Unfiltered	Magnesium	N	µg/L	32200		29200		31900		42700		39600	
Metals - Unfiltered	Manganese	N	µg/L	21.6		20.7		24.5		51.8		22.1	
Metals - Unfiltered	Mercury	N	µg/L	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Metals - Unfiltered	Nickel	N	µg/L	4	J	40	U	6.67	U	6.28	J	5.36	J
Metals - Unfiltered	Potassium	N	µg/L	521	J	5000	U	548	J	1260		405	J
Metals - Unfiltered	Selenium	N	µg/L	11.1	U	5	U	11.1	U	7.55	J	11.1	U
Metals - Unfiltered	Silver	N	µg/L	11.1	U	10	U	11.1	U	11.1	U	11.1	U
Metals - Unfiltered	Sodium	N	µg/L	6860		6380		6990		12200		9150	
Metals - Unfiltered	Thallium	N	µg/L	5.56	U	10	U	5.56	U	5.56	U	5.56	U
Metals - Unfiltered	Vanadium	N	µg/L	4.44	U	50	U	4.44	U	5.39		4.44	U
Metals - Unfiltered	Zinc	N	µg/L	55.6	U	20	U	55.6	U	55.6	U	55.6	U
Metals - Filtered	Aluminum	Y	µg/L	88.9	U	200	U	88.9	U	88.9	U	88.9	U
Metals - Filtered	Antimony	Y	µg/L	5.56	U	60	U	5.56	U	5.56	U	5.56	U
Metals - Filtered	Arsenic	Y	µg/L	11.1	U	10	U	11.1	U	11.1	U	11.1	U
Metals - Filtered	Barium	Y	µg/L	29.3		200	U	28.2		34.9		22.8	
Metals - Filtered	Beryllium	Y	µg/L	4.44	U	5	U	4.44	U	4.44	U	4.44	U
Metals - Filtered	Cadmium	Y	µg/L	3.98	J	5	U	3.9	J	4.36	J	4.13	J

Appendix H

Chemical Analytical Data Summary
Groundwater
Plum Brook Ordnance Works, Sandusky, Ohio

			LOCATION_CODE	ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ01		ASH PIT 2-PZ03		ASH PIT 2-PZ04	
			SAMPLE_NO	AP3015		AP3016		AP3022		AP3018		AP3019	
			SAMPLE_DATE	2-Feb-09		2-Feb-09		2-Feb-09		31-Jan-09		1-Feb-09	
			FK_DEPTH	0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
			SAMPLE_PURPOSE	FD		FS		REG		REG		REG	
Test Group	Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual	Result	ValQual
Metals - Filtered	Calcium	Y	µg/L	108000		103000		103000		172000		135000	
Metals - Filtered	Chromium	Y	µg/L	11.1	U	10	U	11.1	U	11.1	U	11.1	U
Metals - Filtered	Cobalt	Y	µg/L	8.89	U	50	U	8.89	U	8.89	U	8.89	U
Metals - Filtered	Copper	Y	µg/L	11.1	U	25	U	11.1	U	6.9	J	11.1	U
Metals - Filtered	Iron	Y	µg/L	88.9	U	100	U	88.9	U	88.9	U	88.9	U
Metals - Filtered	Lead	Y	µg/L	5.56	U	3	U	5.56	U	5.56	U	5.56	U
Metals - Filtered	Magnesium	Y	µg/L	31100		29900		31400		42800		40800	
Metals - Filtered	Manganese	Y	µg/L	17.1		30.7		19		4.44	U	16.2	
Metals - Filtered	Mercury	Y	µg/L	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Metals - Filtered	Nickel	Y	µg/L	6.67	U	40	U	6.67	U	6.67	U	6.67	U
Metals - Filtered	Potassium	Y	µg/L	445	J	5000	U	460	J	510	J	346	J
Metals - Filtered	Selenium	Y	µg/L	11.1	U	5	U	11.1	U	6.82	J	11.1	U
Metals - Filtered	Silver	Y	µg/L	11.1	U	10	U	11.1	U	11.1	U	11.1	U
Metals - Filtered	Sodium	Y	µg/L	6840		6180		7000		12500		9280	
Metals - Filtered	Thallium	Y	µg/L	5.56	U	10	U	5.56	U	5.56	U	5.56	U
Metals - Filtered	Vanadium	Y	µg/L	4.44	U	50	U	4.44	U	4.44	U	4.44	U
Metals - Filtered	Zinc	Y	µg/L	55.6	U	20	U	55.6	U	55.6	U	55.6	U
Cyanide	Cyanide, total	N	ppm	0.025	U			0.025	U	0.025	U	0.025	U
Water Quality Parameters	Alkalinity	N	ppm	222		260		169		231		132	
Water Quality Parameters	Chloride	N	ppm	2.81	J	2.1		3.04	J	11.6	J	5.14	J
Water Quality Parameters	Cyanide, total	N	ppm			0.044							
Water Quality Parameters	Hardness	N	ppm	408		620		407		622		501	
Water Quality Parameters	HARDNESS (as CaCO3)	N	ppm										
Water Quality Parameters	Nitrate	N	ppm			0.1	U						
Water Quality Parameters	Nitrate-Nitrite	N	ppm	0.4	UJ			0.028	J	0.566	J	0.049	J
Water Quality Parameters	Sulfate	N	ppm	79.6		177		80.6		341		236	
Water Quality Parameters	Total dissolved solids	N	ppm	442		450		450		804		619	
Water Quality Parameters	Total suspended solids	N	ppm	4	U	4	U	4		59		3	J
Water Quality Parameters	Turbidity	N	NTU	4.93		1.3		4.52		51.5	J	4.56	J

APPENDIX I

DETECTED HITS SUMMARY

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = DS or SS

LOCATION_CODE				ASH PIT 2-SB01			ASH PIT 2-SB01			ASH PIT 2-SB01			ASH PIT 2-SB02			ASH PIT 2-SB02		
SAMPLE_NO				AP0100			AP0101			AP0102			AP0103			AP0104		
SAMPLE_DATE				15-Jan-09			15-Jan-09			15-Jan-09			16-Jan-09			16-Jan-09		
FK_DEPTH				0 - 1 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft		
SAMPLE_PURPOSE				REG			REG			REG			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
GEN CHEMISTRY	% Solids	N	Percent															
GEN CHEMISTRY	Total organic carbon	N	mg/kg										11400	B				
METALS	Aluminum	N	mg/kg	6460		J	6420		J	8750		J	9310		J	12700		J
METALS	Antimony	N	mg/kg	0.81			0.269	J	J	0.355	J	J	0.958			0.362	J	J
METALS	Arsenic	N	mg/kg	11.6			4.93			11.3			15.3			15.7		J
METALS	Barium	N	mg/kg	55.7		J	45.6			26.8			84.4		J	85.3		J
METALS	Beryllium	N	mg/kg	4.74			5.97			6.72			15.3		J	9.06		J
METALS	Cadmium	N	mg/kg	0.436	J	J	- -		-	- -		-	0.381	J	J	- -		-
METALS	Calcium	N	mg/kg	47200		J	4310			47400			7110			23300		
METALS	Chromium	N	mg/kg	8.64			11.5			13			11.1			19.8		
METALS	Cobalt	N	mg/kg	7.74			8.32			11.9			14.6		J	13.4		J
METALS	Copper	N	mg/kg	23.6		J	18.3		J	32		J	33.7		J	28.9		J
METALS	Iron	N	mg/kg	14300		J	16500		J	23100		J	61300		J	30500		J
METALS	Lead	N	mg/kg	50.7			8.39			13			22.5			13.8		
METALS	Magnesium	N	mg/kg	8960		J	2350		J	11400		J	1560		J	8640		J
METALS	Manganese	N	mg/kg	354		J	172			386			546			726		J
METALS	Mercury	N	mg/kg	0.0959			0.0245			0.0128	J	J	0.0539			0.0162	J	J
METALS	Nickel	N	mg/kg	18.3		J	20.2			32.6			35.5			35.6		
METALS	Potassium	N	mg/kg	893		J	589			1160			587			1170		
METALS	Selenium	N	mg/kg	0.727	J	J	- -		-	- -		-	1.36			- -		-
METALS	Silver	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	mg/kg	55.1			68.7			107			60.4			93.9		
METALS	Thallium	N	mg/kg	0.425	J	J	- -		-	0.423	J	J	0.416	J	J	0.3	J	J
METALS	Vanadium	N	mg/kg	15.9			16.5			17.3			21.4			26.2		
METALS	Zinc	N	mg/kg	64			67.4			59.1			88.6			74.6		
PEST/PCB	Aroclor 1016	N	mg/kg	- -		-	- -		-				0.525	P	J	- -		-
PEST/PCB	Aroclor 1260	N	mg/kg	- -		-	- -		-				- -		-	- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	mg/kg	0.0827	J	J	- -		-	- -		-	0.0464	J	J	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	mg/kg	0.0844	J	J	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	mg/kg	0.13	J	J	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	mg/kg	- -		-	- -		-	- -		-	1.43			- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	mg/kg	0.0979	J	J	- -		-	- -		-	0.0639	J	J	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	mg/kg	0.132	J	J	- -		-	- -		-	0.131	J	J	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	mg/kg	0.0446	J	J	- -		-	- -		-	0.0559	J	J	- -		-
SEMIVOLATILES	Phenanthrene	N	mg/kg	0.0733	J	J	- -		-	0.0855	J	J	0.0964	J	J	- -		-
SEMIVOLATILES	Pyrene	N	mg/kg	0.111	J	J	- -		-	- -		-	0.0894	J	J	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = DS or SS

LOCATION_CODE				ASH PIT 2-SB02			ASH PIT 2-SB02			ASH PIT 2-SB02			ASH PIT 2-SB03			ASH PIT 2-SB03		
SAMPLE_NO				AP0105			AP0106			AP0107			AP0108			AP0109		
SAMPLE_DATE				16-Jan-09			16-Jan-09			16-Jan-09			18-Jan-09			18-Jan-09		
FK_DEPTH				3 - 5 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft		
SAMPLE_PURPOSE				FD			FS			REG			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
GEN CHEMISTRY	% Solids	N	Percent				82.2											
GEN CHEMISTRY	Total organic carbon	N	mg/kg															
METALS	Aluminum	N	mg/kg	8930		J	6930			10700		J	8070			15000		
METALS	Antimony	N	mg/kg	0.287	J	J	- -		-	0.626			0.637			0.257	J	J
METALS	Arsenic	N	mg/kg	8.31		J	4			12.1			7.71		J	5.27		J
METALS	Barium	N	mg/kg	59.4		J	54.4			41.2		J	69.4		J	98.9		J
METALS	Beryllium	N	mg/kg	6.76		J	- -		-	7.06		J	6.46		J	7.43		J
METALS	Cadmium	N	mg/kg	- -		-	- -		-	- -		-	0.558			- -		-
METALS	Calcium	N	mg/kg	16100			7170		J	46600			3430		J	36500		J
METALS	Chromium	N	mg/kg	13.7			10.6			16			12		J	22.1		J
METALS	Cobalt	N	mg/kg	10.9		J	8.3			11.7		J	8.68		J	10.8		J
METALS	Copper	N	mg/kg	20.9		J	13.4			27.8		J	22.5			29.8		
METALS	Iron	N	mg/kg	19400		J	13300			23200		J	19100			24900		
METALS	Lead	N	mg/kg	11.9			7.5			18.9			27.7		J	16.7		J
METALS	Magnesium	N	mg/kg	4940		J	3340			10800		J	2150		J	10100		J
METALS	Manganese	N	mg/kg	351		J	320			431			211			436		
METALS	Mercury	N	mg/kg	0.0164	J	J	- -		-	- -		-	0.0642			0.013	J	J
METALS	Nickel	N	mg/kg	26.9			18.7			30.8			21.7		J	31.5		J
METALS	Potassium	N	mg/kg	803			1070		J	1450			745			1570		
METALS	Selenium	N	mg/kg	- -		-	- -		-	- -		-	0.928	J	J	- -		-
METALS	Silver	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	mg/kg	64.9			- -		-	152			36.3			119		
METALS	Thallium	N	mg/kg	- -		-	- -		-	0.343	J	J	0.47	J	J	0.35	J	J
METALS	Vanadium	N	mg/kg	18.1			13			20.2			18.7			25.3		
METALS	Zinc	N	mg/kg	66.2			43.5			62.9			80		J	68.5		J
PEST/PCB	Aroclor 1016	N	mg/kg	- -		-	- -		-				- -		-	- -		-
PEST/PCB	Aroclor 1260	N	mg/kg	- -		-	- -		-				0.0162	P,J	J	- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	mg/kg	- -		-	- -		-	- -		-	0.0307	K		- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	mg/kg	- -		-				- -		-	- -		-	- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	0.0599	J	J	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Phenanthrene	N	mg/kg	- -		-	- -		-	0.0544	J	J	- -		-	- -		-
SEMIVOLATILES	Pyrene	N	mg/kg	- -		-	- -		-	- -		-	0.044	J	J	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = DS or SS

LOCATION_CODE				ASH PIT 2-SB03			ASH PIT 2-SB04			ASH PIT 2-SB04			ASH PIT 2-SB04			ASH PIT 2-SB05		
SAMPLE_NO				AP0110			AP0111			AP0112			AP0113			AP0114		
SAMPLE_DATE				18-Jan-09			18-Jan-09			18-Jan-09			19-Jan-09			16-Jan-09		
FK_DEPTH				8 - 10 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft		
SAMPLE_PURPOSE				REG			REG			REG			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
GEN CHEMISTRY	% Solids	N	Percent															
GEN CHEMISTRY	Total organic carbon	N	mg/kg															
METALS	Aluminum	N	mg/kg	7720			7130			7830			8670			8800		J
METALS	Antimony	N	mg/kg	0.329	J	J	0.485			0.312	J	J	0.392	J	J	0.922		
METALS	Arsenic	N	mg/kg	12.6		J	26.8		J	4.51		J	12.1		J	24.4		
METALS	Barium	N	mg/kg	18.6		J	98.4		J	61.5		J	35.6		J	109		J
METALS	Beryllium	N	mg/kg	6.35		J	16.3		J	6.68		J	7.02		J	15.5		J
METALS	Cadmium	N	mg/kg	- -		-	- -		-	- -		-	- -		-	0.716		
METALS	Calcium	N	mg/kg	54300		J	2160		J	3010		J	50700		J	4140		
METALS	Chromium	N	mg/kg	11.8		J	10.5		J	11.9		J	12.7		J	12.8		
METALS	Cobalt	N	mg/kg	10.7		J	5.96		J	7.88		J	11		J	8.29		J
METALS	Copper	N	mg/kg	29.6			26			20.9			38.4			31.3		J
METALS	Iron	N	mg/kg	22100			109000			19200			24400			61600		J
METALS	Lead	N	mg/kg	15.8		J	10.1		J	18.9		J	16		J	27.4		
METALS	Magnesium	N	mg/kg	10400		J	442		J	2530		J	10800		J	1320		J
METALS	Manganese	N	mg/kg	414			116			87.4			522			319		
METALS	Mercury	N	mg/kg	0.0132	J	J	0.0265			0.0352			0.0147	J	J	0.118		
METALS	Nickel	N	mg/kg	27.4		J	17.1		J	24.8		J	28.8		J	20.5		
METALS	Potassium	N	mg/kg	1110			827			705			1150			837		
METALS	Selenium	N	mg/kg	- -		-	0.678	J	J	0.859	J	J	- -		-	1.44		
METALS	Silver	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	mg/kg	120			55.7			43.6			119			79.2		
METALS	Thallium	N	mg/kg	0.336	J	J	0.468	J	J	- -		-	0.315	J	J	0.939		
METALS	Vanadium	N	mg/kg	15.4			26.9			17.8			17.5			23		
METALS	Zinc	N	mg/kg	61.5		J	57		J	64.4		J	60.4		J	102		
PEST/PCB	Aroclor 1016	N	mg/kg				- -		-	- -		-				- -		-
PEST/PCB	Aroclor 1260	N	mg/kg				- -		-	- -		-				- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	0.0444	J	J
SEMIVOLATILES	Phenanthrene	N	mg/kg	0.0667	J	J	- -		-	- -		-	0.0453	J	J	- -		-
SEMIVOLATILES	Pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = DS or SS

LOCATION_CODE				ASH PIT 2-SB05			ASH PIT 2-SB05			ASH PIT 2-SB06			ASH PIT 2-SB06			ASH PIT 2-SB06		
SAMPLE_NO				AP0115			AP0116			AP0117			AP0118			AP0119		
SAMPLE_DATE				16-Jan-09			16-Jan-09			15-Jan-09			15-Jan-09			15-Jan-09		
FK_DEPTH				3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
SAMPLE_PURPOSE				REG			REG			REG			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
GEN CHEMISTRY	% Solids	N	Percent															
GEN CHEMISTRY	Total organic carbon	N	mg/kg															
METALS	Aluminum	N	mg/kg	8060		J	9300		J	7150		J	6750		J	13200		J
METALS	Antimony	N	mg/kg	0.259	J	J	0.486			0.708			0.412	J	J	0.44	J	J
METALS	Arsenic	N	mg/kg	6.27			11.1			11.4			6.33			3.55		
METALS	Barium	N	mg/kg	68.2		J	49		J	98.7			58.3			53.4		J
METALS	Beryllium	N	mg/kg	7.61		J	7.53		J	12.1			6.9			7.73		J
METALS	Cadmium	N	mg/kg	- -		-	0.276	J	J	0.423	J	J	0.293	J	J	- -		-
METALS	Calcium	N	mg/kg	351			42300			2830			2090			44000		
METALS	Chromium	N	mg/kg	11.7			14.4			7.84			10.1			19.4		
METALS	Cobalt	N	mg/kg	6.67		J	14		J	4.64			8.93			14.6		J
METALS	Copper	N	mg/kg	15.6		J	33.6		J	22.2		J	12.6		J	32.1		J
METALS	Iron	N	mg/kg	22100		J	24500		J	51800		J	19900		J	24000		J
METALS	Lead	N	mg/kg	12.2			13.4			12.5			11.2			14.3		
METALS	Magnesium	N	mg/kg	1980		J	8760		J	819		J	2110		J	12000		J
METALS	Manganese	N	mg/kg	100			551			243			234			392		
METALS	Mercury	N	mg/kg	0.0242	J	J	- -		-	0.0688			0.0156	J	J	0.0132	J	J
METALS	Nickel	N	mg/kg	18			36.8			13.7			21.8			36.7		
METALS	Potassium	N	mg/kg	513			990			616			426			1730		
METALS	Selenium	N	mg/kg	- -		-	0.779	J	J	0.737	J	J	- -		-	- -		-
METALS	Silver	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	mg/kg	18.4			91.4			76.3			37.1			135		
METALS	Thallium	N	mg/kg	- -		-	0.347	J	J	0.312	J	J	- -		-	0.293	J	J
METALS	Vanadium	N	mg/kg	17			18.2			17.3			15.5			23.2		
METALS	Zinc	N	mg/kg	68.9			85.3			53.2			63.7			73		
PEST/PCB	Aroclor 1016	N	mg/kg	- -		-				- -		-	- -		-			
PEST/PCB	Aroclor 1260	N	mg/kg	- -		-				- -		-	- -		-			
SEMIVOLATILES	Benzo(a)anthracene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	mg/kg	- -		-	- -		-	0.622			- -		-	- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Phenanthrene	N	mg/kg	- -		-	0.0491	J	J	- -		-	- -		-	0.0403	J	J
SEMIVOLATILES	Pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = DS or SS

LOCATION_CODE				ASH PIT 2-SB07			ASH PIT 2-SB07			ASH PIT 2-SB07			ASH PIT 2-SB07			ASH PIT 2-SB07		
SAMPLE_NO				AP0120			AP0121			AP0122			AP0123			AP0124		
SAMPLE_DATE				16-Jan-09			16-Jan-09			16-Jan-09			16-Jan-09			16-Jan-09		
FK_DEPTH				0 - 1 Ft			0 - 1 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
SAMPLE_PURPOSE				REG			FD			FS			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
GEN CHEMISTRY	% Solids	N	Percent							79.9								
GEN CHEMISTRY	Total organic carbon	N	mg/kg															
METALS	Aluminum	N	mg/kg	7100		J	8180		J	7200			5250		J	7150		J
METALS	Antimony	N	mg/kg	0.336	J	J	0.291	J	J	- -		-	0.269	J	J	0.479		
METALS	Arsenic	N	mg/kg	6.09			6.04			5.5			6.18			10.9		
METALS	Barium	N	mg/kg	44.5			56.7			48.6			43.7			20.8		J
METALS	Beryllium	N	mg/kg	6.01			6.41			- -		-	5.46			6.31		J
METALS	Cadmium	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Calcium	N	mg/kg	2100			2270			1820		J	1840			153000		
METALS	Chromium	N	mg/kg	10.6			11.8			10.4			8.82			11		
METALS	Cobalt	N	mg/kg	8.14			8.99			7.7			7.46			11		J
METALS	Copper	N	mg/kg	18		J	16.5		J	14.6			13.8		J	31.5		J
METALS	Iron	N	mg/kg	17600		J	19100		J	16600			15500		J	55100		J
METALS	Lead	N	mg/kg	12.5			12.8			9.3			9.74			15.9		
METALS	Magnesium	N	mg/kg	2100		J	2350		J	1880			1730		J	9490		J
METALS	Manganese	N	mg/kg	198			226			169			152			372		
METALS	Mercury	N	mg/kg	0.0203	J	J	0.0193	J	J	- -		-	0.0112	J	J	- -		-
METALS	Nickel	N	mg/kg	19.1			20.2			17.9			18.5			32.5		
METALS	Potassium	N	mg/kg	450			470			703		J	323			1060		
METALS	Selenium	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Silver	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	mg/kg	28.4			28			- -		-	43.3			116		
METALS	Thallium	N	mg/kg	- -		-	- -		-	- -		-	- -		-	0.316	J	J
METALS	Vanadium	N	mg/kg	15.4			17.4			14.1			13.6			13.6		
METALS	Zinc	N	mg/kg	63.2			27.8			51.4			55.4			52.7		
PEST/PCB	Aroclor 1016	N	mg/kg	- -		-	- -		-	- -		-	- -		-			
PEST/PCB	Aroclor 1260	N	mg/kg	- -		-	- -		-	- -		-	- -		-			
SEMIVOLATILES	Benzo(a)anthracene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	mg/kg	- -		-	- -		-				- -		-	- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Phenanthrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	0.0798	J	J
SEMIVOLATILES	Pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = DS or SS

LOCATION_CODE				ASH PIT 2-SB08			ASH PIT 2-SB08			ASH PIT 2-SB08			ASH PIT 2-SB08			ASH PIT 2-SB08		
SAMPLE_NO				AP0125			AP0126			AP0127			AP0128			AP0129		
SAMPLE_DATE				16-Jan-09			16-Jan-09			16-Jan-09			16-Jan-09			16-Jan-09		
FK_DEPTH				0 - 1 Ft			3 - 5 Ft			8 - 10 Ft			8 - 10 Ft			8 - 10 Ft		
SAMPLE_PURPOSE				REG			REG			REG			FD			FS		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
GEN CHEMISTRY	% Solids	N	Percent													72.9		
GEN CHEMISTRY	Total organic carbon	N	mg/kg															
METALS	Aluminum	N	mg/kg	4070		J	5350		J	15100		J	14900		J	12100		
METALS	Antimony	N	mg/kg	- -		-	0.227	J	J	- -		-	0.248	J	J	- -		-
METALS	Arsenic	N	mg/kg	12.8			12.6			6.16			6.61			7		
METALS	Barium	N	mg/kg	73.2		J	56		J	81		J	83.7		J	85		
METALS	Beryllium	N	mg/kg	16.9		J	8.48		J	8.51		J	8.11		J	- -		-
METALS	Cadmium	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Calcium	N	mg/kg	1650			1860			44800			45500			45000	E	J
METALS	Chromium	N	mg/kg	6.13			8.82			22.4			21.9			18.5		
METALS	Cobalt	N	mg/kg	3.9		J	8.7		J	15.6		J	14.6		J	12.4		
METALS	Copper	N	mg/kg	21.3		J	11		J	31.1		J	30.1		J	23.9		
METALS	Iron	N	mg/kg	72600		J	28000		J	26600		J	28500		J	23900		
METALS	Lead	N	mg/kg	4.64			9.05			11.6			14.1			10.7		
METALS	Magnesium	N	mg/kg	312		J	1730		J	12200		J	11500		J	10100		
METALS	Manganese	N	mg/kg	98.2			196			473			432			363		
METALS	Mercury	N	mg/kg	0.034			0.0151	J	J	- -		-	- -		-	- -		-
METALS	Nickel	N	mg/kg	10.5			22			39.7			38			32.8		
METALS	Potassium	N	mg/kg	477			371			1980			1990			2870	E	J
METALS	Selenium	N	mg/kg	0.914	J	J	- -		-	- -		-	- -		-	- -		-
METALS	Silver	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	mg/kg	36.4			27.4			145			134			- -		-
METALS	Thallium	N	mg/kg	0.308	J	J	- -		-	- -		-	- -		-	- -		-
METALS	Vanadium	N	mg/kg	18.8			15.1			25.4			24.7			20.5		
METALS	Zinc	N	mg/kg	41.4			58.9			76.6			73.4			61.3		
PEST/PCB	Aroclor 1016	N	mg/kg	- -		-	- -		-									
PEST/PCB	Aroclor 1260	N	mg/kg	- -		-	- -		-									
SEMIVOLATILES	Benzo(a)anthracene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	mg/kg	- -		-	- -		-	- -		-	- -		-			
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Phenanthrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002		
SAMPLE_NO				AP3063			AP3079			AP3081			AP3082		
SAMPLE_DATE				24-May-09			17-Nov-09			17-Nov-09			17-Nov-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	ug/L	- -		-	- -		-	- -		-			
FIELD TESTS	Dissolved Oxygen	N	ppm	1.64			1.01						1.01		
FIELD TESTS	FERROUS IRON	N	mg/L				2						0		
FIELD TESTS	Oxidation Reduction Potential	N	mV	-144.8			-6.9						-6.9		
FIELD TESTS	pH	N	pH_units	6.2			6.78						6.78		
FIELD TESTS	Specific Conductivity	N	mS/cm	2.968			2.635						2.635		
FIELD TESTS	Temperature	N	C	17			9.67						9.67		
FIELD TESTS	Turbidity	N	NTU	16.2			3.6						3.6		
GEN CHEMISTRY	Alkalinity	N	ppm	417			472		J	492		J			
GEN CHEMISTRY	Chloride	N	ppm	40.6			74.2		J	46.9		J			
GEN CHEMISTRY	Cyanide, total	N	ppm	0.0072	B	J	- -		-	- -		-			
GEN CHEMISTRY	Hardness	N	ppm												
GEN CHEMISTRY	HARDNESS (as CaCO3)	N	ppm	1440			1490			1460					
GEN CHEMISTRY	Nitrate-Nitrite	N	ppm	- -		-	2		J						
GEN CHEMISTRY	Sulfate	N	ppm	946			776		J	1070		J			
GEN CHEMISTRY	Total dissolved solids	N	ppm	2240		J	2200		J	2050		J			
GEN CHEMISTRY	Total suspended solids	N	ppm	18			4	B	UJ	- -		-			
GEN CHEMISTRY	Turbidity	N	NTU	38.2		J	1.7		J	21.4		J			
METALS	Aluminum	N	ug/L	42.8	B	J	46.7	B	J	45.5	B	J			
METALS	Aluminum	Y	ug/L	16.2	B	J									
METALS	Antimony	N	ug/L	- -		-	- -		-	- -		-			
METALS	Antimony	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Arsenic	N	ug/L	- -		-	- -		-	- -		-			
METALS	Arsenic	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Barium	N	ug/L	22.7	B	J	21.1	B	J	21.3	B	J			
METALS	Barium	Y	ug/L	22.6	B	J	19.8	B	J	18.8	B	J			
METALS	Beryllium	N	ug/L	- -		-	- -		-	- -		-			
METALS	Beryllium	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Cadmium	N	ug/L	- -		-	- -		-	- -		-			
METALS	Cadmium	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Calcium	N	ug/L	377000			392000		J	385000		J			
METALS	Calcium	Y	ug/L	389000			347000		J	335000		J			
METALS	Chromium	N	ug/L	- -		-	- -		-	- -		-			
METALS	Chromium	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Cobalt	N	ug/L	- -		-	- -		-	- -		-			
METALS	Cobalt	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Copper	N	ug/L	- -		-	- -		-	- -		-			
METALS	Copper	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Iron	N	ug/L	283	B	J	- -		-	- -		-			
METALS	Iron	Y	ug/L	- -		-	36.1	B	J	46.5	B	J			
METALS	Lead	N	ug/L	- -		-	- -		-						

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002		
SAMPLE_NO				AP3063			AP3079			AP3081			AP3082		
SAMPLE_DATE				24-May-09			17-Nov-09			17-Nov-09			17-Nov-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
METALS	Lead	Y	ug/L				- -		-	- -		-			
METALS	Magnesium	N	ug/L	121000			124000			123000					
METALS	Magnesium	Y	ug/L	119000			118000		J	113000		J			
METALS	Manganese	N	ug/L	53.7			11.1	B	J	10.7	B	J			
METALS	Manganese	Y	ug/L	52.4			9.6	B	J	9.3	B	J			
METALS	Mercury	N	ug/L	- -		-	- -		-	- -		-			
METALS	Mercury	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Nickel	N	ug/L	- -		-	- -		-	- -		-			

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002		
SAMPLE_NO				AP3063			AP3079			AP3081			AP3082		
SAMPLE_DATE				24-May-09			17-Nov-09			17-Nov-09			17-Nov-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
METALS	Nickel	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Potassium	N	ug/L	7740	B	J	10900			11000					
METALS	Potassium	Y	ug/L	9790	B	J	11500		J	11000		J			
METALS	Selenium	N	ug/L	- -		-	21.3		J	17.7		J			
METALS	Selenium	Y	ug/L	- -		-	74.9		J	14.3		J			
METALS	Silver	N	ug/L	- -		-	- -		-	- -		-			
METALS	Silver	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Sodium	N	ug/L	26400			32100		J	32100		J			
METALS	Sodium	Y	ug/L	28900			33100			31400					
METALS	Thallium	N	ug/L	- -		-	- -		-	- -		-			
METALS	Thallium	Y	ug/L	- -		-	- -		-	- -		-			
METALS	Vanadium	N	ug/L	1.6	B	J	1.1	B	J	- -		-			
METALS	Vanadium	Y	ug/L	1.1	B	J	2	B	J	2.3	B	J			
METALS	Zinc	N	ug/L	- -		-	- -		-	- -		-			
METALS	Zinc	Y	ug/L	- -		-	- -		-	- -		-			
PEST/PCB	Aroclor 1016	N	ug/L	- -		-									
PEST/PCB	Aroclor 1260	N	ug/L	- -		-									
SEMIVOLATILES	Benzo(a)anthracene	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Benzo(a)pyrene	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Benzo(b)fluoranthene	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Benzoic acid	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Chrysene	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Dimethylphenol, 2,4-	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Fluoranthene	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Methylnaphthalene, 2-	N	ug/L	2.8	J	J	2.8	J	J	2.5	J	J			
SEMIVOLATILES	Naphthalene	N	ug/L	2	J	J	1.9	J	J	1.6	J	J			
SEMIVOLATILES	Phenanthrene	N	ug/L	- -		-	- -		-	- -		-			
SEMIVOLATILES	Pyrene	N	ug/L	- -		-	- -		-	- -		-			
VOLATILES	Acetone	N	ug/L	- -		-	50.6		J	34.4		J			
VOLATILES	Benzene	N	ug/L	8.5			9.4		J	6.2		J			
VOLATILES	Butanone, 2-	N	ug/L	7.4			2.4	J	J	- -		-			
VOLATILES	Carbon disulfide	N	ug/L	- -		-	- -		-						
VOLATILES	Chloroform	N	ug/L	- -		-									
VOLATILES	Chloromethane	N	ug/L	- -		-	7.7	J	J	3.5	J	J			
VOLATILES	Cyclohexane	N	ug/L												
VOLATILES	Dichloropropene, trans-1,3-	N	ug/L	- -		-	- -		-	- -		-			
VOLATILES	Ethylbenzene	N	ug/L	9.6			9.7		J	6.6		J			
VOLATILES	Isopropylbenzene	N	ug/L												
VOLATILES	Methylcyclohexane	N	ug/L												
VOLATILES	Methylene chloride	N	ug/L	- -		-	- -		-	- -		-			

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002		
SAMPLE_NO				AP3063			AP3079			AP3081			AP3082		
SAMPLE_DATE				24-May-09			17-Nov-09			17-Nov-09			17-Nov-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
VOLATILES	Toluene	N	ug/L	5.3			4.8		J	3.3		J			
VOLATILES	Xylenes, total	N	ug/L	63.2			55.7		J	36.8		J			

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-BEDGW-003			AP2-BEDGW-003			AP2-BEDGW-003			AP2-BEDGW-003			AP2-MW01		
SAMPLE_NO				AP3064			AP3065			AP3066			AP3080			AP3057		
SAMPLE_DATE				23-May-09			23-May-09			23-May-09			16-Nov-09			23-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			FD			FS			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
FIELD TESTS	Dissolved Oxygen	N	ppm	0.22									4.51			10.27		
FIELD TESTS	FERROUS IRON	N	mg/L	0									0			0		
FIELD TESTS	Oxidation Reduction Potential	N	mV	-315.1									-1.8			-141.3		
FIELD TESTS	pH	N	pH_units	6.15									6.72			6.35		
FIELD TESTS	Specific Conductivity	N	mS/cm	2.141									2.202			0.895		
FIELD TESTS	Temperature	N	C	25.59									8.87			13.59		
FIELD TESTS	Turbidity	N	NTU	5.9									0			2.5		
GEN CHEMISTRY	Alkalinity	N	ppm	649		J	632			590			662		J	362		
GEN CHEMISTRY	Chloride	N	ppm	111			105			93.6			118			4.6		
GEN CHEMISTRY	Cyanide, total	N	ppm	- -		-	- -		-	0.71			- -		-	- -		-
GEN CHEMISTRY	Hardness	N	ppm							1200								
GEN CHEMISTRY	HARDNESS (as CaCO3)	N	ppm	1090			1140						1160			439		
GEN CHEMISTRY	Nitrate-Nitrite	N	ppm	0.76	B	J	- -		-	- -		-				0.065	B	J
GEN CHEMISTRY	Sulfate	N	ppm	519			476			626			496			81.5		
GEN CHEMISTRY	Total dissolved solids	N	ppm	1900		J	1740		J	1500			1570		J	294		J
GEN CHEMISTRY	Total suspended solids	N	ppm	- -		-	17			- -		-	- -		-	- -		-
GEN CHEMISTRY	Turbidity	N	NTU	14		J	- -		-	94			51.2			- -		-
METALS	Aluminum	N	ug/L	- -		-	17.4	B	J	- -		-	33.9	B	J	133	B	J
METALS	Aluminum	Y	ug/L	- -		-	12.4	B	J	- -		-				- -		-
METALS	Antimony	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Antimony	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Arsenic	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Arsenic	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Barium	N	ug/L	175	B	J	184	B	J	- -		-	161	B	J	98	B	J
METALS	Barium	Y	ug/L	171	B	J	186	B	J	- -		-	164	B	J	88.1	B	J
METALS	Beryllium	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Beryllium	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Cadmium	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Cadmium	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Calcium	N	ug/L	266000		J	275000			317000			280000		J	112000		
METALS	Calcium	Y	ug/L	257000			281000			323000			256000		J	102000		
METALS	Chromium	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Chromium	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Cobalt	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Cobalt	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Copper	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Copper	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Iron	N	ug/L	- -		-	33	B	J	- -		-	- -		-	80.8	B	J
METALS	Iron	Y	ug/L	- -		-	- -		-	- -		-	65.5	B	J	- -		-
METALS	Lead	N	ug/L	- -		-	- -		-	- -		-	- -		-	2.4	B	J

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-BEDGW-003			AP2-BEDGW-003			AP2-BEDGW-003			AP2-BEDGW-003			AP2-MW01		
SAMPLE_NO				AP3064			AP3065			AP3066			AP3080			AP3057		
SAMPLE_DATE				23-May-09			23-May-09			23-May-09			16-Nov-09			23-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			FD			FS			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
METALS	Lead	Y	ug/L	- -		-	- -		-	- -		-	- -		-			
METALS	Magnesium	N	ug/L	103000		J	110000			120000			112000			38700		
METALS	Magnesium	Y	ug/L	98700		J	108000			123000			109000		J	34100		
METALS	Manganese	N	ug/L	5.9	B	J	5.4	B	J	- -		-	7.1	B	J	82.2		
METALS	Manganese	Y	ug/L	5.6	B	J	6.1	B	J	- -		-	7.2	B	J	72.3		
METALS	Mercury	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Mercury	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Nickel	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-BEDGW-003			AP2-BEDGW-003			AP2-BEDGW-003			AP2-BEDGW-003			AP2-MW01		
SAMPLE_NO				AP3064			AP3065			AP3066			AP3080			AP3057		
SAMPLE_DATE				23-May-09			23-May-09			23-May-09			16-Nov-09			23-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			FD			FS			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
METALS	Nickel	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Potassium	N	ug/L	13300			11500	B	J	11300			15600			4150	B	J
METALS	Potassium	Y	ug/L	13000			13800			11800			16300		J	5030	B	J
METALS	Selenium	N	ug/L							- -		-	12.4		J	- -		-
METALS	Selenium	Y	ug/L	8.1	B	J	8.8	B	J	- -		-	22.4		J	3.5	B	J
METALS	Silver	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Silver	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	ug/L	56600		J	58500			63000			61100		J	7440	B	J
METALS	Sodium	Y	ug/L	55700			58700			65900			63100			8520	B	J
METALS	Thallium	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Thallium	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Vanadium	N	ug/L	1	B	J	1.3	B	J	- -		-	- -		-	3.7	B	J
METALS	Vanadium	Y	ug/L	1.2	B	J	1.1	B	J	- -		-	2.6	B	J	3.5	B	
METALS	Zinc	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Zinc	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
PEST/PCB	Aroclor 1016	N	ug/L	- -		-	- -		-	- -		-				- -		-
PEST/PCB	Aroclor 1260	N	ug/L	- -		-	- -		-	- -		-				- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	ug/L	- -		-	- -		-				- -		-	- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	ug/L	- -		-	- -		-	- -		-	1.7	J	J	- -		-
SEMIVOLATILES	Fluoranthene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	ug/L	1.9	J	J	1.3	J	J	- -		-	6.3			- -		-
SEMIVOLATILES	Naphthalene	N	ug/L	2.9	J	J	1.9	J	J	- -		-	7.4			- -		-
SEMIVOLATILES	Phenanthrene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Pyrene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
VOLATILES	Acetone	N	ug/L	- -		-	- -		-	- -		-	86.1	J	J	- -		-
VOLATILES	Benzene	N	ug/L	94.1			91.3			100			336			- -		-
VOLATILES	Butanone, 2-	N	ug/L	4.3	J	J	4.9	J	J	- -		-	- -		-	- -		-
VOLATILES	Carbon disulfide	N	ug/L	- -		-	- -		-	5.2			3.7	J	J	- -		-
VOLATILES	Chloroform	N	ug/L	- -		-	- -		-	- -		-				- -		-
VOLATILES	Chloromethane	N	ug/L	- -		-	- -		-	- -		-	44.9	J	J	- -		-
VOLATILES	Cyclohexane	N	ug/L							74								
VOLATILES	Dichloropropene, trans-1,3-	N	ug/L	- -		-	- -		-	- -		-	1.7	J	J	- -		-
VOLATILES	Ethylbenzene	N	ug/L	17.7			17.2			21			57.1			- -		-
VOLATILES	Isopropylbenzene	N	ug/L							5.8								
VOLATILES	Methylcyclohexane	N	ug/L							29								
VOLATILES	Methylene chloride	N	ug/L	- -		-	- -		-	- -		-				- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-BEDGW-003			AP2-BEDGW-003			AP2-BEDGW-003			AP2-BEDGW-003			AP2-MW01		
SAMPLE_NO				AP3064			AP3065			AP3066			AP3080			AP3057		
SAMPLE_DATE				23-May-09			23-May-09			23-May-09			16-Nov-09			23-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			FD			FS			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
VOLATILES	Toluene	N	ug/L	41.3			39.6			54			147			- -		-
VOLATILES	Xylenes, total	N	ug/L	193			185			260			630			- -		-

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Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-MW01			AP2-MW02			AP2-MW02			AP2-MW02			AP2-MW03		
SAMPLE_NO				AP3075			AP3058			AP3059			AP3060			AP3061		
SAMPLE_DATE				13-Nov-09			25-May-09			25-May-09			26-May-09			24-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	ug/L				- -		-	- -		-	- -		-	- -		-
FIELD TESTS	Dissolved Oxygen	N	ppm	1.32			1.92									5.6		
FIELD TESTS	FERROUS IRON	N	mg/L				0									0		
FIELD TESTS	Oxidation Reduction Potential	N	mV	-8.3			623.8									-394.8		
FIELD TESTS	pH	N	pH_units	6.99			5.72									6.29		
FIELD TESTS	Specific Conductivity	N	mS/cm	0.98			0.856									1.368		
FIELD TESTS	Temperature	N	C	14.59			11.69									13.2		
FIELD TESTS	Turbidity	N	NTU	7.8			1.7									10.1		
GEN CHEMISTRY	Alkalinity	N	ppm				70.3			73.4			72			116		
GEN CHEMISTRY	Chloride	N	ppm				4.1			3.6			12.6			6.5		
GEN CHEMISTRY	Cyanide, total	N	ppm				- -		-	- -		-	- -		-	- -		-
GEN CHEMISTRY	Hardness	N	ppm										330					
GEN CHEMISTRY	HARDNESS (as CaCO3)	N	ppm				300			302						188		
GEN CHEMISTRY	Nitrate-Nitrite	N	ppm				10.9			10.9			8.7			0.61		
GEN CHEMISTRY	Sulfate	N	ppm				165			159			173			94.9		
GEN CHEMISTRY	Total dissolved solids	N	ppm				507		J	508		J	460			295		J
GEN CHEMISTRY	Total suspended solids	N	ppm				- -		-	4	B	J	- -		-	- -		-
GEN CHEMISTRY	Turbidity	N	NTU				- -		-	- -		-	- -		-	1	B	J
METALS	Aluminum	N	ug/L				79.1	B	J	77.6	B	J	- -		-	47.1	B	J
METALS	Aluminum	Y	ug/L				45.4	B	J	44	B	J	- -		-	- -		-
METALS	Antimony	N	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Antimony	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Arsenic	N	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Arsenic	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Barium	N	ug/L				25.3	B	J	24.5	B	J	- -		-	25.2	B	J
METALS	Barium	Y	ug/L				23.9	B	J	23.6	B	J	- -		-	22.3	B	J
METALS	Beryllium	N	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Beryllium	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Cadmium	N	ug/L				1.1	B	J	1	B	J	- -		-	- -		-
METALS	Cadmium	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Calcium	N	ug/L				102000			102000			94900			54400		
METALS	Calcium	Y	ug/L				96400			93100			103000			47200		
METALS	Chromium	N	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Chromium	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Cobalt	N	ug/L				7.9	B	J	8.3	B	J	- -		-	- -		-
METALS	Cobalt	Y	ug/L				8.9	B	J	8.7	B	J	- -		-	- -		-
METALS	Copper	N	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Copper	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Iron	N	ug/L				- -		-	- -		-	- -		-	37	B	J
METALS	Iron	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Lead	N	ug/L				- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-MW01			AP2-MW02			AP2-MW02			AP2-MW02			AP2-MW03		
SAMPLE_NO				AP3075			AP3058			AP3059			AP3060			AP3061		
SAMPLE_DATE				13-Nov-09			25-May-09			25-May-09			26-May-09			24-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
METALS	Lead	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Magnesium	N	ug/L				11600			11600			10800			12700		
METALS	Magnesium	Y	ug/L				11000			10600			11900		J	11500		
METALS	Manganese	N	ug/L				229			229			212			173		
METALS	Manganese	Y	ug/L				220			214			218			171		
METALS	Mercury	N	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Mercury	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Nickel	N	ug/L				74.2			74.2			68.9			- -		-

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Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-MW01			AP2-MW02			AP2-MW02			AP2-MW02			AP2-MW03		
SAMPLE_NO				AP3075			AP3058			AP3059			AP3060			AP3061		
SAMPLE_DATE				13-Nov-09			25-May-09			25-May-09			26-May-09			24-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
METALS	Nickel	Y	ug/L				74.5			72.1			72.6			- -		-
METALS	Potassium	N	ug/L				7690	B	J	7410	B	J	8940			1500	B	J
METALS	Potassium	Y	ug/L				9090	B	J	8950	B	J	9500			1950	B	J
METALS	Selenium	N	ug/L				- -		-	- -		-	- -		-			
METALS	Selenium	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Silver	N	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Silver	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	ug/L				2560	B	J	2460	B	J	- -		-	10200	B	J
METALS	Sodium	Y	ug/L				3030	B	J	2930	B	J	- -		-	11000		
METALS	Thallium	N	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Thallium	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Vanadium	N	ug/L				- -		-	- -		-	- -		-	1.4	B	J
METALS	Vanadium	Y	ug/L				- -		-	- -		-	- -		-	- -		-
METALS	Zinc	N	ug/L				42.6			33.9			29.9			- -		-
METALS	Zinc	Y	ug/L				33.6			32.4			31			- -		-
PEST/PCB	Aroclor 1016	N	ug/L				- -		-	- -		-	- -		-	- -		-
PEST/PCB	Aroclor 1260	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	ug/L				- -		-	- -		-				- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Phenanthrene	N	ug/L				- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Pyrene	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Acetone	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Benzene	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Butanone, 2-	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Carbon disulfide	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Chloroform	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Chloromethane	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Cyclohexane	N	ug/L										- -		-			
VOLATILES	Dichloropropene, trans-1,3-	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Ethylbenzene	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Isopropylbenzene	N	ug/L										- -		-			
VOLATILES	Methylcyclohexane	N	ug/L										- -		-			
VOLATILES	Methylene chloride	N	ug/L				- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				AP2-MW01			AP2-MW02			AP2-MW02			AP2-MW02			AP2-MW03		
SAMPLE_NO				AP3075			AP3058			AP3059			AP3060			AP3061		
SAMPLE_DATE				13-Nov-09			25-May-09			25-May-09			26-May-09			24-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
VOLATILES	Toluene	N	ug/L				- -		-	- -		-	- -		-	- -		-
VOLATILES	Xylenes, total	N	ug/L				- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				ASH PIT 2-PZ03			ASH PIT 2-PZ04			ASH PIT 2-PZ07			ASH PIT 2-PZ07			ASH PIT 2-PZ07		
SAMPLE_NO				AP3018			AP3019			AP3015			AP3016			AP3022		
SAMPLE_DATE				31-Jan-09			1-Feb-09			2-Feb-09			2-Feb-09			2-Feb-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
FIELD TESTS	Dissolved Oxygen	N	ppm	2.02			1.1									0.5		
FIELD TESTS	FERROUS IRON	N	mg/L				0									0		
FIELD TESTS	Oxidation Reduction Potential	N	mV	14.4			23.7									20.4		
FIELD TESTS	pH	N	pH_units	6.77			6.55									6.53		
FIELD TESTS	Specific Conductivity	N	mS/cm	1.251			0.958									0.778		
FIELD TESTS	Temperature	N	C	1.52			7.31									6.19		
FIELD TESTS	Turbidity	N	NTU	60.1			26.6									28.2		
GEN CHEMISTRY	Alkalinity	N	ppm	231			132			222			260			169		
GEN CHEMISTRY	Chloride	N	ppm	11.6	J		5.14	J		2.81	J		2.1			3.04	J	
GEN CHEMISTRY	Cyanide, total	N	ppm										0.044					
GEN CHEMISTRY	Hardness	N	ppm	622			501			408			620			407		
GEN CHEMISTRY	HARDNESS (as CaCO3)	N	ppm															
GEN CHEMISTRY	Nitrate-Nitrite	N	ppm	0.566	J		0.049	J		- -	-					0.028 J	J	
GEN CHEMISTRY	Sulfate	N	ppm	341			236			79.6			177			80.6		
GEN CHEMISTRY	Total dissolved solids	N	ppm	804			619			442			450			450		
GEN CHEMISTRY	Total suspended solids	N	ppm	59			3 J	J		- -	-		- -	-		4		
GEN CHEMISTRY	Turbidity	N	NTU	51.5	J		4.56	J		4.93			1.3			4.52		
METALS	Aluminum	N	ug/L	2400			74.3 J	j		93.3	J		- -	-		147	J	
METALS	Aluminum	Y	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Antimony	N	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Antimony	Y	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Arsenic	N	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Arsenic	Y	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Barium	N	ug/L	51.1			24			31.3			- -	-		31.9		
METALS	Barium	Y	ug/L	34.9			22.8			29.3			- -	-		28.2		
METALS	Beryllium	N	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Beryllium	Y	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Cadmium	N	ug/L	4.16 J	J		4.28 J	J		4.27 J	J		- -	-		3.91 J	J	
METALS	Cadmium	Y	ug/L	4.36 J	J		4.13 J	J		3.98 J	J		- -	-		3.9 J	J	
METALS	Calcium	N	ug/L	179000			135000			110000			101000			110000		
METALS	Calcium	Y	ug/L	172000			135000			108000			103000			103000		
METALS	Chromium	N	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Chromium	Y	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Cobalt	N	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Cobalt	Y	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Copper	N	ug/L	12.3			5.63 J	J		5.71 J	J		- -	-		- -	-	
METALS	Copper	Y	ug/L	6.9 J	J		- -	-		- -	-		- -	-		- -	-	
METALS	Iron	N	ug/L	5060			203			325	J		191			593	J	
METALS	Iron	Y	ug/L	- -	-		- -	-		- -	-		- -	-		- -	-	
METALS	Lead	N	ug/L	3.02 J	J		- -	-		- -	-	-	-	-		- -	-	

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				ASH PIT 2-PZ03			ASH PIT 2-PZ04			ASH PIT 2-PZ07			ASH PIT 2-PZ07			ASH PIT 2-PZ07		
SAMPLE_NO				AP3018			AP3019			AP3015			AP3016			AP3022		
SAMPLE_DATE				31-Jan-09			1-Feb-09			2-Feb-09			2-Feb-09			2-Feb-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
METALS	Lead	Y	ug/L	-	-	-	-	-	-	- -	-	-	-	-		- -		-
METALS	Magnesium	N	ug/L	42700			39600			32200			29200			31900		
METALS	Magnesium	Y	ug/L	42800			40800			31100			29900			31400		
METALS	Manganese	N	ug/L	51.8			22.1			21.6			20.7			24.5		
METALS	Manganese	Y	ug/L	- -		-	16.2			17.1			30.7			19		
METALS	Mercury	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Mercury	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Nickel	N	ug/L	6.28	J	J	5.36	J	J	4	J	J	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				ASH PIT 2-PZ03			ASH PIT 2-PZ04			ASH PIT 2-PZ07			ASH PIT 2-PZ07			ASH PIT 2-PZ07		
SAMPLE_NO				AP3018			AP3019			AP3015			AP3016			AP3022		
SAMPLE_DATE				31-Jan-09			1-Feb-09			2-Feb-09			2-Feb-09			2-Feb-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
METALS	Nickel	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Potassium	N	ug/L	1260			405	J	J	521	J	J	- -		-	548	J	J
METALS	Potassium	Y	ug/L	510	J	J	346	J	J	445	J	J	- -		-	460	J	J
METALS	Selenium	N	ug/L	7.55	J	J	- -		-	- -		-	- -		-	- -		-
METALS	Selenium	Y	ug/L	6.82	J	J	- -		-	- -		-	- -		-	- -		-
METALS	Silver	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Silver	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	ug/L	12200			9150			6860			6380			6990		
METALS	Sodium	Y	ug/L	12500			9280			6840			6180			7000		
METALS	Thallium	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Thallium	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Vanadium	N	ug/L	5.39			- -		-	- -		-	- -		-	- -		-
METALS	Vanadium	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Zinc	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
METALS	Zinc	Y	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
PEST/PCB	Aroclor 1016	N	ug/L															
PEST/PCB	Aroclor 1260	N	ug/L															
SEMIVOLATILES	Benzo(a)anthracene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	ug/L	- -		-	- -		-	- -		-				- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	ug/L	- -		-	- -		-	3.38	J	J	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Methylnaphthalene, 2-	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Phenanthrene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Pyrene	N	ug/L	- -		-	- -		-	- -		-	- -		-	- -		-
VOLATILES	Acetone	N	ug/L															
VOLATILES	Benzene	N	ug/L															
VOLATILES	Butanone, 2-	N	ug/L															
VOLATILES	Carbon disulfide	N	ug/L															
VOLATILES	Chloroform	N	ug/L															
VOLATILES	Chloromethane	N	ug/L															
VOLATILES	Cyclohexane	N	ug/L															
VOLATILES	Dichloropropene, trans-1,3-	N	ug/L															
VOLATILES	Ethylbenzene	N	ug/L															
VOLATILES	Isopropylbenzene	N	ug/L															
VOLATILES	Methylcyclohexane	N	ug/L															
VOLATILES	Methylene chloride	N	ug/L															

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = GW

LOCATION_CODE				ASH PIT 2-PZ03			ASH PIT 2-PZ04			ASH PIT 2-PZ07			ASH PIT 2-PZ07			ASH PIT 2-PZ07		
SAMPLE_NO				AP3018			AP3019			AP3015			AP3016			AP3022		
SAMPLE_DATE				31-Jan-09			1-Feb-09			2-Feb-09			2-Feb-09			2-Feb-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
VOLATILES	Toluene	N	ug/L															
VOLATILES	Xylenes, total	N	ug/L															

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = SD

LOCATION_CODE				ASH PIT 2-SD01			ASH PIT 2-SD02			ASH PIT 2-SD03		
SAMPLE_NO				AP1000			AP1001			AP1002		
SAMPLE_DATE				24-May-09			24-May-09			24-May-09		
FK_DEPTH				0 - _5 Ft			0 - _5 Ft			0 - _5 Ft		
SAMPLE_PURPOSE				REG			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	mg/kg	- -		-	- -		-	0.0647	J	J
GEN CHEMISTRY	% Solids	N	Percent	74.2			77.9			79.9		
GEN CHEMISTRY	Total organic carbon	N	mg/kg	0.57								
METALS	Aluminum	N	mg/kg	3640			6310			7220		
METALS	Antimony	N	mg/kg	- -		-	- -		-	- -		-
METALS	Arsenic	N	mg/kg	4.1			5.1			10.1		J
METALS	Barium	N	mg/kg	22.8			43.5			67.1		J
METALS	Beryllium	N	mg/kg	0.36			0.49			0.52		
METALS	Cadmium	N	mg/kg	0.24	B	J	0.37			- -		-
METALS	Calcium	N	mg/kg	7660			26000			12900		J
METALS	Chromium	N	mg/kg	6.4			10.5			8.6		J
METALS	Cobalt	N	mg/kg	7.4			7.4			6.2		J
METALS	Copper	N	mg/kg	9.6			14.2			17.2		
METALS	Iron	N	mg/kg	10400			14000			39100		J
METALS	Lead	N	mg/kg	7.9			7.9			10.6	B	J
METALS	Magnesium	N	mg/kg	1950			7440			7470		J
METALS	Manganese	N	mg/kg	127			379			151		J
METALS	Mercury	N	mg/kg	- -		-	0.018	B	J	0.016	B	J
METALS	Nickel	N	mg/kg	15.7			16.1			16		J
METALS	Potassium	N	mg/kg	498	B	J	1300			1060		J
METALS	Selenium	N	mg/kg	1	B	J	0.39	B	J	0.92	B	J
METALS	Silver	N	mg/kg	- -		-	- -		-	0.083	B	J
METALS	Sodium	N	mg/kg	85.2	B	J	157	B	J	54.8	B	J
METALS	Thallium	N	mg/kg	- -		-	- -		-	- -		-
METALS	Vanadium	N	mg/kg	9.4			15.2			13.6		J
METALS	Zinc	N	mg/kg	34.7			38.9			27		J
PEST/PCB	Aroclor 1016	N	mg/kg	- -		-	- -		-	- -		-
PEST/PCB	Aroclor 1260	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	mg/kg	- -		-	- -		-	0.0525	J	J
SEMIVOLATILES	Methylnaphthalene, 2-	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Phenanthrene	N	mg/kg	- -		-	- -		-	- -		-
SEMIVOLATILES	Pyrene	N	mg/kg	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = SD

LOCATION_CODE				ASH PIT 2-SD04			ASH PIT 2-SD04			ASH PIT 2-SD04			ASH PIT 2-SD05		
SAMPLE_NO				AP1003			AP1004			AP1005			AP1006		
SAMPLE_DATE				25-May-09			25-May-09			25-May-09			25-May-09		
FK_DEPTH				0 - _5 Ft			0 - _5 Ft			0 - _5 Ft			0 - _5 Ft		
SAMPLE_PURPOSE				REG			FD			FS			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	mg/kg	- -		-	- -		-	- -		-	- -		-
GEN CHEMISTRY	% Solids	N	Percent	80.5			79.7			80			65.4		
GEN CHEMISTRY	Total organic carbon	N	mg/kg												
METALS	Aluminum	N	mg/kg	8000			6840			6780			4690		
METALS	Antimony	N	mg/kg	- -		-	- -		-	- -		-	- -		-
METALS	Arsenic	N	mg/kg	9.3			7.8			8.8			3.9		
METALS	Barium	N	mg/kg	59.8			50			53			43.1		
METALS	Beryllium	N	mg/kg	0.59			0.53			- -		-	0.42		
METALS	Cadmium	N	mg/kg	0.6			0.53			- -		-	0.26	B	J
METALS	Calcium	N	mg/kg	28700			25200			37600			9790		
METALS	Chromium	N	mg/kg	12.8			10.5			11.6			7.7		
METALS	Cobalt	N	mg/kg	14.1			9.8			9.9			8		
METALS	Copper	N	mg/kg	23.7			20.4			22.8			12.2		
METALS	Iron	N	mg/kg	19400			17700			20700			10400		
METALS	Lead	N	mg/kg	15.2		J	9.1		J	11			9.7		
METALS	Magnesium	N	mg/kg	6110			6040			8170			2450		
METALS	Manganese	N	mg/kg	668			547			413			187		
METALS	Mercury	N	mg/kg	0.015	B	J	0.019	B	J	- -		-	0.025	B	J
METALS	Nickel	N	mg/kg	27.6			22.6			27.1			17.8		
METALS	Potassium	N	mg/kg	1850			1470			1420			628	B	J
METALS	Selenium	N	mg/kg	0.83	B	J	0.48	B	J	- -		-	0.96	B	J
METALS	Silver	N	mg/kg	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	mg/kg	170	B	J	157	B	J	- -		-	123	B	J
METALS	Thallium	N	mg/kg	- -		-	- -		-	- -		-	- -		-
METALS	Vanadium	N	mg/kg	14.9			12.5			13.3			11.1		
METALS	Zinc	N	mg/kg	59.7			54.9			62.5			45.1		
PEST/PCB	Aroclor 1016	N	mg/kg	- -		-	- -		-	- -		-	- -		-
PEST/PCB	Aroclor 1260	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	mg/kg	- -		-	- -		-				- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	mg/kg	- -		-	- -		-	- -		-	0.0547	J	J
SEMIVOLATILES	Methylnaphthalene, 2-	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Naphthalene	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Phenanthrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Pyrene	N	mg/kg	- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = SW

LOCATION_CODE				AP2-SW01			AP2-SW02			AP2-SW03		
SAMPLE_NO				AP2000			AP2001			AP2002		
SAMPLE_DATE				24-May-09			24-May-09			24-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				REG			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	ug/L	- -		-	- -		-	- -		-
FIELD TESTS	Dissolved Oxygen	N	ppm	7.55			7.81			7.94		
FIELD TESTS	Oxidation Reduction Potential	N	mV	163.5			124.3			113.8		
FIELD TESTS	pH	N	pH_units	7.28			7.42			7.6		
FIELD TESTS	Specific Conductivity	N	mS/cm	0.924			0.912			0.908		
FIELD TESTS	Temperature	N	C	17.45			18.94			19.16		
FIELD TESTS	Turbidity	N	NTU	12.9			12.5			17.7		
GEN CHEMISTRY	HARDNESS (as CaCO3)	N	ppm	286								
METALS	Aluminum	N	ug/L	720			531			357		
METALS	Antimony	N	ug/L	- -		-	- -		-	- -		-
METALS	Arsenic	N	ug/L	- -		-	- -		-	- -		-
METALS	Barium	N	ug/L	48.4	B	J	46.8	B	J	44.7	B	J
METALS	Beryllium	N	ug/L	- -		-	- -		-	- -		-
METALS	Cadmium	N	ug/L	- -		-	- -		-	- -		-
METALS	Calcium	N	ug/L	79100			78800			76400		
METALS	Chromium	N	ug/L	- -		-	- -		-	- -		-
METALS	Cobalt	N	ug/L	- -		-	- -		-	- -		-
METALS	Copper	N	ug/L	- -		-	- -		-	- -		-
METALS	Iron	N	ug/L	1060			700			451		
METALS	Lead	N	ug/L	- -		-	- -		-	2.9	B	J
METALS	Magnesium	N	ug/L	21400			21200			20500		
METALS	Manganese	N	ug/L	102			63			52.6		
METALS	Mercury	N	ug/L	- -		-	- -		-	- -		-
METALS	Nickel	N	ug/L	- -		-	- -		-	- -		-
METALS	Potassium	N	ug/L	3290	B	J	3340	B	J	3150	B	J
METALS	Selenium	N	ug/L	- -		-	- -		-	- -		-
METALS	Silver	N	ug/L	- -		-	- -		-	- -		-
METALS	Sodium	N	ug/L	32800			32700			32100		
METALS	Thallium	N	ug/L	- -		-	- -		-	- -		-
METALS	Vanadium	N	ug/L	2.6	B	J	1.8	B	J	1.7	B	J
METALS	Zinc	N	ug/L	12.1	B	J	12.4	B	J	- -		-
PEST/PCB	Aroclor 1016	N	ug/L	- -		-	- -		-	- -		-
PEST/PCB	Aroclor 1260	N	ug/L	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	ug/L	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	ug/L	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	ug/L	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	ug/L	- -		-	- -		-	- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	ug/L	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	ug/L	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	ug/L	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	ug/L	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = SW

LOCATION_CODE				AP2-SW01		AP2-SW02		AP2-SW03	
SAMPLE_NO				AP2000		AP2001		AP2002	
SAMPLE_DATE				24-May-09		24-May-09		24-May-09	
FK_DEPTH				0 - 0 Ft		0 - 0 Ft		0 - 0 Ft	
SAMPLE_PURPOSE				REG		REG		REG	
SEMIVOLATILES	Methylnaphthalene, 2-	N	ug/L	- -	-	- -	-	- -	-
SEMIVOLATILES	Naphthalene	N	ug/L	- -	-	- -	-	- -	-
SEMIVOLATILES	Phenanthrene	N	ug/L	- -	-	- -	-	- -	-
SEMIVOLATILES	Pyrene	N	ug/L	- -	-	- -	-	- -	-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = SW

LOCATION_CODE				AP2-SW03			AP2-SW03			AP2-SW04			AP2-SW05		
SAMPLE_NO				AP2003			AP2004			AP2005			AP2006		
SAMPLE_DATE				24-May-09			24-May-09			25-May-09			25-May-09		
FK_DEPTH				0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft		
SAMPLE_PURPOSE				FD			FS			REG			REG		
Test Group	Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual
EXPLOSIVES	Trinitrotoluene, 2,4,6-	N	ug/L	- -		-	- -		-	- -		-	- -		-
FIELD TESTS	Dissolved Oxygen	N	ppm							7.4			8.37		
FIELD TESTS	Oxidation Reduction Potential	N	mV							193.5			157.8		
FIELD TESTS	pH	N	pH_units							7.43			7.66		
FIELD TESTS	Specific Conductivity	N	mS/cm							0.885			0.9		
FIELD TESTS	Temperature	N	C							15.93			16.26		
FIELD TESTS	Turbidity	N	NTU							24.6			11.7		
GEN CHEMISTRY	HARDNESS (as CaCO3)	N	ppm												
METALS	Aluminum	N	ug/L	377			368			1030		J	359		
METALS	Antimony	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Arsenic	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Barium	N	ug/L	45.3	B	J	- -		-	50.9	B	J	43.9	B	
METALS	Beryllium	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Cadmium	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Calcium	N	ug/L	77400			80900			80700			75900		
METALS	Chromium	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Cobalt	N	ug/L	- -		-	- -		-	1.2	B	J	- -		-
METALS	Copper	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Iron	N	ug/L	455			546			1020			376		
METALS	Lead	N	ug/L	- -		-	- -		-	2.9	B	J	- -		-
METALS	Magnesium	N	ug/L	20800			22300		J	20700			19800		
METALS	Manganese	N	ug/L	52.9			53.4			83.1			53.3		
METALS	Mercury	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Nickel	N	ug/L	- -		-	- -		-	6.2	B	J	- -		-
METALS	Potassium	N	ug/L	3190	B	J	- -		-	4400	B	J	2900	B	
METALS	Selenium	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Silver	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Sodium	N	ug/L	32800			40000			34800			30300		
METALS	Thallium	N	ug/L	- -		-	- -		-	- -		-	- -		-
METALS	Vanadium	N	ug/L	1.6	B	J	- -		-	3.1	B	J	2	B	
METALS	Zinc	N	ug/L	8.1	B	J	- -		-	10.6	B	J	9.9	B	
PEST/PCB	Aroclor 1016	N	ug/L	- -		-	- -		-	- -		-	- -		-
PEST/PCB	Aroclor 1260	N	ug/L	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)anthracene	N	ug/L	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(a)pyrene	N	ug/L	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzo(b)fluoranthene	N	ug/L	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Benzoic acid	N	ug/L	- -		-				- -		-	- -		-
SEMIVOLATILES	Bis(2-ethylhexyl)phthalate	N	ug/L	2	J	J	- -		-	- -		-	- -		-
SEMIVOLATILES	Chrysene	N	ug/L	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Dimethylphenol, 2,4-	N	ug/L	- -		-	- -		-	- -		-	- -		-
SEMIVOLATILES	Fluoranthene	N	ug/L	- -		-	- -		-	- -		-	- -		-

Appendix I

Detected Hits Summary Excluding "B" Qualifiers
Plum Brook Ordnance Works

[SAMPLE_TYPE] = SW

LOCATION_CODE				AP2-SW03		AP2-SW03		AP2-SW04		AP2-SW05			
SAMPLE_NO				AP2003		AP2004		AP2005		AP2006			
SAMPLE_DATE				24-May-09		24-May-09		25-May-09		25-May-09			
FK_DEPTH				0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		0 - 0 Ft			
SAMPLE_PURPOSE				FD		FS		REG		REG			
SEMIVOLATILES	Methylnaphthalene, 2-	N	ug/L	- -	-	- -	-	- -	-	- -	-		
SEMIVOLATILES	Naphthalene	N	ug/L	- -	-	- -	-	- -	-	- -	-		
SEMIVOLATILES	Phenanthrene	N	ug/L	- -	-	- -	-	- -	-	- -	-		
SEMIVOLATILES	Pyrene	N	ug/L	- -	-	- -	-	- -	-	- -	-		

APPENDIX J

DATA QUALITY EVALUATIONS

MARCH 2010
POWERHOUSE 2 ASH PITS SAMPLING
DATA QUALITY EVALUATION

DATA QUALITY EVALUATION

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List of Acronyms

AR/COC	analysis request/chain of custody
CCAL	continuing calibration
CFR	Code of Federal Regulations
CI	chemical investigation
DI	deionized
DQO	data quality objectives
EPA	U.S. Environmental Protection Agency
ICAL	initial calibration
ICS	Interference Check Sample
ID	identification
LCS	laboratory control sample
MB	material blank or method blank
MDL	method detection limit
MQL	method quantitation limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
NFG	national functional guidelines
PBOW	Plum Brook Ordnance Works
PQL	practical quanitation limit
QA/QC	quality assurance/quality control
SAP	quality assurance project plan
RI	remedial investigation
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SOP	standard operating procedures
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compounds

1.0 Introduction

This appendix presents results of the quality assurance/quality control (QA/QC) measures implemented for the sampling and analysis activities at the Plum Brook Ordnance Works (PBOW), Sandusky, Ohio. The quality indicators from every aspect of the data collection were reviewed, and an assessment of the data with regard to project-specific objectives is presented. Successful execution of project-specific objectives and procedures provides strong support for the acceptance of the data generated as adequate for the purpose of evaluating the analytical results from this assessment at PBOW.

Shaw Environmental, Inc. (Shaw) conducted investigative work at the Ash Pit 2 area in January, February, May, and November of 2009. Primary and field duplicate project samples collected in January and February 2009 were analyzed by AML Scientific, LLC of Olathe, Kansas. AML Scientific ceased operations at the end of February 2009. Regular and field duplicate project samples collected after February 2009 were analyzed by Accutest Laboratories, of Orlando, Florida. Field splits were analyzed by Test America, Inc., Canton, Ohio. Analysis for nitroaromatic field split samples was performed by Test America of Knoxville, Tennessee and Test America of Denver, Colorado. One hundred percent of the data analyzed were subjected to data validation following the guidelines in the *EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, June 2008 (EPA, 2008) and *EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, October 2004 (EPA, 2004), the QAPP (Shaw, 2008c), and specific analytical method requirements. Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness, and comparability goals established to meet the project data quality objectives (DQO). The criteria for blank evaluation were based on those detailed in *Region III Modifications to National Functional Guidelines for Organic Data Review,* September 1994 (EPA, 1994b) and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (EPA, 1993). Since these documents specify procedures for Contract Laboratory Program (CLP) data, they are used as guidelines only. Method and laboratory quality assurance and quality control requirements supercede these guidelines, where applicable. Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness and comparability goals established to meet the project data quality objectives (DQO). To verify that these DQOs were met, field measurements, sampling and handling procedures, laboratory analysis and reporting, and all nonconformances and discrepancies in the data were examined to determine compliance with the appropriate and applicable procedures defined in the SAP. The results of this review are

presented in the following sections, with all analytical outliers or nonconformances discussed where they occurred.

This report is divided into three subsections. Section 2.0 discusses the field investigation and QC procedures used during the sampling effort. Section 3.0 outlines the analytical program and the associated QC activities performed. The final part of this document, Section 4.0, summarizes the data findings and their overall impact on the usability of the analytical data.

2.0 Field Sampling and QC Activities

Shaw was retained by the U. S. Army Corps of Engineers, Nashville District to conduct investigative and sampling activities at PBOW. Field activities at this site included collection of soil, sediment, surface water and groundwater samples. The collection of these samples and their associated QC samples are discussed in this section of the Data Quality Evaluation (DQE).

Twenty-four project and three field duplicate soil samples, five project and one field duplicate sediment samples, five project and one field duplicate surface water samples, and twelve project and four field duplicate groundwater samples were submitted to AML and Accutest for analysis. Sample shipments from the field were performed under custody and documented using standard Shaw Analysis Request/Chain of Custody (AR/COC) forms. These forms provided project-specific analytical specifications and QC instructions to the laboratory. A formal COC transfer record was prepared and included with these forms to document custody during sample transportation, storage, and disposition by the laboratory. Table 1 summarizes the field sample number, location, sample type, date of collection, lot number, and laboratory for each sample collected.

2.1 Trip Blanks

Aqueous samples designated for volatile organic compound (VOC) analysis may be susceptible to contamination by diffusion of organic compounds into the sample container. Trip blanks are analyzed in order to assess the potential for contamination to be introduced to an aqueous volatile sample during transport and handling procedures. A trip blank is a sample of analyte free deionized (DI) water that is prepared at the laboratory, shipped to the field with sample containers, and returned to the laboratory with the water matrix samples receiving VOC analysis. A trip blank is then analyzed for volatile organics using the same sample preparation and analysis procedures used for the actual field samples.

The data validator applied the 5X-10X rule to the samples for the analytes detected. The 10 times limit is applicable only for common laboratory contaminants such as acetone, methylene chloride, and 2-butanone.

VOC constituents qualified due to associated trip blank contamination are listed below:

SDG Number	Samples Affected	Compounds	Blank Contaminant	Validation Qualifier
F69607	AP3080	Methylene Chloride	Trip	B

2.2 Equipment Rinsates

Equipment rinsates are used to assess the effectiveness of the decontamination procedures used by the sampling team on reusable sampling equipment. Three equipment rinsate samples collected were associated with Ash Pit 2.

The following samples were qualified due to contamination detected in associated equipment rinsates:

SDG Number	Samples Affected	Analytes	Blank Contaminant	Validation Qualifier
F69607	AP3079, AP3080, AP3081	Chloroform	Equipment	B
	AP3081	Carbon Disulfide	Equipment	B
F65480	AP3057, AP3063	Pb (Filtered)	Equipment	B
	AP3061, AP3064, AP3065	Se (Total)	Equipment	B
F69607	AP3081	Pb (Total)	Equipment	B
	AP3079, AP3080, AP3081	Al (Filtered)	Equipment	B
	AP3080, AP3081	Nitrate-Nitrite	Equipment	B

2.3 Field Duplicates

Field duplicate samples are collected and submitted to the laboratory for analysis along with their corresponding original sample. The data generated from the analysis of field duplicate samples are used to evaluate the precision of the sample collection and analysis procedures. It is difficult to collect and analyze sediment samples in duplicate due to the heterogeneous nature of sediment. High relative percent difference (RPD) between an original sample and its field duplicate may indicate a difference in sample matrix or sample collection rather than true problems with precision of sample analysis. Also, when estimated "J" or nondetected "U" results are reported, there is a potential for increased variability between the primary and duplicate sample results

Field duplicate samples were collected at a frequency of one for every ten samples (10 percent). Nine field duplicate samples were collected during this sampling event: three soils, one sediment, one surface water, and four groundwaters. Table 2 compares the original and field duplicate results and shows the RPDs calculated for those detected compounds. Compounds not presented in the table were not detected in either the original or field duplicate samples. Sample sets with no detections are not presented in the table. In cases where duplicates were performed and one result is less than the reporting limit, but greater than the method detection limit, the RPD is reported, but is of limited value. Only samples with detections in both the regular and the duplicate were qualified for high RPDs.

The acceptance criterion of 30 percent RPD for waters and 50 percent RPD for soils was used to evaluate these sample results. The data compared well when detected concentrations were greater than the reporting limit. RPD is calculated by using the following formula:

$$RPD = \left| \frac{A - B}{(A + B)/2} \right| \quad x \quad 100$$

where:

RPD	=	relative percent difference
A	=	original result
B	=	field duplicate result.

2.4 Field Split Samples

Split samples were collected in conjunction with field duplicate samples and sent to Test America Laboratories, Inc. of North Canton. The split samples were submitted to the laboratory for the same analysis as their corresponding field duplicates and original field samples. The split samples are used to determine if data results are reproducible when analyzed by two different laboratories. Results are also evaluated to determine if a contracted laboratory's preparation and analysis procedures are in control and meet the approved method criteria.

Field split samples were collected at a frequency of approximately one for every ten regular samples. Nine splits were collected during this sampling event: three soils, one sediment, one surface water, and four groundwaters.

Table 2 compares the original and field split results and shows the RPDs calculated for those detected compounds. Compounds not presented in the table were not detected in either the

original or field split samples. Samples with no detections are not presented in the table. Samples were not qualified because of sample RPDs.

3.0 Analytical Program and QC Activities

The project QA/QC program described in the SAP was followed for the collection and laboratory analysis of samples. Each of the analytical methods used require that method-specific QA/QC protocols be followed during sample analysis. These protocols are a critical part of the methods employed and were followed by the laboratory during sample analysis. Specific measures included detailed record keeping procedures, instrument calibrations, and analysis of method blanks, blank spikes, MS/MSD, surrogates, and internal standards. The following SW-846 and USEPA methods were used to analyze PBOW samples:

Analysis	Method
Semivolatiles	SW-846 8270C
Nitroaromatics	SW-846 8330
Volatiles	SW-846 8260B
Metals	SW-846 6010B/7470A
Polychlorinated Biphenyls	SW-846 8082
Wet Chemistry	MCAWW 300.0A (Chloride, Sulfate and Nitrate as N), MCAWW 310.1 (Alkalinity), MCAWW 180.1 (Turbidity), MCAWW 160.1 (TDS), MCAWW 160.2 (TSS), MCAWW 130.2 (Hardness), SW846 9012A (Cyanide), TOC by Walkley Black (Total Organic Carbon)

The validator used the QA/QC criteria defined in the SAP, laboratory-derived acceptance criteria, and analytical method criteria to qualify data. Any qualifiers added to these data by the data validator are included in the data summary report.

3.1 Laboratory QA/QC Procedures

The following sections discuss specific QA/QC protocols required and performed by the laboratory during this investigation.

3.1.1 Calibration

The calibration of instruments is required to ensure that the instruments are operating properly. Calibration is achieved when instrument response can be related to the concentration of an analyte. Several analytes were qualified because of unacceptable performance in the initial and

continuing calibration standards. The following analytes exhibited initial calibration individual relative response factors <0.1.

These analytes are qualified as follows:

SDG Number	Samples Affected	Analyte(s)	Validation Qualifier
F65480	AP3057, AP3058, AP3059, AP3061, AP3063, AP3064, AP3065	Acetone	R
F69338	AP3070	Acetone	R
A9E270266	AP3060, AP3066	2-Butanone, Chloroethane, 1,2-Dibromo-3-chloropropane	R

The table below lists the analytes that exhibited individual ICAL percent relative standard deviation and/or CCAL percent difference outside QC criteria. The criteria used to evaluate these data are: individual ICAL percent relative standard deviation > 30% and/or CCAL percent difference > 20% (volatile and semivolatile organics); >15% (explosives); for metals, individual ICAL/CCAL percent relative standard deviation > 10%; and for mercury, individual ICAL/CCAL percent relative standard deviation > 20%.

SDG Number	Samples Affected	Analyte(s)	Validation Qualifier
0901026	AP0102, AP0104, AP0107, AP0116, AP0119, AP0121, AP0123, AP0124, AP0127, AP0128	Benzoic Acid	UJ
	AP0105, AP0114, AP0115,	2,4-Dinitrophenol	UJ
0902003	AP3015, AP3018, AP3019, AP3022	Hexachlorocyclopentadiene	UJ
F65476	AP1002, AP1003, AP1004, AP1006	2,4-Dinitrophenol	UJ
A9E270266	AP3060, AP3066	2-Butanone, Chloroethane, Acetone, Chloromethane, 4-Methyl-2-pentanone	UJ/R
	AP2004 (Total), AP3060 (Filtered)	Magnesium	J
A9K190539	AP3082	Bromoform, 1,2-Dibromo-3-chloropropane, cis-1,3-Dichloropropene, trans-1,3-Dichloropropene	UJ
A9B030206	AP3016	Bis(2-Chloroethyl)ether	UJ

3.1.2 Method/Calibration Blanks

Method blanks are analyzed with each analytical "batch" processed on a per matrix (i.e., soil and water) basis. Method blanks are carried step-wise through the same analytical procedure as their associated field samples including the addition of solvents, surrogate and standard spikes, and reagents as required in the analysis process. The purpose of a method blank is to identify any contaminants that may be introduced to the sample as a result of the analytical process. The data validator evaluated all blank data associated with each sample.

The following analytes were qualified because of detections in the method or calibration blanks:

SDG Number	Samples Affected	Analytes	Blank Contaminant	Validation Qualifier
F69338	AP3070, AP3071, AP3072	Pb (Total)	Method	B
	AP3070, AP3072, AP3073	Zn (Total)	Method	B

3.1.3 Surrogate Recoveries

Surrogate standards are defined as non-target compounds added to standards, blanks, and samples prior to extraction or purging. They are used in organic analyses to monitor the percent recovery efficiencies of the sample preparation and analytical procedures.

The following samples were qualified due to surrogate recoveries outside of QC limits:

SDG Number	Samples Affected	Surrogate	Validation Qualifier
0901026	AP0103, AP0114, AP0117, AP0125	1-Chloro-3-nitrobenzene	UJ/R
0901026	AP0125	DCB	UJ
0901027	AP0111	1-Chloro-3-nitrobenzene	UJ
F69338	AP3073	1-Chloro-3-nitrobenzene	UJ

3.1.4 Matrix Spikes and Laboratory Control Spikes

Two types of spikes were performed for all analyses: matrix spikes (MS) and laboratory control samples (LCS). MS compounds are spiked into an aliquot of a field sample. LCS compounds are spiked into a blank matrix. The spiked compounds are representative compounds that are quantified during performance of the method. Recovery of the spiked compound is used as an assessment of analytical accuracy for the sample matrix analyzed. These results are useful in distinguishing sample matrix interferences from analysis interferences through a comparison of MS and LCS recovery data. Often, spikes are performed in duplicate as a matrix spike duplicate (MSD) or LCS duplicate. In this manner, the precision of the assessment can be quantified as the RPD of the original and duplicate spike.

Matrix spikes were assigned at a frequency of at least 1 for every 20 field samples collected. Ten MS/MSD pairs were assigned to samples. Additional sample volume was provided to the laboratory for the MS/MSD analyses. This sampling frequency meets the collection criteria for this program as specified in the SAP. In addition to the overall collection frequency, the analytical method requires that the laboratory analyze 1 set of spikes per analytical batch. To comply with this method requirement, the laboratory may analyze additional MS/MSD pairs. The validator evaluated all batch QC. The laboratory's statistically determined target acceptance limits were used to assess the spike recovery and RPD.

The following MS/MSD recoveries are outside of established QC criteria:

SDG Number	Samples Affected	Analytes(s)	Validation Qualifier
F65480	AP3064	Cis-1,3-Dichloropropene, trans-1,3-Dichloropropene	UJ
	AP3064	Se (Total and Filtered), Mg (Filtered)	B/J
	AP3064	Tetryl, 1,3,5-Trinitrobenzene, 2,4,6-Trinitrotoluene	UJ
	AP3057, AP3058, AP3059, AP3061, AP3063, AP3064, AP3065	Cyanide	J/UJ
	AP3064	Alkalinity	J
F69607	AP3079	trans-1,3-Dichloropropene, Methyl bromide, Methyl chloride, Vinyl chloride	J/UJ
	AP3079, AP3080, AP3081	Se (Total and Filtered)	J
	AP3079	Tetryl	R
	AP3079, AP3080, AP3081	Alkalinity, Cyanide	J/UJ
0901026	AP1000	Hexachlorocyclopentadiene*	UJ
	AP0100, AP0101, AP0102, AP0117, AP0118, AP0120, AP0121, AP0123	(Total) Al, Cu, Fe, Mg	J/UJ
	AP0103, AP0104, AP0105, AP0107, AP0114, AP0115, AP0116, AP0119, AP0124, AP0125, AP0126, AP0127, AP0128	(Total) Al, Ba, Co*, Cu, Mg	J/UJ
	AP1000	4-Amino-2,6-dinitrotoluene, 2-Amino-4,6-dinitrotoluene, 1,3-Dinitrobenzene, 2,4-Dinitrotoluene, 3-Nitrotoluene	UJ
	AP0117	4-Amino-2,6-dinitrotoluene, 2-Amino-4,6-dinitrotoluene, 1,3-Dinitrobenzene, 2,4-Dinitrotoluene, Nitrobenzene, 2- Nitrobenzene, 3- Nitrobenzene, 4- Nitrobenzene, 1,3,5-Trinitrobenzene	UJ

SDG Number	Samples Affected	Analytes(s)	Validation Qualifier
0901026 (cont'd)	AP0127	2-Amino-4,6-dinitrotoluene, 2,4-Dinitrotoluene, 1,3,5-Trinitrobenzene, 2,4,6-Trinitrotoluene	UJ
0901027	AP0108, AP0109, AP0110, AP0111, AP0112, AP0113	(Total) As, Ba*, Co*, Mg, Ni, Se, Ag*	J/UJ
0902003	AP3015, AP3018, AP3019, AP3022	Chloride, Nitrate-Nitrite	J/UJ
F65476	AP1002	2-Amino-4,6-dinitrotoluene	UJ
F65479	AP2005	4-Amino-2,6-dinitrotoluene	UJ
F69338	AP3070, AP3071, AP3073	Nitrate-Nitrite, Sulfate	J/UJ
A9E270266	AP1005	Sb*	UJ

*Analytes were qualified for %RPD outside QC limits for the MS/MSD analysis.

LCS results are used to evaluate lab method performance in the same manner as the MS/MSD results except the LCS is not performed on an actual field sample matrix. The LCS is prepared for each analytical batch and for each parameter and matrix analyzed. All LCS recoveries met QC criteria.

3.1.5 Laboratory Duplicate Sample Analysis

Laboratory Duplicate determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate Sample analyses are also performed to generate data in order to determine the long-term precision of the analytical method on various matrices.

Laboratory duplicate analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Samples Affected	Analyte(s)	Validation Qualifier
F65476	AP1001, AP1002, AP1003, AP1004, AP1006	(Total) Hg	J
	AP1002	(Total) Sb, Zn, As, Ba, Ca, Fe, Mg, Mn, K, Ag, Na	J
F65479	AP2005	(Total) Al, Co, V	J
F65480	AP3064	Se (Total and Filtered)	B/J
	AP3057, AP3058, AP3059, AP3061, AP3063, AP3064, AP3065	TDS	J
F69338	AP3070, AP3071, AP3072	(Total) Lead	B
	AP3071, AP3072	(Total) Selenium	J
F69607	AP3079, AP3080, AP3081	Se (Total and Filtered), V (Total)	J/UJ
	AP3079, AP3080, AP3081	TDS, TSS	J/UJ

3.1.6 Column Agreement

For high performance liquid chromatography (HPLC) analyses, sample results are confirmed using two dissimilar columns. In order for an analyte to be reported, it must be detected on both columns. Results differing by greater than 40 percent are qualified estimated, "J".

All detections were in agreement with the exception of the following:

SDG Number	Samples Affected	Analyte(s)	Validation Qualifier
0901026	AP0103	Aroclor 1016	J
0901027	AP0108	Aroclor 1260	J

3.1.7 Interference Check Sample

The ICP Interference Check Sample (ICS) verifies the contract laboratory's interelement and background correction factors. The ICS consists of two solutions: Solution A and Solution AB. Solution A consists of the interferents, and solution AB consists of the analytes mixed with the interferents. An ICS analysis consists of analyzing both solutions consecutively, starting with solution A, for all wavelengths used for each analyte reported by ICP. Results for the ICP analysis of the ICS solution AB must fall within the control limits of $\pm$ 20% of the true value for the analytes included in the solution.

All Interference Check Sample (ICS) percent recoveries were acceptable with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
F69607	AP3079, AP3080, AP3081	Ca (Filtered)	J

3.1.8 Inductively Coupled Plasma Serial Dilutions

The ICP serial dilution analysis is performed to determine whether or not significant physical or chemical interferences exist due to sample matrix.

All QC criteria were met for the serial dilutions associated with the project samples, with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
0901026	AP0100	(Total) Al, Fe, Mg, Ba, Ca, Mn, Ni, K	J
	AP0103, AP0104, AP0105, AP0107, AP0114, AP0115, AP0116, AP0119, AP0124, AP0125, AP0126, AP0127, AP0128	(Total) Be, Fe	J
0901027	Total: AP0108, AP0109, AP0110, AP0111, AP0112, AP0113	Ba, Co, Mg, Ni, Be, Ca, Cr, Pb, Zn	J
F65476	AP1002	(Total) Ca, Fe, Mg, Mn, Cr, Co, Pb, Ni, V, Zn	J
F65479	AP2005	(Total) Al	J
F69607	AP3079, AP3080, AP3081	Ca (Total and Filtered), Na (Total), Mg, K (Filtered)	J
A9A170114	AP0106, AP0122, AP0129	(Total) Ca, K	J

3.2 Reporting Limits

Limits have been established to describe project sensitivity requirements. Each laboratory is required to demonstrate method performance through method detection limit (MDL) studies for every method employed. These studies are required to be laboratory-specific so that individual laboratory variables such as equipment brands, reagent suppliers, and chemist technique are factored into the performance study. MDLs are established using controlled matrices (i.e., DI water). Practical quantitation limits (PQL) or method quantitation limits (MQL), used for this project are those statistically determined by the laboratories. The analytical program executed for this project required the use of SW-846 methods, which specify the procedure for calculating the MDLs. The PQL/MQL calculation adjusts the limit by a predetermined mathematical factor for the analysis of actual environmental sample matrices (i.e. soil, groundwater, etc.). Method reporting limits (MRL) are based on the project action or decision levels.

These limits are generally defined as follows:

- ***MDL.*** The minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the concentration is greater than zero.
- ***MQL/PQL.*** The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. It is set at the lowest standard used for the calibration curve.

- ***MRL.*** A threshold value below which the laboratory reports a result as non-detected. Ideally, the MRL will be established anywhere between the MDL and 1/2 the project action levels.

An MDL is the lower limit at which the laboratory can differentiate a measurement from background. The MDL is determined in accordance with the procedures in 40 CFR Part 136. If project action levels are near or below the MDL, it is unlikely the sensitivity of the method will be achievable. A compromise must be reached. The PQL/MQL is the lower limit at which a measurement becomes meaningful. This measurement (the PQL or the RL) is generally a multiple of three to five times the MDL.

Most samples were handled and analyzed as expected without significant changes to the anticipated project MQLs. Thirteen samples had elevated MQLs due to dilutions.

3.3 Holding Times/Preservation

All laboratory results submitted for this investigation have been reviewed with respect to laboratory adherence to extraction and analysis holding times. Maximum sample extraction and analysis hold times were those specified in USACE document EM200-1-3.

All results were acceptable with the following exception(s):

SDG Number	Samples Affected	Analysis	Validation Qualifier
F65480	AP3057	Semivolatiles	UJ
0902003	AP3018, AP3019	Turbidity	J
F65480	AP3057, AP3058, AP3059, AP3061, AP3063, AP3064, AP3065	Turbidity	J/UJ
A9K190539	AP3082(FS)	Nitrate	UJ

4.0 Data Evaluation and Usability

The analytical data review process identified a few analytical nonconformance issues that were noted during this analytical program. These anomalies have been discussed in the previous sections of this appendix. Table 3 summarizes all compounds requiring qualifier application due to anomalies discovered during data validation. Table 4 defines the reason codes for qualification and Table 5 defines the data validation qualifiers.

The following definitions are used for defining precision, accuracy, representativeness, completeness, and comparability as they have been applied to this evaluation.

Precision. Precision is a measurement of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision data were obtained through the analysis and evaluation of duplicate QA samples. Accuracy was determined through the analysis and evaluation of method blanks, LCSs, trip blanks, equipment rinsates, and MS samples.

Accuracy. Accuracy is a measurement of bias in a system and is expressed as a percent recovery. These QA samples were collected and/or analyzed at the frequency established in the SAP, verifying the completeness element of the DQOs along with the evaluation of holding times and reporting limits. Percent recovery is calculated as follows:

$$Percent\ \mathrm{Recov}ery = \left(\frac{(x-s)}{T}\right) * 100$$

Where:

X = the lab determined concentration of a spiked sample
S = the sample native concentration prior to spike
T = the true concentration of the spike

Relative Percent Difference is calculated as follows:

$$\mathrm{Re}lative\ Percent\ Difference = \left[\frac{|D1 - D2|}{\frac{D1 + D2}{2}}\right] * 100$$

Where:

D1 and D2 = the results of duplicate measurements

Representativeness. Representativeness is a qualitative parameter that expresses the degree to which sample data actually represent the matrix and site conditions. For example, in conducting ground water monitoring, representativeness requires proper location of wells and the collection of samples under consistent, documented procedures. Wells are located based upon the results of the hydrological study in progress and are designed to provide maximum coverage of the flow conditions. Requirements and procedures for sample collection and handling are

designed to maximize sample representativeness. Representativeness also can be monitored by reviewing field documentation and by performing field audits.

The samples were collected using Shaw SOPs and were fully documented through the use of standard Shaw field forms. Samples are representative of the matrix and site sampled.

Completeness. Completeness is a measure of the amount of valid data that are obtained during a sampling event as compared to the amount of data planned to be collected under optimum conditions. Some data for this project were qualified as estimated in the validation process because of the outliers noted in the MS recoveries, duplicate results for certain elements, and various other calibration and column confirmation percent difference results. Completeness is calculated as follows:

$$Completeness\ \% = \left(\frac{D_r}{D_c}\right) X\ 100$$

Where:

D_r = the number of data points for which valid results are reported

D_c = the number of valid samples/data points that are collected and reach the laboratory for analysis.

During this task, 46 regular project samples were collected resulting in approximately 5,945 targeted analytical records. 85 results were rejected. Using the above calculation, 98% completeness was achieved for the task.

Comparability. Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Comparability ensures that results for the sampling event can be compared with data from other past and/or future sampling programs. Comparability for this sampling event was achieved through the use of established and recognized techniques and accepted standard EPA methods. All samples collected and analyzed were subjected to the same sampling, handling, preparation, analysis, reporting, and validation criteria for the purpose of achieving comparability goals within the data set.

4.1 Statement of Data Usability

The overall results of the analyses, as discussed in this evaluation, suggest that representative samples were collected and analyzed, and the results are indicative of the media analyzed, with the exception of the few anomalies noted. The data do reflect expected site conditions and are usable for their intended purpose.

Tables 1 through 5 summarize the analytical program and the results for the data validation effort for all samples collected by Shaw at PBOW.

TABLES

Table 1

Sample Cross-reference
Former Plum Brook Ordnance Works
Sandusky, Ohio

Sample Type	Sample Location	Sample Number	Sample Date	Sample Purpose	Lot Number	Analytical Laboratory
GW	ASH PIT 2-PZ01	AP3015	02/02/2009	FD	0902003	AML
GW	ASH PIT 2-PZ01	AP3016	02/02/2009	FS	A9B030206	Test America
GW	ASH PIT 2-PZ01	AP3022	02/02/2009	REG	0902003	AML
GW	ASH PIT 2-PZ03	AP3018	01/31/2009	REG	0902003	AML
GW	ASH PIT 2-PZ04	AP3019	02/01/2009	REG	0902003	AML
SS	ASH PIT 2-SB01	AP0100	01/15/2009	REG	0901026	AML
DS	ASH PIT 2-SB01	AP0101	01/15/2009	REG	0901026	AML
DS	ASH PIT 2-SB01	AP0102	01/15/2009	REG	0901026	AML
SS	ASH PIT 2-SB02	AP0103	01/16/2009	REG	0901026	AML
DS	ASH PIT 2-SB02	AP0104	01/16/2009	REG	0901026	AML
DS	ASH PIT 2-SB02	AP0105	01/16/2009	FD	0901026	AML
DS	ASH PIT 2-SB02	AP0106	01/16/2009	FS	A9A170114	Test America
DS	ASH PIT 2-SB02	AP0107	01/16/2009	REG	0901026	AML
SS	ASH PIT 2-SB03	AP0108	01/18/2009	REG	0901027	AML
DS	ASH PIT 2-SB03	AP0109	01/18/2009	REG	0901027	AML
DS	ASH PIT 2-SB03	AP0110	01/18/2009	REG	0901027	AML
SS	ASH PIT 2-SB04	AP0111	01/18/2009	REG	0901027	AML
DS	ASH PIT 2-SB04	AP0112	01/18/2009	REG	0901027	AML
DS	ASH PIT 2-SB04	AP0113	01/19/2009	REG	0901027	AML
SS	ASH PIT 2-SB05	AP0114	01/16/2009	REG	0901026	AML
DS	ASH PIT 2-SB05	AP0115	01/16/2009	REG	0901026	AML
DS	ASH PIT 2-SB05	AP0116	01/16/2009	REG	0901026	AML
SS	ASH PIT 2-SB06	AP0117	01/15/2009	REG	0901026	AML
DS	ASH PIT 2-SB06	AP0118	01/15/2009	REG	0901026	AML
DS	ASH PIT 2-SB06	AP0119	01/15/2009	REG	0901026	AML
SS	ASH PIT 2-SB07	AP0120	01/16/2009	REG	0901026	AML
SS	ASH PIT 2-SB07	AP0121	01/16/2009	FD	0901026	AML
SS	ASH PIT 2-SB07	AP0122	01/16/2009	FS	A9A170114	Test America
DS	ASH PIT 2-SB07	AP0123	01/16/2009	REG	0901026	AML
DS	ASH PIT 2-SB07	AP0124	01/16/2009	REG	0901026	AML
SS	ASH PIT 2-SB08	AP0125	01/16/2009	REG	0901026	AML
DS	ASH PIT 2-SB08	AP0126	01/16/2009	REG	0901026	AML
DS	ASH PIT 2-SB08	AP0127	01/16/2009	REG	0901026	AML
DS	ASH PIT 2-SB08	AP0128	01/16/2009	FD	0901026	AML
DS	ASH PIT 2-SB08	AP0129	01/16/2009	FS	A9A170114	Test America
SD	ASH PIT 2-SD01	AP1000	05/24/2009	REG	F65476	Accutest
SD	ASH PIT 2-SD02	AP1001	05/24/2009	REG	F65476	Accutest
SD	ASH PIT 2-SD03	AP1002	05/24/2009	REG	F65476	Accutest
SD	ASH PIT 2-SD04	AP1003	05/25/2009	REG	F65476	Accutest
SD	ASH PIT 2-SD04	AP1004	05/25/2009	FD	F65476	Accutest
SD	ASH PIT 2-SD04	AP1005	05/25/2009	FS	A9E270266	Test America
SD	ASH PIT 2-SD05	AP1006	05/25/2009	REG	F65476	Accutest
GW	AP2-BEDGW-002	AP3063	05/24/2009	REG	F65480	Accutest
GW	AP2-BEDGW-003	AP3064	05/23/2009	REG	F65480	Accutest
GW	AP2-BEDGW-003	AP3065	05/23/2009	FD	F65480	Accutest
GW	AP2-BEDGW-003	AP3066	05/23/2009	FS	A9E270266	Test America
GW	AP2-MW01	AP3057	05/23/2009	REG	F65480	Accutest
GW	AP2-MW02	AP3058	05/25/2009	REG	F65480	Accutest
GW	AP2-MW02	AP3059	05/25/2009	FD	F65480	Accutest
GW	AP2-MW02	AP3060	05/26/2009	FS	A9E270266	Test America

Table 1

Sample Cross-reference
Former Plum Brook Ordnance Works
Sandusky, Ohio

Sample Type	Sample Location	Sample Number	Sample Date	Sample Purpose	Lot Number	Analytical Laboratory
GW	AP2-MW03	AP3061	05/24/2009	REG	F65480	Accutest
SW	AP2-SW01	AP2000	05/24/2009	REG	F65479	Accutest
SW	AP2-SW02	AP2001	05/24/2009	REG	F65479	Accutest
SW	AP2-SW03	AP2002	05/24/2009	REG	F65479	Accutest
SW	AP2-SW03	AP2003	05/24/2009	FD	F65479	Accutest
SW	AP2-SW03	AP2004	05/24/2009	FS	A9E270266	Test America
SW	AP2-SW04	AP2005	05/25/2009	REG	F65479	Accutest
SW	AP2-SW05	AP2006	05/25/2009	REG	F65479	Accutest
GW	AP2-BEDGW-002	AP3079	11/17/2009	REG	F69607	Accutest
GW	AP2-BEDGW-003	AP3080	11/16/2009	REG	F69607	Accutest
GW	AP2-BEDGW-002	AP3081	11/17/2009	FD	F69607	Accutest
GW	AP2-BEDGW-002	AP3082	11/17/2009	FS	A9K190539	Test America
GW	AP2-MW02	AP3076	11/13/2009	REG	F69502	Accutest
GW	AP2-MW01	AP3070	11/04/2009	REG	F69338	Accutest

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			ASH PIT 2-SB02			ASH PIT 2-SB02			ASH PIT 2-SB02			Relative	Relative
SAMPLE_NO			AP0104			AP0105			AP0106			Percent	Percent
SAMPLE_DATE			16-Jan-09			16-Jan-09			16-Jan-09			Difference	Difference
SAMPLE_PURPOSE			REG			FD			FS			REG and FD	REG and FS
FK.DEPTH			DS			DS			DS				
Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual		
Aluminum	N	mg/kg	12700		J	8930		J	6930			34.86	58.79
Antimony	N	mg/kg	0.362	J	J	0.287	J	J	ND	U	U	23.11	-
Arsenic	N	mg/kg	15.7		J	8.31		J	4			61.56	118.78
Barium	N	mg/kg	85.3		J	59.4		J	54.4			35.80	44.24
Beryllium	N	mg/kg	9.06		J	6.76		J	ND	U	U	29.08	-
Calcium	N	mg/kg	23300			16100			7170		J	36.55	105.87
Chromium	N	mg/kg	19.8			13.7			10.6			36.42	60.53
Cobalt	N	mg/kg	13.4		J	10.9		J	8.3			20.58	47.00
Copper	N	mg/kg	28.9		J	20.9		J	13.4			32.13	73.29
Iron	N	mg/kg	30500		J	19400		J	13300			44.49	78.54
Lead	N	mg/kg	13.8			11.9			7.5			14.79	59.15
Magnesium	N	mg/kg	8640		J	4940		J	3340			54.49	88.48
Manganese	N	mg/kg	726		J	351		J	320			69.64	77.63
Mercury	N	mg/kg	0.0162	J	J	0.0164	J	J	ND	U	U	1.23	-
Nickel	N	mg/kg	35.6			26.9			18.7			27.84	62.25
Potassium	N	mg/kg	1170			803			1070		J	37.20	8.93
Sodium	N	mg/kg	93.9			64.9		B	ND	U	U	36.52	-
Thallium	N	mg/kg	0.3	J	J	ND	U	U	ND	U	U	-	-
Vanadium	N	mg/kg	26.2			18.1			13			36.57	67.35
Zinc	N	mg/kg	74.6			66.2			43.5			11.93	52.67

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			ASH PIT 2-SB07			ASH PIT 2-SB07			ASH PIT 2-SB07			Relative	Relative
SAMPLE_NO			AP0120			AP0121			AP0122			Percent	Percent
SAMPLE_DATE			16-Jan-09			16-Jan-09			16-Jan-09			Difference	Difference
SAMPLE_PURPOSE			REG			FD			FS			REG and FD	REG and FS
FK.DEPTH			SS			SS			SS				
Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual		
Aluminum	N	mg/kg	7100		J	8180		J	7200			14.14	1.40
Antimony	N	mg/kg	0.336	J	J	0.291	J	J	ND	U	U	14.35	-
Arsenic	N	mg/kg	6.09			6.04			5.5			0.82	10.18
Barium	N	mg/kg	44.5			56.7			48.6			24.11	8.81
Beryllium	N	mg/kg	6.01			6.41			ND	U	U	6.44	-
Calcium	N	mg/kg	2100			2270			1820		J	7.78	14.29
Chromium	N	mg/kg	10.6			11.8			10.4			10.71	1.90
Cobalt	N	mg/kg	8.14			8.99			7.7			9.92	5.56
Copper	N	mg/kg	18		J	16.5		J	14.6			8.70	20.86
Iron	N	mg/kg	17600		J	19100		J	16600			8.17	5.85
Lead	N	mg/kg	12.5			12.8			9.3			2.37	29.36
Magnesium	N	mg/kg	2100		J	2350		J	1880			11.24	11.06
Manganese	N	mg/kg	198			226			169			13.21	15.80
Mercury	N	mg/kg	0.0203	J	J	0.0193	J	J	ND	U	U	5.05	-
Nickel	N	mg/kg	19.1			20.2			17.9			5.60	6.49
Potassium	N	mg/kg	450			470			703		J	4.35	43.89
Sodium	N	mg/kg	28.4		B	28		B	ND	U	U	1.42	-
Vanadium	N	mg/kg	15.4			17.4			14.1			12.20	8.81
Zinc	N	mg/kg	63.2			27.8			51.4			77.80	20.59

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			ASH PIT 2-SB08			ASH PIT 2-SB08			ASH PIT 2-SB08			Relative	Relative
SAMPLE_NO			AP0127			AP0128			AP0129			Percent	Percent
SAMPLE_DATE			16-Jan-09			16-Jan-09			16-Jan-09			Difference	Difference
SAMPLE_PURPOSE			REG			FD			FS			REG and FD	REG and FS
FK.DEPTH			DS			DS			DS				
Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual		
Aluminum	N	mg/kg	15100		J	14900		J	12100			1.33	22.06
Antimony	N	mg/kg	ND	U	U	0.248	J	J	ND	U	U	-	-
Arsenic	N	mg/kg	6.16			6.61			7			7.05	12.77
Barium	N	mg/kg	81		J	83.7		J	85			3.28	4.82
Beryllium	N	mg/kg	8.51		J	8.11		J	ND	U	U	4.81	-
Calcium	N	mg/kg	44800			45500			45000	E	J	1.55	0.45
Chromium	N	mg/kg	22.4			21.9			18.5			2.26	19.07
Cobalt	N	mg/kg	15.6		J	14.6		J	12.4			6.62	22.86
Copper	N	mg/kg	31.1		J	30.1		J	23.9			3.27	26.18
Iron	N	mg/kg	26600		J	28500		J	23900			6.90	10.69
Lead	N	mg/kg	11.6			14.1			10.7			19.46	8.07
Magnesium	N	mg/kg	12200		J	11500		J	10100			5.91	18.83
Manganese	N	mg/kg	473			432			363			9.06	26.32
Nickel	N	mg/kg	39.7			38			32.8			4.38	19.03
Potassium	N	mg/kg	1980			1990			2870	E	J	0.50	36.70
Sodium	N	mg/kg	145			134			ND	U	U	7.89	-
Vanadium	N	mg/kg	25.4			24.7			20.5			2.79	21.35
Zinc	N	mg/kg	76.6			73.4			61.3			4.27	22.19

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			ASH PIT 2-SD04			ASH PIT 2-SD04			ASH PIT 2-SD04			Relative	Relative
SAMPLE_NO			AP1003			AP1004			AP1005			Percent	Percent
SAMPLE_DATE			25-May-09			25-May-09			25-May-09			Difference	Difference
SAMPLE_PURPOSE			REG			FD			FS			REG and FD	REG and FS
FK.DEPTH			0 - _5 Ft			0 - _5 Ft			0 - _5 Ft				
Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual		
Aluminum	N	mg/kg	8000			6840			6780			15.63	16.51
Arsenic	N	mg/kg	9.3			7.8			8.8			17.54	5.52
Barium	N	mg/kg	59.8			50			53			17.85	12.06
Beryllium	N	mg/kg	0.59			0.53			ND	U	U	10.71	-
Cadmium	N	mg/kg	0.6			0.53			ND	U	U	12.39	-
Calcium	N	mg/kg	28700			25200			37600			12.99	26.85
Chromium	N	mg/kg	12.8			10.5			11.6			19.74	9.84
Cobalt	N	mg/kg	14.1			9.8			9.9			35.98	35.00
Copper	N	mg/kg	23.7			20.4			22.8			14.97	3.87
Iron	N	mg/kg	19400			17700			20700			9.16	6.48
Lead	N	mg/kg	15.2		J	9.1		J	11			50.21	32.06
Magnesium	N	mg/kg	6110			6040			8170			1.15	28.85
Manganese	N	mg/kg	668			547			413			19.92	47.18
Mercury	N	mg/kg	0.015	B	J	0.019	B	J	ND	U	U	23.53	-
Nickel	N	mg/kg	27.6			22.6			27.1			19.92	1.83
Potassium	N	mg/kg	1850			1470			1420			22.89	26.30
Selenium	N	mg/kg	0.83	B	J	0.48	B	J	ND	U	U	53.44	-
Sodium	N	mg/kg	170	B	J	157	B	J	ND	U	U	7.95	-
Vanadium	N	mg/kg	14.9			12.5			13.3			17.52	11.35
Zinc	N	mg/kg	59.7			54.9			62.5			8.38	4.58

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			AP2-SW03			AP2-SW03			AP2-SW03			Relative	Relative
SAMPLE_NO			AP2002			AP2003			AP2004			Percent	Percent
SAMPLE_DATE			24-May-09			24-May-09			24-May-09			Difference	Difference
SAMPLE_PURPOSE			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			REG and FD	REG and FS
FK.DEPTH			REG			FD			FS				
Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual		
Aluminum	N	ug/L	357			377			368			5.45	3.03
Barium	N	ug/L	44.7	B	J	45.3	B	J	ND	U	U	1.33	-
Calcium	N	ug/L	76400			77400			80900			1.30	5.72
Iron	N	ug/L	451			455			546			0.88	19.06
Lead	N	ug/L	2.9	B	J	ND	U	U	ND	U	U	-	-
Magnesium	N	ug/L	20500			20800			22300		J	1.45	8.41
Manganese	N	ug/L	52.6			52.9			53.4			0.57	1.51
Potassium	N	ug/L	3150	B	J	3190	B	J	ND	U	U	1.26	-
Sodium	N	ug/L	32100			32800			40000			2.16	21.91
Vanadium	N	ug/L	1.7	B	J	1.6	B	J	ND	U	U	6.06	-
Zinc	N	ug/L	ND	U	U	8.1	B	J	ND	U	U	-	-
Bis(2-ethylhexyl)phthalate	N	ug/L	ND	U	U	2	J	J	ND	U	U	-	-

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			AP2-BEDGW-002			AP2-BEDGW-002			AP2-BEDGW-002			Relative	Relative
SAMPLE_NO			AP3079			AP3081			AP3082			Percent	Percent
SAMPLE_DATE			17-Nov-09			17-Nov-09			17-Nov-09			Difference	Difference
SAMPLE_PURPOSE			0 - 0 Ft			0 - 0 Ft			0 - 0 Ft			REG and FD	REG and FS
FK.DEPTH			REG			FD			FS				
Parameter	Filtered	Units	Result	Qual	ValQual	Result	Qual	ValQual	Result	Qual	ValQual		
Acetone	N	ug/L	50.6		J	34.4		J	ND		U	38.12	-
Benzene	N	ug/L	9.4		J	6.2		J	4.1			41.03	78.52
Butanone, 2-	N	ug/L	2.4		J	ND		U	ND		U	-	-
Carbon disulfide	N	ug/L	ND		U	1.2		B	1.3			-	-
Chloroform	N	ug/L	5.6		B	4		B	ND		U	33.33	-
Chloromethane	N	ug/L	7.7		J	3.5		J	ND		U	75.00	-
Cyclohexane	N	ug/L							54			-	200.00
Ethylbenzene	N	ug/L	9.7		J	6.6		J	5			38.04	63.95
Isopropylbenzene	N	ug/L							2.5			-	200.00
Methylcyclohexane	N	ug/L							39			-	200.00
Toluene	N	ug/L	4.8		J	3.3		J	2.3			37.04	70.42
Xylenes, total	N	ug/L	55.7		J	36.8		J	29			40.86	63.05
Methylnaphthalene, 2-	N	ug/L	2.8		J	2.5		J	ND		U	11.32	-
Naphthalene	N	ug/L	1.9		J	1.6		J	ND		U	17.14	-
Aluminum	N	ug/L	46.7		J	45.5		J	ND		U	2.60	-
Barium	N	ug/L	21.1		J	21.3		J	ND		U	0.94	-
Calcium	N	ug/L	392000		J	385000		J	404000			1.80	3.02
Iron	N	ug/L	ND		U	ND		U	194			-	-
Lead	N	ug/L	ND		U	2.4		B	ND		U	-	-
Magnesium	N	ug/L	124000			123000			119000			0.81	4.12
Manganese	N	ug/L	11.1		J	10.7		J	ND		U	3.67	-
Potassium	N	ug/L	10900			11000			7380			0.91	38.51
Selenium	N	ug/L	21.3		J	17.7		J	ND		U	18.46	-
Sodium	N	ug/L	32100		J	32100		J	28500			0.00	11.88
Vanadium	N	ug/L	1.1		J	ND		UJ	ND		U	-	-
Aluminum	Y	ug/L	37.4		B	39.3		B	ND		U	4.95	-
Barium	Y	ug/L	19.8		J	18.8		J	ND		U	5.18	-
Calcium	Y	ug/L	347000		J	335000		J	411000			3.52	16.89
Iron	Y	ug/L	36.1		J	46.5		J	ND		U	25.18	-
Magnesium	Y	ug/L	118000		J	113000		J	121000			4.33	2.51
Manganese	Y	ug/L	9.6		J	9.3		J	ND		U	3.17	-
Potassium	Y	ug/L	11500		J	11000		J	7540			4.44	41.60

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

Selenium	Y	ug/L	74.9	J	14.3	J	ND	U	135.87	-
Sodium	Y	ug/L	33100		31400		29100		5.27	12.86
Vanadium	Y	ug/L	2	J	2.3	J	ND	U	13.95	-
Alkalinity	N	ppm	472	J	492	J	490		4.15	3.74
Chloride	N	ppm	74.2	J	46.9	J	48.8		45.09	41.30
Cyanide, total	N	ppm	ND	UJ	ND	UJ	0.51		-	-
Hardness	N	ppm					1600		-	200.00
HARDNESS (as CaCO3)	N	ppm	1490		1460				2.03	200.00
Nitrate-Nitrite	N	ppm	2	J	0.054	B			189.48	200.00
Sulfate	N	ppm	776	J	1070	J	1080		31.85	32.76
Total dissolved solids	N	ppm	2200	J	2050	J	2000		7.06	9.52
Turbidity	N	NTU	1.7	J	21.4	J	110		170.56	193.91

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			AP2-MW02		AP2-MW02		AP2-MW02		Relative	Relative
SAMPLE_NO			AP3058		AP3059		AP3060		Percent	Percent
SAMPLE_DATE			25-May-09		25-May-09		26-May-09		Difference	Difference
FK_DEPTH			0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		REG and FD	REG and FS
SAMPLE_PURPOSE			REG		FD		FS			
Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual		
Aluminum	N	ug/L	79.1	J	77.6	J	ND	U	1.91	-
Barium	N	ug/L	25.3	J	24.5	J	ND	U	3.21	-
Cadmium	N	ug/L	1.1	J	1	J	ND	U	9.52	-
Calcium	N	ug/L	102000		102000		94900		0.00	7.21
Cobalt	N	ug/L	7.9	J	8.3	J	ND	U	4.94	-
Magnesium	N	ug/L	11600		11600		10800		0.00	7.14
Manganese	N	ug/L	229		229		212		0.00	7.71
Nickel	N	ug/L	74.2		74.2		68.9		0.00	7.41
Potassium	N	ug/L	7690	J	7410	J	8940		3.71	15.03
Sodium	N	ug/L	2560	J	2460	J	ND	U	3.98	-
Zinc	N	ug/L	42.6		33.9		29.9		22.75	35.03
Aluminum	Y	ug/L	45.4	J	44	J	ND	U	3.13	-
Barium	Y	ug/L	23.9	J	23.6	J	ND	U	1.26	-
Calcium	Y	ug/L	96400		93100		103000		3.48	6.62
Cobalt	Y	ug/L	8.9	J	8.7	J	ND	U	2.27	-
Magnesium	Y	ug/L	11000		10600		11900	J	3.70	7.86
Manganese	Y	ug/L	220		214		218		2.76	0.91
Nickel	Y	ug/L	74.5		72.1		72.6		3.27	2.58
Potassium	Y	ug/L	9090	J	8950	J	9500		1.55	4.41
Sodium	Y	ug/L	3030	J	2930	J	ND	U	3.36	-
Zinc	Y	ug/L	33.6		32.4		31		3.64	8.05
Alkalinity	N	ppm	70.3		73.4		72		4.31	2.39
Chloride	N	ppm	4.1		3.6		12.6		12.99	101.80
Hardness	N	ppm					330		-	200.00
HARDNESS (as CaCO3)	N	ppm	300		302				0.66	200.00
Nitrate-Nitrite	N	ppm	10.9		10.9		8.7		0.00	22.45
Sulfate	N	ppm	165		159		173		3.70	4.73
Total dissolved solids	N	ppm	507	J	508	J	460		0.20	9.72
Total suspended solids	N	ppm	ND	U	4	J	ND	U	-	-

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			AP2-BEDGW-003		AP2-BEDGW-003		AP2-BEDGW-003		Relative	Relative
SAMPLE_NO			AP3064		AP3065		AP3066		Percent	Percent
SAMPLE_DATE			23-May-09		23-May-09		23-May-09		Difference	Difference
FK_DEPTH			0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		REG and FD	REG and FS
SAMPLE_PURPOSE			REG		FD		FS			
Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual		
Tetryl	N	ug/L	ND	UJ	ND	U	0.41		-	-
Acetone	N	ug/L	25	R	25	R	ND	UJ	0.00	-
Benzene	N	ug/L	94.1		91.3		100		3.02	6.08
Butanone, 2-	N	ug/L	4.3	J	4.9	J	50	R	13.04	168.32
Carbon disulfide	N	ug/L	ND	U	ND	U	5.2		-	-
Cyclohexane	N	ug/L					74		-	200.00
Dibromo-3-chloropropane, 1,2-	N	ug/L					10	R	-	200.00
Ethylbenzene	N	ug/L	17.7		17.2		21		2.87	17.05
Isopropylbenzene	N	ug/L					5.8		-	200.00
Toluene	N	ug/L	41.3		39.6		54		4.20	26.65
Xylenes, total	N	ug/L	193		185		260		4.23	29.58
3-Methylphenol and 4-Methylphenol	N	ug/L	ND	U	ND	U			-	-
Methylnaphthalene, 2-	N	ug/L	1.9	J	1.3	J	ND	U	37.50	-
Naphthalene	N	ug/L	2.9	J	1.9	J	ND	U	41.67	-
Aluminum	N	ug/L	ND	U	17.4	J	ND	U	-	-
Barium	N	ug/L	175	J	184	J	ND	U	5.01	-
Calcium	N	ug/L	266000	J	275000		317000		3.33	17.50
Iron	N	ug/L	ND	U	33	J	ND	U	-	-
Magnesium	N	ug/L	103000	J	110000		120000		6.57	15.25
Manganese	N	ug/L	5.9	J	5.4	J	ND	U	8.85	-
Potassium	N	ug/L	13300		11500	J	11300		14.52	16.26
Selenium	N	ug/L	6.7	B	14.3	B	ND	U	72.38	-
Sodium	N	ug/L	56600	J	58500		63000		3.30	10.70
Vanadium	N	ug/L	1	J	1.3	J	ND	U	26.09	-
Aluminum	Y	ug/L	ND	U	12.4	J	ND	U	-	-
Barium	Y	ug/L	171	J	186	J	ND	U	8.40	-
Calcium	Y	ug/L	257000		281000		323000		8.92	22.76
Magnesium	Y	ug/L	98700	J	108000		123000		9.00	21.92
Manganese	Y	ug/L	5.6	J	6.1	J	ND	U	8.55	-
Potassium	Y	ug/L	13000		13800		11800		5.97	9.68
Selenium	Y	ug/L	8.1	J	8.8	J	ND	U	8.28	-
Sodium	Y	ug/L	55700		58700		65900		5.24	16.78

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

Vanadium	Y	ug/L	1.2	J	1.1	J	ND	U	8.70	-
Alkalinity	N	ppm	649	J	632		590		2.65	9.52
Chloride	N	ppm	111		105		93.6		5.56	17.01
Cyanide, total	N	ppm	ND	UJ	ND	UJ	0.71		-	-
Hardness ('HARDNESS (as CaCO3)	N	ppm	1090		1140		1200		4.48	9.61
Nitrate-Nitrite	N	ppm	0.76	J	ND	U	ND	U	-	-
Sulfate	N	ppm	519		476		626		8.64	18.69
Total dissolved solids	N	ppm	1900	J	1740	J	1500		8.79	23.53
Total suspended solids	N	ppm	ND	U	17		ND	U	-	-
Turbidity	N	NTU	14	J	ND	UJ	94		-	148.15

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Realtive Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

LOCATION_CODE			ASH PIT 2-PZ07		ASH PIT 2-PZ07		ASH PIT 2-PZ07		Relative	Relative
SAMPLE_NO			AP3022		AP3015		AP3016		Percent	Percent
SAMPLE_DATE			2-Feb-09		2-Feb-09		2-Feb-09		Difference	Difference
FK_DEPTH			0 - 0 Ft		0 - 0 Ft		0 - 0 Ft		REG and FD	REG and FS
SAMPLE_PURPOSE			REG		FD		FS			
Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual		
Dimethylphenol, 2,4-	N	ug/L	ND	U	3.38	J	ND	U	-	-
Aluminum	N	ug/L	147	J	93.3	J	ND	U	44.69	-
Barium	N	ug/L	31.9		31.3		ND	U	1.90	-
Cadmium	N	ug/L	3.91	J	4.27	J	ND	U	8.80	-
Calcium	N	ug/L	110000		110000		101000		0.00	8.53
Copper	N	ug/L	ND	U	5.71	J	ND	U	-	-
Iron	N	ug/L	593	J	325	J	191		58.39	102.55
Magnesium	N	ug/L	31900		32200		29200		0.94	8.84
Manganese	N	ug/L	24.5		21.6		20.7		12.58	16.81
Nickel	N	ug/L	ND	U	4	J	ND	U	-	-
Potassium	N	ug/L	548	J	521	J	ND	U	5.05	-
Sodium	N	ug/L	6990		6860		6380		1.88	9.12
Barium	Y	ug/L	28.2		29.3		ND	U	3.83	-
Cadmium	Y	ug/L	3.9	J	3.98	J	ND	U	2.03	-
Calcium	Y	ug/L	103000		108000		103000		4.74	0.00
Magnesium	Y	ug/L	31400		31100		29900		0.96	4.89
Manganese	Y	ug/L	19		17.1		30.7		10.53	47.08
Potassium	Y	ug/L	460	J	445	J	ND	U	3.31	-
Sodium	Y	ug/L	7000		6840		6180		2.31	12.44
Alkalinity	N	ppm	169		222		260		27.11	42.42
Chloride	N	ppm	3.04	J	2.81	J	2.1		7.86	36.58
Cyanide, total	N	ppm					0.044		-	200.00
Hardness	N	ppm	407		408		620		0.25	41.48
Nitrate-Nitrite	N	ppm	0.028	J	ND	UJ			-	200.00
Sulfate	N	ppm	80.6		79.6		177		1.25	74.84
Total dissolved solids	N	ppm	450		442		450		1.79	0.00
Total suspended solids	N	ppm	4		ND	U	ND	U	-	-
Turbidity	N	NTU	4.52		4.93		1.3		8.68	110.65

Table 3

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Reason Code	Description
01	Sample received outside of 4+/-2 degrees Celsius
01A	Improper sample preservation
02	Holding Time Exceeded
02A	Extraction
02B	Analysis
03	Instrument Performance - Outside Criteria
03A	BFB
03B	DFTPP
03C	DDT and/or Endrin % breakdown exceeds criteria
03D	retention time windows
03E	Resolution
04	Initial Calibration results outside specified criteria
04A	Compound mean RRF<0.05
04B	Compound %RSD>30
04C	Correlation Coefficient<0.995
05	Continuing Calibration results outside specified criteria
05A	Compound mean RRF<0.05
05B	Compound %D>25
06	Result qualified as a result of the 5x/10x blank correction
06A	Method or Preparation Blank
06B	ICB or CCB
06C	ER
06D	TB
06E	FB
07	Surrogate Recoveries outside control limits
07A	Sample
07B	Associated method blank or LCS
08	MS/MSD/Duplicate results outside criteria
08A	MS and/or MSD recovery not within control limits (accuracy)
08B	%RPD outside acceptance criteria (precision)
09	Post Digestion Spike outside criteria (GFAA)
10	Internal Standards outside specified control limits
10A	Recovery
10B	Retention Time
11	Laboratory Control Sample recoveries outside specified control limits
11A	Recovery
11B	%RPD (if run in duplicate)
12	Interference Check Standard
13	Serial Dilution
14	Tentatively Identified Compounds
15	Quantitation
16	Multiple results available; alternate analysis preferred
17	Field duplicate RPD criteria exceeded
18	Percent difference between original and second column > 25%
19	Professional judgement was used to qualify the data
20	Pesticide clean-up checks
21	Target compound identification
22	Radiological calibration
23	Radiological quantitation
24	Reported result and/or lab qualifier revised to reflect validation findings
999	See hard copy for details.

Table 3

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Reason Code	Description
01	Sample received outside of 4+/-2 degrees Celsius
01A	Improper sample preservation
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03E	Resolution
04	Initial Calibration results outside specified criteria
04A	Compound mean RRF<0.05
04B	Compound %RSD>30
04C	Correlation Coefficient<0.995
05	Continuing Calibration results outside specified criteria
05A	Compound mean RRF<0.05
05B	Compound %D>25
06	Result qualified as a result of the 5x/10x blank correction
06A	Method or Preparation Blank
06B	ICB or CCB
06C	ER
06D	TB
06E	FB
07	Surrogate Recoveries outside control limits
07A	Sample
07B	Associated method blank or LCS
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08A	MS and/or MSD recovery not within control limits (accuracy)
08B	%RPD outside acceptance criteria (precision)
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21	Target compound identification
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Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Plum Brook Ordnance Works, Sandusky, Ohio

SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0901026	AP0100	EXPLOSIVES	1,3-DINITROBENZENE	UJ	08A			
0901026	AP0100	EXPLOSIVES	2,4-DINITROTOLUENE	UJ	08A			
0901026	AP0100	EXPLOSIVES	2-AMINO-4,6-DINITROTOLUENE	UJ	08A			
0901026	AP0100	EXPLOSIVES	3-NITROTOLUENE	UJ	08A			
0901026	AP0100	EXPLOSIVES	4-AMINO-2,6-DINITROTOLUENE	UJ	08A			
0901026	AP0100	METALS	ALUMINUM	J	08A	13		
0901026	AP0100	METALS	BARIUM	J	13			
0901026	AP0100	METALS	CADMIUM	J	15			
0901026	AP0100	METALS	CADMIUM	R	16			
0901026	AP0100	METALS	CALCIUM	J	13			
0901026	AP0100	METALS	COPPER	J	08A			
0901026	AP0100	METALS	IRON	J	08A	13		
0901026	AP0100	METALS	LEAD	R	16			
0901026	AP0100	METALS	MAGNESIUM	J	08A	13		
0901026	AP0100	METALS	MANGANESE	J	13			
0901026	AP0100	METALS	NICKEL	J	13			
0901026	AP0100	METALS	POTASSIUM	J	13			
0901026	AP0100	METALS	SELENIUM	J	15			
0901026	AP0100	METALS	THALLIUM	J	15			
0901026	AP0100	SEMIVOLATILES	BENZO(A)ANTHRACENE	J	15			
0901026	AP0100	SEMIVOLATILES	BENZO(A)PYRENE	J	15			
0901026	AP0100	SEMIVOLATILES	BENZO(B)FLUORANTHENE	J	15			
0901026	AP0100	SEMIVOLATILES	CHRYSENE	J	15			
0901026	AP0100	SEMIVOLATILES	FLUORANTHENE	J	15			
0901026	AP0100	SEMIVOLATILES	HEXACHLOROCYCLOPENTADIENE	UJ	08A	08B		
0901026	AP0100	SEMIVOLATILES	NAPHTHALENE	J	15			
0901026	AP0100	SEMIVOLATILES	PHENANTHRENE	J	15			
0901026	AP0100	SEMIVOLATILES	PYRENE	J	15			
0901026	AP0101	METALS	ALUMINUM	J	08A			
0901026	AP0101	METALS	ANTIMONY	J	15			
0901026	AP0101	METALS	CADMIUM	R	16			
0901026	AP0101	METALS	COPPER	J	08A			
0901026	AP0101	METALS	IRON	J	08A			
0901026	AP0101	METALS	LEAD	R	16			
0901026	AP0101	METALS	MAGNESIUM	J	08A			
0901026	AP0102	METALS	ALUMINUM	J	08A			
0901026	AP0102	METALS	ANTIMONY	J	15			
0901026	AP0102	METALS	CADMIUM	R	16			
0901026	AP0102	METALS	COPPER	J	08A			
0901026	AP0102	METALS	IRON	J	08A			
0901026	AP0102	METALS	LEAD	R	16			
0901026	AP0102	METALS	MAGNESIUM	J	08A			
0901026	AP0102	METALS	MERCURY	J	15			
0901026	AP0102	METALS	THALLIUM	J	15			
0901026	AP0102	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0102	SEMIVOLATILES	PHENANTHRENE	J	15			
0901026	AP0103	EXPLOSIVES	1,3,5-TRINITROBENZENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	1,3-DINITROBENZENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	1-CHLORO-3-NITROBENZENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	2,4,6-TRINITROTOLUENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	2,4-DINITROTOLUENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	2,6-DINITROTOLUENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	2-AMINO-4,6-DINITROTOLUENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	2-NITROTOLUENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	3-NITROTOLUENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	4-AMINO-2,6-DINITROTOLUENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	4-NITROTOLUENE	UJ	07A			
0901026	AP0103	EXPLOSIVES	HMX	UJ	07A			
0901026	AP0103	EXPLOSIVES	NITROBENZENE	UJ	07A			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Plum Brook Ordnance Works, Sandusky, Ohio

SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0901026	AP0103	EXPLOSIVES	RDX	UJ	07A			
0901026	AP0103	EXPLOSIVES	TETRYL	UJ	07A			
0901026	AP0103	METALS	ALUMINUM	J	08A			
0901026	AP0103	METALS	BARIUM	J	08A			
0901026	AP0103	METALS	BERYLLIUM	J	13			
0901026	AP0103	METALS	CADMIUM	J	15			
0901026	AP0103	METALS	CADMIUM	R	16			
0901026	AP0103	METALS	COBALT	J	08A	08B		
0901026	AP0103	METALS	COPPER	J	08A			
0901026	AP0103	METALS	IRON	J	13			
0901026	AP0103	METALS	LEAD	R	16			
0901026	AP0103	METALS	MAGNESIUM	J	08A			
0901026	AP0103	METALS	THALLIUM	J	15			
0901026	AP0103	PEST/PCB	AROCLOR 1016	J	18			
0901026	AP0103	SEMIVOLATILES	BENZO(A)ANTHRACENE	J	15			
0901026	AP0103	SEMIVOLATILES	CHRYSENE	J	15			
0901026	AP0103	SEMIVOLATILES	FLUORANTHENE	J	15			
0901026	AP0103	SEMIVOLATILES	NAPHTHALENE	J	15			
0901026	AP0103	SEMIVOLATILES	PHENANTHRENE	J	15			
0901026	AP0103	SEMIVOLATILES	PYRENE	J	15			
0901026	AP0104	METALS	ALUMINUM	J	08A			
0901026	AP0104	METALS	ANTIMONY	J	15			
0901026	AP0104	METALS	ARSENIC	J	17			
0901026	AP0104	METALS	BARIUM	J	08A			
0901026	AP0104	METALS	BERYLLIUM	J	13			
0901026	AP0104	METALS	CADMIUM	R	16			
0901026	AP0104	METALS	COBALT	J	08A	08B		
0901026	AP0104	METALS	COPPER	J	08A			
0901026	AP0104	METALS	IRON	J	13			
0901026	AP0104	METALS	LEAD	R	16			
0901026	AP0104	METALS	MAGNESIUM	J	08A	17		
0901026	AP0104	METALS	MANGANESE	J	17			
0901026	AP0104	METALS	MERCURY	J	15			
0901026	AP0104	METALS	THALLIUM	J	15			
0901026	AP0104	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0105	METALS	ALUMINUM	J	08A			
0901026	AP0105	METALS	ANTIMONY	J	15			
0901026	AP0105	METALS	ARSENIC	J	17			
0901026	AP0105	METALS	BARIUM	J	08A			
0901026	AP0105	METALS	BERYLLIUM	J	13			
0901026	AP0105	METALS	CADMIUM	R	16			
0901026	AP0105	METALS	COBALT	J	08A	08B		
0901026	AP0105	METALS	COPPER	J	08A			
0901026	AP0105	METALS	IRON	J	13			
0901026	AP0105	METALS	LEAD	R	16			
0901026	AP0105	METALS	MAGNESIUM	J	08A	17		
0901026	AP0105	METALS	MANGANESE	J	17			
0901026	AP0105	METALS	MERCURY	J	15			
0901026	AP0105	SEMIVOLATILES	2,4-DINITROPHENOL	UJ	05B			
0901026	AP0107	METALS	ALUMINUM	J	08A			
0901026	AP0107	METALS	BARIUM	J	08A			
0901026	AP0107	METALS	BERYLLIUM	J	13			
0901026	AP0107	METALS	CADMIUM	R	16			
0901026	AP0107	METALS	COBALT	J	08A	08B		
0901026	AP0107	METALS	COPPER	J	08A			
0901026	AP0107	METALS	IRON	J	13			
0901026	AP0107	METALS	LEAD	R	16			
0901026	AP0107	METALS	MAGNESIUM	J	08A			
0901026	AP0107	METALS	THALLIUM	J	15			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Plum Brook Ordnance Works, Sandusky, Ohio

SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0901026	AP0107	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0107	SEMIVOLATILES	PHENANTHRENE	J	15			
0901026	AP0114	EXPLOSIVES	1,3,5-TRINITROBENZENE	R	07A			
0901026	AP0114	EXPLOSIVES	1,3-DINITROBENZENE	R	07A			
0901026	AP0114	EXPLOSIVES	2,4,6-TRINITROTOLUENE	R	07A			
0901026	AP0114	EXPLOSIVES	2,4-DINITROTOLUENE	R	07A			
0901026	AP0114	EXPLOSIVES	2,6-DINITROTOLUENE	R	07A			
0901026	AP0114	EXPLOSIVES	2-AMINO-4,6-DINITROTOLUENE	R	07A			
0901026	AP0114	EXPLOSIVES	2-NITROTOLUENE	R	07A			
0901026	AP0114	EXPLOSIVES	3-NITROTOLUENE	R	07A			
0901026	AP0114	EXPLOSIVES	4-AMINO-2,6-DINITROTOLUENE	R	07A			
0901026	AP0114	EXPLOSIVES	4-NITROTOLUENE	R	07A			
0901026	AP0114	EXPLOSIVES	HMX	R	07A			
0901026	AP0114	EXPLOSIVES	NITROBENZENE	R	07A			
0901026	AP0114	EXPLOSIVES	RDX	R	07A			
0901026	AP0114	EXPLOSIVES	TETRYL	R	07A			
0901026	AP0114	METALS	ALUMINUM	J	08A			
0901026	AP0114	METALS	BARIUM	J	08A			
0901026	AP0114	METALS	BERYLLIUM	J	13			
0901026	AP0114	METALS	CADMIUM	R	16			
0901026	AP0114	METALS	COBALT	J	08A	08B		
0901026	AP0114	METALS	COPPER	J	08A			
0901026	AP0114	METALS	IRON	J	13			
0901026	AP0114	METALS	LEAD	R	16			
0901026	AP0114	METALS	MAGNESIUM	J	08A			
0901026	AP0114	SEMIVOLATILES	2,4-DINITROPHENOL	UJ	05B			
0901026	AP0114	SEMIVOLATILES	NAPHTHALENE	J	15			
0901026	AP0115	METALS	ALUMINUM	J	08A			
0901026	AP0115	METALS	ANTIMONY	J	15			
0901026	AP0115	METALS	BARIUM	J	08A			
0901026	AP0115	METALS	BERYLLIUM	J	13			
0901026	AP0115	METALS	CADMIUM	R	16			
0901026	AP0115	METALS	COBALT	J	08A	08B		
0901026	AP0115	METALS	COPPER	J	08A			
0901026	AP0115	METALS	IRON	J	13			
0901026	AP0115	METALS	LEAD	R	16			
0901026	AP0115	METALS	MAGNESIUM	J	08A			
0901026	AP0115	METALS	MERCURY	J	15			
0901026	AP0115	SEMIVOLATILES	2,4-DINITROPHENOL	UJ	05B			
0901026	AP0116	METALS	ALUMINUM	J	08A			
0901026	AP0116	METALS	BARIUM	J	08A			
0901026	AP0116	METALS	BERYLLIUM	J	13			
0901026	AP0116	METALS	CADMIUM	J	15			
0901026	AP0116	METALS	CADMIUM	R	16			
0901026	AP0116	METALS	COBALT	J	08A	08B		
0901026	AP0116	METALS	COPPER	J	08A			
0901026	AP0116	METALS	IRON	J	13			
0901026	AP0116	METALS	LEAD	R	16			
0901026	AP0116	METALS	MAGNESIUM	J	08A			
0901026	AP0116	METALS	SELENIUM	J	15			
0901026	AP0116	METALS	THALLIUM	J	15			
0901026	AP0116	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0116	SEMIVOLATILES	PHENANTHRENE	J	15			
0901026	AP0117	EXPLOSIVES	1,3,5-TRINITROBENZENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	1,3-DINITROBENZENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	1-CHLORO-3-NITROBENZENE	UJ	07A			
0901026	AP0117	EXPLOSIVES	2,4,6-TRINITROTOLUENE	UJ	07A			
0901026	AP0117	EXPLOSIVES	2,4-DINITROTOLUENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	2,6-DINITROTOLUENE	UJ	07A			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Plum Brook Ordnance Works, Sandusky, Ohio

SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0901026	AP0117	EXPLOSIVES	2-AMINO-4,6-DINITROTOLUENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	2-NITROTOLUENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	3-NITROTOLUENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	4-AMINO-2,6-DINITROTOLUENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	4-NITROTOLUENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	HMX	UJ	07A			
0901026	AP0117	EXPLOSIVES	NITROBENZENE	UJ	07A	08A		
0901026	AP0117	EXPLOSIVES	RDX	UJ	07A			
0901026	AP0117	EXPLOSIVES	TETRYL	UJ	07A			
0901026	AP0117	METALS	ALUMINUM	J	08A			
0901026	AP0117	METALS	CADMIUM	J	15			
0901026	AP0117	METALS	CADMIUM	R	16			
0901026	AP0117	METALS	COPPER	J	08A			
0901026	AP0117	METALS	IRON	J	08A			
0901026	AP0117	METALS	LEAD	R	16			
0901026	AP0117	METALS	MAGNESIUM	J	08A			
0901026	AP0117	METALS	SELENIUM	J	15			
0901026	AP0117	METALS	THALLIUM	J	15			
0901026	AP0118	METALS	ALUMINUM	J	08A			
0901026	AP0118	METALS	ANTIMONY	J	15			
0901026	AP0118	METALS	CADMIUM	J	15			
0901026	AP0118	METALS	CADMIUM	R	16			
0901026	AP0118	METALS	COPPER	J	08A			
0901026	AP0118	METALS	IRON	J	08A			
0901026	AP0118	METALS	LEAD	R	16			
0901026	AP0118	METALS	MAGNESIUM	J	08A			
0901026	AP0118	METALS	MERCURY	J	15			
0901026	AP0119	METALS	ALUMINUM	J	08A			
0901026	AP0119	METALS	ANTIMONY	J	15			
0901026	AP0119	METALS	BARIUM	J	08A			
0901026	AP0119	METALS	BERYLLIUM	J	13			
0901026	AP0119	METALS	CADMIUM	R	16			
0901026	AP0119	METALS	COBALT	J	08A	08B		
0901026	AP0119	METALS	COPPER	J	08A			
0901026	AP0119	METALS	IRON	J	13			
0901026	AP0119	METALS	LEAD	R	16			
0901026	AP0119	METALS	MAGNESIUM	J	08A			
0901026	AP0119	METALS	MERCURY	J	15			
0901026	AP0119	METALS	THALLIUM	J	15			
0901026	AP0119	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0119	SEMIVOLATILES	PHENANTHRENE	J	15			
0901026	AP0120	METALS	ALUMINUM	J	08A			
0901026	AP0120	METALS	ANTIMONY	J	15			
0901026	AP0120	METALS	CADMIUM	R	16			
0901026	AP0120	METALS	COPPER	J	08A			
0901026	AP0120	METALS	IRON	J	08A			
0901026	AP0120	METALS	LEAD	R	16			
0901026	AP0120	METALS	MAGNESIUM	J	08A			
0901026	AP0120	METALS	MERCURY	J	15			
0901026	AP0121	METALS	ALUMINUM	J	08A			
0901026	AP0121	METALS	ANTIMONY	J	15			
0901026	AP0121	METALS	CADMIUM	R	16			
0901026	AP0121	METALS	COPPER	J	08A			
0901026	AP0121	METALS	IRON	J	08A			
0901026	AP0121	METALS	LEAD	R	16			
0901026	AP0121	METALS	MAGNESIUM	J	08A			
0901026	AP0121	METALS	MERCURY	J	15			
0901026	AP0121	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0123	METALS	ALUMINUM	J	08A			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0901026	AP0123	METALS	ANTIMONY	J	15			
0901026	AP0123	METALS	CADMIUM	R	16			
0901026	AP0123	METALS	COPPER	J	08A			
0901026	AP0123	METALS	IRON	J	08A			
0901026	AP0123	METALS	LEAD	R	16			
0901026	AP0123	METALS	MAGNESIUM	J	08A			
0901026	AP0123	METALS	MERCURY	J	15			
0901026	AP0123	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0124	METALS	ALUMINUM	J	08A			
0901026	AP0124	METALS	BARIUM	J	08A			
0901026	AP0124	METALS	BERYLLIUM	J	13			
0901026	AP0124	METALS	CADMIUM	R	16			
0901026	AP0124	METALS	COBALT	J	08A	08B		
0901026	AP0124	METALS	COPPER	J	08A			
0901026	AP0124	METALS	IRON	J	13			
0901026	AP0124	METALS	LEAD	R	16			
0901026	AP0124	METALS	MAGNESIUM	J	08A			
0901026	AP0124	METALS	THALLIUM	J	15			
0901026	AP0124	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0124	SEMIVOLATILES	PHENANTHRENE	J	15			
0901026	AP0125	EXPLOSIVES	1,3,5-TRINITROBENZENE	R	07A			
0901026	AP0125	EXPLOSIVES	1,3-DINITROBENZENE	R	07A			
0901026	AP0125	EXPLOSIVES	2,4,6-TRINITROTOLUENE	R	07A			
0901026	AP0125	EXPLOSIVES	2,4-DINITROTOLUENE	R	07A			
0901026	AP0125	EXPLOSIVES	2,6-DINITROTOLUENE	R	07A			
0901026	AP0125	EXPLOSIVES	2-AMINO-4,6-DINITROTOLUENE	R	07A			
0901026	AP0125	EXPLOSIVES	2-NITROTOLUENE	R	07A			
0901026	AP0125	EXPLOSIVES	3-NITROTOLUENE	R	07A			
0901026	AP0125	EXPLOSIVES	4-AMINO-2,6-DINITROTOLUENE	R	07A			
0901026	AP0125	EXPLOSIVES	4-NITROTOLUENE	R	07A			
0901026	AP0125	EXPLOSIVES	HMX	R	07A			
0901026	AP0125	EXPLOSIVES	NITROBENZENE	R	07A			
0901026	AP0125	EXPLOSIVES	RDX	R	07A			
0901026	AP0125	EXPLOSIVES	TETRYL	R	07A			
0901026	AP0125	METALS	ALUMINUM	J	08A			
0901026	AP0125	METALS	BARIUM	J	08A			
0901026	AP0125	METALS	BERYLLIUM	J	13			
0901026	AP0125	METALS	CADMIUM	R	16			
0901026	AP0125	METALS	COBALT	J	08A	08B		
0901026	AP0125	METALS	COPPER	J	08A			
0901026	AP0125	METALS	IRON	J	13			
0901026	AP0125	METALS	LEAD	R	16			
0901026	AP0125	METALS	MAGNESIUM	J	08A			
0901026	AP0125	METALS	SELENIUM	J	15			
0901026	AP0125	METALS	THALLIUM	J	15			
0901026	AP0125	PEST/PCB	AROCLOR 1016	UJ	07A			
0901026	AP0125	PEST/PCB	AROCLOR 1221	UJ	07A			
0901026	AP0125	PEST/PCB	AROCLOR 1232	UJ	07A			
0901026	AP0125	PEST/PCB	AROCLOR 1242	UJ	07A			
0901026	AP0125	PEST/PCB	AROCLOR 1248	UJ	07A			
0901026	AP0125	PEST/PCB	AROCLOR 1254	UJ	07A			
0901026	AP0125	PEST/PCB	AROCLOR 1260	UJ	07A			
0901026	AP0126	METALS	ALUMINUM	J	08A			
0901026	AP0126	METALS	ANTIMONY	J	15			
0901026	AP0126	METALS	BARIUM	J	08A			
0901026	AP0126	METALS	BERYLLIUM	J	13			
0901026	AP0126	METALS	CADMIUM	R	16			
0901026	AP0126	METALS	COBALT	J	08A	08B		
0901026	AP0126	METALS	COPPER	J	08A			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0901026	AP0126	METALS	IRON	J	13			
0901026	AP0126	METALS	LEAD	R	16			
0901026	AP0126	METALS	MAGNESIUM	J	08A			
0901026	AP0126	METALS	MERCURY	J	15			
0901026	AP0127	EXPLOSIVES	1,3,5-TRINITROBENZENE	UJ	08A			
0901026	AP0127	EXPLOSIVES	2,4,6-TRINITROTOLUENE	UJ	08A			
0901026	AP0127	EXPLOSIVES	2,4-DINITROTOLUENE	UJ	08A			
0901026	AP0127	EXPLOSIVES	2-AMINO-4,6-DINITROTOLUENE	UJ	08A			
0901026	AP0127	METALS	ALUMINUM	J	08A			
0901026	AP0127	METALS	BARIUM	J	08A			
0901026	AP0127	METALS	BERYLLIUM	J	13			
0901026	AP0127	METALS	CADMIUM	R	16			
0901026	AP0127	METALS	COBALT	J	08A	08B		
0901026	AP0127	METALS	COPPER	J	08A			
0901026	AP0127	METALS	IRON	J	13			
0901026	AP0127	METALS	LEAD	R	16			
0901026	AP0127	METALS	MAGNESIUM	J	08A			
0901026	AP0127	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901026	AP0128	METALS	ALUMINUM	J	08A			
0901026	AP0128	METALS	ANTIMONY	J	15			
0901026	AP0128	METALS	BARIUM	J	08A			
0901026	AP0128	METALS	BERYLLIUM	J	13			
0901026	AP0128	METALS	CADMIUM	R	16			
0901026	AP0128	METALS	COBALT	J	08A	08B		
0901026	AP0128	METALS	COPPER	J	08A			
0901026	AP0128	METALS	IRON	J	13			
0901026	AP0128	METALS	LEAD	R	16			
0901026	AP0128	METALS	MAGNESIUM	J	08A			
0901026	AP0128	SEMIVOLATILES	BENZOIC ACID	UJ	05B			
0901027	AP0108	METALS	ARSENIC	J	08A			
0901027	AP0108	METALS	BARIUM	J	08A	08B	13	
0901027	AP0108	METALS	BERYLLIUM	J	13			
0901027	AP0108	METALS	CADMIUM	R	16			
0901027	AP0108	METALS	CALCIUM	J	13			
0901027	AP0108	METALS	CHROMIUM	J	13			
0901027	AP0108	METALS	COBALT	J	08A	08B	13	
0901027	AP0108	METALS	LEAD	J	13			
0901027	AP0108	METALS	LEAD	R	16			
0901027	AP0108	METALS	MAGNESIUM	J	08A	13		
0901027	AP0108	METALS	NICKEL	J	08A	13		
0901027	AP0108	METALS	SELENIUM	J	08A	15		
0901027	AP0108	METALS	SILVER	UJ	08A	08B		
0901027	AP0108	METALS	THALLIUM	J	15			
0901027	AP0108	METALS	ZINC	J	13			
0901027	AP0108	PEST/PCB	AROCLOR 1260	J	18	15		
0901027	AP0108	SEMIVOLATILES	FLUORANTHENE	J	15			
0901027	AP0108	SEMIVOLATILES	PYRENE	J	15			
0901027	AP0109	METALS	ANTIMONY	J	15			
0901027	AP0109	METALS	ARSENIC	J	08A			
0901027	AP0109	METALS	BARIUM	J	08A	08B	13	
0901027	AP0109	METALS	BERYLLIUM	J	13			
0901027	AP0109	METALS	CADMIUM	R	16			
0901027	AP0109	METALS	CALCIUM	J	13			
0901027	AP0109	METALS	CHROMIUM	J	13			
0901027	AP0109	METALS	COBALT	J	08A	08B	13	
0901027	AP0109	METALS	LEAD	J	13			
0901027	AP0109	METALS	LEAD	R	16			
0901027	AP0109	METALS	MAGNESIUM	J	08A	13		
0901027	AP0109	METALS	MERCURY	J	15			

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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0901027	AP0109	METALS	NICKEL	J	08A	13		
0901027	AP0109	METALS	SELENIUM	UJ	08A			
0901027	AP0109	METALS	SILVER	UJ	08A	08B		
0901027	AP0109	METALS	THALLIUM	J	15			
0901027	AP0109	METALS	ZINC	J	13			
0901027	AP0110	METALS	ANTIMONY	J	15			
0901027	AP0110	METALS	ARSENIC	J	08A			
0901027	AP0110	METALS	BARIUM	J	08A	08B	13	
0901027	AP0110	METALS	BERYLLIUM	J	13			
0901027	AP0110	METALS	CADMIUM	R	16			
0901027	AP0110	METALS	CALCIUM	J	13			
0901027	AP0110	METALS	CHROMIUM	J	13			
0901027	AP0110	METALS	COBALT	J	08A	08B	13	
0901027	AP0110	METALS	LEAD	J	13			
0901027	AP0110	METALS	LEAD	R	16			
0901027	AP0110	METALS	MAGNESIUM	J	08A	13		
0901027	AP0110	METALS	MERCURY	J	15			
0901027	AP0110	METALS	NICKEL	J	08A	13		
0901027	AP0110	METALS	SELENIUM	UJ	08A			
0901027	AP0110	METALS	SILVER	UJ	08A	08B		
0901027	AP0110	METALS	THALLIUM	J	15			
0901027	AP0110	METALS	ZINC	J	13			
0901027	AP0110	SEMIVOLATILES	PHENANTHRENE	J	15			
0901027	AP0111	EXPLOSIVES	1,3,5-TRINITROBENZENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	1,3-DINITROBENZENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	2,4,6-TRINITROTOLUENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	2,4-DINITROTOLUENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	2,6-DINITROTOLUENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	2-AMINO-4,6-DINITROTOLUENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	2-NITROTOLUENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	3-NITROTOLUENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	4-AMINO-2,6-DINITROTOLUENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	4-NITROTOLUENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	HMX	UJ	07A			
0901027	AP0111	EXPLOSIVES	NITROBENZENE	UJ	07A			
0901027	AP0111	EXPLOSIVES	RDX	UJ	07A			
0901027	AP0111	EXPLOSIVES	TETRYL	UJ	07A			
0901027	AP0111	METALS	ARSENIC	J	08A			
0901027	AP0111	METALS	BARIUM	J	08A	08B	13	
0901027	AP0111	METALS	BERYLLIUM	J	13			
0901027	AP0111	METALS	CADMIUM	R	16			
0901027	AP0111	METALS	CALCIUM	J	13			
0901027	AP0111	METALS	CHROMIUM	J	13			
0901027	AP0111	METALS	COBALT	J	08A	08B	13	
0901027	AP0111	METALS	LEAD	J	13			
0901027	AP0111	METALS	LEAD	R	16			
0901027	AP0111	METALS	MAGNESIUM	J	08A	13		
0901027	AP0111	METALS	NICKEL	J	08A	13		
0901027	AP0111	METALS	SELENIUM	J	08A	15		
0901027	AP0111	METALS	SILVER	UJ	08A	08B		
0901027	AP0111	METALS	THALLIUM	J	15			
0901027	AP0111	METALS	ZINC	J	13			
0901027	AP0112	METALS	ANTIMONY	J	15			
0901027	AP0112	METALS	ARSENIC	J	08A			
0901027	AP0112	METALS	BARIUM	J	08A	08B	13	
0901027	AP0112	METALS	BERYLLIUM	J	13			
0901027	AP0112	METALS	CADMIUM	R	16			
0901027	AP0112	METALS	CALCIUM	J	13			
0901027	AP0112	METALS	CHROMIUM	J	13			

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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0901027	AP0112	METALS	COBALT	J	08A	08B	13	
0901027	AP0112	METALS	LEAD	J	13			
0901027	AP0112	METALS	LEAD	R	16			
0901027	AP0112	METALS	MAGNESIUM	J	08A	13		
0901027	AP0112	METALS	NICKEL	J	08A	13		
0901027	AP0112	METALS	SELENIUM	J	08A	15		
0901027	AP0112	METALS	SILVER	UJ	08A	08B		
0901027	AP0112	METALS	ZINC	J	13			
0901027	AP0113	METALS	ANTIMONY	J	15			
0901027	AP0113	METALS	ARSENIC	J	08A			
0901027	AP0113	METALS	BARIUM	J	08A	08B	13	
0901027	AP0113	METALS	BERYLLIUM	J	13			
0901027	AP0113	METALS	CADMIUM	R	16			
0901027	AP0113	METALS	CALCIUM	J	13			
0901027	AP0113	METALS	CHROMIUM	J	13			
0901027	AP0113	METALS	COBALT	J	08A	08B	13	
0901027	AP0113	METALS	LEAD	J	13			
0901027	AP0113	METALS	LEAD	R	16			
0901027	AP0113	METALS	MAGNESIUM	J	08A	13		
0901027	AP0113	METALS	MERCURY	J	15			
0901027	AP0113	METALS	NICKEL	J	08A	13		
0901027	AP0113	METALS	SELENIUM	UJ	08A			
0901027	AP0113	METALS	SILVER	UJ	08A	08B		
0901027	AP0113	METALS	THALLIUM	J	15			
0901027	AP0113	METALS	ZINC	J	13			
0901027	AP0113	SEMIVOLATILES	PHENANTHRENE	J	15			
0902003	AP3015	GEN CHEMISTRY	Chloride	J	08A			
0902003	AP3015	GEN CHEMISTRY	Nitrate/Nitrite as N	UJ	08A			
0902003	AP3015	GEN CHEMISTRY	Sulfate	R	16			
0902003	AP3015	METALS	Aluminum	J	17			
0902003	AP3015	METALS	Cadmium	J	15			
0902003	AP3015	METALS	Copper	J	15			
0902003	AP3015	METALS	Iron	J	17			
0902003	AP3015	METALS	Nickel	J	15			
0902003	AP3015	METALS	Potassium	J	15			
0902003	AP3015	SEMIVOLATILES	2,4-Dimethylphenol	J	15			
0902003	AP3015	SEMIVOLATILES	Hexachlorocyclopentadiene	UJ	05B			
0902003	AP3018	GEN CHEMISTRY	Chloride	J	08A			
0902003	AP3018	GEN CHEMISTRY	Nitrate/Nitrite as N	J	08A			
0902003	AP3018	GEN CHEMISTRY	Sulfate	R	16			
0902003	AP3018	GEN CHEMISTRY	Turbidity	J	02B			
0902003	AP3018	METALS	Cadmium	J	15			
0902003	AP3018	METALS	Copper	J	15			
0902003	AP3018	METALS	Lead	J	15			
0902003	AP3018	METALS	Nickel	J	15			
0902003	AP3018	METALS	Potassium	J	15			
0902003	AP3018	METALS	Selenium	J	15			
0902003	AP3018	SEMIVOLATILES	Hexachlorocyclopentadiene	UJ	05B			
0902003	AP3019	GEN CHEMISTRY	Chloride	J	08A			
0902003	AP3019	GEN CHEMISTRY	Nitrate/Nitrite as N	J	08A			
0902003	AP3019	GEN CHEMISTRY	Sulfate	R	16			
0902003	AP3019	GEN CHEMISTRY	Total Suspended Solids	J	15			
0902003	AP3019	GEN CHEMISTRY	Turbidity	J	02B			
0902003	AP3019	METALS	Aluminum	j	15			
0902003	AP3019	METALS	Cadmium	J	15			
0902003	AP3019	METALS	Copper	J	15			
0902003	AP3019	METALS	Nickel	J	15			
0902003	AP3019	METALS	Potassium	J	15			
0902003	AP3019	SEMIVOLATILES	Hexachlorocyclopentadiene	UJ	05B			

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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
0902003	AP3022	GEN CHEMISTRY	Chloride	J	08A			
0902003	AP3022	GEN CHEMISTRY	Nitrate/Nitrite as N	J	08A	15		
0902003	AP3022	GEN CHEMISTRY	Sulfate	R	16			
0902003	AP3022	METALS	Aluminum	J	17			
0902003	AP3022	METALS	Cadmium	J	15			
0902003	AP3022	METALS	Iron	J	17			
0902003	AP3022	METALS	Potassium	J	15			
0902003	AP3022	SEMIVOLATILES	Hexachlorocyclopentadiene	UJ	05B			
A9A17011	AP0106	METALS	CALCIUM	J	13			
A9A17011	AP0106	METALS	POTASSIUM	J	13			
A9A17011	AP0122	METALS	CALCIUM	J	13			
A9A17011	AP0122	METALS	POTASSIUM	J	13			
A9A17011	AP0129	METALS	CALCIUM	J	13			
A9A17011	AP0129	METALS	POTASSIUM	J	13			
A9B03020	AP3016	SEMIVOLATILES	BIS(2-CHLOROETHYL) ETHER	UJ	05B			
A9E27026	AP1005	METALS	ANTIMONY	UJ	08A	08B		
A9E27026	AP2004	METALS	MAGNESIUM	J	05B			
A9E27026	AP3060	METALS	MAGNESIUM	J	05B			
A9E27026	AP3060	VOLATILES	1,2-DIBROMO-3-CHLOROPROPANE	R	04A	05A		
A9E27026	AP3060	VOLATILES	2-BUTANONE	R	04A	05A	05B	
A9E27026	AP3060	VOLATILES	4-METHYL-2-PENTANONE	UJ	05B			
A9E27026	AP3060	VOLATILES	ACETONE	UJ	05B			
A9E27026	AP3060	VOLATILES	CHLOROETHANE	R	04A	05A	05B	
A9E27026	AP3060	VOLATILES	CHLOROMETHANE	UJ	05B			
A9E27026	AP3066	VOLATILES	1,2-DIBROMO-3-CHLOROPROPANE	R	04A	05A		
A9E27026	AP3066	VOLATILES	2-BUTANONE	R	04A	05A	05B	
A9E27026	AP3066	VOLATILES	4-METHYL-2-PENTANONE	UJ	05B			
A9E27026	AP3066	VOLATILES	ACETONE	UJ	05B			
A9E27026	AP3066	VOLATILES	CHLOROETHANE	R	04A	05A	05B	
A9E27026	AP3066	VOLATILES	CHLOROMETHANE	UJ	05B			
A9K19053	AP3082	GEN CHEMISTRY	NITRATE AS N	UJ	02B			
A9K19053	AP3082	VOLATILES	1,2-DIBROMO-3-CHLOROPROPANE	UJ	05B			
A9K19053	AP3082	VOLATILES	BROMOFORM	UJ	05B			
A9K19053	AP3082	VOLATILES	CIS-1,3-DICHLOROPROPENE	UJ	05B			
A9K19053	AP3082	VOLATILES	TRANS-1,3-DICHLOROPROPENE	UJ	05B			
F65476	AP1000	METALS	Cadmium	J	15			
F65476	AP1000	METALS	Potassium	J	15			
F65476	AP1000	METALS	Selenium	J	15			
F65476	AP1000	METALS	Sodium	J	15			
F65476	AP1001	METALS	Mercury	J	08B	15		
F65476	AP1001	METALS	Selenium	J	15			
F65476	AP1001	METALS	Sodium	J	15			
F65476	AP1002	EXPLOSIVES	2,4,6-Trinitrotoluene	J	15			
F65476	AP1002	EXPLOSIVES	2-amino-4,6-Dinitrotoluene	UJ	08A			
F65476	AP1002	METALS	Antimony	UJ	08A			
F65476	AP1002	METALS	Arsenic	J	08B			
F65476	AP1002	METALS	Barium	J	08B	08A		
F65476	AP1002	METALS	Calcium	J	08B	13		
F65476	AP1002	METALS	Chromium	J	13			
F65476	AP1002	METALS	Cobalt	J	13			
F65476	AP1002	METALS	Iron	J	08B	13		
F65476	AP1002	METALS	Lead	J	13	15		
F65476	AP1002	METALS	Magnesium	J	08B	13		
F65476	AP1002	METALS	Manganese	J	08B	13		
F65476	AP1002	METALS	Mercury	J	08B	15		
F65476	AP1002	METALS	Nickel	J	13			
F65476	AP1002	METALS	Potassium	J	08B			
F65476	AP1002	METALS	Selenium	J	15			
F65476	AP1002	METALS	Silver	J	08B	15		

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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
F65476	AP1002	METALS	Sodium	J	08B	15		
F65476	AP1002	METALS	Vanadium	J	13			
F65476	AP1002	METALS	Zinc	J	08A	13		
F65476	AP1002	SEMIVOLATILES	2,4-Dinitrophenol	UJ	05B			
F65476	AP1002	SEMIVOLATILES	Fluoranthene	J	15			
F65476	AP1003	METALS	Lead	J	17			
F65476	AP1003	METALS	Mercury	J	08B	15		
F65476	AP1003	METALS	Selenium	J	15	17		
F65476	AP1003	METALS	Sodium	J	15			
F65476	AP1003	SEMIVOLATILES	2,4-Dinitrophenol	UJ	05B			
F65476	AP1004	METALS	Lead	J	17			
F65476	AP1004	METALS	Mercury	J	08B	15		
F65476	AP1004	METALS	Selenium	J	15	17		
F65476	AP1004	METALS	Sodium	J	15			
F65476	AP1004	SEMIVOLATILES	2,4-Dinitrophenol	UJ	05B			
F65476	AP1006	METALS	Cadmium	J	15			
F65476	AP1006	METALS	Mercury	J	08B	15		
F65476	AP1006	METALS	Potassium	J	15			
F65476	AP1006	METALS	Selenium	J	15			
F65476	AP1006	METALS	Sodium	J	15			
F65476	AP1006	SEMIVOLATILES	2,4-Dinitrophenol	UJ	05B			
F65476	AP1006	SEMIVOLATILES	Fluoranthene	J	15			
F65479	AP2000	METALS	Barium	J	15			
F65479	AP2000	METALS	Potassium	J	15			
F65479	AP2000	METALS	Vanadium	J	15			
F65479	AP2000	METALS	Zinc	J	15			
F65479	AP2001	METALS	Barium	J	15			
F65479	AP2001	METALS	Potassium	J	15			
F65479	AP2001	METALS	Vanadium	J	15			
F65479	AP2001	METALS	Zinc	J	15			
F65479	AP2002	METALS	Barium	J	15			
F65479	AP2002	METALS	Lead	J	15			
F65479	AP2002	METALS	Potassium	J	15			
F65479	AP2002	METALS	Vanadium	J	15			
F65479	AP2003	METALS	Barium	J	15			
F65479	AP2003	METALS	Potassium	J	15			
F65479	AP2003	METALS	Vanadium	J	15			
F65479	AP2003	METALS	Zinc	J	15			
F65479	AP2003	SEMIVOLATILES	bis(2-Ethylhexyl)phthalate	J	15			
F65479	AP2005	EXPLOSIVES	4-amino-2,6-Dinitrotoluene	UJ	08A			
F65479	AP2005	METALS	Aluminum	J	08B	13		
F65479	AP2005	METALS	Barium	J	15			
F65479	AP2005	METALS	Cobalt	J	08B	15		
F65479	AP2005	METALS	Lead	J	15			
F65479	AP2005	METALS	Nickel	J	15			
F65479	AP2005	METALS	Potassium	J	15			
F65479	AP2005	METALS	Vanadium	J	08B	15		
F65479	AP2005	METALS	Zinc	J	15			
F65480	AP3057	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F65480	AP3057	GEN CHEMISTRY	Nitrogen, Nitrate + Nitrite	J	15			
F65480	AP3057	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F65480	AP3057	GEN CHEMISTRY	Turbidity	UJ	02B			
F65480	AP3057	METALS	Aluminum	J	15			
F65480	AP3057	METALS	Barium	J	15			
F65480	AP3057	METALS	Iron	J	15			
F65480	AP3057	METALS	Lead	B	06C	15		
F65480	AP3057	METALS	Lead	J	15			
F65480	AP3057	METALS	Potassium	J	15			
F65480	AP3057	METALS	Selenium	J	15			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Plum Brook Ordnance Works, Sandusky, Ohio

SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
F65480	AP3057	METALS	Sodium	J	15			
F65480	AP3057	METALS	Vanadium	J	15			
F65480	AP3057	SEMIVOLATILES	1,2,4-Trichlorobenzene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	1,2-Dichlorobenzene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	1,3-Dichlorobenzene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	1,4-Dichlorobenzene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2,4,5-Trichlorophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2,4,6-Tribromophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2,4,6-Trichlorophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2,4-Dichlorophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2,4-Dimethylphenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2,4-Dinitrophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2,4-Dinitrotoluene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2,6-Dinitrotoluene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2-Chloronaphthalene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2-Chlorophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2-Fluorobiphenyl	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2-Fluorophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2-Methylnaphthalene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2-Methylphenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2-Nitroaniline	UJ	02A			
F65480	AP3057	SEMIVOLATILES	2-Nitrophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	3 and 4-Methylphenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	3,3'-Dichlorobenzidine	UJ	02A			
F65480	AP3057	SEMIVOLATILES	3-Nitroaniline	UJ	02A			
F65480	AP3057	SEMIVOLATILES	4,6-Dinitro-o-cresol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	4-Bromophenyl phenyl ether	UJ	02A			
F65480	AP3057	SEMIVOLATILES	4-Chloro-3-methyl phenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	4-Chloroaniline	UJ	02A			
F65480	AP3057	SEMIVOLATILES	4-Chlorophenyl phenyl ether	UJ	02A			
F65480	AP3057	SEMIVOLATILES	4-Nitroaniline	UJ	02A			
F65480	AP3057	SEMIVOLATILES	4-Nitrophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Acenaphthene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Acenaphthylene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Anthracene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Benzo(a)anthracene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Benzo(a)pyrene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Benzo(b)fluoranthene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Benzo(g,h,i)perylene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Benzo(k)fluoranthene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Benzoic Acid	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Benzyl Alcohol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Butyl benzyl phthalate	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Carbazole	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Chrysene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Di-n-butyl phthalate	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Di-n-octyl phthalate	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Dibenzo(a,h)anthracene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Dibenzofuran	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Diethyl phthalate	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Dimethyl phthalate	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Fluoranthene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Fluorene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Hexachlorobenzene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Hexachlorobutadiene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Hexachlorocyclopentadiene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Hexachloroethane	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Indeno(1,2,3-cd)pyrene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Isophorone	UJ	02A			

Table 4

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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
F65480	AP3057	SEMIVOLATILES	N-Nitroso-di-n-propylamine	UJ	02A			
F65480	AP3057	SEMIVOLATILES	N-Nitrosodiphenylamine	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Naphthalene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Nitrobenzene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Nitrobenzene-d5	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Pentachlorophenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Phenanthrene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Phenol	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Phenol-d5	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Pyrene	UJ	02A			
F65480	AP3057	SEMIVOLATILES	Terphenyl-d14	UJ	02A			
F65480	AP3057	SEMIVOLATILES	bis(2-Chloroethoxy)methane	UJ	02A			
F65480	AP3057	SEMIVOLATILES	bis(2-Chloroethyl)ether	UJ	02A			
F65480	AP3057	SEMIVOLATILES	bis(2-Chloroisopropyl)ether	UJ	02A			
F65480	AP3057	SEMIVOLATILES	bis(2-Ethylhexyl)phthalate	UJ	02A			
F65480	AP3057	VOLATILES	Acetone	R	04A	05A		
F65480	AP3058	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F65480	AP3058	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F65480	AP3058	GEN CHEMISTRY	Turbidity	UJ	02B			
F65480	AP3058	METALS	Aluminum	J	15			
F65480	AP3058	METALS	Barium	J	15			
F65480	AP3058	METALS	Cadmium	J	15			
F65480	AP3058	METALS	Cobalt	J	15			
F65480	AP3058	METALS	Potassium	J	15			
F65480	AP3058	METALS	Sodium	J	15			
F65480	AP3058	VOLATILES	Acetone	R	04A	05A		
F65480	AP3059	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F65480	AP3059	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F65480	AP3059	GEN CHEMISTRY	Solids, Total Suspended	J	15			
F65480	AP3059	GEN CHEMISTRY	Turbidity	UJ	02B			
F65480	AP3059	METALS	Aluminum	J	15			
F65480	AP3059	METALS	Barium	J	15			
F65480	AP3059	METALS	Cadmium	J	15			
F65480	AP3059	METALS	Cobalt	J	15			
F65480	AP3059	METALS	Potassium	J	15			
F65480	AP3059	METALS	Sodium	J	15			
F65480	AP3059	VOLATILES	Acetone	R	04A	05A		
F65480	AP3061	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F65480	AP3061	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F65480	AP3061	GEN CHEMISTRY	Turbidity	J	02B	15		
F65480	AP3061	METALS	Aluminum	J	15			
F65480	AP3061	METALS	Barium	J	15			
F65480	AP3061	METALS	Iron	J	15			
F65480	AP3061	METALS	Potassium	J	15			
F65480	AP3061	METALS	Selenium	B	06C	15		
F65480	AP3061	METALS	Sodium	J	15			
F65480	AP3061	METALS	Vanadium	J	15			
F65480	AP3061	VOLATILES	Acetone	R	04A	05A		
F65480	AP3063	GEN CHEMISTRY	Cyanide, Total	J	08A	15		
F65480	AP3063	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F65480	AP3063	GEN CHEMISTRY	Turbidity	J	02B			
F65480	AP3063	METALS	Aluminum	J	15			
F65480	AP3063	METALS	Barium	J	15			
F65480	AP3063	METALS	Iron	J	15			
F65480	AP3063	METALS	Lead	B	06C	15		
F65480	AP3063	METALS	Potassium	J	15			
F65480	AP3063	METALS	Vanadium	J	15			
F65480	AP3063	SEMIVOLATILES	2-Methylnaphthalene	J	15			
F65480	AP3063	SEMIVOLATILES	Naphthalene	J	15			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
F65480	AP3063	VOLATILES	Acetone	R	04A	05A		
F65480	AP3064	EXPLOSIVES	1,3,5-Trinitrobenzene	UJ	08A			
F65480	AP3064	EXPLOSIVES	2,4,6-Trinitrotoluene	UJ	08A			
F65480	AP3064	EXPLOSIVES	Tetryl	UJ	08A			
F65480	AP3064	GEN CHEMISTRY	Alkalinity, Total as CaCO3	J	08A			
F65480	AP3064	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F65480	AP3064	GEN CHEMISTRY	Nitrogen, Nitrate + Nitrite	J	15			
F65480	AP3064	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F65480	AP3064	GEN CHEMISTRY	Turbidity	J	02B			
F65480	AP3064	METALS	Barium	J	15			
F65480	AP3064	METALS	Calcium	J	13			
F65480	AP3064	METALS	Magnesium	J	08A			
F65480	AP3064	METALS	Magnesium	J	13			
F65480	AP3064	METALS	Manganese	J	15			
F65480	AP3064	METALS	Selenium	B	06C	08A	08B	17
F65480	AP3064	METALS	Selenium	J	08A	08B	15	
F65480	AP3064	METALS	Sodium	J	13			
F65480	AP3064	METALS	Vanadium	J	15			
F65480	AP3064	SEMIVOLATILES	2-Methylnaphthalene	J	15	17		
F65480	AP3064	SEMIVOLATILES	Naphthalene	J	17	15		
F65480	AP3064	VOLATILES	Acetone	R	04A	05A		
F65480	AP3064	VOLATILES	Methyl ethyl ketone	J	15			
F65480	AP3064	VOLATILES	cis-1,3-Dichloropropene	UJ	08A			
F65480	AP3064	VOLATILES	trans-1,3-Dichloropropene	UJ	08A			
F65480	AP3065	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F65480	AP3065	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F65480	AP3065	GEN CHEMISTRY	Turbidity	UJ	02B			
F65480	AP3065	METALS	Aluminum	J	15			
F65480	AP3065	METALS	Barium	J	15			
F65480	AP3065	METALS	Iron	J	15			
F65480	AP3065	METALS	Manganese	J	15			
F65480	AP3065	METALS	Potassium	J	15			
F65480	AP3065	METALS	Selenium	B	06C	17		
F65480	AP3065	METALS	Selenium	J	15			
F65480	AP3065	METALS	Vanadium	J	15			
F65480	AP3065	SEMIVOLATILES	2-Methylnaphthalene	J	15	17		
F65480	AP3065	SEMIVOLATILES	Naphthalene	J	15	17		
F65480	AP3065	VOLATILES	Acetone	R	04A	05A		
F65480	AP3065	VOLATILES	Methyl ethyl ketone	J	15			
F69607	AP3079	EXPLOSIVES	Tetryl	R	08A			
F69607	AP3079	GEN CHEMISTRY	Alkalinity, Total as CaCO3	J	08A			
F69607	AP3079	GEN CHEMISTRY	Chloride	J	17			
F69607	AP3079	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F69607	AP3079	GEN CHEMISTRY	Nitrogen, Nitrate + Nitrite	J	17			
F69607	AP3079	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F69607	AP3079	GEN CHEMISTRY	Solids, Total Suspended	UJ	08B			
F69607	AP3079	GEN CHEMISTRY	Sulfate	J	17			
F69607	AP3079	GEN CHEMISTRY	Turbidity	J	17			
F69607	AP3079	METALS	Aluminum	B	06C	15		
F69607	AP3079	METALS	Aluminum	J	15			
F69607	AP3079	METALS	Barium	J	15			
F69607	AP3079	METALS	Calcium	J	12	13		
F69607	AP3079	METALS	Calcium	J	13			
F69607	AP3079	METALS	Iron	J	15			
F69607	AP3079	METALS	Magnesium	J	13			
F69607	AP3079	METALS	Manganese	J	15			
F69607	AP3079	METALS	Potassium	J	13			
F69607	AP3079	METALS	Selenium	J	08A	08B	17	
F69607	AP3079	METALS	Selenium	J	08A	08B		

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Plum Brook Ordnance Works, Sandusky, Ohio

SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
F69607	AP3079	METALS	Sodium	J	13			
F69607	AP3079	METALS	Vanadium	J	08B	15		
F69607	AP3079	METALS	Vanadium	J	15			
F69607	AP3079	SEMIVOLATILES	2-Methylnaphthalene	J	15			
F69607	AP3079	SEMIVOLATILES	Naphthalene	J	15			
F69607	AP3079	VOLATILES	Acetone	J	17			
F69607	AP3079	VOLATILES	Benzene	J	17			
F69607	AP3079	VOLATILES	Chloroform	B	06C		17	
F69607	AP3079	VOLATILES	Ethylbenzene	J	17			
F69607	AP3079	VOLATILES	Methyl bromide	UJ	08A			
F69607	AP3079	VOLATILES	Methyl chloride	J	08A	17	15	
F69607	AP3079	VOLATILES	Methyl ethyl ketone	J	15			
F69607	AP3079	VOLATILES	Toluene	J	17			
F69607	AP3079	VOLATILES	Vinyl chloride	UJ	08A			
F69607	AP3079	VOLATILES	Xylene (total)	J	17			
F69607	AP3079	VOLATILES	trans-1,3-Dichloropropene	UJ	08A			
F69607	AP3080	GEN CHEMISTRY	Alkalinity, Total as CaCO3	J	08A			
F69607	AP3080	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F69607	AP3080	GEN CHEMISTRY	Nitrogen, Nitrate + Nitrite	B	06C	15		
F69607	AP3080	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F69607	AP3080	GEN CHEMISTRY	Solids, Total Suspended	UJ	08B			
F69607	AP3080	METALS	Aluminum	B	06C	15		
F69607	AP3080	METALS	Aluminum	J	15			
F69607	AP3080	METALS	Barium	J	15			
F69607	AP3080	METALS	Calcium	J	12	13		
F69607	AP3080	METALS	Calcium	J	13			
F69607	AP3080	METALS	Iron	J	15			
F69607	AP3080	METALS	Magnesium	J	13			
F69607	AP3080	METALS	Manganese	J	15			
F69607	AP3080	METALS	Potassium	J	13			
F69607	AP3080	METALS	Selenium	J	08A	08B		
F69607	AP3080	METALS	Sodium	J	13			
F69607	AP3080	METALS	Vanadium	J	15			
F69607	AP3080	METALS	Vanadium	UJ	08B			
F69607	AP3080	SEMIVOLATILES	2,4-Dimethylphenol	J	15			
F69607	AP3080	VOLATILES	Acetone	J	15			
F69607	AP3080	VOLATILES	Carbon disulfide	J	15			
F69607	AP3080	VOLATILES	Chloroform	B	06C			
F69607	AP3080	VOLATILES	Methyl chloride	J	15			
F69607	AP3080	VOLATILES	Methylene chloride	B	06D	15		
F69607	AP3080	VOLATILES	trans-1,3-Dichloropropene	J	15			
F69607	AP3081	GEN CHEMISTRY	Alkalinity, Total as CaCO3	J	08A			
F69607	AP3081	GEN CHEMISTRY	Chloride	J	17			
F69607	AP3081	GEN CHEMISTRY	Cyanide, Total	UJ	08A			
F69607	AP3081	GEN CHEMISTRY	Nitrogen, Nitrate + Nitrite	B	06C	17	15	
F69607	AP3081	GEN CHEMISTRY	Solids, Total Dissolved	J	08B			
F69607	AP3081	GEN CHEMISTRY	Solids, Total Suspended	UJ	08B			
F69607	AP3081	GEN CHEMISTRY	Sulfate	J	17			
F69607	AP3081	GEN CHEMISTRY	Turbidity	J	17			
F69607	AP3081	METALS	Aluminum	B	06C	15		
F69607	AP3081	METALS	Aluminum	J	15			
F69607	AP3081	METALS	Barium	J	15			
F69607	AP3081	METALS	Calcium	J	12	13		
F69607	AP3081	METALS	Calcium	J	13			
F69607	AP3081	METALS	Iron	J	15			
F69607	AP3081	METALS	Lead	B	06C	15		
F69607	AP3081	METALS	Magnesium	J	13			
F69607	AP3081	METALS	Manganese	J	15			
F69607	AP3081	METALS	Potassium	J	13			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
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SDG	Sample Number	Analysis	Parameter	Validation Qualifier	Reason Code 1	Reason Code 2	Reason Code 3	Reason Code 4
F69607	AP3081	METALS	Selenium	J	08A	08B	17	
F69607	AP3081	METALS	Selenium	J	08A	08B		
F69607	AP3081	METALS	Sodium	J	13			
F69607	AP3081	METALS	Vanadium	J	15			
F69607	AP3081	METALS	Vanadium	UJ	08B			
F69607	AP3081	SEMIVOLATILES	2-Methylnaphthalene	J	15			
F69607	AP3081	SEMIVOLATILES	Naphthalene	J	15			
F69607	AP3081	VOLATILES	Acetone	J	17			
F69607	AP3081	VOLATILES	Benzene	J	17			
F69607	AP3081	VOLATILES	Carbon disulfide	B	06C	15		
F69607	AP3081	VOLATILES	Chloroform	B	06C	17		
F69607	AP3081	VOLATILES	Ethylbenzene	J	17			
F69607	AP3081	VOLATILES	Methyl chloride	J	17	15		
F69607	AP3081	VOLATILES	Toluene	J	17			
F69607	AP3081	VOLATILES	Xylene (total)	J	17			

Table 5

Laboratory and Validation Qualifier Definitions
Former Plum Brook Ordnance Works
Sandusky, Ohio

Qualifier	Definition
Laboratory	
B (metals)	The analyte was detected; the concentration is below the reporting limit.
B (organics)	Indicates analyte is found in associated method blank.
J (metals)	The compound was detected in the blank.
J (organics)	The compound was positively identified; the reported value is below the reporting limit.
U	Not detected. The compound was analyzed for, but not detected above the associated reporting limit.
E	Indicates that the result is above the maximum calibration range.
N	Indicates presumptive evidence of a compound.
P	RPD > 40% between the primary and confirmation column results for dual column chromatographic method (e.g. GC and HPLC methods).
*	Exceeds QC limit.
Q1	The %D or %Drift for the associated CCV is outside the method QC limit.
ME	Marginal Exceedence of the 3-sigma QC limits.
ME*	Exceedence of the 4-sigma QC limits.
Validation	
B	The compound/analyte was detected in a lab or field blank.
J	The compound/analyte was positively identified; the reported value is an estimated concentration.
U	Not detected. The compound/analyte was analyzed for, but not detected above the associated reporting limit.
UJ	The analyte is not detected; the result is an estimated value.
R	Analyte is rejected.

APPENDIX K

CHAINS-OF-CUSTODY

0901026

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 16 09AML

PAGE 1 OF 5

Project Name No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132458
Required Report Date: 21 DAYS

Sample Shipment Date: 1-16-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8422553585 74

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901026-01	SL0075	SOIL	1-14-09/1035	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-02	SL0076	SOIL	1-14-09/1035	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-03	SL0078	SOIL	1-14-09/1040	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-04	SL0079	SOIL	1-14-09/1140	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-05	SL0080	SOIL	1-14-09/1145	Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver Shaw E&I	Date: 1-16-09 Time: 1330	1. Received by: [signature]	Date: 1/19/09 Time: 0800am.
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 16 09AML

PAGE 2 OF 5

Project Name/No: PDOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 1-16-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901026-06	AP0100	SOIL	1-15-09/830	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-06	AP0100 MS	SOIL	1-15-09/830	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-06	AP0100 MSD	SOIL	1-15-09/830	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-07	AP0101	SOIL	1-15-09/835	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-08	AP0117	SOIL	1-15-09/920	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-09	AP0118	SOIL	1-15-09/923	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-10	AP0120	SOIL	1-16-09/1000	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-11	AP0121	SOIL	1-16-09/1000	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-12	AP0123	SOIL	1-16-09/1003	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		

Special Instructions:

Possible Hazard Identification:
Non-haz: Flammable: Poison B: Unknown: X

Sample Disposal:
Return to Client: Disposal by Lab: X Archive:

Turnaround Time:
Normal: X Rush:

Level of QC Required:
Definitive: X
Project Specific:

1. Relinquished by: Eddie Weaver Shaw E&I — Date: 1-16-09 Time: 1730
2. Relinquished by: Date: Time:
3. Relinquished by: Date: Time:

1. Received by: Date: 1/19/09 Time: 0800am
2. Received by: Date: Time:
2. Received by: Date: Time:

Comments:

9.10

Shaw
Shaw E & I, Inc.

0901026

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 16 09AML

PAGE 3 OF 5

Project Name No.: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 1-16-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901026-13	AP0102	SOIL	1-15-09/840	Wide Mouth Glass Jar	9 ~~X~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
0901026-14	AP0119	SOIL	1-15-09/930	Wide Mouth Glass Jar	9 ~~X~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
0901026-15	AP0124	SOIL	1-16-09/1005	Wide Mouth Glass Jar	9 ~~X~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
0901026-16	AP0107	SOIL	1-16-09/1200	Wide Mouth Glass Jar	9 ~~X~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
0901026-17	AP0116	SOIL	1-16-09/1235	Wide Mouth Glass Jar	9 ~~X~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
0901026-18	AP0128	SOIL	1-16-09/1320	Wide Mouth Glass Jar	9 ~~X~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
0901026-19	AP0127	SOIL	1-16-09/1320	Wide Mouth Glass Jar	9 ~~X~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		

Special Instructions:

Possible Hazard Identification:
Non-haz: Flammable: Poison B: Unknown: X

Sample Disposal:
Return to Client: Disposal by Lab: X Archive:

Turnaround Time:
Normal: X Rush:

Level of QC Required:
Definitive: X Project Specific:

1. Relinquished by: Eddie W. Weaver Shaw E&I Date: 1-16-09 Time: 1730
1. Received by: Date: 1/19/09 Time: 0000am
2. Relinquished by: Date: Time:
2. Received by: Date: Time:
3. Relinquished by: Date: Time:
2. Received by: Date: Time:

Comments:

0901026

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 16 09AML

PAGE 4 OF 5

Project Name No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 1-16-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901026-20	AP0104	SOIL	1-16-09/1033	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-21	AP0105	SOIL	1-16-09/1033	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-22	AP0114	SOIL	1-16-09/1225	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-23	AP0115	SOIL	1-16-09/1227	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-24	AP0125	SOIL	1-16-09/1305	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-25	AP0126	SOIL	1-16-09/1307	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		

Special Instructions:

Possible Hazard Identification:
Non-haz: Flammable: Poison B: Unknown: X

Sample Disposal:
Return to Client: Disposal by Lab: X Archive:

Turnaround Time:
Normal: X Rush:

Level of QC Required:
Definitive: X Project Specific:

1. Relinquished by: E. W. Weaver Shaw E&I	Date: 1-16-09 Time: 1730	1. Received by:	Date: 1/19/09 Time: 0800
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

0901026

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 16 09AML

PAGE 5 OF 5

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 1-16-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP0103	SOIL	1-16-09 / 1030	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901026-06				4 oz	Cool	TOC by Walkley-Black		
	SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				2 oz	Cool	TOC by Walkley-Black		

Special Instructions:

Possible Hazard Identification:
Non-haz: Flammable: Poison B: Unknown: X

Sample Disposal:
Return to Client: Disposal by Lab: X Archive:

Turnaround Time:
Normal: X Rush:

Level of QC Required:
Definitive: X Project Specific:

1. Relinquished by: Eddie W. Weaver Shaw E&I Date: 1-16-09 Time: 1930
1. Received by: Date: 1/19/09 Time: 8:00am
2. Relinquished by: Date: Time:
2. Received by: Date: Time:
3. Relinquished by: Date: Time:
2. Received by: Date: Time:

Comments:

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 16 09TA

PAGE 1 OF 2

Project Name No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 1/16/09
Laboratory Destination: Test America
Laboratory Contact: Lois Lizzo
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 842255358585

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP0122	SOIL	1-16-09 / 1000	2-Wide Mouth Jars	~~4~~ oz 9 EW	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
			Wide Mouth Glass Jar	~~4~~ oz	Cool	Explosives by 8330		
AP0106	SOIL	1-16-09 / 1033	2-Wide Mouth Jars	~~4~~ oz 9 EW	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
			Wide Mouth Glass Jar	~~4~~ oz	Cool	Explosives by 8330		
	SOIL		2-Wide Mouth Jars	4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
			Wide Mouth Glass Jar	4 oz	Cool	Explosives by 8330		
	SOIL		2-Wide Mouth Jars	4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
			Wide Mouth Glass Jar	4 oz	Cool	Explosives by 8330		
	SOIL		2-Wide Mouth Jars	4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
			Wide Mouth Glass Jar	4 oz	Cool	Explosives by 8330		

DKK 1/16/09

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler - Shaw Date: 1/16/09 Time: 1800
2. Relinquished by: Date: Time:
3. Relinquished by: Date: Time:

1. Received by: [illegible] Date: 1-17-09 Time: 0935
2. Received by: Date: Time:
2. Received by: Date: Time:

Comments:

North Canton

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 16 09TA

PAGE 1 OF 2

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 1/16/09
Laboratory Destination: Test America
Laboratory Contact: Lois Fizzo
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP0129	SOIL	1-16-09 / 1320	2-Wide Mouth Jars	4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471		
			Wide Mouth Glass Jar	4 oz	Cool	Explosives by 8330		
	SOIL		2-Wide Mouth Jars	4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471		
			Wide Mouth Glass Jar	4 oz	Cool	Explosives by 8330		
	SOIL		2-Wide Mouth Jars	4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471		
			Wide Mouth Glass Jar	4 oz	Cool	Explosives by 8330		
	SOIL		2-Wide Mouth Jars	4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471		
			Wide Mouth Glass Jar	4 oz	Cool	Explosives by 8330		
	SOIL		2-Wide Mouth Jars	4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471		
			Wide Mouth Glass Jar	4 oz	Cool	Explosives by 8330		

David Kessler

Possible Hazard Identification:
Non-haz: Flammable: Poison B: Unknown:

Sample Disposal:
Return to Client: Disposal by Lab: X Archive:

Turnaround Time:
Normal: X Rush:

Level of QC Required:
Definitive: X Project Specific:

1. Relinquished by: David Kessler - Shaw Date: 1/16/09 Time: 1800
2. Relinquished by: Date: Time:
3. Relinquished by: Date: Time:

1. Received by: Date: 1-17-09 Time: 0935
2. Received by: Date: Time:
2. Received by: Date: Time:

Comments:

0901027

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 19 09AML

PAGE 1 OF 5

Bill To: Accounting, Shaw E & I, 312 Directors Drive, Knoxville, TN 37923

Report To: Eddie Weaver, Shaw E & I, 312 Directors Drive, Knoxville, TN 37923

Project Name No.: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 1-19-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8531 9327 9450

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901027-01	AP0108	SOIL	1-18-09/925	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901027-02	AP0109	SOIL	1-18-09/928	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901027-03	AP0111	SOIL	1-18-09/845	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
0901027-04	AP0112	SOIL	1-18-09/848	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: E. W. Weaver Shaw E&I — Date: 1-19-09 Time: 1700
2. Relinquished by: — Date: ____ Time: ____
3. Relinquished by: — Date: ____ Time: ____

1. Received by: [signature] — Date: 1/20/09 Time: 0930 AM
2. Received by: — Date: ____ Time: ____
3. Received by: — Date: ____ Time: ____

Comments:

0901027

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 19 09AML

PAGE 2 OF 5

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name No.: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 1-19-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8531 9327 9450

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901027-05	AP0110	SOIL	1-18-09/930	Wide Mouth Glass Jar	9 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
0901027-06	AP0113	SOIL	1-18-09/850	Wide Mouth Glass Jar	9 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: K

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: Eddie W. Weaver Shaw E&I	Date: 1-19-09 Time: 1700	1. Received by:	Date: 1/20/09 Time: 0930am
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

0901027

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 19 09AML

PAGE 3 OF 5

Project Name No: PBDW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133762
Required Report Date: 21 DAYS

Sample Shipment Date: 1-19-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8531 9327 9450

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901027-07	LBA0026	Soil	1-19-09/1010	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOC's by 8260		
0901027-08	LBA0027	Soil	1-19-09/1010	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOC's by 8260		
0901027-09	LBA0029	Soil	1-19-09/1013	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOC's by 8260		
0901027-10	LBA0031	Soil	1-19-09/0955	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOC's by 8260		
0901027-11	LBA0032	Soil	1-19-09/0957	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOC's by 8260		
0901027-11	LBA0032MS	Soil	1-19-09/0957	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOC's by 8260		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: K

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: L. W. Weaver Shaw E&I	Date: 1-19-09	1. Received by:	Date: 1/20/09
	Time: 1700		Time: 0930 AM
2. Relinquished by:	Date:	2. Received by:	Date:
	Time:		Time:
3. Relinquished by:	Date:	2. Received by:	Date:
	Time:		Time:

Comments:

0901027

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 19 09AML

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name No: PHOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133767
Required Report Date: 21 DAYS

Sample Shipped Date: 1-19-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8531 9327 9450

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901027-12	LBA 0030	SOIL	1-19-09 / 1015	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
				Terra Core	5 Grams	Cool	VOC's by 8260		
0901027-13	LBA0033	SOIL	1-19-09 / 1000	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
				Terra Core	5 Grams	Cool	VOC's by 8260		
0901027-14	LBA0036	SOIL	1-19-09 / 0940	Wide Mouth Glass Jar	9 oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
				Terra Core	5 Grams	Cool	VOC's by 8260		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
				Terra Core	5 Grams	Cool	VOC's by 8260		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
				Terra Core	5 Grams	Cool	VOC's by 8260		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
				Terra Core	5 Grams	Cool	VOC's by 8260		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: Eddie W. Weaver Shaw E&I	Date: 1-19-09 Time: 1700	1. Received by:	Date: 1/20/09 Time: 0930 am
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

0901027

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB01 19 09AML

PAGE 5 OF 5

Project Name No: DOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 131767
Required Report Date: 21 DAYS

Sample Shipment Date: 1-19-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 0531 9327 9450

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
0901027-11	LBA0032MSD	SOIL	1-19-09 / 0957	Wide Mouth Glass Jar	9 ~~8~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOCs by 8260		
0901027-15	LBA0034	SOIL	1-19-09 / 0935	Wide Mouth Glass Jar	9 ~~8~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOCs by 8260		
0901027-16	LBA0035	SOIL	1-19-09 / 0937	Wide Mouth Glass Jar	9 ~~8~~ oz EW	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOCs by 8260		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOCs by 8260		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOCs by 8260		
		SOIL		Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				Terra Core	5 Grams	Cool	VOCs by 8260		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: E. W. Weaver Shaw E&I — Date: 1-19-09 Time: 1700
2. Relinquished by: — Date: ____ Time: ____
3. Relinquished by: — Date: ____ Time: ____

1. Received by: — Date: ____ Time: ____
2. Received by: — Date: ____ Time: ____
2. Received by: — Date: ____ Time: ____

Comments:

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: ~~P3010~~ B2 02 09TA

PAGE 1 OF 1

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name No: PHOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 2-2-09
Laboratory Destination: Test America
Laboratory Contact: Lois Ezzo
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8672 3651 1856

Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP3016	WATER	2-2-09 1030	2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	1 L	HNO3	Total TAL Metals by 6010B 7470A		
			1 - HDPE	1 L	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOC's by 8270C		
			1 - HDPE	250 mL	HNO3	Hardness		
			1 - HDPE	250 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride, Nitrate		

Special Instructions:

Possible Hazard Identification:
Non-haz: Flammable: Poison B: Unknown: X

Sample Disposal:
Return to Client: Disposal by Lab: X Archive:

Turnaround Time
Normal: X Rush:

Level of QC Required:
Definitive: X Project Specific:

1. Relinquished by: Eric W. Weaver Shaw E&I — Date: 2-2-09 Time: 1700
1. Received by: [signature] — Date: 2/3/09 Time: 0940
2. Relinquished by: — Date: Time:
2. Received by: — Date: Time:
3. Relinquished by: — Date: Time:
2. Received by: — Date: Time:

Comments:

17

North Canton

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: EW/ PW16 18 09TA

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Shaw™

Shaw E & I, Inc.

Sample Team Member: ~~David Kessler~~ Eric Weaver
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457 ~~[illegible]~~ EW
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Test America,
Laboratory Contact: Lois Ezzo
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8697-5709-6300

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP3082	WATER	11-17-09 0945	2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	1 L	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	1 L	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - VOA Vial	40 mL	HCL	VOCs by 8260		
			1 - HDPE	250 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride, Nitrate		
			1 - HDPE	250 mL	HNO3	Hardness		
TB111809TAE (Trip Blank)	Water	11-18-09/1430	2xVOA vial	~~[illegible]~~ 40ml EW	HCL	VOCs		

Special Instructions:

Possible Hazard Identification:

Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:

Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:

Normal: X Rush: ____

Level of QC Required:

Definitive: X Project Specific: ____

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: Matthew L. Jones (TEST AMERICA)	Date: 19 NOV 2009 Time: 0915
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

15

North Canton

F69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: EW1 PW18 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-9331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1 AP3081	WATER	11-17-09 0945	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER	EW	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:00	2. Received by: Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

F69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: ~~PW1~~ EW1 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
2 GH-FB1109	WATER	11-18-09 1430	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:

Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:

Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:

Normal: X Rush: ___

Level of QC Required:

Definitive: X Project Specific: ___

1. Relinquished by: [signature]	Date: 11-18-09 Time: 1455	1. Received by: [signature]	Date: Time:
2. Relinquished by: [signature]	Date: 11/19/09 Time: 9:00	2. Received by: [signature] Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4/4

F69607

REFERENCE COC NO.: PW1 18 09ACCT

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
3 AP3080	WATER	11-16-09 1400	~~3 VOA Vial~~	~~40ml~~	HCL	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
~~WATER~~			3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, ~~Sulfate~~, Chloride		

Special Instructions:

Possible Hazard Identification:

Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:

Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:

Normal: X Rush: ____

Level of QC Required:

Definitive: X Project Specific: ____

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:00	2. Received by: CR/Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

F69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8604-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
4 APZ-ER1109	WATER	11-18-09 1000	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver FX	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:00	2. Received by: CR / Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

F69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1[illegible] 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
5 TNTB-ER1109	WATER	11-18-09 1300	~~3 VOA Vial~~	~~40mL~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:30	2. Received by: C. Acutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

3.4 4.0 4.6 3.8 3.0 2.8 4.0 3.2 4.4 4.4

F69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW10 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
6 SL3100	WATER	11-18-09 1005	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:

Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:

Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:

Normal: X Rush: ____

Level of QC Required:

Definitive: X Project Specific: ____

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:30	2. Received by: Accutest	Date: 11/19/09 Time: 9:30
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

F64607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1 18 09ACCT

PAGE 1 OF

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
7 AP3079	WATER	11-17-09 0945	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	~~Explosives by 8330~~		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:

Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:

Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:

Normal: X Rush: ____

Level of QC Required:

Definitive: X Project Specific: ____

1. Relinquished by: EW Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:00	2. Received by: Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

F69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW18 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
2 AP3079MS	WATER	11-17-09 0945	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: [illegible]	Date: Time:
2. Relinquished by: [illegible]	Date: 11/19/09 Time: 900	2. Received by: [illegible] Accutest	Date: 11/19/09 Time: 900
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

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ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW18 18 09ACCT

PAGE 1 OF 1

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
7 AP3079MSD	WATER	11-17-09 0945	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER	EW	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E-W, Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:00	2. Received by: [illegible]	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.9 4.9

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ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: ~~PW1~~ EW1 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
8 SL3101	WATER	11-17-09 / 1557	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:

Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:

Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:

Normal: X Rush: ____

Level of QC Required:

Definitive: X Project Specific: ____

1. Relinquished by: E.W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:00	2. Received by: Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

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ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW18 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 7684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
9 Trip Blank 11-18-09	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: [signature]	Date: 11-18-09 Time: 1455	1. Received by: [signature]	Date: Time:
2. Relinquished by: [signature]	Date: 11/19/09 Time: 9:00	2. Received by: [signature] Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.9 8.4

P69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1 18 09ACCT

PAGE 1 OF 1

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 7684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1 AP3081	WATER	11-17-09 0945	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
6 SL3100	WATER	11-18-09 1005	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: [illegible]	Date: Time:
2. Relinquished by: [illegible]	Date: 11/19/09 Time: 9:00	2. Received by: [illegible] Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

F69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PWI 18 09ACCT

PAGE 1 OF 1

Shaw

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 7684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
2GH-FB1109	WATER	11-18-09 1430	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:

Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:

Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:

Normal: X Rush: ___

Level of QC Required:

Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: [signature]	Date: Time:
2. Relinquished by: [signature]	Date: 11/19/09 Time: 9:00	2. Received by: [signature] Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.9

F69607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1 18 09ACCT

PAGE 1 OF 1

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 7654-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
3 AP3080	WATER	11-16-09 1400	* 3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
7 AP3079	WATER	11-17-09 0945	* 3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 9:00	2. Received by: Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

F64607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1 18 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 7684-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
4	APZ-ER1109	WATER	11-18-09 1000	3 VOA Vial *	40ml	HCL	VOCs by 8260		
				2 - Amber	1 L	Cool	Explosives by 8330		
				1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
				1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
				1 - HDPE	500 mL	H2SO4	Nitrate		
				1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
				1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
5	TNTB-ER1109	WATER	11-18-09 1300	3 VOA Vial *	40ml	HCL	VOCs by 8260		
				2 - Amber	1 L	Cool	Explosives by 8330		
				1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
				1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
				1 - HDPE	500 mL	H2SO4	Nitrate		
				1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
				1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:

Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:

Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:

Normal: X Rush: ___

Level of QC Required:

Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: [illegible]	Date: Time:
2. Relinquished by: [illegible]	Date: 11/19/09 Time: 9:00	2. Received by: [illegible] Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.4

FL9607

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW18 18 09ACCT

PAGE 1 OF 1

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-18-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 2654-4331-1980

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
7 AP3079MS	WATER	11-17-09 0945	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
7 AP3079MSD	WATER	11-17-09 0945	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver	Date: 11-18-09 Time: 1455	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/19/09 Time: 0905	2. Received by: Accutest	Date: 11/19/09 Time: 9:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.4 4.0 4.6 3.8 3.0 2.8 4.0 5.2 4.4 4.9

Originals

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

0902003

REFERENCE COC NO.: PB0 02 09AML

PAGE 1 OF 4

Project Name No: PB OW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 2-2-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8672 3651 1867

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP3022	WATER	2-2-09	2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	500 ml	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOC's by 8270C		
		1030	1 - HDPE	125 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
0902003-01			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
AP3015	WATER	2-2-09	2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOC's by 8270C		
		1030	1 - HDPE	125 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
0902003-02			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: Eddie W. Weaver Shaw E&I — Date: 2-2-09 Time: 1700
1. Received by: [signature] — Date: 2/3/09 Time: 0945am
2. Relinquished by: — Date: Time:
2. Received by: — Date: Time:
3. Relinquished by: — Date: Time:
2. Received by: — Date: Time:

Comments:

9 0 0 1 3 6 9

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB0~~K~~ 02 09AML

0902003

Project Name No.: ~~[illegible]~~ PB
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 2-2-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melavia Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8672 3651 1867

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP3019	WATER	2-1-09 1110	2 - Amber	1 L.	Cool	Explosives by 8330		
			1 - HDPE	500 mL.	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	500 mL.	HNO3	Dissolved TAL Metals by 6010B 7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	125 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL.	NaOH	Cyanide by 9010/9012		
0902003-03			1 - HDPE	1 L.	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
AP3019MS	WATER	2-1-09 1110	2 - Amber	1 L.	Cool	Explosives by 8330		
			1 - HDPE	500 mL.	HNO3	Total TAL Metals by 6010B 7470A		
			1 - HDPE	500 mL.	HNO3	Dissolved TAL Metals by 6010B 7470A		
			2 - Amber	1 L.	Cool	TCL SVOCs by 8270C		
			1 - HDPE	125 mL.	H2SO4	Nitrate		
			1 - HDPE	500 mL.	NaOH	Cyanide by 9010/9012		
0902003-03			1 - HDPE	1 L.	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: E. W. Weaver Shaw E&I	Date: 2-2-09 Time: 1700	1. Received by: [signature]	Date: 2/3/09 Time: 0945am
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB~~01~~ 02 09AML

PAGE 3 OF 4

0902003

Project Name No: ~~OW~~ PB
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422
Required Report Date: 21 DAYS

Sample Shipment Date: 2-2-09
Laboratory Destination: AML Scientific, LLC
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8672 3657 1867

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP3019MSD 0902003-03	WATER	2-1-09 1110	2 - Amber	1 L.	Cool	Explosives by 8330		
			1 - HDPE	500 mL.	HNO3	Total TAL Metals by 6010B 7470A		
			1 - HDPE	500 mL.	HNO3	Dissolved TAL Metals by 6010B 7470A		
			2 - Amber	1 L.	Cool	TCL SVOC's by 8270C		
			1 - HDPE	125 mL.	H2SO4	Nitrate		
			1 - HDPE	500 mL.	NaOH	Cyanide by 9010 9012		
			1 - HDPE	1 L.	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
AP3018 0202003-04	WATER	1-31-09 1730	2 - Amber	1 L.	Cool	Explosives by 8330		
			1 - HDPE	500 mL.	HNO3	Total TAL Metals by 6010B 7470A		
			1 - HDPE	500 mL.	HNO3	Dissolved TAL Metals by 6010B 7470A		
			2 - Amber	1 L.	Cool	TCL SVOC's by 8270C		
			1 - HDPE	125 mL.	H2SO4	Nitrate		
			1 - HDPE	500 mL.	NaOH	Cyanide by 9010-9012		
			1 - HDPE	1 L.	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: Erin W. Weaver Shawtell	Date: 2-2-09 Time: 1700	1. Received by:	Date: 2/3/09 Time: 0945am
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	3. Received by:	Date: Time:

Comments:

01C1369

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: ~~PAUL~~ B2 02 09AML

PAGE 4 OF 4

0902003

Project Name No: ~~WOW~~ PB
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133767
Required Report Date: 21 DAYS

Sample Shipment Date: 2-2-09
Laboratory Destination: AML
Laboratory Contact: Melania Harris
Project Contact Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8672 3657 1867

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
LBA3000	WATER	1-31-09	3 VOA Vial	40ml	HCL	VOC's by 8260		
			2 - Amber	1 L.	Cool	Explosives by 8330		
			1 - HDPE	500 ml.	HNO3	Total TAL Metals by 6010B 7470A		
			1 - HDPE	500 ml.	HNO3	Dissolved TAL Metals by 6010B 7470A		
		0935	2 - Amber	1 L.	Cool	TCL SVOC's by 8270C		
			1 - HDPE	125 ml.	H2SO4	Nitrate		
			1 - HDPE	500 ml.	NaOH	Cyanide by 9010 9012		
0902003-05			1 - HDPE	1 L.	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
LBA3005	WATER	1-30-09	3 VOA Vial	40ml	HCL	VOC's by 8260		
			2 - Amber	1 L.	Cool	Explosives by 8330		
			1 - HDPE	500 ml.	HNO3	Total TAL Metals by 6010B 7470A		
			1 - HDPE	500 ml.	HNO3	Dissolved TAL Metals by 6010B 7470A		
		1610	2 - Amber	1 L.	Cool	TCL SVOC's by 8270C		
			1 - HDPE	125 ml.	H2SO4	Nitrate		
0902003-06			1 - HDPE	500 ml.	NaOH	Cyanide by 9010 9012		
			1 - HDPE	1 L.	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
Trip Blank	Water	2-2-09	3 VOA vial	40ml	HCL	VOC by 8260		

Special Instructions: 0902003-07

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver Shaw E&I	Date: 2-2-09 Time: 1700	1. Received by:	Date: 2/3/09 Time: 0945am
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

12 01 1369

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

F6S479

REFERENCE NO.: PB/05-6 09ACCT

PAGE 1 OF 2

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5-26-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 4684 4331 1258

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1	AP2000	Surface Water	5-24-09 1025	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
2	AP2001	"	5/24/09 1350	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
3	AP2002	"	5/24/09 1505	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
4	AP2003	"	5/24/09 1505	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
5	AP2005	"	5/25/09 0925	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: David Kessler - Shaw	Date: 5-26-09 Time: 1630	1. Received by: [signature]	Date: Time:
2. Relinquished by: [signature]	Date: 5/27/09 Time: 0900	2. Received by: [signature] / Accutest	Date: 5/27/09 Time: 0900
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 6 : 4.0 4.2 3.8 3.0 3.4 3.6

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

R65479

REFERENCE COC NO.: PW09-29-09-CCT

PAGE 2 OF 2

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 4684 4331 1258

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
5	AP2005MS	Surface Water	5/25/09 0925	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
5	AP2005MSD	"	5/25/09 0925	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
6	AP2006	"	5/25/09 1155	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
	—	—	—	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
	—	—	—	2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler-Shaw — Date: 5-26-09 Time: 1630
2. Relinquished by: [signature] — Date: 5/27/09 Time: 0800
3. Relinquished by: — Date: Time:

1. Received by: [signature] — Date: Time:
2. Received by: [signature]/Accutest — Date: 5/27/09 Time: 0800
2. Received by: — Date: Time:

Comments: 6: 4.0 4.2 3.8 3.0 3.4 3.6

T65476

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB05 26 09ACCT

PAGE 1 OF 2

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No.: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2 Sediment
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1358

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
5	AP1000	Sediment	5-24-09 1050	CWM	4 oz	Cool	PCBs by 8082		
				CWM	4 oz	Cool	TOC by Walkley Black		
				CWM	4 oz	Cool	SVOCs by 8270C		
				CWM	4 oz	Cool	Explosives by 8330A		
				CWM	4 oz	Cool	TAL Metals 6010/7471		
6	AP1001	Sediment	5-24-09 1415	CWM	4 oz	Cool	PCBs by 8082		
				CWM	4 oz	Cool	SVOCs by 8270C		
				CWM	4 oz	Cool	Explosives by 8330A		
				CWM	4 oz	Cool	TAL Metals 6010/7471		
4	AP1002	Sediment	5-24-09 1550	CWM	4 oz	Cool	PCBs by 8082		
				CWM	4 oz	Cool	SVOCs by 8270C		
				CWM	4 oz	Cool	Explosives by 8330A		
				CWM	4 oz	Cool	TAL Metals 6010/7471		
4	AP1002MS	Sediment	5-24-09 1550	CWM	4 oz	Cool	PCBs by 8082		
				CWM	4 oz	Cool	SVOCs by 8270C		
				CWM	4 oz	Cool	Explosives by 8330A		
				CWM	4 oz	Cool	TAL Metals 6010/7471		

Special Instructions:

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Level of QC Required:
Definitive: X
Project Specific: ___

Turnaround Time:
Normal: X Rush: ___

1. Relinquished by: David Kessler - Shaw Date: 5-26-09 Time: 1640
2. Relinquished by: Date: ___ Time: ___
3. Relinquished by: Date: ___ Time: ___

1. Received by: Date: ___ Time: ___
2. Received by: Date: ___ Time: ___
2. Received by: Date: ___ Time: ___

Comments:

F65476

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB05 26 09ACCT

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2 Sediment
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1258

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
4	AP1002MSD	Sediment	5/24/09 1550	CWM	4 oz	Cool	PCBs by 8082		
				CWM	4 oz	Cool	SVOCs by 8270C		
				CWM	4 oz	Cool	Explosives by 8330A		
				CWM	4 oz	Cool	TAL Metals 6010/7471		
1	AP1006	Sediment	5/25/09 1215	CWM	4 oz	Cool	PCBs by 8082		
				CWM	4 oz	Cool	SVOCs by 8270C		
				CWM	4 oz	Cool	Explosives by 8330A		
				CWM	4 oz	Cool	TAL Metals 6010/7471		
2	AP1003	Sediment	5/25/09 1020	CWM	4 oz	Cool	PCBs by 8082		
				CWM	4 oz	Cool	SVOCs by 8270C		
				CWM	4 oz	Cool	Explosives by 8330A		
				CWM	4 oz	Cool	TAL Metals 6010/7471		
3	AP1004	Sediment	5/25/09 1020	CWM	4 oz	Cool	PCBs by 8082		
				CWM	4 oz	Cool	SVOCs by 8270C		
				CWM	4 oz	Cool	Explosives by 8330A		
				CWM	4 oz	Cool	TAL Metals 6010/7471		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler-Shaw	Date: 5-26-09 Time: 1630	1. Received by:	Date: Time:
2. Relinquished by:	Date: Time:	2. Received by: Accutest	Date: 5-27-09 Time: 0900
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 3.6

TA

P65476

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB05 26 09TA

PAGE 1 OF 1

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2 Sediment
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Test America
Laboratory Contact: Lois Ezzo
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8672 3651 2006

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP1005	Sediment	5/25/09 1020	Wide Mouth Glass Jar	2 X 4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				4 oz	Cool	Explosives by 8330A		
			~~Tera Core~~	~~5 grams~~	~~Cool~~	~~VOCs by 8260B~~		
			~~CWM~~	~~2 oz~~	~~Cool~~	~~% Moisture VOCs~~		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler - Shaw Date: 5-26-09 Time: 1630
2. Relinquished by: fx Date: Time:
3. Relinquished by: Date: Time:

1. Received by: fx Date: Time:
2. Received by: Auenters Date: 5-27-09 Time: 0900
2. Received by: Date: Time:

Comments:

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Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW05 26 09TA

PAGE 1 OF 2

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Test America
Laboratory Contact: Lois Ezzo
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 9472 3651 2006

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP 3066	WATER	5/28/09 1550	2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	1 L	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	1 L	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - VOA Vial	40 mL	HCL	VOCs by 8260		
			1 - HDPE	250 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride, Nitrate		
			1 - HDPE	250 mL	HNO3	Hardness		
	WATER		2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	1 L	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	1 L	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - VOA Vial	40 mL	HCL	VOCs by 8260		
			1 - HDPE	250 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride, Nitrate		
			1 - HDPE	250 mL	HNO3	Hardness		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X
Project Specific:

1. Relinquished by: M. Yantin-Shaw — Date: 05/26/09 Time: 1800
1. Received by: [signature] — Date: 5-27-09 Time: 9:50
2. Relinquished by: — Date: Time:
2. Received by: — Date: Time:
3. Relinquished by: — Date: Time:
2. Received by: — Date: Time:

Comments:

North Canton

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Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW05 26 09TA

PAGE 2 OF 2

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Test America
Laboratory Contact: Lois Ezzo
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8672 3651 2004

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
052609-TB	WATER	5/26/09 1800	2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	1 L	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	1 L	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			2 3 - VOA Vial	40 mL	HCL	VOCs by 8260 ME		
			1 - HDPE	250 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride, Nitrate		
			1 - HDPE	250 mL	HNO3	Hardness		
AP3060	WATER	5/25/09 0932	2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	1 L	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	1 L	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			3 - VOA Vial	40 mL	HCL	VOCs by 8260		
			1 - HDPE	250 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride, Nitrate		
			1 - HDPE	250 mL	HNO3	Hardness		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: M. Yantin - Shaw	Date: 5/26/09 Time: 1800	1. Received by:	Date: 5-27-09 Time: 9:50
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

21

North Canton

TA

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Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW05 26 09TA

PAGE 1 OF 1

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5-26-09
Laboratory Destination: Test America
Laboratory Contact: Lois Ezzo
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 86072 86051 2006

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP2004	WATER	5-26-09 1505	2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	1 L	HNO3	Total TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X
Project Specific: ___

1. Relinquished by: David Kessler-Shaw Date: 5-26-09 Time: 1630
2. Relinquished by: Date: Time:
3. Relinquished by: Date: Time:

1. Received by: Date: 5-27-09 Time: 9:55
2. Received by: Date: Time:
2. Received by: Date: Time:

Comments:

North Canton

7A

23

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB05 26 09TA

PAGE 1 OF 1

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2 Sediment
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Test America
Laboratory Contact: Lois Ezzo
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8672 3651 2006

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP1005	Sediment	5/25/09 1020	Wide Mouth Glass Jar	2 X 4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				4 oz	Cool	Explosives by 8330A		
			~~Tera Core~~	~~5 grams~~	~~Cool~~	~~VOCs by 8260B~~		
			~~CWM~~	~~2 oz~~	~~Cool~~	~~% Moisture VOCs~~		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: David Kessler - Shaw	Date: 5-26-09 Time: 1630	1. Received by: [signature]	Date: 5-27-09 Time: 9:55
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

North Canton

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

PL5480

REFERENCE COC NO.: PW05 26 09ACCT

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1258

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1 AP 3064	WATER	5/23/09 1550	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
1 AP 3064 MS	WATER	5/23/09 1550	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: M. Martin-Shaw	Date: 05/26/09 Time: 1800	1. Received by:	Date: Time:
2. Relinquished by:	Date: Time:	2. Received by:	Date: 5-27-09 Time: 09:00
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.2 3.4 3.6 4.8 3.0

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

P65480

REFERENCE COC NO.: PW05 26 09ACCT

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1258

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1	AP 3064 MSD	WATER	5/23/09 1550	3 VOA Vial	40ml	HCL	VOCs by 8260		
				2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
				1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
				1 - HDPE	500 mL	H2SO4	Nitrate		
				1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
				1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
2	AP 3065	WATER	5/23/09 1550	3 VOA Vial	40ml	HCL	VOCs by 8260		
				2 - Amber	1 L	Cool	Explosives by 8330		
				2 - Amber	1 L	Cool	PCBs by 8082		
				1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
				1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
				1 - HDPE	500 mL	H2SO4	Nitrate		
				1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
				1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: M. Yantin - Shaw	Date: 5/26/09 Time: 1800	1. Received by: fx	Date: Time:
2. Relinquished by: fx	Date: Time:	2. Received by: Accutest	Date: 5-27-09 Time: 09:20
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.2 34 36 4.8 30

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

P65480

REFERENCE COC NO.: PW05 26 09ACCT

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1258

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
3 ER2	WATER	5/26/09 1400	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOC's by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
1 052609-TB	WATER	5/26/09 1800	2 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOC's by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

HOLD 5/26/09

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: M. Martin - Shaw	Date: 05/26/09 Time: 1800	1. Received by:	Date: Time:
2. Relinquished by:	Date: Time:	2. Received by: Hunter	Date: 5-27-09 Time: 9:10
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.2 3.4 3.6 4.8 3.0

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

P65480

REFERENCE COC NO.: PW05 26 09ACCT

PAGE 4 OF 6

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1258

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
AP3061	WATER	5/24/09 1058	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
AP3063	WATER	5/24/09 1531	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: H. Yantin	Date: 5/24/09 Time: 1800	1. Received by: fx	Date: Time:
2. Relinquished by: fx	Date: Time:	2. Received by: Accutest	Date: 5-27-09 Time: 0920
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

4.2 3.4 3.6 4.8 5.0

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

P65480

REFERENCE COC NO.: PW05 26 09ACCT

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: David Kessler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1258

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
7 AP 3058	WATER	5/25/09 0932	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
8 AP 3059	WATER	5/25/09 0932	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: M. Martin - Shaw	Date: 05/26/09 Time: 1800	1. Received by:	Date: Time:
2. Relinquished by:	Date: Time:	2. Received by: Accutest	Date: 5-27-09 Time: 0900
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.2 3.4 3.6 4.8 3.0

F65480

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PWDS 26 09ACCT

(PAGE 6 OF 6)

Project Name/No.: PBOW
Sample Team Member: David Keasler
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133422 Ash Pit 2
Required Report Date: 21 DAYS

Sample Shipment Date: 5/26/09
Laboratory Destination: Arcutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 9684 4331 1253

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
9 AP 3057	WATER	5/23/09 1055	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER	5/26/09	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			2 - Amber	1 L	Cool	PCBs by 8082		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: M. Yantin	Date: 5/26/09 Time: 1100	1. Received by:	Date: Time:
2. Relinquished by:	Date: Time:	2. Received by:	Date: Time:
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

05/27/2009 15:57 4196254438 COMFORT INN MAINGATE PAGE 03/03

F69338

REFERENCE COC NO.: PWM 1106 09ACCT

PAGE 1 OF 1

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1 LB3076	WATER	11/5/09 0930	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
			~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~Explosives by 8330~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Total TAL Metals/Hardness by 6010B/7470A~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Dissolved TAL Metals by 6010B/7470A~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~TCL SVOCs by 8270C~~		
			~~1 - HDPE~~	~~500 mL~~	~~H2SO4~~	~~Nitrate~~		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~		
			~~1 - HDPE~~	~~1 L~~	~~Cool~~	~~Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride~~		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by:	Date: 11/6/09 Time: 1430	1. Received by:	Date: Time:
2. Relinquished by:	Date: 11/7/09 Time: 930	2. Received by: Accutest	Date: 11/7/09 Time: 9:30
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler

4.0 4.2 5.0 4.6 3.2 3.4 3.6
5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW~~B~~ 1106 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1 LB3076-MSD	WATER	11/5/09 0930	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		~~3 VOA Vial~~	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:

Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: ____

Sample Disposal:

Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:

Normal: X Rush: ____

Level of QC Required:

Definitive: X Project Specific: ____

1. Relinquished by:	Date: 11/06/09 Time: 1430	1. Received by:	Date: Time:
2. Relinquished by:	Date: 11/7/09 Time: 930	2. Received by: CWR / Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler

4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0
4.8 4.2 3.0 2.0

A69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW10 11061 09ACCT

PAGE 1 OF 1

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1 LB3076-MS	WATER	11/5/09 0930	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
~~WATER~~			~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~Explosives by 8330~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Total TAL Metals/Hardness by 6010B/7470A~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Dissolved TAL Metals by 6010B/7470A~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~TCL SVOCs by 8270C~~		
			~~1 - HDPE~~	~~500 mL~~	~~H2SO4~~	~~Nitrate~~		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~		
			~~1 - HDPE~~	~~1 L~~	~~Cool~~	~~Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride~~		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by:	Date: 11/6/09 Time: 1430	1. Received by:	Date: Time:
2. Relinquished by:	Date: 11/7/09 Time: 930	2. Received by: Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: ~~PW10~~ 106 09ACCT

PAGE 1 OF 1

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 172457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
2 RC3084	WATER	11-5-09 / 0830	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ GW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E W Weaver	Date: 11-6-09 Time: 1200	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 930	2. Received by: Accutest	Date: 11/7/05 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1 06 09ACCT

PAGE ___ OF ___

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-6-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
3 AP3073	WATER	11-6-09 0945	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
4 Trip Blank (prepared by lab)	WATER	11-6-09 1130	3 VOA Vial	40ml	HCL	VOCs by 8260		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~Explosives by 8330~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Total TAL Metals/Hardness by 6010B/7470A~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Dissolved TAL Metals by 6010B/7470A~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~TCL SVOCs by 8270C~~		
			~~1 - HDPE~~	~~500 mL~~	~~H2SO4~~	~~Nitrate~~		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~		
			~~1 - HDPE~~	~~1 L~~	~~Cool~~	~~Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride~~		

Special Instructions:

Possible Hazard Identification:

Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:

Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:

Normal: X Rush: ___

Level of QC Required:

Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver	Date: 11-6-09 Time: 1200	1. Received by: Fx	Date: Time:
2. Relinquished by: Fx	Date: 11/7/09 Time: 930	2. Received by: Carl Accutest	Date: 11/7/09 Time: 9:30
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW10 1106 09ACCT

PAGE 1 OF 1

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
5 AP3070	WATER	11/4/09 1700	~~3-VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
			~~3-VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~Explosives by 8330~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Total TAL Metals/Hardness by 6010B/7470A~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Dissolved TAL Metals by 6010B/7470A~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~TCL SVOCs by 8270C~~		
			~~1 - HDPE~~	~~500 mL~~	~~H2SO4~~	~~Nitrate~~		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~		
			~~1 - HDPE~~	~~1 L~~	~~Cool~~	~~Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride~~		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by:	Date: 11/6/09 Time: 1430	1. Received by:	Date: Time:
2. Relinquished by:	Date: 11/7/09 Time: 9:30	2. Received by: Accutest	Date: 11/7/09 Time: 9:30
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

Shaw™

Shaw E & I, Inc.

REFERENCE COC NO.: PW0711 06 09ACCT

PAGE 1 OF 2

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
6	LB 3077	WATER	11/5/09 0930	3 VOA Vial	40ml	HCL	VOCs by 8260		
				2 - Amber	1 L	Cool	Explosives by 8330		
				1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
				1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
				1 - HDPE	500 mL	H2SO4	Nitrate		
				1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
				1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	LB 3080	WATER	11/3/09 1610	3 VOA Vial	40ml	HCL	VOCs by 8260		
				2 - Amber	1 L	Cool	Explosives by 8330		
				1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
				1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
				2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
				1 - HDPE	500 mL	H2SO4	Nitrate		
				1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
				1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
1	LB 3076-MSD		11/5/09 0930	3 VOA Vial	40 ml	HCL	VOCs by 8260		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: [signature]	Date: 11/6/09 Time: 1430	1. Received by: [signature]	Date: Time:
2. Relinquished by: [signature]	Date: 11/7/09 Time: 930	2. Received by: [signature] / Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW16 06 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-6-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
7 LBA-ER-1109	WATER	11-4-09 1645	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: [signature]	Date: 11/6/09 Time: 1430	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 930	2. Received by: [signature] / Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1 06 09ACCT

PAGE ___ OF ___

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-6-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
11 LBA-ER 1109	WATER	11-4-09 1700	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
7 WWTP1-ER 1109	WATER	11-4-09 1645	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: C. [illegible]	Date: 11/6/09 Time: 1430	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 930	2. Received by: Clark Accutest	Date: 11/7/09 Time: 9:30
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.0 4.2 5.0 4.6 3.2 3.4 3.2 5.0 4.8 4.2 3.0 3.0

P69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW11 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Sample Team Member:
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 133767
Required Report Date: 21 DAYS

Sample Shipment Date:
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
8 DI-Water-Blk1	WATER	11-4-09 1630	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	125 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	125 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush:

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: [signature]	Date: 11/6/09 Time: 1430	1. Received by: [signature]	Date: Time:
2. Relinquished by: [signature]	Date: 11/7/09 Time: 930	2. Received by: [signature] Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

FL69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW~~10~~ 1106 09ACCT

PAGE ___ OF ___

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
8 DI-Water BLK1	WATER	11-4-09 1630	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: [signature]	Date: 11/6/09 Time: 1436	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 9:30	2. Received by: [signature] / Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

A69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW10 06 09ACCT

PAGE ___ OF ___

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-6-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
2 RC3084	WATER	11-5-09 0830	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
9 BEDGW-001-ER1	WATER	11-6-09 0830	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: K

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: Eddie W. Weaver	Date: 11-6-09 Time: 1200	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 930	2. Received by: Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69334

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW10 06 09ACCT

PAGE ___ OF ___

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-6-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
9 BEDGW-001-ER1	WATER	11-6-09 0830	3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: [signature]	Date: 11-6-09 Time: 1200	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 9:30	2. Received by: [signature] Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

A69338

PW1106

REFERENCE COC NO.: ~~[illegible]~~ 09ACCT

PAGE 2 OF 2

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1	LB3076 - MS	water	11/5/09 0930	3 VOA vial	40 ml	HCL	VOCs by 8260		
1	LB3076	↓	11/5/09 0930	↓	↓	↓	↓		
	LB3075		11/4/09 0945						
10	AP3071		11/6/09 0920						
5	AP3070		11/4/09 1700						
12	AP3072	↓	11/6/09 0830	↓	↓	↓	↓		
13	trip blank	water	11/3/09 1200	3 VOA vial	40 ml	HCL	VOCs by 8260		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: [signature]	Date: 11/6/09 Time: 1430	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 930	2. Received by: [signature] Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW~~011~~ 06 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
10 AP3071	WATER	11/6/09 0920	~~3 VOA Vial~~	~~40ml~~	~~HCL~~ CPS	~~VOCs by 8260~~		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
~~CPS~~	~~WATER~~		~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~Explosives by 8330~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Total TAL Metals/Hardness by 6010B/7470A~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Dissolved TAL Metals by 6010B/7470A~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~TCL SVOCs by 8270C~~		
			~~1 - HDPE~~	~~500 mL~~	~~H2SO4~~	~~Nitrate~~		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~		
			~~1 - HDPE~~	~~1 L~~	~~Cool~~	~~Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride~~		
			CPS					

Special Instructions:

Possible Hazard Identification:

Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: ____

Sample Disposal:

Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:

Normal: X Rush: ____

Level of QC Required:

Definitive: X Project Specific: ____

1. Relinquished by: CPS	Date: 11/6/09 Time: 1430	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 930	2. Received by: CAR/Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F64338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW1 EW1 06 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-6-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
11 LBA-ER-1109	WATER	11-4-09 1700	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~ EWJ		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: [signature]	Date: 11/6/09 Time: 1430	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 930	2. Received by: [signature] Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

F69338

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PW~~06~~ 1106 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/6/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.:

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
12 AP3072	WATER	11/6/09 0830	~~3 VOA Vial~~	~~40ml~~	~~HCL~~ CB	~~VOCs by 8260~~		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~ CB		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
~~WATER~~ CB		CB	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~Explosives by 8330~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Total TAL Metals/Hardness by 6010B/7470A~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Dissolved TAL Metals by 6010B/7470A~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~TCL SVOCs by 8270C~~ CB		
			~~1 - HDPE~~	~~500 mL~~	~~H2SO4~~	~~Nitrate~~		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~		
			~~1 - HDPE~~	~~1 L~~	~~Cool~~	~~Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride~~		
		CB						

Special Instructions:

Possible Hazard Identification:

Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:

Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:

Normal: X Rush: ___

Level of QC Required:

Definitive: X Project Specific: ___

1. Relinquished by: CB	Date: ~~CB~~ 11/6/09 Time: 1430	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 11/7/09 Time: 930	2. Received by: Accutest	Date: 11/7/09 Time: 930
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler 4.0 4.2 5.0 4.6 3.2 3.4 3.6 5.0 4.8 4.2 3.0 2.0

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

F109502

REFERENCE COC NO.: PW11 13 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Sample Team Member: Joseph Biltz, Chris Strzempka
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: ~~133767~~ 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/13/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1940

Bill To: Accounting
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
6 WW 3034	WATER	11/12/09 0900	~~3 VOA Vial~~	~~40ml~~	~~HCL~~ CPS	~~VOCs by 8260~~		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	125 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
~~CPS~~	~~WATER~~		~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~Explosives by 8330~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Total TAL Metals by 6010B/7470A~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Dissolved TAL Metals by 6010B/7470A~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~TCL SVOCs by 8270C~~		
			~~1 - HDPE~~	~~125 mL~~	~~H2SO4~~	~~Nitrate~~ CB		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~		
			~~1 - HDPE~~	~~1 L~~	~~Cool~~	~~Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride~~		

Special Instructions:

Possible Hazard Identification:

Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:

Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:

Normal: X Rush: ___

Level of QC Required:

Definitive: X Project Specific: ___

1. Relinquished by: CB	Date: 11/13/09 Time: 1200	1. Received by: fx	Date: Time:
2. Relinquished by: fx	Date: Time:	2. Received by: [signature]	Date: 11-14-09 Time: 0900
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 cooler

4.8 5.6 5.4 ~~5.2~~ 4.2 4.4

3.8 5.0 5.4 5.4

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

F69502

REFERENCE COC NO.: PW1 13 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-13-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 9664 4331 1990

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
7 WW3035	WATER	11-13-09 0850	~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
~~CRS~~	~~WATER~~		~~3 VOA Vial~~	~~40ml~~	~~HCL~~	~~VOCs by 8260~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~Explosives by 8330~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Total TAL Metals/Hardness by 6010B/7470A~~		
			~~1 - HDPE~~	~~500 mL~~	~~HNO3~~	~~Dissolved TAL Metals by 6010B/7470A~~		
			~~2 - Amber~~	~~1 L~~	~~Cool~~	~~TCL SVOCs by 8270C~~		
			~~1 - HDPE~~	~~500 mL~~	~~H2SO4~~	~~Nitrate~~		
			~~1 - HDPE~~	~~500 mL~~	~~NaOH~~	~~Cyanide by 9010/9012~~		
			~~1 - HDPE~~	~~1 L~~	~~Cool~~	~~Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride~~		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: Eric W. Weaver	Date: 11-13-09 Time: 1200	1. Received by:	Date: Time:
2. Relinquished by:	Date: Time:	2. Received by: Accutest	Date: 11/14/09 Time: 0920
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

485.654.2 4-4
5.0 2.8 5.4 5.4

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

F69502

REFERENCE COC NO.: EW1 PW10 13 09ACCT

PAGE 1 OF 1

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11-13-09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1940

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
8 WW3037	WATER	11-12-09 1535	3 VOA Vial	40ml	HCL	VOCs by 8260 EW		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		
	B WATER		3 VOA Vial	40ml	HCL	VOCs by 8260		
			2 - Amber	1 L	Cool	Explosives by 8330		
			1 - HDPE	500 mL	HNO3	Total TAL Metals/Hardness by 6010B/7470A		
			1 - HDPE	500 mL	HNO3	Dissolved TAL Metals by 6010B/7470A		
			2 - Amber	1 L	Cool	TCL SVOCs by 8270C		
			1 - HDPE	500 mL	H2SO4	Nitrate		
			1 - HDPE	500 mL	NaOH	Cyanide by 9010/9012		
			1 - HDPE	1 L	Cool	Turbidity, Alkalinity, TDS, TSS, Sulfate, Chloride		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: X

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by: E. W. Weaver	Date: 11-13-09 Time: 1200	1. Received by:	Date: Time:
2. Relinquished by:	Date: Time:	2. Received by:	Date: 11/14/09 Time: 0900
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

485654424
285054 54

F69502

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB11113 09ACCT

PAGE 1 OF 2

Shaw™
Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/13/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8694 4331 1990

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
6	WW 3034	water	11/12/09, 0900	3 VOA vial	40 ml	HCL	VOCs by 8260		
11	Trip Blank	water	11/13/09, 1200	2 VOA vial	40 ml	HCL	VOCs by 8260		
5	WWTP3-ER1109	water	11/11/09, 1630	3 VOA vial	40 ml	HCL	VOCs by 8260		
2	WW3032	water	11/11/09, 1315	3 VOA vial	40 ml	HCL	VOCs by 8260		
4	WW 3033	water	11/12/09, 0930	3 VOA vial	40 ml	HCL	VOCs by 8260		
9	AP3075	water	11/13/09, 0900	2 Amber	1 L	Cool	Explosives by 8330		
10	AP3076	water	11/13/09, 0830	2 Amber	1 L	Cool	Explosives by 8330		
7	WW3035	water	11/13/09, 0850	3 VOA vial	40 ml	HCL	VOCs by 8330		
1	WW3036	water	11/13/09, 1010	3 VOA vial	40 ml	HCL	VOCs by 8330		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
Normal: X Rush: ___

Level of QC Required:
Definitive: X Project Specific: ___

1. Relinquished by:	Date: 11/13/09 Time: 1200	1. Received by:	Date: Time:
2. Relinquished by:	Date: Time:	2. Received by:	Date: 11.14.09 Time: 0940
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments: 1 Cooler

4.8 3.8 5.0 5.4 5.4
5.4 4.2 4.4 5.6

SLA

P69502

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PBIX 1113 09ACCT

PAGE 2 OF 2

Shaw™

Shaw E & I, Inc.

Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457
Required Report Date: 21 DAYS

Sample Shipment Date: 11/13/09
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8684 4331 1990

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
8 WW3037	water	11/12/09, 1535	3 VOA vial	40 ml	HCL	VOAs by 8260		
3 SL3094	water	11/11/09, 1638	3 VOA vial	40 ml	HCL	VOAs by 8260		

Special Instructions:

Possible Hazard Identification:
Non-haz: ___ Flammable: ___ Poison B: ___ Unknown: ___

Sample Disposal:
Return to Client: ___ Disposal by Lab: X Archive: ___

Turnaround Time:
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Comments: 1 cooler

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3.8 5.0 5.4 5.4

APPENDIX L

COMMENTS AND RESPONSES

RESPONSE TO COMMENTS
OHIO ENVIRONMENTAL PROTECTION AGENCY
POWERHOUSE 2 ASH PITS SITE CHARACTERIZATION REPORT
FORMER PLUM BROOK ORDNANCE WORKS, SANDUSKY, OHIO
(Report dated March 2010)

Reference: Comments from Paul Jayko, OEPA, email dated 06 May 2010.

Comment 1: We have finished looking at Shaw's Powerhouse 2 Ash Pit Site Characterization Report, received March 30, 2010, and have no substantive comments on the document.

Response 1: Accepted.

APPENDIX B

POWERHOUSE NO. 2 ASH PITS BHHRA

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September 29, 2010

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

Submittal of the Final Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment Power House 2 Ash Pits Former Plum Brook Ordnance Works, Sandusky, Ohio Contract No. W912QR-08-D-0013: Shaw Project Number 133422

Dear Ms. McClanahan:

In accordance with the requirements of Delivery Order No. DX05 of Contract No. W912QR-08-D-0013 Shaw is pleased to submit the draft Baseline Human Health Risk Assessment and the draft Screening Level Ecological Risk Assessment for the Power House 2 Ash Pits at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio. These reports were prepared consistent with those prepared for other PBOW sites, the agreements among the PBOW project delivery team members, and specifically the Power House 2 Ash Pits Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment work plans.

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

Sincerely,

Steven T. Downey, PE, PMP
Project Manager

Enclosures

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DISCIPLINE SIGN-OFF REVIEW

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

Project Description: Baseline Human Health Risk Assessment for Power House 2 Ash Pits Remedial Investigation
Former Plum Brook Ordnance Works, Sandusky, Ohio

Contract No. W912QR-08-D-0013 Delivery Order No. DX05

Project No. 133422 Task/Phase Number: 13000000

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☐	Design Calculations		☐ Draft
☐	Tables		☐ Draft Final
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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.

Baseline Human Health Risk Assessment

Powerhouse 2 Ash Pits
Plum Brook Ordnance Works
Sandusky, Ohio

Prepared for:

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Shaw Project No. 133422

September 2010

Final

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List of Acronyms

ABS	dermal absorption factor
AF	soil-to-skin adherence factor
AP2	Powerhouse 2 Ash Pits
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^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
DNT	dinitrotoluene
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPC	exposure-point concentration
ET	exposure time
FI	fractional term
GAF	gastrointestinal absorption factor
gpm	gallons per minute
g	gram
g/kg-day	grams per kilogram of body weight per day
g/m^3	grams per cubic meter
GSA	General Services Administration
HHEM	human health evaluation manual
HI	hazard index
HQ	hazard quotient
ICP	inductively coupled plasma
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
IT	IT Corporation

List of Acronyms *(Continued)*

kg	kilogram
kg/day	kilograms per day
LMS	linearized multistage
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
m/second	meters per second
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/m^3	milligrams per cubic meter
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
µg/L	micrograms per liter
mg/L	milligrams per liter
MS	mass spectrometry
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OEPA	Ohio Environmental Protection Agency
ORNL	Oak Ridge National Laboratory
PAH	polycyclic aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works
PEF	particulate emission factor
PRG	preliminary remediation goal
QC	quality control
RBSC	risk-based screening concentration
RfC	reference concentration
RfD	reference dose
RI	remedial investigation

List of Acronyms *(Continued)*

RME	reasonable maximum exposure
RSL	regional screening level
SF	cancer slope factor
Shaw	Shaw Environmental, Inc.
TNT	trinitrotoluene
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
VOC	volatile organic compound
WRS	Wilcoxon Rank Sum

Executive Summary

A baseline human health risk assessment (BHHRA) was conducted to evaluate risks associated with exposure to soil, groundwater, surface water and sediment at the Powerhouse 2 Ash Pits (AP2) at the Plum Brook Ordnance Works (PBOW), 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, Inc.

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 (TNT), 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, 3,280 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 their John 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.

Three power stations, Powerhouse 1, Powerhouse 2, and Powerhouse 3, were constructed and utilized to support the TNT manufacturing process. The powerhouses generated steam that was used for space heating, driving compressors, and generating electrical power. Coal ash waste from each of the boilers in the powerhouses was collected in pits. Water was added to the ash, producing a slurry that flowed through a sluice trench to an ash sump located at the end of each

powerhouse. From the ash sump, the ash slurry traveled through a pipeline to a nearby surface water/ash impoundment, referred to as an "ash pit." AP2 was associated with Powerhouse 2.

AP2 is located in the western portion of PBOW, just west of Campbell Road and east of Pipe Creek. Historical drawings indicate that the AP2 surface impoundment was rectangular in shape, measuring approximately 400 feet long by 200 feet wide, and was surrounded by an earthen embankment. Based on topographical quadrangles, aerial photographs, and a visual site survey conducted in 1999, the ash pit areas are noted to have essentially remained unchanged other than vegetative growth. During a site walk conducted in October 2008, AP2 was observed to be overgrown with trees and nearly indistinguishable from surrounding forest. A nondescript, east-to-west ditch bisects AP2 and apparently drains to Pipe Creek during precipitation events.

Approach. The BHHRA evaluated exposure to chemicals in surface soil, subsurface soil, bedrock groundwater, overburden groundwater, surface water, and sediment for cancer risks and noncancer hazards. Only validated analytical data were used in the BHHRA. Validated analytical data are from samples collected during 2009, as reported in the 2010 site characterization report, and those collected in 1996 and reported in the limited site investigation 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. Each COPC in each medium was evaluated for exposure via the relevant exposure pathways and the resultant risk and hazards were estimated. One or more COPCs were found in surface soil, subsurface soil, bedrock groundwater, overburden groundwater, and sediment. No COPCs were identified for surface water, indicating that this medium does not contribute significantly to risks associated with AP2. The receptors listed below were evaluated for exposure and risk. The media evaluated for each receptor are shown in parentheses. Note that if no COPCs were found in a medium (e.g., surface water), then the relevant medium is still shown as evaluated.

- Current groundskeeper (surface soil)
- Future groundskeeper (combined surface and subsurface soil [referred to as "total soil"], bedrock groundwater, overburden groundwater)
- Indoor worker (surface soil, subsurface soil [air pathway only], bedrock groundwater, overburden groundwater)
- Construction worker (total soil, surface water, sediment)
- On-site resident (total soil, surface water, sediment, bedrock groundwater, overburden groundwater)

- Hunter (surface soil)
- Hunter's child (surface soil [venison pathway only]).

Note that there is currently no groundskeeper at AP2, but this receptor is included because current land use does not prohibit the presence of a groundskeeper or other on-site workers. The hunter and the hunter's child are both regarded as current receptors, because hunting is allowed seasonally by permit at AP2; hunting may also continue under future land use. No construction is planned for AP2, but a construction worker is assumed to be potentially exposed under current or future land use. The future groundskeeper, indoor worker, and resident are evaluated for future land use; these three receptors are also evaluated assuming groundwater use as potable water. Overburden groundwater and bedrock groundwater are evaluated for each receptor separately.

Results/Conclusions. Risks were characterized for each COPC identified in each medium 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) 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 in the following bullets; exceedances of PBOW cancer risk criteria (ILCR>1E-5) are shown as bold and exceedances of the noncancer hazard criterion (HI>1) or the NCP risk management range (1E-6 to 1E-4) are shown as bold italics:

- Current groundskeeper: ILCR = 2E-6; HI = 0.09
- Future groundskeeper – overburden groundwater use: ILCR = 2E-6; HI = 0.1
- Future groundskeeper – bedrock groundwater use: **ILCR = 7E-5**; HI = 1
- Future indoor worker – overburden groundwater use: ILCR = 2E-7; HI = 0.06
- Future indoor worker – bedrock groundwater use: **ILCR = 7E-5**; HI = 1
- Current/Future Construction worker: ILCR = 4E-7; HI = 0.4
- Resident – overburden groundwater use: ILCR = 5E-6; adult HI = 0.2; child HI = 0.9
- Resident – bedrock groundwater use: ***ILCR = 3E-4; adult HI = 3; child HI = 7***
- Current/Future Hunter: ILCR = 6E-8; HI = 0.003
- Current/Future Hunter's child: ILCR = 4E-13; HI = 0.000003.

The ILCR of the future resident that is hypothetically assumed to use bedrock groundwater as household tap water exceeds the NCP risk management range as well as the PBOW target cancer risk criterion. The HI values of the child and adult resident also exceed the target criterion of 1,

indicating that adverse human health risks under this scenario cannot be regarded as unlikely. The ILCR for each of the other future scenarios assumed to use bedrock groundwater as a potable source had an ILCR that exceeded the PBOW target cancer risk criterion, but were within the NCP risk management range.

Cancer risks and noncancer hazards to all potential receptors evaluated under current land use (i.e., current groundskeeper, construction worker, hunter, and hunter's child) are within or less than the NCP risk management range, are less than the target HI criterion, and are less than the PBOW cancer risk criterion, indicating that cancer risks are at acceptable levels and adverse noncancer effects are unlikely to occur under potential current scenarios. Similarly, all future scenarios which do not assume bedrock groundwater use meet the NCP risk management range, the target HI criterion, and the PBOW risk criterion.

Risks associated with the use of bedrock groundwater as tap water easily account for the majority of the ILCR and HI for the future groundskeeper, indoor worker, and future resident. Specifically, benzene in bedrock groundwater is by far responsible for the largest portion of cancer risk and noncancer hazards for these receptors. It is responsible for 97 to 99 percent of the total ILCR and 82 to 89 percent of the total HI for these three receptors. Benzene was identified as the only contaminant with an HI exceeding a value of 1 and an ILCR exceeding a value of 1E-5 for any receptor. Benzene is a petroleum constituent that is known to be naturally occurring in the limestone groundwater at PBOW, and petroleum was reported seeping at depth (47 feet and 69.5 feet) in AP2 bedrock well AP2-BEDGW-003. Without the contribution of benzene, the residual noncancer HI value for each receptor does not exceed a value of 1 and the ILCR does not exceed a value of 1E-5.

It is highly doubtful that bedrock groundwater would ever be used as potable tap water because of naturally poor water quality in the area and low, undependable groundwater yield. This poor quality is associated with the presence of hydrogen sulfide off-gassing, the associated health and aesthetic issues with high-sulfate water, and the presence of petroleum product as encountered in AP2 well AP2-BEDGW-003. Thus, if a more likely and serviceable source of tap water were to be used by a future groundskeeper or residential receptor (e.g., municipal water or perhaps even overburden groundwater), then the ILCR and HI values would meet the NCP risk management range (1E-6 to 1E-4), PBOW cancer risk criterion of 1E-5, and the target HI criterion of 1.

1.0 Introduction

This baseline human health risk assessment (BHHRA) evaluates potential human health risks associated with exposure to soil, groundwater, surface water, and sediment associated with Powerhouse 2 Ash Pits (AP2) located at the former Plum Brook Ordnance Works (PBOW), Sandusky, Erie County, Ohio. This work is being conducted 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 procedures established in the BHHRA for TNT Areas A and C soil (IT Corporation [IT], 2001a), the BHHRA for groundwater at PBOW (Shaw Environmental, Inc. [Shaw], 2006) and, most specifically, the AP2 BHHRA work plan (Shaw, 2010a).

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 (DNT), and pentolite (USACE, 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 explosive 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 structures, equipment, and manufacturing debris were either removed and salvaged or removed and burned. After the property was certified as decontaminated, 3,280 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 (GSA). This transfer did not include the Plum Brook Depot area, which consists of 2,800 acres. The Department of the Army reacquired the 3,230 acres in 1954 and performed cleanup efforts from the mid-1950s until 1963. In 1955, the Army completed further decontamination of the manufacturing process lines. This effort included removal of contaminated surface and subsurface soil around the building 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.

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; then 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 likewise buried. 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 nitroaromatic-filled flumes that were excavated (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 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 GSA 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 (USACE, 1995).

1.3 Powerhouse 2 Ash Pits Description and History

As noted previously, PBOW was built in early 1941 and manufactured TNT, DNT, and pentolite until 1945. Three power stations, Powerhouse 1, Powerhouse 2, and Powerhouse 3, were constructed and utilized to support the TNT manufacturing process. Each power station consisted of a main powerhouse, a coal storage area, and an aboveground fuel storage tank. The powerhouse buildings also contained two to four large coal-burning boilers, a turboelectric generator, a feed water treatment system, and several steam-driven or electric air compressors. The generated steam was used for space heating, driving compressors, and generating electrical power. Coal ash generated from each of the boilers in the powerhouse was collected in pits. Water was added to the ash, producing a slurry that flowed through a sluice trench to an ash sump located at the end of each powerhouse. From the ash sump, the ash slurry traveled through a pipeline to a nearby surface water/ash impoundment, referred to as an “ash pit” (USACE, 1995). AP2 was associated with Powerhouse 2.

AP2 is located in the western portion of PBOW, just west of Campbell Road in an area that appears to be an old surface impoundment (Figure 1-2). Pipe Creek lies just west of the western boundary of AP2. Historical drawings indicated that the surface impoundment was rectangular in shape, measuring approximately 400 feet long by 200 feet wide, and was surrounded by an earthen embankment (USACE, 1995). A nondescript, east-to-west ditch bisects AP2 and apparently drains to Pipe Creek during precipitation events. Based on topographical quadrangles (dated 1959 and 1969), aerial photographs, and a visual site survey conducted in 1999, the ash pit areas are noted to have essentially remained unchanged other than vegetative growth. As mentioned in the previous paragraph, ash from the coal-fired boilers was reportedly disposed of in the ash pit through a pipeline. During this investigation, the bermed area was observed and black to dark brown cinders were found within the bermed area at depths up to 4 feet. Environmental sampling was not conducted prior to the 1996 investigation.

During a site walk conducted in October 2008, the AP2 area was observed to be overgrown with trees and nearly indistinguishable from surrounding forest. Several moss-covered concrete slabs approximately 7 feet long and 3 feet wide were observed partially buried in the underbrush northwest of the powerhouse. A small hole constructed of mortared shale/limestone blocks and approximately 2 feet in diameter was located near the concrete slabs. Based on the construction, this appears to be a hand-dug well. The depth of the hand-dug well is 12 feet. A strong sulfur odor was noted to be emanating from it. The structure was nearly filled with water during a site

visit in December 2008. The origin of these concrete structures is not known with certainty; however, they appear to be remnants associated with a historical farmstead. A review of historical drawings and other documents indicates that a farmstead was present south of the slabs and hand-dug well. Remnants of other concrete and stone foundations are present in the former farmstead area indicated on the historic drawings. It is likely that all of the concrete and stone foundations, concrete slabs, and hand-dug well are remnants associated with agricultural activities predating the PBOW facility.

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. Upwards of 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 groundwater system exists within the unconsolidated material atop the bedrock under much of the site.

In this BHHRA, the term "facility" refers to the entire former PBOW property, and the term "site" refers to areas within PBOW under investigation, in this case AP2. 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 National Guard.
- Construction activities may be performed during development of any of the sites.

In summary, future site use of AP2 is considered to be industrial or residential for the purpose of developing receptor and exposure scenarios. There are no current NASA activities at AP2, but because PBOW is under NASA control, the potential for NASA human activities at AP2 may

exist. Hunting is currently allowed by permit in AP2; therefore, hunting is evaluated in this BHHRA. It is assumed that groundwater may be developed as a source of potable water in the future. 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 consistent with the AP2 BHHRA work plan (Shaw, 2010a). The AP2 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), 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: 9285.6-03.

- 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), 2009a, ***ProUCL Version 4.00.04***, 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), 2009b, ***ProUCL Version 4.00.04 Technical Guide***, Draft, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, EPA/600/R-07/041, February.

- U.S. Environmental Protection Agency (EPA), 2009c, ***ProUCL Version 4.00.04 User Guide***, Draft, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, EPA/600/R-07/038, April.

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.

- ***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 likely to directly affect site management decisions.

- ***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 AP2 environmental medium.

2.1 Data Sources

All soil, groundwater, sediment, and surface water 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, surface water, sediment, and monitoring well samples. The sample summary table identifies each sample used in the BHHRA and the associated analytical suite. This includes samples collected as part of the limited site investigation for AP2 (IT, 1997a), and the remedial investigation (RI) samples (Shaw, 2010a). All sampling locations are shown on Figure 2-1.

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 RI report (Shaw, 2010b) and the limited site investigation report (IT, 1997a). The surface soil and subsurface soil are considered separate media. Surface and subsurface soil data are typically combined to assess exposures under the construction worker, future groundskeeper, and residential site use scenarios, which would involve excavation and mixing of surface and subsurface soil. 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 either a surface soil COPC or a subsurface soil COPC (or both), then that chemical is a total soil COPC. The EPCs for total soil are typically generated from the combined data sets. As presented in Section 2.5, for AP2, a conservative determination was made to use the surface soil data set as total soil due to a lack of COPCs in subsurface soil.

Surface soil is defined as samples taken from within the interval of 0 to 1 foot below ground surface (bgs), and subsurface soil is defined as samples taken from depths greater than 1 foot bgs per the RI work plan (Shaw, 2009). The limited site investigation (IT, 1997a) historical soil samples were collected from a depth of either 0 to 0.5 or 2 to 3 feet bgs; these intervals are

consistent with surface soil and subsurface soil, respectively, as described in the RI report (Shaw, 2010b). As possible, the RI subsurface soil samples were generally collected at depths of 3 to 5 and 8 to 10 feet bgs. Note that where refusal or the water table was encountered before a depth of 10 feet bgs, samples from the deepest 2-foot interval were collected.

2.3 Evaluation of Data Quality

The quality of the 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 (QC) 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 - QC 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 (5x, 10x) 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" qualified data (nondetects) 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 is reasonably high that the chemical is present, 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 DNT isomers are analyzed by EPA Method 8330 for nitroaromatics as well as EPA Method 8270C for semivolatile organic compounds. 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 which also considers status as a human nutrient (Section 2.4.1), a frequency-of-detection evaluation (Section 2.4.2), and a background 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 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. In groundwater, for example, both the MDC and RBSC have units of micrograms per liter (µg/L) in water.

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 Oak Ridge National Laboratory–EPA regional screening levels (RSL) table "tap water" values, and RBSCs for soil are derived from "residential soil" RSL values (Oak Ridge National Laboratory [ORNL]-EPA, 2009a). This is a change in the source of the RBSCs based on discussion between USACE and OEPA (2009c), and this change is consistent with recent OEPA (OEPA, 2009a) guidelines. Previously, the groundwater and soil RBSCs were derived from the corresponding EPA (2004b) Region 9 preliminary remediation goals (PRG). The soil RBSCs are applied to both surface and subsurface soil.

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; ORNL-EPA, 2009b). This 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. The 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.

Risks associated with exposure to sediment and surface water along Pipe Creek in the vicinity of AP2 are also evaluated in the BHHRA. Although RSLs have not been developed specifically for sediment and surface water, RBSCs can be derived from the RSLs based on site conditions at PBOW and the types of exposure to these media that may reasonably be anticipated. The routes by which receptors may be exposed to sediment (i.e., incidental ingestion, dermal contact) are similar to those by which receptors may be exposed to soil. However, sediment contact is expected to be appreciably less intense than soil contact, due to the lower duration and frequency of contact with sediment as compared with soil. Similarly, surface water exposure is expected to be much less intense than exposure to groundwater, as surface water from Pipe Creek is not regarded as a plausible source of drinking water, partly because the Erie County Health Department does not permit using surface water as private drinking water. Consequently, the exposure frequency is expected to be much lower for surface water, and the incidental ingestion of surface water would be much lower than the assumed intentional ingestion and use of groundwater from the tap. For these reasons, OEPA (1999) stated that unadjusted tap water PRG values (i.e., HQ = 1; ILCR = 1E-6) should be used for screening PBOW surface water. This screening protocol was adopted specifically because it was agreed that the magnitude of exposure associated with PBOW surface water exposure would be far less than that associated with household tap water. In other words, it was agreed that analytes with a maximum concentration at the PRG level would not contribute appreciably to overall risks and hazards for PBOW sites based on the exposure pathways of the surface water exposure scenarios for PBOW.

The same agreement was reached for screening sediment against unadjusted residential soil PRGs. This protocol has been updated to base RBSCs on RSLs rather than PRGs. Even though the sediment and surface water RBSCs are an order of magnitude higher for noncarcinogens than the respective soil and groundwater RBSCs, these sediment and surface water RBSCs are regarded as protective of sediment and surface water receptors for screening because of the lower exposure rate to these media. Note that this previously made PBOW Team agreement for screening surface water and sediment (OEPA, 1999), which considered site-specific conditions, takes precedence over current OEPA (2009b) guidance, which simply states that adjusted RSLs (i.e., RBSCs) for soil may be used to screen contaminants in sediment, and those for groundwater may be used to screen surface water. The surface water RBSCs also meet the outside-of-the-mixing-zone average non-drinking water concentrations for the Lake Erie Basin.

The screening of lead in soil and groundwater is a special case. The EPA (2006) Office of Water treatment technique action level of 15 µg/L for lead is listed in the RSL table, and the RSL User's Guide recommends this level for use as an RSL. Lead exposure and risk is evaluated separately from other chemicals using the EPA (2004c) 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, 2004c) 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. 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, and 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. Note that for AP2 soil, the MDC for lead (50.7 mg/kg) is less than both the RBSC (400 mg/kg) and the criterion for average concentration (250 mg/kg); the average lead concentration in AP2 surface soil was 20.4 mg/kg. Likewise, the lead MDC in overburden groundwater (2.4 µg/L) is less than the RBSC (15 µg/L) and lead was not detected in bedrock groundwater. Therefore, the IEUBK model was not run for the AP2 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, 2006). Secondary drinking water regulations are non-promulgated 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, 2006).

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. There are no RSLs 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 is 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 (see Section 3.1.1).

Site 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 (refer to Section 2.4.3.1) and is performed after the risk characterization (Chapter 5.0), and the results are discussed in the uncertainty analysis (Chapter 6.0). No suitable background data set exists for overburden wells, so no background screening or statistical comparisons to background concentrations can be made for overburden groundwater samples. Similarly, no background screening or statistical evaluation can be performed for surface water or sediment analytical data, as these media lack PBOW background data sets.

Inorganics and organics are treated similarly from a quantitative perspective. However, all organics not eliminated on the basis of RBSC exceedance (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 IT (1998), and the background data set and derivation of BSCs for PBOW bedrock groundwater are described in the 2004 groundwater report (Shaw, 2005). It is noted that the method agreed upon for the development of BSCs, as recorded in the September 11, 2002 PBOW Team Meeting minutes, differs from that shown in current OEPA (2004) guidance. This PBOW Team agreement, which has been used for all PBOW risk assessments to date, takes precedence over the subsequent OEPA (2004) guidance. Summary tables of the background data sets for soil and groundwater are provided as Tables 2-2 and 2-3, respectively. The background soil samples were collected from near the property boundary, away from any potential source areas, and the background groundwater wells were installed in off-site areas upgradient of PBOW sources. Briefly, BSCs were calculated for use at PBOW based on concentrations found in these background soil and bedrock monitoring well samples. Each BSC is either the MDC or the calculated 95th percent upper tolerance limit of the background data set, whichever value is lower (IT, 1998; Shaw, 2005). The background monitoring well samples were collected using low-flow samples and were unfiltered.

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 found in the 2004 groundwater report (Shaw, 2005), and the background data set for soil is found in the site investigation for the acid areas (IT, 1998). As mentioned previously, background data sets do not exist for overburden groundwater, surface water, or sediment; therefore, a 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). WRS testing is performed for inorganics having MDCs that exceed the respective BSCs and are identified as COPCs based on RBSC comparison (Section 2.4.1) and frequency of detection (Section 2.4.2). All COPCs are carried through the risk characterization process; thus, statistical testing results are not used to screen out any chemicals.

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). The WRS evaluation was not performed for AP2 because only two inorganic analytes were detected in soil or bedrock groundwater and neither of these contributed appreciably to a significant risk.

2.4.3.3 Treatment of Organics

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. Instead, all detected organic compounds are carried through the risk assessment process (i.e., exposure assessment, toxicity assessment, 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 contribution of organics are discussed in the uncertainties analysis, as applicable.

2.5 Data Evaluation Summary

Data summary tables are provided for the following media: surface soil (Table 2-4), subsurface soil (Table 2-5), bedrock groundwater (Table 2-6) and overburden groundwater (wells) (Table 2-7), sediment (Table 2-8), and surface water (Table 2-9). 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)
- 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 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 this 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 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 media are identified as follows:

- ***Surface Soil*** – Beryllium, thallium, Aroclor 1016, benzo(a)pyrene, benzo(b)fluoranthene
- ***Subsurface Soil*** – Thallium
- ***Bedrock Groundwater*** –Benzene, chloromethane, trans-1,3-dichloropropene, ethylbenzene, xylenes
- ***Overburden Groundwater*** – Nickel
- ***Sediment*** – Arsenic, chromium
- ***Surface Water*** – None.

As discussed in Section 2.2, the total soil COPCs include all surface soil and subsurface soil COPCs. In the case of AP2 soils, thallium is the only chemical identified as a COPC in subsurface soil. This analyte was also reported as a COPC in surface soil, in which it was reported at higher concentrations than in subsurface soil. Further observation of the surface and subsurface soil data sets revealed that all thallium RBSC exceedances were reported only in the 1996 analytical results; all 2009 soil samples were nondetect or were reported at concentrations less than the RBSC for thallium (Shaw, 2010b); also, all 2009 reporting limits were less than the RBSC. The apparent reason for the reported exceedances in the 1996 samples is that they were analyzed using inductively coupled plasma spectrometry (ICP) without mass spectrometry (MS). The 2009 samples used the combined ICP/MS method, which attained much lower reporting limits. False positives are common using ICP alone. It is likely that the reported detections among the 1996 samples were all false positives, and it is unlikely the subsurface soil truly contained any legitimate COPCs.

Because thallium is the only subsurface analyte identified as a COPC (and its presence at detectable levels is unlikely), a determination was made to conservatively assume that the surface soil data set be used in the BHHRA to represent total soil. It is recognized that this approach provides an additional high bias to the receptors evaluated for exposure to total 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 soil, groundwater, surface water, and sediment associated with AP2 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 possible 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, 1997b). 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 3.1.3.8. 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 (e.g., Shaw [2008]); however, the groundwater underlying these sites cannot be summarily excluded for consideration as a tap water source based on natural water quality parameters or general assumptions concerning 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 regarded as plausible for purposes of this BHHRA.

3.1.1 Physical Setting

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 (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 (0.01 inch or greater) per month (10) occurring during July, August, September, and October, and the most (15) 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 to 65 percent sunshine during the summer months (City-Data.com, 2004).

Geology. Three formations, all of Devonian Age, outcrop across PBOW, each of which was encountered in the upper 100 feet of bedrock at PBOW (Shaw, 2005). The Delaware Limestone is the lowermost formation screened by site wells. It is characterized as a hard, dense, finely

crystalline limestone and dolomite. The unit is typically buff colored and usually is described as fossiliferous. In the vicinity of PBOW, quarries mine limestone from the Delaware. Traces of natural petroleum-derived hydrocarbons and hydrogen sulfide are common in area quarries (Shaw, 2005). Hydrogen sulfide was detected in the groundwater during development of AP2 monitoring well AP2-BEDGW-003 (more than 200 parts per million). It was also detected in the breathing air in a piezometer (PZ-01) installed near the historical hand-dug farm well (Section 1.3); an obvious hydrogen sulfide odor was also noted as emanating from the hand-dug well.

Overlying the Delaware Limestone is the Olentangy Shale. Two members of the Olentangy Shale have been characterized at the site: the Plum Brook Shale and the overlying Prout Limestone. The Plum Brook Shale is interpreted to consist of approximately 35 feet of bluish-gray, soft, fossiliferous shale containing thin layers of dark, hard, fossiliferous limestone. The Prout Limestone has been described as a 15-foot-thick unit which occasionally outcrops in a 1,000- to 2,000-foot-wide, northeast-striking band across the middle portion of PBOW. It is described as a dark-gray to blue, very hard, siliceous, fossiliferous limestone or dolomitic mudstone. The uppermost formation at the site is the Ohio Shale. Only one member of the Ohio Shale, the Huron Shale, is present in the PBOW area. This unit has been described as black, thinly bedded, with abundant carbonaceous matter. Some large pyrite/carbonate concretions are also present in the Huron Shale, some as large as 6 feet in diameter (D&M, 1997). Based on drilling logs of previous boreholes in the area, the shale layer is not expected at AP2.

Soils. The bedrock 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 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. Overburden is thickest on the northern portion of the site in the vicinity of the Reactor Facility Area, where it has filled in a bedrock low (Shaw, 2005). In the vicinity of AP2, the overburden thickness ranges from 13 to 20 feet, based on soil boring logs.

The soil in the northwest portion of PBOW is placed within the Kibbie-Elnora-Tuscola-Colwood Association, which is described as nearly level to gently sloping. This soil is described as somewhat poorly drained, moderately well drained, and very poorly drained soils formed in outwash, lacustrine, and deltaic sediments. Along a strip from west to northeast across the site is the Castalia-Millsdale-Milton-Ritchey Association. This association is described as shallow to moderately deep, nearly level to moderately steep, well-drained and very poorly drained soils formed in glacial till, lacustrine sediments, and limestone residuum. Across much of the central portion of the site is the Hornell-Fries-Colwood Association, described as moderately deep to

deep, nearly level to gently sloping, somewhat poorly drained to very poorly drained soils formed in glacial till and lacustrine sediments over shale bedrock. At the extreme southeast portion of PBOW is the Pewamo-Bennington Association, described as nearly level to gently sloping, very poorly drained and somewhat poorly drained soils formed from glacial till and lacustrine sediments.

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 PBOW groundwater evaluation. As mentioned, shale appears to be absent at AP2. Data collected during the more recent investigations (Shaw, 2005; IT, 1997b, 1999, 2001b) 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. In contrast, the limestone bedrock water-bearing zone is saturated year round. During periods of low precipitation, only limited migration of contaminants would occur in the overburden due to less infiltration. During a wet period, the general flow direction in the overburden water-bearing zone is to the west in the immediate vicinity of AP2. 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.

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. Water in the limestone 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. These fractures result in a localized groundwater flow direction that is likely to be to the west in the vicinity of AP2.

At PBOW, the bedrock groundwater has been subdivided into three zones based on location and yield. 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). AP2 is in Zone 1.

Surface Water. No surface water bodies are located within the AP2 study area. Surface drainage in AP2 is generally westward toward Pipe Creek, which lies approximately 50 feet west of the study area. Pipe Creek is a small, perennial creek that flows south-southeast to north-northwest. AP2 contains low-lying areas in which water has been observed to pond after heavy rain events and in which water may pond seasonally.

3.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways

Contaminant sources, release mechanisms, and migration pathways are summarized on Figure 3-1. Briefly, AP2 received a coal ash slurry via a pipeline from Powerhouse 2, as described in Section 1.3. This pipeline is still in existence, as shown on Figure 1-2. This coal ash layer is present from the surface up to a depth of approximately 4 feet. Thus, the coal ash and any contaminants within it may represent surface and subsurface soil.

Leaching and downward migration may have carried contaminants from the subsurface soil to the groundwater. It is possible that that surface water and sediment at the nearby Pipe Creek may have been impacted by contaminants originating from the AP2 through surface drainage and groundwater migration.

3.1.3 Receptors and Exposure Pathways

Receptors, selected to represent the upper bound on exposure from all plausibly exposed groups of people associated with AP2 as well as the pathways by which they may be exposed to chemicals, are summarized on Figure 3-1 and in Table 3-1. The exposure variable values used in the contaminant intake models are compiled in Table 3-2. The receptors evaluated in the BHHRA include the following. 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. Receptors such as the construction worker, hunter, and hunter's child may be viable under current or future land use. However, the evaluation for these receptors is exactly the same under current and future land use.

- Current groundskeeper
- Future groundskeeper
- Indoor worker (future)
- Construction worker (current/future)
- On-site resident (future)

- Hunter (current/future)
- Hunter's child (current/future).

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; 1991a). It is interpreted as reflecting the 90 to 95th percentile on exposure. In keeping with EPA (1989a; 1991a) 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 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. An FI may also be split between two comparable media. For example, if a resident is exposed to both soil and sediment, FI values are introduced that apportion exposure between the two media such that the FI value for the two analogous media does not exceed a value of 1 (see Section 3.1.3.5).

Receptors and the associated exposure pathways are presented in the following subsections. Please note that some of the pathways considered for the receptors (e.g., surface water exposure; volatile organic compounds [VOC] in soil) could not be quantitatively evaluated because pertinent chemicals associated with these pathways were not identified as COPCs.

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 no groundskeeper is currently working at the site, but current land use does not prohibit a site worker from performing groundskeeping activities at the site.

Exposure to surface soil is evaluated for a (potential) current groundskeeper. Total soil is typically evaluated under the future groundskeeper use scenario because hypothetical future construction may include considerable excavation of subsurface soil. This soil may be spread on the surface and regraded such that some of the soil currently in the subsurface (i.e., 1 to 10 feet bgs) will be spread as surface soil (0 to 1 foot bgs). As discussed in Section 2.5, essentially no COPCs were identified for subsurface soil (aside from a likely false positive for thallium which was also reported at a higher concentration in the surface soil), so the conservative assumption was made that the surface soil data set would also be used to represent total soil. Groundwater use is also evaluated for the groundskeeper in the future site use scenario, as discussed in Section 3.1, which could theoretically be developed as a source of drinking water. It is assumed that any contact with surface water or sediment associated with Pipe Creek by this receptor would be infrequent and sporadic, because such contact would not be a part of the groundskeeper’s regular duties or activities. Therefore, exposure to these media is not quantified.

Direct soil exposure pathways include incidental ingestion and dermal contact. Inhalation of dust raised by lawnmowers or other equipment is also evaluated because relatively high dust concentrations may be produced within the groundskeeper's breathing zone, with little opportunity for dilution by the large volume of ambient air.

Shaw’s experience has been that surface soil that is contaminated with VOCs and that has been in place for extended periods is not a significant source of airborne VOCs, because infiltration and dissipation over time reduces residues at the surface (i.e., first few centimeters) from which volatilization would occur. However, as noted above, the data set for surface soil may include samples taken from up to 1 foot bgs, which would include the soil zone deeper than the top few centimeters, where dissipation has not reduced VOC concentrations. In other words, the surface

soil data set might indicate the presence of VOCs, although volatilization to the air is unlikely to be significant. Therefore, a surface soil-to-air volatilization model is not used in addition to the activity-based dust emissions model to estimate airborne concentrations of VOCs. Instead, the airborne concentrations estimated by the dust emissions model are assumed to sufficiently estimate levels of VOCs that may arise from volatilization, because the dust emissions model treats the VOCs as if they were located at the surface. It is assumed that VOC emissions from subsurface soil (i.e., at depths greater than 1 foot bgs) would be attenuated by the overlying soil so that concentrations in ambient air would not be toxicologically significant.

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, 1991a), 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 future groundskeeper would be exposed to soil via the same exposure pathways as the current groundskeeper described in Section 3.1.3.1. However, the future groundskeeper scenario assumes that construction has taken place and that some of the soil currently in the subsurface has been brought to the surface during earthmoving activities. Therefore, the future groundskeeper is assumed to be exposed to a combination of surface and subsurface soil (total soil) rather than surface soil alone.

In addition, a hypothetical future groundskeeper is assumed to be exposed to groundwater, which could theoretically be developed as a source of drinking water in the future. His drinking water ingestion rate is assumed to be 1 liter per day (L/day) (EPA, 1991a). 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 (see Section 3.3).

3.1.3.3 Indoor Worker

This receptor scenario was created to evaluate exposure to indoor airborne VOCs entrapped in a building. VOCs released from subsurface soil may enter a building through joints or cracks in the foundation or slab. The indoor worker is also potentially exposed to surface soil via incidental ingestion. Exposure to COPCs in surface soil via dermal contact and inhalation of airborne dust and VOCs from surface soil, although plausible, are expected to be less significant than incidental ingestion, because this receptor spends his work time indoors. Therefore, dermal contact and inhalation of dust and airborne VOCs from surface soil are not quantified separately from ingestion exposure (EPA, 2002). Under a future use scenario for this receptor, construction of a building would be necessary. This would require excavation and regrading of soil. Normally, when construction is involved, such as for the future groundskeeper or resident, total soil rather than surface soil would be evaluated for ingestion exposure. However, the chief purpose for this receptor is to evaluate exposure via vapor intrusion of contaminants from subsurface soil into indoor air. Thus, the evaluation of direct contact with subsurface soil as a component of total soil would equate to "double counting" of COPCs in subsurface soil. Also, the groundskeeper reflects a worst-case exposure for a long-term worker with respect to direct contact with both surface soil and total soil. Therefore, direct contact with surface soil for the indoor worker is included to reflect a more complete exposure scenario, but direct contact of subsurface soil is most effectively addressed from an RME perspective by the groundskeeper.

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, 1991a).

A future indoor worker is assumed to be exposed to groundwater, which could theoretically be developed as a source of drinking water (see Section 3.1). His drinking water ingestion rate is assumed to be 1 L/day (EPA, 1991a). 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 (see Section 3.3.4).

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. Construction projects are expected to be infrequent. It is assumed that the construction worker participates in only one construction project on the site. Note that no construction projects are anticipated for this site, but AP2 is currently under NASA control and a construction project may be possible under current land use. Relevant exposure pathways include incidental ingestion and dermal contact, inhalation of dust raised by operating construction equipment, and inhalation of airborne VOCs released from subsurface soil during excavation and grading. 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 groundskeeper would have longer and/or more frequent groundwater exposure. Therefore, groundwater exposure is not evaluated for the construction worker.

The construction worker may also be exposed to surface water and sediment at Pipe Creek during projects such as installation of underground utilities or rerouting stream flow. Dermal contact is the most significant pathway for exposure to surface water. Incidental ingestion of surface water is also possible but is not expected to be nearly as significant as dermal contact. Inhalation of VOCs from surface water is also possible, but the large volume of outdoor air and natural air currents are expected to dilute airborne concentrations, so that this pathway is expected to be less significant than dermal contact, which is quantified. For these reasons, incidental ingestion and inhalation of VOCs from surface water are not quantified separately from dermal contact. Dermal contact and incidental ingestion may be important pathways for exposure to sediment, and both are evaluated.

The construction worker is assumed to be a 70-kg adult who works 8 hours/day, approximately 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, 1991a). 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 are assumed, which represent the head, hands, and forearms (EPA, 2002; 2004a).

The construction worker may be exposed to surface water and sediment during the 6-month construction period. The construction worker dermal exposure parameters for sediment are

assumed to be exactly the same as those for soil. Dermal exposure to surface water is assumed to occur for up to 4 hours per day, or one-half the normal work day. It is assumed the exposure to surface water is intermittent during this period. An exposed body surface area of 3,300 cm^2, the same as for sediment and soil, is assumed for exposure of the construction worker to surface water. It is expected that the construction worker would wear appropriate footgear and leg protection to minimize surface water and sediment exposure to the legs.

The construction worker scenario described above provides for several different kinds of construction projects, such as upland excavation and building projects (exposure primarily to soil), as well as stream rerouting (exposure primarily to surface water and sediment). It is unlikely, however, that a single construction worker would participate in all these activities during a given project. Therefore, the evaluation described above is probably overly conservative and may represent some double counting. For example, it is unlikely that the construction worker would be simultaneously ingesting soil, sediment, and surface water. Similarly, the air in his breathing zone is not likely to contain the reasonable maximum concentrations of COPCs estimated for soil while he is exposed to surface water. The potential for double counting is not expected to contribute significantly to total risk estimates summed across chemicals, pathways, and media. Should construction worker risk estimates exceed acceptable limits, risk and hazard estimates may be performed using refined exposure assumptions based on the physical characteristics of the site. For example, an upland excavation and building project may be assumed for one or more areas of the site, and a stream rerouting project may be assumed for another. Effectively, the risks and hazards associated with surface water/sediment exposure and soil exposure could be separated. This approach would more precisely reflect plausible exposure scenarios, reduce the likelihood of double counting, and more accurately identify risk-driving media and chemicals. These refined estimates would be presented in the uncertainty analysis.

3.1.3.5 On-Site Resident

The on-site residential scenario is created to evaluate the upper bound for long-term exposure to site soil, surface water, sediment, and groundwater under the future land-use scenario. 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 such as TNTA and TNTC (IT, 2001a).

The on-site residential scenario is evaluated assuming a 30-year residential exposure scenario, considering exposure to a resident as a young child (6-year duration, ages 1 through 6 years) through the adult portion of life spent at this residence (24-year duration) (EPA, 1991a). 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; ORNL-EPA, 2009b).

The resident is assumed to be exposed directly to total soil, because residential development would involve excavation and regrading, which would mix surface and subsurface soil. Relevant pathways for total soil exposure include incidental ingestion, dermal contact, and inhalation of dust and VOCs. Evaluation of VOCs from total soil is addressed during evaluation of airborne dust, as described for the groundskeeper. For evaluating inhalation of airborne dust, it is assumed that 80 percent of the soil surface is covered with pavement or vegetation. Inhalation of VOCs released from subsurface soil entrapped in indoor air is also evaluated. The resident is also assumed to be exposed to VOCs that have been released from subsurface soil through cracks in the building foundation to indoor air. It is noted that because some of the subsurface soil is expected to be brought to the surface in the future, using only subsurface soil data will conservatively result in some double counting of exposure to any VOC COPCs that may be present in the subsurface soil. This may be addressed in the uncertainty analysis should the subsurface soil-to-indoor air pathway significantly affects risk and hazard estimates. This pathway did not contribute significantly to risk at AP2, as no VOCs were identified as COPCs.

It is assumed that, under future residential land use, the overburden and limestone bedrock water units will be developed as sources of potable water (see Section 3.1). 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, dermal contact during bathing/washing, and inhalation of VOCs released to the air during household use of tap water associated with multiple household uses.

The resident could have access to Pipe Creek in the vicinity of AP2 and could be exposed to contaminants in surface water and sediment associated with AP2. Plausible exposure pathways include dermal contact with surface water and incidental ingestion and dermal contact with sediment. Incidental ingestion of surface water in a wading scenario is considered less significant than dermal contact and is not quantified separately from dermal contact. Inhalation of VOC emissions from surface water is also possible, but the large volume of outdoor air and natural air currents are expected to dilute airborne concentrations, so that this pathway is expected to be less significant than dermal contact, which is quantified. For these reasons, the inhalation of VOC emissions from surface water is not quantified separately from dermal contact.

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 0.83m^3/hr (EPA, 1991a). 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, 1991a; 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, 2004d). 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, 1991a; 2002).

It is assumed that the resident would visit Pipe Creek for 8 hours/day, 2 days/week during the warmer half of the year. This resident is assumed to wade for 3 hours/day on 52 days of the year. Mechanisms of exposure to soil and sediment are likely to be similar. Therefore, the incidental soil ingestion rate of 100 mg/day, the surface area of 5,700 cm^2, and the AF of 0.07 mg/cm^2 are also applied to sediment exposure in the adult. Similarly, the resident child soil ingestion rate of 200 mg/day, skin surface area of 2,800 cm^2, and soil AF of 0.2 mg/cm^2 are applied to sediment exposure for this receptor. Pipe Creek in the vicinity of AP2 generally contains less than 1 foot of water, limiting the surface area of the body that would typically be exposed. It is assumed that an adult body surface area of 7,000 cm^2 is available for exposure to surface water. This represents the same body parts to which soil and sediment would be exposed (i.e., hands, forearms, head, and lower legs) plus the feet (EPA, 1997a; 2004a). The body surface area of 2,800 cm^2, representing the hands, forearms, head, lower legs, and feet, used for soil and sediment exposure in the young child are also used for surface water exposure for this receptor.

EPA (1989a) permits the development of an FI to reflect the proportion of total daily exposure that a receptor obtains from potentially contaminated medium (refer to Section 3.1.3). For this receptor, the FI is used to apportion the resident's time of exposure between site soil and sediment. It is assumed that the resident spends 16 hours/day awake and potentially exposed to soil or sediment. As previously noted, 350 days/year are available for contact with soil; 52 of those days are also available for contact with sediment. It is assumed that contact with soil and sediment does not occur simultaneously; i.e., on those days when the resident spends time at the streams, 8 hours would be spent in contact with soil and 8 hours would be spent in contact with sediment. Therefore, the fraction of exposure to soil is 16 hours/16 hours = 1 on the 298 days without time spent at the streams, and the fraction of exposure to soil is estimated as 8 hours/16

hours = 0.5 on the 52 days with some time spent at the streams. A weighted fraction of 0.93 (rounded to 0.9) is estimated for exposure to soil over the entire 350 days/year exposure frequency. A weighted fraction of 0.07 (rounded to 0.1) is estimated for exposure to sediment over the entire 350 days/year exposure frequency.

An adolescent resident may be the most likely individual to have regular exposure to sediment and surface water associated with Pipe Creek. It is not expected that adults would regularly visit Pipe Creek, as it does not support game fish and would seemingly not provide any attraction. It is unlikely that a young child (i.e., ages 1 through 6) would frequent Pipe Creek for substantial portions of time, because such young children (especially at the lower end of this age range) would require continued adult supervision. However, as described above, it is conservatively assumed that the resident will be regularly exposed to surface water and sediment for 30 years, 6 years assumed as a young child and 24 years assumed as an adult. For cancer effects, the 30-year exposure to surface water and sediment represented by both the young child and adult are combined. This approach is more conservative than evaluating an adolescent and is also consistent with BHHRAs performed for PBOW sites in the past.

With respect to groundwater exposure, it is assumed that an adult resident ingests 2 L/day of tap water (EPA, 1991a) and that the young child drinks 1 L/day (ORNL-EPA, 2009b). 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). Inhalation rates of 0.833 m^3/hr for the adult (EPA, 1991a) and 0.416 m^3/hr for the child (EPA, 2004d) are used. 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 Hunter

This scenario is created to evaluate the potential for contaminants in soil to affect food chain pathways. AP2 provides habitat for deer and other wildlife. Deer hunting is permitted on portions of the PBOW facility, including AP2. Therefore, a hunter who consumes his game is evaluated in the AP2 BHHRA. Hunting is also a potential land use into the future if general land use does not change at AP2.

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.

Inhalation exposure to airborne VOCs from subsurface soil and surface water is not evaluated for the reasons previously explained for other receptors. Also, 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, 1991a). 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, 2000) and subsequently applied to TNTA and TNTC (IT, 2001a). A highly conservative but plausible scenario consists of a hunter who kills one deer from AP2 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 kilograms per day (kg/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, 1991a) that the hunter spends at his residence.

3.1.3.7 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 <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, 1991a; 2002), the child's venison ingestion rate may be expressed as 0.005 kg/day.

3.1.3.8 Other Receptors Not Considered

Another plausible receptor group is delivery personnel. These receptors, however, would be less intensively exposed to soil than the groundskeeper; therefore, their exposures are not evaluated. AP2 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 above. Because they would likely not represent an upper bound for nonresidential exposure, these receptors are not evaluated. Pipe Creek is too small to support game fish. Therefore, fish ingestion as an indirect pathway for exposure to surface water and sediment is not evaluated. Also, 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.

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, groundwater, surface water, and sediment are derived based on measured analytical data. Note that the EPC for dermal exposure to VOCs in groundwater is based on one-half the EPC concentration derived from the measured concentrations in groundwater (Sections 3.2.1 and 3.2.2.3). This value is used because it is assumed that 50 percent of the groundwater VOC concentration is volatilized during normal household use (Section 3.2.2.2). 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 approaches used to derive EPCs for direct exposure to soil, groundwater, surface water, and sediment based on analytical measurements from samples of these media. Models to derive EPCs for the air are described in Sections 3.2.2.1 and 3.2.2.2, and the model used to derive venison EPCs is described in Section 3.2.2.4.

3.2.1 Soil, Groundwater, Surface Water, and Sediment Concentrations

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 (2009a,b,c) ProUCL (Version 4.00.04) software was used to estimate UCLs for the data sets of all environmental media 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 (see Section 2.5). One-half the reporting 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 nondetected 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 latest version of ProUCL (EPA, 2009a) includes mathematical manipulations that are more robust than previous 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. The re-evaluation of elevated nondetects was not performed in the AP2 BHHRA.

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 discernable) that provides the best fit, number of nondetects, size of the data set, and skewness. In general, the UCL recommended by ProUCL is selected as the EPC. 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; 1991a).

The UCL generated by ProUCL or the MDC, whichever is smaller, is selected as the EPC and is understood to represent a conservative estimate of average for use in the risk assessment or in various transport models used to estimate EPCs. 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. As mentioned, its output includes one or more recommendations. 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 number 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 use 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 models shown in the following subsections for estimating COPC concentrations in air include only those relevant and used specifically for AP2 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):

Eq. 3.1

$$C_a = (D)(C_s)(CF_1)$$

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)
C_s	=	contaminant concentration in soil (mg/kg)
CF_1	=	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.

Airborne concentrations of VOCs estimated by the dust loading model are assumed to sufficiently estimate levels of VOCs that may arise from volatilization, because the dust loading model treats the VOCs as if they were located at the ground surface.

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:

Eq. 3.2

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

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 [see Section 3.1.1])
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:

Eq. 3.3

$$C_a = \frac{C_s}{PEF}$$

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).

Airborne concentrations of VOCs estimated by the wind erosion model are assumed to sufficiently estimate levels of VOCs that may arise from volatilization, because the wind erosion model treats the VOCs as if they were located at the ground surface.

3.2.2.2 Concentrations in Household Air from Groundwater Use

The inhalation of VOCs released from groundwater, which is assumed to be used as tap water, is evaluated for the on-site residential scenario. Chemicals that have a Henry's Law value exceeding 1E-5 atmospheres/m^3-mole and a molecular weight less than 200 g/mole are considered to be VOCs and are subject to evaluation via this pathway; Henry's Law values and molecular weights are presented in Table 3-3. Other groundwater contaminants are considered on a case-by-case basis for their potential contribution to risk via the inhalation pathway based on the degree of departure from the Henry's Law and molecular weight criteria, groundwater concentration, and toxicity.

The simple whole-house tap water-to-air model described in Part B of the Human Health Evaluation Manual (HHEM) (EPA, 1991b) was used to evaluate the tap water-to-air pathway. This model was selected based on correspondence between OEPA (2004) and USACE. Part B of the HHEM recommends a volatilization constant of 0.0005 for the total concentrations of all VOCs detected in groundwater; the conversion is characterized by the following equation:

Eq. 3.4

$$C_a = C_{gw} \times K_{wa} \times 1{,}000 \, L/m^3$$

where:

C_a = modeled concentration in air (mg/m^3)
C_{gw} = groundwater EPC (mg/L)
K_{wa} = tap water-to-air volatilization constant (0.0005 [unitless]: [EPA, 1991b])

Implicit in the HHEM Part B application of this model are the following assumptions: 1) A family of four uses the groundwater as the sole source of household tap water, 2) the volume of the house is 150 m^3, 3) the daily groundwater use is 720 L/day, 4) 50 percent of VOCs in tap water volatilize to household air, and 5) the air exchange rate of the house is 0.25 volumes per hour (EPA, 1991b).

3.2.2.3 Concentrations of VOCs in Groundwater: Resident Dermal Uptake

Volatilization of VOCs from household water reduces the remaining concentration available for dermal contact. As mentioned in Section 3.2.2.2, the HHEM Part B whole-house tap water-to-air model assumes that 50 percent of the VOC concentrations are released to household air. Thus, the concentrations of VOCs remaining in the water after volatilization occurs are calculated by difference as follows:

Eq. 3.5

$$C_d = C_{gw} \times (1 - F_v)$$

where:

C_d = concentration of VOC in household water available for dermal exposure (mg/L, calculated)
C_{gw} = concentration of VOC in groundwater (mg/L)
F_v = fraction of VOCs volatilized to air, (0.5 unitless).

Only the concentration remaining in tap water after volatilization (C_d), as applicable, is assumed to be available for contact with the skin during bathing/showering.

3.2.2.4 Exposure-Point 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 AP2; therefore, the fraction of total browse consumed from AP2 is expected to be relatively small.

- Indirect food chain pathways may be significant for some metals and for those semivolatile organic compounds 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:

Eq. 3.6

$$B_v = 0.20(B_b)(FI_r)$$

where:

B_v	=	biotransfer factor for venison (unitless, 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 (0.03, unitless, see below)
B_b	=	biotransfer factor for beef.

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

The AP2 area is relatively small in comparison to the home range of a white-tailed deer. The total acreage of the AP2 study area is approximately 5 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 AP2 is approximately 3 percent of this land area. Therefore, an FI_r value of 0.03 is used in the BHHRA.

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):

Eq. 3.7

$$C_p = (CF)(C_s)(B_p)$$

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]):

Eq. 3.8

$$C_v = (Q_p)(C_p)(B_v)$$

where:

C_v	=	contaminant concentration in venison (mg/kg, 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).

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 above. Models were taken or modified from EPA (1989a) unless otherwise indicated.

3.3.1 Inhalation of COPCs in Air

The inhaled dose of a COPC in air (for the groundskeeper, construction worker, on-site resident: inhalation of dust and VOCs in ambient air from surface or total soil; for the construction worker: inhalation of VOCs in ambient air from subsurface soil; for the indoor worker and on-site resident: inhalation of VOCs in indoor air from subsurface soil) is estimated as follows:

Eq. 3.9

$$I_a = \frac{(C_a)(FI_a)(IR_a)(EF)(ED)}{(BW)(AT)}$$

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 or Sediment

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

Eq. 3.10

$$I = \frac{(C)(FI)(IR)(EF)(ED)(CF)}{(BW)(AT)}$$

where:

I	=	I_s for soil, I_{sd} for sediment, = ingested dose of COPC (mg/kg-day, calculated)
C	=	C_s for soil; C_{sd} for sediment; = concentration of COPC (mg/kg)
FI	=	FI_s for soil; FI_{sd} for sediment; = fraction of exposure attributed to site medium (unitless)
IR	=	IR_s for soil; IR_{sd} for sediment; = 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, resident) is estimated from the following equation:

$$I_w = \frac{(C_w)(IR_w)(FI_w)(EF_w)(ED_w)}{(BW)(AT)} \qquad \text{Eq. 3.11}$$

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, Sediment, 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):

Eq. 3.12

$$DAD = \frac{(DA)(SA)(EF)(ED)}{(BW)(AT)}$$

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 = SA_s for soil, SA_{sd} for sediment, S_{gw} for groundwater, SA_{sw} for surface water, = 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/sediment and from water. Dermal uptake of constituents from soil (groundskeeper, construction worker, on-site resident, hunter) or sediment (construction worker, on-site resident) 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):

Eq. 3.13

$$DA = (C_s)(FI_s)(CF)(AF)(ABS)$$

where:

DA = dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C = C_s for soil, C_{sd} for sediment, = concentration of COPC in medium (mg/kg)
FI = FI_s for soil, FI_{sd} for sediment, = fraction of exposure attributed to site medium (unitless)
CF = conversion factor (1E-6 kg/mg)
AF = AF_s for soil, AF_{sd} for sediment, = soil- or sediment-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, resident) or surface water (construction 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 the same as the equation for dermal uptake of chemicals from soil (Eq. 3.12). DA is calculated differently for inorganic and organic chemicals in water. For inorganic chemicals, DA is calculated from the following equation:

Eq. 3.14

$$DA = (C_w)(FI)(K_p)(ET_w)(CF)$$

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)
K_p	=	permeability coefficient (cm/hour)
ET_w	=	time of exposure (hours/day)
CF	=	conversion factor (1E-3 liters per cubic centimeter [L/cm^3]).

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. Therefore, different equations are used to estimate DA, depending on whether the exposure time is less than or greater than the estimated time to reach steady state. Non-steady-state exposures occur when either the exposure time is relatively brief (e.g., showering, for most chemicals) or when intermittent exposure occurs throughout the day (e.g., wading exposure to surface water or washing of hands). For exposure scenarios under which steady state is not reached for a given organic chemical (τ>exposure time [ET], see below), the following equation is used to calculate DA (EPA, 2004a):

Eq. 3.15

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

where:

DA	=	dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C_w	=	C_{sw} for surface water, 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	=	time for concentration of contaminant in stratum corneum to reach steady state per event (hours)
ET_w	=	time of contact (hour(s)/day).

In cases where steady state is reached (τ<ET), 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):

Eq. 3.16

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

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	=	time for concentration of contaminant in stratum corneum to reach steady state per event (hours)
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 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):

Eq. 3.17

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

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).

Eq. 3.18

$$\tau = 0.105 \times 10^{(0.0056 \times MW)}$$

where:

τ = time for concentration of contaminant in stratum corneum to reach steady state (hours, calculated)
MW = molecular weight.

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

3.3.5 Consumption of Venison

Consumption of venison by the hunter or the hunter's child is evaluated by the following equation:

Eq. 3.19

$$I_v = \frac{(C_v)(IR_v)(EF)(ED)}{(BW)(AT)}$$

where:

I_v = ingested dose of COPC in venison (mg/kg-day, calculated)
Cv = concentration of COPC in venison (mg/kg)
IRv = venison ingestion rate (kg/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days).

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, 2010). 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, 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, 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 background in a population corrected for background incidence. It is calculated using the following equation:

Eq. 4.1

$$SF = (p_{(d)} - p_{(0)})/(1 - p_{(0)})$$

where:

SF	=	chemical-specific slope factor per unit dose $(mg/kg\text{-}day)^{-1}$
$p_{(d)}$	=	the probability of developing cancer at a dose of 1 mg/kg-day of the chemical of interest
$p_{(0)}$	=	the background probability of developing cancer at a dose of 0 mg/kg-day of the chemical of interest.

The SF 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.

IRIS (EPA, 2010) 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 µg/mg, and dividing the result by 20 m^3 per 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.

IRIS (EPA, 2010) expresses the inhalation noncancer reference value as a reference concentration (RfC) in units of mg/m^3. Because noncancer hazard 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.

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, 2010) 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 the EPA's Health Effects Assessment Summary Tables (EPA, 1997b) and

the California Environmental Protection Agency (2005) Office of Environmental Health Hazard Assessment Toxicity Criteria Database.

The Environmental Council of 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:

- Oral absorption efficiency data compiled by the National Center for Environmental Assessment for the Superfund Health Risk Technical Support Center of EPA
- 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. 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 toxicity profiles 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, target organs, and sources, 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):

Eq. 5.1

$$ILCR = (CDI)(SF)$$

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 3.9 through 3.12 and 3.19 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):

Eq. 5.2

$$ILCR = 1 - e^{[-(CDI)(SF)]}$$

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.

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):

Eq. 5.3

$$ILCR_p = ILCR_{(chem\,1)} + ILCR_{(chem\,2)} + \cdots ILCR_{(chem\,i)}$$

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 equation below:

Eq. 5.4

$$Total\ ILCR = ILCR_{(p\,1)} + ILCR_{(p\,2)} + \cdots ILCR_{(p\,i)}$$

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 criterion 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 criterion 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):

Eq. 5.5

$$HQ = I \ / \ RfD$$

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 5.4 is equivalent to the "I" or "DAD" terms (intake or dose) in Equations 3.9 through 3.12 and 3.19 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:

Eq. 5.6

$$HI = HQ_1 + HQ_2 + ... HQ_i$$

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 (please see 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:

Eq. 5.7

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

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. The following subsections describe the risk characterization results for each receptor. Risk summary tables are shown for each receptor as referenced. The detailed quantitative evaluation tables that include the exposure equations presented in Chapter 3.0 and the risk characterization equations presented in Chapter 5.0 are provided in Appendix D.

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 2E-6. This is within the 1E-6 to 1E-4 NCP risk management range and is less than the PBOW cancer risk criterion of 1E-5.

The total HI for the current groundskeeper (Table 5-1) is 0.09. This is far less than the target HI value of 1, indicating that noncancer health effects are unlikely to occur.

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 total soil rather than surface soil, and the future groundkeeper is also assumed to be exposed to groundwater via direct contact (ingestion and dermal exposure). However, as described in Section 2.5, the surface soil data set for AP2 is also conservatively used as the total soil data set. Therefore, the only difference between the AP2 future groundkeeper and the AP2 current groundskeeper is groundwater exposure assumed for the former. The risk characterization was run separately for bedrock groundwater exposure and overburden (well) groundwater exposure.

Bedrock Groundwater Use. The total ILCR for the future groundskeeper, assuming bedrock groundwater exposure, is 7E-5 (Table 5-1). This value is within the NCP risk management range but exceeds the PBOW target cancer risk criterion of 1E-5. Over 99 percent of this ILCR is associated with benzene in groundwater. Benzene is a petroleum constituent that is known to be naturally occurring in the limestone groundwater at PBOW (Shaw, 2006), and petroleum was reported seeping at depth (47 feet and 69.5 feet) in AP2 bedrock well AP2-BEDGW-003 (Shaw, 2010b).

If the contribution of benzene in groundwater were excluded, the ILCR associated with the remaining COPCs in all media would be 2E-6 (Table 5-2).

The total HI for the future groundskeeper (Table 5-1) is 1. This equals and, thus, meets the target HI value of 1, indicating that noncancer health effects are unlikely to occur. Note that more than 80 percent of this HI value is associated with benzene in groundwater. As stated above, this benzene is not associated with former PBOW operations but is associated with naturally occurring conditions. The HI for this receptor without the contributions from benzene would be 0.2.

Overburden Groundwater Use. No carcinogenic COPCs were identified for overburden groundwater. Therefore, the only cancer risks to the future groundskeeper are those associated with surface soil. The ILCR for the future groundskeeper is thus the same as for the current groundskeeper, 2E-6 (Table 5-1). This value is within the NCP cancer risk management range and meets the 1E-5 PBOW cancer risk criterion.

The total HI for the future groundskeeper is 0.1 (Table 5-1). This is less than the target HI criterion of 1, indicating that noncancer health effects are unlikely to occur.

5.3.3 Indoor Worker

The exposure assumptions for the future indoor worker include direct contact with surface soil, inhalation of volatiles from subsurface soil, and direct exposure with groundwater via direct contact (ingestion and dermal exposure). The risk characterization was run separately for bedrock groundwater exposure and overburden (well) groundwater exposure.

Bedrock Groundwater Use. The total ILCR for the future indoor worker, assuming bedrock groundwater exposure, is 7E-5 (Table 5-1). This value is within the NCP risk management range but exceeds the PBOW target cancer risk criterion of 1E-5. Over 99 percent of this ILCR is associated with benzene in groundwater. As described in Section 5.3.2, benzene is a petroleum constituent that is known to be naturally occurring in the limestone groundwater at PBOW (Shaw, 2006), and petroleum was reported seeping at depth (47 feet and 69.5 feet) in AP2 bedrock well AP2-BEDGW-003 (Shaw, 2010b) (Table 5-2).

If the contributions from benzene in groundwater were excluded, the ILCR associated with the remaining COPCs in all media would be 8E-7 (Table 5-2).

The total HI for the indoor worker (Table 5-1) is 1. This equals the target HI value of 1, indicating that noncancer health effects are unlikely to occur. Note that nearly 90 percent of this HI value is associated with benzene in groundwater. As stated in Section 5.3.2, this benzene is not associated with former PBOW operations but is associated with naturally occurring conditions. The HI for this receptor without the contributions from benzene would be 0.1.

Overburden Groundwater Use. The ILCR for the future indoor worker is 2E-7 (Table 5-1). This value is less than the NCP cancer risk management range and meets the 1E-5 PBOW cancer risk criterion.

The total HI for the indoor worker is 0.06 (Table 5-1). This is far less than the target HI criterion of 1, indicating that noncancer health effects are unlikely to occur.

5.3.4 Construction Worker

The ILCR for the construction worker (Table 5-1) exposed to total soil both through direct contact and via inhalation of suspended particulates is estimated as 4E-7. This is less than the 1E-6 to 1E-4 NCP risk management range and the PBOW cancer risk criterion of 1E-5.
The total HI for the construction worker (Table 5-1) is 0.4. This is less than the target HI value of 1, indicating that noncancer health effects are unlikely to occur.

5.3.5 Resident

The exposure assumptions for the resident include direct contact with total soil, inhalation of particulates from total soil, inhalation of volatiles from subsurface soil, direct exposure to sediment and surface water (ingestion and dermal exposure), and direct exposure with groundwater via direct contact (ingestion and dermal exposure). The risk characterization was run separately for bedrock groundwater exposure and overburden (well) groundwater exposure. The ILCR 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 (refer to Section 3.1.3.5). The results of each are described below.

Bedrock Groundwater Use. The total ILCR for the resident, assuming bedrock groundwater exposure, is 3E-4 (Table 5-1). This value exceeds both the NCP risk management range and the PBOW target cancer risk criterion. Approximately 97 percent of this ILCR is associated with benzene in groundwater. As described in Section 5.3.2, benzene is a petroleum constituent that is known to be naturally occurring in the limestone groundwater at PBOW (Shaw, 2006), and during well installation, petroleum was observed seeping at depth from bedrock well AP2-BEGW-002 (Shaw, 2010b). If this naturally occurring benzene were not present, the resulting ILCR of 1E-5 would meet the PBOW cancer risk criterion (Table 5-2).

The total HI for the child resident, assuming bedrock groundwater exposure, is 7 (Table 5-1). This exceeds the target HI value of 1, indicating that noncancer health effects cannot be regarded as unlikely to occur. Note that 86 percent of this HI value is associated with benzene (82 percent) and xylenes (4 percent) in groundwater. These two chemicals are related to naturally occurring petroleum, which has been encountered throughout PBOW, including AP2 (Section 5.3.2). Note that if the contributions of benzene are excluded, the resulting HI is 1, which equals and thus meets the noncancer target HI criteria (Table 5-2).

The total HI for the adult resident assuming bedrock groundwater exposure is 3 (Table 5-1). This exceeds the target HI value of 1, indicating that noncancer health effects cannot be regarded as unlikely to occur. Note that 92 percent of this HI value is associated with benzene (88 percent) and xylenes (4 percent) in groundwater. These two chemicals are related to naturally occurring petroleum, which has been encountered throughout PBOW, including AP2 (Section 5.3.2). Note that if the contributions of benzene are excluded, the resulting HI is 0.3, which meets the noncancer target HI criteria.

Overburden Groundwater Use. The total ILCR for the future resident, assuming overburden groundwater exposure, is 5E-6 (Table 5-1). This value is within the NCP risk management range and meets the PBOW target cancer risk criterion.

The total HI for the child resident, assuming overburden groundwater exposure, is 0.9 (Table 5-1). This meets the target HI value of 1, indicating that noncancer health effects are regarded as unlikely to occur.

The total HI for the adult resident, assuming overburden groundwater exposure, is 0.2 (Table 5-1). This meets the target HI value of 1, indicating that noncancer health effects are regarded as unlikely to occur.

5.3.6 Adult Hunter

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

The total HI for the adult hunter is (Table 5-1) is 0.003. This is far less than the target HI value of 1, indicating that noncancer health effects are unlikely to occur.

5.3.7 Hunter's Child

The ILCR for the current hunter's child (Table 5-1) exposed to surface soil via the ingestion of venison from deer which grazed on site is estimated as 4E-13. This is less than the 1E-6 to 1E-4 NCP risk management range and is less than the PBOW cancer risk criterion of 1E-5.

The total HI for the current hunter's child is (Table 5-1) is 3E-6. This is far less than the target HI value of 1, indicating that noncancer health effects are unlikely to occur.

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 OEPA risk criterion) and that of scenario "B" may be 5E-5 (exceeds the OEPA risk criterion). 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 set of uncertainties that is peculiar to AP2.

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 typically 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 the 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 subsections 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 within the former AP2 area where ash waste was deposited. The well locations were selected from within and adjacent to AP2, including downgradient areas. Surface water and sediment samples were collected along areas of Pipe Creek that had potentially been impacted by AP2 materials. The sample locations appear to be representative of the site, and no information suggests that they have introduced an identifiable bias.

6.2.2 Laboratory Analysis

State-of-the-practice laboratory methods were used for analysis of the RI samples (Shaw, 2010b). Site investigation samples, also used in this AP2 BHHRA, were collected in 1996 (IT, 1997a). The ICP method used for certain metals in the 1996 data resulted in relatively high reporting limits and tended to result in false positives when compared with the ICP/MS method used in the 2009 RI samples. Among these metals is thallium, which was a COPC in AP2 soil. The RBSC for thallium in soil is 0.51 mg/kg and the BSC is 1.3 mg/kg. The MDC among the 2009 soil samples is only 0.939 mg/kg, which is less than the BSC. This means that based on the 2009 data, thallium would not be identified as a COPC. The seven reported detections of thallium among the 1996 surface soil samples ranged from 1.9 to 8.5 mg/kg. Therefore, use of the 1996 analytical data appears to have introduced a high bias to the resulting risk calculations.

6.2.3 Exposure-Point Concentration Estimates

Uncertainty is introduced in the statistical approach used to calculate the EPCs. As stated in the *Human Health Evaluation Manual (Part A)* (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 4.0 software (EPA, 2009a) 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 as to 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.

Both overburden groundwater and bedrock groundwater data sets have fewer than five samples. Thus, the MDC was used as the EPC for these data sets. Use of the MDC likely introduces as high bias to the risk values.

As discussed in Section 2.5, the surface soil data set was used to represent total soil. Thallium was the only COPC identified for subsurface soil, and it was reported at a higher concentration in surface soil than in subsurface soil (note: also see Section 6.2.2 with respect to false positives in thallium). Because the subsurface soil appears to be virtually unimpacted from site activities with respect to risk, a conservative determination was made to use the surface soil data set to represent total soil. This assumption introduces a high bias to the resulting risk values of affected receptors.

6.2.4 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 at AP2, the use of this receptor likely overestimates risks and hazards to a current site worker. The use of the hunter and the hunter's child are reasonable, as this area may be legally hunted by permit under current land use.

Unrestricted land use, including residential use, is a reasonable assumption for the future, given the rural residential use of property adjacent to the PBOW facility. However, the assumption that either the overburden or bedrock groundwater will be used as a potable water source in the future is unlikely for reasons described in the following paragraphs.

The use of bedrock groundwater is regarded as unlikely because it contains natural petroleum and hydrogen sulfide, which can be commonly observed in area quarries (Shaw, 2005). A strong hydrogen odor was observed in the boreholes of each of the three AP2 bedrock monitoring wells during well installation. Petroleum hydrocarbon seepage was noted on the rock cores at depth in the boring log of bedrock well AP2-BEDGW-003. The presence of the petroleum hydrocarbon at depth, but not at shallower intervals or in overburden groundwater, provides evidence that this seepage is resultant from naturally occurring petroleum that is observed elsewhere in the bedrock regionally. Additionally, bedrock well AP2-BEDGW-001 was dry during both sampling events and could not be sampled. Although the remaining two bedrock wells, AP2-BEDGW-002 and AP2-BEDGW-003, could be sampled in May 2009 using low-flow technique, samples from

these two wells had to be collected via bailer in November 2009 because of inadequate water yield for low-flow sampling.

The overburden groundwater has been found to be of low yield, as well as regionally and seasonally discontinuous throughout much of PBOW (Shaw, 2006). This also appears to be true of the AP2. Although all three of the overburden wells could be sampled using low-flow technique in May 2009, no water for sampling could be collected from two of the three wells, and the third overburden well, AP2-MW01, produced enough volume only for collection of nitroaromatics analysis, which had to be collected via bailer.

In summary, use of either the bedrock groundwater or overburden groundwater as a potable source at AP2 is regarded as implausible for the following reasons: 1) Both bedrock and overburden groundwater yield water volumes appear to be inadequate, 2) bedrock groundwater has naturally occurring petroleum and hydrodgen sulfide constituents that make the water unsuitable regardless of yield, 3) none of the private wells in the region of PBOW are used as a potable source, and 4) municipal water is available in the area.

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). However, this conservativeness is consistent 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 is not resultant from assumptions made specifically for AP2.

6.2.6 Groundwater-to-Air Household Model

The groundwater-to-air household model (EPA, 1991b) has considerable uncertainties. Some parameters that can change the model include the air exchange rate of the house which can vary with the season, level of groundwater usage, and size of the house. EPA (1991b) states that the model assumes a four-member household that uses 720 liters of water per day, a home with a volume of 150 m^3, and 0.25 household air exchanges per hour. The *Exposure Factors Handbook* (EPA, 1997a) lists the following information for the average four-person home: household use of 892 L/day (4 × 223 L/day), volume of 431 m^3, and an air exchange rate of 0.63 volumes per hour. If the values from the *Exposure Factors Handbook* were used instead of the default values from EPA (1991b), the resultant estimated household air concentrations would be less than those estimated in the BHHRA by a factor of nearly 5. Therefore, the selection of the groundwater-to-

air parameter values used by EPA (1991b) may contribute a conservative bias to the resultant risk estimates.

6.2.7 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. A general summary of these uncertainties is provided in the following paragraphs.

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 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., Group B2; refer to Section 4.1). Also, the linearized multistage (LMS) 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. This application of the LMS model is the subject of much controversy. Thus, the LMS approach used to develop SFs, combined with other assumptions, tends to overestimate potential risks.

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.

6.2.8 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 dictate 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.

7.0 Summary and Conclusions

7.1 Summary

Cancer risks and noncancer hazards were evaluated for soil, sediment, surface water, overburden groundwater, and bedrock groundwater at AP2. A risk-based screening approach was used to identify COPCs and focus the risk assessment on those chemicals detected at AP2.

The BHHRA was conducted to evaluate cancer risk and noncancer hazards associated with AP2 surface soil, subsurface soil, groundwater, surface water, and sediment. These 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, groundwater)
- Indoor worker (surface soil, subsurface soil [air pathway only], groundwater)
- Construction worker (total soil, sediment)
- Resident (total soil, groundwater, surface water, sediment)
- Adult hunter (surface soil, venison)
- Hunter's child (venison).

Each receptor scenario that includes groundwater was run separately for overburden groundwater and bedrock groundwater. 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 in the following bullets; exceedances of the PBOW cancer risk criteria (ILCR>1E-5) are shown as bold and exceedances of the noncancer hazard criterion (HI>1) or the NCP risk management range (1E-6 to 1E-4) are shown as bold italics:

- Current groundskeeper: ILCR = 2E-6; HI = 0.09
- Future groundskeeper – overburden groundwater use: ILCR = 2E-6; HI = 0.1
- Future groundskeeper – bedrock groundwater use: **ILCR = 7E-5**; HI = 1

- Future indoor worker – overburden groundwater use: ILCR = 2E-7; HI = 0.06
- Future indoor worker – bedrock groundwater use: **ILCR = 7E-5**; HI = 1
- Current/future construction worker: ILCR = 4E-7; HI = 0.4
- Future resident – overburden groundwater use: ILCR = 5E-6; adult HI = 0.2; child HI = 0.9
- Future resident – bedrock groundwater use: ***ILCR = 3E-4; adult HI = 3; child HI = 7***
- Current/future hunter: ILCR = 6E-8; HI = 0.003.
- Current/future hunter's child: ILCR = 4E-13; HI = 0.000003.

7.2 Conclusions

The ILCR of the future resident that is hypothetically assumed to use bedrock groundwater as household tap water exceeds the NCP risk management range as well as the PBOW target cancer risk criterion. The HI values of the child and adult resident also exceed the target criterion of 1, indicating that adverse human health risks under this scenario cannot be regarded as unlikely. The ILCR for each of the other future scenarios assumed to use bedrock groundwater as a potable source had an ILCR that exceeded the PBOW target cancer risk criterion, but were within the NCP risk management range.

Cancer risks and noncancer hazards to all potential receptors evaluated under current land use (i.e., current groundskeeper, construction worker, hunter, and hunter's child) are within or less than the NCP risk management range, are less than the target HI criterion, and are less than the PBOW cancer risk criterion, indicating that cancer risks are at acceptable levels and adverse noncancer effects are unlikely to occur under potential current scenarios. Similarly, all future scenarios which do not assume bedrock groundwater use meet the NCP risk management range, target HI criterion, and the PBOW risk criterion.

Risks associated with the use of bedrock groundwater as tap water easily account for the majority of the ILCR and HI for the future groundskeeper, indoor worker, and future resident. Specifically, benzene in bedrock groundwater is by far responsible for the largest portion of cancer risk and noncancer hazards for these receptors. It is responsible for 97 to 99 percent of the total ILCR and 82 to 89 percent of the total HI for these three receptors. Benzene was identified as the only contaminant with an HI exceeding a value of 1 and an ILCR exceeding a value of 1E-5 for any receptor. Benzene is a petroleum constituent that is known to be naturally occurring in the limestone groundwater at PBOW, and petroleum was reported seeping at depth (47 feet and 69.5 feet) in AP2 bedrock well AP2-BEDGW-003. Without the contribution of benzene, the residual noncancer HI value for each receptor does not exceed a value of 1 and the ILCR does not exceed a value of 1E-5.

It is highly doubtful that bedrock groundwater would ever be used as potable tap water because of naturally poor water quality in the area and low, undependable groundwater yield. This poor quality is associated with the presence of hydrogen sulfide off-gassing in the area and the associated health and aesthetic issues with high-sulfate water, and the presence of petroleum product as encountered in AP2 well AP2-BEDGW-003. Thus, if a more likely and serviceable source of tap water were to be used by a future groundskeeper or residential receptor (e.g., municipal water or perhaps even overburden groundwater), then the ILCR and HI values would meet the NCP risk management range (1E-6 to 1E-4), PBOW cancer risk criterion of 1E-5, and the target HI criterion of 1.

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TABLES

Table 2-1

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
Powerhouse 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
Surface Soil					
ASH PIT 2-SB01	AP0100	REG	15-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0103	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB03	AP0108	REG	18-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB04	AP0111	REG	18-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB05	AP0114	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB06	AP0117	REG	15-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0120	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0121	FD	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB08	AP0125	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
PH2SO01	4010	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO02	4030	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO03	4050	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4070	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO05	4090	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO06	4110	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO07	4130	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4150	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO09	4170	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO10	4190	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO11	4210	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO12	4230	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
Subsurface Soil					
ASH PIT 2-SB01	AP0101	REG	15-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB01	AP0102	REG	15-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB02	AP0104	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0105	FD	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0107	REG	16-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB03	AP0109	REG	18-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB03	AP0110	REG	18-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB04	AP0112	REG	18-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB04	AP0113	REG	19-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB05	AP0115	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB05	AP0116	REG	16-Jan-09	8 - 10	Exp, Metals, SVOC

Table 2-1

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
Powerhouse 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
ASH PIT 2-SB06	AP0118	REG	15-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB06	AP0119	REG	15-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB07	AP0123	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0124	REG	16-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB08	AP0126	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB08	AP0127	REG	16-Jan-09	8 - 10	Exp, Metals, SVOC
ASH PIT 2-SB08	AP0128	FD	16-Jan-09	8 - 10	Exp, Metals, SVOC
PH2SO01	4020	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO02	4040	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO03	4060	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4080	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4081	FD	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO05	4100	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO06	4120	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO07	4140	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4160	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4161	FD	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO09	4180	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO10	4200	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO11	4220	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO12	4240	REG	29-Sep-96	3 - 4	Cyanide, Metals, Pest, PCB, SVOC, VOC
Groundwater Samples					
Overburden Well Samples					
AP2-MW01	AP3057	REG	23-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f& uf), PCB, SVOC, VOC
AP2-MW01	AP3075	REG	13-Nov-09	NA	Exp, Field Tests
AP2-MW02	AP3058	REG	25-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f& uf), PCB, SVOC, VOC
AP2-MW02	AP3059	FD	25-May-09	NA	Exp, Gen Chem, Metals (f & uf), PCB, SVOC, VOC
AP2-MW02	AP3076	REG	13-Nov-09	NA	Exp
AP2-MW03	AP3061	REG	24-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f& uf), PCB, SVOC, VOC

Table 2-1

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
Powerhouse 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
Bedrock Well Samples					
AP2-BEDGW-002	AP3063	REG	24-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), PCB, SVOC, VOC
AP2-BEDGW-002	AP3079	REG	17-Nov-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
AP2-BEDGW-002	AP3081	FD	17-Nov-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
AP2-BEDGW-003	AP3064	REG	23-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), PCB, SVOC, VOC
AP2-BEDGW-003	AP3065	FD	23-May-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), PCB, SVOC, VOC
AP2-BEDGW-003	AP3080	REG	16-Nov-09	NA	Exp, Field Tests, Gen Chem, Metals (f & uf), SVOC, VOC
Sediment Samples					
ASH PIT 2-SD01	AP1000	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD02	AP1001	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD03	AP1002	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD04	AP1003	REG	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD04	AP1004	FD	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD05	AP1006	REG	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
Surface Water Samples					
AP2-SW01	AP2000	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW02	AP2001	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW03	AP2002	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW03	AP2003	FD	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW04	AP2005	REG	25-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW05	AP2006	REG	25-May-09	NA	Exp, Metals, PCB, SVOC

FD - Field duplicate.
Exp - Explosives.
Pest - Organochlorine pesticides.
PCB - Polychlorinated biphenyls.
SVOC - Semivolatile organic compounds.
VOC - Volatile organic compounds.

Table 2-2

Background Screening Concentrations of Inorganics in Soil
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UTL [a]	Background Screening Criterion [b]
Aluminum	12 / 12	3520 - 15500	NA	L	8.43E+03	2.69E+04	15500
Antimony	9 / 25	5.9 - 9.3	5.4 - 74	NP	4.68E+00	NA	9.30
Arsenic	23 / 26	2.1 - 36.5	1.2 - 3.7	L	1.08E+01	7.10E+01	36.5
Barium	9 / 12	35.6 - 826	23.2 - 24.7	L	1.16E+02	1.30E+03	826
Beryllium	6 / 25	0.57 - 1	0.57 - 1.2	L	5.65E-01	1.17E+00	1.00
Cadmium	0 / 25	NA	0.57 1.2	L	4.49E-01	NA	NA
Calcium	12 / 12	735 - 52300	NA	L	1.13E+04	2.18E+05	52300
Chromium	25 / 26	4.4 - 29	12.3 - 12.3	NP	1.34E+01	NA	29.0
Cobalt	9 / 12	9.6 - 116	5.8 - 6.2	L	2.26E+01	2.48E+02	116
Copper	23 / 26	2.3 - 56.2	2.2 - 2.9	L	1.70E+01	1.47E+02	56.2
Iron	12 / 12	5880 - 234000	NA	L	4.01E+04	3.58E+05	234000
Lead	26 / 26	1.9 - 48.6	NA	L	1.28E+01	5.13E+01	48.6
Magnesium	12 / 12	629 - 10400	NA	L	3.26E+03	3.08E+04	10400
Manganese	26 / 26	21 - 13300	NA	L	7.29E+02	3.51E+03	3506
Mercury	2 / 26	0.085 - 0.085	0.037 - 0.3	L	9.06E-02	5.60E-01	0.085
Nickel	26 / 26	5.4 - 55.1	NA	L	2.28E+01	7.79E+01	55.1
Potassium	11 / 12	579 - 3390	617 - 617	L	1.24E+03	6.08E+03	3390
Selenium	5 / 25	0.61 - 2	0.57 - 4.9	NP	1.55E+00	NA	2.00
Silver	2 / 26	1.1 - 11.1	1.1 - 1.3	NP	1.00E+00	NA	11.1
Sodium	0 / 12	NA	566 - 663	L	3.03E+02	NA	NA
Thallium	2 / 25	1.2 - 1.3	1.1 - 6.1	NP	1.91E+00	NA	1.30
Vanadium	11 / 12	9 - 40.9	61.7 - 61.7	L	2.48E+01	8.31E+01	40.9
Zinc	26 / 26	6.6 - 655	NA	L	7.30E+01	3.22E+02	322

mg/kg - Milligrams per kilogram.
NA - Not applicable; not available.

[a] 95% UTL - 95% upper tolerance limit calculated as described in Shaw (2005).

[b] The maximum detected concentration is used as the background screening criterion for nonparametric data sets; for normal or lognormal data sets, the 95% UTL or the maximum detected concentration, whichever is less, is used.

Note: Detection limits from sample 6990 were deleted when calculating results for antimony, beryllium, cadmium, selenium, and thallium. The detection limits were elevated by dilution factors which greatly exceed any detected concentration and would bias results unrealistically high.

Source: Shaw Environmental, Inc. (shaw), 2005, 2004 Data Summary and Evaluation Report, Final, Plum Brook Ordnance Works, Sandusky, Ohio, April.

Table 2-3

Background Screening Concentrations for Inorganics and BTEX Compounds in Groundwater Powerhouse 2 Ash Pits Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent hits	Range of Values, µg/L: Detected Concentrations Minimum	Detected Concentrations Maximum	Reporting Limits Minimum	Reporting Limits Maximum	Mean µg/L	Standard Deviation	UTL [a] µg/L	BSC [b] µg/L
Metals - Unfiltered										
Aluminum	11 / 13	85	3.15E+01	3.09E+02	2.00E+02	2.00E+02	1.05E+02	6.98E+01	4.17E+02	309
Arsenic	4 / 26	15	3.30E+00	7.40E+00	1.00E+01	1.00E+01	4.99E+00	6.56E-01	7.92E+00	7.4
Barium	28 / 28	100	2.58E+01	1.18E+04	2.00E+02	2.00E+03	1.73E+03	3.77E+03	1.86E+04	11800
Calcium	28 / 28	100	1.74E+04	3.16E+05	5.00E+03	5.00E+03	1.38E+05	8.31E+04	5.09E+05	316000
Cobalt	6 / 27	22	1.00E+00	1.21E+01	5.00E+01	5.00E+01	2.05E+01	8.75E+00	5.96E+01	12.1
Copper	2 / 28	7	3.30E+00	1.98E+01	2.50E+01	2.50E+01	1.24E+01	2.26E+00	2.25E+01	19.8
Iron	24 / 27	89	3.82E+01	1.55E+03	1.00E+02	1.00E+02	4.15E+02	4.87E+02	2.59E+03	1550
Magnesium	28 / 28	100	7.28E+03	2.17E+05	5.00E+03	5.00E+03	7.17E+04	5.85E+04	3.33E+05	217000
Manganese	28 / 28	100	3.60E+00	6.88E+02	1.50E+01	1.50E+01	8.12E+01	1.24E+02	6.36E+02	636
Nickel	4 / 27	15	4.80E+00	8.60E+00	4.00E+01	4.00E+01	1.81E+01	4.67E+00	3.90E+01	8.6
Potassium	28 / 28	100	2.53E+03	1.16E+05	5.00E+03	5.00E+04	2.70E+04	3.06E+04	1.64E+05	116000
Sodium	28 / 28	100	1.33E+04	1.39E+06	5.00E+03	5.00E+04	3.55E+05	4.36E+05	2.30E+06	1390000
Zinc	14 / 19	74	8.30E-01	5.07E+02	2.00E+01	2.00E+01	5.55E+01	1.23E+02	6.06E+02	507
Voltile Organic Compounds										
Benzene	9 / 28	32	1.45E-01	2.40E+00	1.00E+00	5.00E+00	6.73E-01	5.43E-01	3.10E+00	2.4
Ethybenzene	6 / 28	21	1.30E-01	8.70E-01	1.00E+00	5.00E+00	5.82E-01	4.00E-01	2.37E+00	0.87
Toluene	8 / 28	29	1.20E-01	1.70E+00	1.00E+00	5.00E+00	4.99E-01	2.83E-01	1.76E+00	1.7
Xylenes, total	8 / 28	29	3.60E-01	5.50E+00	1.00E+00	5.00E+00	1.22E+00	1.53E+00	8.07E+00	5.5

[a] The UTL (upper tolerance limit) is calculated as described in Shaw (2005).

[b] The BSC (background screening criterion) is the calculated UTL or the maximum detected concentration, whichever is less.

µg/L - Micrograms per liter.

BTEX - Benzene, toluene, ethylbenzene, and xylenes.

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

Table 2-4

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil
Powerhouse 2 Ash Pits, 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 [i] mg/kg
Inorganics														
Aluminum	20 / 20	100	4.07E+03	J	1.39E+04		1.82E+00	3.57E+01	9.46E+03	1.55E+04	7.70E+03	N (b)		---
Antimony	7 / 20	35	3.14E-01	JJ	9.58E-01		4.54E-01	1.07E+01	3.02E+00	9.30E+00	3.10E+00	N (b)		---
Arsenic	20 / 20	100	6.07E+00		2.68E+01	J	9.08E-01	1.80E+00	1.46E+01	3.65E+01	3.90E-01	N (b)		---
Barium	20 / 20	100	5.06E+01		1.41E+02		1.82E-01	3.57E+01	9.88E+01	8.26E+02	1.50E+03	N (b)		---
Beryllium	20 / 20	100	7.30E-01		1.69E+01	J	1.82E-01	8.90E-01	5.36E+00	1.00E+00	1.60E+01	Y	1.14E+01	1.14E+01
Cadmium	7 / 20	35	3.81E-01	J	1.40E+00		4.54E-01	8.90E-01	4.79E-01		7.00E+00	N (a)		---
Calcium	20 / 20	100	1.65E+03		4.72E+04	J	4.54E+00	8.91E+02	7.86E+03	5.23E+04	Nutrient	N (c)		---
Chromium	20 / 20	100	1.90E+00		1.77E+01		4.54E-01	1.80E+00	1.15E+01	2.90E+01	2.90E-01	N (b)		---
Cobalt	20 / 20	100	3.90E+00	J	1.90E+01		3.63E-01	8.90E+00	1.19E+01	1.16E+02	2.30E+00	N (b)		---
Copper	20 / 20	100	1.68E+01		3.86E+01		4.54E-01	4.50E+00	2.58E+01	5.62E+01	3.10E+02	N (b)		---
Iron	20 / 20	100	1.43E+04	J	1.09E+05		3.67E+00	3.79E+01	4.78E+04	2.34E+05	5.50E+03	N (b)		---
Lead	20 / 20	100	4.64E+00		5.07E+01		3.80E-01	5.99E-01	2.04E+01	4.86E+01	4.00E+02	N (a)		---
Magnesium	20 / 20	100	3.12E+02	J	8.96E+03	J	1.82E+00	8.91E+02	2.07E+03	1.04E+04	Nutrient	N (c)		---
Manganese	20 / 20	100	9.82E+01		1.02E+03		1.82E-01	2.70E+00	3.59E+02	3.51E+03	1.80E+02	N (b)		---
Mercury	17 / 20	85	1.98E-02	JJ	1.40E-01		2.22E-02	5.90E-02	6.51E-02	8.50E-02	2.30E+00	N (a)		---
Nickel	20 / 20	100	1.05E+01		4.19E+01		2.72E-01	7.10E+00	2.47E+01	5.51E+01	1.50E+02	N (b)		---
Potassium	20 / 20	100	4.60E+02		2.26E+03		2.27E+01	8.91E+02	1.16E+03	3.39E+03	Nutrient	N (c)		---
Selenium	18 / 20	90	6.50E-01		2.60E+00		6.30E-01	1.20E+00	1.40E+00	2.00E+00	3.90E+01	N (a)		---
Silver	3 / 20	15	1.60E+00		2.00E+00		4.54E-01	1.80E+00	7.22E-01	1.11E+01	3.90E+01	N (b)		---
Sodium	8 / 20	40	2.82E+01		7.92E+01		9.08E+00	8.91E+02	2.52E+02		Nutrient	N (c)		---
Thallium	14 / 20	70	3.08E-01	J	8.50E+00		4.54E-01	1.80E+00	1.79E+00	1.30E+00	5.10E-01 f	Y	2.95E+00	2.95E+00
Vanadium	19 / 20	95	8.80E+00		2.69E+01		1.82E-01	8.90E+00	1.82E+01	4.09E+01	3.90E+01	N (b)		---
Zinc	20 / 20	100	4.14E+01		1.27E+02		2.27E+00	3.60E+00	7.40E+01	3.22E+02	2.30E+03	N (b)		---
Cyanide														
Cyanide, total	3 / 12	25	7.10E-01		9.30E-01		6.30E-01	8.90E-01	4.93E-01		1.60E+02	N (a)		---
Polychlorinated biphenyls (PCB)														
Aroclor 1016	1 / 20	5	5.25E-01	J	5.25E-01	J	4.05E-02	5.90E-02	4.91E-02		3.90E-01	Y	1.58E-01	1.58E-01
Aroclor 1260	1 / 20	5	1.62E-02	J	1.62E-02	J	4.05E-02	5.90E-02	2.38E-02		2.20E-01	N (a)		---
Organochlorine Pesticides														
DDE, 4,4'-	7 / 12	58	2.40E-03		7.40E-03		2.20E-03	3.00E-03	3.30E-03		1.40E+00	N (a)		---
DDT, 4,4'-	8 / 12	67	2.60E-03		7.10E-03		2.20E-03	3.00E-03	3.45E-03		1.70E+00	N (a)		---
Methoxychlor	2 / 12	17	6.10E-03		6.50E-03		4.20E-03	5.90E-03	3.14E-03		3.10E+01	N (a)		---
Semivolatile Organic Compounds														
Acenaphthylene	1 / 20	5	1.10E-01	J	1.10E-01	J	4.05E-01	5.90E-01	2.33E-01		1.70E+03 g	N (a)		---
Anthracene	1 / 20	5	5.80E-02	J	5.80E-02	J	4.05E-01	5.90E-01	2.31E-01		1.70E+03	N (a)		---
Benzo(a)anthracene	5 / 20	25	3.07E-02		1.30E-01	J	4.05E-01	5.90E-01	1.98E-01		1.50E-01	N (a)		---
Benzo(a)pyrene	3 / 20	15	8.44E-02	J	1.70E-01	J	4.05E-01	5.90E-01	2.21E-01		1.50E-02	Y	4.84E-01	1.70E-01
Benzo(b)fluoranthene	2 / 20	10	1.30E-01	J	1.60E-01	J	4.05E-01	5.90E-01	2.32E-01		1.50E-01	Y	4.95E-01	1.60E-01
Benzo(ghi)perylene	1 / 20	5	1.30E-01	J	1.30E-01	J	4.05E-01	5.90E-01	2.34E-01		1.70E+02 h	N (a)		---
Benzo(k)fluoranthene	1 / 20	5	2.30E-01	J	2.30E-01	J	4.05E-01	5.90E-01	2.39E-01		1.50E+00	N (a)		---
Benzoic acid	2 / 8	25	6.22E-01		1.43E+00		4.05E-01	4.99E-01	4.22E-01		2.40E+04	N (a)		---
Bis(2-ethylhexyl)phthalate	1 / 20	5	9.50E-02	J	9.50E-02	J	4.05E-01	5.90E-01	2.31E-01		3.50E+01	N (a)		---
Chrysene	4 / 20	20	6.39E-02	J	1.60E-01	J	4.05E-01	5.90E-01	2.12E-01		1.50E+01	N (a)		---

Table 2-4

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil
Powerhouse 2 Ash Pits, 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
Di-n-butyl phthalate	1 / 20	5	1.70E-01	J	1.70E-01	J	4.05E-01	5.90E-01	2.36E-01		6.10E+02	N (a)		---
Fluoranthene	8 / 20	40	5.99E-02	J	3.00E-01	J	4.05E-01	5.90E-01	1.93E-01		2.30E+02	N (a)		---
Indeno(1,2,3-cd)pyrene	1 / 20	5	1.20E-01	J	1.20E-01	J	4.05E-01	5.90E-01	2.34E-01		1.50E-01	N (a)		---
Naphthalene	3 / 20	15	4.44E-02	J	5.59E-02	J	4.05E-01	5.90E-01	2.14E-01		3.60E+00	N (a)		---
Phenanthrene	4 / 20	20	6.30E-02	J	1.00E-01	J	4.05E-01	5.90E-01	2.08E-01		1.70E+02 [h]	N (a)		---
Pyrene	8 / 20	40	4.40E-02	J	2.50E-01	J	4.05E-01	5.90E-01	1.82E-01		1.70E+02	N (a)		---
Volatile Organic Compounds														
Acetone	2 / 12	17	4.20E-02	J	1.20E-01	J	2.50E-02	1.80E-01	6.46E-02		6.10E+03	N (a)		---
Methylene chloride	1 / 12	8	5.20E-02	J	5.20E-02	J	6.30E-03	4.50E-02	1.85E-02		1.10E+01	N (a)		---
Toluene	1 / 12	8	1.80E-02	J	1.80E-02	J	6.30E-03	4.50E-02	1.43E-02		5.00E+02	N (a)		---

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 Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA) Regional Screening Level Table (December 2009) residential s
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 4.00.04 (U.S. Environmental Protection Agency (EPA), 2009, ProUCL Version 4.00.04, 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). Calculated only for COPC
[f] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower. The EPC used to evaluate lead using the Lead Model
(see text for details) is equal to the arithmetic mean.
[g] RBSC based on thallium from IRIS, 2009.
[h] RBSC based on anthracene.
[i] RBSC based on pyrene.

Table 2-5

Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil
Powerhouse 2 Ash Pits, 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 mg/kg	RBSC mg/kg	COPC? [b,c]	95% UCL [d] mg/kg	EPC [e] mg/kg
Inorganics														
Aluminum	28 / 28	100	3.52E+03		1.50E+04	JJ	1.71E+00	2.55E+01	8.33E+03	1.55E+04	7.70E+03	N (b)		---
Antimony	16 / 28	57	2.27E-01	J	6.26E-01		4.13E-01	7.60E+00	1.70E+00	9.30E+00	3.10E+00	N (b)		---
Arsenic	28 / 28	100	3.55E+00		1.26E+01		8.27E-01	1.30E+00	7.11E+00	3.65E+01	3.90E-01	N (b)		---
Barium	28 / 28	100	1.86E+01	J	9.89E+01	J	1.65E-01	2.55E+01	5.52E+01	8.26E+02	1.50E+03	N (b)		---
Beryllium	21 / 28	75	5.90E-01		8.48E+00	J	1.65E-01	6.40E-01	4.25E+00	1.00E+00	1.60E+01	N (a)		---
Cadmium	2 / 28	7	2.76E-01	J	2.93E-01	J	4.13E-01	6.40E-01	2.62E-01		7.00E+00	N (a)		---
Calcium	28 / 28	100	3.51E+02		1.53E+05		4.39E+00	6.37E+02	2.09E+04	5.23E+04	Nutrient	N (c)		---
Chromium	28 / 28	100	6.10E+00		2.22E+01		4.13E-01	1.30E+00	1.24E+01	2.90E+01	2.90E-01	N (b)		---
Cobalt	28 / 28	100	5.60E+00		2.47E+01		3.31E-01	6.40E+00	1.15E+01	1.16E+02	2.30E+00	N (b)		---
Copper	28 / 28	100	8.30E+00		3.84E+01		4.13E-01	3.20E+00	2.08E+01	5.62E+01	3.10E+02	N (b)		---
Iron	28 / 28	100	1.05E+04		5.51E+04	J	1.90E+00	1.27E+01	2.18E+04	2.34E+05	5.50E+03	N (b)		---
Lead	28 / 28	100	6.10E+00		1.89E+01	J	3.30E-01	5.41E-01	1.20E+01	4.86E+01	4.00E+02	N (b)		---
Magnesium	28 / 28	100	1.19E+03		1.20E+04	J	1.65E+00	6.37E+02	5.05E+03	1.04E+04	Nutrient	N (c)		---
Manganese	28 / 28	100	8.21E+01	J	1.56E+03	J	1.65E-01	1.90E+00	3.69E+02	3.51E+03	1.80E+02	N (b)		---
Mercury	13 / 28	46	1.12E-02	J	3.90E-02		1.94E-02	4.20E-02	1.80E-02	8.50E-02	2.30E+00	N (b)		---
Nickel	28 / 28	100	1.38E+01		3.89E+01		2.48E-01	5.10E+00	2.64E+01	5.51E+01	1.50E+02	N (b)		---
Potassium	27 / 28	96	3.23E+02		1.99E+03		2.07E+01	6.37E+02	9.46E+02	3.39E+03	Nutrient	N (c)		---
Selenium	4 / 28	14	6.40E-01		8.59E-01	J	5.40E-01	1.08E+00	4.45E-01	2.00E+00	3.90E+01	N (b)		---
Silver	2 / 28	7	1.20E+00		1.60E+00		4.13E-01	1.30E+00	4.44E-01	1.11E+01	3.90E+01	N (b)		---
Sodium	16 / 28	57	1.84E+01		1.52E+02		8.27E+00	6.37E+02	1.75E+02		Nutrient	N (c)		---
Thallium	14 / 28	50	2.93E-01	J	2.40E+00		4.13E-01	1.30E+00	6.22E-01	1.30E+00	5.10E-01 [f]	Y	7.77E-01	7.77E-01
Vanadium	28 / 28	100	7.50E+00		2.53E+01		1.65E-01	6.40E+00	1.65E+01	4.09E+01	3.90E+01	N (b)		---
Zinc	28 / 28	100	3.53E+01		8.53E+01		2.07E+00	2.71E+00	6.20E+01	3.22E+02	2.30E+03	N (b)		---
Semivolatile Organic Compounds														
Bis(2-ethylhexyl)phthalate	1 / 28	4	6.60E-02	J	6.60E-02	J	3.60E-01	4.51E-01	1.94E-01		3.50E+01	N (a)		---
Di-n-butyl phthalate	1 / 28	4	6.60E-02	J	6.60E-02	J	3.60E-01	4.51E-01	1.94E-01		6.10E+02	N (a)		---
Phenanthrene	7 / 28	25	4.03E-02	J	8.55E-02	J	3.60E-01	4.51E-01	1.65E-01		1.70E+02 [g]	N (a)		---
Volatile Organic Compounds														
Acetone	2 / 12	17	1.30E-02	J	1.20E-01		2.20E-02	1.30E-01	2.52E-02		6.10E+03	N (a)		---
Bromomethane	1 / 12	8	1.10E-03	J	1.10E-03	J	1.10E-02	6.40E-02	9.51E-03		7.30E-01	N (a)		---
Toluene	1 / 12	8	1.10E-02		1.10E-02		5.40E-03	3.20E-02	5.56E-03		5.00E+02	N (a)		---
Xylenes, total	1 / 12	8	6.50E-03		6.50E-03		5.40E-03	3.20E-02	5.18E-03		6.30E+01	N (a)		---

RBSC - Risk-based screening concentration.
COPC - Chemical of potential concern.
mg/kg - Milligrams per kilogram.
BSC - Background screening criterion.
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] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA) Regional Screening Level Table (December 2009) residentia

Table 2-5

Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil
Powerhouse 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

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) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.

[c] Y = Chemical is chosen as COPC.

[d] 95% UCL determined using ProUCL Version 4.00.04 (U.S. Environmental Protection Agency (EPA), 2009, ProUCL Version 4.00.04, 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). Calculated only for COPC.

[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

[f] RBSC based on thallium from IRIS, 2009.

[g] RBSC based on pyrene.

Table 2-6

Statistical Summary and COPC Selection of Chemicals Detected in Bedrock Groundwater
Powerhouse 2 Ash Pits
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	COPC? [c,d]	EPC [e] µg/L
Metals													
Aluminum	4 / 4	100	1.74E+01	J	4.61E+01	JJ	2.00E+02	2.00E+02	3.51E+01	3.09E+02	3.70E+03	N (a)	---
Barium	4 / 4	100	2.12E+01	J/J	1.80E+02	J/J	2.00E+02	2.00E+02	9.61E+01	1.18E+04	7.30E+02	N (a)	---
Calcium	4 / 4	100	2.71E+05	J	3.89E+05	J/J	1.00E+03	1.00E+03	3.29E+05	3.16E+05	Nutrient	N (c)	---
Iron	2 / 4	50	3.30E+01	J	2.83E+02	J	3.00E+02	3.00E+02	1.54E+02	1.55E+03	2.60E+03	N (a)	---
Magnesium	4 / 4	100	1.07E+05	J	1.24E+05		5.00E+03	5.00E+03	1.16E+05	2.17E+05	Nutrient	N (c)	---
Manganese	4 / 4	100	5.65E+00	J/J	5.37E+01		1.50E+01	1.50E+01	1.93E+01	6.36E+02	8.80E+01	N (a)	---
Potassium	4 / 4	100	7.74E+03	J	1.56E+04		1.00E+04	2.00E+04	1.17E+04	1.16E+05	Nutrient	N (c)	---
Selenium	2 / 3	67	1.24E+01	J	1.95E+01	J/J	1.00E+01	1.00E+01	1.23E+01		1.80E+01	Y	1.95E+01
Sodium	4 / 4	100	2.64E+04		6.11E+04	J	1.00E+04	2.00E+04	4.43E+04	1.39E+06	Nutrient	N (c)	---
Vanadium	3 / 4	75	1.10E+00	J	1.60E+00	J	5.00E+01	5.00E+01	7.21E+00	5.01E+02	1.80E+01	N (a)	---
Semivolatile Organic Compounds													
Dimethylphenol, 2,4-	1 / 4	25	1.70E+00	J	1.70E+00	J	4.80E+00	4.80E+00	2.23E+00		7.30E+01	N (a)	---
Methylnaphthalene, 2-	4 / 4	100	1.60E+00	J/J	6.30E+00		4.80E+00	4.80E+00	3.34E+00		1.50E+01	N (a)	---
Naphthalene	4 / 4	100	1.75E+00	J/J	7.40E+00		4.80E+00	4.80E+00	3.39E+00		1.40E-01	Y	7.40E+00
Volatile Organic Compounds													
Acetone	2 / 2	100	4.25E+01	J/J	8.61E+01	J	2.50E+01	1.30E+02	6.43E+01		2.20E+03	N (a)	---
Benzene	4 / 4	100	7.80E+00	J/J	3.36E+02		1.00E+00	5.00E+00	1.11E+02		4.10E-01	Y	3.36E+02
Butanone, 2-	3 / 4	75	2.40E+00	J	7.40E+00		5.00E+00	2.50E+01	6.73E+00		7.10E+02	N (a)	---
Carbon disulfide	1 / 4	25	3.70E+00	J	3.70E+00	J	2.00E+00	1.00E+01	1.68E+00		1.00E+02	N (a)	---
Chloromethane	2 / 4	50	5.60E+00	J/J	4.49E+01	J	2.00E+00	1.00E+01	1.31E+01		1.90E+01	Y	4.49E+01
Dichloropropene, trans-1,3-	1 / 4	25	1.70E+00	J	1.70E+00	J	1.00E+00	5.00E+00	8.00E-01		4.30E-01	Y	1.70E+00
Ethylbenzene	4 / 4	100	8.15E+00	J/J	5.71E+01		1.00E+00	5.00E+00	2.31E+01		1.50E+00	Y	5.71E+01
Toluene	4 / 4	100	4.05E+00	J/J	1.47E+02		1.00E+00	5.00E+00	4.92E+01		2.30E+02	N (a)	---
Xylenes, total	4 / 4	100	4.63E+01	J/J	6.30E+02		3.00E+00	1.50E+01	2.32E+02		2.00E+01	Y	6.30E+02
General Chemistry (mg/L)													
Chloride	4 / 4	100	4.06E+01		1.18E+02		2.00E+00	2.50E+01	8.18E+01		Nutrient	N (c)	---
Cyanide, total	1 / 4	25	7.20E-03	J	7.20E-03	J	1.00E-02	1.00E-02	5.55E-03		7.30E-02	N (a)	---
Sulfate	4 / 4	100	4.96E+02		9.46E+02		1.00E+01	4.00E+01	7.16E+02		2.50E+05 [g]	N (a)	---

RBSC - Risk-based screening concentration.
COPC - Chemical of potential concern.
µg/L - Micrograms per liter.
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), 2005b, *2004 Groundwater Data Summary and Evaluation Report* , Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, April.

[b] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA) Regional Screening Level Table (December 2009) tap wate 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] Concentration used in risk assessment is equal to maximum detected concentration.

[f] Screening criteria for lead based on the action level of 15 µg/L (EPA, 1996, *Drinking Water Regulations and Health Advisories* , Office of Water, Washington, D.C., October).

[g] US Environmental Protection Agency (EPA), 2009, *2009 Edition of the Drinking Water Standards and Health Advisories* , Office of Water, October, EPA 822-R-09-011.

Table 2-7

Statistical Summary and COPC Selection of Chemicals Detected in Groundwater Overburden Wells
Powerhouse 2 Ash Pits
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		COPC? [c,d]	Source-Term Concentration [e] µg/L
Inorganics														
Aluminum	3 / 3	100	4.71E+01	J	1.33E+02	J	2.00E+02	2.00E+02	8.62E+01	3.09E+02	3.70E+03		N (a)	---
Barium	3 / 3	100	2.49E+01	JJ	9.80E+01	J	2.00E+02	2.00E+02	4.94E+01	1.18E+04	7.30E+02		N (a)	---
Cadmium	1 / 3	33	1.05E+00	JJ	1.05E+00	JJ	5.00E+00	5.00E+00	2.02E+00		1.80E+00		N (a)	---
Calcium	3 / 3	100	5.44E+04		1.12E+05		1.00E+03	1.00E+03	8.95E+04	3.16E+05	Nutrient		N (c)	---
Cobalt	1 / 3	33	8.10E+00	JJ	8.10E+00	JJ	5.00E+01	5.00E+01	1.94E+01	1.21E+01	1.10E+00		N (b)	---
Iron	2 / 3	67	3.70E+01	J	8.08E+01	J	3.00E+02	3.00E+02	8.93E+01	1.55E+03	2.60E+03		N (a)	---
Lead	1 / 3	33	2.40E+00	J	2.40E+00	J	5.00E+00	5.00E+00	2.47E+00		1.50E+01	f	N (a)	---
Magnesium	3 / 3	100	1.16E+04		3.87E+04		5.00E+03	5.00E+03	2.10E+04	2.17E+05	Nutrient		N (c)	---
Manganese	3 / 3	100	8.22E+01		2.29E+02		1.50E+01	1.50E+01	1.61E+02	6.36E+02	8.80E+01		N (b)	---
Nickel	1 / 3	33	7.42E+01		7.42E+01		4.00E+01	4.00E+01	3.81E+01	8.60E+00	7.30E+01		Y	7.42E+01
Potassium	3 / 3	100	1.50E+03	J	7.55E+03	JJ	1.00E+04	2.00E+04	4.40E+03	1.16E+05	Nutrient		N (c)	---
Sodium	3 / 3	100	2.51E+03	JJ	1.02E+04	J	1.00E+04	2.00E+04	6.72E+03	1.39E+06	Nutrient		N (c)	---
Vanadium	2 / 3	67	1.40E+00	J	3.70E+00	J	5.00E+01	5.00E+01	1.00E+01		1.80E+01		N (a)	---
Zinc	1 / 3	33	3.83E+01		3.83E+01		2.00E+01	2.00E+01	1.94E+01	5.01E+02	1.10E+03		N (a)	---
General Chemistry (mg/L)														
Sulfate	3 / 3	100	81.5		162		2	10	1.13E+02		2.50E+02	g	N (a)	---

RBSC - Risk-based screening concentration.
COPC - Chemical of potential concern.
µg/L - Micrograms per liter.
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), 2005b, *2004 Groundwater Data Summary and Evaluation Report* , Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, April.

[b] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA)Regional Screening Level Table (December 2009) tap 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] Concentration used in risk assessment is equal to maximum detected concentration.

[f] Screening criteria for lead based on the action level of 15 µg/L (EPA, 1996, *Drinking Water Regulations and Health Advisories* , Office of Water, Washington, D.C., October).

[g] US Environmental Protection Agency (EPA), 2009, *2009 Edition of the Drinking Water Standards and Health Advisories* , Office of Water, October, EPA 822-R-09-011.

Table 2-8

Statistical Summary and COPC Selection of Chemicals Detected in Sediment
Powerhouse 2 Ash Pits, 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	RBSC [a] mg/kg	COPC? [b,c]	95% UCL [d] mg/kg	EPC [e] mg/kg
Inorganics													
Aluminum	5 / 5	100	3.64E+03		7.42E+03		1.20E+01	1.50E+01	5.86E+03	7.70E+04	N (a)		---
Arsenic	5 / 5	100	3.90E+00		1.01E+01	J	4.75E-01	9.50E-01	6.35E+00	3.90E-01	Y	9.03E+00	9.03E+00
Barium	5 / 5	100	2.28E+01		6.71E+01	J	1.20E+01	1.50E+01	4.63E+01	1.50E+04	N (a)		---
Beryllium	5 / 5	100	3.60E-01		5.60E-01		3.00E-01	3.60E-01	4.70E-01	1.60E+02	N (a)		---
Cadmium	4 / 5	80	2.40E-01	J	5.65E-01		2.40E-01	4.80E-01	3.35E-01	7.00E+01	N (a)		---
Calcium	5 / 5	100	7.66E+03		2.70E+04		3.00E+02	3.60E+02	1.67E+04	Nutrient	N (b)		---
Chromium	5 / 5	100	6.40E+00		1.17E+01		5.95E-01	7.30E-01	8.97E+00	2.90E-01	Y	1.10E+01	1.10E+01
Cobalt	5 / 5	100	6.20E+00	J	1.20E+01		3.00E+00	3.60E+00	8.19E+00	2.30E+01	N (a)		---
Copper	5 / 5	100	9.60E+00		2.21E+01		1.50E+00	1.80E+00	1.51E+01	3.10E+03	N (a)		---
Iron	5 / 5	100	1.04E+04		3.91E+04	J	5.95E+00	1.20E+01	1.85E+04	5.50E+04	N (a)		---
Lead	5 / 5	100	7.90E+00		1.22E+01	JJ	5.95E+00	1.20E+01	9.65E+00	4.00E+02	N (a)		---
Magnesium	5 / 5	100	1.95E+03		7.47E+03	J	3.00E+02	3.60E+02	5.08E+03	Nutrient	N (b)		---
Manganese	5 / 5	100	1.27E+02		6.08E+02		9.90E-01	4.45E+00	2.90E+02	1.80E+03	N (a)		---
Mercury	4 / 5	80	1.60E-02	J	2.50E-02	J	9.80E-02	1.20E-01	2.62E-02	2.30E+01	N (a)		---
Nickel	5 / 5	100	1.57E+01		2.51E+01		2.40E+00	2.90E+00	1.81E+01	1.50E+03	N (a)		---
Potassium	5 / 5	100	4.98E+02	J	1.66E+03		6.00E+02	1.50E+03	1.03E+03	Nutrient	N (b)		---
Selenium	5 / 5	100	3.90E-01	J	1.00E+00	J	5.95E+00	1.20E+01	7.85E-01	3.90E+02	N (a)		---
Silver	1 / 5	20	8.30E-02	J	8.30E-02	J	5.95E-01	7.30E-01	2.79E-01	3.90E+02	N (a)		---
Sodium	5 / 5	100	5.48E+01	J	1.64E+02	JJ	6.00E+02	1.50E+03	1.17E+02	Nutrient	N (b)		---
Vanadium	5 / 5	100	9.40E+00		1.52E+01		3.00E+00	6.00E+00	1.26E+01	3.90E+02	N (a)		---
Zinc	5 / 5	100	2.70E+01	J	5.73E+01		1.20E+00	1.50E+00	4.06E+01	2.30E+04	N (a)		---
Explosives													
Trinitrotoluene, 2,4,6-	1 / 5	20	6.47E-02	J	6.47E-02	J	1.55E-01	1.90E-01	8.14E-02	1.90E+01	N (a)		---
Semivolatiles Organic Compounds													
Fluoranthene	2 / 5	40	5.25E-02	J	5.47E-02	J	2.05E-01	2.60E-01	8.49E-02	2.30E+03	N (a)		---

RBSC - Risk-based screening concentration.
COPC - Chemical of potential concern.
mg/kg - Milligrams per kilogram.
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] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA) Regional Screening Level Table (December 2009) residential soil and are based on a risk level of 1.0E-06 and a hazard index of 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 determined using ProUCL Version 4.00.04 (U.S. Environmental Protection Agency (EPA), 2009, ProUCL Version 4.00.04, 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). Calculated only for COPC.

[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

Table 2-9

Statistical Summary and COPC Selection of Chemicals Detected in Surface Water
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Detection Frequency	Percent hits	Range of values, µg/L: Detected Conc Minimum	VQ	Detected Conc Maximum	VQ	Reporting Limits Minimum	Reporting Limits Maximum	Arithmetic Mean µg/L	RBSC [a] µg/L		COPC? [b,c]
Metals												
Aluminum	5 / 5	100	359		1030	J	200	200	6.01E+02	3.70E+04		N (a)
Barium	5 / 5	100	43.9		50.9	J	200	200	4.70E+01	7.30E+03		N (a)
Calcium	5 / 5	100	75900		80700		1000	1000	7.83E+04	Nutrient		N (b)
Cobalt	1 / 5	20	1.2	J	1.2	J	50	50	2.02E+01	1.10E+01		N (a)
Iron	5 / 5	100	376		1060		300	300	7.22E+02	2.60E+04		N (a)
Lead	2 / 5	40	2.9	J	2.9	J	5	10	2.66E+00	1.50E+01	d	N (a)
Magnesium	5 / 5	100	19800		21400		5000	5000	2.08E+04	Nutrient		N (b)
Manganese	5 / 5	100	52.75		102		15	15	7.08E+01	8.80E+02		N (a)
Nickel	1 / 5	20	6.2	J	6.2	J	40	40	1.72E+01	7.30E+02		N (a)
Potassium	5 / 5	100	2900		4400	J	10000	20000	3.42E+03	Nutrient		N (b)
Sodium	5 / 5	100	30300		34800		10000	20000	3.26E+04	Nutrient		N (b)
Vanadium	5 / 5	100	1.65	JJ	3.1	J	50	50	2.23E+00	1.80E+02		N (a)
Zinc	5 / 5	100	8.1	J	12.4	J	20	20	1.06E+01	1.10E+04		N (a)
Semivolatile Organic Compounds												
Bis(2-ethylhexyl)phthalate	1 / 5	20	2	J	2	J	4.8	4.8	2.32E+00	4.80E+00		N (a)

RBSC - Risk-based screening concentration.
COPC - Chemical of potential concern.
µg/L - Micrograms per liter.
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] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA) Regional Screening Level Tal (December 2009) tap water values are based on a risk level of 1.0E-06 and a hazard index of 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] 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).

Table 3-1

Receptor/Exposure Scenarios
Powerhouse 2 Ash Pits
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]		
Surface Water	Not Quantified[b]		
Sediment	Not Quantified[b]		
Groundskeeper – Future			
Total Soil[d]	None	Soil	Incidental Ingestion
			Dermal Contact
	Dust Emissions Based on Activity	Ambient Air	Inhalation
	Volatilization from Soil	Ambient Air	Inhalation
Groundwater	None	Tap Water	Ingestion
			Dermal Contact
Surface Water	Not Quantified[b]		
Sediment	Not Quantified[b]		
Indoor Worker – Future[c]			
Surface Soil	None	Soil	Incidental Ingestion
			Dermal Contact[a]
	Dust Emissions; Volatilization	Indoor Air	Not Quantified[a]
Subsurface Soil	Volatilization from Soil	Indoor Air	Inhalation
Groundwater	None	Tap Water	Ingestion
			Dermal Contact
Surface Water	Not Quantified[b]		
Sediment	Not Quantified[b]		

Table 3-1

Receptor/Exposure Scenarios
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Source Medium	Model	Exposure Medium	Exposure Route
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	Inhalation
Groundwater	Not Quantified[b]		
Surface Water	None	Surface Water	Dermal Contact
	Volatilization from Water	Ambient Air	Not Quantified[a]
Sediment	None	Sediment	Incidental Ingestion
			Dermal Contact
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	Inhalation
Subsurface Soil	Volatilization from Soil	Indoor Air	Inhalation
Groundwater	None	Tap Water	Ingestion
			Dermal Contact
	Volatilization from Water	Indoor Air	Inhalation
Surface Water	None	Surface Water	Not Quantified[a]
	Volatilization from Water	Ambient Air	Dermal Contact
Sediment	None	Sediment	Incidental Ingestion
			Dermal Contact

Table 3-1

Receptor/Exposure Scenarios
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Source Medium	Model	Exposure Medium	Exposure Route
Hunter – Current/Future			
Surface Soil	None	Soil	Incidental Ingestion
			Dermal Contact
	Dust Emissions, Volatilization	Ambient Air	Not Quantified[a]
	Biouptake	Venison	Venison Consumption
Subsurface Soil	Not Quantified[c]		
Surface Water	Not Quantified[b]		
Sediment	Not Quantified[b]		
Hunter's Child – Current/Future			
Surface Soil	Not Quantified[c]		
	Not Quantified[c]		
	Biouptake	Venison	Venison Consumption
Subsurface Soil	Not Quantified[c]		
Surface Water	Not Quantified[c]		
Sediment	Not Quantified[c]		

[a] Although theoretically complete, this pathway is not quantified as explained in text.

[b] Although contact with this medium is possible, exposure would be sporadic, rather than continuous or predictable. Such exposures do not lend themselves to evaluation under the chronic toxicity paradigm used in a baseline risk assessment.

[c] There is no plausible pathway for exposure.

[d] Total soil represents a mixture of surface and subsurface soil. This is assumed for future scenarios where excavation and regrading is assumed to take place.

[e] Even though the mixing of surface and subsurface soil described in footnote "d" might otherwise be applicable, this receptor was selected primarily to evaluate exposure to indoor air resulting from subsurface soil contamination. Surface soil was used for direct contact exposure to avoid potential "double counting" of contaminants in subsurface soil (refer to Section 3.1.3.2 of text).

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	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 VOCs and Resuspended Dust from Surface Soil, Total Soil or Subsurface Soil					
Fraction exposed to contaminated medium (FI_a), unitless	1[c]	1[c]	1[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[c]	350[a]	NA	NA
Exposure duration (ED), years	25[a]	0.5[c]	Child: 6[a] Adult: 24[a]	NA	NA

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter and Hunter's Child
Inhalation of VOCs in Indoor Air from Subsurface Soil					
Fraction exposed to contaminated medium (FI_a), unitless	NA	NA	1[c]	1[c]	NA
Inhalation rate (IR_a), m^3/day	NA	NA	Child: 10[e] Adult: 20[d]	20[d]	NA
Exposure frequency (EF), days/year	NA	NA	350[a]	250[a]	NA
Exposure duration (ED), years	NA	NA	Child: 6[a] Adult: 24[a]	25[a]	NA
Incidental Ingestion of Soil					
Fraction exposed to contaminated medium (FI_{so}), unitless	1[c]	1[c]	0.9[f]	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[c]	Child: 6[a] Adult: 24[a]	25[a]	30[a]
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[c]
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[c]

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter and Hunter's Child
Dermal absorption factor (ABS), unitless	csv	csv	Csv	NA	csv
Exposure frequency (EF), days/year	250[d]	250[a]	350[a]	NA	14[c]
Exposure duration (ED), years	25[a]	0.5[c]	Child: 6[a] Adult: 24[a]	NA	30[a]
Inhalation of VOCs from Groundwater					
Exposure time (ET), hours/day	NA	NA	24[h]	NA	NA
Inhalation rate (IR_a), m^3/hour	NA	NA	Child: 0.416[e] Adult: 0.833[e]	NA	NA
Exposure frequency (EF), days/year	250[d]	NA	350[a]	250[a]	NA
Drinking Water Ingestion of Groundwater					
Fraction exposed to contaminated medium (Fl_{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[d]	NA	350[a]	250[a]	NA
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[c]	NA	Child: 6,600[i] Adult: 20,000[i]	3,300[i]	NA

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter and Hunter's Child
Permeability coefficient (PC), cm/hour	csv	NA	csv	csv	NA
Exposure time (ET_{gw}), hours/day	1[c]	NA	Child: 0.333[i] Adult: 0.2[i]	1[c]	NA
Exposure frequency (EF), days/year	250[d]	NA	350[d]	250[a]	NA
Incidental Ingestion of Sediment					
Fraction exposed to contaminated medium (FI_{sd}), unitless	NA	1[c]	0.1[f]	NA	NA
Sediment incidental ingestion rate (IR_{sd}), mg/day	NA	330[a]	Child: 200[a] Adult: 100[a]	NA	NA
Exposure frequency (EF), days/year	NA	250[c]	350[a]	NA	NA
Exposure duration (ED), years	NA	0.5[c]	Child: 6[a] Adult: 24[a]	NA	NA
Dermal Contact with Sediment					
Fraction exposed to contaminated medium (FI_{sd}), unitless	NA	1[c]	0.1[f]	NA	NA
Body surface area exposed to sediment (SA_{sd}), cm^2	NA	3,300[g]	Child: 2,800[g] Adult: 5,700[g]	NA	NA
Sediment-to-skin adherence factor (AF_{sd}), mg/cm^2	NA	0.3[g]	Child: 0.2[g] Adult: 0.07[g]	NA	NA
Dermal absorption factor (ABS), unitless	NA	csv	csv	NA	NA
Exposure frequency (EF), days/year	NA	250[c]	52[c]	NA	NA
Exposure duration (ED), years	NA	0.5[c]	Child: 6[a] Adult: 24[a]	NA	NA

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter and Hunter's Child
Dermal Contact with Surface Water					
Body surface area exposed to surface water (SA_{sw}), cm^2	NA	3,300[j]	Child: 2,800[j] Adult: 7,000[c]	NA	NA
Permeability coefficient (PC), cm/hour	NA	csv	csv	NA	NA
Exposure time (ET_{sw}), hour/day	NA	4[c]	3[c]	NA	NA
Exposure frequency (EF), days/year	NA	250[c]	52[c]	NA	NA
Exposure duration (ED), years	NA	0.5[c]	Child: 6[a] Adult: 24[a]	NA	NA
Venison Consumption					
Venison ingestion rate (IR_v), kg/day	NA	NA	NA	NA	Child: 0.005[c] Adult: 0.013[c]
Exposure frequency (EF), days/year	NA	NA	NA	NA	350[a]
Exposure duration (ED), years	NA	NA	NA	NA	Child: 6[a] Adult: 30[c]

[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, D.C., 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] Assumed; see text.

[d] 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: 9285.603.

[e] U.S. Environmental Protection Agency (EPA), 2004a, *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] It is assumed that on days when the resident is visiting the ditches and is exposed to sediment that half of the daily exposure via dermal contact and

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

ingestion are associated with ditch sediment (sediment FI=0.5) and half of the exposure is associated with soil (soil FI=0.5). The resident is assumed to be exposed to soil 350 days/year and to sediment 52 days/year. The FI values of 0.1 for sediment and 0.9 for soil are weighted average daily values as described in Section 3.1.3.4 of the text.

[g] U.S. Environmental Protection Agency (EPA), 2004b, *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] The *Exposure Factors Handbook* (see reference i) indicates that the 90th percentile for the amount of time spent at a residence is more than 23 hours per day.

[i] U.S. Environmental Protection Agency (EPA), 1997, *Exposure Factors Handbook*, Final, National Center for Environmental Assessment, Washington, D.C., EPA/600/P-95/002Fa, August.

[j] Value for dermal soil exposure (EPA, 2004b) was selected as appropriate for exposure to this medium by this receptor; refer to text for detail.

NA – Pathway not applicable for receptor.

Table 3-3

Physical Properties of Site-Related Chemicals[a]
Powerhouse 2 Ash Pits, 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														
Arsenic	NA	NA	NA	NA	2.90E+01	NA	0.03	1.00E-03	NA	NA	NA	NA	74.92	NA
Beryllium	NA	NA	NA	NA	7.90E+02	NA	NA	1.00E-03	NA	NA	NA	NA	9.01	NA
Chromium III	NA	NA	NA	NA	1.80E+06	NA	NA	1.00E-03	NA	NA	NA	NA	52	NA
Chromium VI	NA	NA	NA	NA	1.90E+01	NA	NA	2.00E-03	NA	NA	NA	NA	52	NA
Nickel	NA	NA	NA	NA	6.50E+01	NA	NA	2.00E-04	NA	NA	NA	NA	58.69	NA
Selenium	2.50E-02	1.50E-02	9.00E-05	NA	5.00E+00	NA	NA	1.00E-03	NA	NA	NA	NA	78.96	NA
Thallium	4.00E-04	4.00E-02	2.40E-04	NA	7.10E+01	NA	NA	1.00E-03	NA	NA	NA	NA	204.38	NA
Pesticides and PCBs														
Aroclor 1016	2.24E-02	1.00E-02	6.00E-05	4.69E-02	9.12E+04	5.6	0.14	4.30E-01	11.29	47.9	0.5	3.2	257.9	2.90E-04
Semivolatile Organic Compounds														
Benzo(a)pyrene	NA	NA	NA	4.30E-02	1.02E+06	6.1	0.13	7.00E-01	2.69	11.67	1.0	4.3	252.3	1.13E-06
Benzo(b)fluoranthene	NA	NA	NA	2.26E-02	1.23E+06	6.12	0.13	7.00E-01	2.77	12.03	1.0	4.3	252.3	1.11E-04
Naphthalene	NA	NA	NA	5.90E-02	2.00E+03	3.3	0.13	4.70E-02	0.56	1.34	1	0.2	128.2	4.83E-04
Volatile Organic Compounds														
Benzene	NA	NA	NA	NA	1.77E+00	2.13	NA	1.50E-02	0.29	0.70	1	0.1	78.1	5.56E-03
Chloromethane (Methyl Chloride)	NA	NA	NA	1.39E-01	1.41E+01	0.91	NA	3.30E-03	0.2	0.49	1	0	50.5	8.82E-03
Ethylbenzene	NA	NA	NA	7.50E-02	3.63E+02	3.15	NA	4.90E-02	0.42	1.01	1.0	0.2	106.2	7.88E-03
trans-1,3-Dichloropropene	NA	NA	NA	6.26E-02	8.13E+01	2	NA	4.30E-03	0.45	1.07	1	0	111	3.55E-03
Xylenes	NA	NA	NA	7.00E-02	4.07E+02	3.2	NA	5.30E-02	0.42	1.01	1.0	0.2	106.2	7.34E-03

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.
B - Ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis
kg - Kilogram.
g - Gram.
atm-m^3 - Atmospheres per cubic meter.
[a]Appendix C provides references for these values.

Table 4-1

Summary of Toxicity Assessment[a]
Powerhouse 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical of Potential Concern	GAF	Weight of Evidence	Oral Slope Factor (mg/kg-day) $^{-1}$	Dermal Slope Factor (mg/kg-day) $^{-1}$	Weight of Evidence	Inhalation Unit Risk (µg/m^3) $^{-1}$	Inhalation Slope Factor (mg/kg-day) $^{-1}$
Metals							
Arsenic	1	A	1.5E+00	1.5E+00	A	4.3E-03	1.5E+01
Beryllium	0.007	D	NA	NA	B1	2.4E-03	8.4E+00
Chromium III	0.013	D	NA	NA	D	NA	NA
Chromium VI	0.025	D	NA	NA	A	1.2E-02	4.2E+01
Chromium, Total	0.013	D	NA	NA	A	1.2E-02	4.2E+01
Nickel	0.04	D	NA	NA	A	2.4E-04	8.4E-01
Selenium	1	D	NA	NA	D	NA	ND
Thallium	1	D	NA	NA	D	NA	ND
Pesticides and PCBs							
Aroclor 1016	1	B2	7.0E-02	7.0E-02	B2	NA	7.0E-02
Semivolatile Organic Compounds							
Benzo(a)pyrene	1	B2	7.3E+00	7.3E+00	B2	8.8E-04	3.1E+00
Benzo(b)fluoranthene	1	B2	7.3E-01	7.3E-01	B2	8.8E-05	3.1E-01
Naphthalene	1	C	ND	ND	C	3.4E-05	1.2E-01
Volatile Organic Compounds							
Benzene		A	5.5E-02	5.5E-02	A	7.8E-06	2.7E-02
Chloromethane (Methyl Chloride)	1	D	NA	NA	D	NA	NA
Ethylbenzene	1	D	NA	NA	D	NA	ND
trans-1,3-Dichloropropene	1	B2	1.0E-01	1.0E-01	B2	4.0E-06	1.4E-02
Xylenes	1	D	NA	NA	D	NA	ND

mg/kg-day - Milligrams per kilogram - day.
µg/m^3 - Milligrams per cubic meter.
GAF - Gastrointestinal absorption factor.
NA - Not available or not applicable.
ND - No data or not determined.

Weight of Evidence 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 cardcinogenic potential
D - Inadequate evidence to assess carcinogenic potential

Table 4-1

Summary of Toxicity Assessment[a]
Powerhouse 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

		Oral		Dermal	Reference	Inhalation	
Chemical of Potential Concern	GAF	Reference Dose mg/kg-day	Target Organs	Reference Dose mg/kg-day	Concentration mg/m^3	Reference Dose mg/kg-day	Target Organs
Metals							
Arsenic	1	3.0E-04	S	3.0E-04	NA	ND	NA
Beryllium	0.007	2.0E-03	GI	1.4E-05	2.0E-02	5.7E-06	RT
Chromium III	0.013	1.5E+00	ND	2.0E-02	NA	ND	NA
Chromium VI	0.025	3.0E-03	ND	7.5E-05	1.0E-04	2.9E-05	Lung
Chromium, Total	0.013	2.1E-02	ND	2.7E-04	7.0E-04	2.0E-04	Lung
Nickel	0.04	2.0E-02	RB/OW	8.0E-04	NA	ND	NA
Selenium	1	5.0E-03	Selenosis	5.0E-03	NA	ND	NA
Thallium	1	6.5E-05	S,L	6.5E-05	NA	ND	NA
Pesticides and PCBs							
Aroclor 1016	1	7.0E-05	F	7.0E-05	NA	ND	NA
Semivolatile Organic Compounds							
Benzo(a)pyrene	1	ND	NA	ND	NA	ND	NA
Benzo(b)fluoranthene	1	ND	NA	ND	NA	ND	NA
Naphthalene	1	2.0E-02	RB/OW	2.0E-02	3.0E-03	8.6E-04	RT
Volatile Organic Compounds							
Benzene		4.0E-03	BC	4.0E-03	3.0E-03	8.6E-03	BC
Chloromethane (Methyl Chloride)	1	ND	NA	ND	9.0E-02	2.6E-02	CNS
Ethylbenzene	1	1.0E-01	L,K	1.0E-01	1.0E+00	2.9E-01	F
trans-1,3-Dichloropropene	1	3.0E-02	Stomach Irritation	3.0E-02	2.0E-02	5.7E-03	NE
Xylenes	1	2.0E-01	RB/OW, Su	2.0E-01	1.0E-01	2.9E-02	CNS

mg/kg-day - Milligrams per kilogram - day.
mg/m^3 - Milligrams per cubic meter.
GAF - Gastrointestinal absorption factor.
NA - Not available or not applicable.
ND - No data.

Target Organs: BC - blood cells; S - skin; GI - gastrointestinal; CNS - central nervous system; L - liver; F - fetus; NE - nasal epithelium; NS - nervous system; RB/OW - reduced body/organ weight; SU - reduced survival; RT - respiratory tract.

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

Table 5-1

Summary of Risk for All Receptors
Powerhouse 2 Ash Pit
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
Bedrock Groundwater Use													
Exposure to:													
Soil [b]	1.56E-06	0.09	9.08E-08	0.3	2.39E-07	0.03	2.84E-06	0.07	0.6	5.97E-08	0.003	4.43E-13	0.000003
Groundwater	7.01E-05	1.0	NE	NE	7.01E-05	1.0	3.39E-04	2.9	6.5	NE	NE	NE	NE
Sediment	NE	NE	3.40E-07	0.1	NE	NE	2.15E-06	0.004	0.04	NE	NE	NE	NE
Surface Water	NE	NE	NA	NA	NE	NE	NA	NA	NA	NE	NE	NE	NE
Total ILCR or HI	**7.E-05**	**1**	**4.E-07**	**0.4**	**7.E-05**	**1**	**3.E-04**	**3**	**7**	**6.E-08**	**0.003**	**4.E-13**	**0.000003**
Overburden Groundwater Use													
Exposure to:													
Soil [b]	1.56E-06	0.09	9.08E-08	0.3	2.39E-07	0.03	2.84E-06	0.07	0.6	5.97E-08	0.003	4.43E-13	0.000003
Groundwater	NA	0.04	NE	NE	NA	0.04	NA	0.1	0.2	NE	NE	NE	NE
Sediment	NE	NE	3.40E-07	0.1	NE	NE	2.15E-06	0.004	0.04	NE	NE	NE	NE
Surface Water	NE	NE	NA	NA	NE	NE	NA	NA	NA	NE	NE	NE	NE
Total ILCR or HI	**2.E-06**	**0.1**	**4.E-07**	**0.4**	**2.E-07**	**0.06**	**5.E-06**	**0.2**	**0.9**	**6.E-08**	**0.003**	**4.E-13**	**0.000003**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - No chemicals of potential concern available for exposure evaluation.
NE - Pathway not evaluated for this receptor.

[a] Total ILCR and total HI values for the groundskeeper reflect the respective totals for the future groundskeeper assumed to use either bedrock or overburden groundwater. The total ILCR and HI values for the current groundskeeper are simply those shown for soil. The rounded current groundskeeper ILCR is 2E-6 and the HI is 0.09.
[b] Because the surface soil data set is used to represent total soil (refer to Section 2.5 of text), associated risk of total soil and surface soil are not shown separately.

Table 5-2

Summary of Risk for Receptors Exposed to Bedrock Groundwater Without the Contributions of Benzene
Powerhouse 2 Ash Pits
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
Bedrock Groundwater Use							
Exposure to:							
Soil	1.56E-06	0.09	2.39E-07	0.03	2.84E-06	0.07	0.6
Groundwater	6.10E-07	0.1	6.10E-07	0.1	5.44E-06	0.3	0.6
Sediment	NE	NE	NE	NE	2.15E-06	0.004	0.04
Surface Water	NE	NE	NE	NE	NA	NA	NA
Total ILCR or HI	**2.E-06**	**0.2**	**8.E-07**	**0.1**	**1.E-05**	**0.3**	**1**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - No chemicals of potential concern available for exposure evaluation.
NE - Pathway not evaluated for this receptor.

Note: Benzene is naturally occurring in bedrock groundwater underlying the Powerhouse 2 Ash Pits; refer to Section 7.2 of the text.

FIGURES

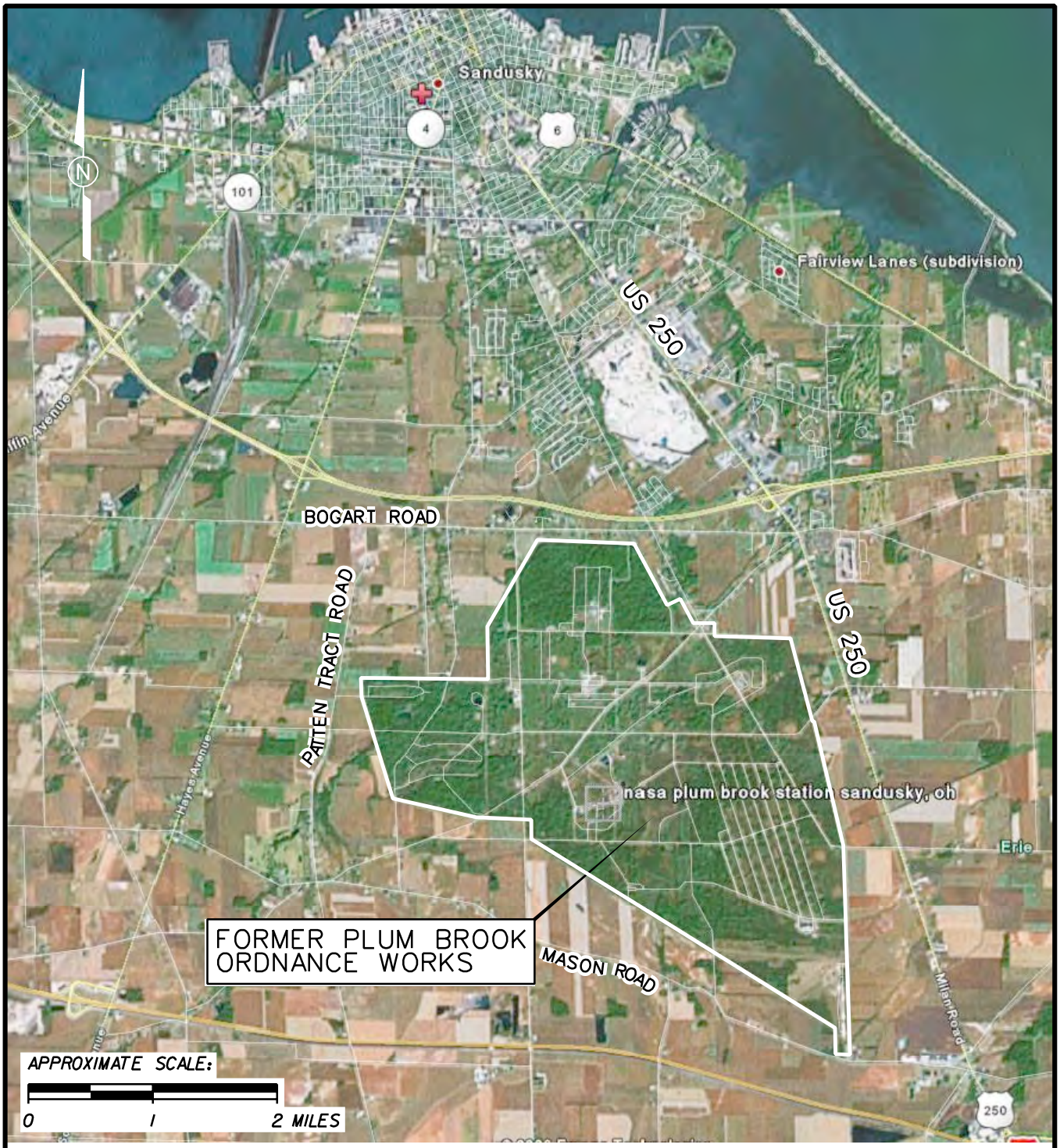

FIGURE 1-1
PBOW VICINITY MAP

POWERHOUSE 2 ASH PITS
BASELINE HUMAN HEALTH
RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® a world of Solutions™

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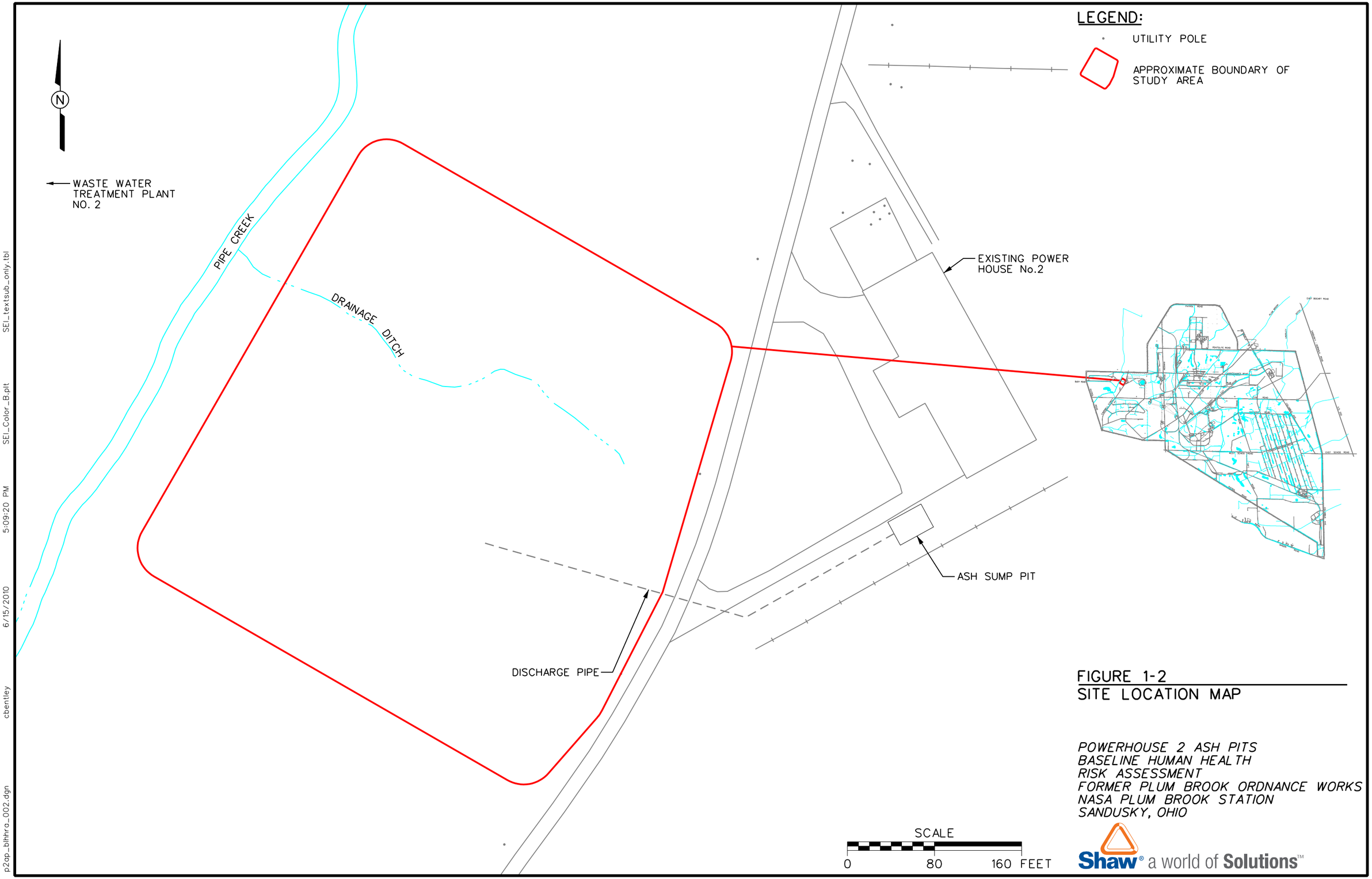

FIGURE 1-2
SITE LOCATION MAP

POWERHOUSE 2 ASH PITS
BASELINE HUMAN HEALTH
RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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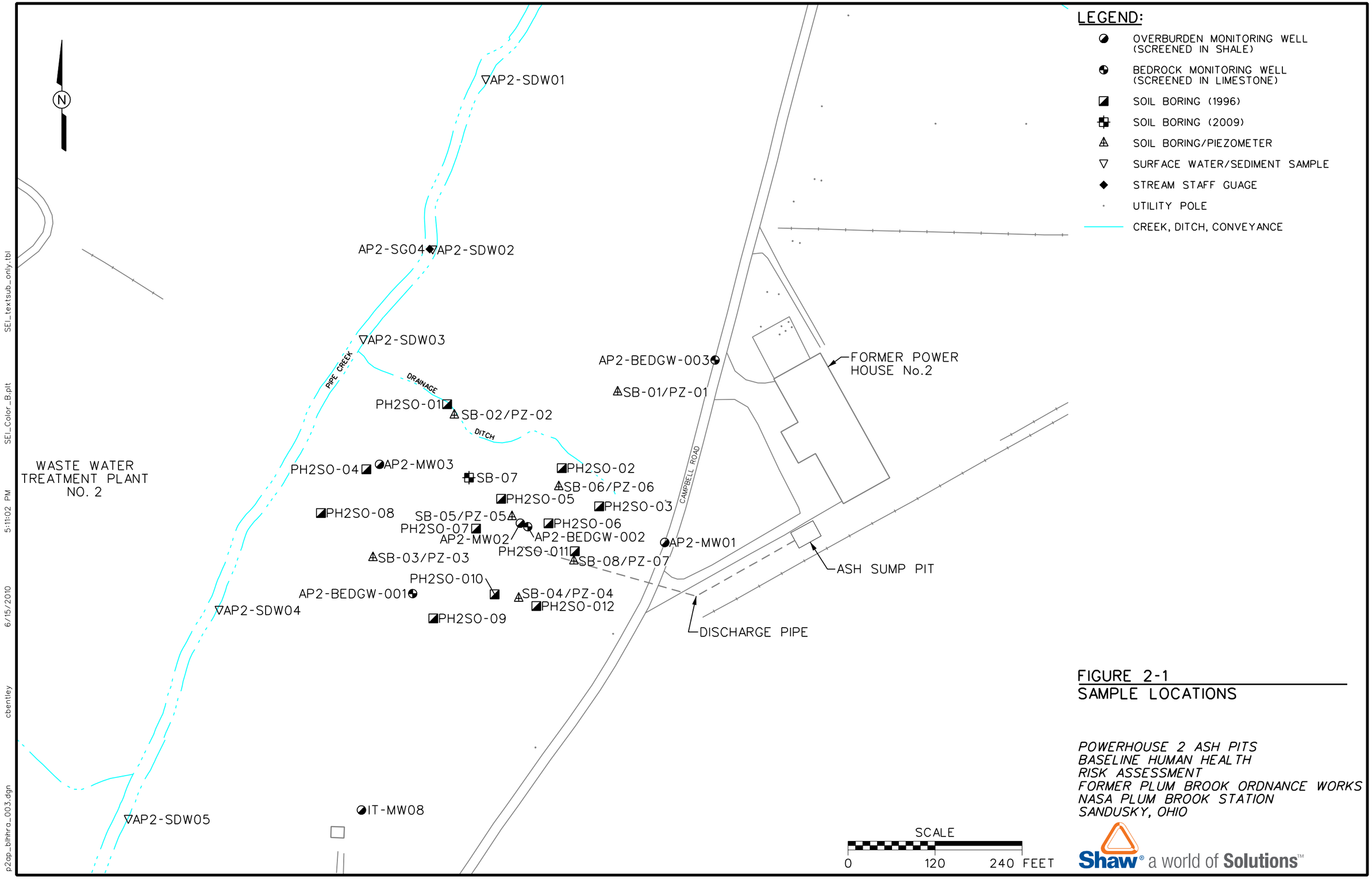
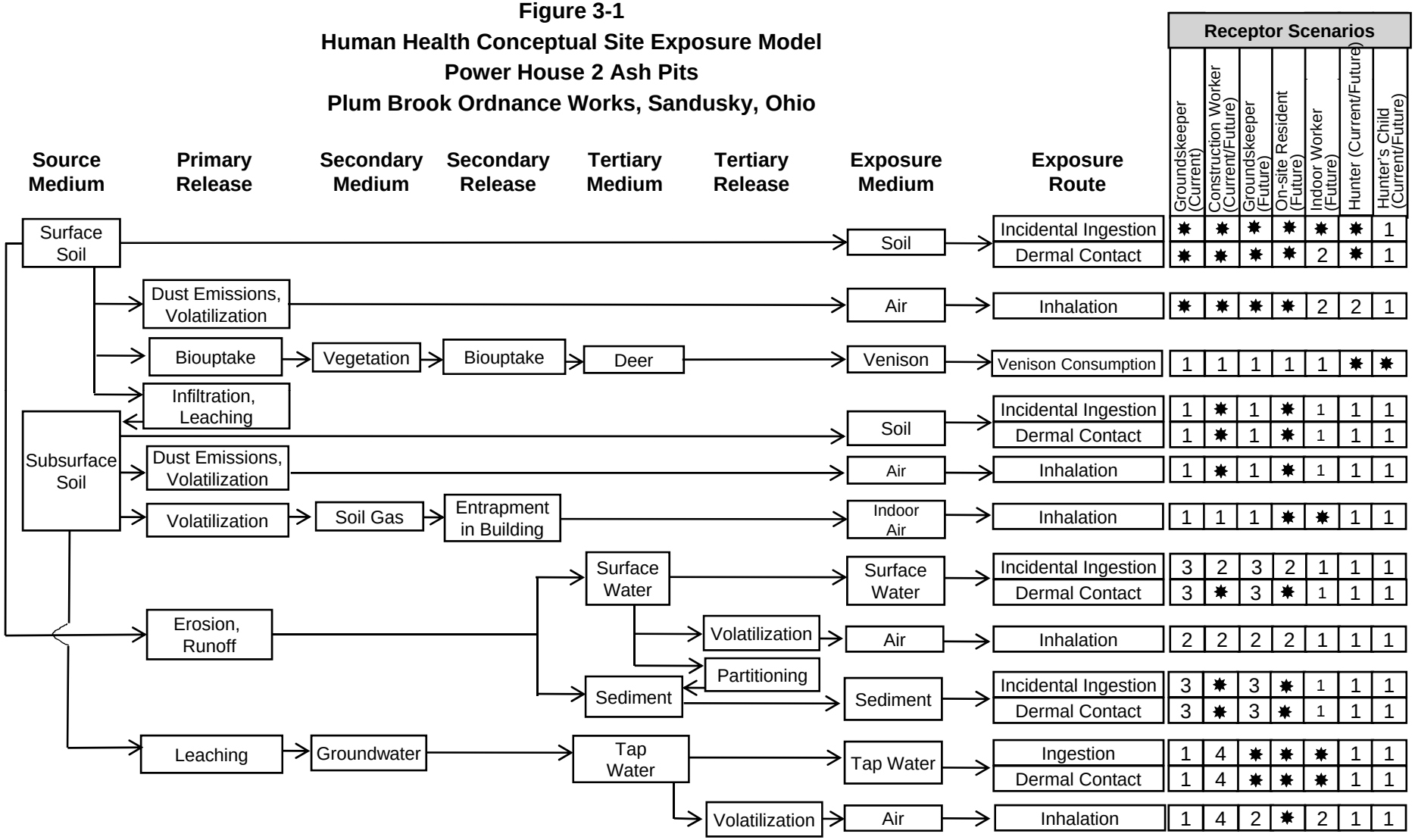


FIGURE 2-1
SAMPLE LOCATIONS

POWERHOUSE 2 ASH PITS
BASELINE HUMAN HEALTH
RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Figure 3-1
Human Health Conceptual Site Exposure Model
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio



✸ = 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 = Contact with this medium, although plausible, is not part of this receptor's normal or expected activities; therefore contact would be sporadic and is not quantified.
4 = 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.

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APPENDIX A

DATA SUMMARY OF CHEMICALS DETECTED IN OVERBURDEN GROUNDWATER PIEZOMETERS

Table A-1

Sample Summary of Overburden Groundwater Piezometers
Powerhouse 2 Ash Pit
Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Analyses
ASH PIT 2-PZ03	AP3018	REG	31-Jan-09	Cyanide, Exp, Field Tests, Gen Chem, Metals, (f & uf), SVOC
ASH PIT 2-PZ04	AP3019	REG	1-Feb-09	Cyanide, Exp, Field Tests, Gen Chem, Metals, (f & uf), SVOC
ASH PIT 2-PZ07	AP3015	FD	2-Feb-09	Cyanide, Exp, Gen Chem, Metals, (f & uf), SVOC
ASH PIT 2-PZ07	AP3022	REG	2-Feb-09	Cyanide, Exp, Field Tests, Gen Chem, Metals, (f & uf), SVOC

Table A-2

Summary and Screening of Chemicals Detected in Overburden Groundwater Piezometers
Powerhouse 2 Ash Pits
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	4 / 5	80	7.43E+01	J	2.40E+03		8.89E+01	2.00E+02	5.63E+02	3.09E+02	3.70E+03		Y	N
Barium	4 / 5	80	2.40E+01		5.11E+01		4.44E+00	2.00E+02	4.77E+01	1.18E+04	7.30E+02		N	N
Cadmium	4 / 5	80	3.91E+00	J	4.28E+00	J	4.44E+00	5.00E+00	3.82E+00		1.80E+00			Y
Calcium	5 / 5	100	1.01E+05		1.79E+05		1.11E+02	5.00E+03	1.27E+05	3.16E+05	Nutrient		N	N
Copper	3 / 5	60	5.63E+00	J	1.23E+01		1.11E+01	2.50E+01	8.34E+00	1.98E+01	1.50E+02		N	N
Iron	5 / 5	100	1.91E+02		5.06E+03		8.89E+01	1.00E+02	1.27E+03	1.55E+03	2.60E+03		Y	Y
Lead	1 / 5	20	3.02E+00	J	3.02E+00	J	3.00E+00	5.56E+00	2.57E+00		1.50E+01	e		N
Magnesium	5 / 5	100	2.92E+04		4.27E+04		4.44E+01	5.00E+03	3.51E+04	2.17E+05	Nutrient		N	N
Manganese	5 / 5	100	2.07E+01		5.18E+01		4.44E+00	1.50E+01	2.81E+01	6.36E+02	8.80E+01		N	N
Nickel	3 / 5	60	4.00E+00	J	6.28E+00	J	6.67E+00	4.00E+01	7.80E+00	8.60E+00	7.30E+01		N	N
Potassium	4 / 5	80	4.05E+02	J	1.26E+03		5.56E+02	5.00E+03	1.05E+03	1.16E+05	Nutrient		N	N
Selenium	1 / 5	20	7.55E+00	J	7.55E+00	J	5.00E+00	1.11E+01	5.34E+00		1.80E+01			N
Sodium	5 / 5	100	6.38E+03		1.22E+04		2.22E+02	5.00E+03	8.32E+03	1.39E+06	Nutrient		N	N
Vanadium	1 / 5	20	5.39E+00		5.39E+00		4.44E+00	5.00E+01	7.41E+00		1.80E+01			N
Inorganics - Filtered														
Barium	4 / 5	80	2.28E+01		3.49E+01		4.44E+00	2.00E+02	4.30E+01	1.08E+04	7.30E+02		N	N
Cadmium	4 / 5	80	3.90E+00	J	4.36E+00	J	4.44E+00	5.00E+00	3.77E+00		1.80E+00			Y
Calcium	5 / 5	100	1.03E+05		1.72E+05		1.11E+02	5.00E+03	1.24E+05	3.16E+05	Nutrient		N	N
Copper	1 / 5	20	6.90E+00	J	6.90E+00	J	1.11E+01	2.50E+01	7.21E+00	6.10E+00	1.50E+02		Y	N
Magnesium	5 / 5	100	2.99E+04		4.28E+04		4.44E+01	5.00E+03	3.52E+04	2.19E+05	Nutrient		N	N
Manganese	4 / 5	80	1.62E+01		3.07E+01		4.44E+00	1.50E+01	1.70E+01	6.69E+02	8.80E+01		N	N
Potassium	4 / 5	80	3.46E+02	J	5.10E+02	J	5.56E+02	5.00E+03	8.52E+02		Nutrient			N
Selenium	1 / 5	20	6.82E+00	J	6.82E+00	J	5.00E+00	1.11E+01	5.19E+00		1.80E+01			N
Sodium	5 / 5	100	6.18E+03		1.25E+04		2.22E+02	5.00E+03	8.36E+03	1.39E+06	Nutrient		N	N
Semivolatile Organic Compounds														
Dimethylphenol, 2,4-	1 / 5	20	3.38E+00	J	3.38E+00	J	1.00E+01	1.03E+01	4.70E+00		7.30E+01			N
General Chemistry (mg/L)														
Chloride	5 / 5	100	2.10E+00		1.16E+01	J	2.50E-01	1.00E+00	4.94E+00		Nutrient			N
Cyanide, total	1 / 5	20	4.40E-02		4.40E-02		1.00E-02	2.50E-02	1.88E-02		7.30E-02			N
Nitrate-Nitrite	3 / 4	75	2.80E-02	J	5.66E-01	J	4.00E-02	4.00E-01	2.11E-01		NA			Y
Sulfate	5 / 5	100	7.96E+01		3.41E+02		1.00E+00	5.00E+00	1.83E+02		2.50E+02	f		Y

RBSC - Risk based screening concentration; BSC - background screening concentration.
µg/L - micrograms per liter.
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), 2005b, 2004 Groundwater Data Summary and Evaluation Report, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, April.

[b] Risk-Based Screening Concentrations based on Oak Ridge National Laboratory-U.S. Environmental Protection Agency (ORNL-EPA) Regional Screening Level Table (December 2009) 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, DC, October).

[f] US 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

Appendix B

Surface Soil UCL Data Input
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Sample Location	Sample Number	Beryllium	D_Beryllium	Lead	D_Lead	Thallium	D_Thallium	Benzo(a)pyrene	D_Benzo(a)pyrene	Benzo(b)fluoranthene	D_Benzo(b)fluoranthene	Aroclor 1016
PH2SO01	4010	1.2	1	32.2	1	1.9	1	0.34	1	0.16	1	0.027
PH2SO02	4030	1.1	1	15.6	1	2.9	1	0.51	0	0.51	0	0.0255
PH2SO03	4050	1.2	1	25.4	1	1.7	0	0.198	1	0.57	0	0.0285
PH2SO04	4070	0.83	1	14.8	1	1.3	0	0.42	0	0.42	0	0.021
PH2SO05	4090	1.4	1	18.8	1	1.9	1	0.53	0	0.53	0	0.0265
PH2SO06	4110	1	1	15.6	1	4.4	1	0.43	0	0.43	0	0.0215
PH2SO07	4130	1.6	1	19.1	1	1.7	0	0.56	0	0.56	0	0.028
PH2SO08	4150	0.73	1	17.6	1	1.3	0	0.44	0	0.44	0	0.022
PH2SO09	4170	0.96	1	21.8	1	1.4	0	0.47	0	0.47	0	0.0235
PH2SO10	4190	1.2	1	25.5	1	5	1	0.59	0	0.59	0	0.0295
PH2SO11	4210	1.3	1	22.6	1	3.9	1	0.54	0	0.54	0	0.027
PH2SO12	4230	1.2	1	11.7	1	8.5	1	0.5	0	0.5	0	0.025
ASH PIT 2-SB01	AP0100	4.74	1	50.7	1	0.425	1	0.1688	1	0.13	1	0.0206
ASH PIT 2-SB02	AP0103	15.3	1	22.5	1	0.416	1	0.499	0	0.499	0	0.525
ASH PIT 2-SB03	AP0108	6.46	1	27.7	1	0.47	1	0.468	0	0.468	0	0.0234
ASH PIT 2-SB04	AP0111	16.3	1	10.1	1	0.468	1	0.442	0	0.442	0	0.02225
ASH PIT 2-SB05	AP0114	15.5	1	27.4	1	0.939	1	0.488	0	0.488	0	0.02405
ASH PIT 2-SB06	AP0117	12.1	1	12.5	1	0.312	1	0.417	0	0.417	0	0.0206
ASH PIT 2-SB07	AP0121AP0120	6.21	1	12.65	1	0.4585	0	0.4045	0	0.4045	0	0.020225
ASH PIT 2-SB08	AP0125	16.9	1	4.64	1	0.308	1	0.432	0	0.432	0	0.0212

Appendix B

Surface Soil UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

General UCL Statistics for Surface Soil

User Selected Options

From File	C:\Documents and Settings\debbi.freer\My Documents\PBOW\UCLss input.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Beryllium

General Statistics

Number of Valid Observations	20	Number of Distinct Observations	17

Raw Statistics		Log-transformed Statistics	
Minimum	0.73	Minimum of Log Data	-0.315
Maximum	16.9	Maximum of Log Data	2.827
Mean	5.362	Mean of log Data	1.009
Median	1.35	SD of log Data	1.181
SD	6.14		
Coefficient of Variation	1.145		
Skewness	1.078		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.717	Shapiro Wilk Test Statistic	0.809
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	7.735	95% H-UCL	12.11
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12.13
95% Adjusted-CLT UCL	7.973	97.5% Chebyshev (MVUE) UCL	15.12
95% Modified-t UCL	7.791	99% Chebyshev (MVUE) UCL	20.99

Gamma Distribution Test		Data Distribution
k star (bias corrected)	0.777	Data do not follow a Discernable Distribution (0.05)
Theta Star	6.897	
MLE of Mean	5.362	
MLE of Standard Deviation	6.081	
nu star	31.09	
Approximate Chi Square Value (.05)	19.35	**Nonparametric Statistics**
Adjusted Level of Significance	0.038	95% CLT UCL 7.62
Adjusted Chi Square Value	18.62	95% Jackknife UCL 7.735
		95% Standard Bootstrap UCL 7.556
Anderson-Darling Test Statistic	1.944	95% Bootstrap-t UCL 8.233
Anderson-Darling 5% Critical Value	0.774	95% Hall's Bootstrap UCL 7.496
Kolmogorov-Smirnov Test Statistic	0.312	95% Percentile Bootstrap UCL 7.664
Kolmogorov-Smirnov 5% Critical Value	0.2	95% BCA Bootstrap UCL 7.992
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 11.35
		97.5% Chebyshev(Mean, Sd) UCL 13.94
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 19.02
95% Approximate Gamma UCL	8.613	
95% Adjusted Gamma UCL	8.952	

Potential UCL to Use	Use 99% Chebyshev (Mean, Sd) UCL 19.02

Recommended UCL exceeds the maximum observation

Thallium

General Statistics

Appendix B

Surface Soil UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Number of Valid Observations	20	Number of Distinct Observations	17

Raw Statistics		Log-transformed Statistics	
Minimum	0.308	Minimum of Log Data	-1.178
Maximum	8.5	Maximum of Log Data	2.14
Mean	1.985	Mean of log Data	0.222
Median	1.35	SD of log Data	1
SD	2.076		
Coefficient of Variation	1.046		
Skewness	1.937		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.772	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	2.787	95% H-UCL	3.768
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4.155
95% Adjusted-CLT UCL	2.963	97.5% Chebyshev (MVUE) UCL	5.093
95% Modified-t UCL	2.821	99% Chebyshev (MVUE) UCL	6.935

Gamma Distribution Test		Data Distribution
k star (bias corrected)	1.068	Data appear Gamma Distributed at 5% Significance Level
Theta Star	1.858	
MLE of Mean	1.985	
MLE of Standard Deviation	1.921	
nu star	42.72	
Approximate Chi Square Value (.05)	28.73	**Nonparametric Statistics**
Adjusted Level of Significance	0.038	95% CLT UCL 2.748
Adjusted Chi Square Value	27.83	95% Jackknife UCL 2.787
		95% Standard Bootstrap UCL 2.718
Anderson-Darling Test Statistic	0.575	95% Bootstrap-t UCL 3.16
Anderson-Darling 5% Critical Value	0.764	95% Hall's Bootstrap UCL 3.296
Kolmogorov-Smirnov Test Statistic	0.181	95% Percentile Bootstrap UCL 2.823
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL 2.918
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 4.008
		97.5% Chebyshev(Mean, Sd) UCL 4.883
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 6.603
95% Approximate Gamma UCL	2.951	
95% Adjusted Gamma UCL	3.047	

Potential UCL to Use	Use 95% Approximate Gamma UCL 2.951

Appendix B

Surface Soil UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Aroclor 1016

General Statistics

Number of Valid Observations	20	Number of Distinct Observations	18

Raw Statistics		Log-transformed Statistics	
Minimum	0.0202	Minimum of Log Data	-3.901
Maximum	0.525	Maximum of Log Data	-0.644
Mean	0.0491	Mean of log Data	-3.58
Median	0.0238	SD of log Data	0.701
SD	0.112		
Coefficient of Variation	2.281		
Skewness	4.467		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.257	Shapiro Wilk Test Statistic	0.388
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.0924	95% H-UCL	0.0511
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0608
95% Adjusted-CLT UCL	0.117	97.5% Chebyshev (MVUE) UCL	0.0719
95% Modified-t UCL	0.0966	99% Chebyshev (MVUE) UCL	0.0936

Gamma Distribution Test		Data Distribution
k star (bias corrected)	0.898	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.0547	
MLE of Mean	0.0491	
MLE of Standard Deviation	0.0518	
nu star	35.94	
Approximate Chi Square Value (.05)	23.22	**Nonparametric Statistics**
Adjusted Level of Significance	0.038	95% CLT UCL 0.0903
Adjusted Chi Square Value	22.41	95% Jackknife UCL 0.0924
		95% Standard Bootstrap UCL 0.0889
Anderson-Darling Test Statistic	6.027	95% Bootstrap-t UCL 1.146
Anderson-Darling 5% Critical Value	0.768	95% Hall's Bootstrap UCL 0.406
Kolmogorov-Smirnov Test Statistic	0.501	95% Percentile Bootstrap UCL 0.0992
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL 0.125
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.158
		97.5% Chebyshev(Mean, Sd) UCL 0.206
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.298
95% Approximate Gamma UCL	0.076	
95% Adjusted Gamma UCL	0.0788	

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	0.158

Appendix B

Surface Soil UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Benzo(a)pyrene

General Statistics

Number of Valid Observations	20	Number of Distinct Observations	20

Raw Statistics		Log-transformed Statistics	
Minimum	0.169	Minimum of Log Data	-1.779
Maximum	0.59	Maximum of Log Data	-0.528
Mean	0.442	Mean of log Data	-0.855
Median	0.455	SD of log Data	0.317
SD	0.106		
Coefficient of Variation	0.241		
Skewness	-1.404		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.867	Shapiro Wilk Test Statistic	0.738
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.484	95% H-UCL	0.512
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.586
95% Adjusted-CLT UCL	0.474	97.5% Chebyshev (MVUE) UCL	0.646
95% Modified-t UCL	0.482	99% Chebyshev (MVUE) UCL	0.765

Gamma Distribution Test		Data Distribution
k star (bias corrected)	11	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.0402	
MLE of Mean	0.442	
MLE of Standard Deviation	0.133	
nu star	440.1	
Approximate Chi Square Value (.05)	392.5	**Nonparametric Statistics**
Adjusted Level of Significance	0.038	95% CLT UCL 0.482
Adjusted Chi Square Value	388.9	95% Jackknife UCL 0.484
		95% Standard Bootstrap UCL 0.479
Anderson-Darling Test Statistic	1.594	95% Bootstrap-t UCL 0.475
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL 0.476
Kolmogorov-Smirnov Test Statistic	0.262	95% Percentile Bootstrap UCL 0.479
Kolmogorov-Smirnov 5% Critical Value	0.194	95% BCA Bootstrap UCL 0.473
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.546
		97.5% Chebyshev(Mean, Sd) UCL 0.591
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.679
95% Approximate Gamma UCL	0.496	
95% Adjusted Gamma UCL	0.501	

Potential UCL to Use		Use 95% Student's-t UCL	0.484
		or 95% Modified-t UCL	0.482

Appendix B

Surface Soil UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Benzo(b)fluoranthene

General Statistics

Number of Valid Observations	20	Number of Distinct Observations	20

Raw Statistics		Log-transformed Statistics	
Minimum	0.13	Minimum of Log Data	-2.04
Maximum	0.59	Maximum of Log Data	-0.528
Mean	0.45	Mean of log Data	-0.853
Median	0.469	SD of log Data	0.388
SD	0.118		
Coefficient of Variation	0.261		
Skewness	-1.79		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.796	Shapiro Wilk Test Statistic	0.638
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.495	95% H-UCL	0.545
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.635
95% Adjusted-CLT UCL	0.482	97.5% Chebyshev (MVUE) UCL	0.712
95% Modified-t UCL	0.494	99% Chebyshev (MVUE) UCL	0.862

Gamma Distribution Test		Data Distribution
k star (bias corrected)	8.001	Data do not follow a Discernable Distribution (0.05)
Theta Star	0.0562	
MLE of Mean	0.45	
MLE of Standard Deviation	0.159	
nu star	320	
Approximate Chi Square Value (.05)	279.6	**Nonparametric Statistics**
Adjusted Level of Significance	0.038	95% CLT UCL 0.493
Adjusted Chi Square Value	276.6	95% Jackknife UCL 0.495
		95% Standard Bootstrap UCL 0.491
Anderson-Darling Test Statistic	2.357	95% Bootstrap-t UCL 0.486
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL 0.485
Kolmogorov-Smirnov Test Statistic	0.317	95% Percentile Bootstrap UCL 0.488
Kolmogorov-Smirnov 5% Critical Value	0.194	95% BCA Bootstrap UCL 0.483
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL 0.565
		97.5% Chebyshev(Mean, Sd) UCL 0.614
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL 0.712
95% Approximate Gamma UCL	0.515	
95% Adjusted Gamma UCL	0.521	

Potential UCL to Use		Use 95% Student's-t UCL	0.495
		or 95% Modified-t UCL	0.494

Appendix B

Subsurface Soil UCL Data Input
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

		Thallium	D_Thallium
ASH PIT 2-SB01	AP0101	0.458	0
ASH PIT 2-SB01	AP0102	0.423	1
ASH PIT 2-SB02	AP0107	0.343	1
ASH PIT 2-SB03	AP0109	0.35	1
ASH PIT 2-SB03	AP0110	0.336	1
ASH PIT 2-SB04	AP0112	0.541	0
ASH PIT 2-SB04	AP0113	0.315	1
ASH PIT 2-SB05	AP0115	0.482	0
ASH PIT 2-SB05	AP0116	0.347	1
ASH PIT 2-SB06	AP0118	0.497	0
ASH PIT 2-SB06	AP0119	0.293	1
ASH PIT 2-SB07	AP0123	0.439	0
ASH PIT 2-SB07	AP0124	0.316	1
ASH PIT 2-SB08	AP0126	0.444	0
PH2SO01	4020	1.1	0
PH2SO02	4040	1.2	0
PH2SO03	4060	1.3	1
PH2SO05	4100	1.1	0
PH2SO06	4120	1.3	0
PH2SO07	4140	1.1	0
PH2SO09	4180	1.2	0
PH2SO10	4200	2	1
PH2SO11	4220	2.4	1
PH2SO12	4240	1.4	1
ASH PIT 2-SB02	AP0104	0.3	1
ASH PIT 2-SB08	AP0127AP0128	0.5015	0
PH2SO04	40804081	1.2	0
PH2SO08	4160	1.5	1

Appendix B

Subsurface Soil UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

General UCL Statistics for Subsurface Soil

User Selected Options	
From File	C:\Documents and Settings\debbi.freer\My Documents\PBOW\UCLsbs input.wst
Full Precision	OFF
Confidence Coefficient	95%
lumber of Bootstrap Operations	2000

Thallium

General Statistics

Number of Valid Data	28	Number of Detected Data	14
Number of Distinct Detected Data	14	Number of Non-Detect Data	14
		Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.293	Minimum Detected	-1.228
Maximum Detected	2.4	Maximum Detected	0.875
Mean of Detected	0.83	Mean of Detected	-0.521
SD of Detected	0.736	SD of Detected	0.818
Minimum Non-Detect	0.439	Minimum Non-Detect	-0.823
Maximum Non-Detect	1.3	Maximum Non-Detect	0.262

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	23
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	5
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	82.14%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.74	Shapiro Wilk Test Statistic	0.758
5% Shapiro Wilk Critical Value	0.874	5% Shapiro Wilk Critical Value	0.874
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	0.622	Mean	-0.752
SD	0.567	SD	0.695
95% DL/2 (t) UCL	0.804	95% H-Stat (DL/2) UCL	0.843
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.538	Mean in Log Scale	-0.726
SD	0.819	SD in Log Scale	0.625
95% MLE (t) UCL	0.802	Mean in Original Scale	0.617
95% MLE (Tiku) UCL	1.236	SD in Original Scale	0.558
		95% Percentile Bootstrap UCL	0.795
		95% BCA Bootstrap UCL	0.839

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Subsurface Soil UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.336
Theta Star	0.622
nu star	37.4
A-D Test Statistic	1.714
5% A-D Critical Value	0.749
K-S Test Statistic	0.749
5% K-S Critical Value	0.232

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.293
Maximum	2.4
Mean	0.831
Median	0.833
SD	0.511
k star	2.823
Theta star	0.294
Nu star	158.1
AppChi2	130
95% Gamma Approximate UCL	1.01
95% Adjusted Gamma UCL	1.023

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.583
SD	0.56
SE of Mean	0.11
95% KM (t) UCL	0.77
95% KM (z) UCL	0.764
95% KM (jackknife) UCL	0.767
95% KM (bootstrap t) UCL	0.854
95% KM (BCA) UCL	0.763
95% KM (Percentile Bootstrap) UCL	0.777
95% KM (Chebyshev) UCL	1.063
97.5% KM (Chebyshev) UCL	1.27
99% KM (Chebyshev) UCL	1.678

Potential UCLs to Use

95% KM (t) UCL	0.77
95% KM (% Bootstrap) UCL	0.777

Appendix B

Sediment UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Sample Location	Sample Number	Arsenic	D_Arsenic	Chromium	D_Chromium
ASH PIT 2-SD04	AP1003AP1004	8.55	1	11.65	1
ASH PIT 2-SD01	AP1000	4.1	1	6.4	1
ASH PIT 2-SD02	AP1001	5.1	1	10.5	1
ASH PIT 2-SD03	AP1002	10.1	1	8.6	1
ASH PIT 2-SD05	AP1006	3.9	1	7.7	1

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Sediment UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

General UCL Statistics for Sediment

User Selected Options

From File	C:\Documents and Settings\debbi.freer\My Documents\PBOW\UCL input.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5

Raw Statistics		**Log-transformed Statistics**	
Minimum	3.9	Minimum of Log Data	1.361
Maximum	10.1	Maximum of Log Data	2.313
Mean	6.35	Mean of log Data	1.772
Median	5.1	SD of log Data	0.433
SD	2.808		
Coefficient of Variation	0.442		
Skewness	0.665		

Warning: A sample size of 'n' = 5 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 5 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.

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.856	Shapiro Wilk Test Statistic	0.872
Shapiro Wilk Critical Value	0.762	Shapiro Wilk Critical Value	0.762
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	9.027	95% H-UCL	11.71
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11.65
95% Adjusted-CLT UCL	8.814	97.5% Chebyshev (MVUE) UCL	13.95
95% Modified-t UCL	9.089	99% Chebyshev (MVUE) UCL	18.47

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Sediment UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Gamma Distribution Test

k star (bias corrected)	2.812
Theta Star	2.258
MLE of Mean	6.35
MLE of Standard Deviation	3.787
nu star	28.12
Approximate Chi Square Value (.05)	17.02
Adjusted Level of Significance	0.0086
Adjusted Chi Square Value	13.39
Anderson-Darling Test Statistic	0.451
Anderson-Darling 5% Critical Value	0.68
Kolmogorov-Smirnov Test Statistic	0.261
Kolmogorov-Smirnov 5% Critical Value	0.358

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	10.49
95% Adjusted Gamma UCL	13.33

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	8.415
95% Jackknife UCL	9.027
95% Standard Bootstrap UCL	8.232
95% Bootstrap-t UCL	15.35
95% Hall's Bootstrap UCL	26.06
95% Percentile Bootstrap UCL	8.48
95% BCA Bootstrap UCL	8.28
95% Chebyshev(Mean, Sd) UCL	11.82
97.5% Chebyshev(Mean, Sd) UCL	14.19
99% Chebyshev(Mean, Sd) UCL	18.84

Potential UCL to Use

Use 95% Student's-t UCL 9.027

Chromium

General Statistics

Number of Valid Observations	5	Number of Distinct Observations	5

Raw Statistics

Minimum	6.4
Maximum	11.65
Mean	8.97
Median	8.6
SD	2.114
Coefficient of Variation	0.236
Skewness	0.166

Log-transformed Statistics

Minimum of Log Data	1.856
Maximum of Log Data	2.455
Mean of log Data	2.171
SD of log Data	0.24

Warning: A sample size of 'n' = 5 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 5 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.

Appendix B

Sediment UCL Data Output
Powerhouse 2 Ash Pits
former Plum Brook Ordnance Works
Sandusky, Ohio

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.97
Shapiro Wilk Critical Value	0.762

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.974
Shapiro Wilk Critical Value	0.762

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	10.99

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL	10.6
95% Modified-t UCL	11

Assuming Lognormal Distribution

95% H-UCL	11.85
95% Chebyshev (MVUE) UCL	13.15
97.5% Chebyshev (MVUE) UCL	14.96
99% Chebyshev (MVUE) UCL	18.52

Gamma Distribution Test

k star (bias corrected)	9.013
Theta Star	0.995
MLE of Mean	8.97
MLE of Standard Deviation	2.988
nu star	90.13
Approximate Chi Square Value (.05)	69.24
Adjusted Level of Significance	0.0086
Adjusted Chi Square Value	61.28
Anderson-Darling Test Statistic	0.209
Anderson-Darling 5% Critical Value	0.679
Kolmogorov-Smirnov Test Statistic	0.197
Kolmogorov-Smirnov 5% Critical Value	0.357

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	11.68
95% Adjusted Gamma UCL	13.19

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	10.53
95% Jackknife UCL	10.99
95% Standard Bootstrap UCL	10.36
95% Bootstrap-t UCL	11.86
95% Hall's Bootstrap UCL	12.22
95% Percentile Bootstrap UCL	10.4
95% BCA Bootstrap UCL	10.35
95% Chebyshev(Mean, Sd) UCL	13.09
97.5% Chebyshev(Mean, Sd) UCL	14.87
99% Chebyshev(Mean, Sd) UCL	18.38

Potential UCL to Use

Use 95% Student's-t UCL 10.99

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 the latest USEPA (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, 2010; NIST, 2010) 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

A toxicokinetics section was added to the toxicological profiles in early 2004. 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 EPA (2010) 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, 2010). 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 (2010) 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 supercede 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.

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METALS

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, 2000; HSDB, 2010). 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), 2004, National Library of Medicine, on line, accessed 21 April.
[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), 2000, ***Update Toxicological Profile for Arsenic***, U.S. Public Health Service, Atlanta, Georgia, September, on line.

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, 2010). 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, 2000).

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, 2000). 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, 2000). 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, 2000). 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, 2000). 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, 2000). 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, 2010). Similar effects were observed in persons exposed to high levels of arsenic in water in Utah and the northern part of Mexico. EPA (2010) 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 (2010) 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, 2010). 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 (2010) 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 (200) 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, 2010).

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

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
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: 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

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U.S. Environmental Protection Agency (EPA), 2010, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

BERYLLIUM

Beryllium is a naturally occurring **metal**, which is used in its pure state or as alloys in a wide variety of electrical components, tools, optical components, precision instruments, structural components of aircraft, missiles and satellites, and other metal-fabricating applications (ATSDR, 2000; HSDB, 2010. Beryllium oxide is used in high-technology ceramics, electronic heat sinks, and several refractory applications. 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)
9.01[a] (element)	NA	NA	7.9E+2[b]	NA	NA	ND	Note 1[c]

NA = not applicable, ND = no data.
Note 1: Beryllium chloride (typical soluble salt): very soluble.
[a]Hazardous Substance Data Bank (HSDB), 2010, 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), 2000, ***Update Toxicological Profile for Beryllium***, U.S. Public Health Service, Atlanta, Georgia, September, on line.

Although beryllium is a naturally occurring metal, the predominant release to the atmosphere is emissions from fossil fuel combustion, particularly coal (ATSDR, 2000; HSDB, 2010). Beryllium production and use in alloys, microelectronics, aerospace technology, as a solid-propellant in rocket fuels, in aircraft brakes, X-ray windows, and neutron reflectors contribute small amounts to the environment. Beryllium exists in air as particulates that are subject to wet and dry deposition. Smaller particles may travel large distances before removal from the air.

Deposition from the atmosphere and waste disposal contributes beryllium to soil (ATSDR, 2000; HSDB, 2010). Beryllium is expected to be essentially immobile in soil regardless of pH or the presence or absence of specific soil constituents; therefore, leaching to groundwater is not expected to be significant. Beryllium in surface water tends to form insoluble beryllium hydroxide or sorb to suspended mineral solids and sediments in water; very little beryllium exists in a soluble form.

Beryllium is not expected to bioconcentrate or reach significance in aquatic or terrestrial chain pathways (ATSDR, 2000). Therefore, biotransfer factors for beryllium are not compiled. A GAF of 0.01 is chosen for this evaluation (EPA, 2004).

Data were not located regarding the extent of dermal uptake of beryllium 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 beryllium from water were not located. The EPA (2004) default PC for inorganic chemicals of 1E-3 cm/hour is selected for beryllium.

A (172-week) dietary study in dogs identified GI lesions as the critical effect of chronic ingestion exposure to beryllium (EPA, 2010). A verified chronic oral RfD of 2E-3 mg/kg-day was based

on a BMD_{10} (statistical estimate of a dose level associated with a 10 percent dose rate) of 4.6E-1 mg/kg-day in the dog study. An uncertainty factor of 300 was applied. Confidence in the RfD is low to medium. The GI tract is the target organ for chronic oral exposure.

Occupational exposure is associated with dermatitis, acute pneumonitis and chronic pulmonary granulomatosis (Reeves, 1986), also known as berylliosis or chronic beryllium disease. Berylliosis has also been observed in humans living in the vicinity of a beryllium plant. Similar pulmonary effects were observed in laboratory animals subjected to inhalation exposure. A verified chronic inhalation RfC of 2E-2 mg/m^3 was based on a LOAEL of 2.0E-1 μg/m^3 in an occupational study, and a NOAEL of 1.0E-2 to 1.0E-1 μg/m^3 in a community exposure study (EPA, 2010). The critical endpoint is beryllium sensitization and progression to berylliosis. An uncertainty factor of 10 was used. The target organ for inhalation exposure to airborne beryllium is the lung. Confidence in the inhalation RfC is medium. The RfC is equivalent to a chronic inhalation RfD of 5.7E-6 mg/kg-day.

EPA (2010) classified beryllium in cancer weight-of-evidence Group B1 (probable human carcinogen) based on limited human (occupational) cancer data and sufficient animal data. A significant increase in lung tumors occurred in rats and in rhesus monkeys subjected to inhalation exposure or intratracheal instillation of a variety of beryllium compounds. Osteogenic sarcomas were induced in rabbits and mice, but not in rats or guinea pigs, injected intravenously with various beryllium compounds. A verified inhalation URF of 2.4E-3 per μg/m^3 equivalent to an SF of 8.4E+0 per mg/kg-day was derived from an occupational study. The B1 classification applies only to inhalation exposure. Oral studies in animals yielded inconclusive results. EPA (2010) concluded that the potential carcinogenicity of oral exposure of humans to beryllium cannot be determined.

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CHROMIUM (7440-47-3)

1.0 Introduction and Physical Properties

Chromium is a naturally occurring **metal** (ATSDR, 2000). 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), 2000, ***Toxicological Profile for Chromium***, U.S. Public Health Service, Atlanta, Georgia, September, on line.
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, 2000). 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, 2000). 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, 2000). 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, 2000; 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, 2000). 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, 2000). 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, 2000). 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, 2000). 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, 2000). 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, 2000). 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, 2000).

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, 2010).

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, 2000). EPA (2010) 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 (2010) 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 (2010) 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 relatively recent (1998) revision to a previously verified derivation. Nonetheless, EPA (2010) 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.

The data summarized by EPA (2010) are insufficient to identify a mechanism of toxicity or target organ(s) for chronic oral exposure to chromium (VI). Data from other sources, however, are sufficient to identify potential target organs. Goyer (1991) reported that renal tubular necrosis is the major effect in humans from ingestion of chromium compounds. The context, however, suggests that this effect is associated with acute exposure to high doses (e.g., accidental or attempted suicide ingestion); therefore, the kidney may not be an acceptable candidate as a target organ for chronic oral exposure. Furthermore, a review of human and animal studies by EPA (1998a) did not implicate the kidney as a target organ for chronic oral exposure. EPA (1998a), however, reported GI effects in a cohort of 155 Chinese villagers who consumed water from a well located adjacent to a chromium alloy plant. Symptoms included oral ulcers, diarrhea, abdominal pain, indigestion, and leukocytosis with a left shift. The dose rate of chromium (VI) was estimated at 0.57 mg/kg-day, nearly 200 times the oral RfD. It is likely that the GI symptoms reflect the irritant nature of chromium (VI).

EPA (1998a) also reviewed several reproductive studies. An early and inadequately conducted study reported no effects in rats fed a diet containing 0.125 percent K_2CrO_4. A diet containing 0.25 percent resulted in “subnormal condition” (including rough coat) and “subnormal” offspring; a diet containing 0.5 percent resulted in diarrhea and sterility. Assuming rats consume food equivalent to 5 percent of their body weight each day (EPA, 1980), dietary levels of 0.125, 0.25 and 0.5 percent correspond to chromium (VI) dose rates of 17, 33, and 67 mg/kg-day, respectively. Drinking water studies consistently report developmental effects and impaired reproduction in rats and mice ingesting approximately 20 mg chromium (VI)/kg-day. A well controlled study reported slightly decreased erythrocyte size and hemoglobin content in rats and mice of either sex fed diets containing 400 ppm potassium chromate. The effects were interpreted as “suggestive of a potential bone marrow/erythroid response.” The 400 ppm diet is equivalent to chromium (VI) dose rates of 6.4 mg/kg-day in rats (EPA, 1998a) and approximately 11 mg/kg-day in mice, assuming that mice consume food equivalent to 10 percent of their body weight/day (EPA, 1980). In addition, cytoplasmic vacuolization of hepatocytes was observed in mice fed diets containing 50, 100 or 400 ppm potassium chromate, but it is not clear if either the incidence or intensity occurred in a dose-related manner. The 50 ppm diet, the lowest associated with hepatocellular vacuolization, is equivalent to a chromium (VI) intake rate of approximately 1.3 mg/kg-day. A subsequent study reported decreased erythrocyte hemoglobin content in female mice fed a diet containing 100 ppm potassium chromate, equivalent to a chromium (VI) dose rate of 6.0 mg/kg-day.

The GI signs reported in humans are clearly an indication of adverse effects; therefore, the GI tract is selected as a target organ. The mechanism of toxicity is assumed to be the irritation induced by tissue contact with chromium (VI). The slight hematologic changes observed in rats and mice and the hepatocellular vacuolization observed in mice do not appear to be sufficiently threatening to be considered adverse. Therefore, target organs selected for chronic oral exposure to chromium (VI) include the GI tract, unborn child (fetus), and reproductive system.

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, 2010). 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, 2010) 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 (2010) 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 (2010) 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 (2010) 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, 2010). 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 (2010) 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, 2010). 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 (200) 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
Chromium (VI)[b]										
8E-3	3E-3	GI, F, Re	3E-4/ 9.7E-5	1E-4/ 2.9E-5	Lu	D	ND	A	1.2E-2	4.2E+1

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
Total Chromium[c]										
NA	2.1E-2	GI, F, Re	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: GI = gastrointestinal tract, F = unborn child (fetus), Re = reproductive system, 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 2010; EPA, 2004b).

8.0 References

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NICKEL 7440-02-0)

1.0 Introduction and Physical Properties

Nickel is a naturally occurring **metal** whose concentration ranks 24th in the crust of the earth (ATSDR, 2003), averaging approximately 180 mg/kg (HSDB, 2010). Its primary use is in metal alloys, to which it imparts many desirable characteristics. Nickel compounds are used for nickel plating, to color ceramics, to make some batteries, and as catalysts that increase the rate of various chemical reactions (ATSDR, 2003). Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
58.69[a] (element)	NA	NA	6.5E+1[b]	NA	NA	ND	Note1[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: Nickel chloride as a typical nickel salt: 6.42E+5 at 20°C.
[a]Hazardous Substance Data Bank (HSDB), 2010, National Library of Medicine, on line.
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 [c]Agency for Toxic Substances and Disease Registry, (ATSDR), 2003, *Update Toxicological Profile for Nickel*, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia, September, on line.

2.0 Environmental Fate and Transport

Natural sources of airborne particles that contain nickel include soil, sea, volcanoes, forest fires, and vegetation (ATSDR, 2003; HSDB, 2010). Meteorites that enter the atmosphere contribute free nickel to the air. Anthropogenic releases of nickel, approximately 1.4 to 5 times as great as natural releases, include combustion of fuel oils (including diesel engine emissions) and coal, nickel refining, municipal waste incineration, and steel and nickel alloy production. Nickel exists in the atmosphere as free metal and as various compounds, all in the form of particulates. Small particles may remain suspended in the air for long periods (half-life up to 30 days) and travel great distances. Removal mechanisms are limited to gravitational settling and wet and dry deposition.

Nickel is deposited on soil from the atmosphere (ATSDR, 2003; HSDB, 2010). Other contributions to soil include direct disposal of nickel-containing waste. Nickel in soil is subject to adsorption, precipitation, coprecipitation and complexation, which tend to immobilize it and reduce leaching. Several soil properties, such as calcium and magnesium content and pH, control the extent to which nickel remains immobile or available for leaching because several nickel salts are quite soluble.

Nickel gains access to surface water bodies by direct deposition from the atmosphere, in waste streams from industries that process or use nickel, from domestic waste water treatment plants, and by erosion and runoff from soil (ATSDR, 2003; HSDB, 2010). Nickel in water is subject to the same processes that occur in soil. These processes transfer nickel to particles that are subject to settling; however, large proportions may remain in solution (e.g., 75 percent in one polluted lake).

Empirical data with voles and rabbits living in sludge-amended land, as well as with aquatic invertebrates and vertebrates, suggest that nickel is not biomagnified in either aquatic or terrestrial food chain pathways (ATSDR, 2003). Nickel was identified by the EPA (1995) as a metal of no concern to human health from bioconcentration in fish. Therefore, biotransfer factors are not presented for nickel.

3.0 Toxicokinetics

Absorption of inhaled nickel that reaches the lungs (i.e., particles less than 1 micrometer in diameter) approximates 20 to 35 percent, depending on the specific compound involved (ATSDR, 2003). Uptake from the GI tract depends greatly on the specific compound and the mode of administration. In one study with humans uptake of nickel sulfate given in drinking water was much higher (approximately 27 percent) than when given in food (approximately 0.7 percent). Other studies show that the nature of the food items and their time of consumption relative to the time of administration of nickel have a great effect on the extent of uptake. EPA (2004) cited a 1972 study to support the GAF of 4 percent in humans for nickel in food and water.

Nickel has been shown to penetrate the skin. Studies in humans with radioactive nickel sulfate applied to occluded skin indicate that 55 to 77 percent of the dose is absorbed within 24 hours (ATSDR, 2003). A study in guinea pigs indicated that systemic absorption accounts for 0.005 percent to 0.51 percent of the dermally applied dose of radioactive nickel chloride. The extent to which nickel is sequestered in the dermis and the extent to which it passes to the bloodstream is unclear.

Highest levels of nickel are found in the lungs in occupationally exposed humans and animals exposed by the inhalation route (ATSDR, 2003). Highest levels in animals treated *per os* were found in the kidneys and blood. Significant levels were also found in liver, heart, lung and fat. Highest levels in animals following dermal treatment were found in the skin, blood, kidneys and liver.

Nickel metabolism is limited to ligand exchange reactions by which the cation binds to albumin and other serum proteins (ATSDR, 2003). Dogs lack some of the binding sites present in the serum of other species; therefore, more nickel in dog serum remains free and unbound. Some serum nickel binds to nickeloplasmin, which appears to represent a non-exchangeable pool.

Absorbed nickel is excreted in the urine regardless of the route of exposure (ATSDR, 2003). An excretion half-time of approximately 28 hours has been estimated for humans.

4.0 Dermal Exposure

As noted above, EPA (2004) estimated a GAF for nickel of 4 percent.

Data were not located regarding dermal uptake of nickel in 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. EPA (2004) compiled *in vitro* data from human experiments of dermal uptake of soluble salts of nickel from water. An

average K_p value of 6.4E-5 cm/hour is estimated for nickel from 5 studies reviewed by EPA (2004) and is used in this evaluation.

5.0 Noncancer Effects Evaluation

In a subchronic gavage study with nickel chloride in water, clinical signs of toxicity in rats included lethargy, ataxia, irregular breathing, reduced body temperature, salivation and discolored extremities (EPA, 2010). EPA (2010) presented a verified RfD of 2E-2 mg/kg-day for chronic oral exposure to nickel, based on a NOAEL for decreased organ and body weights in a two-year dietary study with nickel sulfate in rats and an uncertainty factor of 300. Confidence in the oral RfD is medium. The critical effect of prolonged oral exposure to low levels of nickel appears to be reduced body and organ weights without histopathological lesions. EPA (1997) adopted the verified chronic oral RfD of 2E-2 mg/kg-day as the provisional subchronic oral RfD. These oral RfDs are appropriate for oral exposure to soluble salts of nickel or unspeciated nickel compounds.

Inhalation exposure is associated with asthma and pulmonary fibrosis in welders using nickel alloys (ACGIH, 1991). Lung effects were observed in laboratory animals exposed by inhalation. Although the lung is clearly the target organ for inhalation exposure, the data are inadequate for derivation of an inhalation RfC or RfD.

6.0 Carcinogenicity Evaluation

Occupational exposure to nickel is associated with increased risk of nasal, laryngeal and lung cancer (ACGIH, 1991; ATSDR, 2003). Inhalation exposure of rats to nickel subsulfide increased the incidence of lung tumors. EPA (2010) presented a cancer weight-of-evidence Group A classification (human carcinogen) for nickel, and an inhalation URF of 2.4E-4 per $\mu g/m^3$ for nickel refinery dust. The URF is equivalent to 8.4E-1 per mg/kg-day. The quantitative estimate was derived from human occupational studies. EPA (2010) also presented a URF of 4.8E-4 per $\mu g/m^3$, which is equivalent to 1.7E+0 per mg/kg-day, for nickel subsulfide, one of the most predominant constituents in nickel refinery dust. The evaluation for nickel refinery dust is ordinarily chosen when the form of nickel in air is unknown. The Group A classification should apply only to inhalation exposure.

7.0 Toxicity Summary

Toxicity values for nickel 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
Nickel, Soluble Salts or Unspeciated										
2E-2	2E-2	BW	ND	ND	NA	Please see below.				
Nickel Refinery Dust										
Please see above						NA	NA	A	2.4E-4	8.4E-1
Nickel Subsulfide										
Please see above.						NA	NA	A	4.8E-4	1.7E+0

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

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
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: BW = reduced body weight. [a]sRfDo and cRfDo should be adjusted by the GAF of 0.04 when applied to dermal exposure.										

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SELENIUM (7782-49-2)

Introduction and Physical Properties

Selenium is an inorganic element ubiquitously distributed in nature that occurs in most rocks and soils at concentrations of 0.1 to 2.0 mg/kg, or 0.05 to 0.09 mg/kg in the earth s crust as a whole (ATSDR, 1996, HSDB, 2010). Selenium is used predominantly in the semiconductor industry and in photoelectric applications. Other uses include glass making, pigments, anti-dandruff shampoos, fungicides and medical imaging. Dietary supplements for livestock are the largest agricultural use. Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
78.96[a] (Element)	NA	NA	5.0E+0[b]	NA	NA	ND	Note 1[a, 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: Element insoluble in water; many selenites and selenates are relatively soluble.
[a]Hazardous Substance Data Bank (HSDB), 2010, National Library of Medicine, on line, last accessed 26 September.
[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]Agency for Toxic Substances and Disease Registry, (ATSDR), 1996, ***Update Toxicological Profile for Selenium***, U.S. Public Health Service, Atlanta, Georgia, August, on line.

Environmental Fate and Transport

Natural atmospheric releases of selenium result from volatilization, as a result of biomethylation of selenium by plants and bacteria, and from volcanic eruptions (ATSDR, 1996; HSDB, 2010). Leaching and weathering of parent bedrock material may result in release to soil. Anthropogenic selenium releases include mining and milling operations, base metal smelting and refining, selenium refining, the burning of coal, oil and solid waste, and the uses described above. Burning of coal and production of copper account for approximately 62 and 26 percent, respectively, of the total anthropogenic selenium released to the atmosphere. One study showed that approximately 53 percent of the selenium contained in coal is emitted to the atmosphere as volatilized selenium compounds or included with particles of fly ash.

The majority of selenium in the atmosphere is expected to exist in the particulate form (HSDB, 2010). Particulate-phase selenium may be physically removed from the air by wet and dry deposition (ATSDR, 1996; HSDB, 2010). The volatile selenium compounds such as selenium dioxide, hydrogen selenide, dimethyl selenide, and dimethyl diselenide are expected to exist in the gaseous state in the atmosphere. Hydrogen selenide released to the air is unstable and will be oxidized to elemental selenium and water. Selenium dioxide released to the air from the combustion of fossil fuels is expected to be reduced to elemental selenium by sulfur dioxide formed during combustion.

The behavior of selenium in soils is affected by redox conditions, pH, hydrous oxide content, clay content, organic materials and the presence of competing anions (ATSDR, 1996; HSDB, 2010). Heavy metal selenides, which are insoluble, predominate in acidic soils and soils with

high amounts of organic matter. Selenium in this form is immobile. Sodium and potassium selenites dominate in neutral, well-drained mineral soils. Selenites are soluble, but can strongly adsorb to soil minerals and organic matter. Iron and manganese oxides adsorb selenite, with iron oxides adsorbing more than manganese. In alkaline, well-oxidized soil environments, selenates predominate. The selenates are very mobile because of their high water solubility and low tendency to sorb to soil particles. Selenite adsorption was observed to decrease with increasing pH in the range 4 to 9, and selenate adsorption was minimal under most pH conditions. In soils, elemental selenium and inorganic selenium compounds can be methylated by microorganisms and subsequently volatilize to the atmosphere. Dimethyl selenide and dimethyl diselenide are the principal methylation products.

Surface water may receive selenium from the atmosphere by wet or dry deposition, from surface runoff or erosion, from subsurface drainage or from various waste streams (ATSDR, 1996; HSDB, 2010). Selenium in surface water forms oxyanions and exhibits anionic chemistry. Volatilization of the ionic forms is not expected to be an important fate process. Which anionic form predominates is determined by the pH and redox potential of the water. Elemental selenium is favored by low pH and reducing conditions. Selenates are stable under alkaline oxidizing conditions. Selenious acid species occur under the intermediate to slightly oxidizing conditions generally encountered in aerobic water. Over the pH range of 3 to 9, the biselenite species predominate; at pH values greater than 9, selenite is the major species. At pH values less than 7 and under mildly reducing conditions, selenites are reduced to elemental selenium. Reducing conditions in surface sediments or ponded laboratory sediment columns promote the progressive reduction of soluble selenate to soluble selenite to insoluble elemental selenium, which tends to accumulate. Reduced selenium adsorbed to sediment will remain relatively immobile unless the sediments are chemically or biologically oxidized. Biological methylation of selenium may occur in aquatic environments; inorganic selenium undergoes biological methylation to dimethyl selenide and dimethyl diselenide, which are subject to volatilization.

Selenium has been identified by the EPA (1995) as a chemical that is not a bioaccumulative chemical of concern in fish; therefore, a BCF is not included for selenium. Other data, however, indicate that selenium has the potential to bioaccumulate and possibly to biomagnify in terrestrial food chain pathways (ATSDR, 1996; HSDB, 2010). Biotransfer factors for selenium are compiled below:

BCF	Bpr	Bpv	Bb	Bm
NA[a]	2.5E-2[b]	2.5E-2[b]	1.5E-2[b]	4.0E-3[b]

BCF = bioconcentration factor, L/kg; Bpr = soil-to-plant (reproductive portions) biotransfer factor, unitless; Bpv = soil-to-plant (vegetative portions) biotransfer factor, unitless; Bb = soil-to-beef biotransfer factor, days/kg; Bm = soil-to-milk biotransfer factor, days/kg; NA = not applicable.
[a]See above.
[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.

Data for Evaluating Dermal Exposure

Selenium appears to be readily absorbed from the GI tract, apparently nearly free from homeostatic control, especially the soluble forms, but the form of selenium administered affects absorption efficiency (ATSDR, 1996; HSDB, 2010). Reported absorption efficiencies range

from 30 to 46 percent up to 95 to 97 percent. Reasons for the wide range are unclear. Cats treated with a variety of selenium compounds excreted not more than 20 percent of the dose in the feces, indicating that upwards of 80 percent was absorbed. EPA (2004) recommends that oral toxicity values should not be adjusted to reflect the extent of GI absorption unless GI absorption is significantly less than complete. Therefore, a GAF is not estimated for selenium and the oral toxicity values are used for dermal exposure without adjustment.

The empirical data indicate that selenium is absorbed by the skin, at least by mice. However, data were not located regarding the extent of dermal uptake of selenium 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 (2001) default PC for metals of 1E-3 cm/hour is used for selenium.

Noncancer Effects Evaluation

Selenium is a nutritionally essential trace element that is an integral part of the enzyme glutathione peroxidase and other proteins (Högberg and Alexander, 1986). NRC (1989) recommended dietary allowances for humans range from 10 to 75 μg/day. Chronic ingestion of 5 mg/day (7.1E-2 mg/kg-day, assuming humans weigh 70 kg) induces clinical selenosis in humans, characterized by the characteristic "garlic odor" of excess selenium excretion in the breath and urine, thickened and brittle nails, hair and nail loss and abnormal re-growth, lowered hemoglobin levels, mottled teeth, skin lesions, and CNS abnormalities (peripheral anesthesia, acroparesthesia and pain in the extremities) (EPA, 2010; Högberg and Alexander, 1986). Effects in domestic grazing animals exposed to high levels of selenium include emaciation, lameness, and loss of hair and hooves. EPA (2010) presents a verified RfD of 5E-3 mg/kg-day for chronic oral exposure to selenium compounds based on effects in humans exposed to selenium in high selenium areas. An uncertainty factor of 3 was used. Confidence in the RfD is high. The target organs for oral exposure to selenium are the skin (including the nails and hair), teeth, erythrocyte and CNS.

EPA (1997) adopted the chronic oral RfD of 5E-3 mg/kg-day as sufficiently protective for subchronic oral exposure as well.

Occupational exposure to selenium fume or various selenium compounds is associated with intense ocular and respiratory tract irritation, chemical pneumonia, skin rashes, garlic odor to the breath, metallic taste in the mouth, and various socio-psychological effects (ACGIH, 1991). The data are inadequate for estimation of an inhalation RfC.

Carcinogenicity Evaluation

An impressive body of data indicates that selenium exerts an anticarcinogenic effect (Högberg and Alexander, 1986). In laboratory animals, selenium supplementation decreases the incidence of chemical-induced cancers. In humans, the incidence of lymphomas and cancers of the breast, digestive tract and lung were lower in geographic areas with high soil selenium levels. Occupational data suggest that selenium may protect against lung cancer. Several animal tests with various deficiencies in design and conduct equivocally associated exposure to selenium with increased incidence of cancer. In a well controlled oral experiment, selenium sulfide was associated with an increase in the incidence of liver tumors in rats, and with liver and lung

tumors in mice. On the basis of this study, EPA (2010) classified selenium sulfide a cancer weight-of-evidence Group B2 compound (probable human carcinogen), but declined to derive quantitative risk estimates. Selenium and other selenium compounds were classified in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) (EPA, 2010). Quantitative risk estimates are not derived for Group D substances.

Toxicity Summary

Toxicity values for selenium 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
5E-3	5E-3	S, Te, E, CNS	ND	ND	NA	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 abbreviations: S = skin; Te = teeth; E = erythrocyte; CNS = central nervous system; NA = not applicable.
[a]sRfDo and cRfDo should be used for dermal exposure without adjustment for GI absorption.

References

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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, D.C., EPA/540/R-99/005, July.

U.S. Environmental Protection Agency (EPA), 2010, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

THALLIUM (7440-28-0)

1.0 Introduction and Physical Properties

Thallium is a naturally occurring metal with an abundance of about 0.3-0.6 ppm in the earth s crust (HSDB, 2010). Thallium compounds are used in a variety of applications, including pharmaceuticals, semiconductors, photoelectric cells, optical systems, ore separation, glass production, and as oxidizing agents in organic synthesis (ATSDR, 1992; HSDB, 2010). An important former use of thallium and its compounds (before 1972) was in pesticide formulations for the control of insects and rodents. Relevant physical properties are compiled below:

MW	log K_{ow}	H	K_d	D_a	D_w	VP	S
204.38[a] (Elemental)	NA	NA	7.1E+1[b,c]	NA	NA	NA	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.
Note 1: Thallium sulfate as a typical thallium salt: 4.87E+4 mg/L (20° C).
[a]Agency for Toxic Substances and Disease Registry, (ATSDR), 1992, ***Toxicological Profile for Thallium***, U.S. Public Health Service, Atlanta, Georgia, July, 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]pH = 6.8.

2.0 Environmental Fate and Transport

Thallium is released to the atmosphere largely from coal-burning power plants, cement factories, and ferrous and nonferrous smelting operations (ATSDR, 1992; HSDB, 2010). Facilities that produce or use thallium or its compounds account for a much smaller part of the total release.

Thallium in air exists as oxide, hydroxide, sulfate or sulfide particles (ATSDR, 1992; HSDB, 2010). The hydroxide and sulfate are water soluble and may partition to water vapor for eventual removal in precipitation. The less soluble particulate forms are probably removed by dry deposition.

Thallium released to surface water usually occurs as the monovalent ion that forms soluble salts with several anions (ATSDR, 1992; HSDB, 2010). Adsorption to suspended particulates may also occur, but the soluble forms remain in the water column.

Although empirical data are sparse, the high solubility of several thallium salts suggests that mobility in soil could be high and the potential for leaching could be significant (ATSDR, 1992).

Terrestrial plants have been shown to absorb thallium from soil, but there is no evidence that biomagnification occurs. EPA (1995) identifies thallium as a chemical unlikely to be of concern for bioaccumulation in aquatic food chains. For these reasons it is concluded that thallium is unlikely to participate significantly in food-chain pathways and biotransfer factors are not estimated or compiled.

3.0 Toxicokinetics

Data regarding absorption from the respiratory tract following inhalation exposure were not located; however, small particles are probably absorbed to some extent and larger particles are probably removed by mucocilliary clearance and swallowed, where they become available for GI absorption. Thallium compounds appear to be completely absorbed from the GI tract in humans and laboratory animals (ATSDR, 1992). Quantitative data regarding dermal uptake of thallium were not located, although HSDB (2010) states that absorption through the skin occurs readily.

Tissue levels in acutely poisoned humans appear to be highest in the brain in regions dense with neurons, such as the gray matter (HSDB, 2010). Tissue distribution testing in a single human volunteer cancer patient treated orally with a small dose of radiolabeled thallium indicated that highest concentrations were located in scalp hair followed by kidney, heart, bone, spleen and brain (ATSDR, 1992). Distribution in orally treat laboratory animals is rapid and widespread, with higher levels generally associated with the kidney. The rank of levels in other tissues is more variable (ATSDR, 1992), but high levels are ordinarily found in the testis (HSDB, 200).

The biological half-life in rats in one study was 3.3 days, indicating that excretion is efficient (ATSDR, 1992). Excretion in humans may be somewhat slower. Excretion appears to be primarily through the urine in humans, and through the urine and feces. However, the data are somewhat confusing because animal studies indicate that the ratio of fecal to urinary excretion increases with time. This suggests that biliary excretion and enterohepatic recirculation may be operative, which could result in underestimation of fecal excretion in the human study.

4.0 Dermal Exposure

As noted above, GI absorption of thallium is essentially complete. EPA (2004) concluded that a GAF should not be estimated for thallium 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.

Thallium may be readily absorbed by the skin (HSDB, 2010); however, data were not located regarding the extent of dermal uptake of thallium 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 thallium from water were not located. The EPA (2004) default K_p for inorganic chemicals of 1E-3 cm/hour is selected for thallium.

5.0 Noncancer Effects Evaluation

Thallium is highly toxic. Acute oral exposure to thallium and its compounds may cause death preceded by neurological disturbances and effects on the lungs, heart and liver (ATSDR, 1992). Formerly, thallium was used medicinally to induce alopecia to facilitate treatment of ringworm of the scalp, sometimes with disastrous results. The critical effect of chronic oral exposure to low levels of thallium compounds in animals and humans is alopecia (ACGIH, 1992; EPA, 2010). EPA (2010) verified chronic oral RfDs for several thallium salts (thallium acetate, thallium carbonate, thallium chloride, thallium nitrate and thallium sulfate) based on a study with thallium sulfate. The oral RfD for thallium sulfate of 8E-5 mg/kg-day was based on a NOAEL of 0.25 mg/kg-day in rats treated by gavage with thallium sulfate for 90 days. No adverse effects

were seen in this study. An uncertainty factor of 3000 was used, consisting of factors of 10 each to extrapolate from subchronic to chronic data, for intraspecies extrapolation and to account for interspecies variability, and a factor of 3 to account for lack of reproductive and chronic toxicity data. Confidence in the chronic RfD is low. The skin (alopecia) and liver (altered blood biochemistry) are considered the target organs for oral exposure to thallium, based on other data reviewed by EPA (2010). Effects on the testis and kidney were observed in rats exposed to higher dose rates. The chronic oral RfD for thallium sulfate of 8E-5, when adjusted for differences in molecular weight, is equivalent to a chronic oral RfD for thallium of 6.5E-5 mg/kg-day. This adjustment is based on the assumption that the toxicity of thallium sulfate is due entirely to thallium, rather than to the sulfate moiety. The oral RfD for thallium of 6.5E-5 mg/kg-day will be used in this evaluation.

EPA (1997) provides a provisional subchronic oral RfD for thallium sulfate of 8E-4 mg/kg-day, equivalent to a subchronic oral RfD for thallium of 6.5E-4 mg/kg-day, based on the study discussed above and an uncertainty factor of 300, eliminating the factor of 10 to expand from subchronic to chronic exposure. EPA (1997) provides provisional subchronic chronic oral RfDs for several thallium salts (thallium acetate, thallium carbonate, thallium chloride, thallium nitrate and thallium sulfate) based on the same study with thallium sulfate.

Inhalation exposure data are very limited. An occupational study suggests that neurological effects may develop following prolonged inhalation exposure (ATSDR, 1992). The nervous system appears to be more sensitive than the skin as a target organ for inhalation exposure. The data are inadequate for estimation of an inhalation RfC or RfD.

6.0 Carcinogenicity Evaluation

Several thallium compounds (thallium oxide, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, thallium sulfate) are classified as cancer weight-of-evidence Group D substances (not classifiable as to carcinogenicity to humans) (EPA, 2010). No weight-of-evidence classification was located for thallium alone, but the Group D classification can be applied to thallium. Quantitative cancer risk estimates are not derived for Group D chemicals.

7.0 Toxicity Summary

Toxicity values for thallium 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
6.5E-4	6.5E-5	S, L	ND	ND	NA	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 or critical effect abbreviations: L = liver; S = skin.
[a]sRfDo and cRfDo should be used for dermal exposure without adjustment for GI absorption.

8.0 References

Agency for Toxic Substances and Disease Registry, (ATSDR), 1992, ***Toxicological Profile for Thallium***, U.S. Public Health Service, Atlanta, Georgia, July, on line.

Hazardous Substance Data Bank (HSDB), 2010, National Library of Medicine, on line.

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POLYCHLORINATED BIPHENYLS (PCBs)

Introduction and Physical Properties

The nomenclature of the PCBs is somewhat unique, including the terms homologue and congener. The PCB molecule consists of two joined phenyl groups. The carbon atoms are numbered 1 through 6 on one ring and 1′ through 6′ on the other ring. Numbering proceeds consecutively starting with the carbon atom attached to the other ring. The term homologue refers to the degree of chlorination. Since one carbon atom in each phenyl group is bonded to the other ring, five carbon atoms on each phenyl group – a total of 10 carbon atoms – are available for bonding to chlorine atoms. Consequently, there are ten possible *homologues* of PCBs – monochlorinate biphenyls, dichlorinated biphenyls, through decachlorinated biphenyls. Congener refers to the exact placement of each chlorine atom. For example, there are three congeners of monochlorinated biphenyls: 2-PCB, 3-PCB and 4-PCB. The term isomer is often incorrectly used instead of congener with the PCBs. Free rotation around the C-C bond, however, precludes stereoisomerism, which limits the number of theoretically possible congeners.

The PCBs are a class of chemicals generally considered to be **SVOC**s including 209 possible individual congeners (ATSDR, 2000). The PCBs formerly manufactured and used in the U.S. are called Aroclors. The Aroclors are mixtures of several PCB congeners and related compounds. Many individual PCB congeners are common to all or many of the different Aroclors. The Aroclors differ from one another primarily in the relative proportions of the different congeners. ATSDR (2000) provides a summary of the proportion of each homologue in commercial mixtures of the various Aroclors. Of interest to this evaluation is the observation that Aroclor-1016 and Aroclor-1221 contain no homologues with 5 or more chlorines. Most Aroclors occur as oily or viscous liquids at room temperatures, although Aroclor-1260 occurs as a sticky resin. Aroclors were used as dielectric and heat exchange agents in several open and closed systems, but since the middle 1970s, use has been restricted largely to electrical transformers and capacitors.

Analysis of PCBs in environmental media is often performed using EPA Method SW8082. Method SW8082 is usually performed as a "finger printing" procedure and the results are reported as the commercial Aroclor(s) that most closely reflect the fingerprint(s) (ATSDR, 2000). Recently, however, concern has arisen that some individual PCB congeners may behave toxicologically in the same manner as the polychlorinated dibenzo-p-dioxins (PCDD), and that they may have greater toxic potency than is reflected in the toxicity assessment of the commercial Aroclors. This problem may be exacerbated by weathering, which may preferentially remove the less toxic (generally less highly chlorinated) congeners, leading to a relative concentration of the more highly chlorinated congeners. The more highly chlorinated congeners are generally the more persistent and the more toxic (ATSDR, 2000; EPA, 2010). For this reason, Method SW8082 has been expanded so that the analytical results can be reported in terms of selected specific congeners. In addition, EPA Method E1668 is a very high-resolution protocol (highly sensitive and highly selective) that reports individual congeners as well as totals for each of the homologues. Method E1668 is seldom used for environmental media, with the exception of incinerator emissions testing, because of its unusually high cost.

EPA (2000) identified 12 individual PCB congeners with dioxin-like activity. The PCB mixtures and dioxin-like congeners analyzed by the EPA methods mentioned above are compiled below:

PCB Mixture or Congener	CASRN	IUPAC No.	Method 8082	Method 1668
Aroclor-1016	12674-11-2	NA	Yes	No
Aroclor-1221	11104-28-2	NA	Yes	No
Aroclor-1232	11141-16-5	NA	Yes	No
Aroclor-1242	53469-21-9	NA	Yes	No
Aroclor-1248	12672-29-6	NA	Yes	No
Aroclor-1254	11097-69-1	NA	Yes	No
Aroclor-1260	11096-82-5	NA	Yes	No
3,3′,4,4′-Tetrachlorobiphenyl	**32598-13-3**	**77**	**Probably[a]**	**Yes**
3,4,4′,5-Tetrachlorobiphenyl	**70362-50-4**	**81**	**Probably[a]**	**Yes**
2,3,3′,4,4′-Pentachlorobiphenyl	**32598-14-4**	**105**	**Probably[a]**	**Yes**
2,3,4,4′,5-Pentachlorobiphenyl	**74472-37-0**	**114**	**Probably[a]**	**Yes**
2,3′,4,4′,5-Pentachlorobiphenyl	**31508-00-6**	**118**	**Probably[a]**	**Yes**
2′,3,4,4′,5-Pentachlorobiphenyl 2,3′,4,4′,5′-Pentachlorobiphenyl)	**65510-44-3**	**123**	**Probably[a]**	**Yes**
3,3′,4,4′,5-Pentachlorobiphenyl	**57465-28-8**	**126**	**Probably[a]**	**Yes**
2,3,3′,4,4′,5-Hexachlorobiphenyl	**38380-08-4**	**156**	**Probably[a]**	**Yes**
2,3,3′,4,4′,5′-Hexachlorobiphenyl	**69782-90-7**	**157**	**Probably[a]**	**Yes**
2,3′,4,4′,5,5′-Hexachlorobiphenyl	**52663-72-6**	**167**	**Probably[a]**	**Yes**
3,3′,4,4′,5,5′-Hexachlorobiphenyl	**32774-16-6**	**169**	**Probably[a]**	**Yes**
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl	**39635-31-9**	**189**	**Probably[a]**	**Yes**
Total Monochlorobiphenyls	NA	NA	No	Yes
Total Dichlorobiphenyls	NA	NA	No	Yes
Total Trichlorobiphenyls	NA	NA	No	Yes
Total Tetrachlorobiphenyls	NA	NA	No	Yes
Total Pentachlorobiphenyls	NA	NA	No	Yes
Total Hexachlorobiphenyls	NA	NA	No	Yes
Total Heptachlorobiphenyls	NA	NA	No	Yes
Total Octachlorobiphenyls	NA	NA	No	Yes
Total Nonachlorobiphenyls	NA	NA	No	Yes
Total Decachlorobiphenyls	NA	NA	No	Yes

PCB = polychlorinated biphenyl; CASRN = Chemical Abstract Service Registry Number; IUPAC No. = congener-specific identification number assigned by the International Union of Pure and Applied Chemists. The specific congeners are sometimes called PCB-77, PCB-81, etc., and are sometimes *inappropriately* called Aroclor-77, Aroclor-81, etc. Technically, the term Aroclor should be reserved for chemical mixtures, where the name Aroclor is followed by a four-digit identifier code.
Dioxin-like congeners are bolded.
[a]Although the congeners listed have not been tested by Method 8082, it is likely that they could be quantified by the method. Other non-dioxin-like congeners can routinely be analyzed by this method.

Data regarding the physical properties of the individual PCB congeners are very limited. The physical characteristics of the Aroclor mixtures have been much more thoroughly evaluated. Although the Aroclors described below are classified as SVOCs, largely on the basis of MW, their H values suggest that volatilization could be important. Furthermore, the MW values provided are proportional averages based on the composition of the various Aroclor mixtures. Several individual PCB congeners have MW values below the limit of 200 g/mole ordinarily used to distinguish VOCs from SVOCs. For these reasons it is recommended that the Aroclors should be evaluated in exposure pathways (such as vapor intrusion into indoor air) that involve volatilization. Relevant physical properties are compiled below:

MW[a]	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$
Aroclor-1016 (12674-11-2)										
257.9[b]	5.6[b]	2.9E-4[b] (25°C)	4.96[c]	4.69E-2[d] (25°C)[e]	6.8E-6[c] (25°C)	5.3E-7[b] (25°C)	4.2E-1[b] (25°C)	340.50[f]	475.22[f]	1.8E+4[f]
Aroclor-1221 (11104-28-2)										
200.7[b]	4.7[b]	3.5E-3[b] (25°C)	2.44[c]	5.54E-2[d] (25°C)[e]	7.5E-6[c] (25°C)	8.8E-6[b] (25°C)	5.9E-1[b] (24°C)	571[b]	ND	ND
Aroclor-1232 (11141-16-5)										
232.2[B]	5.1[B]	8.64E-4[c] (25°C)[e]	2.83[c]	5.03E-2[d] (25°C)[e]	7.2E-6[c] (20°C)	5.34E-6[b] (25°C)	4.5E-1[b] (25°C)	581[b]	ND	ND
Aroclor-1242 (53469-21-9)										
266.5[b]	5.6[b]	5.2E-4[b] (25°C)	4.59[c]	4.59E-2[d] (25°C)[e]	6.1E-6[c] (20°C)	5.34E-7[b] (25°C)	2.4E-1[b] (25°C)	345.5[f]	482.20[f]	1.8E+4[f]
Aroclor-1248 (12672-29-6)										
299.5[g]	6.2[g]	2.8E-3[g] (25°C)	5.64[c]	4.24E-2[d] (25°C)[e]	6.6E-6[c] (20°C)	6.5E-7[g] (25°C)	5.7E-2[g] (24°C)	631[g]	ND	ND
Aroclor-1254 (11097-69-1)										
328[b]	6.5[b]	2.0E-3[b] (25°C)	5.0[c]	3.99E-2[d] (25°C)[e]	5.6E-6[c] (20°C)	1.01E-7[b] (25°C)	3.5E-2[b] (24°C)	377.50[f]	512.27[f]	1.9E+4[f]
Aroclor-1260 (11096-82-5)										
375.7[b]	6.8[b]	4.6E-3[b] (25°C)	6.42[c]	3.65E-2[d] (25°C)[e]	5.3E-6[c] (20°C)	5.33E-8[b] (25°C)	8.0E-2[b] (24°C)	402.50[f]	539.37[f]	1.9E+4[f]
Aroclor-1262 (1336-36-3)										
389[b]	ND	ND	ND	3.57E-2[d] (25°C)[e]	4.13E-6[d] (25°C)[e]	ND	5.2E-2[b] (24°C)	680.7[b]	ND	ND
Aroclor-1268 (11100-14-4)										
453[b]	ND	ND	ND	3.22E-2[d] (25°C)[e]	3.73E-6[d] (25°C)[e]	ND	3.0E-1[b] (24°C)	ND	ND	ND

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 of pure liquid compound (°K); T_c = critical temperature (°K); $\Delta H_{v,b}$ = enthalpy of vaporization at the boiling point (cal/mole); I = insoluble; ND = no data.

[a]Average molecular mass for the proportions of individual congeners in the commercial product.

[b]Agency for Toxic Substances and Disease Registry (ATSDR), 2000, ***Update Toxicological Profile for Polychlorinated Biphenyls***, U.S. Department of Health and Human Services, Atlanta, Georgia, November, on line.

[c]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York.

[d]Calculated as described in Introduction to Toxicological profiles.

[e]Assumed.

[f]U.S. Environmental Protection Agency (EPA), 1997, ***User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings***, prepared by Environmental Quality Management, Inc. for the Office of Emergency and Remedial Response, Washington, DC, September.

[g]Earlier version (1995 Draft for Public Comment) of ATSDR Toxicological profile.

Environmental Fate and Transport

Former PCB releases occurred as a result of their manufacture, use, disposal, and leakage from damaged PCB-containing equipment (ATSDR, 2000). Currently the major source of PCB release to the environment is recycling of PCBs previously introduced into the environment, which involves volatilization from ground surfaces (water, soil) into the atmosphere with subsequent removal from the atmosphere via wet/dry deposition, followed by volatilization (HSDB, 2010). PCBs are also currently released to the environment from landfills containing PCB waste materials and products, incineration of municipal refuse and sewage sludge, and improper (or illegal) disposal of PCB materials, such as waste transformer fluid, to open areas.

Major sources to air include emissions from the overhaul, repair or reuse of PCB-containing items, and the recycling of previously released PCBs described above (ATSDR, 2000; HSDB, 2010). The vapor pressures of the PCBs indicate that they would exist primarily in the vapor-phase in the atmosphere; monitoring data have shown that between 87 and 100% of the PCBs in air are in the vapor-phase. Vapor pressure of the PCBs generally decreases with an increase in the extent of chlorination; therefore, the more highly chlorinated PCBs are more likely to be associated with the particulate phase in air than are the lesser chlorinated PCBs. Physical removal of PCBs in the atmosphere is accomplished by wet and dry deposition; dry deposition occurs only for PCBs in the particulate phase.

Major sources to soil include leaks or discharges from PCB-containing items and deposition from the atmosphere (ATSDR, 2000). PCBs sorb tightly to constituents of soil with adsorption generally increasing with the degree of chlorination. Although the lesser chlorinated biphenyls may exhibit some mobility in soil, PCBs generally will not leach significantly in most aqueous soil systems. In the presence of organic solvents, PCBs may leach quite rapidly through soil. Vapor loss of PCBs from soil surfaces appears to be an important loss mechanism with the rate of volatilization decreasing with increasing chlorination. Although the volatilization rate may be low, the total loss by volatilization over time may be significant because of the persistence and stability of the PCBs. In general, persistence of the PCBs increases with an increase in the degree of chlorination (ATSDR, 2000; HSDB, 2010). Mono-, di- and trichlorinated biphenyls (Aroclors-1221 and -1232) biodegrade relatively rapidly, tetrachlorinated biphenyls (Aroclors-1016 and -1242) biodegrade slowly, and higher chlorinated biphenyls (Aroclors-1248, -1254 and -1260) are quite resistant to biodegradation. The position of chlorination within a given homologue also determines the extent of biodegradation. Although biodegradation of the more highly chlorinated congeners may occur very slowly on an environmental basis, no other degradation mechanisms have been shown to be important in soil systems; therefore, biodegradation may be the ultimate degradation process in soil.

Former sources of PCBs to surface water include waste streams and discharges from waste water treatment plants (ATSDR, 2000). Currently, direct deposition, runoff and erosion probably predominate. Removal from water involves sorption to particles and sedimentation, as well as volatilization.

The PCBs are among the compounds that bioaccumulate in food chain pathways and are of special concern for biomagnification from sediment in benthic fish. Biotransfer factors for the PCBs are compiled below:

BSAF	Bpr[a,b]	Bpv[a,b]	Bb[a]	Bm[a]
Aroclor-1016				
See below	2.24E-2	2.24E-2	1.00E-2	3.16E-3
Aroclor-1221				
See below	7.44E-2	7.44E-2	1.26E-3	3.98E-4
Aroclor-1232				
See below	4.37E-2	4.37E-2	3.16E-3	1.00E-3
Aroclor-1242				
See below	2.24E-2	2.24E-2	1.00E-2	3.16E-3
Aroclor-1248				
See below	1.01E-2	1.01E-2	3.98E-2	1.26E-2
Aroclor-1254				
See below	6.78E-3	6.78E-3	7.94E-2	2.51E-2
Aroclor-1260				
See below	4.55E-3	4.55E-3	1.58E-1	5.01E-2
Aroclor-1262				
See below	ND	ND	ND	ND
Aroclor-1268				
See below	ND	ND	ND	ND

BSAF = biota-sediment accumulation factor, unitless; Bpr = soil-to-plant (reproductive portions) biotransfer factor, unitless; Bpv = soil-to-plant (vegetative portions) biotransfer factor, unitless; Bb = soil-to-beef biotransfer factor, days/kg; Bm = soil-to-milk biotransfer factor, days/kg; ND = no data.
[a]Calculated as described in Introduction to the Toxicological profiles.
[b]The methodology for estimating biotransfer of organic chemicals to plants does not differentiate vegetative and reproductive portions.

EPA (1995) reported a biota/sediment absorption factor (BSAF) for total PCBs of 1.85 for trout in the Great Lakes ecosystem. The BSAF of 1.85 is applied to all PCBs in this evaluation.

Data for Evaluating Dermal Exposure

Toxicokinetic data from laboratory animals suggest that the efficiency of GI absorption is roughly inversely related to the degree of chlorination (ATSDR, 2000). The GI absorption of mono- to hexachlorinated biphenyls exceeds 90 percent. Dichlorobiphenyl GI absorption efficiency is approximately 95 percent, but the absorption efficiency of octachlorobiphenyl approximates only 75 percent. GI absorption efficiency of Aroclor-1254 approximates 85.4 percent in ferrets and greater than 90 percent in monkeys. EPA (2004) notes that organic chemicals are generally well absorbed from the GI tract, and recommends that oral toxicity values should not be adjusted when used for dermal exposure unless empirical data demonstrate that GI absorption is significantly less than complete. Therefore, no GAF is developed for the PCBs and the oral toxicity values described below should be used for dermal exposure without adjustment for GI absorption.

The PCBs appear to be readily absorbed by the skin when applied as neat compound or mixed with a suitable vehicle (ATSDR, 2000), but efficiency falls when soil is the medium of exchange. The EPA (2004) recommended ABS of 0.14 for PCBs is used in this evaluation. EPA (2004) provides values for K_p, τ, FA and B for 4-chlorobiphenyl and hexachlorobiphenyl. Generally, the more highly chlorinated PCB congeners are the more persistent in the environment; therefore, the values for hexachlorobiphenyl provided below are applied to all PCBs in this evaluation.

Chemical	K_p	τ	FA	B
Hexachlorobiphenyl	4.3E-1	1.13E+1	0.5	3.2

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).

Noncancer Effects Evaluation

The acute oral toxicity of the PCBs is low to moderate, as indicated by LD_{50} values in laboratory animals ranging from 750 mg/kg (mink) to 4250 mg/kg (rats) (ATSDR, 2000). Mink appear to be unusually sensitive, which is also true for prolonged oral exposure. Death appears to be due to respiratory depression and dehydration from diarrhea.

The best known incident involving oral exposure of humans to PCBs is the "Yusho" incident in Japan, in which persistent chloracne, gastrointestinal irritation and central nervous symptoms followed ingestion of cooking oil contaminated with PCBs (Gaffey, 1983). Further investigation, however, revealed that concentrations of polychlorinated dibenzofurans (PCDF) and polychlorinated quaterphenyls in the cooking oil were similar to those of PCBs, which confounds interpretation of the reported observations and symptoms.

Prolonged oral exposure of laboratory animals to various Aroclors leads to liver damage, signs of chloracne, immunological effects, and neurological impairment, particularly of the young (EPA, 2010). A verified oral RfD for Aroclor-1254 of 2E-5 mg/kg-day for chronic oral exposure is based on a LOAEL of 5E-3 mg/kg-day associated with chloracne and related signs and immunological effects in monkeys treated with the test material in gelatin capsules for over five years. An uncertainty factor of 300 was applied. Confidence in the RfD is medium. The immune system and skin are considered the target organs for prolonged oral exposure to Aroclor-1254.

EPA (1997) derived a provisional RfD for subchronic oral exposure to Aroclor-1254 of 5E-5 by applying an uncertainty factor of 100 to the LOAEL from the monkey study described above.

A verified oral RfD of 7E-5 mg/kg-day for Aroclor-1016 is based on a NOAEL of 7E-3 mg/kg-day in a perinatal and neurobehavioral toxicity study in monkeys (EPA, 2010). An uncertainty factor of 100 was applied to the NOAEL. The uncertainty factor of 100 consists of factors of 3 each to extrapolate from monkeys to humans, to provide greater protection for more sensitive humans, to account for deficiencies in the database, and to expand from a subchronic study to chronic exposure. The LOAEL (2.8E-2 mg/kg-day) was associated with low birth weights. The

fetus is considered to be the most sensitive member of the population. The fetus and nervous system are selected as "target organs" for prolonged oral exposure to Aroclor-1016. Confidence in the oral RfD is medium.

There is no EPA-derived subchronic oral RfD for exposure to Aroclor-1016. However, a preliminary RfD can be derived from the NOAEL of 7E-3 mg/kg-day in the monkey study described above by application of an uncertainty factor of 30. The uncertainty factor of 30 includes all the factors described above except the factor of 3 to expand from subchronic to chronic exposure. The preliminary subchronic oral RfD so derived is 2.3E-4 mg/kg-day, which is expressed as 2E-4 mg/kg-day when rounded to one significant figure.

The similarities in the nature of the adverse effects and the thresholds for these effects for various Aroclors suggest that the adverse effects and thresholds across all the Aroclors may be similar. That this may be true is supported by the fact that many of the same PCB congeners are present in the different Aroclors, which differ from one another primarily only in the relative proportions of the individual congeners. Therefore, it is reasonable to apply the RfDs described above to any of the Aroclor mixtures, or to total PCBs. The chronic and subchronic oral RfDs developed for Aroclor-1016 rather than those developed for Aroclor-1254 are selected as surrogates for evaluating the adverse effects of the other Aroclors or total PCBs. The RfDs developed for Aroclor-1016 are preferred because they include less uncertainty than the RfDs developed for Aroclor-1254. Therefore, the verified chronic oral RfD of 7E-5 mg/kg-day and the preliminary subchronic oral RfD of 2E-4 mg/kg-day developed for Aroclor-1016 are applied to the Aroclors other than Aroclor-1254 or to total PCBs.

Occupational exposure to PCBs, which involved both inhalation and dermal exposure, was associated with upper respiratory tract and ocular irritation, loss of appetite, liver enlargement and increased serum concentrations of liver enzymes, skin irritation, rashes and chloracne, and, in heavily exposed female workers, decreased birth weight of their infants (ATSDR, 2000). Concurrent exposure to PCB contaminants, such as polychlorinated dibenzofurans, confounds the interpretation of the occupational exposure studies. Rats, mice, rabbits and guinea pigs intermittently exposed to Aroclor-1254 vapors exhibit moderate liver degeneration, decreased body weight gain and slight renal tubular degeneration; however, the accuracy of the reported exposure concentration is in doubt. Neither verified nor provisional chronic inhalation RfC values are available.

Carcinogenicity Evaluation

EPA (2010) declined to evaluate the carcinogenicity of the individual Aroclor mixtures. Instead, EPA (2010) classified PCBs in cancer weight-of-evidence Group B2 (probable human carcinogen) based on adequate evidence for liver tumors in laboratory animals and inadequate data in humans. EPA (2010) established a three-tiered approach for estimating the cancer potency of exposure to PCBs.

<u>High-Risk Tier</u> A SF of 2.0E+0 per mg/kg-day is verified as an upper-bound potency factor for exposure to PCBs in the high-risk tier (EPA, 2010). The high-risk tier includes ingestion in the food chain, incidental ingestion of soil or sediment, inhalation of dust or aerosol, or dermal contact with soil or sediment if a dermal absorption factor is applied. The high-risk SF of 2.0E+0 per mg/kg-day is used for mixtures containing any congeners considered to be persistent

or acting in a dioxin-like manner, and for any early life exposures (e.g., residential scenario, which includes both adults and children). In this context, persistent congeners are those with five or more chlorines. The 12 PCB congeners considered to act in a dioxin-like manner were identified above. The SF of 2.0E+0 per mg/kg-day is equivalent to a URF (for dust or aerosol inhalation) of 5.7E-4 per $\mu g/m^3$.

The high-risk tier SF for central tendency (CT) assessment is 1.0E+0 per mg/kg-day. The SF of 1.0E+0 per mg/kg-day is equivalent to a URF (for dust or aerosol inhalation) of 2.9E-4 per $\mu g/m^3$.

Low-Risk Tier EPA (2010) verified an upper-bound SF of 4E-1 per mg/kg-day for the low-risk tier, which includes ingestion of water-soluble congeners (assumed to be PCBs detected in drinking water), inhalation of evaporated congeners, and dermal exposure if no absorption factor is applied. The SF of 4E-1 per mg/kg-day is equivalent to a URF for vapor inhalation of 1E-4 per $\mu g/m^3$. A SF of 3E-1 per mg/kg-day is recommended for the low-risk CT evaluation. The SF of 3E-1 per mg/kg-day is equivalent to a URF (for vapor inhalation) of 9E-5 per $\mu g/m^3$.

Lowest-Risk Tier EPA (2010) verified an upper-bound SF of 7E-2 per mg/kg-day for the lowest-risk tier, which is restricted to data sets for which homologue-or congener-specific data verify that congeners containing 5 or more chlorines constitute less than 0.5 percent of the total PCBs. The SF of 7E-2 per mg/kg-day is equivalent to a URF for inhalation of 2E-5 per $\mu g/m^3$. These values are used in for Aroclor 1016. An SF of 4E-2 per mg/kg-day is recommended for the low-risk CT evaluation. The SF of 4E-2 per mg/kg-day is equivalent to a URF for vapor inhalation of 1E-5 per $\mu g/m^3$.

An alternative method of PCB cancer risk assessment was proposed by EPA (2000, 2010) for sites where congener-specific analytical results are available. This method involves application of toxicity equivalency factors (TEF) adopted by EPA (2000) to the 12 dioxin-like congeners identified above. TEFs are factors that express the toxicity of the dioxin-like congeners relative to 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD or "dioxin"), the reference compound. EPA (1997) presented a provisional oral and inhalation SF for 2,3,7,8-TCDD of 1.5E+5 per mg/kg-day. As explained in the toxicological profile for polychlorinated dibenzo-p-dioxins and dibenzofurans, the inhalation SF is more accurately expressed as 1.1E+5 per mg/kg-day, which is equivalent to 3.3E+1 per $\mu g/m^3$, or 3.3E+4 per mg/m^3. Application of the EPA (2000) TEFs to the dioxin-like PCB congeners yields the cancer potency factors presented below:

Dioxin-Like PCB Congener	IUPAC No.	TEF	SFo	URFi	SFi
3,3′,4,4′-Tetrachlorobiphenyl	77	0.0001	1.5E+1	3.3E+0	1.1E+1
3,4,4′,5-Tetrachlorobiphenyl	81	0.0001	1.5E+1	3.3E+0	1.1E+1
2,3,3′,4,4′-Pentachlorobiphenyl	105	0.0001	1.5E+1	3.3E+0	1.1E+1
2,3,4,4′,5-Pentachlorobiphenyl	114	0.0005	7.5E+1	1.7E+1	5.5E+1
2,3′,4,4′,5-Pentachlorobiphenyl	118	0.0001	1.5E+1	3.3E+0	1.1E+1
2′,3,4,4′,5-Pentachlorobiphenyl 2,3′,4,4′,5′-Pentachlorobiphenyl)	123	0.0001	1.5E+1	3.3E+0	1.1E+1
3,3′,4,4′,5-Pentachlorobiphenyl	126	0.1	1.5E+4	3.3E+3	1.1E+4
2,3,3′,4,4′,5-Hexachlorobiphenyl	156	0.0005	7.5E+1	1.7E+1	5.5E+1
2,3,3′,4,4′,5′-Hexachlorobiphenyl	157	0.0005	7.5E+1	1.7E+1	5.5E+1
2,3′,4,4′,5,5′-Hexachlorobiphenyl	167	0.00001	1.5E+0	3.3E-1	1.1E+0
3,3′,4,4′,5,5′-Hexachlorobiphenyl	169	0.01	1.5E+3	3.3E+2	1.1E+3

Dioxin-Like PCB Congener	IUPAC No.	TEF	SFo	URFi	SFi
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl	189	0.0001	1.5E+1	3.3E+0	1.1E+1

IUPAC No. = unique sequentially numbered congener identifier proposed by the International Union of Pure and Applied Chemists; TEF = toxicity equivalency factor (EPA, 2000); SFo = oral slope factor (risk per milligram per kilogram-day); URFi = inhalation unit risk factor (risk per milligram per cubic meter); SFi = inhalation slope factor (risk per milligram per kilogram-day).

Toxicity Summary

Cancer potency factors for the dioxin-like congeners are summarized above. Toxicity values for PCBs other than the dioxin-like congeners, 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
Aroclor-1016[b]										
2E-4	7E-5	F	ND	ND	NA	Please see below.				
Aroclor-1254										
5E-5	2E-5	Is, S	ND	ND	NA	Please see below.				
PCBs, High-Risk, Upper Bound (Reasonable Maximum Exposure) Assumptions										
Please see above, including footnote “b.”						B2	2.0E+0	B2	5.7E-1[c]	2.0E+0[c]
PCBs, High-Risk, Central Tendency Exposure Assumptions										
Please see above, including footnote “b.”						B2	1.0E+0	B2	2.9E-1[c]	1.0E+0[c]
PCBs, Low-Risk, Upper Bound (Reasonable Maximum Exposure) Assumptions										
Please see above, including footnote “b.”						B2	4E-1	B2	1E-1[d]	4E-1[d]
PCBs, Low-Risk, Central Tendency Exposure Assumptions										
Please see above, including footnote “b.”						B2	3E-1	B2	9E-2[d]	3E-1[d]
PCBs, Lowest-Risk, Upper Bound (Reasonable Maximum Exposure) Assumptions										
Please see above, including footnote “b.”						B2	7E-2	B2	2E-2	7E-2
PCBs, Lowest-Risk, Central Tendency Exposure Assumptions										
Please see above, including footnote “b.”						B2	4E-2	B2	1E-2	4E-2

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 milligram per cubic meter); SFi = inhalation cancer slope factor (risk per milligram per kilogram-day); ND = no data.
Target organ abbreviations: F = unborn child; Is = immune system; S = skin; NA = not applicable.
[a]sRfDo, cRfDo and SFo should be used for dermal exposure without adjustment for GI absorption.
[b]sRfDo and cRfDo derived for Aroclor-1016 should be applied to all other Aroclor mixtures except Aroclor-1254. They should also be applied to total PCBs, but not to specific PCB homologues congeners.

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

[c]Reasonable maximum exposure evaluation of inhalation pathways including dusts or aerosols.
[d]Reasonable maximum exposure evaluation of inhalation pathways limited to vapors, excluding dusts or aerosols.

PCB Risk Assessment

The approach to risk assessment of PCB-contaminated sites depends on the analytical data available. Typically, PCB analysis is limited to Method 8082 for the seven commonly encountered Aroclors. When this is the case, the hazard associated with noncancer effects is evaluated with the oral RfDs provided in the table above. Cancer risk is evaluated with the upper bound (reasonable maximum exposure) SFo and URFi or SFi from the "High-Risk" or "Low-Risk" scenarios, depending on the Aroclors identified, and the receptors and exposure pathways evaluated.

If homologue-specific analytical results are available in addition to results for the seven common Aroclors, it will be necessary to decide which is the better data set. This decision will depend, at least in part, on the samples included in each data set. Generally, the data set that better represents contamination across the area of investigation or a given exposure unit should be used in the risk assessment. If the same samples were analyzed for both Aroclors and specific homologues so that representativeness is not an issue, EPA (2010) generally considers that the homologue data are preferable because they are based on greater sensitivity (lower reporting limits) and are more likely to reflect selective removal of the more labile and mobile congeners due to weathering. Homologue-specific analytical results in the absence of data for the seven common Aroclors can be evaluated directly in the risk assessment.

The homologues should not be evaluated individually for noncancer hazard using the oral RfDs provided above. However, their sum (total PCBs) can be evaluated with the oral RfD for Aroclor-1016, assuming that the total PCBs reflect the characteristics of a mixture not unlike one or more of the Aroclors. If this assumption is not reasonable, the reason should be clearly stated, total PCBs should not be evaluated for noncancer hazard, and the uncertainty imparted to the risk assessment (probably a non-conservative bias) should be discussed. For example, it might be that only the most highly chlorinated homologues persist and are identified from an "old" release.

Cancer risk is estimated for total PCBs rather than the individual homologues. If the penta-, hexa-, hepta-, octa-, nona- and deca-chlorinated homologues together constitute not more than 0.5 percent of the total PCB, the SFo and URFi or SFi for the "Lowest-Risk" scenario should be used. If the penta-, hexa-, hepta-, nona- and deca-chlorinated homologues together constitute more than 0.5 percent of the total PCB, the SFo and URFi or SFi for the "High-Risk" or "Low-Risk" scenario should be used, depending on the receptors and exposure pathways evaluated.

It is unlikely that congener-specific data will be the only PCB data available. Should that be the case, however, the noncancer hazard can be estimated for total PCBs as described in the previous

paragraph. For cancer risk assessment, the dioxin-like congeners should be assessed as explained below. The non-dioxin-like congeners should be summed. If the penta-, hexa-, hepta-, nona- and deca-chlorinated congeners together constitute not more than 0.5 percent of the total PCB, the SFo and URFi or SFi for the "Lowest-Risk" scenario should be used. If the penta-, hexa-, hepta-, nona- and deca-chlorinated congeners together constitute more than 0.5 percent of the total PCB, the SFo and URFi or SFi for the "High-Risk" or "Low-Risk" scenario should be used, depending on the receptors and exposure pathways evaluated. The cancer risks from the non-dioxin-like and the dioxin-like congeners (see next paragraph) should be summed.

It is more likely that limited congener-specific data will be available *in addition to* data for the Aroclors or homologues. (Limited in the number of congeners analyzed and/or the number of samples analyzed for individual congeners.) For cancer risk assessment, EPA (2010) recommends evaluating the Aroclors or homologues as described above, after reducing their exposure-point concentrations by the contribution from the dioxin-like congeners. In most cases the concentrations of the dioxin-like congeners will be so much lower than the concentrations of the Aroclors or homologues that their subtraction would make little difference. The cancer risk for the dioxin-like congeners is assessed by using the TEF-based SFo and URFi or SFi values presented above. The two sets of risk estimates are then summed.

The newer trends in PCB analysis and risk assessment introduce additional sources of uncertainty to the assessment. PCBs tend to be somewhat ubiquitous because of their once-common use, potential for widespread dispersion, and persistence in environmental media (ATSDR, 2000). Method 1668 is a high-resolution method that is likely to identify very low "anthropogenic background" levels of PCBs that may not be reflected in the results of Aroclor analysis using Method 8082. This may impart an overly conservative bias to the risk assessment. Another source of uncertainty may arise from analyzing only a limited number or proportion of PCB-bearing samples for individual congeners. The limited analysis could impart either a conservative or non-conservative bias to the risk assessment, depending on the relative level of contamination in the samples selected for analysis of individual congeners.

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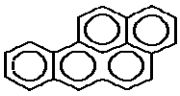
Semivolatile Organic Compounds

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, 1995a; HSDB, 2010). 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, 1995b). 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]	1.13E-6[b] (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]	1.11E-4[b] (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]	4.83E-4[b] (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), 2010, National Library of Medicine, on line, accessed 23 April.

[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.

[i]Syracuse Research Corporation (SRC), 2004, ***CHEMFATE Search Results***, on line, accessed 23 April.

[j]National Institute of Standards and Technology (NIST), 2004, Standard Reference Data Program, Online Data Bases, accessed 23 April.

2.0 Environmental Fate and Transport

The PAHs are ubiquitous products of incomplete combustion; natural sources include volcanoes and forest fires (ATSDR, 1995a, b; HSDB, 2010). 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
Diesel total emissions	Acenaphthene, fluorene, phenanthrene

Source[a]	Individual PAHs
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, ***Update Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)***, U.S. Public Health Service, Atlanta, Georgia, August, on line.	

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, 1995a). 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, 1995a; 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 (1995a) 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, 1995a, b; HSDB, 2010). 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, 1995a, b). 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, 1995a, b). 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, 1995a). 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, 1995a). 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, 1995a). 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, 1995a). 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 (1995a) 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, 1995a). 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, 1995b).

Distribution of absorbed PAHs is generally widespread, with highest levels located initially in lipid-rich tissues (ATSDR, 1995a). 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, 1995a). 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 (1995a) 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, 1995a). 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, 1995a). 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, 1995a). 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, 1995a). 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, 1995b). 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, 1995a). 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. (1999) 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, 1995b). 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, 2010). 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, 2010). 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, 1995a). 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, 1995a).

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, 2010). 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 (200) 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 (2010) 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.

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VOLATILE ORGANIC COMPOUNDS

BENZENE (71-43-2)

1.0 Introduction and Physical Properties

Benzene is a naturally occurring **VOC**, present in low levels in many plants and animals, as well as a synthetic compound derived from petroleum (ATSDR, 1997). It occurs as a colorless or slightly yellow liquid, or as a solid at temperatures below approximately 5.5 EC (HSDB, 2010). Benzene is widely used as a solvent and in the manufacturing of other organic compounds such as styrene, phenol, detergents, pesticides, explosives, polychlorinated biphenyls, flavors, perfumes, paints and coatings, nylon intermediates and photographic chemicals, among others. It is also used in food processing and leather tanning and occurs as a component of gasoline. Relevant physical properties are compiled below:

MW	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$
78.1[a]	2.13[a]	5.56E-3[b] (25°C)	1.77[b]	8.80E-2[b] (25°C)	9.80E-6[b] (25°C)	1.25E-1[c] (25°C)	1.75E+3[b] (20-25°C)	353.24[d]	562.16[d]	7.34E+3[d]

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).

[a]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.

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[d]U.S. Environmental Protection Agency (EPA), 2003, *Users Guide for Evaluating Subsurface Vapor Intrusion into Buildings*, Office of Emergency and Remedial Response, Washington, DC, 19 June.

2.0 Environmental Fate and Transport

Benzene enters the atmosphere primarily from fugitive emissions and automobile exhaust because of its presence in gasoline (ATSDR, 1997; HSDB, 2010). Other important sources are emissions associated with its production and use as a solvent, as an industrial intermediate in the production of the materials mentioned above, and coke oven blast furnaces and coke by-product recovery plants. In addition, there are discharges into water from industrial effluents and losses during spills. Sources of release to soil include land disposal of benzene-containing wastes, industrial discharge, and leaks from underground storage tanks and associated plumbing.

Benzene released to the atmosphere will exist almost exclusively in the vapor phase (ATSDR, 1997; HSDB, 2010). It is not subject to direct photolysis but it will react with photochemically produced hydroxyl radicals with a half-life of approximately 13 days. The reaction time in polluted atmospheres containing nitrogen oxides or sulfur dioxide is accelerated with the half-life being reported as 4 to 6 hours. Products of photooxidation include phenol, nitrophenols, nitrobenzene, formic acid, and peroxyacetyl nitrate. Benzene is fairly soluble in water and is removed from the atmosphere in rain.

Benzene released to soil will be subject to rapid volatilization near the surface; that which does not evaporate will be highly to very highly mobile in the soil and may leach to groundwater (ATSDR, 1997; HSDB, 2010). Benzene may be subject to biodegradation under aerobic conditions. Microbial transformation proceeds through formation of cis-dihydrodiols to catechols, which lead to destruction of the aromatic ring.

Benzene may be subject to photooxidation and biodegradation in shallow, aerobic groundwaters, but probably not significantly under deeper or anaerobic conditions (ATSDR, 1997; HSDB, 2010). Benzene released to surface water will be subject to rapid volatilization. It is not expected to sorb to sediment or to hydrolyze significantly. Biodegradation is unlikely to be a significant fate process in sediment.

Benzene is not expected to participate significantly in food-chain pathways (ATSDR, 1997; EPA, 1995; HSDB, 2010); therefore, biotransfer factors are not provided.

3.0 Toxicokinetics

Benzene is rapidly and readily absorbed during inhalation exposures of humans or laboratory animals to vapors (ATSDR, 1997). However, the extent of uptake and retention decrease with increasing concentration or time of exposure, reflecting saturation of the metabolic processes that remove the substance from the blood. Excretion data from laboratory animals show that absorption is rapid and essentially complete following oral administration. Dermal uptake of liquid benzene through intact skin has been demonstrated in humans and may be toxicologically significant. The extent of dermal uptake of benzene vapor has not been quantified in humans, but experiments in laboratory animals suggest this exposure route also may be toxicologically significant.

Benzene is widely distributed following any route of exposure (ATSDR, 1997). Highest levels were located in adipose and other tissues high in fat such as the brain following inhalation exposure. Highest levels following oral administration were located in liver, kidney and bone marrow.

Quantitative aspects of the metabolism of benzene are somewhat species-, exposure route- and dose-dependent (ATSDR, 1997), but certain relevant generalizations pertain. The first metabolic step appears to be cytochrome P-450-catalyzed oxidation of benzene to benzene epoxide in the liver, which rearranges to phenol. Phenol is transformed to hydroxyquinone, which is further oxidized to benzoquinone, considered to be a major toxicant in bone marrow. Alternatively, phenol may be further oxidized to catechol and possibly to trihydroxybenzene. Phenol and all its derivatives except benzoquinone have been shown to undergo detoxication by conjugation with glucuronide or sulfate, followed by excretion.

A second general pathway involves the further oxidation of benzene oxide to benzene dihydrodiol, which leads to ring-opening and the formation of muconic dialdehyde, a known hematotoxin, primarily in the liver (ATSDR, 1997).

Absorbed benzene is excreted through the lungs as unchanged compound, and through the urinary tract as conjugated metabolites (ATSDR, 1997). Urinary excretion predominates.

Nothing in this review of toxicokinetics suggests that laboratory animals would not serve as appropriate models for the toxicity of benzene to humans.

4.0 Dermal Exposure

EPA (2004) notes that organic chemicals are generally well absorbed from the GI tract, and recommends that oral toxicity values should not be adjusted when used for dermal exposure unless empirical data demonstrate that GI absorption is significantly less than complete. Therefore, no GAF is developed for benzene and the oral toxicity values described below should be used for dermal exposure without adjustment for GI absorption.

As mentioned above, benzene in the liquid and vapor form are absorbed through the skin (ATSDR, 1997). Combining benzene with soil slows dermal uptake. EPA (2004) notes that VOCs tend to volatilize from soil when applied to the skin, reducing dermal uptake to toxicologically insignificant levels. Therefore, dermal uptake of benzene from soil is not evaluated. EPA (2003) provides t*, K_p, τ, B and FA values as follows:

Chemical	t*	K_p	τ	FA	B
Benzene	0.70	1.5E-2	0.29	1	0.1

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).

5.0 Noncancer Effects Evaluation

Short-term exposure to benzene induces central nervous system (CNS) effects such as drowsiness, dizziness and headaches; long-term exposure may induce anemia (ATSDR, 1997). Oral dosing in animals induces hematopoietic and immune effects. EPA (2010) verified a chronic oral RfD of 4E-3 mg/kg-day, based on hematological effects (reduced lymphocyte count) in a cross-sectional occupational study of 44 workers exposed to benzene. The workers were exposed for 0.7 to 16 years, with a mean of 6.3 years. Because the mean fell below 7 years, the minimal length considered to be chronic, the study is judged to be subchronic in duration. The control group consisted of an equal number of age- and gender-matched unexposed workers. The exposed workers were divided into two equal groups of 22: those exposed to airborne concentrations below and those exposed to airborne concentrations above the median concentration for all workers of 99 mg/m^3. An exposure-adjusted benchmark concentration (BMC) for minimal hematologic effects of 8.2 mg/m^3 was estimated. Assuming that uptake from the respiratory tract is approximately 50 percent of that from the GI tract allowed application of inhalation-to-oral extrapolation to estimate a benchmark dose (BMD) of 1.2 mg/kg-day. Application of an uncertainty factor of 300 to the BMD yielded the verified chronic oral RfD of 4E-3 mg/kg-day. The uncertainty factor of 300 consists of factors of 3 each for extrapolation from a BMC for minimal adverse effects to a BMC for no adverse effects, to expand from subchronic to chronic exposure, and to reflect deficiencies in the data base; a factor of 10 was used to provide additional protection for more sensitive human subpopulations. The blood cells (specifically inhibited hematopoiesis) are the target for prolonged oral exposure to benzene. Confidence in the chronic oral RfD is medium.

A preliminary subchronic oral RfD can be developed from the BMD described above. The subchronic oral RfD is derived by applying an uncertainty factor of 100 to the BMD of 1.2

mg/kg-day. The uncertainty factor of 100 reflects the uncertainty factor of 300 developed by EPA (2010) without the factor of 3 to expand from subchronic to chronic exposure. The preliminary subchronic oral RfD so derived is 1.2E-2 mg/kg-day, which is rounded to 1E-2 mg/kg-day.

A verified chronic inhalation RfC of 3E-2 mg/m^3 for benzene was based on the exposure-adjusted BMC of 8.2 mg/m^3 in the occupational exposure study from which the oral RfD values were derived (EPA, 2010). Application of the uncertainty factor of 300 (as described for the verified chronic oral RfD) to the BMC of 8.2 mg/m^3 yielded the chronic RfC of 3E-2 mg/m^3. The RfC is equivalent to an inhalation RfD of 8.6E-3 mg/kg-day. Confidence in the chronic inhalation RfC is medium. The blood cells (specifically inhibited hematopoiesis) are the target for prolonged inhalation exposure to benzene. A preliminary subchronic inhalation RfC can be derived by application of an uncertainty factor of 100 to the BMC of 8.2 mg/m^3 in the same manner as was done to derive the subchronic oral RfD. The subchronic inhalation RfC so derived is 8.2E-2 mg/m^3, rounded to 8E-2 mg/m^3. The preliminary subchronic inhalation RfC is equivalent to an inhalation RfD of 2.3E-2 mg/kg-day.

6.0 Carcinogenicity Evaluation

Benzene is classified as an EPA cancer weight-of-evidence Group A chemical – a known human carcinogen for all routes of exposure based upon convincing human evidence as well as supporting evidence from animal studies (EPA, 2010). Epidemiologic studies and case studies provide clear evidence of a causal association between exposure to benzene and acute nonlymphocytic leukemia, and also provide supportive evidence for chronic nonlymphocytic leukemia and chronic lymphocytic leukemia. Other neoplastic conditions in humans that are associated with benzene exposure include hematologic neoplasms, blood disorders such as preleukemia and aplastic anemia, Hodgkin's lymphoma, and myelodysplastic syndrome. Experimental animal data add to the weight of evidence that exposure to benzene increases the risk of cancer in multiple species at multiple organ sites (hematopoietic, oral and nasal, liver, forestomach, preputial gland, lung, ovary, and mammary gland). A verified URF range for inhalation exposure of 2.2E-6 to 7.8E-6 per µg/m^3 was based on the incidence of leukemia in humans exposed to benzene while employed in the Pliofilm industry (EPA, 2010). A low-dose linearity model utilizing maximum likelihood estimates was used to estimate the URF. The range reflects differences in the exposure assumptions estimated from the study. EPA (2010) concluded that neither any specific URF value nor either end of the range is more defensible than the other. Therefore, the upper end of the range, 7.8E-6 per µg/m^3, is conservatively selected for this evaluation. The URF of 7.8E-6 per µg/m^3 is equivalent to an inhalation SF of 2.7E-2 per mg/kg/day.

The occupational data that serve as the basis for the inhalation URF also serve as the basis for a verified oral SF for benzene (EPA, 2010). The inhalation URF range was mathematically converted to an equivalent oral SF range by applying standard inhalation rate and body weight assumptions, and by adjusting for route-specific differences in absorption as described for the chronic oral RfD derivation. The oral SF range so derived is 1.5E-2 to 5.5E-2 per mg/kg-day. The upper end of the range, 5.5E-2 per mg/kg-day, is conservatively selected as the oral SF for this evaluation.

7.0 Toxicity Summary

Toxicity values for benzene are summarized as follows:

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
1E-2	4E-3	Bc	8E-2/ 2.3E-2	3E-2/ 8.6E-3	Bc	A	5.5E-2	A	7.8E-6	2.7E-2

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).
Target organ abbreviations: Bc = blood cells.
[a]sRfDo, cRfDo and SFo should be used for dermal exposure without adjustment for GI absorption.

8.0 References

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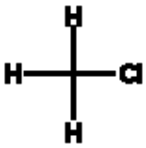
CHLOROMETHANE (METHYL CHLORIDE) (74-87-3)



1.0 Introduction and Physical Properties

Chloromethane is a **VOC** that exists as a colorless gas at ambient temperatures (HSDB, 2010). It is used largely as a methylating agent in the production of silicones, tetramethyl lead, methyl cellulose, methylene chloride, methyl mercaptan, plastics, pesticides, pharmaceuticals, dyes, perfumes, ethers, resins, agricultural chemicals, quaternary amines and butyl rubber (ACGIH, 1991; ATSDR, 1998; HSDB, 2010). It is also used as an extractant for fats, oils and resins, as a blowing agent and as a refrigerant. It was formerly used as a propellant in various aerosol products. Relevant physical properties are compiled below:

MW	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$
50.5[a]	0.91[a]	8.82E-3[b] (25 C)	1.15[b]	1.39E-1[c] (25 C)[d]	1.49E-5[e] (20 C)	5.66E+0[b] (25 C)	5.32E+3[b] (25 C)	247[f]	416[f]	5.15E+3[f]

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).
[a]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, EPA/540/R/99/005, OSWER 9285.7-02EP, July.
[b]Hazardous Substance Data Bank (HSDB), 2010, National Library of Medicine, on line.
[c]Calculated as described in Introduction to Toxicological profiles.
[d]Assumed.
[e]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York, pp. 664-666.
[f]National Institute of Standards and Technology (NIST), 2010, ***NIST Chemistry WebBook***, on line.

2.0 Environmental Fate and Transport

Chloromethane is one of the few halogenated organic chemicals for which natural sources are significant. Natural sources include volcanoes, volatilization from plants, and forest fires (HSDB, 2010). It is produced in seawater by the reaction of methyl iodide with chloride ions. Methyl iodide is produced photosynthetically by several marine organisms, and there may be other oceanic sources as well. The mean air flux of 1.3E-6 g/cm^2-year for the eastern Pacific Ocean, when extrapolated to global waters, provides an adequate source to explain the atmospheric reservoir of chloromethane. Chloromethane is released from brush and forest fires. The estimated 0.6 g of chloromethane released per kg of vegetation burned is believed to make a significant impact on the global burden of the compound.

The production and many uses of chloromethane may result in its release to the environment through various waste streams (HSDB, 2010). It is also released in tobacco smoke and turbine exhaust. Just as forest fires contribute to natural sources, wood burning, field burning, and backyard burning also contribute to atmospheric burdens. Chloromethane is formed in the chlorination of drinking water and sewage effluent, and is found in the effluent of some publically owned treatment works.

Most chloromethane is released to the atmosphere where it is expected to exist solely as a gas (HSDB, 2010). Gas-phase chloromethane is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to

be 310 days, which provides opportunity for widespread dispersion. The dominant process for removal from the troposphere is upward diffusion, although washout by rain may also be important. From the tropopause to about 30 km, both upward diffusion and reaction with hydroxyl radicals will be of approximately equal importance, and above 30 km in the stratosphere, diffusion, reaction with hydroxyl radicals, and photodissociation will have approximately equal importance. The surface half-life resulting from upward diffusion is approximately 80 days.

Based on its very low estimated K_{oc} value, chloromethane is expected to have very high mobility in soil (HSDB, 2010). Its relatively high water solubility suggests the compound released in sufficient quantity in the liquid phase or dissolved in water could leach readily to groundwater. Volatilization from moist soil surfaces is expected to be an important removal process for small quantities released to the surface. Volatilization from dry soil surfaces may also be important. Field and laboratory studies demonstrate that several halogenated aliphatics may biodegrade slowly under anaerobic conditions, but not under aerobic conditions. Biodegradation is not expected to be a significant removal process.

Chloromethane is not expected to adsorb to suspended solids and sediment in surface water (HSDB, 2010). Volatilization from water surfaces is expected to be a significant removal mechanism; volatilization half-lives for a model river and model lake are 46 minutes and 3 days, respectively. Field and laboratory studies demonstrate that several halogenated aliphatics may biodegrade slowly under anaerobic conditions, but not under aerobic conditions. Biodegradation is not expected to be a significant removal process. Hydrolysis may occur, but very slowly, with a half-life of approximately 2 years (ATSDR, 1998). Hydrolysis will not be a significant removal process for chloromethane in surface water, but may be the only significant removal process for the compound in groundwater, where it has been shown to persist.

Chloromethane is water soluble, volatile and labile, and is not expected to participate significantly in food-chain pathways (ATSDR, 1998; HSDB, 2010). Therefore, biotransfer factors are not estimated for this compound.

3.0 Toxicokinetics

Studies regarding the toxicokinetics of chloromethane are limited to inhalation exposure. Chloromethane is readily absorbed by the respiratory system and equilibrium conditions are reached in approximately one hour in exposed humans and laboratory animals (ATSDR, 1998). Data regarding the extent of respiratory absorption were not located. Although data were not located for GI absorption, it is expected that GI absorption would be rapid and extensive because the compound is a low MW organic substance that is readily absorbed by the respiratory system. HSDB (2010) stated that dermal absorption can occur, but no other information was provided.

Radioactivity is rapidly and extensively distributed throughout the body following inhalation exposure to radiolabeled chloromethane, with highest levels of radioactivity measured in liver, kidney, testis and lung (ATSDR, 1998). Approximately 20 percent of the radiolabel in liver and testis was found to have been metabolically incorporated into the cellular structure, reflecting uptake and utilization from the one-carbon atom pool of the body.

The primary and predominant metabolic pathway of chloromethane involves enzymatic conjugation with glutathione to form S-methylglutathione (ATSDR, 1998). Further metabolism involves deamination to yield S-methylcysteine and other sulfur-containing conjugation derivatives, which are excreted in the urine. Another metabolic pathway involves dehalogenation of chloromethane to form formaldehyde (a toxicant in its own right) and formic acid. These intermediates contribute to the one-carbon atom pool that is available for incorporation into the tissues or for mineralization to carbon dioxide followed by excretion through the lungs.

Studies have shown that adult humans, unlike laboratory animals, may be divided into two groups – fast or slow metabolizers – depending on the activity in their erythrocytes of glutathione-S-transferase, which is responsible for the first conjugation reaction (ATSDR, 1998). Fast metabolizers clear chloromethane from the body more rapidly than slow metabolizers. Whether the unborn, new born or young children exhibit this characteristic is unknown. The implications of glutathione-S-transferase activity regarding population differences in toxic potency are unclear. On the one hand, it may appear that fast metabolizers should be more tolerant of chloromethane because of their enhanced ability to clear the compound from the body. On the other hand, experiments in laboratory animals suggest that a metabolite of S-methylglutathione may be the ultimate toxicant, in which case fast metabolizers may be more sensitive to chloromethane toxicity.

Chloromethane residues are rapidly cleared from the body following the cessation of inhalation exposure (ATSDR, 1998). Clearance in laboratory animals and humans is biphasic, consistent with a linear 2-compartment model. The half-lives for both phases were measured in minutes, indicating the rapidity with which clearance occurs. The exception is that the β-phase in some humans (slow metabolizers) approximated 1.5 hours.

4.0 Dermal Exposure

EPA (2004) notes that organic chemicals are generally well absorbed from the GI tract, and recommends that oral toxicity values should not be adjusted when used for dermal exposure unless empirical data demonstrate that GI absorption is significantly less than complete. Chloromethane is assumed to be absorbed readily from the GI tract; therefore, no GAF is developed.

Data regarding the dermal uptake of chloromethane were not located, except that HSDB (2010) stated that dermal absorption could occur. VOCs tend to volatilize from soil when applied to the skin, reducing dermal uptake to toxicologically insignificant levels (EPA, 2004). Therefore, dermal uptake of chloromethane from soil is not quantified. EPA (2004a) provides t*, K_p, τ, FA and B values as follows:

Chemical	t*	K_p	τ	FA	B
Chloromethane	0.49	3.3E-3	0.20	1	0

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).

5.0 Noncancer Effects Evaluation

Data regarding the toxicity of oral exposure to chloromethane consist of the statement that liver effects were not observed in rats given a single oral dose of 420 mg/kg (ATSDR, 1998; EPA, no date). EPA (no date) derived a provisional chronic oral RfD of 4E-3 mg/kg-day based on a LOAEL of 69.32 mg/m^3 for subtle neurobehavioral effects from an occupational (inhalation) study. Subsequently, EPA (2010) reviewed the data and determined that ingestion exposure is not applicable because the compound exists as a gas at ambient temperatures. They also noted that the oral exposure data are insufficient to develop an oral RfD. Therefore, the EPA (no date) derivation is considered to be not applicable and no oral RfD is offered herein.

EPA (2010) verified a chronic inhalation RfC of 9E-2 mg/m^3 based on a NOAEL of 50 ppm (103.2 mg/m^3) from an 11-day continuous exposure study in mice. The NOAEL corresponds to a human equivalent concentration (HEC) of 94.6 mg/m^3. The LOAEL in this study, 100 ppm (206.4 mg/m^3 or a HEC of 189.2 mg/m^3) was associated with slight to moderate degenerative changes in the granule cells of the cerebellum. EPA (2010) applied an uncertainty factor of 1000 to the NOAEL HEC of 94.6 mg/m^3 to derive the RfC of 9E-2 mg/m^3. The uncertainty factor consists of factors of 10 each to provide additional protection for unusually sensitive humans and to expand from a short-term to lifetime exposure, and factors of 3 each to extrapolate from mice to humans and to address the uncertainty regarding the potential for CNS effects in the developing young. Confidence in the verified chronic inhalation RfC is medium. The verified inhalation RfC is equivalent to an inhalation RfD of 2.6E-2 mg/kg-day. The CNS is the target organ for prolonged inhalation exposure to chloromethane.

EPA (1996) developed a provisional chronic RfC based on subtle neurobehavioral effects from an occupational (inhalation) study. They adopted the provisional chronic RfC for subchronic application, noting no significant differences in response between chronic and subchronic exposure. However, given the EPA (2010) reevaluation and verification of a more conservative chronic RfC, it is deemed prudent to adopt the verified chronic RfC rather than the provisional chronic RfC as sufficiently protective for subchronic exposure.

6.0 Carcinogenicity Evaluation

Previous EPA (1997, 1998) evaluations classified chloromethane in EPA weight-of-cancer Group C (possible human carcinogen), and developed an oral SF and an inhalation URF. More recently, EPA (2010) reevaluated the data, noting that chloromethane is a naturally occurring compound, and concluded that it is more appropriately classified in Group D (not classifiable as to its human carcinogenicity). Applying more recent cancer assessment guidelines, EPA (2010) concluded that the available data suggest that chloromethane would be classified as an agent whose carcinogenic potential *cannot be determined*. Previously developed potency factors are considered to be not applicable; no potency factors are offered herein for chloromethane.

7.0 Toxicity Summary

Toxicity values for chloromethane are summarized below:

Noncancer Effects						Carcinogenicity				
Oral Exposure			Inhalation Exposure			Oral Exposure		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
			9E-2/	9E-2/						

Noncancer Effects						Carcinogenicity				
Oral Exposure			Inhalation Exposure			Oral Exposure		Inhalation Exposure		
sRfDo	cRfDo	TO	sRfC/ sRfDi	cRfC/ cRfDi	TO	WOE	SFo	WOE	URFi	SFi
ND	ND	NA	2.6E-2	2.6E-2	CNS	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 or critical effect abbreviations: CNS = central nervous system.

8.0 References

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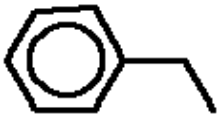
U.S. Environmental Protection Agency (EPA), 2010, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

ETHYLBENZENE (PHENYLETHANE) (100-41-4)



1.0 Introduction and Physical Properties

Ethylbenzene, also known as phenylethane, is a **VOC** that exists in the pure state as a colorless liquid at ambient temperatures (HSDB, 2010). It is used primarily as a precursor in the manufacture of styrene (ATSDR, 1999). It is also used as a solvent and diluent, and as an intermediate in the manufacturing of cellulose acetate, rubber and other organic compounds (ATSDR, 1999; HSDB, 2010). It is also a constituent of asphalt, naphtha, and automotive and aviation fuels. Relevant physical properties are compiled below:

MW	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$
106.2[a]	3.15[a]	7.88E-3[b] (25°C)	2.56[b]	7.50E-2[b] (25°C)	7.80E-6[b] (25°C)	1.26E-2[c] (25°C)	1.69E+2[b] (20-25°C)	409.34[d]	617.20[d]	8.50E+3[d]

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).

[a]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, EPA/540/R/99/005, OSWER 9285.7-02EP, July.

[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]Hazardous Substance Data Bank (HSDB), 2010, National Library of Medicine, on line.

[d]U.S. Environmental Protection Agency (EPA), 2003, ***User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings***, Office of Emergency and Remedial Response, Washington, DC, June 19.

2.0 Environmental Fate and Transport

Ethylbenzene enters the atmosphere primarily from fugitive emissions and exhaust connected with its use in gasoline (ATSDR, 1999; HSDB, 2010). More localized sources to the air and other environmental media include fugitive emissions, waste water and spills from its production and industrial use, leaking underground storage tanks, land disposal of ethylbenzene-containing waste, and municipal and hazardous waste combustion.

Ethylbenzene exists in the air in the vapor phase (ATSDR, 1999; HSDB, 2010). It is somewhat water soluble and may be removed by precipitation; however, it is likely to reenter the air by volatilization. Ethylbenzene is transformed in air by various oxidative processes to yield ethylphenols, benzaldehyde, acetophenone, and m- and p-nitroethylbenzene. Reaction with photolytically generated hydroxyl radicals is probably the most significant reaction, with a half-life estimated to be 55 hours, suggesting that ethylbenzene will not persist in the air or travel long distances.

Ethylbenzene released to soil will volatilize rapidly (ATSDR, 1999; HSDB, 2010). That which infiltrates is expected to be quite mobile in soil and may leach to groundwater because sorption to soil particles is not sufficiently strong to retard movement. Biodegradation in soil in aerobic conditions involves oxidation of the ethyl side chain, ring hydroxylation and ring cleavage, and may be a significant source of removal. Anaerobic degradation is expected to be insignificant.

Ethylbenzene released to surface water will volatilize rapidly to air (ATSDR, 1999; HSDB, 2010). Biodegradation in aerobic conditions will significantly reduce water-borne

concentrations. Photolysis and hydrolysis are unlikely to be significant. Ethylbenzene partitions weakly to sediment.

Ethylbenzene is not expected to participate significantly in food-chain pathways (ATSDR, 1999; EPA, 1995; HSDB, 2010); therefore, biotransfer factors are not provided.

3.0 Toxicokinetics

Ethylbenzene is rapidly absorbed during inhalation exposure, with retention near or exceeding 50 percent of the inhaled concentration (ATSDR, 1999). The compound is similarly rapidly absorbed following oral administration. Excretion data in rabbits suggest that a minimum of 72 to 92 of an oral dose is absorbed. Liquid ethylbenzene applied to the skin of humans is rapidly absorbed, but ethylbenzene vapor is poorly absorbed.

Ethylbenzene appears to be efficiently and widely distributed throughout the body following inhalation exposure (ATSDR, 1999). The same is expected following oral and dermal exposure, but data are lacking.

Metabolism in humans of absorbed ethylbenzene following either inhalation or oral exposure predominantly involves successive oxidation of the ethyl side-chain through 1-phenylethanol, acetophenone, ω-hydroxyacetophenone, and 1-phenyl-1,2-ethanediol to form mandelic acid and phenylglyoxylic acid (ATSDR, 1999). Small quantities of the first 4 intermediates are conjugated and excreted in the urine. Mandelic acid and phenylglyoxylic acid are excreted without conjugation and comprise the majority of excreted metabolites. A minor metabolic pathway involves epoxide formation and hydroxylation of the phenyl ring with or without oxidation of the ethyl group to yield small quantities of metabolites that are conjugated and excreted. Experiments with laboratory animals reveal species differences in the predominance of certain metabolites, but the pathways described above appear to hold. There is no evidence that the metabolites are more toxic than the parent compound.

Excretion of metabolites, primarily through the urine, is rapid and extensive in humans and laboratory animals (ATSDR, 1999). Pulmonary excretion of carbon dioxide is a minor pathway.

Nothing in this review of toxicokinetics suggests that laboratory animals would not serve as appropriate models for the toxicity of ethylbenzene to humans.

4.0 Dermal Exposure

EPA (2004) notes that organic chemicals are generally well absorbed from the GI tract, and recommends that oral toxicity values should not be adjusted when used for dermal exposure unless empirical data demonstrate that GI absorption is significantly less than complete. GI absorption of ethylbenzene is extensive as discussed in Section 3.0. Therefore, no GAF is developed for ethylbenzene and the oral toxicity values described below should be used for dermal exposure without adjustment for GI absorption.

Data were not located for dermal uptake of ethylbenzene from soil. VOCs tend to volatilize from soil when applied to the skin, reducing dermal uptake to toxicologically insignificant levels (EPA, 2004). Therefore, dermal uptake of ethylbenzene from soil is not evaluated. Values for t^*, K_p, τ, FA and B are provided by EPA (2004) as follows:

Chemical	t*	K_p	τ	FA	B
Ethylbenzene	1.01	4.9E-2	0.42	1.0	0.2
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).					

5.0 Noncancer Effects Evaluation

An oral LD_{50} in rats of 5.46 g/kg (HSDB, 2010) suggests that the acute toxicity of ingested ethylbenzene is low. Subchronic to chronic oral exposure of laboratory animals to ethylbenzene induces mild liver and kidney lesions (EPA, 2010). EPA (2010) presents a verified chronic oral RfD for ethylbenzene of 1E-1 mg/kg-day based on a NOEL for liver and kidney lesions in female rats of 136 mg/kg-day in a six-month gavage study. The LOAEL in this study was 408 mg/kg-day. An uncertainty factor of 1000 was applied to the NOEL to derive the chronic oral RfD. The uncertainty factor consists of factors of 10 each to extrapolate from animals to humans, to provide additional protection for more sensitive humans, and to expand from subchronic to chronic exposure. Confidence in the oral RfD is low. The liver and kidney are the target organs for prolonged oral exposure to ethylbenzene.

No EPA-derived subchronic oral RfD is available for ethylbenzene. A preliminary subchronic oral RfD can be made, however, by applying an uncertainty factor of 100 to the NOEL of 136 mg/kg-day in the 6-month rat study described above. The uncertainty factor of 100 reflects the chronic uncertainty factor of 1000 without the factor of 10 for expansion from subchronic to chronic exposure. The preliminary subchronic oral RfD so derived is 1E+0 mg/kg-day.

Acute inhalation exposure induces irritation of the mucous membranes in animals and humans (ACGIH, 1991). Prolonged inhalation exposure induces liver enzymes and results in elevated liver and kidney weights; prolonged exposure to relatively high levels is associated with mild histopathological lesions of the liver, kidney and testes (ACGIH, 1991; EPA, 2010). EPA (2010) considered that the effects on the liver at the lower exposure concentrations are adaptive rather than adverse. EPA (2010) presented a verified chronic inhalation RfC of 1E+0 mg/m^3 derived from a human equivalent adjusted NOAEL of 434 mg/m^3 from studies on developmental effects in rats and rabbits. An uncertainty factor of 300 was used. The human equivalent adjusted LOAEL of 4340 mg/m^3 was associated with equivocal evidence of reduced fetal size in rabbits, an increased incidence of extra ribs in rat fetuses, and increased liver, kidney and spleen weights in the rats. The inhalation RfC is equivalent to 2.9E-1 mg/kg-day. Confidence in the RfC is low. The chronic inhalation RfC is adopted as being sufficiently conservative for subchronic as well as chronic inhalation exposure.

The key study from which the inhalation RfC is derived does not clearly identify target organ(s) for inhalation exposure to ethylbenzene. The entire inhalation exposure data base, however, suggests that the liver, kidneys and fetus may be the most significant target organs for prolonged inhalation exposure.

6.0 Carcinogenicity Evaluation

Ethylbenzene is currently verified as a cancer weight-of-evidence Group D compound (not classifiable as carcinogenicity to humans) (EPA, 2010) based on an absence of human or animal cancer studies. Cancer potency factors are not estimated for Group D compounds.

7.0 Toxicity Summary

Toxicity values for ethylbenzene 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
1E+0	1E-1	L, K	1E+0/ 2.9E-1	1E+0/ 2.9E-1	L, K, F	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); NA = not applicable.
Target organ or critical effect abbreviations: L = liver; K = kidney; F = fetus.
[a]sRfDo and cRfDo should be used for dermal exposure without adjustment for GI absorption.

8.0 References

Agency for Toxic Substances and Disease Registry, (ATSDR), 1999, ***Update Toxicological Profile for Ethylbenzene***, U.S. Department of Health and Human Services, Atlanta, Georgia, July, on line.

American Conference of Governmental Industrial Hygienists (ACGIH), 1991, ***Documentation of the Threshold Limit Values and Biological Exposure Indices***, Sixth Edition, Cincinnati, OH, p. 581-584.

Hazardous Substance Data Bank (HSDB), 2010, National Library of Medicine, on line.

U.S. Environmental Protection Agency (EPA), 1995, "Final Water Quality Guidance for the Great Lakes System; Final Rule," (40 CFR 9, 122, 123, 131, and 132), ***Federal Register***, 60(56): 15365-15425.

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, EPA/540/R/99/005, OSWER 9285.7-02EP, July.

U.S. Environmental Protection Agency (EPA), 2010, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

DICHLOROPROPENES

1,3-Dichloropropene

1.0 Introduction and Physical Properties

This profile addresses 1,1-dichloropropene, 1,2-dichloropropene, 1,3-dichloropropene, and 2,3-dichloropropene. All are **VOCs** and all are liquid at ambient temperatures (ATSDR, 2006; EPA, 2002; HSDB, 2010)

Various mixtures and formulations of dichloropropenes and 1,2-dichloropropane (78-87-5) are used as soil fumigants and nematocides (HSDB, 2010; Meister, 1999). It is generally applied pre-planting by injection equipment at depths of 12 to 18 inches. Compacting the treated soil, covering the treated soil with tarps, or irrigating with water are often done immediately after treatment to retard volatilization loss.

Most soil fumigant mixtures contain predominantly 1,3-dichloropropene (542-75-6), with lesser amounts of 1,2-dichloropropene (563-54-2) and traces of 1,1-dichloropropene (563-58-6) and 2,3-dichloropropene (78-88-6) as well (ATSDR, 2006; HSDB, 2010). The use of 1,3-dichloropropene as a pesticide increased after the EPA phased out the use of ethylene dibromide, and its use is likely to increase further with the planned EPA phase-out of methyl bromide. 1,3-Dichloropropene is also used in much smaller quantities in organic synthesis and as a solvent; small quantities of 2,3-dichloropropene are used in organic synthesis.

Little is known about the physical properties of 1,1-dichloropropene or 2,3-dichloropropene. 1,2-Dichloropropene occurs as a minor constituent in Telone II, one of the more common dichloropropene formulations used as a soil fumigant. There are 2 isomers of 1,3-dichloropropene (542-75-6): cis- (or Z-) 1,3-dichloropropene (10061-01-5) and trans- (or E-) 1,3-dichloropropene (10061-02-6). Many preparations and formulations of 1,3-dichloropropene contain approximately equivalent proportions of the two isomers (HSDB, 2010). Relevant physical properties of the dichloropropenes are compiled below:

MW	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$
1,1-Dichloropropene (563-58-6)										
110.97[a]	2.53[a,b]	2.16E-2[a,b] (25°C)	1.83[a,b]	8.23E-2[c] (25°C)[d]	9.53E-6[c] (25°C)[d]	1.19E-1[a,e] (20°C)	1.18E+3[a,b] (25°C)[d]	349.65[f]	551.66[g]	7.15E+3[h]
1,2-Dichloropropene (563-54-2)										
110.97[i]	2.53[a,b]	4.91E-3[a,e] (25°C)	1.83[a,b]	8.23E-2[c] (25°C)[d]	9.53E-6[c] (25°C)[d]	3.16E-2[a,e] (25°C)	2.7E+3[i,e] (25°C)	348[i]	549[g]	7.11E+3[h]
1,3-Dichloropropene (both isomers: 542-75-6)										
111[j]	2.00[i]	3.55E-3[a,b] (25°C)	1.91[a,b]	6.26E-2[k] (25°C)	1.00E-5[k] (25°C)	4.47E-2[a,e] (25°C)	2.80E+3[k] (20-25°C)	381.15[l]	587.38[l]	7.90E+3[l]
2,3-Dichloropropene (78-88-6)										
110.97[a]	2.42[a,b]	4.16E-3[a,e] (25°C)	1.83[a,b]	8.23E-2[c] (25°C)[d]	9.53E-6[c] (25°C)[d]	8.05E-2[i] (25°C)	2.15E+3[a,e] (25°C)	367.2[i]	551.6[i]	8.44E+3[i]

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.

MW	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$

[a]U.S. Environmental Protection Agency (EPA), 2004a, ***EPI Suite Version 3.12*** Software for estimating physical properties, online, 30 November.
[b]Estimated.
[c]Calculated as described in Introduction to Toxicological profiles.
[d]Assumed.
[e]Measured.
[f]Agency for Toxic Substances and Disease Registry (ATSDR), 2006, ***Toxicological Profile for Dichloropropenes***, Draft for Public Comment, U.S. Department of Health and Human Services, Atlanta, GA, September, on line.
[g]Estimated by Equation 12-4 of Lyman, W.J., W.F. Reehl and D.H. Rosenblatt, 1990, ***Handbook of Chemical Property Estimation Methods***, American Chemical Society, Washington, DC.
[h]Estimated by Equation 13-5 of Lyman, W.J., W.F. Reehl and D.H. Rosenblatt, 1990, ***Handbook of Chemical Property Estimation Methods***, American Chemical Society, Washington, DC.
[i]Hazardous Substances Data Bank (HSDB), 2010, National Library of Medicine, on line.
[j]U.S. Environmental U.S. Environmental Protection Agency (EPA), 2004b, ***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, NTIS No. PB99-963312, July.
[k]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.
[l]U.S. Environmental Protection Agency (EPA), 2003, ***Users Guide for Evaluating Subsurface Vapor Intrusion into Buildings***, Office of Emergency and Remedial Response, Washington, DC, 19 June.

Considerable discrepancy was noted in the VP values for 1,2-dichloropropene. HSDB (2010) offered a value of 90.8 mm Hg (1.19E-1 atm) at 20 °C from a 1981 report, and EPA (2004a) offered a value of 24 mm Hg (3.16E-2 atm) at 25 °C from an experimental data base (not specified). The reason for the discrepancy is not apparent. The value of 24 mm Hg (3.16E-2 atm) at 25 °C from EPA (2004a) was selected as the more rigorously reviewed source.

There was also discrepancy between the log K_{ow} values for 1,3-dichloropropene. EPA (2004a) offered a value of 1.60, but the source is unclear. HSDB (2010) offered a value of 2.00, and EPA (2004a) cited experimental values of 2.03 and 2.06. The value of 2.00 from HSDB (2010) was selected as better documented and more consistent with the experimental values compiled by EPA (2004a).

Considerable discrepancy was noted in values for H for 1,3-dichloropropene. EPA (2002) offered a value for H' (unitless) of 7.26E-1, equivalent to 1.77E-2 atm-m^3/mole, from an unclear source. HSDB (2010) offered 9.76E-4 atm-m^3/mole, but the source is unclear. EPA (2004a) offered 3.55E-3 atm-m^3/mole from an experimental database. The latter value is chosen because it is surrounded with less uncertainty than the other values. Similar discrepancy was noted in values for K_{oc}. EPA (2002) offered a value for K_{oc} of 45.7 L/kg from an unclear source. HSDB (2010) offered 290 L/kg estimated by a regression equation from the K_{ow}. EPA (2004a) offered 80.77 L/kg from an updated regression equation. The value of 80.77 L/kg (log K_{oc} = 1.91) from EPA (2002a) is selected as fraught with less uncertainty than the EPA (2002) value and estimated by a more current model than the HSDB (2010) value.

2.0 Environmental Fate and Transport

Dichloropropenes may be released in wastewater or as fugitive emissions during their production and use as chemical intermediates or soil fumigants; however releases of 1,1-, 1,2-, and 3,3-

dichloropropene are probably low because no uses were located for these isomers, although they may appear at low levels in other dichloropropene mixtures and formulations. The dichloropropenes may be inadvertently formed by the chlorination of water supplies carrying organic matter (ATSDR, 2006).

Dichloropropenes released to soil are likely to be highly mobile because of their low K_{oc} values (HSDB, 2010). Although the dichloropropenes may leach to groundwater, hydrolysis and biodegradation may attenuate the leaching process (ATSDR, 2006). Also, dichloropropenes will adsorb much more readily from the vapor phase than from the dissolved phase. Volatilization from moist soil surfaces is expected to be an important removal process for the dichloropropenes. Volatilization from dry soil surfaces may also be important.

Dichloropropenes released to water are not expected to adsorb to suspended solids and sediment (HSDB, 2010). Volatilization from water surfaces is likely to be the major removal mechanism. Volatilization half-lives for a model river and model lake have been estimated at 1 and 101 hours (specific isomer[s] not specified), respectively. Hydrolysis may also be significant; a hydrolysis half-life of 11 days was estimated for the dichloropropenes at a temperature range of 15 to 25 °C. Biodegradation is also expected to be significant (ATSDR, 2006).

The dichloropropenes are expected to exist entirely in the vapor phase in the ambient atmosphere (HSDB, 2010). Vapor-phase dichloropropene is subject to reaction with photochemically-produced hydroxyl radicals; a half-life of 3 days (specific isomer[s] not specified) was estimated for this reaction. The dichloropropenes are not expected to directly photolyze in the presence of sunlight. Wet deposition may also be a significant removal mechanism (ATSDR, 2006) (1,3-dichloropropene has been detected in rainwater), but volatilization is likely to rapidly return the dichloropropenes to the atmosphere.

Their relatively low log K_{ow}, high water solubility and their potential for metabolism suggests that the dichloropropenes are unlikely to participate significantly in food-chain pathways (HSDB, 2010). 1,3-Dichloropropene was identified by the EPA (1995) as not being of concern for human health through the aquatic food chain. Therefore, biotransfer factors are not compiled or estimated.

3.0 Toxicokinetics

Data for 1,3- and 2,3-dichloropropene indicate that the dichloropropenes are readily absorbed following inhalation or oral exposure (ATSDR, 2006). Excretion data from rats indicate that 62 to 82 percent of inhaled 1,3-dichloropropene and 35 to 40 percent of inhaled 2,3-dichloropropene are absorbed. The higher absorption percentages were estimated at lower concentrations. Higher concentrations were shown to decrease respiratory rate and saturate elimination mechanisms, which effectively reduced respiratory absorption.

Excretion data for 1,3- and 2,3-dichloropropene in rats indicate that well upwards of 90 percent of an ingested dose is absorbed from the GI tract. Excretion data from human volunteers indicate that dermal uptake occurs, but reliable quantitative data were not located.

The dichloropropenes appear to be widely distributed following absorption. After 6-hour inhalation exposure to radiolabeled 2,3-dichloropropene, tissue levels of radioactivity from

highest to lowest were found in the urinary bladder, nasal turbinates, kidneys, small intestine, liver, trachea and larynx (ATSDR, 2006). Approximately 9 percent of the absorbed radioactivity was accounted for in the body tissues. Following gavage treatment with radiolabeled 1,3-dichloropropene, highest levels of radioactivity were found in the forestomach and urinary bladder; lower levels were located in a wide variety of tissues. Tissue levels fall rapidly after exposure is terminated; there appears to be no tendency for the body to accumulate the parent compound or its metabolites. It is noteworthy that the forestomach is the target organ of prolonged oral exposure, the nasal turbinates are the target of prolonged inhalation exposure, and the urinary bladder is a target organ for the carcinogenicity of 1,3-dichloropropene.

Data from rats indicate that 1,3-dichloropropene is metabolized by three primary pathways. Most important is dechlorination and conjugation with glutathione at carbon-3, followed by conversion to a mecapturic acid and acetylation to form the N-acetyl-cysteine metabolite, which is excreted (ATSDR, 2006). Excretion data from occupationally exposed humans indicate that this pathway predominates in humans as well. A minor pathway involves hydrolysis and dechlorination at carbon-3 to form 1-chloroallyl alcohol, which undergoes further oxidation and oxidative dechlorination at carbon-1 and breakage of the chain to form carbon dioxide and acetyl-CoA, which may be incorporated into body tissues. Another minor pathway involves epoxide formation followed by dechlorination and additional oxidation to form glycidaldehyde and methylglyoxal.

Data from rats indicate that 2,3-dichloropropene is subject to the same three metabolic pathways as observed for the 1,3-isomer (ATSDR, 2006). Conjugation with glutathione predominantes. The other two minor pathways (epoxide formation and hydrolysis with dechlorination) yield metabolites that have been shown to be mutagenic, which apparently accounts for the carcinogenicity of the 1,3-isomer.

Excretion of dichloropropene metabolites is primarily in the urine following inhalation exposure of rats (ATSDR, 2006). Fecal excretion is also significant, more so for 2,3-dichloropropene than for 1,3-dichloropropene. Approximately 3 percent of the absorbed amount of 2,3-dichloropropene was excreted as carbon dioxide. Similar patterns are observed after oral exposure of rats; urinary excretion predominates. cis-1,3-Dichloropropene is metabolized and excreted in the urine as mercapturic acid metabolites more efficiently than the trans-isomer. trans-1,3-Dichloropropene is metabolized to carbon dioxide more efficiently than the cis-isomer.

The limited toxicokinetic data suggest that there is more variation between the dichloropropene isomers than between species. The differences appear to be quantitative rather than qualitative, supporting the assumption that the toxicity of the isomers may be similar.

4.0 Dermal Exposure

EPA (2004b) notes that organic chemicals are generally well absorbed from the GI tract, and recommends that oral toxicity values should not be adjusted when used for dermal exposure unless empirical data demonstrate that GI absorption is significantly less than complete. As noted above, the dichloropropenes are extensively absorbed from the GI tract. Therefore, no GAF is developed for the dichloropropenes and the oral toxicity values described below should be used for dermal exposure without adjustment for GI absorption.

It appears from the previous section that the dichloropropenes are absorbed through the skin, but data are not available regarding the extent of dermal uptake from soil. VOCs tend to volatilize from soil when applied to the skin, reducing dermal uptake to toxicologically insignificant levels (EPA, 2004b). Therefore, dermal uptake of the dichloropropenes from soil is not quantified.

As noted above, the value selected for log K_{ow} for 1,3-dichloropropene differs slightly from that provided by EPA (2004b). Therefore, values for t*, K_p, τ, FA and B tabulated below were not taken directly from EPA (2004b). Instead, they were recalculated from MW and the accepted log K_{ow} given above using the EPA (2004b) method. Values for t*, K_p, τ, FA and B for the other isomers were also estimated from the MW and log K_{ow} values given above and the EPA (2004b) method, as follows:

Chemical	t*	K_p	τ	FA	B
1,1-Dichloropropene	1.05	1.77E-2	0.44	1	0[a]
1,2-Dichloropropene	1.05	1.77E-2	0.44	1	0[a]
1,3-Dichloropropene	1.05	7.92E-3	0.44	1	0[a]
2,3-Dichloropropene	1.05	1.50E-2	0.44	1	0[a]

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]Sufficiently small to be rounded to zero.

5.0 Noncancer Effects Evaluation

Toxicity data were not located for 1,1-dichloropropene. Acute toxicity data for 1,2-dichloropropene include an oral LD_{50} value of 2 g/kg in rats and a dermal LD_{50} of 8750 mg/kg in rabbits (HSDB, 2010), indicating that the acute toxicity of the 1,2-isomer is relatively low. Descriptions of agonal signs or necropsy findings were not located. Data regarding prolonged exposure to 1,2-dichloropropene were not located.

Oral LD_{50} values for 1,3-dichloropropene include 94 to 713 mg/kg in rats and 215 to 640 mg/kg in mice (ATSDR, 2006; HSDB, 2010). The wide range of values within species probably reflects differences in the preparations and formulations tested. Necropsy of the decedents from one study revealed liver and kidney damage. EPA (2010) verified a chronic oral RfD for 1,3-dichloropropene of 3E-2 mg/kg-day based on chronic stomach irritation in rats treated with a microencapsulated formulation of Telone II (96 percent 1,3-dichloropropene) in the diet. In the key study, male and female rats were fed diets that provided dose rates of 0 (control), 2.5, 12.5 or 25 mg/kg-day for 24 months. Decreased body weight gain was observed in a dose-related manner that reached statistical significance in rats of both sexes in the high dose group. The incidence of hyperplasia of the epithelium of the forestomach showed a statistically significant increase in rats in the 12.5 and 25 mg/kg-day groups. Hyperplasia of the forestomach was interpreted as a response to chronic stomach irritation, which was identified as the critical effect of prolonged ingestion exposure. The 95 percent lower confidence limit on the maximum likelihood estimate of the dose corresponding to a 10 percent response rate ($BMDL_{10}$) was estimated as 3.4 mg/kg-day. Application of an uncertainty factor of 100 (factors of 10 each for intra- and inter-species variation) to the $BMDL_{10}$ yields the verified chronic oral RfD of 3E-2 mg/kg-day. Confidence in the verified chronic oral RfD is high. Stomach irritation is considered the critical effect of prolonged oral exposure.

EPA (1997) provides a provisional subchronic oral RfD for 1,3-dichloropropene of 3E-3 mg/kg-day based on a NOEL for increased organ weights of 3 mg/kg-day in rats in a 90-day dietary study. A LOAEL was not identified. An uncertainty factor of 1000 was used. It is likely that the increase in organ weights reported by EPA (1997) may reflect increased organ-to-body weight ratios, which would be expected and consistent with the observation of decreased overall body weight gain in the chronic study described in the previous paragraph. The NOEL of 3 mg/kg-day in the 90-day study also is consistent with the effect levels observed in the chronic study described in the previous paragraph. It is not reasonable, however, that a subchronic oral RfD should be lower than a chronic oral RfD. Therefore, the verified chronic oral RfD of 3E-2 mg/kg-day is adopted as sufficiently protective for subchronic as well as chronic exposure.

Occupational exposure to high levels of 1,3-dichloropropene in air is associated with skin, eye and respiratory tract irritation (ACGIH, 1991). EPA (2010) presents a verified inhalation RfC for 1,3-dichloropropene of 2E-2 mg/m^3 based on a human equivalent adjusted 95 percent lower confidence limit on the maximum likelihood estimate of the concentration corresponding to a 10 percent response rate ($BMCL_{10}$) of 0.72 mg/m^3 in an intermittent exposure inhalation study in mice. In the key study rats and mice were exposed to technical grade 1,3-dichloropropene at concentrations of 0 (control), 5 ppm (22.7 mg/m^3), 20 ppm (90.8 mg/m^3) or 60 ppm (272 mg/m^3) 6 hours/day, 5 days/week for two years. The only treatment-related effects in rats were histopathological changes in the nasal epithelium in the high-concentration group after 24 months, but not after 6 or 12 months of exposure. Effects in mice included masses in the lungs in males in the high-dose group, and slight hypertrophy and hyperplasia of the nasal epithelium in the two lower concentration groups. Hyperplasia of the urinary bladder epithelium was also observed in female mice in the high-concentration group. Hypertrophy and hyperplasia in the nasal epithelium of mice was identified as the critical effect of inhalation exposure. An uncertainty factor of 30 was applied to the human equivalent adjusted $BMCL_{10}$ of 0.72 mg/m^3 to derive the verified chronic inhalation RfC of 2E-2 mg/m^3. The chronic inhalation RfC is equivalent to an inhalation RfD of 5.7E-3 mg/kg-day.

EPA (1997) adopted the verified chronic inhalation RfC of 2E-2 mg/m^3 (5.7E-3 mg/kg-day) as the provisional subchronic inhalation RfC. Hypertrophy and hyperplasia of the nasal epithelium is the critical effect of prolonged inhalation exposure to 1,3-dichloropropene.

Toxicity date for 2,3-dichloropropene are largely limited to an oral LD_{50} values in rats of 285 to 320 mg/kg and a dermal LD_{50} in rabbits of 1580 mg/kg (ATSDR, 2006; HSDB, 2010).

Toxicity information sufficient for RfD or RfC estimation is not available for 1,1-, 1,2- or 2,3-dichloropropene. 1,3-Dichloropropene is selected as a surrogate for 1,1-, 1,2- and 2,3-dichloropropene because of the similarity in chemical structure. Therefore, the noncancer oral and inhalation toxicity values described for 1,3-dichloropropene are applied also to 1,1-, 1,2- and 2,3-dichloropropene.

6.0 Carcinogenicity Evaluation

In an earlier assessment, EPA (2010) verified 1,3-dichloropropene as a cancer weight-of-evidence B2 compound – probable human carcinogen – on the basis of increased incidences of various tumor types in rats and mice in three oral studies and an inhalation study. Also, 1,3-dichloropropene yields positive results in tests for mutagenic activity and is structurally similar

to chemicals known to produce similar types of tumors in rodents. Consistent with more recent EPA (2005) cancer assessment guidelines, EPA (2010) characterized 1,3-dichloropropene as likely to be a human carcinogen.

EPA (2010) developed and verified oral cancer SFs of 1E-1 per mg/kg-day from the incidence of urinary bladder tumors in female mice in a two-year gavage study, 5E-2 per mg/kg-day for liver tumors in male rats in the same study, and 5E-2 per mg/kg-day for liver tumors in male rats in a two-year dietary study. EPA (2010) recommended the SF of 1E-1 per mg/kg-day because it is the most conservative estimate and there was less uncertainty regarding the actual dose delivered.

EPA (2010) developed and verified an inhalation URF of 4E-6 per $\mu g/m^3$ based on the incidence of lung tumors in male mice in a two-year inhalation study. The URF is equivalent to an inhalation SF of 1.4E-2 per mg/kg-day.

The toxicokinetic data summarized above and the EPA (2010) cancer evaluation strongly indicate that the mode of action for carcinogenicity arises from genotoxicity. EPA (2005) proposed that the oral and inhalation cancer potency factors developed for genotoxic chemicals should be modified with the age dependent adjustment factors (ADAF) of 10 for children under 2 years of age, 3 for children 2 to 16 years of age, and 1 for adults and children over 16 years of age.

7.0 Toxicity Summary

Toxicity values for 1,3-dichloropropene are summarized as follows:

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-2	3E-2	St	2E-2/ 5.7E-3	2E-2/ 5.7E-3	NE	See above	1E-1	See above	4E-6	1.4E-2

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: St = stomach; NE = nasal epithelium.
[a]sRfDo, cRfDo and SFo should be used for dermal exposure without adjustment for GI absorption.

8.0 References

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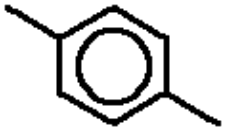
XYLENES (DIMETHYLBENZENE), TOTAL (1330-20-7)



p-Xylene

1.0 Introduction and Physical Properties

The xylenes, also known as dimethylbenzenes, exist as three isomers: 2-xylene (1,2-dimethylbenzene, ortho- or o-xylene) (95-47-6), 3-xylene (1,3-dimethylbenzene, meta- or m-xylene) (108-38-3) and 4-xylene (1,4-dimethylbenzene, para- or p-xylene) (106-42-3) (HSDB, 2010). The o-, m-, and p-xylene nomenclature will be used herein to be consistent with the manner in which xylene concentrations in environmental media are usually reported by the analytical laboratories.

The xylenes are **VOCs** derived from coal tar, coal gas, and petroleum distillation (ATSDR, 1995; HSDB, 2010). They occur as clear liquids in the pure state at most ambient temperatures, although 4-xylene occurs as colorless plates or prisms at temperatures below 56EF (13.33EC). Natural sources include petroleum, forest fires and volatiles from plants.

Xylenes are used in the manufacture of other organic compounds, dyes, insecticides and pharmaceuticals, and as solvents (ATSDR, 1995; HSDB, 2010). They are components of aviation gasoline, asphalt and naphtha, and automobile exhaust. Technical xylene consists of approximately 44 percent m-xylene, 20 percent o-xylene, 20 percent p-xylene, and 15 percent ethylbenzene. Relevant physical properties are compiled below:

MW	log K_{ow}	H	log K_{oc}	D_a	D_w	VP	S	T_b	T_c	$\Delta H_{v,b}$
o-Xylene (95-47-6)										
106.16[a]	3.12[a]	5.20E-3[b] (25°C)	2.56[b]	8.70E-2[b] (25°C)	1.00E-5[b] (25°C)	8.70E-3[a] (25°C)	1.78E+2[b] (20-25°C)	417.60[c]	630.30[c]	8.66E+3[c]
m-Xylene (108-38-3)										
106.2[d]	3.20[d]	7.34E-3[b] (25°C)	2.61[b]	7.00E-2[b] (25°C)	7.80E-6[b] (25°C)	1.09E-2[a] (25°C)	1.16E+2[b] (20-25°C)	412.27[c]	617.05[c]	8.52E+3[c]
p-Xylene (106-42-3)										
106.16[a]	3.15[a]	7.66E-3[b] (25°C)	2.59[b]	7.69E-2[b] (25°C)	8.44E-6[b] (25°C)	1.16E-2[a] (25°C)	1.85E+2[b] (20-25°C)	411.52[c]	616.20[c]	8.53E+3[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).

[a]Hazardous Substance Data Bank (HSDB), 2010, National Library of Medicine, on line.

[b]U.S. 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]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.

It is recommended that the physical properties for m-xylene should be applied to mixed xylene isomers or data where the specific isomer is not identified, because m-xylene is the major component of the technical mixture and is likely to predominate following xylene releases.

2.0 Environmental Fate and Transport

Naturally occurring sources of xylenes are petroleum, forest fires and volatiles from plants (ATSDR, 1995; HSDB, 2010). The production and use of xylenes in petroleum products and as chemical solvents and intermediates may result in their release to the environment as fugitives and through various waste streams. Outgassing from landfills and automobile exhaust are other significant sources. Spills, leaking underground storage tanks and associated plumbing, and leaching from landfills may release xylenes to soil and groundwater.

Xylenes will exist solely in the vapor phase in the ambient atmosphere, where they are subject to degradation by reaction with photochemically-produced hydroxyl radicals as the only significant removal process (ATSDR, 1995; HSDB, 2010). The atmospheric lifetime of xylenes is about 1 to 2 days. Products of photooxidation include a wide variety of ring hydroxylation and ring cleavage products.

Volatilization is expected to be the major removal mechanism for xylenes released to surface soil, but, depending on the size and rate of release, the majority of the release may infiltrate to subsurface soil (ATSDR, 1995). Photooxidation may degrade a significant part of the small amount that remains at the surface. Biodegradation is probably the only significant subsurface removal mechanism, but it is expected to be slow. A wide range of experimental K_{oc} values have been reported in soil samples with differing pH and organic carbon content (HSDB, 2010), suggesting a wide range in the extent to which the xylenes adsorb to soil particles. Generally, however, xylene is fairly mobile and may readily leach to groundwater.

Volatilization is probably the most significant removal mechanism for xylenes in surface water (ATSDR, 1995). Biodegradation may occur in surface water, groundwater and landfill leachate, although quite slowly. Oxidative reactions are expected to be insignificant. Xylenes are expected to adsorb somewhat to suspended solids and sediment in water (HSDB, 2010).

Xylenes are not expected to participate significantly in food-chain pathways (ATSDR, 1995; HSDB, 2010); therefore, biotransfer factors are not provided.

3.0 Toxicokinetics

Xylenes are rapidly and extensively absorbed during inhalation and following oral exposure (ATSDR, 1995). In humans, approximately 50 to 73 percent of the inhaled concentration is retained. In laboratory animals, approximately 90 percent of an ingested dose is absorbed. Liquid xylene is absorbed through the skin of humans, but dermal uptake of xylene vapors approximates only 1 percent of inhalation uptake. A study in rats showed that dermal uptake of xylene adsorbed to soil is much slower than dermal uptake of the neat liquid.

Absorbed xylene is largely bound to serum protein in the blood and is distributed rapidly and widely throughout the body, but particularly to highly vascular tissues and those high in lipid content (e.g., blood, brain, liver) (ATSDR, 1995). Levels in fetal tissues approximate 2 percent of those measured in maternal brain.

The predominant metabolic pathway in humans and animals for all xylene isomers is oxidation of one of the methyl groups to the corresponding alcohol, with further oxidation to the corresponding methylbenzoic acid (ATSDR, 1995). The methylbenzoic acids conjugate with

glycine to form the corresponding methylhippuric acids, which are the major urinary metabolites. Much lesser quantities of the alcohols and o-methylbenzoic acid are also excreted in the urine. Methylbenzaldehyde, proposed as the ultimate toxicant because it inactivates enzymes involved in electron transport, has been identified in laboratory animals but not in humans. Metabolism in laboratory animals differs from that in humans largely in the nature of the conjugates that are formed. Ring hydroxylation to form phenolic compounds represents a minor metabolic pathway is both humans and animals.

The xylenes are rapidly excreted from the body, largely in the form of urinary metabolites (ATSDR, 1955) as described above. Approximately 5 percent of an oral dose is eliminated in the breath as unchanged compound. Residues are slightly more persistent in adiposa and muscle tissue than other tissues of the body, but no organ or tissue accumulates xylene residues.

4.0 Dermal Exposure

EPA (2003) recommends that oral toxicity values should not be adjusted when used for dermal exposure unless empirical data demonstrate that GI absorption is significantly less than complete. Xylenes are nearly completely absorbed from the GI tract; therefore, no GAF is developed for the xylenes and the oral toxicity values described below should be used for dermal exposure without adjustment for GI absorption.

Xylene in soil is absorbed by the skin, albeit very slowly, but quantitative data were not located. VOCs tend to volatilize from soil when applied to the skin, reducing dermal uptake to toxicologically insignificant levels (EPA, 2004). Therefore, dermal uptake of xylenes from soil is not evaluated. Values for t*, K_p, τ, FA and B are provided by EPA (2003) for m-xylene as follows:

Chemical	t*	K_p	τ	FA	B
m-Xylene	1.01	5.3E-2	0.42	1.0	0.2
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).					

The dermal uptake parameters presented by EPA (2004) for m-xylene are applied to all the xylene isomers as well as to total xylenes.

5.0 Noncancer Effects Evaluation

Oral LD_{50} values for xylenes include 3.5 to 8.6 g/kg in rats and 1.6 to 5.6 g/kg in mice (HSDB, 2010), suggesting that the acute toxicity is low, but that mice may be slightly more sensitive than rats to the acute effects of ingested xylenes. Prolonged oral exposure of animals to xylenes is associated with reduced body weight and survival without histopathological alterations in the internal organs (EPA, 2010). EPA (2010) confirmed a previously verified chronic oral RfD for total xylenes of 2E-1 mg/kg-day based on a NOAEL of 250 mg/kg, equivalent to a continuous dose rate of 179 mg/kg-day, for decreased body weight and survival in male rats in chronic gavage studies with mixed xylenes. The LOAEL was 500 mg/kg, equivalent to 357 mg/kg-day. Mice were also included in the study. The LOAEL in mice was 1000 mg/kg, equivalent to 714 mg/kg-day, associated with hyperactivity, which was consistently observed at 5 to 30 minutes after treatment. The mice did not exhibit the effects on body weight or survival that was observed with the rats, establishing the rat as the more sensitive species to prolonged oral

exposure. An uncertainty factor of 1000 was applied to the rat NOAEL to derive the verified chronic oral RfD. Confidence in the chronic oral RfD is medium.

EPA (1997) presented provisional chronic oral RfDs for o-xylene and m-xylene of 2E+0 mg/kg-day based on an earlier IRIS evaluation of the same rat and mouse gavage study. Given the EPA (2010) re-evaluation of this study and the lowering of the chronic oral RfD by an order of magnitude, it seems prudent to adopt the verified chronic oral RfD of 2E-1 mg/kg-day for use with mixed xylenes and all xylene isomers. The critical effects of prolonged oral exposure to xylenes are reduced body weight and reduced survival. The verified chronic oral RfD is adopted as sufficiently protective for subchronic oral exposure to mixed xylenes and all xylene isomers.

Occupational exposure to xylenes induces CNS effects and GI disturbances (ACGIH, 1991). Other effects attributed to occupational exposure to xylene (blood dyscrasias, and heart, liver and kidney damage) may arise from concurrent exposure to other chemicals. EPA (2010) verified a chronic inhalation RfC of 1E-1 mg/m^3 based on CNS effects. In the key study, male rats were intermittently exposed to m-xylene at airborne concentrations of 0, 50 or 100 ppm for three months. Endpoints evaluated included spontaneous motor activity and motor coordination as measured by performance on a rotorod. Body and organ weights and limited blood chemistry and hematological parameters were also evaluated, but minor alterations in these endpoints were not attributed to exposure to m-xylene. The study identified 50 ppm as the NOAEL and 100 ppm as the LOAEL for impaired rotorod performance. The NOAEL is equivalent to an adjusted human equivalent concentration of 39 mg/m^3. Application of an uncertainty factor of 300 to the NOAEL yields the verified chronic inhalation RfC of 1E-1 mg/m^3, which is equivalent to a chronic inhalation RfD of 2.9E-2 mg/kg-day. The uncertainty factor consists of a factor of 10 to provide greater protection for more sensitive individuals, and factors of 3 each to extrapolate from animals to humans, to expand from subchronic to chronic exposure, and to account for deficiencies in the data base. The CNS is considered to be the target organ for prolonged inhalation exposure to xylenes. Confidence in the chronic inhalation RfC is medium.

No EPA-derived subchronic inhalation RfC is available for exposure to xylene. However, a preliminary subchronic inhalation RfC can be derived by applying an uncertainty factor of 100 to the NOAEL of 39 mg/m^3 in the subchronic rotorod study in rats described above. The uncertainty factor of 100 reflects the chronic uncertainty factor of 300 without the factor of 3 to expand from subchronic to chronic exposure. The preliminary subchronic inhalation RfC so derived is 4E-1 mg/m^3, which is equivalent to a subchronic inhalation RfD of 1.1E-1 mg/kg-day.

6.0 Carcinogenicity Evaluation

Xylene was previously characterized as a cancer weight-of-evidence Group D compound (not classifiable as to carcinogenicity to humans). Using a more descriptive characterization, EPA (2010) concluded that the cancer *data are inadequate for an assessment of the carcinogenic potential of xylenes*. Adequate human data on the carcinogenicity of the xylenes are not available, and the available animal data are inconclusive as to the ability of xylenes to cause a carcinogenic response. Evaluations of the genotoxic effects of xylenes have consistently given negative results. Potency factors are not available.

7.0 Toxicity Summary

Toxicity values for the xylenes 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
2E-1	2E-1	BW, Su	4E-1/ 1.1E-1	1E-1/ 2.9E-2	CNS	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); NA = not applicable.
Target organ or critical effect abbreviations: BW = reduced body weight; Su = reduced survival; CNS = central nervous system.
[a]sRfDo and cRfDo should be used for dermal exposure without adjustment for GI absorption.

8.0 References

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APPENDIX D

RISK CHARACTERIZATION SPREADSHEETS

Table D-1

Groundskeeper, Current and Future Scenarios, Exposure to Soil [a]
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		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
Inorganics										
Beryllium	1.14E+01	3.97E-06	1.11E-05	NA	5.55E-03	NA	NA	NA	NA	NA
Thallium	2.95E+00	1.03E-06	2.89E-06	NA	4.44E-02	NA	NA	NA	NA	NA
Polychlorinated biphenyls (PCB)										
Aroclor 1016	1.58E-01	5.52E-08	1.55E-07	3.86E-09	2.21E-03	4.42E-09	5.10E-08	1.43E-07	3.57E-09	2.04E-03
Semivolatile Organic Compounds										
Benzo(a)pyrene	1.70E-01	5.94E-08	1.66E-07	4.34E-07	NA	4.42E-09	5.10E-08	1.43E-07	3.72E-07	NA
Benzo(b)fluoranthene	1.60E-01	5.59E-08	1.57E-07	4.08E-08	NA	4.16E-09	4.80E-08	1.34E-07	3.50E-08	NA
Total ILCR or HI				**4.78E-07**	**5.22E-02**				**4.11E-07**	**2.04E-03**

[a] This receptor is exposed to both surface soil and total soil; however all COPCs come from surface soil so the EPC is the same for both.

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/m^3 - milligram per cubic meter

Table D-1

Groundskeeper, Current and Future Scenarios, Exposure to Soil [a]
Powerhouse 2 Ash Pits
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**
Inorganics							
Beryllium	1.14E-06	7.93E-08	2.22E-07	6.66E-07	3.90E-02	**6.66E-07**	**4.45E-02**
Thallium	2.95E-07	2.06E-08	5.77E-08	NA	NA	**NA**	**4.44E-02**
Polychlorinated biphenyls (PCB)							
Aroclor 1016	1.58E-08	1.10E-09	3.09E-09	7.73E-11	NA	**7.51E-09**	**4.25E-03**
Semivolatile Organic Compounds							
Benzo(a)pyrene	1.70E-08	1.19E-09	3.33E-09	3.68E-09	NA	**8.09E-07**	**NA**
Benzo(b)fluoranthene	1.60E-08	1.12E-09	3.13E-09	3.47E-10	NA	**7.62E-08**	**NA**
Total ILCR or HI				**6.70E-07**	**3.90E-02**	**1.56E-06**	**9.32E-02**

[a] This receptor is exposed to both surface soil and total soil; however all COPCs come from surface soil so the EPC is the same for both.

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/m^3 - milligram per cubic meter

Table D-2

Groundskeeper, Future Scenario, Exposure to Bedrock Groundwater
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion				Dermal Contact					All Pathways	
		Cancer	Noncancer			Dose	Cancer	Noncancer				
Chemicals of Potential Concern	EPC mg/L	Dose mg/kg-day	Dose mg/kg-day	ILCR	HQ	Absorbed mg/cm^2-day	Dose mg/kg-day	Dose mg/kg-day	ILCR	HQ	**Total ILCR**	**Total HI**
Inorganics												
Selenium	1.95E-02	6.81E-05	1.91E-04	NA	3.82E-02	1.95E-08	2.25E-07	6.30E-07	NA	1.26E-04	**NA**	**3.83E-02**
Semivolatile Organic Compounds												
Naphthalene	7.40E-03	2.59E-05	7.24E-05	NA	3.62E-03	7.19E-07	8.30E-06	2.32E-05	NA	1.16E-03	**NA**	**4.78E-03**
Volatile Organic Compounds												
Benzene	3.36E-01	1.17E-03	3.29E-03	6.46E-05	8.22E-01	7.79E-06	8.99E-05	2.52E-04	4.94E-06	6.29E-02	**6.95E-05**	**8.85E-01**
Chloromethane	4.49E-02	1.57E-04	4.39E-04	NA	NA	2.07E-07	2.39E-06	6.70E-06	NA	NA	**NA**	**NA**
trans-1,3-Dichloropropene	1.70E-03	5.94E-06	1.66E-05	5.94E-07	5.54E-04	1.36E-08	1.56E-07	4.38E-07	1.56E-08	1.46E-05	**6.10E-07**	**5.69E-04**
Ethylbenzene	5.71E-02	2.00E-04	5.59E-04	NA	5.59E-03	5.01E-06	5.78E-05	1.62E-04	NA	1.62E-03	**NA**	**7.21E-03**
Xylenes, total	6.30E-01	2.20E-03	6.16E-03	NA	3.08E-02	5.98E-05	6.90E-04	1.93E-03	NA	9.66E-03	**NA**	**4.05E-02**
Total ILCR or HI				**6.52E-05**	**9.01E-01**				**4.96E-06**	**7.55E-02**	**7.01E-05**	**9.76E-01**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/L - milligram per liter
mg/cm^2 - milligram per square meter
mg/kg - milligram per kilogram

Table D-3

Groundskeeper, Future Scenario, Exposure to Groundwater, Overburden Wells
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion				Dermal Contact					All Pathways	
		Cancer	Noncancer			Dose	Cancer	Noncancer				
Chemicals of Potential Concern	EPC mg/L	Dose mg/kg-day	Dose mg/kg-day	ILCR	HQ	Absorbed mg/cm^2-day	Dose mg/kg-day	Dose mg/kg-day	ILCR	HQ	**Total ILCR**	**Total HI**
Inorganics												
Nickel	7.42E-02	2.59E-04	7.26E-04	NA	3.63E-02	1.48E-08	1.71E-07	4.79E-07	NA	5.99E-04	**NA**	**3.69E-02**
Total ILCR or HI				**NA**	**3.63E-02**				**NA**	**5.99E-04**	**NA**	**3.69E-02**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/L - milligram per liter
mg/cm^2 - milligram per square meter
mg/kg - milligram per kilogram

Table D-4

Indoor Worker, Future Scenario, Exposure to Surface Soil
Powerhouse 2 Ash Pits
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**
Inorganics							
Beryllium	1.14E+01	1.98E-06	5.55E-06	NA	2.78E-03	**NA**	**2.78E-03**
Thallium	2.95E+00	5.16E-07	1.44E-06	NA	2.22E-02	**NA**	**2.22E-02**
Polychlorinated biphenyls (PCB)							
Aroclor 1016	1.58E-01	2.76E-08	7.73E-08	1.93E-09	1.10E-03	**1.93E-09**	**1.10E-03**
Semivolatile Organic Compounds							
Benzo(a)pyrene	1.70E-01	2.97E-08	8.32E-08	2.17E-07	NA	**2.17E-07**	**NA**
Benzo(b)fluoranthene	1.60E-01	2.80E-08	7.83E-08	2.04E-08	NA	**2.04E-08**	**NA**
Total ILCR or HI						**2.39E-07**	**2.61E-02**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram

Table D-5

Indoor Worker, Future Scenario, Exposure to Bedrock Groundwater
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion				Dermal Contact					All Pathways	
		Cancer	Noncancer			Dose	Cancer	Noncancer				
Chemicals of Potential Concern	EPC mg/L	Dose mg/kg-day	Dose mg/kg-day	ILCR	HQ	Absorbed mg/cm^2-day	Dose mg/kg-day	Dose mg/kg-day	ILCR	HQ	**Total ILCR**	**Total HI**
Inorganics												
Selenium	1.95E-02	6.81E-05	1.91E-04	NA	3.82E-02	1.95E-08	2.25E-07	6.30E-07	NA	1.26E-04	**NA**	**3.83E-02**
Semivolatile Organic Compounds												
Naphthalene	7.40E-03	2.59E-05	7.24E-05	NA	3.62E-03	7.19E-07	8.30E-06	2.32E-05	NA	1.16E-03	**NA**	**4.78E-03**
Volatile Organic Compounds												
Benzene	3.36E-01	1.17E-03	3.29E-03	6.46E-05	8.22E-01	7.79E-06	8.99E-05	2.52E-04	4.94E-06	6.29E-02	**6.95E-05**	**8.85E-01**
Chloromethane	4.49E-02	1.57E-04	4.39E-04	NA	NA	2.07E-07	2.39E-06	6.70E-06	NA	NA	**NA**	**NA**
trans-1,3-Dichloropropene	1.70E-03	5.94E-06	1.66E-05	5.94E-07	5.54E-04	1.36E-08	1.56E-07	4.38E-07	1.56E-08	1.46E-05	**6.10E-07**	**5.69E-04**
Ethylbenzene	5.71E-02	2.00E-04	5.59E-04	NA	5.59E-03	5.01E-06	5.78E-05	1.62E-04	NA	1.62E-03	**NA**	**7.21E-03**
Xylenes, total	6.30E-01	2.20E-03	6.16E-03	NA	3.08E-02	5.98E-05	6.90E-04	1.93E-03	NA	9.66E-03	**NA**	**4.05E-02**
Total ILCR or HI				**6.52E-05**	**9.01E-01**				**4.96E-06**	**7.55E-02**	**7.01E-05**	**9.76E-01**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/L - milligram per liter
mg/cm^2 - milligram per square meter
mg/kg - milligram per kilogram

Table D-6

Indoor Worker, Future Scenario, Exposure to Overburden Groundwater
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion				Dermal Contact					All Pathways	
		Cancer	Noncancer			Dose	Cancer	Noncancer				
Chemicals of Potential Concern	EPC mg/L	Dose mg/kg-day	Dose mg/kg-day	ILCR	HQ	Absorbed mg/cm^2-day	Dose mg/kg-day	Dose mg/kg-day	ILCR	HQ	**Total ILCR**	**Total HI**
Inorganics												
Nickel	7.42E-02	2.59E-04	7.26E-04	NA	3.63E-02	1.48E-08	1.71E-07	4.79E-07	NA	5.99E-04	**NA**	**3.69E-02**
Total ILCR or HI				**NA**	**3.63E-02**				**NA**	**5.99E-04**	**NA**	**3.69E-02**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/L - milligram per liter
mg/cm^2 - milligram per square meter

Table D-7

Construction Worker, Current and Future Scenarios, Exposure to Total Soil
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		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
Inorganics										
Beryllium	1.14E+01	2.62E-07	3.65E-05	NA	1.83E-02	NA	NA	NA	NA	NA
Thallium	2.95E+00	6.81E-08	9.50E-06	NA	1.46E-01	NA	NA	NA	NA	NA
Polychlorinated biphenyls (PCB)										
Aroclor 1016	1.58E-01	3.64E-09	5.09E-07	2.55E-10	7.27E-03	6.64E-09	1.53E-09	2.14E-07	1.07E-10	3.05E-03
Semivolatile Organic Compounds										
Benzo(a)pyrene	1.70E-01	3.92E-09	5.47E-07	2.86E-08	NA	6.63E-09	1.53E-09	2.13E-07	1.12E-08	NA
Benzo(b)fluoranthene	1.60E-01	3.69E-09	5.15E-07	2.69E-09	NA	6.24E-09	1.44E-09	2.01E-07	1.05E-09	NA
Total ILCR or HI				**3.16E-08**	**1.72E-01**				**1.23E-08**	**3.05E-03**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/m^3 - milligram per cubic meter

Table D-7

Construction Worker, Current and Future Scenarios, Exposure to Total Soil
Powerhouse 2 Ash Pits
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**
Inorganics							
Beryllium	3.97E-06	5.55E-09	7.75E-07	4.66E-08	1.36E-01	**4.66E-08**	**1.54E-01**
Thallium	1.03E-06	1.44E-09	2.02E-07	NA	NA	**NA**	**1.46E-01**
Polychlorinated biphenyls (PCB)							
Aroclor 1016	5.53E-08	7.73E-11	1.08E-08	5.41E-12	NA	**3.68E-10**	**1.03E-02**
Semivolatile Organic Compounds							
Benzo(a)pyrene	5.95E-08	8.32E-11	1.16E-08	2.58E-10	NA	**4.00E-08**	**NA**
Benzo(b)fluoranthene	5.60E-08	7.83E-11	1.09E-08	2.43E-11	NA	**3.77E-09**	**NA**
Total ILCR or HI				**4.69E-08**	**1.36E-01**	**9.08E-08**	**3.11E-01**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/m^3 - milligram per cubic meter

Table D-8

Construction Worker, Current and Future Scenarios, Exposure to Sediment
Powerhouse 2 Ash Pits
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/kg	mg/kg-day	mg/kg-day	ILCR	HQ	mg/cm^2-day	mg/kg-day	mg/kg-day	ILCR	HQ	**ILCR**	**HI**
Inorganics												
Arsenic	9.03E+00	2.08E-07	2.91E-05	3.12E-07	9.69E-02	8.12E-08	1.87E-08	2.62E-06	2.81E-08	8.72E-03	**3.40E-07**	**1.06E-01**
Chromium	1.10E+01	2.53E-07	3.54E-05	NA	1.69E-03	NA	NA	NA	NA	NA	**NA**	**1.69E-03**
Total ILCR or HI				**3.12E-07**	**9.86E-02**				**2.81E-08**	**8.72E-03**	**3.40E-07**	**1.07E-01**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/cm^2 - milligram per centimeter squared

Table D-9

On-Site Resident, Cancer Risk, Future Scenario, Exposure to Total Soil
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion			Dermal Contact				
	EPC	Adult Dose	Child Dose	Resident	Adult Dose Absorbed	Adult Dose	Child Dose Absorbed	Child Dose	Resident
Chemicals of Potential Concern	mg/kg	mg/kg-day	mg/kg-day	ILCR	mg/cm^2-day	mg/kg-day	mg/cm^2-day	mg/kg-day	ILCR
Inorganics									
Beryllium	1.14E+01	4.80E-06	1.12E-05	NA	NA	NA	NA	NA	NA
Thallium	2.95E+00	1.25E-06	2.91E-06	NA	NA	NA	NA	NA	NA
Polychlorinated biphenyls (PCB)									
Aroclor 1016	1.58E-01	6.68E-08	1.56E-07	1.56E-08	1.55E-09	4.15E-08	4.42E-09	6.79E-08	7.65E-09
Semivolatile Organic Compounds									
Benzo(a)pyrene	1.70E-01	7.19E-08	1.68E-07	1.75E-06	1.55E-09	4.14E-08	4.42E-09	6.78E-08	7.97E-07
Benzo(b)fluoranthene	1.60E-01	6.76E-08	1.58E-07	1.65E-07	1.46E-09	3.90E-08	4.16E-09	6.38E-08	7.50E-08
Total ILCR				**1.93E-06**					**8.80E-07**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
mg/kg - milligram per kilogram
mg/cm^2 - milligram per square meter
mg/m^3 - milligram per cubic meter

Table D-9

On-Site Resident, Cancer Risk, Future Scenario, Exposure to Total Soil
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemicals of Potential Concern	Concentration in Air C_a mg/m^3	Inhalation Adult Dose mg/kg-day	Inhalation Child Dose mg/kg-day	Inhalation Resident ILCR	**All Pathways Total ILCR**
Inorganics					
Beryllium	2.24E-08	2.10E-09	1.22E-09	2.79E-08	**2.79E-08**
Thallium	5.81E-09	5.46E-10	3.18E-10	NA	**NA**
Polychlorinated biphenyls (PCB)					
Aroclor 1016	3.11E-10	2.92E-11	1.71E-11	3.24E-12	**2.32E-08**
Semivolatile Organic Compounds					
Benzo(a)pyrene	3.35E-10	3.15E-11	1.83E-11	1.54E-10	**2.55E-06**
Benzo(b)fluoranthene	3.15E-10	2.96E-11	1.73E-11	1.45E-11	**2.40E-07**
Total ILCR				**2.81E-08**	**2.84E-06**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
mg/kg - milligram per kilogram
mg/cm^2 - milligram per square meter
mg/m^3 - milligram per cubic meter

Table D-10

On-Site Child Resident, Noncancer Evaluation, Future Scenario, Exposure to Total Soil
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			Concentration	Inhalation		All
	EPC	Child Dose	Child Resident	Dose Absorbed	Child Dose	Child Resident	in Air 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**
Inorganics										
Beryllium	1.14E+01	1.31E-04	6.53E-02	NA	NA	NA	2.24E-08	1.43E-08	2.51E-03	**6.78E-02**
Thallium	2.95E+00	3.40E-05	5.22E-01	NA	NA	NA	5.81E-09	3.72E-09	NA	**5.22E-01**
Polychlorinated biphenyls (PCB)										
Aroclor 1016	1.58E-01	1.82E-06	2.60E-02	4.42E-09	7.92E-07	1.13E-02	3.11E-10	1.99E-10	NA	**3.73E-02**
Semivolatile Organic Compounds										
Benzo(a)pyrene	1.70E-01	1.96E-06	NA	4.42E-09	7.91E-07	NA	3.35E-10	2.14E-10	NA	**NA**
Benzo(b)fluoranthene	1.60E-01	1.84E-06	NA	4.16E-09	7.45E-07	NA	3.15E-10	2.01E-10	NA	**NA**
Total HI			**6.14E-01**			**1.13E-02**			**2.51E-03**	**6.28E-01**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/cm^2 - milligram per square meter
mg/m^3 - milligram per cubic meter

Table D-11

On-Site Adult Resident, Noncancer Evaluation, Future Scenario, Exposure to Total Soil
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			Concentration	Inhalation		All
	EPC	Adult Dose	Adult Resident	Dose Absorbed	Adult Dose	Adult Resident	in Air 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**
Inorganics										
Beryllium	1.14E+01	1.40E-05	7.00E-03	NA	NA	NA	2.24E-08	6.12E-09	1.07E-03	**8.07E-03**
Thallium	2.95E+00	3.64E-06	5.60E-02	NA	NA	NA	5.81E-09	1.59E-09	NA	**5.60E-02**
Polychlorinated biphenyls (PCB)										
Aroclor 1016	1.58E-01	1.95E-07	2.78E-03	1.55E-09	1.21E-07	1.73E-03	3.11E-10	8.53E-11	NA	**4.51E-03**
Semivolatile Organic Compounds										
Benzo(a)pyrene	1.70E-01	2.10E-07	NA	1.55E-09	1.21E-07	NA	3.35E-10	9.17E-11	NA	**NA**
Benzo(b)fluoranthene	1.60E-01	1.97E-07	NA	1.46E-09	1.14E-07	NA	3.15E-10	8.63E-11	NA	**NA**
Total HI			**6.58E-02**			**1.73E-03**			**1.07E-03**	**6.86E-02**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/cm^2 - milligram per square meter
mg/m^3 - milligram per cubic meter

Table D-12

On-Site Resident, Future Scenario, Cancer Risk from Exposure to Bedrock Groundwater
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion			Dermal Contact					Inhalation of VOCs				All
		Adult	Child		Dose	Adult	Dose	Child		Concentration	Adult	Child		Pathways
Chemicals of Potential Concern	EPC mg/L	Dose mg/kg-day	Dose mg/kg-day	ILCR	Absorbed mg/cm^2-day	Dose mg/kg-day	Absorbed mg/cm^2-day	Dose mg/kg-day	ILCR	in Air mg/m^3	Dose mg/kg-day	Dose mg/kg-day	ILCR	Total ILCR
Inorganics														
Selenium	1.95E-02	1.83E-04	1.07E-04	NA	3.90E-09	3.66E-07	6.49E-09	2.35E-07	NA	NA	NA	NA	NA	**NA**
Semivolatile Organic Compounds														
Naphthalene	7.40E-03	6.95E-05	4.05E-05	NA	3.22E-07	3.02E-05	4.15E-07	1.50E-05	NA	3.70E-03	1.45E-05	8.43E-06	2.75E-06	**2.75E-06**
Volatile Organic Compounds														
Benzene	3.36E-01	3.16E-03	1.84E-03	2.75E-04	4.13E-06	3.88E-04	4.74E-06	1.71E-04	3.08E-05	1.68E-01	6.57E-04	3.83E-04	2.81E-05	**3.34E-04**
Chloromethane	4.49E-02	4.22E-04	2.46E-04	NA	8.89E-08	8.35E-06	1.09E-07	3.93E-06	NA	2.25E-02	8.78E-05	5.12E-05	NA	**NA**
trans-1,3-Dichloropropene	1.70E-03	1.60E-05	9.32E-06	2.53E-06	6.06E-09	5.69E-07	7.82E-09	2.83E-07	8.52E-08	8.50E-04	3.33E-06	1.94E-06	7.37E-08	**2.69E-06**
Ethylbenzene	5.71E-02	5.36E-04	3.13E-04	NA	2.24E-06	2.11E-04	2.89E-06	1.05E-04	NA	2.86E-02	1.12E-04	6.51E-05	NA	**NA**
Xylenes, total	6.30E-01	5.92E-03	3.45E-03	NA	2.67E-05	2.51E-03	3.45E-05	1.25E-03	NA	3.15E-01	1.23E-03	7.18E-04	NA	**NA**
Total ILCR				**2.77E-04**					**3.08E-05**				**3.09E-05**	**3.39E-04**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
mg/L - milligram per liter
mg/cm^2 - milligram per square meter
mg/kg - milligram per kilogram
mg/m^3- milligram per cubic meter

Table D-13

Child On-Site Resident, Future Scenario, Noncancer Hazard from Exposure to Bedrock Groundwater
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			Inhalation of VOCs			All
		Child		Dose	Child		Concentration	Child		Pathways
Chemicals of Potential Concern	EPC mg/L	Dose mg/kg-day	HQ	Absorbed mg/cm^2-day	Dose mg/kg-day	HQ	in Air mg/m^3	Dose mg/kg-day	HQ	Total HI
Inorganics										
Selenium	1.95E-02	1.25E-03	2.49E-01	6.49E-09	2.74E-06	5.48E-04	NA	NA	NA	**2.50E-01**
Semivolatile Organic Compounds										
Naphthalene	7.40E-03	4.73E-04	2.37E-02	4.15E-07	1.75E-04	8.76E-03	3.70E-03	9.84E-05	8.46E-08	**3.24E-02**
Volatile Organic Compounds										
Benzene	3.36E-01	2.15E-02	5.37E+00	4.74E-06	2.00E-03	5.00E-01	1.68E-01	4.47E-03	3.84E-05	**5.87E+00**
Chloromethane	4.49E-02	2.87E-03	NA	1.09E-07	4.58E-05	NA	2.25E-02	5.97E-04	1.55E-05	**1.55E-05**
trans-1,3-Dichloropropene	1.70E-03	1.09E-04	3.62E-03	7.82E-09	3.30E-06	1.10E-04	8.50E-04	2.26E-05	1.29E-07	**3.73E-03**
Ethylbenzene	5.71E-02	3.65E-03	3.65E-02	2.89E-06	1.22E-03	1.22E-02	2.86E-02	7.59E-04	2.20E-04	**4.89E-02**
Xylenes, total	6.30E-01	4.03E-02	2.01E-01	3.45E-05	1.46E-02	7.28E-02	3.15E-01	8.38E-03	2.43E-04	**2.74E-01**
Total HI			**5.88E+00**			**5.94E-01**			**5.17E-04**	**6.48E+00**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/L - milligram per liter
mg/cm^2 - milligram per square meter
mg/kg - milligram per kilogram
mg/m^3- milligram per cubic meter

Table D-14

Adult On-Stie Resident, Future Scenario, Noncancer Hazard from Exposure to Bedrock Groundwater
Powerhouse 2 Ash Pits
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										
Selenium	1.95E-02	5.34E-04	1.07E-01	3.90E-09	1.07E-06	2.14E-04	NA	NA	NA	**1.07E-01**
Semivolatile Organic Compounds										
Naphthalene	7.40E-03	2.03E-04	1.01E-02	3.22E-07	8.81E-05	4.41E-03	3.70E-03	4.22E-05	3.63E-08	**1.45E-02**
Volatile Organic Compounds										
Benzene	3.36E-01	9.21E-03	2.30E+00	4.13E-06	1.13E-03	2.83E-01	1.68E-01	1.92E-03	1.65E-05	**2.58E+00**
Chloromethane	4.49E-02	1.23E-03	NA	8.89E-08	2.44E-05	NA	2.25E-02	2.56E-04	6.66E-06	**6.66E-06**
trans-1,3-Dichloropropene	1.70E-03	4.66E-05	1.55E-03	6.06E-09	1.66E-06	5.54E-05	8.50E-04	9.70E-06	5.53E-08	**1.61E-03**
Ethylbenzene	5.71E-02	1.56E-03	1.56E-02	2.24E-06	6.14E-04	6.14E-03	2.86E-02	3.26E-04	9.45E-05	**2.19E-02**
Xylenes, total	6.30E-01	1.73E-02	8.63E-02	2.67E-05	7.33E-03	3.66E-02	3.15E-01	3.59E-03	1.04E-04	**1.23E-01**
Total HI			**2.52E+00**			**3.30E-01**			**2.22E-04**	**2.85E+00**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/L - milligram per liter
mg/cm^2 - milligram per square meter
mg/kg - milligram per kilogram
mg/m^3- milligram per cubic meter

Table D-15

On-Site Resident, Future Scenario, Cancer Risk from Exposure to Overburden Groundwater
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion			Dermal Contact					All
		Adult	Child		Dose	Adult	Dose	Child		Pathways
Chemicals of Potential Concern	EPC mg/L	Dose mg/kg-day	Dose mg/kg-day	ILCR	Absorbed mg/cm^2-day	Dose mg/kg-day	Absorbed mg/cm^2-day	Dose mg/kg-day	ILCR	**Total ILCR**
Inorganics										
Nickel	7.42E-02	6.97E-04	4.07E-04	NA	2.97E-09	2.79E-07	4.94E-09	1.79E-07	NA	**NA**
Total ILCR				**NA**					**NA**	**NA**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
mg/L - milligram per liter
mg/cm^2 - milligram per square meter

Table D-16

Child On-Site Resident, Future Scenario, Noncancer Hazard from Exposure to Overburden Groundwater
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			All
		Noncancer		Dose	Noncancer		**Pathways**
	EPC	Dose		Absorbed	Dose		**Total**
Chemicals of Potential Concern	mg/L	mg/kg-day	HQ	mg/cm²-day	mg/kg-day	HQ	**HI**
Inorganics							
Nickel	7.42E-02	4.74E-03	2.37E-01	4.94E-09	2.08E-06	2.61E-03	**2.40E-01**
Total HI			**2.37E-01**			**2.61E-03**	**2.40E-01**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/L - milligram per liter
mg/cm² - milligram per square meter

Table D-17

Adult On-Stie Resident, Future Scenario, Noncancer Hazard from Exposure to Overburden Groundwater
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			All
		Noncancer		Dose	Adult		**Pathways**
	EPC	Dose		Absorbed	Dose		**Total**
Chemicals of Potential Concern	mg/L	mg/kg-day	HQ	mg/cm^2-day	mg/kg-day	HQ	**HI**
Inorganics							
Nickel	7.42E-02	2.03E-03	1.02E-01	2.97E-09	8.13E-07	1.02E-03	**1.03E-01**
Total HI			**1.02E-01**			**1.02E-03**	**1.03E-01**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/L - milligram per liter
mg/cm^2 - milligram per square meter

Table D-18

On-Site Resident, Future Scenario, Exposure to Sediment Cancer Risk
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion			Dermal Contact					All
		Adult	Child		Dose	Adult	Dose	Child		Pathways
Chemicals of Potential Concern	EPC mg/kg	Dose mg/kg-day	Dose mg/kg-day	Resident ILCR	Absorbed mg/cm^2-day	Dose mg/kg-day	Absorbed mg/cm^2-day	Dose mg/kg-day	Resident ILCR	**Total ILCR**
Inorganics										
Arsenic	9.03E+00	4.24E-07	9.89E-07	2.12E-06	1.90E-09	7.54E-09	5.42E-09	1.23E-08	2.98E-08	**2.15E-06**
Chromium	1.10E+01	5.16E-07	1.20E-06	NA	NA	NA	NA	NA	NA	**NA**
Total ILCR or HI				**2.12E-06**					**2.98E-08**	**2.15E-06**

EPC - Exposure Point Concentration
ILCR - Incremental Lifetime Cancer Risk
mg/kg - milligram per kilogram
mg/cm^2 - milligram per centimeter squared

Table D-19

On-Site Child Resident, Future Scenario, Exposure to Sediment Noncancer Risk
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			All
		Child		Dose	Child		**Pathways**
	EPC	Dose	Child	Absorbed	Dose	Child	**Total**
Chemicals of Potential Concern	mg/kg	mg/kg-day	HQ	mg/cm^2-day	mg/kg-day	HQ	**HI**
Inorganics							
Arsenic	9.03E+00	1.15E-05	3.85E-02	5.42E-09	1.44E-07	4.80E-04	**3.90E-02**
Chromium	1.10E+01	1.41E-05	6.69E-04	NA	NA	NA	**6.69E-04**
Total ILCR or HI			**3.91E-02**			**4.80E-04**	**3.96E-02**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/cm^2 - milligram per centimeter squared

Table D-20

On-Site Adult Resident, Future Scenario, Exposure to Sediment Noncancer Risk
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion		Dermal Contact			All
		Adult		Dose	Adult		Pathways
	EPC	Dose	Adult	Absorbed	Dose	Adult	Total
Chemicals of Potential Concern	mg/kg	mg/kg-day	HQ	mg/cm^2-day	mg/kg-day	HQ	HI
Inorganics							
Arsenic	9.03E+00	1.24E-06	4.12E-03	1.90E-09	2.20E-08	7.33E-05	**4.20E-03**
Chromium	1.10E+01	1.51E-06	7.17E-05	NA	NA	NA	**7.17E-05**
Total ILCR or HI			**4.19E-03**			**7.33E-05**	**4.27E-03**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/cm^2 - milligram per centimeter squared

Table D-21

Adult Hunter, Future Scenario, Exposure to Surface Soil
Powerhouse 2 Ash Pits
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
Inorganics										
Beryllium	1.14E+01	2.67E-07	6.22E-07	NA	3.11E-04	NA	NA	NA	NA	NA
Thallium	2.95E+00	6.93E-08	1.62E-07	NA	2.49E-03	NA	NA	NA	NA	NA
Polychlorinated biphenyls (PCB)										
Aroclor 1016	1.58E-01	3.71E-09	8.66E-09	2.60E-10	1.24E-04	4.42E-09	3.43E-09	8.00E-09	2.40E-10	1.14E-04
Semivolatile Organic Compounds										
Benzo(a)pyrene	1.70E-01	3.99E-09	9.32E-09	2.91E-08	NA	4.42E-09	3.43E-09	7.99E-09	2.50E-08	NA
Benzo(b)fluoranthene	1.60E-01	3.76E-09	8.77E-09	2.74E-09	NA	4.16E-09	3.22E-09	7.52E-09	2.35E-09	NA
Total HI				**3.21E-08**	**2.92E-03**				**2.76E-08**	**1.14E-04**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/cm^2 - milligram per square meter

Table D-21

Adult Hunter, Future Scenario, Exposure to Surface Soil
Powerhouse 2 Ash Pits
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**
Inorganics								
Beryllium	NA	NA	NA	NA	NA	NA	**NA**	**3.11E-04**
Thallium	1.48E-03	3.08E-07	2.35E-11	5.49E-11	NA	8.44E-07	**NA**	**2.49E-03**
Polychlorinated biphenyls (PCB)								
Aroclor 1016	4.42E-03	2.31E-07	1.76E-11	4.11E-11	1.23E-12	5.88E-07	**5.01E-10**	**2.39E-04**
Semivolatile Organic Compounds								
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	**5.41E-08**	**NA**
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	**5.10E-09**	**NA**
Total HI					**1.23E-12**	**1.43E-06**	**5.97E-08**	**3.04E-03**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram
mg/cm^2 - milligram per square meter

Table D-22

Hunter's Child, Future Scenario, Exposure to Surface Soil
Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemicals of Potential Concern	EPC mg/kg	Concentration in Forage C_p mg/kg	Concentration in Venison C_v mg/kg	Consumption of Venison: Cancer Dose mg/kg-day	Consumption of Venison: Noncancer Dose mg/kg-day	ILCR	HQ	**Total ILCR**	**Total HI**
Inorganics									
Beryllium	1.14E+01	NA	NA	NA	NA	NA	NA	**NA**	**NA**
Thallium	2.95E+00	1.48E-03	3.08E-07	8.44E-12	9.85E-11	NA	1.51E-06	**NA**	**1.51E-06**
Polychlorinated biphenyls (PCB)									
Aroclor 1016	1.58E-01	4.42E-03	2.31E-07	6.33E-12	7.38E-11	4.43E-13	1.05E-06	**4.43E-13**	**1.05E-06**
Semivolatile Organic Compounds									
Benzo(a)pyrene	1.70E-01	NA	NA	NA	NA	NA	NA	**NA**	**NA**
Benzo(b)fluoranthene	1.60E-01	NA	NA	NA	NA	NA	NA	**NA**	**NA**
Total HI						**4.43E-13**	**2.57E-06**	**4.43E-13**	**2.57E-06**

EPC - Exposure Point Concentration
HQ - Hazard Quotient; HI - Hazard Index
mg/kg - milligram per kilogram

RESPONSE TO COMMENTS

Responses to Comments
Baseline Human Health Risk Assessment (BHHRA) Assessment
for Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio,
Dated June 21, 2010

Comments by Janusz Byczkowski, Risk Assessor, Ohio Environmental Protection Agency, received August 9, 2010. Note that additional Comment Nos. 5 through 7 were made by the reviewer with respect to the screening level human health risk assessment (SLERA). Responses to these additional comments are attached to the final SLERA report.

Comment 1: **<u>Section 2.4.2, Page 2-3, Line 26, Section 8.0, Page 8-2, Line 10, Table 2-4 to 2-9</u>. This document states: *"…Groundwater RBSCs used in the BHHRA are derived from the Oak Ridge National Laboratory-EPA regional screening levels (RSL) table…"* The RSL are no longer provided by the *Oak Ridge National Laboratory*. The RSLs are provided at the U.S. EPA's "Mid Atlantic Risk Assessment" Website. The initial Website used to be developed with DOE's ORNL involvement, under an Interagency Agreement, but currently it serves as an official update of the harmonized EPA Region 3 RBC, Region 6 HHMSSL and the Region 9 PRG Tables. A few editorial corrections are recommended before releasing this document to the public. Please correctly attribute the RSL table to the U.S EPA.**

Response 1: The references will be revised to "EPA" instead of "ORNL-EPA," although the Oak Ridge National Laboratory (ORNL) is still integrally involved in the revision of RSL values. As the reviewer states, the RSL website was developed as an update of various Region 3, Region 6 and Region 9 values. The RSLs are a regionally lead effort, which receives only guidance from Superfund/Headquarters. The website itself is no longer hosted by ORNL, but is now hosted by EPA Region 3. However, updated RSLs are still calculated by ORNL, under the direction of the EPA Regions. ORNL still also provides assistance such as how the interpretation of new guidance may affect the RSLs. Note that the calculator link (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) on the RSL website hosted by Region 3 links back to ORNL

Comment 2: **<u>Section 1.4, Page 1-4, Line 27, and Section 3.1.8, Page 3-16, Line 23</u>. This document states: *"…Parts of the facility may be used for training by the National Guard…"* and then: *"…Because they would likely not represent an upper bound for nonresidential exposure, these receptors are not evaluated…"* It is not clear, which exposure scenario could be relevant to the National Guardsmen. In the Section 7.0 there is no discussion on how the cumulative health hazards/cancer risks to guardsmen would compare with those, whose ILCRs and HIs were actually calculated. Please discuss exposure scenario pertinent to the National Guard's trainee and provide some evaluation of risk/hazards relative to the other receptors, whose ILCRs and HIs were calculated.**

Response 2: The exposure pathways encountered by the National Guard Reserve soldier would likely not differ from those of a groundskeeper and the two receptors would be similarly attired (shoes/boots, pants, shirt). Text will be added to Section 3.1.3.8 that qualitatively compares a 25-year daily groundskeeper exposure scenario (250 days per year, 8 hours per day) to a National Guard Trainee who does all of his training at the LBA assuming and subsequently remains in the Guard as a 20-year Reserve soldier, again spending his entire National Guard Reserve career at the LBA. Please note that the National Guard scenario has been mentioned and described as a potential receptor that would not represent a reasonable maximum exposure non-residential scenario in each of the BHHRA work plans and reports submitted over the past decade.

Comment 3: **In the Equation 3-19, the variable "l_v" is not defined. Please add a definition of "l_v" below the equation.**

Response 3: The definition provided for the first "IR_v" actually applies to "I_v". The first term "IR_v" will be revised as "I_v".

Comment 4: **<u>Tables 2-3 to 2-9 and A-2; also SLERA Table 2-9</u>. Some chemicals, whose reporting limits (RL) exceed screening levels (RBSC), have not been selected as chemicals of potential concern (COPC), and thus, they are not included in baseline risk assessment – for example: *"Indeno(1,2,3-cd)pyrene"* in Table 2-4; or *"Cadmium"* in Table 2-7; etc. All chemicals whose RL>RBSC should not be just eliminated from the data set used for baseline risk assessment. Instead, it should be assumed that each of them may be present at a concentration equal to ½ RL, and thus, it should be processed as COPC. Similarly in SLERA, the chemicals whose RL>ESV should be included as COPECs, assuming their concentration = ½ of RL. Please check the data tables for cases of RL>RBSC and/or ESV, and evaluate those that exceed screening levels as COPC in the BHHRA and/or as COPEC in SLERA, assuming that their concentration = ½ of RL.**

Response 4: The data evaluation protocols used in the BHHRA and SLERA are consistent with that which has been performed for PBOW human health and ecological risk assessments for the past decade. These protocols are described in the approved site-specific risk assessment work plans (Shaw, 2010a). Further, these approaches are clearly consistent with EPA (1989) guidance which emphasizes the use of positive data and recognizes that the state of the practice is such that achieving RLs that are lower than screening values is not possible for certain chemicals. This guidance even recommends that individual samples with elevated RLs be excluded from the quantitative risk assessment.

The focus of the BHHRA and SLERA is quantitative risk assessment. Please note that the MDCs are used for screening, and that this is the most conservative value that is reasonable to consider in quantitative evaluation as

an exposure point concentration (EPC). The ProUCL statistical program, used to estimate EPCs, weighs nondetects differently and will typically not recommend a value that exceeds the MDC. The method that has been used in the BHHRA and SLERA, as described the work plan, ensures that the EPC will not exceed the MDC. Therefore, the use of the MDC as the screening value reflects the "worst case" of the quantitative portion of the risk assessment.

The reviewer cites two examples in the BHHRA, indeno(1,2,3-c,d)pyrene in surface soil and cadmium in overburden groundwater, that the reviewer suggests should be evaluated based on the surrogate value for a nondetect rather than the MDC. These two chemicals are discussed in greater detail in the following paragraphs to exemplify that the use of the MDC to is the appropriate technical approach during screening.

Indeno(1,2,3-c,d)pyrene was reported in only 1 of 20 surface soil samples. This sample, PH2SO01, was collected in 1996 as part of the limited site investigation. Of the 13 PAHs detected in AP2 surface soil, the MDCs for 12 were detected in this sample. Clearly, it appears that this sample represents higher concentrations of PAHs than any of the other samples. The fact that the lone detection of indeno(1,2,3-c,d)pyrene was detected in this higher-PAH sample provides evidence that the value is appropriate to represent the true maximum concentration of the data set; it is extremely unlikely that a concentration higher than the detection but below the RL is present at one of the nondetect sample locations, given the evident higher concentrations in sample PH2SO01 for the full suite of PAHs, and not just indeno(1,2,3-c,d)pyrene. Thus, indeno(1,2,3-c,d)pyrene was appropriately screened out during the COPC screening step.

The example of cadmium cited by the reviewer was collected from AP2-MW02 in May 2009 during the wet season, which was the most turbid of the wells sampled in May 2009 (Shaw, 2010b). Duplicate samples were collected and both filtered and unfiltered inorganics were run. In both cases, cadmium was reported as detected in the unfiltered samples (1.1J and 1.0J µg/L), but not in the filtered samples. Even though the RLs exceed the RBSCs, the analytical method used is shown to consistently detect cadmium in the unfiltered samples at concentrations less than the RBSC of 1.8 µg/L. Because the analysis can clearly and reproducibly detect cadmium at less than the one-half the RL, there is no technical justification for assuming a surrogate value instead of the MDC. Incidentally, the analytical results also suggest that the cadmium reported in the unfiltered samples were associated with suspended particulates. May 2009 results could not be compared to November 2009 results for LBA-MW02 because it was found to be highly turbid in November 2009 and did not produce enough water to sample for inorganics.

References Used in Responses

Shaw Environmental, Inc. (Shaw), 2010a, ***Baseline Human Health Risk Assessment Work Plan, Garage Maintenance Area (Locomotive Building Area), Plum Brook Ordnance Works, Sandusky, Ohio***, May.

Shaw Environmental, Inc. (Shaw), 2010b, ***Site Characterization Report, Garage Maintenance Area (Locomotive Building Area), Final, Plum Brook Ordnance Works, Sandusky, Ohio***, September.

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.

APPENDIX C

POWERHOUSE NO. 2 ASH PITS SLERA

Shaw® a world of Solutions™

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September 29, 2010

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

Submittal of the Final Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment Power House 2 Ash Pits Former Plum Brook Ordnance Works, Sandusky, Ohio Contract No. W912QR-08-D-0013: Shaw Project Number 133422

Dear Ms. McClanahan:

In accordance with the requirements of Delivery Order No. DX05 of Contract No. W912QR-08-D-0013 Shaw is pleased to submit the draft Baseline Human Health Risk Assessment and the draft Screening Level Ecological Risk Assessment for the Power House 2 Ash Pits at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio. These reports were prepared consistent with those prepared for other PBOW sites, the agreements among the PBOW project delivery team members, and specifically the Power House 2 Ash Pits Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment work plans.

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

Sincerely,

Steven T. Downey, PE, PMP
Project Manager

Enclosures

Control Copy Distribution List

Name	Control Copy
U.S. Army Engineer District, Nashville ATTN: CELRN-EC-E (Ms. Kathy McClanahan) 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. Janusz Z. Byczkowski Division of Emergency and Remedial Response (DERR) Lazarus Government Center 1220 South Front Street 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. Dennis Druck US Army Public Health Command (Provisional) ATTN: MCHB-TS-HER, BLDG E1675 Aberdeen Proving Grounds, MD 21010-5403	12

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DISCIPLINE SIGN-OFF REVIEW

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

Project Description: Screening Level Ecological Risk Assessment for Power House 2 Ash Pits Remedial Investigation
Former Plum Brook Ordnance Works, Sandusky, Ohio

Contract No. W912QR-08-D-0013 Delivery Order No. DX05

Project No. 133422 Task/Phase Number: 14000000

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		
☐	Report		**Document Status**
X	Risk Assessment / Evaluation	Screening Level Ecological Risk Assessment	☐ Preliminary
☐	Specifications & Plans		☐ Internal Draft
☐	Design Calculations		☐ Draft
☐	Tables		☐ Draft Final
☐	Drawings / Figures		X Final
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Final

Screening-Level Ecological Risk Assessment
Power House 2 Ash Pits

Plum Brook Ordnance Works,
Sandusky, Ohio

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List of Acronyms

AP2	Power House 2 Ash Pits
ARP	assessment receptor profile
BAF	bioaccumulation factor
BERA	baseline ecological risk assessment
bgs	below ground surface
BSC	background screening concentration
COPEC	chemical of potential ecological concern
CT	central tendency
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESCM	ecological site conceptual model
ESV	ecological screening value
HQ	hazard quotient
IAEA	International Atomic Energy Agency
ICP	inductively coupled plasma spectrometry
IT	IT Corporation
K_{ow}	octanol-water partition coefficient
LOAEL	lowest-observed-adverse-effect level
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS	mass spectrometry
NASA	National Aeronautics and Space Administration
NOAEL	no-observed-adverse-effect level
NWI	National Wetland Inventory
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
PAH	polynuclear aromatic hydrocarbons
PBOW	Plum Brook Ordnance Works
RME	reasonable maximum exposure
Shaw	Shaw Environmental, Inc.
SLERA	screening-level ecological risk assessment
TNT	trinitrotoluene
TNTA	TNT Area A

List of Acronyms *(continued)*

TNTB	TNT Area B
TNTC	TNT Area C
TRV	toxicity reference value
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
WRS	Wilcoxon Rank Sum

Executive Summary

A screening-level ecological risk assessment was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases within the Power House 2 Ash Pits site at Plum Brook Ordnance Works in Sandusky, Ohio. The results of the screening-level ecological risk assessment contribute to the overall characterization of the site and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives, if necessary. The primary objective of the assessment was to determine the potential for unacceptable risks to ecological receptors as a result of exposure to chemicals detected at the site This objective was met by characterizing the ecological communities in the vicinity of the site, determining the particular hazardous substances being released from the site, identifying pathways for receptor exposure, and estimating the magnitude and likelihood of potential risk to identified receptors. The assessment addresses the potential for adverse effects to the vegetation, wildlife, aquatic life, and endangered and threatened species.

Vegetative communities at the site were classified during two site reconnaissance trips. The site consists almost entirely of successional and lowland forest. A small stream, Pipe Creek, flows from the southwest to northeast and is located adjacent to the site's western boundary. No wetlands were formally identified at the site, although ponding of water likely associated with rain events was observed in localized depressions. Vegetative stress attributable to chemicals was not observed at the site. No threatened or endangered species were documented at the site. Based on the site reconnaissance information, there was no indication that ecological threats exist at the site, as there was no definitive absence of biota or animal life in areas expected to support these ecological components.

The maximum detected concentrations of chemicals detected in sampled media were compared with risk-based screening ecotoxicity values during an initial screening step. Chemicals that exceeded the screening values, or for which no screening values were available, and that did not meet additional screening criteria (e.g., comparison with background data, nutrient status, frequency of detection, etc.) were retained as chemicals of potential ecological concern (COPEC) and assessed further. Four COPECs were selected for soil, four were selected for surface water, and one was chosen for sediment. Ninety-five percent upper confidence limits were calculated for these chemicals and used as their exposure point concentrations during the subsequent stages of the risk assessment.

Eight representative receptor species that are expected or possible at the site were selected as indicator species for the potential effects of the COPECs. The eight species selected included the deer mouse, short-tailed shrew, Eastern cottontail rabbit, marsh wren, white-tailed deer, raccoon, red-tailed hawk, and muskrat. The raccoon and muskrat were selected as aquatic receptors.

The assessment endpoints for the site were the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds. Measurement assessment endpoints, or measurable responses to stressors, included lowest-observed-adverse-effect levels and no-observed-adverse-effect levels, collectively termed toxicity endpoint values.

Measurable responses to stressors, collectively termed toxicity reference values, were selected as measurement endpoints. The most appropriate measurement endpoints were chosen based on exposure pathways as well as ecotoxicity of the contaminant. An exposure analysis combining the spatial and temporal distribution of the assessment receptors and the COPECs was performed to evaluate potential exposure. The focus of the analysis was dependent on the assessment receptors evaluated and the assessment and measurement endpoints.

The intake estimates were combined with the toxicity reference values to derive estimates of potential adverse ecological effects. The uncertainties associated with the estimation of potential adverse ecological effects were identified, with the degree of uncertainty estimated qualitatively or quantitatively, and the impact of the uncertainty estimated qualitatively (overestimate or underestimate, as appropriate).

Risk characterization integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is an estimate of the likelihood, severity, and characteristics of adverse effects to ecological receptors resulting from exposure to environmental stressors present at the site. Qualitative and semiquantitative approaches were taken to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to chemicals.

For the semiquantitative predictive assessment, toxicity reference values and exposure rates were calculated and used to generate hazard quotients by dividing the receptor exposure rate for each chemical by the calculated reference toxicity values. Hazard quotients are a means of estimating the potential for adverse effects to organisms at a contaminated site and for assessing the potential for toxicological effects to occur.

For soil, terrestrial invertebrates and plants may have slightly elevated hazard based upon the exceedance of ecological benchmarks. However, only four chemicals exceeded benchmarks, and the concentrations were not highly elevated. Given the conservative nature of benchmark values, it is unlikely that these communities are adversely impacted at the site. Ecological risk from soil was primarily evaluated using food chain models for the selected terrestrial assessment receptors (i.e., deer mouse, short-tailed shrew, Eastern cottontail rabbit, marsh wren, white-tailed deer, raccoon, and red-tailed hawk). Thallium in soil was the only chemical that resulted in hazard quotients that exceeded the threshold value of 1. However, hazard quotient values using conservative inputs did not exceed 10 when rounded and did not exceed 1 when more realistic input values were used. Further, a review of the data indicated that all elevated thallium detections originated from historical data collected over 15 years ago. Samples collected in 2009 and analyzed using updated laboratory methods did not exceed background or ecological screening values. Therefore, the potential for adverse ecological impacts associated with chemicals in soil is considered to be negligible at this site.

For surface water and sediment, benthic invertebrates and plants may have slightly elevated hazard based upon the exceedance of ecological benchmarks. However, due to the limited aquatic habitat present near the site and the limited number of exceedances, it is unlikely that these communities are significantly impacted. Ecological risk from surface water and sediment was primarily evaluated using a food chain model for the selected aquatic assessment receptors (i.e., the raccoon and muskrat). Based on the food chain model results, the aquatic receptors were not predicted to have elevated hazards from exposure to chemicals in sediment or surface water at this site.

Based on the findings of the screening-level ecological risk assessment, the potential for adverse effects to populations of ecological receptors exposed to chemicals in soil, surface water, and sediment is expected to be very low. No chemicals at the Power House 2 Ash Pits are recommended for further evaluation for ecological purposes alone.

1.0 Introduction

This screening-level ecological risk assessment (SLERA) evaluates the potential for adverse effects posed to ecological receptors from potential releases at Power House 2 Ash Pits (AP2) at the former Plum Brook Ordnance Works (PBOW). This SLERA is consistent with the ecological risk assessment process described in U.S. Environmental Protection Agency (EPA) guidance (e.g., EPA, 1997), Ohio Environmental Protection Agency (OEPA) – Division of Emergency and Remedial Response (OEPA, 2008) guidance, and with the procedures previously established in previous ecological risk assessments performed at PBOW (e.g., IT Corporation [IT], 2001a; Jacobs Engineering Group, 2010), with some adjustments to accommodate current practices in the field of ecological risk assessment.

This work is being conducted by Shaw Environmental, Inc. (Shaw) for the U.S. Army Corps of Engineers (USACE) under the Defense Environmental Restoration Program - Formerly Used Defense Sites and managed by the USACE Huntington District, with technical oversight provided by the USACE Nashville District.

1.1 Facility Description and Location

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-dinitrotoluene, and pentolite (USACE, 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 explosive 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, including 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 War Department in late 1945. During decontamination, all structures, equipment, and manufacturing debris were either removed and salvaged or removed and burned. After decontamination, 3,280 acres of the property was initially transferred to the Ordnance Department, then to the War Assets Administration after it was certified by the U.S. Army to be decontaminated. In 1949, PBOW was transferred to the General Services Administration. This transfer did not include the Plum Brook depot areas, which consists of approximately 2,800 acres. The Department of the Army acquired the 3,280 acres in 1954 and performed remedial efforts from the mid-1950s until 1963. In 1955, the Army completed further decontamination of manufacturing process lines. This effort included removal of contaminated surface and subsurface soil around the building 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.

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 were transferred to NASA on March 15, 1963 for the entire portion of the former PBOW property (6,030 acres) that had been had been under the accountability and custody of the Department of the Army. 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 likewise buried. 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 nitroaromatic-filled flumes that were excavated (Dames & Moore, Inc., 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 Glenn Research Center at Lewis Field, Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the facility are currently on standby or inactive status. On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. 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. NASA currently controls approximately 6,400 acres. The details of land transactions are listed in the site management plan (USACE, 1995).

1.3 Power House 2 Ash Pits Description and History

As noted previously, PBOW was built in early 1941 and manufactured TNT, dinitrotoluene, and pentolite until 1945. Three power stations, Power House 1, Power House 2, and Power House 3, were constructed and utilized to support the TNT manufacturing process. Each power station consisted of a main power house, a coal storage area, and an aboveground fuel storage tank. The power house buildings also contained two to four large coal-burning boilers, a turboelectric generator, a feed water treatment system, and several steam-driven or electric air compressors. The generated steam was used for space heating, driving compressors, and generating electrical power. Coal ash generated from each of the boilers in the power house was collected in pits. Water was added to the ash, producing a slurry that flowed through a sluice trench to an ash sump located at the end of each power house. From the ash sump, the ash slurry traveled through a pipeline to a nearby surface water/ash impoundment, referred to as an “ash pit” (USACE, 1995).

AP2 is located west of Campbell Road in an area that appears to be an old surface impoundment (Figure 1-2). Historical drawings indicated that the surface impoundment was rectangular in shape, measuring approximately 400 feet long by 200 feet wide, and was surrounded by an earthen embankment (USACE, 1995). Based on topographical quadrangles (dated 1959 and 1969), aerial photographs, and a visual site survey conducted in 1999, the ash pit areas are noted to have essentially remained unchanged. As mentioned in the previous paragraph, ash from the coal-fired boilers was reportedly disposed of in the ash pit through a pipeline. During this investigation, the bermed area was observed, and black to dark brown cinders were found within the bermed area at depths up to 4 feet. Environmental sampling was not conducted prior to the 1996 investigation.

During a site walk conducted in October 2008, the AP2 area was observed to be overgrown with trees and nearly indistinguishable from surrounding forest. Several moss-covered concrete slabs approximately 7 feet long and 3 feet wide were observed partially buried in the underbrush northwest of the power house. A small hole constructed of mortared shale/limestone blocks and approximately 2 feet in diameter was located near the concrete slabs. Based on the construction, this appears to be a hand-dug well. The depth of the hand-dug well was not determined. A strong sulfur odor was noted in the vicinity of the well and was thought to be emanating from it. The

structure was nearly filled with water during a site visit in December 2008. The origin of these concrete structures is not known with certainty; however, they appear to be remnants associated with a historical farmstead. A review of historical drawings and other documents indicates that a farmstead was present south of the slabs and the hand-dug well. Remnants of other concrete and stone foundations are present in the former farmstead area indicated on the historic drawings. It is likely that all of the concrete and stone foundations, concrete slabs, and hand-dug well are remnants associated with agricultural activities predating the PBOW facility.

1.4 Scope and Objectives

The objective of this SLERA is to provide an estimate of the potential for adverse ecological effects associated with contamination resulting from former PBOW activities at AP2. The results of the SLERA will contribute to the overall characterization of the site and may be used to determine the need for additional investigations or to develop, evaluate, and select appropriate remedial alternatives. Guidance documents used to perform the SLERA include the general guidelines of the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel, et al., 1996), as well as the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA, 1997), *Region 5 Biological Technical Assistance Group (BTAG) Ecological Risk Assessment Guidance Bulletin No. 1* (EPA, 1996), and *Guidance for Conducting Ecological Risk Assessments* (OEPA, 2008). The SLERA fits into Steps 1 and 2 of the ecological risk assessment guidance for Superfund process (EPA, 1997), and Level I through a maximum of Level III evaluation using the OEPA (2008) process.

The goal of the SLERA is to evaluate the potential for adverse ecological effects to ecological receptors from site-related contaminants at AP2. This objective is met by characterizing the ecological communities in the vicinity of the site, determining the particular contaminants present, identifying pathways for receptor exposure, and estimating the magnitude of the likelihood of potential adverse effects to identified receptors. The SLERA addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (e.g., sediment-dwelling organisms), threatened and endangered species, and wetlands or other sensitive habitats associated with the site.

Concentrations of chemicals measured in relevant environmental media were used to perform a SLERA, which includes a problem formulation (Chapter 2.0); exposure characterization (Chapter 3.0); ecological effects characterization (Chapter 4.0); risk characterization (Chapter 5.0); and summary and conclusions (Chapter 6.0). These subtasks are described in greater detail in the following sections.

The chemicals of potential ecological concern (COPEC), the ecosystems and receptors at risk, the ecotoxicity of the contaminants known or suspected to be present, and observed or anticipated ecological effects are evaluated in this SLERA. This evaluation is conducted in two steps: (1) a screening assessment step and (2) a predictive assessment step. Ecological endpoints to be addressed in both steps are identified. The results and conclusions of the screening assessment determine whether a predictive assessment is needed. The criteria by which the need for a predictive assessment is measured are formalized as null hypotheses to be accepted (in which case a predictive assessment is not needed) or rejected (in which case a predictive assessment is needed).

2.0 Problem Formulation

The screening assessment null hypotheses are stated as follows:

- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of viable habitat for potential ecological receptors.
- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential ecological receptors.
- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential exposure pathways.
- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential chemical stressors.

If one or more of these null hypotheses are accepted, a predictive assessment is not triggered. All four null hypotheses must be rejected for a predictive assessment to be triggered. The first three null hypotheses are tested with the results of the ecological site description, the pre-assessment reconnaissance, the documentation of potential receptors of special concern and critical habitats, and the determination of significant ecological threats (Section 2.1). The fourth null hypothesis is tested with the results of COPEC selection (Section 2.2).

If a predictive assessment is triggered, terrestrial and aquatic ecological conceptual site models are developed, as appropriate, and additional problem formulation tasks are performed as described in Sections 2.3 through 2.5.

2.1 Ecological Site Description

This ecological site description section includes a general discussion of site background and the area of concern, surface water resources, wetlands, and vegetative communities; a species inventory; and a discussion on threatened and endangered species. Ecological characterization of the study area was based on a compilation of existing ecological information and site reconnaissance activities. A photographic record was made during the site reconnaissance (see Figure 2-1). Information was obtained on the presence of state- and federally listed, threatened, and endangered species; species of special concern; and wildlife and fisheries resources. A botanist searched for threatened and endangered plant species. A checklist of biological species present at the site was developed using existing site investigation reports, environmental data sources mentioned previously, and information gathered during the site reconnaissance.

Information on unique and special-concern habitats, preserves, wildlife refuge parks, and natural areas within the general vicinity was also obtained.

2.1.1 General Site Background

PBOW, approximately 6,400 acres in size, is located within the Eastern Lake Plains physiographic region of the Eastern Huron/Erie Lake Plain Ecoregion (Lafferty, 1979; Omernik, 1986). This region is generally characterized as containing flat plains as the predominant land-surface form and as having a dominant natural vegetation of elm and ash in undisturbed areas. Approximately two-thirds of Erie County was once covered by a glacial lake that produced features such as beach ridges and wave-cut cliffs. Much of the region is poorly drained due to the flat topography and low stream gradients. Many of the wetlands adjacent to Lake Erie in this region have been preserved by various federal, state, and private organizations (Peterjohn and Rice, 1991), thereby providing important wetland habitat for wildlife.

Across PBOW, the land slopes gently to the north-northeast towards Lake Erie. Elevations range from 675 feet above mean sea level at the southwest edge of the site to 625 feet above mean sea level in the northern portion of the property at Bogart Road, resulting in an average slope of approximately 0.3 percent. The Lake Plains region itself is over 69 percent cropland, 2.7 percent pasture land, and 10.5 percent forest (Ohio Department of Natural Resources [ODNR], 1985). However, since the U.S. Army acquired the site in 1941 and removed the land from agricultural production, undeveloped portions of the former PBOW have become second generation forest and open fields. This has resulted in PBOW becoming an island of forest and open fields within a sea of agricultural land in north-central Ohio.

AP2, approximately 5 acres in size, is relatively flat with a few low hummocks. The former ash pit area is located in a flat depression that is lower in elevation than Campbell Road to the east. Surface water drainage is generally to the west, to Pipe Creek. Based on site reconnaissance performed by Shaw ecologists on April 29, June 2, and September 9, 2009, a photographic record of the site was prepared and is presented on Figure 2-1. Prior to arrival at the site, Shaw personnel obtained relevant information on the site, including topographic maps; and township, county, or other appropriate maps, and determined the location of potential ecological units such as streams, creeks, ponds, grasslands, forest, and wetlands on or near the site. Additionally, the 1994 biological inventory of PBOW (NASA, 1995), which identifies and shows the locations of threatened and endangered species at PBOW, was reviewed. Shaw personnel completed a checklist similar to EPA’s checklist for ecological assessment/sampling (EPA, 1997); also, information from this checklist was used to complete this chapter. The location of known or potential contaminant sources affecting the site and the probable gradient of the pathway by

which contaminants may be released from the site to the surrounding environment were identified. Shaw personnel also used the reconnaissance to search for any indication of potential effects from contaminant release.

2.1.2 Surface Water

Due to the lack of topography at this site, surface water tends to pool in localized shallow depressions. The area as a whole drains to Pipe Creek, located approximately 800 feet west of Campbell Road.

2.1.3 Wetlands

According to the National Wetland Inventory (NWI) Maps for the area (U.S. Fish and Wildlife Services, 2010), there are no designated wetlands at the AP2 site. It should be noted that the accuracy of NWI maps is limited, especially in relatively flat landscapes (such as PBOW) because minor depressions often contain isolated wetlands not easily identified through air photo interpretation (the process used by the U.S. Fish and Wildlife Service in preparing NWI maps).

2.1.4 Vegetative Communities

Vegetative communities at the site were classified during the site reconnaissance trips. Figure 2-2 presents a map of the vegetation communities at the site. AP2 is entirely forested. This area contains a mosaic of wetland and upland forested areas that are dominated by young to moderate aged trees, primarily *Populus deltoides* (eastern cottonwood), *Fraxinus pennsylvanica* (green ash), *Acer saccharinum* (silver maple) and *A. negundo* (box elder). During the April, 2009 site visit, small areas of understory disturbance were observed in this area that were caused during the installation of monitoring wells and other investigative activities earlier in the year. The vegetational community adjacent to Campbell Road consists of disturbed edge habitat composed of ruderal species. The majority of area within the AP2 is successional and lowland forest (see photographs on Figure 2-1). A list of the plant species identified at the site is presented in Table 2-1.

During the site reconnaissance, the study area was examined for vegetative stress, including looking for plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. Vegetative stress attributable to chemicals was not observed at AP2. As noted previously, a few locations were devoid of understory vegetation at areas where wells had been installed and sampled earlier in the year (see bare areas in Photos 3 and 4 on Figure 2-1). These bare areas were most obvious during the April and June, 2009 site visit, but had mostly re-vegetated by the time the site was visited again in September, 2009 (see Photo 5 on Figure 2-1). Based on site reconnaissance information, abundant and robust ecological resources appeared to be present on site, and there was no evidence that significant ecological threats exist at the site.

2.1.5 Species Inventory

Based on information from ODNR (1995) and collected during the site reconnaissance, species lists were prepared for plants, mammals, birds, reptiles, amphibians, and fish (Tables 2-1 through 2-6). Unless noted on the tables, the species listed in Tables 2-1 through 2-6 apply to the former PBOW as a whole and are not necessarily specific to AP2.

A total of 92 plant species were documented at AP2 during the spring and fall vegetation survey (Table 2-1). This comprises approximately 22 percent of the total number of species documented at the site either during the 1994 biological inventory (ODNR, 1995) or during vegetation surveys at other sites at the former PBOW (Appendix A).

Signs of 5 of the 43 species of mammals that may be found in the region based on species range maps were observed at AP2 during site visits (Table 2-2), including opossum, cottontail rabbit, raccoon, red squirrel, and white-tailed deer. It is likely that other species are present but were not observed due to the short duration of the field visits.

A total of 130 species of birds are likely to be found in the region based on species range maps and field observations, and 105 species have been recorded at the former PBOW by the ODNR during their multi-year studies (Table 2-3). PBOW lies within a major migratory corridor that is used by birds travelling between their southern wintering grounds and their breeding grounds in Canada. Of the species recorded by the ODNR, 49 are neotropical migrants and would not be expected to nest at the former PBOW. Twenty-one bird species were documented at AP2 during the site visits performed by Shaw, and 15 of these were identified as being present during the breeding season.

Of the 14 species of reptiles that may be found in the region based on species range maps, 10 species (71 percent) have been observed at the former PBOW, including turtles and snakes (ODNR, 1995; Table 2-4). No reptiles were observed during the AP2 site reconnaissance.

Of the 10 species of amphibians that may be found in the region based on species range maps, 9 species (90 percent) have been observed at the former PBOW (ODNR, 1995; Table 2-5), including salamanders, toads, and frogs. No amphibians were observed during the AP2 site reconnaissance.

According to ODNR (1995), a combination of electro shocking and seining was conducted during the field investigation that identified 14 species of fish at PBOW. Species observed

included suckers, sunfish, minnows, sticklebacks, and bullheads (Table 2-6). Although no fish were visually observed in the section of Pipe Creek that is adjacent to AP2 during the site reconnaissance, some of the smaller fish species are expected to be present in Pipe Creek.

2.1.6 Threatened and Endangered Species Information

According to an Ohio Division of Natural Areas and Preserves review of their natural heritage maps and files (ODNR, 2010), there are records of State of Ohio threatened or endangered species within a 2-mile radius of the site (no species on the federal list were identified). These species include the following:

- Bushy aster (*Symphyotrichum dumosum*) - endangered
- Canada St. John's wort (*Hypericum canadense*) – endangered
- Flat-leaved rush (*Juncus platyphyllus*) – endangered
- Rough rattlesnake-root (*Prenanthes aspera*) – endangered
- Ashy sunflower (*Helianthus mollis*) – threatened
- Dwarf bulrush (*Lipocarpha micrantha*) – threatened
- Field sedge (*Carex conoidea*) – threatened
- Greene's rush (*Juncus greenei*) – threatened
- Slender spike-rush (*Eleocharis tenuis*) – threatened
- Southern hairy panic grass (*Panicum meridionale*) – threatened
- Thin-leaved sedge (*Carex cephaloidea*) – threatened
- Tufted fescue sedge (*Carex brevior*) – threatened
- Twisted yellow-eye-grass (*Xyris torta*) – threatened
- Upland sandpiper (*Bartramia longicauda*) – threatened.

In addition, based on information contained in ODNR (1995), several species of threatened or endangered plants, potentially threatened plants, and threatened or endangered birds have been recorded at PBOW, as follows (note that the status of some of these species may have changed since the report was published):

- Grove sandwort (*Arenaria lateriflora*) - threatened
- Prairie false indigo (*Baptisia lactea*) - potentially threatened
- Broad-winged sedge (*C. alata*) - potentially threatened
- Round-fruited hedge-hyssop (*Gratiola virginiana*) - potentially threatened
- Tall St. John's wort (*H. majus*) - potentially threatened
- Virginia meadow beauty (*Rhexia virginica*) - potentially threatened
- Tall nut rush (*Scleria triglomerata*) - potentially threatened
- Lance-leaved violet (*Viola lanceolata*) - potentially threatened
- Cattle egret (*Bublucus ibis*) - endangered
- Black-crowned night heron (*Nycticorax nycticorax*) - threatened
- Trumpeter swan (*Cygnus buccinator*) - endangered
- Indiana bat (*Mytolis sodalis*) - endangered.

The site reconnaissance included detailed searches performed by a qualified botanist subcontractor during the June and September 2009 site visits. Based on the results of the site reconnaissance, no threatened or endangered plant species were found at AP2.

None of the threatened or endangered bird species would typically be expected to be found at the site. The cattle egret, trumpeter swan, and upland sandpiper are all considered rare visitors or migrants at the former PBOW (ODNR, 1995), and have not been documented nesting within 1 mile of the site (ODNR, 2010).

The black-crowned night heron, an Ohio threatened species, is a regular visitor at ponds, streams, and ditches within the former PBOW; however, it does not nest at the former PBOW (ODNR, 1995; 2010). The species is typically found near water and wetlands, and since the early 1980s there has been a nesting colony of approximately 100 pairs located on an island in Sandusky Bay, approximately 10 miles north northwest of the study area (Peterjohn and Rice, 1991).

The Indiana bat has not been documented at the site and is generally not expected at PBOW because its preferred habitat (e.g., caves along streams or trees with exfoliated bark) is not present at AP2. Trees with exfoliated bark, such as shagbark or shellbark hickory, are rare or not present at the site, respectively, thereby providing little bat roosting habitat (Appendix A).

With the exception of the Erie Sand Barrens State Nature Preserve, there are no existing or proposed state nature preserves or scenic rivers near the site, and ODNR is unaware of any unique ecological sites, geological features, breeding or nonbreeding animal concentrations, champion trees, or state parks, forests, or wildlife areas within a 2-mile radius of the site (ODNR, 2010). The Erie Sand Barrens State Nature Preserve is located southwest of PBOW. The 32-acre preserve is a remnant sand beach of Lake Warren, the fifth ancestral Lake Erie, that supports many threatened and endangered plant species such as field sedge, Least St. John's wort, dwarf bullrush, twisted yellow-eyed-grass, flat-leaved rush, bushy aster, and Virginia meadow beauty. Many of the preserve's rare plant species thrive in open windswept conditions such as those found on the sand barrens. The ODNR Division of Natural Areas and Preserves actively manages the preserve to ensure that the open wind-swept areas remain and do not become overgrown with woody vegetation.

2.1.7 Pre-Assessment Reconnaissance

Shaw ecological scientists performed site visits to AP2 on April 29, June 2, and September 9, 2009. The primary purpose of the April trip was to perform a habitat assessment and fauna inventory at the site, and the visit was intentionally performed during the period when birds are

migrating north to their breeding areas to capture transient species. The primary purposes of the June and September site visits were to perform a summer and fall walkover to identify plant species (including threatened and endangered species). The June visit was also used as a follow-up to the April fauna visit; during early June, breeding birds are vocalizing as they establish and defend territories, while migrants that breed further to the north have moved on. Therefore, bird species identified during the June site visit were assumed be using the site for breeding. The list of plant species observed during the two site walks is presented in Table 2-1. The bird species observed at AP2 are listed in Table 2-3.

Information obtained during the reconnaissance trips was used to select representative receptors, refine exposure scenarios for the risk assessment, and identify protected species or habitats of special concern in the study area. Reconnaissance personnel completed a checklist similar to that on EPA's checklist for ecological assessment/sampling (EPA, 1997) and OEPA's ecological risk assessment guidance (OEPA, 2008). The locations of known or potential contaminant sources affecting the site and the probable gradient of the pathway by which contaminants may be released from the site to the surrounding environment were identified. Reconnaissance personnel used the site visit to evaluate the site for more subtle clues of potential effects from contaminant release.

The methods used to characterize natural resources focused on aquatic and terrestrial resources at the site and within the immediate vicinity. General habitat maps showing the types and extent of vegetation communities present within the immediate vicinity of the site were prepared based on information collected during the site reconnaissance discussed previously.

2.2 Selection of Chemicals of Potential Ecological Concern

A list of AP2 media samples used for the SLERA is presented in Table 2-7. Sample locations are presented on Figure 2-3. From the chemical results of samples on this list, a COPEC selection process was performed to develop a subset of chemicals detected at the site that are not naturally occurring or are associated with non-site-related sources. These chemicals are also present at sufficient frequency, concentration, and location to pose a potential risk to ecological receptors. Examples of screening criteria that were used include the following: analytical detection limit, frequency of detection less than 5 percent, comparability with background, status as a nutrient, and comparison with risk-based screening ecotoxicity values. This selection process is described in more detail in Section 2.2.3.

2.2.1 Data Organization

Chemical analytical data, as well as all previous and ongoing investigations, were reviewed and evaluated for quality, usefulness, and uncertainty. Data identified as being of acceptable quality for use in the SLERA were summarized in a manner that presents the pertinent information to be applied in the SLERA. Any data rejected during the data evaluation as a result of the data evaluation ("R"-qualified data) were identified along with the rejection rationale. Only validated data were used in the SLERA.

The data for each chemical were sorted by medium. For ecological impacts, soil from 0 to 6 feet below ground surface (bgs) were considered. The 0 to 6 feet depth interval was selected for three primary reasons: (1) to maintain consistency with other PBOW ecological risk assessments (e.g., IT, 2001a); (2) to include potential exposure to ecological receptors that may be exposed to deeper soil; and (3) to increase the size of the total soil database by including samples collected from samples up to 6 feet bgs. Therefore, COPEC selection was performed for the 0 to 6 feet interval. Chemicals that are not detected at least once in a medium were not included in the risk assessment. Available background data were determined for each medium. Potential sources of background information include data from previous and current investigations, as well as monitoring wells in areas unaffected by site activities.

The analytical data included qualifiers from the analytical laboratory quality control or from the data validation process that reflect the level of confidence in the data. 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, probably below the contract-required quantitation limit.
- R - Quality control indicates that the data are unusable (chemical may or may not be present).
- B - Concentration of chemical in sample is not sufficiently higher than concentration in the blank (using the "5-times, 10-times" rule).

"J"-qualified data are used in the risk assessment; "R"- and "B"-qualified data are not. The handling of "U"-qualified data (nondetects) is described in the following sections.

2.2.2 Descriptive Statistical Calculations

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the 95 percent upper confidence limit (UCL) of the mean are usually estimated for chemicals of interest. The EPA ProUCL software (Version 4.00.04 [EPA, 2009]) was used to estimate UCLs for the data sets of all environmental media represented by at least five samples. If the data set consisted of fewer than five data points, the maximum detected concentration (MDC) was selected as the exposure point concentration (EPC). One-half the reporting limit was used as the ProUCL input concentration for nondetects.

ProUCL generates a variety of UCL estimates for each data set. 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 discernable) that provides the best fit, number of nondetects, size of the data set, and skewness. In general, the UCL recommended by ProUCL will be selected as the EPC. Occasionally, ProUCL will recommend the 97.5 or 99 percent UCL on the arithmetic mean estimated by the Chebyshev method. In these cases, the 95 percent UCL estimated by the Chebyshev method was selected as the EPC because this is more consistent with the intent of the reasonable maximum exposure paradigm as defined by EPA (1989a; 2002).

Analytical data from field duplicates were joined with parent sample results to yield one result for use in the generation of mean and UCL concentrations, as follows:

- The average of field duplicate and parent sample was used if both were positive detections, or if both were nondetects.
- The detected value was used if one sample was a positive detection and the other was nondetect.

The UCL generated by ProUCL or the MDC, whichever is smaller, was selected as the EPC, and this value is understood to represent a conservative estimate of average for use in the risk assessment. Unusually high detected values were retained in the calculation of the UCL concentration. Inclusion of these high values increases the statistical variability and the overall conservativeness of the risk estimate.

2.2.3 COPEC Selection Criteria

The criteria used to identify COPECs in the SLERA are described in the following sections.

2.2.3.1 Comparison to Ecological Screening Values

MDCs of chemicals detected in various media were compared with ecological screening values (ESV) for ecological endpoints following recommendations received from OEPA and as discussed in *Region 5 Biological Technical Assistance Group (BTAG) Ecological Risk Assessment Bulletin No. 1* (EPA, 1996). Chemicals that exceed the ESVs, or for which no ESVs are available, were retained as COPECs if other COPEC selection criteria were also met. The following ESVs, or ESV hierarchy (as noted), were used for the ecological evaluation:

- ***Soil.*** Soil screening values were selected using the following hierarchy: (1) EPA ecological soil screening levels (EPA, 2008), (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson, et. al., 1997a), (3) EPA Region 5 ecological screening levels (note: these values were previously known as ecological data quality levels) (EPA, 2003), (4) *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process* (Efroymson, et al., 1997b), and (5) *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants* (Efroymson, et al., 1997c). It should be noted that effects on heterotrophic processes may not be relevant to ecological receptors of concern at the site.

- ***Surface Water.*** The lowest surface water screening value was selected from the following three sources: (1) OEPA Water Quality Criteria (OAC Chapter 3745-1) for the protection of aquatic life, (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson, et al., 1997a), and (3) EPA Region 5 ecological screening levels (EPA, 2003). Because OEPA water quality criteria do not consider food-chain effects, a hierarchy could potentially eliminate important surface water COPECs.

- ***Sediment.*** Sediment screening values were selected using the following hierarchy: (1) Consensus-based threshold effect concentration values (MacDonald, et al., 2000), (2) EPA Region 5 ecological screening levels (EPA, 2003), (4) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson, et al., 1997a), and (5) *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* (Ontario Ministry of the Environment and Energy; 1993).

The development of the ESVs used for the former PBOW SLERAs is presented in Appendix B.

2.2.3.2 Frequency of Detection

Chemicals that are detected infrequently may be artifacts in the data that may not reflect site-related activity or disposal practices. These chemicals are not evaluated further in the risk evaluation. Generally, chemicals that are detected only at low concentrations in less than 5

percent of the samples from a given medium are dropped from further consideration, unless their presence is expected based on historical information about the site. Chemicals detected infrequently at elevated concentrations as compared with applicable risk-based thresholds may identify the existence of “hot spots” and have been retained in the evaluation, unless other information exists to suggest that their presence is unlikely to be related to site activities.

2.2.3.3 Background Evaluation

Chemical concentrations were compared to site-specific background concentrations (see next paragraph for details) as an indication of whether a chemical is present from site-related activity or as natural background. This comparison is generally valid for inorganic chemicals but not for organic chemicals, because inorganic chemicals are naturally occurring and most organic chemicals are not. Statistical techniques are used as tools to aid the exercise of professional judgment in resolving site-related issues for metals, because metals are naturally present in most environmental media. The statistical techniques generally involve comparing the site data with background data. Background data are only available for soil at PBOW. Background soil values were also used to compare to concentrations in sediment from samples collected from Pipe Creek, as the shallow creek bed in Pipe Creek at AP2 most likely accumulates sediment as a result of overland runoff from site soils. Background data do not exist for surface water; therefore, a statistical background evaluation for this medium cannot be performed.

The first statistical technique used for the background screen is the comparison of the MDC of the site data set to the PBOW background screening concentration (BSC). The background data set and derivation of soil BSCs for all PBOW soil investigations are described in IT (1998). The background soil samples were collected from near the property boundary, away from any potential source areas. BSCs were calculated for use at PBOW based on concentrations found in these background soil samples. Each BSC is either the MDC of the concentrations found in these background soil samples or the calculated 95th percent upper tolerance limit of the background data set, whichever value is lower (Shaw, 2005). The upper tolerance limit is the concentration, with a probability of 0.95 (or a confidence of 95 percent), that would capture (or cover) 95 percent of background samples if a larger number of samples were collected. Chemicals with MDCs less than their respective BSCs are eliminated from further consideration. If the MDC exceeds the BSC, the chemical may be retained as a COPEC, or a different statistical analysis may be performed to determine if the background data and the site data are drawn from the same population. The Wilcoxon Rank Sum (WRS) test is used for this purpose.

The WRS test (also known as the Mann-Whitney U test) is described in Appendix M of Shaw (2005). WRS testing is performed for inorganic chemicals in soil whose MDCs exceed their

respective BSCs, and when the site and background data sets each contain less than 50 percent nondetects. The WRS test is not performed on data sets containing 50 percent or more nondetects, because the medians of such data sets are unknown and the test lacks sufficient power to yield reliable results. Likewise, the WRS test is not performed on data sets of size n < 5; in such cases, the test lacks sufficient power to identify differences between the two samples. 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 COPEC data sets are appended to the SLERA for each inorganic data set evaluated against the site background data set. Analytes shown by the WRS results to exceed background (or for which the WRS testing was not run) are assumed to be site related and retained as COPECs, unless a qualitative chemical-specific explanation is presented in the uncertainties analysis as to why the analyte should not be regarded as site related. Analytes shown by the WRS results to be drawn from the same population as the background samples are assumed to be naturally occurring and are not retained as COPECs. WRS results were only used to evaluate lead in soil. Supporting information for the WRS test, including box-and-whisker plots, are presented in Appendix C.

Chemicals that fail the background evaluation are assumed to be site related and are not eliminated at this point of the screening process.

2.2.3.4 Essential Nutrients

Evaluating essential nutrients is a special form of risk-based screening applied to certain ubiquitous elements that are generally considered to be required nutrients. Essential nutrients such as calcium, iron, magnesium, potassium, and sodium are usually eliminated as COPECs because they are generally considered to be innocuous in environmental media. Other essential nutrients, including chloride, iodine, and phosphorus, may be eliminated as COPECs, provided that their presence in a particular medium is shown to be unlikely to cause adverse effects to biological health.

2.2.4 Summary of COPEC Selection

The results of the COPEC screening are presented in Tables 2-8 through 2-10 for soil, surface water, and sediment. The tables present the following information for each medium:

- Chemical name
- Frequency of detection
- Range of detected concentrations
- Range of detection limits
- Arithmetic mean (average) of site concentrations

- Distribution type
- UCL of the mean of the concentration (only for chemicals selected as COPECs)
- Appropriate ESV
- BSC
- COPEC selection conclusion: NO (with rationale for exclusion), or YES (selected).

The selected EPC is also presented for each chemical identified as a COPEC. For soil, two EPC results are presented, including a total soil EPC that represents concentrations in the 0-6 feet bgs depth range, and a surface soil that represents concentrations in the 0-1 foot bgs depth range. These two sets of EPCs are used to evaluate various ecological receptors that may be exposed to different soil depths associated with their various life-history characteristics (see Section 3.1). Footnotes in the tables provide the rationale for selecting or rejecting a chemical as a COPEC. In some situations, it is appropriate to reinstate as COPECs chemicals that have been eliminated using one or more of the screening criteria. Examples of these exceptions include potential breakdown products, chemicals known to have been used on site historically, chemicals with detection limits greater than the ESV, and chemicals with high bioconcentration and/or bioaccumulation factors. A qualitative evaluation of the COPEC tables for soil, surface water, and sediment was performed; based on this evaluation, no additional COPECs are recommended.

Four COPECs were selected for total soil (Table 2-8), four were selected for surface water (Table 2-9), and one was selected for sediment (Table 2-10). As discussed at the beginning of Chapter 2.0, the SLERA null hypotheses are that potential for adverse ecological effects are minimal or nonexistent due to the lack of viable habitat, potential ecological receptors, potential exposure pathways, and/or potential chemical stressors. Given the selection of COPECs in multiple media, and the finding that viable habitat, potential receptors, and potential exposure pathways exist at the site, a predictive assessment is triggered. Chemicals not eliminated using the screening procedures previously presented are considered COPECs and are quantitatively evaluated in the predictive SLERA.

2.3 Ecological Endpoint (Assessment and Measurement) Identification

The first step in the predictive SLERA is the identification of assessment and measurement endpoints. The protection of ecological resources, such as habitats and species of plants and animals, is a principal motivation for conducting the SLERA. Key aspects of ecological protection are presented as policy goals. These are general goals established by legislation or agency policy that are based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and government agency policies (e.g., the Comprehensive Environmental Response, Compensation, and Liability Act, National Environmental Policy Act). Other legislation includes the

Endangered Species Act (16 U.S.Code 1531-1544) (1993, as amended) and the Migratory Bird Treaty Act 16 (U.S. Code 703-711) (1993, as amended). To determine whether these protection goals are met at the site, assessment and measurement endpoints have been formulated to define the specific ecological values to be protected and to define the degree to which each may be protected.

Unlike the human health risk assessment process, which focuses on individual receptors, the SLERA focuses on populations or groups of interbreeding nonhuman, nondomesticated receptors. This is accomplished by selecting measurement endpoints (discussed below) that are related to parameters most likely to result in population level effects (e.g., survival, growth, or reproduction) and consideration of lowest-observed-adverse-effect levels (LOAEL) in addition to no-observed-adverse-effect level (NOAEL) endpoints (see Chapter 4.0). In the SLERA process, risks to individual receptors are assessed only if they are protected under the Endangered Species Act, are species that are candidates for protection, or are species of special concern.

Given the diversity of the biological world and the multiple values placed on it by society, there is no universally applicable list of assessment endpoints. Suggested criteria that may be considered in selecting assessment endpoints suitable for a specific ecological risk assessment are (1) ecological relevance, (2) susceptibility to the contaminant(s), (3) accessibility to prediction and/or measurement, and (4) definability in clear, operational terms (Suter, 1993). Selected assessment endpoints reflect environmental values that are protected by law, are critical resources, or have relevance to ecological functions that may be impaired. Both the entity and attribute are identified for each assessment endpoint.

Assessment endpoints are inferred from effects to one or more measurement endpoints. The measurement endpoint is a measurable response to a stressor that is related to the valued attribute of the chosen assessment endpoint. It serves as a surrogate attribute of the ecological entity of interest (or of a closely related ecological entity) that can be used to draw a predictive conclusion about the potential for effects to the assessment endpoint.

Measurement endpoints for this SLERA are based on toxicity values from the available literature and not statistical or arithmetic summaries of actual field or laboratory observations or measurements. When possible, receptors and endpoints have been concurrently selected by identifying those that are known to be adversely affected by chemicals at the site based on published literature. COPECs for those receptors and endpoints have been identified by drawing on the scientific literature to obtain information regarding potential toxic effects of site chemicals

to site species. This process ensures that a conservative approach is taken in selecting endpoints and evaluating receptors that are likely to be adversely affected by the potentially most toxic chemicals at the site.

2.3.1 Assessment Endpoints

The assessment endpoints for AP2 are stated as "the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds." The corresponding null hypothesis for each of the assessment endpoints is stated as "the presence of site contaminants within soil, surface water, sediment, vegetation, and prey will have no effect on the survival or reproductive capabilities of terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds."

Assessment receptor species were selected based on the likelihood of finding the species at the AP2. Historical information, the site reconnaissance (performed April 29, June 2, and September 9, 2009), and the availability of toxicological data were used to select terrestrial and aquatic assessment receptor species. These receptors species are depicted in food web models (Figures 2-4 and 2-5). Food web models are simplified versions of the possible movement of contaminants through the food chain present or potentially present at the site. Due to lack of data for all possible species, key species have been selected to represent broad classes, or guilds.

The food web conceptual site models were developed to illustrate how the selected terrestrial and aquatic species are ecologically linked within food webs. One species was used to represent each of the major trophic levels and habitats at the site. The decision was made not to complicate the food web models with species names for organisms at the base of the food web (e.g., species names of terrestrial invertebrates). Thus, generic terrestrial invertebrates, benthic invertebrates, and aquatic invertebrates were used to represent the bottom of the food chain. For terrestrial invertebrates and plants, partitioning coefficients and simple empirical uptake models were employed to estimate COPEC concentrations within tissues (Chapter 3.0). Brief life history descriptions for the selected receptor species are provided in Appendix D.

All trophic levels may be exposed to COPECs, either by direct exposure to contaminated abiotic media or through ingestion of lower trophic level food items. Primary producers (plants) absorb COPECs (as well as nutrients) from soil and/or water. Through abiotic processes, COPECs can adsorb to the sediment and detritus particles. When these particles settle and become part of the

benthic substrate, they may also become a source of COPECs to benthic communities. Various species of aquatic biota fulfill the role of aquatic herbivores (feeding on aquatic plants and suspended detritus) and predatory invertebrates (feeding on benthic invertebrate species). The combination of COPEC bioconcentration from water, ingestion of contaminated prey, and restricted ranges for aquatic organisms provides good conditions for significant bioaccumulation of COPECs. In terrestrial species, bioconcentration occurs in plants and invertebrates, and higher food chain receptors bioaccumulate COPECs through the ingestion of food items.

2.3.2 Measurement Endpoints

Measurement endpoints are frequently numerical expressions of observations (e.g., toxicity test results or community diversity indices) that can be compared statistically to detect adverse responses to a site contaminant. Examples of typical measurement endpoints include mortality, growth, or reproduction parameters in toxicity tests; individual abundance; and species diversity (EPA, 1997).

For assessments, measurable responses to stressors may include LOAELs, NOAELs, lethal concentration to 50 percent of the test population, lethal dose to 50 percent of the test population, or effective concentration for 20 percent of the test population, collectively termed toxicity reference values (TRV) (see Section 4.1 for further explanation).

2.4 Selection of Assessment Receptors

In order to focus the exposure characterization portion of the SLERA on species or components that are the most likely to be affected and on those that, if affected, are most likely to result in significant impacts to the on-site ecosystem, the selection of assessment receptors focuses on species, groups of species, or functional groups that are directly related to the assessment endpoints previously identified (Section 2.3.1).

Site biota were organized into major functional groups. For terrestrial communities, the major groups are plants and wildlife, including terrestrial invertebrates, mammals, and birds. For aquatic and/or wetland communities, the major groups are flora and fauna, including vertebrates (water fowl and fish), aquatic invertebrates, and wetland/terrestrial mammals. Species presence and relative abundance were partly determined during the site reconnaissance.

Primary criteria for selecting appropriate assessment receptors include, but are not limited to, the following:

- The assessment receptor has a relatively high likelihood of contacting chemicals via direct or indirect exposure.
- The assessment receptor exhibits marked sensitivity to chemicals.
- The assessment receptor is a key component of ecosystem structure or function (e.g., importance in the food web, ecological relevance).
- The assessment receptor may be listed as rare, threatened, or endangered by a governmental organization, or the receptor consists of critical habitat for rare, threatened, or endangered species.

Additional criteria for selection of assessment receptors were used to identify species that offer the most favorable combination of characteristics for determining the implications of on-site contaminants. These criteria included (1) limited home range, (2) role in local nonhuman food chains, (3) potential high abundance and wide distribution at the site, (4) sufficient toxicological information available in the literature for comparative and interpretive purposes, (5) sensitivity to COPECs, (6) relatively high likelihood of occurrence on site following remediation (if required); (7) suitability for long-term monitoring, (8) importance to the stability of the ecological food-chain or biotic community of concern, and (9) relatively high likelihood that species will be present at the site or that habitats present at the site could support the species. Assessment receptors are representative species that are modeled for exposure to contaminants via multiple exposure routes. Organisms at the base of the food chain (i.e., plants, invertebrates, etc.) are not evaluated for food chain effects because direct exposure is the primary exposure route of concern for these organisms, which is evaluated by the ecological benchmark comparison during the initial COPEC screening process. Therefore, these types of organisms are not selected as assessment receptors.

2.4.1 Terrestrial Receptors

Seven representative terrestrial receptor species that are expected or possible in the area of AP2 (based on the ecological description of the site presented in Section 2.1) were selected as indicator species for the potential effects of COPECs. These indicator species represent two classes of vertebrate wildlife (mammals and birds) and a range of both body size and food habits, and include herbivores, omnivores, and carnivores. Vegetation is not considered an assessment receptor. The seven terrestrial species selected include the deer mouse (*Peromyscus maniculatus*) (small, omnivorous mammal), short-tailed shrew (*Blarina brevicauda*) (small, insectivorous mammal), Eastern cottontail rabbit (*Sylvilagus floridanus*) (medium-sized herbivorous mammal), marsh wren (*Cistothorus palustris*) (small insectivorous bird), white-tailed deer (*Odocoileus*

virginianus) (large herbivorous mammal), raccoon (*Procyon lotor*) (medium-sized omnivorous mammal), and red-tailed hawk (*Buteo jamaicensis*) (large, carnivorous bird).

A terrestrial food web is presented on Figure 2-4. Many of the species evaluated have limited home ranges, particularly the deer mouse, cottontail rabbit, short-tailed shrew, and marsh wren, which make them particularly vulnerable to exposure from site contaminants. All of the selected terrestrial receptor species have a potential high abundance and wide distribution at the site; also, sufficient toxicological information (with the exception of some bird species) is available in the literature for comparative and interpretive purposes. All species are considered important to the stability of the local ecological food chain and biotic community. Finally, all the selected species have readily available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (EPA, 1993).

Larger mammal species were generally not selected as sensitive receptors due to their large home ranges; however, the red-tailed hawk was retained due to its unique role as a top predator in the food chain and the white-tailed deer was retained due to its high abundance at the site. Smaller birds were generally not included because most are migratory. The potential risk to species with larger home ranges and migratory avian species will be included within the predicted risks to the selected terrestrial indicator receptors. Area use factors were set to 100 percent for the mouse, shrew, rabbit, and wren, due to their relatively small home ranges (Section 3.1). However, for the deer, hawk, and raccoon, the area use factor was set at 0.004, 0.002, and 0.01 (or 0.4, 0.2, and 1 percent), respectively, based on these species' relatively large home ranges (518, 842, and 156 hectares, or 1,280, 2,081, and 385 acres, respectively), compared with the size of the site (approximately 5 acres [Figure 1-2]).

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions called assessment receptor profiles (ARP). The biologically relevant criteria used to select the seven terrestrial assessment receptors are also discussed and summarized in the ARP (Appendix D).

2.4.2 Aquatic Receptors

The only aquatic habitat at the site is Pipe Creek, which is a small stream adjacent to the western boundary of the AP2 site that flows from the southwest to northeast. Although water may pond in low areas within AP2 itself, these ponds are considered ephemeral in nature, and not true aquatic habitat (Photos 7 and 8 on Figure 2-1). Exposure to aquatic organisms within the creek is assumed to occur via direct exposure to contaminants in the water column and via ingestion of benthic invertebrates as well as prey exposed to contaminants in surface water and sediment.

Potential uptake through the aquatic food chain is evaluated for the raccoon (also considered as a terrestrial receptor) and muskrat (*Ondatra zibethicus*) (medium-sized aquatic herbivorous mammal). An avian aquatic omnivore such as the mallard (*Anas platyrhynchos*) is not evaluated due to the limited amount of aquatic habitat associated with the creek.

Aquatic organisms represent some of the prey base for aquatic receptors (represented by the raccoon and muskrat). An aquatic food web is presented on Figure 2-5. The raccoon has been documented at the site (Section 2.1) and has a potential high abundance and wide distribution at the site, and sufficient toxicological information is available in the literature for comparative and interpretive purposes. The muskrat is also likely to be found at PBOW (see Table 2-2). Although Pipe Creek may be too small of a water body to support muskrat populations, this receptor is conservatively included to represent mammalian aquatic herbivores. Both the raccoon and muskrat have readily available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (EPA, 1993).

Results of the assessment receptor selection process, including a summary of the relevant biological criteria used, are presented in the ARPs (Appendix D).

2.5 Ecological Site Conceptual Model

Pictorial representations of the evaluated food webs are presented on Figures 2-4 and 2-5. The accompanying text presented in Section 3.1 is intended to clarify the ecological site conceptual models (ESCM). The ESCMs trace the contaminant pathways through both abiotic components and biotic food web components of the environment. The ESCMs present all potentially complete exposure pathways. The ESCMs have been used as a tool for judging the appropriateness and usefulness of the selected measurement endpoints in evaluating the assessment endpoints and for identifying sources of uncertainty in the exposure characterization.

3.0 Exposure Characterization

An estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to COPECs that are present at or migrating from the site is presented in this section, considering both current and reasonably plausible future use of the site. Exposure characterization is critical in further evaluating the risk of chemicals identified as COPECs during the screening process (Section 2.2). The exposure assessment has been conducted by linking the magnitude (concentration) and distribution (locations) of the contaminants detected in the media sampled during the investigation, evaluating pathways by which chemicals may be transported through the environment, and determining the points at which organisms found in the study area may contact contaminants.

3.1 Exposure Analysis

An exposure analysis was performed that combines the spatial and temporal distribution of the ecological receptors with those of the COPECs to evaluate exposure. The exposure analysis focuses on the bioavailable chemicals and the means by which the ecological receptors are exposed (e.g., exposure pathways). The focus of the analysis is dependent on the assessment receptors being evaluated as well as the assessment and measurement endpoints.

Exposure pathways consist of four primary components: source and mechanism of contaminant release, transport medium, potential receptors, and exposure route. A chemical may also be transferred between several intermediate media before reaching the potential receptor. All of these components have been addressed within this SLERA. If any of these components is not complete, then contaminants in the affected media do not constitute an environmental risk at the site. The major fate and transport properties associated with typical site contaminants are described in subsequent sections. These properties directly affect a contaminant's behavior in each of the exposure pathway components.

Ecological routes of exposure for biota may be direct (bioconcentration) or through the food web via the consumption of contaminated organisms (biomagnification). Direct exposure routes include dermal contact, absorption, inhalation, and ingestion. Examples of direct exposure include animals incidentally ingesting contaminated soil or sediment (e.g., during burrowing or dust-bathing activities), animals ingesting surface water, plants absorbing contaminants by uptake from contaminated sediment or soil, and the dermal contact of aquatic organisms with contaminated surface water or sediment. Given the scarcity of available data for wildlife dermal and inhalation exposure pathways, potential risk from these pathways is not estimated in this

SLERA. In addition, these pathways are generally considered to be incidental for most species, with the possible exceptions of burrowing animals and dust-bathing birds.

Food web exposure can occur when terrestrial or aquatic fauna consume contaminated biota. Examples of food web exposure include animals at higher trophic levels consuming plants or animals that bioaccumulate contaminants.

Bioavailability is an important contaminant characteristic that influences the degree of chemical-receptor interaction. The bioavailability of a chemical refers to the degree to which a receptor is able to absorb a chemical from the environmental medium. A chemical's bioavailability is a function of several physical and chemical factors such as grain size, organic carbon content, water hardness, and pH.

Daily doses of COPECs for vertebrate receptors were calculated using standard exposure algorithms. These algorithms incorporate species-specific natural history parameters (i.e., feeding rates, water ingestion rates, dietary composition, etc.) and also use site-specific area use factors, as follows:

$$Total\ Daily\ Dose = \left(\frac{\left(\left[Soil_j * IR_{soil} \right] + \left[Water_j * IR_{water} \right] + \left[\sum_{i=1}^{N} B_{ji} * P_i * IR_{food} \right] \right)}{Body\ Weight} \right) * AUF \qquad \text{Eq. 3.1}$$

where:

$Soil_j$	=	Concentration of COPEC "j" in soil
$Water_j$	=	Concentration of COPEC "j" in surface water
B_{ji}	=	Concentration of COPEC "j" in food type "i"
IR_{soil}	=	Soil ingestion rate
IR_{water}	=	Surface water ingestion rate
IR_{food}	=	Food ingestion rate
P_i	=	Proportion of food $type_i$ in receptor diet
AUF	=	Area use factor (equal to area of exposure unit/home range of receptor
Body Weight	=	Body weight of receptor.

Sediment may replace soil in Equation 3.1 for aquatic or semi-aquatic receptors.

The first step in estimating exposure rates for terrestrial wildlife involves the calculation of feeding and drinking rates for site receptors. EPA (1993) includes a variety of exposure information for a number of avian, herptile, and mammalian species. Information regarding

feeding and drinking rates and dietary composition are available for many species or may be estimated using allometric equations (Nagy, 1987). Data have also been gathered on incidental ingestion of soil and is incorporated for the receptor species. Literature values for animal-specific sediment ingestion are used if available. However, such values generally are not available in the literature. Where sediment ingestion rates could not be found, the animal-specific incidental soil ingestion rate is used for sediment ingestion as well, if the receptor's life history profile suggests a significant aquatic component (e.g., raccoons' use of surface water in foraging activities). This information is summarized in Table 3-1.

To estimate dose associated with ingested food items, concentrations of COPECs in the vegetation or prey in the species' diet is estimated using bioaccumulation factors (BAF) (sometimes referred to as bioconcentration factors [BCF]). BAFs are regression models or scalar variables that reflect the potential for the COPECs to be present in food items at concentrations different from (usually greater than) the ambient environment. Differences in concentration are due to chemical-specific properties of the COPEC that affect its tendency to bioaccumulate in tissue, balanced by the innate ability of the species to regulate body burden levels of the chemical via metabolic and excretory processes.

Selection of appropriate BAFs is a critical component to food chain modeling. General approaches for BAF selection have been discussed in Sample and Suter (1994), EPA (1999a), U.S. Army Environmental Center (2005) and EPA (2008). An approach that is consistent with these sources was followed in the selection of BAFs for PBOW. The general hierarchy for selection of BAFs based on types of sources, is as follows:

1. Use of regression equations derived from paired field- or laboratory-based measurements

2. Ratio-derived BAFs developed based on paired data of tissue concentrations compared to media concentrations where the BAF is equal to the tissue concentration divided by the concentration in the abiotic medium.

3. Modeled equilibrium partitioning-derived BAFs based on physical or chemical characteristics

4. Assumptions based on values common to chemical class.

Both U.S. Army Environmental Center (2005) and EPA (1999a) support the use of ratio BAFs in preference to equilibrium partitioning-based BAFs, which are typically calculated based on

factors such as log octanol-water partition coefficient (K_{ow}) values, fraction of organic carbon in soil, or percent of lipids in invertebrates.

Other general recommendations provided in EPA (2008) were also followed, including the following:

- For selection of ratio-based BAFs, median values are selected over maximum or other high-end BAFs.
- BAFs for accumulation of polynuclear aromatic hydrocarbons (PAH) into mammalian prey are assumed to equal zero due to the high metabolic breakdown of PAHs in mammals.

Regression equations used to calculate prey tissue concentrations of a specific chemical typically take the following general equation form:

$$\text{Ln}\ (C_{food}) = \text{slope value x ln}\ (C_{abiotic\_media}) + \text{intercept value} \qquad \text{Eq. 3.2}$$

where:

C_{food}	=	Concentration of chemical in food type
$C_{abiotic\_media}$	=	Concentration of chemical in abiotic media.

Ratio BAFs can be generally presented as follows:

$$C_{food} = \text{BAF x}\ (C_{abiotic\_media}) \qquad \text{Eq. 3.3}$$

where:

C_{food}	=	Concentration of chemical in food type
$C_{abiotic\_media}$	=	Concentration of chemical in abiotic media
BAF	=	Constant.

BAFs calculated based on equilibrium partitioning typically use a physical constant of a chemical to generate a BAF. A generalized form for this calculation would be as follows:

$$\text{Log (BAF)} = \text{slope value x Log}\ (K_{ow}) + \text{intercept value} \qquad \text{Eq. 4}$$

where:

Log (BAF)	=	Log of the BAF for chemical in food type

BAFs calculated based on equilibrium partitioning are applied in the same fashion as ratio-based BAFs to generate a tissue concentration value. Any K_{ow} values needed for BAFs based on equilibrium partitioning are obtained from the Syracuse Research Corporation Web site (http://www.syrres.com/esc/est_kowdemo.htm).

Finally, where ratio-based BAFs are missing and where no equilibrium partitioning method has been developed for calculating BAFs, other methods, such as using BAFs for chemicals in the same class as surrogates, may be presented for establishing ratio-based BAFs.

For the current SLERA, PBOW-specific BAFs that were developed as part of the Red Water Ponds Phase II baseline ecological risk assessment (BERA) (IT, 2001b) were used for the AP2 food chain model, when available. Site-specific soil-to-earthworm and sediment-to-benthic invertebrate BAFs were developed in this BERA based on 28-day bioaccumulation studies performed using the earthworm species *Eisenia foetida* or the invertebrate species *Lumbriculus variegates,* respectively, and soil or sediment samples collected from the PBOW Red Water Ponds area. Both reasonable maximum exposure (RME) and central tendency (CT) BAFs were estimated in the Red Water Ponds risk assessment. The RME BAFs were based on all tissue concentration results, even if blank related, and the CT BAFs were based on blank-corrected tissue results. Although EPA recommends that median values be selected over maximum or other high-end BAFs, the RME sediment-to-aquatic invertebrate and soil-to-worm BAFs were conservatively selected over the CT BAFs as the selected BAFs for the AP2 SLERA, when available. The Red Water Ponds BERA also developed CT and RME BAFs for surface water-to-fish for two different PBOW sites, the West Area Red Water Ponds and Pentolite Road (IT, 2001b). These values were also adopted for use in the AP2 SLERA. When two values were available for a given chemical from the two areas, the average of the RME values was used as the BAF for the AP2 SLERA.

The hierarchies used to select BAFs specific to the various types of biota are presented below. Chemical-specific BAFs (or the regression equation used to calculate COPEC concentrations) for COPECs selected using the respective hierarchies are presented in Tables 3-2 through 3-6.

Table 3-2 presents the soil-to-plants BAFs for COPECs at AP2. Soil-to-plants BAFs are also used to evaluate sediment-to-plant uptake at PBOW. Soil-to-plants BAFs are selected using the following specific hierarchy of sources:

1. EPA (2008) selected regressions
2. Efroymson, et al. (2001) regressions
3. EPA (2008) recommended median BAFs
4. International Atomic Energy Agency (IAEA) (1994) BAFs
5. Baes, et al. (1984) BAFs (these values were often updated in the more recent IAEA [1994] publication).

Table 3-3 presents the soil-to-invertebrates (earthworms) BAFs for COPECs at AP2. Soil-to-invertebrates BAFs are selected using the following hierarchy of sources:

1. PBOW site-specific BAFs (IT, 2001b)
2. EPA (2008) selected regressions
3. Sample, et al. (1998a) regressions
4. Sample, et al. (1998a) median BAFs
5. Equilibrium BAF calculation method in EPA (2008) based on Jager (1998).

Table 3-4 presents the soil-to-mammals BAFs for COPECs at AP2. Soil-to-mammals BAFs are selected using the following hierarchy or sources:

1. PBOW site-specific BAFs (IT, 2001b)
2. EPA (2008) or Sample, et al., (1998b) selected regressions
3. EPA (2008) referenced BAFs (Note: per EPA [2008], a BAF of zero is used for all PAHs, TNT, and RDX.)
4. Sample, et al. (1998b) median BAFs
5. IAEA (1994) BAFs
6. Baes, et al. (1984) BAFs (these values were often updated in the newer IAEA [1994] publication)
7. EPA (1999b) maximum calculated BAFs/BCFs for feeding guilds.

Table 3-5 presents the sediment-to-aquatic invertebrates BAFs for COPECs at AP2. Sediment-to-aquatic invertebrates BAFs are selected using the following hierarchy of sources:

1. PBOW site-specific BAFs (IT, 2001b)
2. Ratio BAFs from Bechtel Jacobs Company, LLC (1998)
3. Ratio BAFs from EPA (1999b)
4. Ratio BAFs from other literature sources
5. Conservative default based on median BAF for PCBs from Bechtel-Jacobs Corporation, LLC (1998).

Table 3-6 presents the surface water-to-fish BAFs for COPECs at AP2. Surface water-to-fish BAFs are selected using the following hierarchy:

1. PBOW site-specific BAFs (IT, 2001b)
2. EPA (1999b) ratio BAFs

3. EPA (1989b) ratio BAFs
4. RAIS database (ORNL, 2008 on-line)
5. Equilibrium partitioning equation (Bintein and Devillers, 1993).

It should be noted that the BAFs presented in EPA (1989a and 1999b) are presented in units of milligrams per kilogram (mg/kg) (wet) per milligrams per liter (mg/L). These BAFs were adjusted to BAFs with dry weight units of mg/kg(dry) per mg/L by dividing by the proportion of solids of a fish (20 percent, as detailed in Table C-5 of EPA (2000).

Ingestion rates for receptor species are typically developed as a quantity of wet weight material ingested. Soil analytical data results are typically reported on a dry weight basis. Literature-derived BAFs are often a mixture of dry weight to wet weight and dry weight to dry weight values. To avoid underestimating or overestimating food concentrations based on confusion over dry weight versus wet weight, final food concentrations are adjusted in the SLERA to report concentrations on a dry weight basis. Although it was not necessary to convert food intake rates from wet weight to dry weight in this SLERA, the moisture contents of the invertebrate and vegetative material in the receptor species' diets from the EPA's *Wildlife Exposure Factors Handbook* (EPA, 1993) can be used for this conversion, as follows:

- Earthworms - 84 percent
- Fruit - 77 percent
- Roots/young grass - 82 percent
- Seeds - 9.3 percent
- Fruit/young grass - 78 percent.

Exposure to four categories of environmental media are addressed in the SLERA, as discussed in the following subsections.

Soil Exposure Pathway. Soil exposure pathways are potentially important for terrestrial plants and animals at the site. For non-burrowing animals, exposure to soil from a depth of 0 to 1 foot bgs was considered, as this soil depth would represent the depth of regular exposure. For burrowing animals such as the shrew, exposure to soil from a depth of 0 to 6 feet bgs was considered. It is noted that although the shrew itself may not actually burrow to a depth of 6 feet, there may be other burrowing mammals that do burrow this deep. For plants and herbivores feeding on deep-rooted plants (e.g., the white-tailed deer, which is assumed to ingest leaves of trees translocating COPECs from subsoils), exposure to soil from a depth of 0 to 6 feet bgs (or the water table surface) was also evaluated because most feeder roots are located within this depth. Thus, the shrew and the white-tailed deer (Figure 2-4), were evaluated for exposure to

deeper (0 to 6 feet bgs) soil. All other receptors exposed to soil were evaluated for exposure to concentrations in surface (0 to 1 foot bgs) soil.

Environmental conditions such as soil moisture, soil pH, and cation exchange capacities significantly influence whether potential soil contaminants remain chemically bound in the soil matrix or can be chemically mobilized (in a bioavailable form) and released for plant absorption. Generally, neutral to alkaline soils (soil pH of 6.5 or greater) restrict the absorption of toxic metals, making pathway completion to plants difficult.

Sediment Exposure Pathway. Sediment consists of materials precipitated or settled out of suspension in surface water or native soils underlying flowing or standing surface water bodies. Potential contaminant sources for sediment include over-ground transport from the AP2 area, and contaminated surface water, groundwater, and soil. The release mechanisms include surface water runoff, groundwater discharge, and airborne deposition. Potential receptors of chemicals in contaminated sediment include aquatic flora and fauna. Direct exposure routes for contaminated sediment include contact by benthic-dwelling organisms such as amphipod invertebrates, uptake by aquatic flora, and ingestion by aquatic fauna. Indirect exposure pathways from sediment include consumption of bioaccumulated contaminants by consumers in the food chain. Chemical bioavailability of many nonpolar organic compounds (e.g., polychlorinated biphenyls and pesticides) decreases with increasing concentrations of total organic carbon in the sediment; however, these compounds can still bioaccumulate up the food chain (Landrum and Robbins, 1990).

Surface Water Exposure Pathway. Surface water represents a potential transport medium for COPECs. Potential sources for contaminated surface water include over-ground transport from the AP2 area, contaminated soil/sediment and groundwater, and deposition of airborne contaminants. The release mechanisms include surface runoff, leaching, and groundwater seepage. Potential receptors of contaminated surface water include terrestrial and aquatic fauna and aquatic flora. Exposure routes for contaminated surface water include ingestion by terrestrial fauna and uptake and absorption by aquatic flora and fauna. Consumption of bioaccumulated contaminants constitutes a potential indirect exposure pathway for faunal receptors. Chemical bioavailability of some metals and other chemicals is controlled by water hardness, pH, and total suspended solids.

Groundwater Exposure Pathway. Groundwater represents a potential transport medium for COPECs. Potential contaminant sources for groundwater include contaminated soil and buried or

stored waste. The release mechanism for contaminants into groundwater is direct transfer of contaminants from waste materials to water as water passes through the materials.

Groundwater itself is not an exposure point in ecological risk assessments, although contaminant transport along the shallow groundwater pathway may be considered an exposure route to aquatic life, wetlands, and some wildlife where the groundwater discharges to surface water. This pathway is of importance to aquatic and wetland receptors if groundwater is found to be discharging to surface water. Because this scenario is unlikely at AP2, groundwater was not directly evaluated in this SLERA. However, surface water samples were collected from Pipe Creek during the wet season in May 2009, which is when groundwater discharge to Pipe Creek is most likely. Thus, the surface water evaluation considers potential impact from contaminants that may be present in groundwater, under exposure conditions in an aquatic habitat.

3.2 Exposure Characterization Summary

The estimated chemical intakes for each exposed receptor group under each exposure pathway and scenario are presented in the risk characterization spreadsheets in Appendix E. These intake estimates are combined with the COPEC toxicity values, discussed in the following section, to derive estimates and characterize potential ecological risk. The uncertainties associated with the estimation of chemical intake are discussed in Section 5.2.

4.0 Ecological Effects Characterization

The ecological effects characterization primarily describes the development of TRVs.

Development of Toxicity Reference Values. TRVs focusing on the growth, survival, and reproduction of species and/or populations have been developed for the AP2 SLERA. Empirical data are available for the specific receptor-endpoint combinations in some instances. Data on surrogate species and/or on endpoints other than the NOAEL and LOAEL were considered as necessary. The NOAEL is a dose of each COPEC that will produce no known adverse effects in the test species. The NOAEL was judged to be an appropriate toxicological endpoint because it would provide the greatest degree of protection to the receptor species. In addition, the LOAEL was used as a point of comparison for risk management decisions. In instances where data are unavailable for a site-associated COPEC, toxicological information for surrogate chemicals or groups of chemical were used. Safety factors were used to adjust for these differences and extrapolate risks to the site's receptors at the NOAEL and/or LOAEL endpoint. This process is described in the following paragraphs.

Toxicity information pertinent to identified receptors has been gathered for those analytes identified as COPECs. Because the measurement endpoint ranges from the NOAEL to the LOAEL, preference has been given to chronic studies noting concentrations at which no adverse effects were observed and those for which the lowest concentrations associated with adverse effects were observed. As previously noted, where data are unavailable for the exposure of a receptor to a COPEC, data for a surrogate chemical or group of chemicals were considered for use in the SLERA.

Whenever possible, studies that use the site-specific target wildlife receptors were utilized. When studies for these species were not available, alternative species studies were used. TRVs are not applied across classes under any circumstances (e.g., a TRV for a bird species may not be used to estimate hazard for a mammal species). In instances where TRVs for multiple avian or mammalian species are supported, the TRV for the most similar species to the measurement receptor based on feeding strategy and physiological attributes were used in the SLERA. For example, for mercury, which was identified as a COPEC in soil, mammalian TRVs based on both mink and mouse test species data are available. The mink TRV was used in the food chain model to evaluate the raccoon measurement receptor because both the mink and the raccoon are carnivores/omnivores that forage along stream corridors, whereas the mouse TRV was used for

the other mammalian measurement receptors due to closer taxonomic similarity (e.g., short-tailed shrew) and/or foraging patterns (e.g., cottontail rabbit, white-tailed deer). Avian TRVs based on multiple test organisms were also available for two other COPECs, lead and selenium, and were evaluated for specific measurement receptors as follows:

COPEC	TRV Test Species	Measurement Receptor
Lead	Quail	Marsh Wren
Lead	Kestrel	Red-Tailed Hawk
Selenium	Duck	Marsh Wren
Selenium	Owl	Red-Tailed Hawk

Using the relevant toxicity information, TRVs were calculated for each of the COPECs. TRVs represent NOAELs and LOAELs with the safety factors presented in Wentsel, et al. (1996) applied to toxicity information that was derived from studies other than no-effects or lowest-effects studies (Figure 4-1).

Because NOAELs and LOAELs for the selected wildlife receptor species are based on data from test species that are usually different from the species of concern, a mathematical adjustment to the TRVs has often been performed in the past (e.g., Sample, et al., 1996) using a power function of the ratio of body weights. This practice is often referred to as allometric scaling. Alternately, uncertainty factors have also been used to account for the differences in species' sensitivities to chemicals. However, in recent years, these practices have been discouraged by most scientific and regulatory groups. Recent reviews of these practices (e.g., EPA, 2008; Allard, et al., 2009) have concluded that the use of allometric scaling of TRVs does not reflect a sound application of toxicological or ecological risk practices because supporting data for this practice are limited, and the ratio relationships used for the mathematical conversions were developed based on acute (rather than chronic) toxicity data. These reviews further conclude that uncertainty factors based on an arbitrary multiplier should not be used without a scientific basis for their application (Allard, et al., 2009). Therefore, the use of toxicity data without adjustments as reported in the literature is regarded as the most technically sound approach and is adopted for this SLERA. The TRVs used for this SLERA are summarized in Tables 4-1 and 4-2 for mammals and birds, respectively.

Exposure rate TRVs provide a reference point for the comparison of toxicological effects upon exposure to a contaminant and are compared against calculated receptor doses. TRVs are not used for evaluating community-based receptors such as plants or invertebrates.

5.0 Risk Characterization

The risk characterization phase integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is a determination of the likelihood, severity, and characteristics of adverse effects to environmental stressors present at a site. Qualitative and semiquantitative approaches were used to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to COPECs. Because potential adverse affects to terrestrial and aquatic plants and invertebrates have been qualitatively assessed during the initial COPEC screening step, the risk characterization focuses on potential impacts to assessment receptors (Section 2.3).

For the semiquantitative predictive assessment, TRVs and exposure rates have been calculated and are used to generate hazard quotients (HQ) (Wentsel, et al., 1996). HQs are calculated by summing intake doses across all exposure pathways for each chemical for a given receptor and dividing by the TRV. Given the inherent uncertainties associated with the input values, HQs are rounded in this SLERA to a single significant figure for values below 10, and a whole number for values greater than 10. HQs for those chemicals that have a similar mode of toxicological action are typically summed to account for cumulative effects; however, no groups of COPECs with similar toxicity mechanisms were identified for this SLERA, and HQs for multiple chemicals were not summed. HQs are a means of estimating the potential for adverse effects to organisms at a contaminated site, and for assessing the potential that toxicological effects will occur among site receptors.

5.1 Predictive Risk Estimation for Terrestrial and Aquatic Wildlife

The risk estimation was performed through a series of quantitative HQ calculations that compare receptor-specific exposure values with TRVs. The HQs are compared to HQ guidelines for assessing the risk posed from contaminants. HQs less than or equal to 1 represent no probable risk, HQs from 1 up to but less than 10 represent a low potential for environmental effects, HQs from 10 up to but less than 100 represent a significant potential that effects could result from greater exposure, and HQs greater than 100 represent the highest potential for expected effects (Wentsel, et al., 1996). It should be noted that OEPA considers HQs greater than 1 to be potentially significant. It should also be noted that HQs are not measured of risk, are not population-based statistics, and are not linearly scaled statistics. Therefore, an HQ above 1, even exceedingly so, does not definitively indicate that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Tannenbaum, 2005; Bartell, 1996).

Table 5-1 summarizes the NOAEL and LOAEL-based HQs for the eight evaluated assessment receptors. Only thallium had an HQ greater than 1 when rounded for any receptor species. The HQ for thallium did not exceed 10 for the deer mouse (HQ = 5.95) and only slightly exceeded 10 (HQ = 13.4) for the short-tailed shrew. The LOAEL-based HQ for thallium did not exceed 1 when rounded for either receptor. Therefore, thallium is considered to have a low potential for adverse effects. Thallium was detected at concentrations greater than its BSC of 1.3 mg/kg in 11 out of 40 soil samples. However, all 11 of these detections were from the 1996 historical sampling event. Of the 15 soil samples collected during the most recent sampling event in 2009, only 8 had detectable concentrations of thallium. The MDC of these eight samples was 0.47 mg/kg, which is well below the thallium BSC of 1.3 mg/kg and ESV of 1 mg/kg. The apparent reason for the reported exceedances in the 1996 samples is that they were analyzed using inductively coupled plasma spectrometry (ICP) without mass spectrometry (MS). The 2009 samples used the combined ICP/MS method, which attained much lower reporting limits. False positives are common using ICP alone. It is likely that the reported detections among the 1996 samples were all false positives.

Because the 2009 sample locations overlap the same general area as the 1996 samples, thallium concentrations are determined not to be elevated at AP2, and this chemical is not recommended for further evaluation.

5.2 Uncertainty Analysis

A number of factors contribute to the overall variability and uncertainty inherent in ecological risk assessments. Variability is due primarily to measurement error. Laboratory media analyses and receptor study design are the major sources of this kind of error. Uncertainty, on the other hand, is associated primarily with deficiency or irrelevancy of effects, exposure, or habitat data to actual ecological conditions at the site. Species physiology, feeding patterns, and nesting behavior are poorly predictable; therefore, all toxicity information derived from toxicity testing, field studies, or observation have uncertainties associated with them. Laboratory studies conducted to obtain site-specific, measured information often suffer from poor relevance to the actual exposure and uptake conditions on site (i.e., bioavailability, exposure, assimilation, etc., are generally greater under laboratory conditions as compared to field conditions). Calculating an estimated value based on a large number of assumptions is often the only alternative to the accurate, albeit costly, method of direct field or laboratory observation, measurement, or testing. Finally, habitat- or site-specific species may be misidentified if, for example, the observational assessment results are based on only one or even two brief site reconnaissance surveys.

The uncertainty analysis lists:

- Many of the major assumptions made for the SLERA; the direction of bias caused by each assumption, i.e., whether the uncertainty results in an overestimate or underestimate of risk
- The likely magnitude of impact as high, medium, low, or unknown
- Where possible, a description of recommendations for minimizing the identified uncertainties if the SLERA progresses to higher level assessment phases.

The most important uncertainties associated with this SLERA are discussed in the following subsections.

Assumptions of bioavailability. The assumption that COPECs are 100 percent bioavailable likely overestimates the potential for adverse effects. The duration that has lapsed since the contaminant release affects bioavailability as the contaminant becomes sequestered or transformed within the environmental media. Sequestration, transformation, and bioavailability are influenced by medium characteristics including pH, temperature, and organic carbon content.

Use of laboratory-derived or empirically estimated partitioning and transfer factors. The use of laboratory-derived or empirically estimated partitioning and transfer factors to predict COPEC concentrations in plants, invertebrates, prey species, and sediment likely overestimates potential risks. As discussed previously, the incorporation of COPECs into the food chain is influenced by the characteristics of the exposure medium, which likely differs from that used in the laboratory to derive partitioning and transfer factors.

Use of laboratory-derived toxicity reference values. The use of laboratory-derived TRVs may overestimate or underestimate the potential for adverse effects. The method of administration of the contaminant in the laboratory is significantly different than that experienced in the wild by the receptors.

Use of the HQ method to estimate risks to populations or communities. The calculation of HQs also introduces uncertainty. The following limitations associated with HQs (Tannenbaum, et al., 2003) are noted:

- HQs are not measures of risk.
- HQs are not population based.

- HQs are not linearly scaled.
- HQs are often produced that are unrealistically high and toxicologically impossible (e.g., estimated HQs greater than 1,000, although HQs generated for the AP2 SLERA do not appear to fall into this category).
- Trace soil concentrations of inorganic chemicals (including concentrations well below background levels) can lead to HQ threshold exceedances.

Sampling and Analytical Limitations. It is not possible to completely characterize the nature and extent of contamination on any site. Uncertainties arise from limits on the number of locations that can be sampled. The sampling protocol used at AP2, however, was designed to optimize efficiency of the sampling effort and reduce uncertainty by providing coverage of the affected area using historical data and site knowledge to focus on the most likely contaminated areas. This approach will bias potential soil contaminant concentrations higher than that for the entire region to provide a more conservative estimate of potential risk. The sampling and analytical data are considered sufficient to conclude that the potential for adverse impacts associated with chemicals present at the site is very low.

State-of-the-practice laboratory methods were used for analysis of the remedial investigation samples collected in 2009. SI samples, also used in this AP2 SLERA, were collected in 1996. The ICP method used for certain metals in the 1996 data resulted in relatively high reporting limits and tended to result in false positives when compared with the ICP/MS method used in the 2009 remedial investigation samples. Among these metals is thallium, which was a COPEC in AP2 soil. The MDC among the 2009 soil samples is only 0.939 mg/kg, which is less than the BSC. This means that based on the 2009 data, thallium would not be identified as a COPC. Therefore, use of the 1996 analytical data appears to have introduced a high bias to the resulting risk calculations.

Selection and Quantification of Chemicals of Potential Ecological Concern. Uncertainty associated with the processes used to identify COPECs and estimate EPCs arises from the following:

- Identifying background chemicals. Metals are judged to be present at concentrations comparable to background if the MDC does not exceed the BSC, or if statistical testing demonstrates that the site data and background data are drawn from the same population. Statistical testing of site data versus background was performed for this SLERA. Some organic chemicals, such as PAHs, may be considered to be anthropogenic background. The inclusion of ambient anthropogenic compounds in the SLERA may impart a conservative bias towards the risk assessment. However, PAHs were not identified as

COPECs at this site. Soil background values were compared with concentrations of metals detected in AP2 sediment in this SLERA. The use of soil background values for comparison to concentrations detected in sediment results in some added uncertainty to the SLERA. Naturally occurring levels of metals can differ in soil and sediment because the presence of metals in the sediment matrix can be affected by factors such as pH of the sediment and overlying water, oxidation/reduction conditions, sediment texture, presence/absence of organic matter, dissolved oxygen levels, etc. Although the concentrations of naturally occurring metals in soil and sediment may differ somewhat, soil background values can provide a reasonable point of reference for determining concentrations in sediment that may be associated with contamination and that warrant further consideration. Because concentrations in "true" background sediment may be higher or lower than their equivalent BSCs in soil, the direction of bias is unknown.

- Estimated EPCs are uncertain. For statistical purposes, if a constituent is positively identified at a site and has at least a single detection, all the samples with nondetects are assumed to have a value equal to half the reporting limit and are included in the data set, although identified for the ProUCL software (EPA, 2009) as nondetects. However, typical laboratory methods are able to detect concentrations of a chemical well below the reporting limit, or even half the reporting limit. Therefore, although the exact concentration of a nondetect chemical is unknown, the use of half the reporting limit as a surrogate concentration likely overestimates the actual concentration and introduces a conservative bias into the risk assessment. Computed 95 percent UCL values are only estimates of the actual UCLs associated with each data set. Examples of factors affecting the uncertainty of these estimates include the number of samples, proportion of nondetects, conformance with an assumed mathematical distribution, imprecision of laboratory data, elevated detection limits (from dilutions, matrix interference, etc.), and statistical methodology. For some data sets, the MDC was used for the UCL. Uncertainties associated with the statistical determination of EPCs for the COCs in each medium are as follows:

  - A limited number of samples may not completely characterize the site because they provide less information about the population from which they are drawn than do larger sample sets. Accordingly, small sets tend to have a greater variability, which results in the calculation of wide confidence intervals on the mean concentration and high EPCs. In some cases, the 95 percent UCL was greater than the MDC; thus, the MDC was chosen as the EPC. High confidence limits may introduce a conservative bias into the risk assessment.

  - Biased soil sampling is a common practice at contaminated sites for the purposes of identifying nature and extent of contamination and to reduce the potential for Type I errors when performing environmental investigations (i.e., concluding that a site is clean when it really is not). The biased sampling approach likely overestimates chemical concentrations, resulting in greater chemical concentrations and predicted risk. The AP2 sampling strategy was not strongly biased, however, and this uncertainty is considered minor for this particular SLERA.

- Laboratory analytical techniques have a degree of uncertainty associated with them. These uncertainties are documented by using data qualifiers to reflect the degree of certainty of measurement. For example, some data were estimated (e.g., J-qualified), while other data were rejected (i.e., R-qualified). The direction of bias is unclear.

The use of the 95 percent UCL as the EPC is likely to underestimate the EPC in 5 percent of the cases and overestimate exposure in 95 percent of cases, imparting an overall conservative bias to the risk assessment. It should be noted that some COPEC MDCs measured in sediment and surface water were used as EPCs due to the limited number of samples; an additional sampling effort could potentially reduce the hazard estimate.

6.0 Risk Summary and Conclusions

Chemicals detected in soil, surface water, and sediment were screened against conservative benchmark values and other criteria to identify COPECs in media present at AP2. Four chemicals in soil, four chemicals in surface water, and one chemical in sediment were identified as COPECs for further evaluation. A food chain model was used to evaluate the potential hazard associated with exposure to these chemicals by representative measurement receptors. Only thallium resulted in HQ values greater than 1. However, thallium is not considered to be a final COPEC for the site, because HQ values using conservative values did not exceed 10 when rounded, and a review of the data indicated that all elevated thallium detections originated from historical data collected over 15 years ago. The historical data were obtained using a laboratory method (ICP) that often results in false positives for thallium. Samples collected in 2009 and analyzed using updated laboratory methods (ICP/MS) did not exceed background or ecological screening values. Therefore, the potential for adverse ecological impacts is considered to be negligible at this site, and no chemicals are selected for further evaluation for protection of the environment at AP2.

7.0 References

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TABLES

Table 2-1

Plant Species Observed at Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Vegetation observed during June 2, 2009 site walk	
Acer negundo	box elder
Ailanthus altissima	tree of heaven
Alliaria petiolata	garlic mustard
Allium canadense	wild garlic
Allium vineale	field garlic
Ambrosia artemesiifolia	annual ragweed
Apocynum cannabinum	dogbane
Asclepias syriaca	common milkweed
Boehmeria cylindrica	small spike false nettle
Bromus inermis	smooth brome
Carex radiata	eastern star sedge
Carex tribuloides	blunt broom sedge
Carya ovata	shagbark hickory
Circaea lutetiana	southern broad-leaved enchanters nightshade
Cirsium arvense	creeping thistle
Convolvulus arvensis	hedge bindweed
Cornus drummondii	rough dogwood
Dactylis glomerata	orchard grass
Eleagnus angustifolia	autumn olive
Elymus sp.	wild rye
Erigeron annuus	fleabane
Eupatorium rugosum	white snakeroot
Eupatorium sp.	Joe pye weed
Fraxinus pennsylvanica	green ash
Galium aparine	cleavers
Galium asprellum	rough bedstraw
Glecoma hederacea	ground ivy
Gleditsia triacanthos	honeylocust
Glyceria striata	fowl manna grass
Hemerocallus fulva	daylily
Hesperis matronalis	dame's rocket
Impatiens capensis	jewelweed
Leersia virginica	white grass
Lonicera japonica	Japanese honeysuckle
Lysimachia nummularia	moneywort
Maclura pomifera	osage orange
Medicago lupulina	black medick
Melilotus sp.	sweet clover
Mentha piperita	peppermint
Onoclea sensibilis	sensitive fern
Oxalis stricta	sorrel
Parthenocissus quinquefolia	Virginia creeper

Table 2-1

Plant Species Observed at Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Pilea pumila	clearweed
Platanus occidentalis	sycamore
Poa compressa	Canada bluegrass
Polygonum virginianum	Virginia knotweed
Populus deltoides	cottonwood
Pyrus coronaria	crabapple
Quercus imbricaria	shingle oak
Quercus palustris	pin oak
Ranunculus sceleratus	cursed crowfoot
Ribes americanum	American currant
Rosa multiflora	multiflora rose
Rubus occidentalis	black raspberry
Salix nigra	black willow
Scutellaria lateriflora	mad dog skullcap
Teucrium canadense	Germander
Toxicodendron radicans	poison ivy
Tradescantia ohioensis	Ohio spiderwort
Trifolium repens	white clover
Ulmus americana	American elm
Verbesina alternifolia	wingstem
Viola canadensis	Canada violet
Viola cucullata	violet
Vitis aestivalis	summer grape
Vitis riparia	riverbank grape
Vegetation observed during September 9, 2009 site walk	
Acalypha rhomboidea	three-seeded mercury
Acer negundo	box-elder
Agrimonia parviflora	small-flowered groovebur
Ailanthus altissima	tree of heaven
Alliaria petiolata	garlic mustard
Ambrosia artemesiifolia	annual ragweed
Apocynum cannabinum	dogbane
Asclepias syriaca	common milkweed
Aster lateriflorus	calico aster
Aster sp.	aster
Boehmeria cylindrica	small spike false nettle
Bromus inermis	smooth brome
Carex bromoides	brome-like sedge
Carex radiata	eastern star sedge
Carex tribuloides	blunt broom sedge
Carya ovata	shagbark hickory
Catalpa speciosa	catalpa
Celtis occidentalis	hackberry
Cephalanthus occidentalis	common buttonbush

Table 2-1

Plant Species Observed at Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Cichorium intybus	chickory
Cinna arundinacea	wood reed grass
Circaea lutetiana	southern broad-leaved enchanters nightshade
Cirsium arvense	creeping thistle
Convolvulus arvensis	hedge bindweed
Cornus drummondii	rough dogwood
Dactylis glomerata	orchard grass
Eleagnus angustifolia	autumn olive
Elymus villosus	wild rye
Elymus virginicus	Virginia wild rye
Equisetum arvense	field horsetail
Erigeron annuus	fleabane
Eupatorium rugosum	white snakeroot
Euphorbia supina	milk purslane
Fraxinus pennsylvanica	green ash
Galium aparine	cleavers
Glecoma hederacea	ground ivy
Gleditsia triacanthos	honeylocust
Glyceria striata	fowl manna grass
Hemerocallus fulva	daylily
Impatiens capensis	jewelweed
Laportea canadensis	wood nettle
Leersia virginica	white grass
Leptoloma cognatum	fall witch grass
Lonicera japonica	Japanese honeysuckle
Lysimachia nummularia	moneywort
Maclura pomifera	osage orange
Medicago lupulina	black medick
Melilotus sp.	sweet clover
Onoclea sensibilis	sensitive fern
Oxalis stricta	sorrel
Panicum virgatum	switch grass
Parthenocissus quinquefolia	Virginia creeper
Pilea pumila	clearweed
Platanus occidentalis	sycamore
Poa compressa	Canada bluegrass
Polygonum hydropiper	marshpepper smartweed
Polygonum pennsylvanicum	Pennsylvania smartweed
Polygonum virginianum	Virginia knotweed
Populus deltoides	cottonwood
Pyrus coronaria	crabapple
Quercus imbricaria	shingle oak
Quercus palustris	pin oak

Table 2-1

Plant Species Observed at Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Ribes americanum	American currant
Riccia sp.	liverwort
Rosa multiflora	multiflora rose
Rubus occidentalis	black raspberry
Salix nigra	black willow
Scutellaria lateriflora	mad dog skullcap
Setaria faberi	foxtail grass
Setaria glauca	yellow foxtail
Solanum nigrum	black nightshade
Teucrium canadense	germander
Toxicodendron radicans	poison ivy
Trifolium repens	white clover
Triosteum aurantiacum	wild coffee
Tussilago farfara	coltsfoot
Ulmus americana	American elm
Verbena urticifolia	white vervain
Verbesina alternifolia	wingstem
Viola canadensis	Canada violet
Viola cucullata	violet
Vitis aestivalis	summer grape
Vitis riparia	riverbank grape

Table 2-2

Mammals Observed On Site and Likely to be Found in Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site [a]
Didelphidae	*Didelphis virginiana*	Virginia opossum	X
Talpidae	*Condylura cristata*	star-nosed mole (**T**)	
	Parascalops breweri	hairy-tailed mole	
	Scalopus aquaticus	Eastern mole	
Verspertilionidae	*Myotis keenii*	Keen's bat	
	M. lucifugus	little brown bat	
	M. sodalis	Indiana bat **(E*)**	
	Eptesicus fuscus	big brown bat	
	Lasionycteris noctivagans	silver-haired bat	
	Lasiurus borealis	red bat	
	L. cinereus	hoary bat	
	Nycticeius humeralis	evening bat	
	Pipistrellus subflavus	Eastern pipistrelle	
Leporidae	*Sylvilagus floridanus*	cottontail rabbit	X
Sciuridae	*Glaucomys volans*	Southern flying squirrel	
	Marmota monax	woodchuck	
	Sciurus carolinensis	gray squirrel	
	S. niger	fox squirrel	
	Spermophilus tridecemlineatus	thirteen-lined ground squirrel	
	Tamias striatus	Eastern chipmunk	
	Tamiasciurus hudsonicus	red squirrel	X
	Blarina brevicauda	short-tailed shrew	

Table 2-2

Mammals Observed On Site and Likely to be Found in Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site [a]
	Cryptotis parva	least shrew	
	Sorex cinereus	masked shrew	
Castoridae	*Castor canadensis*	beaver	
Cricetidae	*Microtus pennsylvanicus*	meadow vole	
	Mus musculus	house mouse	
	Ondatra zibethicus	muskrat	
	Peromyscus leucopus	white-footed mouse	
	P. maniculatus	deer mouse	
	Rattus norvegicus	Norway rat	
	Synaptomys cooperi	Southern bog lemming	
	Zapus hudsonius	meadow jumping mouse	
Procyonidae	*Procyon lotor*	raccoon	X
Mustelidae	*Mephitis mephitis*	striped skunk	
	Mustela frenata	long-tailed weasel	
	M. nivalis	least weasel	
	M. vison	mink	
	Taxidea taxus	Badger (**T**)	
Canidae	*Canis latrans*	coyote	
	Urocyon cinereoargenteus	gray fox	
	Vulpes vulpes	red fox	
Cervidae	*Odocoileus virginianus*	white-tailed deer	X

Mammals likely to be found in Erie County based on information presented in
Gottschang, J. L., 1981, *A Guide to the Mammals of Ohio*, Ohio State University Press, 176 pages.
T - Ohio threatened species.
E* - Federally endangered species.

[a] Shaw Site Reconnaissance, April 29, June 2, and September 9, 2009.

Table 2-3

Birds Observed On Site and/or Likely to be Found
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Ardeidae	*Ardea herodias*	great blue heron	(1) Regular visitor at ponds, streams, and ditches.
	Bublucus ibis	cattle egret (**E**)	(1) Rare visitor in short grass areas
	Butorides striatus	green heron	(1) Confirmed breeder, rare at ponds, streams.
	Casmerodius albus	great egret	(1) Regular visitor at ponds, streams, and ditches.
	Nycticorax nycticorax	black-crowned night heron (**T**)	(1) Regular visitor at ponds, streams, and ditches.
Anserinae	*Branta canadensis*	Canada goose	(1) Confirmed breeder; uncommon around ponds.
Anatinae	*Aix sponsa*	Wood duck	(1) Confirmed breeder, uncommon around ponds.
	Anas discors	blue-winged teal	Confirmed and/or probable breeder in county.
	A. platyrhynchos	mallard	(1) Confirmed breeder, uncommon at ponds, streams.
	A. rubripes	American black duck	(1) Possible breeder, rare at ponds, streams, ditches.
Merginae	*Lophodytes cucullatus*	hooded merganser	Confirmed and/or probable breeder in county.
Accipitrinae	*Accipiter striatus*	sharp-shinned hawk	Confirmed and/or probable breeder in county.
Buteoninae	*Buteo jamaicensis*	red-tailed hawk	Confirmed and/or probable breeder in county.
	B. lineatus	red-shouldered hawk	Confirmed and/or probable breeder in county.
	B. platypterus	broad-winged hawk	Confirmed and/or probable breeder in county.
	Haliaeetus leucocephalus	bald eagle (**T**)	Confirmed and/or probable breeder in county.
Anatidae	*Cygnus buccinator*	Trumpeter swan (**E**)	(1) Rare migrant seen flying toward lake.
Falconinae	*Falco sparverius*	American kestrel	Confirmed and/or probable breeder in county.
Phasianidae	*Colinus virginianus*	Northern bobwhite quail	Confirmed and/or probable breeder in county.
	Phasianus colchicus	ring-necked pheasant	Confirmed and/or probable breeder in county.
Rallidae	*Gallinula chloropus*	common moorhen	Confirmed and/or probable breeder in county.
	Porzana carolina	Sora	Confirmed and/or probable breeder in county.
Cathartidae	*Cathartes aura*	turkey vulture	Possible breeder in county.

Table 2-3

Birds Observed On Site and/or Likely to be Found
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Charadriidae	*Charadrius vociferus*	killdeer	Confirmed and/or probable breeder in county.
Scolopacidae	*Actitis macularia*	spotted sandpiper	Confirmed and/or probable breeder in county.
	Bartramia longicauda	upland sandpiper (**T**)	(1) Confirmed breeder, rare in grassy areas.
	Gallinago gallinago	common snipe	Confirmed and/or probable breeder in county.
	Scolopax minor	American woodcock	(1) Confirmed breeder, uncommon in moist woodlots.
Larinae	*Larus argentatus*	herring gull	(1) Regular visitor.
	L. delawarensis	ring-billed gull	(1) Regular visitor.
Columbidae	*Columba livia*	rock dove	(1) Confirmed breeder, very common.
	Zenaida macroura	mourning dove	(1) Confirmed breeder, very common.
Cuculidae	*Coccyzus americanus*	yellow-billed cuckoo	(1)(2*) Confirmed breeder, uncommon in woodlots, shrubs.
	C. erythropthalmus	black-billed cuckoo	(1) Probable breeder, rare in woodlots & shruby areas.
Tytonidae	*Bubo virginianus*	great horned owl	(1)(2) Confirmed breeder, uncommon in woodlots.
	Otus asio	Eastern screech-owl	(1) Confirmed breeder, common in woodlots, shrubs.
	Strix varia	barred owl	Confirmed and/or probable breeder in county.
Caprimulgidae	*Chordeiles minor*	common nighthawk	(1) Possible breeder, rare.
Apodidae	*Chaetura pelagica*	chimney swift	(1) Confirmed breeder, uncommon.
Trochilidae	*Archilochus colubris*	ruby-throated hummingbird	(1) Confirmed breeder, uncommon in woodlots, shrubs.
Alcedinidae	*Ceryle alcyon*	belted kingfisher	(1) Confirmed breeder, rare around ponds, streams.

Table 2-3

Birds Observed On Site and/or Likely to be Found
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Picidae	*Colaptes auratus*	Northern flicker	(1) Confirmed breeder, common in woodlots.
	Dryocopus pileatus	pileated woodpecker	Confirmed and/or probable breeder in county.
	Melanerpes carolinus	red-bellied woodpecker	(1) (2*) Confirmed breeder, common in mature woods.
	M. erythrocephalus	red-headed woodpecker	(1) Confirmed breeder, uncommon in mature woods.
	Picoides pubescens	downy woodpecker	(1)(2*) Confirmed breeder, common in woodlots.
	P. villosus	*hairy woodpecker*	(1) Confirmed breeder, uncommon in large woodlots.
Tyrannidae	*Contopus virens*	Eastern wood-pewee	(1)(2*) Confirmed breeder, very common in large woodlots.
	Empidonax alnorum	alder flycatcher	(1) Possible breeder, rare in shrubby wet areas.
	E. minimus	least flycatcher (**T**)	(1) Probable breeder, rare in shrubby areas.
	E. traillii	willow flycatcher	(1) Confirmed breeder, very common in shrubby areas.
	E. virescens	Acadian flycatcher	(1) Confirmed breeder, uncommon in mature woodlots.
	Myiarchus crinitus	great crested flycatcher	(1) Confirmed breeder, common in large woodlots.
	Sayornis phoebe	Eastern phoebe	(1) (2*) Confirmed breeder, common near stream bridges.
	Tyrannus tyrannus	Eastern kingbird	(1) Confirmed breeder, very common - open shrub area.
Alaudidae	*Eremophila alpestris*	horned lark	(1) Probable breeder, rare in grassland, cultiv. fields.
Hirundinidae	*Hirundo pyrrhonota*	cliff swallow	Confirmed and/or probable breeder in county.
	H. rustica	barn swallow	(1) Confirmed breeder, very common near vacant bldgs.
	Progne subis	purple martin	(1) Probable breeder, rare.
	Riparia riparia	bank swallow	(1) Rare migrant or visitor.
	Stelgidopteryx seripennis	Northern rough-winged swallow	(1) Confirmed breeder, rare along streams, ditches.
	Tachycineta bicolor	tree swallow	(1) Confirmed breeder, rare around ponds.

Table 2-3

Birds Observed On Site and/or Likely to be Found
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Corvidae	*Corvus brachyrhynchos*	American crow	(1)(2) Confirmed breeder, very common in woodlots.
	Cyanocitta cristata	blue jay	(1)(2*) Confirmed breeder, abundant in woods.
Paridae	*Parus atricapillus*	black-capped chickadee	(1) Confirmed breeder, common in woodlots.
	P. bicolor	tufted titmouse	(1)(2) Confirmed breeder, common in woodlots.
Sittidae	*Sitta carolinensis*	white-breasted nuthatch	(1) Confirmed breeder, uncommon in woodlots.
Troglodytidae	*Cistothorus palustris*	marsh wren	(1) Possible breeder, rare in wetlands with cattails.
	C. platensis	sedge wren	(1) Confirmed breeder, common in old grassy fields.
	Thryothorus ludovicianus	Carolina wren	(1) Probable breeder, rare in shrubby areas & woodlots.
	Troglodytes aedon	house wren	(1)(2*) Confirmed breeder, abundant in shrubby areas.
	T. troglodytes	winter wren	(1) Rare migrant.
Mimidae	*Dumetella carolinensis*	gray catbird	(1)(2*) Confirmed breeder, abundant in shrubby areas.
	Mimus polyglottos	Northern mockingbird	(1) Confirmed breeder, rare in shrubby areas.
	Toxostoma rufum	brown thrasher	(1) Confirmed breeder, common in shrubby areas.
Turdidae	*Catharus fuscescens*	veery	(1) Confirmed breeder, uncommon in large woodlots.
	Hylocichla mustelina	wood thrush	(1)(2) Confirmed breeder, very common in large woodlots.
	Sialia sialis	Eastern bluebird	(1) Confirmed breeder, common in openfields & edges.
	Turdus migratorius	American robin	(1)(2*) Confirmed breeder, abundant everywhere.
Sylviidae	*Polioptila caerulea*	blue-gray gnatcatcher	(1)(2*) Confirmed breeder, uncommon in woodlots.
	Regulus calendula	ruby-crowned kinglet	(1) Rare migrant.
Bombycillidae	*Bombycilla cedrorum*	cedar waxwing	(1) Confirmed breeder, very common everywhere.
Sturnidae	*Sturnus vulgaris*	European starling	(1) Confirmed breeder, abundant everywhere.

Table 2-3

Birds Observed On Site and/or Likely to be Found
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Vireonidae	*Vireo bellii*	Bell's vireo	Confirmed and/or probable breeder in county.
	V. flavifrons	yellow-throated vireo	(1)(2*) Confirmed breeder, uncommon in mature woodlots.
	V. gilvus	warbling vireo	(1) Confirmed breeder, common in large woodlots.
	V. griseus	white-eyed vireo	(1) Confirmed breeder, uncommon in shrubby areas.
	V. olivaceus	red-eyed vireo	(1)(2*) Confirmed breeder, very common in woodlots.
Parulidae	*Dendroica cerulea*	cerulean warbler	(1) Possible breeder, rare in mature woodlots.
	D. dominica	yellow-throated warbler	(1) Confirmed and/or probable breeder in county.
	D. pensylvanica	chestnut-sided warbler	(1) Probable breeder, uncommon in shrubby areas.
	D. petechia	yellow warbler	(1) Confirmed breeder, abundant in shrubby areas.
	D. virens	*black-throated green warbler*	(1) Possible breeder, rare in mature woodlots.
	Geothylpis trichas	common yellowthroat	(1) Confirmed breeder, abundant in shrub areas, fields.
	Icteria virens	yellow-breasted chat	(1) Confirmed breeder, uncommon in shrubby areas.
	Mniotilta varia	black and white warbler	(1) Possible breeder, rare in mature woodlots.
	Oporornis formosus	Kentucky warbler	(1) Possible breeder, rare in mature woodlots.
	Protonotaria citrea	prothonotary warbler	Confirmed and/or probable breeder in county.
	Seiurus aurocapillus	overbird	(1) Probable breeder, rare in mature woodlots.
	S. motacilla	Louisiana waterthrush	Confirmed and/or probable breeder in county.
	Setophaga ruticilla	American redstart	(1) Probable breeder, rare in shrubby areas & woodlots.
	Vermivora leucobronchialis	Brewster's warbler	(1) Possible breeder, rare in shrubby areas and edges.
	V. pinus	blue-winged warbler	(1) Confirmed breeder, common in shrubby areas.
	Wilsonia citrina	hooded warbler	Confirmed and/or probable breeder in county.

Table 2-3

Birds Observed On Site and/or Likely to be Found
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Icteridae	*Agelaius phoeniceus*	red-winged blackbird	(1) Confirmed breeder, abund. in grasslands, streams.
	Dolichonyx oryzivorus	bobolink	(1) Confirmed breeder, uncommon in grasslands.
	Icterus galbula	Northern oriole	(1) Confirmed breeder, uncommon in open woods.
	I. spurius	orchard oriole	(1) Confirmed breeder, common in open woods & edges.
	Molothrus ater	brown-headed cowbird	(1)(2) Confirmed breeder, abundant everywhere.
	Quiscalus quiscula	common grackle	(1) Confirmed breeder, abundant everywhere.
	Sturnella magna	Eastern meadowlark	(1) Confirmed breeder, common in grasslands.
Ploceidae	*Passer domesticus*	house sparrow	(1) Confirmed breeder, uncommon near buildings.
Thraupidae	*Piranga olivacea*	scarlet tanager	(1)(2*) Possible breeder, rare on open woods.
	P. ruba ruba	summer tanager	(1) Confirmed breeder, common in mature woodlots.
Fringillidae	*Ammodramus henslowii*	Henslow's sparrow	(1) Probable breeder, rare in old fields.
	A. savannarum	grasshopper sparrow	(1) Confirmed breeder, common in grasslands.
	Cardinalis cardinalis	Northern cardinal	(1)(2*) Confirmed breeder, abundant everywhere.
	Carduelis tristis	American goldfinch	(1)(2*) Confirmed breeder, abundant in shrubby areas.
	Carpodacus mexicanus	house finch	(1) Confirmed breeder, uncommon around buildings.
	Melospiza georgiana	swamp sparrow	(1) Confirmed breeder, rare in wet fields and ditches.
	M. melodia	song sparrow	(1) Confirmed breeder, abundant everywhere.
	Passerculus sandwichensis	Savannah sparrow	(1) Confirmed breeder, common in grasslands.
	Passerina cyanea	indigo bunting	(1) Confirmed breeder, abundant everywhere.
	Pheucticus ludovicianus	rose-breasted grosbeak	(1) Confirmed breeder, common in woodlots & edges.
	Pipilo erythrophthalmus	Eastern towhee	(1)(2) Confirmed breeder, very common in woodlots, edges.

Table 2-3

Birds Observed On Site and/or Likely to be Found
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
	Pooecetes gramineus	vesper sparrow	(1) Confirmed breeder, uncommon in grassland & fields.
	Spiza amercana	dickcissel	Confirmed and/or probable breeder in county.
	Spizella passerina	chipping sparrow	(1) Confirmed breeder, common in open woods & lawns.
	S. pusilla	field sparrow	(1) Confirmed breeder, abundant in grasslands, shrubs.
	Zonotrichia albicollis	white-throated sparrow	(1) Late migrant, rare.

[a] Family names from Peterson, R. T., 1947, *A Field Guide to the Birds*, Sponsored by the National Audubon Society, Houghton Mifflin Company, Boston, Massachusetts.

[b] Peterjohn, B. G. and D. L. Rice, 1991, *The Ohio Breeding Bird Atlas*, The Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio, 416 pages.

[c] E - Ohio Endangered species; T - Ohio Threatened species.

Observation References:

(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).

(2) Observed during Shaw Site Reconnaissance on April 29, June 2, and/or September 9, 2009. An asterisk (*) indicates the species was detected during the June site visit, and is likely using the site for breeding.

Table 2-4

Reptiles Observed On Site and Likely to be Found in Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site
Chelydridae	*Chelydra serpentina*	snapping turtle	(1)
Kinosternidae	*Sternotherus odoratus*	musk turtle	
Emydidae	*Chrysemys picta*	painted turtle	(1)
	Emys blandingii	Blanding's turtle	(1)
	Terrapene carolina	box turtle	(1)
Colubridae	*Elaphe vulpina*	fox snake	(1)
	Heterodon platyrhinos	hog-nosed snake	
	Nerodia septemvittata	queen snake	
	N. sipedon sipedon	water snake	(1)
	Opheodrys vernalis	green snake	(1)
	Storeria dekayi	Dekay's brown snake	(1)
	Thamnophis butleri	Butler's garter snake	(1)
	T. sauritus	ribbon snake	
	T. sirtalis	common garter snake	(1)

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America*, Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Pfingsten, R. A. and F. L. Downs (eds.), 1989, *Salamanders of Ohio*, Ohio Biological Survey Bulletin, New Series, Vol. 7, No. 2, 315 pages, 29 pls.

Wright, A. H. and A. A. Wright, 1957, *Handbook of Snakes of the United States and Canada*, Volumes I and II, Comstock Publishing Associates, Ithaca and London, 1105 pages.

Reference for on-site observation:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1995).

Table 2-5

Amphibians Observed On Site and Likely to be Found in Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site
Ambystomatidae	*Ambystoma texanum*	smallmouth salamander	(1)
	Plethodon cinereus	redback salamander	(1)
Bufonidae	*Bufo americanus*	American toad	(1)
Hylidae	*Acris gryllus*	cricket frog	(1)
	Hyla versicolor	gray treefrog	(1)
	Pseudacris crucifer	spring peeper	(1)
	P. triseriata	chorus frog	(1)
Ranidae	*Rana catesbeiana*	bullfrog	(1)
	R. clamitans	green frog	(1)
	R. pipiens	Northern leopard frog	(1)

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America* , Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Pfingsten, R. A. and F. L. Downs (eds.), 1989, *Salamanders of Ohio* , Ohio Biological Survey Bulletin, New Series, Vol. 7, No. 2, 315 pages, 29 pls.

Reference for on-site observation:

(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1995).

Table 2-6

Fish Species Observed at Plum Brook Ordnance Works
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site	Habitat[a]
Catostomidae	*Catostomus commersoni*	white sucker	(1)	lotic
Centrarchidae	*Lepomis cyanellus*	green sunfish	(1)	lentic, lotic
	Lepomis species	green sunfish hybrid	(1)	lentic
	L. gibbosus	pumpkinseed sunfish	(1)	lentic
	L. macrochirus	bluegill	(1)	lentic
	Micropterus salmoides	largemouth bass	(1)	lentic
Cyprinidae	*Campostoma anomalum*	central stoneroller	(1)	lotic
	Carassius auratus	goldfish	(1)	lentic
	Luxilus chrysocephalus	striped shiner	(1)	lotic
	Pimephales notatus	bluntnose minnow	(1)	lotic
	P. promelas	fathead minnow	(1)	lotic
	Semotilus atromaculatus	creek chub	(1)	lotic
Gasterosteidae	*Culaea inconstans*	brook stickleback	(1)	lotic
Ichtaluridae	*Ameiurus melas*	black bullhead	(1)	lentic

[a] Lotic - Flowing water such as brooks, ditches, and creeks.
Lentic - Still waters such as ponds and lakes.

Reference for on-site observation:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).

Table 2-7

Summary of Samples Evaluated in the Ecological Risk Assessment
Power House 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number		Sample Date	Depth (ft)	Analyses
Soil Samples					
ASH PIT 2-SB01	AP0100	REG	15-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0103	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB03	AP0108	REG	18-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB04	AP0111	REG	18-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB05	AP0114	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB06	AP0117	REG	15-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0120	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0121	FD	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
ASH PIT 2-SB08	AP0125	REG	16-Jan-09	0 - 1	Exp, Metals, PCB, SVOC
PH2SO01	4010	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO02	4030	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO03	4050	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4070	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO05	4090	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO06	4110	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO07	4130	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4150	REG	28-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO09	4170	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO10	4190	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO11	4210	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO12	4230	REG	29-Sep-96	0 - 0.5	Cyanide, Metals, Pest, PCB, SVOC, VOC
ASH PIT 2-SB01	AP0101	REG	15-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0104	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB02	AP0105	FD	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB03	AP0109	REG	18-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB04	AP0112	REG	18-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB05	AP0115	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB06	AP0118	REG	15-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB07	AP0123	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
ASH PIT 2-SB08	AP0126	REG	16-Jan-09	3 - 5	Exp, Metals, PCB, SVOC
PH2SO01	4020	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO02	4040	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO03	4060	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4080	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO04	4081	FD	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO05	4100	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO06	4120	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO07	4140	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4160	REG	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO08	4161	FD	28-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO09	4180	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO10	4200	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO11	4220	REG	29-Sep-96	2 - 3	Cyanide, Metals, Pest, PCB, SVOC, VOC
PH2SO12	4240	REG	29-Sep-96	3 - 4	Cyanide, Metals, Pest, PCB, SVOC, VOC
Sediment Samples					
ASH PIT 2-SD01	AP1000	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD02	AP1001	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD03	AP1002	REG	24-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD04	AP1003	REG	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD04	AP1004	FD	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
ASH PIT 2-SD05	AP1006	REG	25-May-09	0 - 0.5	Exp, Metals, PCB, SVOC
Surface Water Samples					
AP2-SW01	AP2000	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW02	AP2001	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW03	AP2002	REG	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW03	AP2003	FD	24-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW04	AP2005	REG	25-May-09	NA	Exp, Metals, PCB, SVOC
AP2-SW05	AP2006	REG	25-May-09	NA	Exp, Metals, PCB, SVOC

FD - Field duplicate.
Exp - Explosives.
NA - Not applicable.
Pest - Organochlorine pesticides.
PCB - Polychlorinated biphenyls.
SVOC - Semivolatile organic compounds.
VOC - Volatile organic compounds.

Table 2-8

Statistical Summary and COPEC Selection of Chemicals Detected in Total Soil (0 to 6 Feet bgs)
Power House 2 Ash Pits, 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)	ESV [b] (mg/kg)	COPEC? [c,d]	Distribution [e]	95% UCL [e] (mg/kg)	EPC [f] (mg/kg)	EPC 0-1' soil depth [g] (mg/kg)
Inorganics																
Aluminum	40 / 40	100	3.52E+03		1.50E+04		1.75E+00	3.57E+01	8.55E+03	1.55E+04	pH Dependent	N (b)			---	---
Antimony	15 / 40	38	2.27E-01	J	9.58E-01		4.39E-01	1.07E+01	2.62E+00	9.30E+00	0.27	N (b)			---	---
Arsenic	40 / 40	100	3.60E+00		2.68E+01	J	8.77E-01	1.80E+00	1.03E+01	3.65E+01	18	N (b)			---	---
Barium	40 / 40	100	2.99E+01		1.41E+02		1.75E-01	3.57E+01	7.98E+01	8.26E+02	330	N (a)			---	---
Beryllium	33 / 40	83	5.90E-01		1.69E+01	J	1.75E-01	8.90E-01	4.23E+00	1.00E+00	21	N (a)			---	---
Cadmium	8 / 40	20	2.93E-01	J	1.40E+00		4.39E-01	8.90E-01	3.76E-01		0.36	Y	Normal	5.32E-01	5.32E-01	6.50E-01
Calcium	40 / 40	100	3.51E+02		4.72E+04	J	4.39E+00	8.91E+02	6.48E+03	5.23E+04	Nutrient	N (c)			---	---
Chromium	40 / 40	100	1.90E+00		2.21E+01	J	4.39E-01	1.80E+00	1.14E+01	2.90E+01	26	N (a)			---	---
Cobalt	40 / 40	100	3.90E+00	J	2.47E+01		3.51E-01	8.90E+00	1.15E+01	1.16E+02	13	N (b)			---	---
Copper	40 / 40	100	8.30E+00		3.86E+01		4.39E-01	4.50E+00	2.11E+01	5.62E+01	28	N (b)			---	---
Iron	40 / 40	100	1.05E+04		1.09E+05		1.93E+00	3.79E+01	3.35E+04	2.34E+05	pH Dependent	N (b)			---	---
Lead	40 / 40	100	4.64E+00		5.07E+01		3.30E-01	5.99E-01	1.56E+01	4.86E+01	11	N (d)			---	---
Magnesium	40 / 40	100	3.12E+02	J	1.01E+04	J	1.75E+00	8.91E+02	2.43E+03	1.04E+04	Nutrient	N (c)			---	---
Manganese	40 / 40	100	8.21E+01	J	1.56E+03	J	1.75E-01	2.70E+00	3.50E+02	3.51E+03	220	N (b)			---	---
Mercury	26 / 40	65	1.12E-02	J	1.40E-01		1.94E-02	5.90E-02	4.27E-02	8.50E-02	0.00051	Y	Gamma	5.28E-02	5.28E-02	7.96E-02
Nickel	40 / 40	100	1.05E+01		4.19E+01		2.63E-01	7.10E+00	2.42E+01	5.51E+01	38	N (b)			---	---
Potassium	39 / 40	98	3.23E+02		2.26E+03		2.19E+01	8.91E+02	9.77E+02	3.39E+03	Nutrient	N (c)			---	---
Selenium	21 / 40	53	6.40E-01		2.60E+00		5.40E-01	1.20E+00	9.12E-01	2.00E+00	0.52	Y	Normal	1.22E+00	1.22E+00	1.66E+00
Silver	5 / 40	13	1.20E+00		2.00E+00		4.39E-01	1.80E+00	6.25E-01	1.11E+01	4.2	N (a)			---	---
Sodium	16 / 40	40	1.84E+01		1.19E+02		8.77E+00	8.91E+02	2.24E+02		Nutrient	N (c)			---	---
Thallium	21 / 40	53	3.00E-01	J	8.50E+00		4.39E-01	1.80E+00	1.26E+00	1.30E+00	1	Y	Approx. Gamma	1.67E+00	1.67E+00	1.68E+00
Vanadium	39 / 40	98	7.50E+00		2.69E+01		1.75E-01	8.90E+00	1.69E+01	4.09E+01	7.8	N (b)			---	---
Zinc	40 / 40	100	3.53E+01		1.27E+02		2.19E+00	3.60E+00	6.71E+01	3.22E+02	46	N (b)			---	---
Cyanide																
Cyanide, total	3 / 24	13	7.10E-01		9.30E-01		5.40E-01	8.90E-01	3.92E-01		1.33	N (a)			---	---
Polychlorinated biphenyls (PCB)																
Aroclor 1016	1 / 40	3	5.25E-01	J	5.25E-01	J	3.60E-02	5.90E-02	3.44E-02		0.371	N (e)			---	---
Aroclor 1260	1 / 40	3	1.62E-02	J	1.62E-02	J	3.60E-02	5.90E-02	2.18E-02		0.371	N (a)			---	---
Organochlorine Pesticides																
DDE, 4,4'-	7 / 24	29	2.40E-03		7.40E-03		1.80E-03	3.00E-03	2.15E-03		0.021	N (a)			---	---
DDT, 4,4'-	8 / 24	33	2.60E-03		7.10E-03		1.80E-03	3.00E-03	2.22E-03		0.021	N (a)			---	---
Methoxychlor	2 / 24	8	6.10E-03		6.50E-03		3.60E-03	5.90E-03	2.53E-03		0.0199	N (a)			---	---
Semivolatile Organic Compounds																
Acenaphthylene	1 / 40	3	1.10E-01	J	1.10E-01	J	3.60E-01	5.90E-01	2.16E-01		29	N (a)			---	---
Anthracene	1 / 40	3	5.80E-02	J	5.80E-02	J	3.60E-01	5.90E-01	2.15E-01		29	N (a)			---	---
Benzo(a)anthracene	5 / 40	13	3.07E-02		1.30E-01	J	3.60E-01	5.90E-01	1.98E-01		1.1	N (a)			---	---
Benzo(a)pyrene	3 / 40	8	8.44E-02	J	1.70E-01	J	3.60E-01	5.90E-01	2.10E-01		1.1	N (a)			---	---
Benzo(b)fluoranthene	2 / 40	5	1.30E-01	J	1.60E-01	J	3.60E-01	5.90E-01	2.15E-01		1.1	N (a)			---	---
Benzo(ghi)perylene	1 / 40	3	1.30E-01	J	1.30E-01	J	3.60E-01	5.90E-01	2.16E-01		1.1	N (a)			---	---
Benzo(k)fluoranthene	1 / 40	3	2.30E-01	J	2.30E-01	J	3.60E-01	5.90E-01	2.19E-01		1.1	N (a)			---	---
Benzoic acid	2 / 16	13	6.22E-01		1.43E+00		3.80E-01	4.99E-01	3.14E-01		NSV	N (a)			---	---
Bis(2-ethylhexyl)phthalate	2 / 40	5	6.60E-02	J	9.50E-02	J	3.60E-01	5.90E-01	2.12E-01		0.925	N (a)			---	---
Chrysene	4 / 40	10	6.39E-02	J	1.60E-01	J	3.60E-01	5.90E-01	2.05E-01		1.1	N (a)			---	---
Di-n-butyl phthalate	2 / 40	5	6.60E-02	J	1.70E-01	J	3.60E-01	5.90E-01	2.15E-01		200	N (a)			---	---
Fluoranthene	8 / 40	20	5.99E-02	J	3.00E-01	J	3.60E-01	5.90E-01	1.96E-01		1.1	N (a)			---	---
Indeno(1,2,3-cd)pyrene	1 / 40	3	1.20E-01	J	1.20E-01	J	3.60E-01	5.90E-01	2.16E-01		1.1	N (a)			---	---
Naphthalene	3 / 40	8	4.44E-02	J	5.59E-02	J	3.60E-01	5.90E-01	2.06E-01		29	N (a)			---	---
Phenanthrene	4 / 40	10	6.30E-02	J	1.00E-01	J	3.60E-01	5.90E-01	2.03E-01		29	N (a)			---	---
Pyrene	8 / 40	20	4.40E-02	J	2.50E-01	J	3.60E-01	5.90E-01	1.90E-01		1.1	N (a)			---	---
Volatile Organic Compounds																
Acetone	4 / 24	17	1.30E-02	J	1.20E-01		2.20E-02	1.80E-01	4.49E-02		2.5	N (a)			---	---
Bromomethane	1 / 24	4	1.10E-03	J	1.10E-03	J	1.10E-02	8.90E-02	1.93E-02		0.235	N (a)			---	---
Methylene chloride	1 / 24	4	5.20E-02	J	5.20E-02	J	5.40E-03	4.50E-02	1.17E-02		4.05	N (a)			---	---
Toluene	2 / 24	8	1.10E-02		1.80E-02	J	5.40E-03	4.50E-02	9.91E-03		200	N (a)			---	---

Table 2-8

Statistical Summary and COPEC Selection of Chemicals Detected in Total Soil (0 to 6 Feet bgs)
Power House 2 Ash Pits, 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)	ESV [b] (mg/kg)	COPEC? [c,d]	Distribution [e]	95% UCL [e] (mg/kg)	EPC [f] (mg/kg)	EPC 0-1' soil depth [g] (mg/kg)
Xylenes, total	1 / 24	4	6.50E-03		6.50E-03		5.40E-03	4.50E-02	9.86E-03		10	N (a)			---	---

BSC - Background screening criterion.
COPEC - Chemical of potential ecological concern.
EPC - Exposure point concentration.
ESV - Ecological screening value.
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.
VQ - Validation qualifier.
NSV - No screening value.
UCL - Upper confidence limit.

[a] IT Corporation (IT), 1998, ***Site Investigation of Acid Areas***, Plum Brook Ordnance Works, Sandusky, Ohio, August.
[b] ESVs and their sources are in Appendix B.
[c] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
(d) = statistical test shows background and site data to be the same; see Appendix C.
(e) = infrequently detected (fewer than 5 percent of all samples)
[d] Y = Chemical is chosen as COPEC.
[e] 95% UCL determined using ProUCL Version 4.00.04 (EPA, 2009, ProUCL Version 4.00.04, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April, on line at http://www.epa.gov/esd/tsc/form.htm). UCLs are calculated only for chemicals selected as COPECs
[f] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.
[g] The EPC for the COPEC at the 0-1 foot soil depth range is used as the exposure concentration for some ecological receptors. See text for details.

Table 2-9

Statistical Summary and COPEC Selection of Chemicals Detected in Surface Water
Power House 2 Ash Pits
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of values, µg/L: Detected Conc Minimum	VQ	Detected Conc Maximum	VQ	Reporting Limits Minimum	Reporting Limits Maximum	Arithmetic Mean µg/L	ESV [a] µg/L	COPEC? [b,c]	Distribution [d]	95% UCL [d] µg/L	EPC [e] µg/L
Metals														
Aluminum	5 / 5	100	359		1030	J	200	200	6.01E+02	8.70E+01	Y	Normal	8.70E+02	8.70E+02
Barium	5 / 5	100	43.9		50.9	J	200	200	4.70E+01	4.00E+00	Y	Normal	4.97E+01	4.97E+01
Calcium	5 / 5	100	75900		80700		1000	1000	7.83E+04	Nutrient	N (b)			---
Cobalt	1 / 5	20	1.2	J	1.2	J	50	50	2.02E+01	2.30E+01	N (a)			---
Iron	5 / 5	100	376		1060		300	300	7.22E+02	1.00E+03	N (b)			---
Lead	2 / 5	40	2.9	J	2.9	J	5	10	2.66E+00	1.17E+00	Y	Nonparametric	2.87E+00	2.87E+00
Magnesium	5 / 5	100	19800		21400		5000	5000	2.08E+04	Nutrient	N (b)			---
Manganese	5 / 5	100	52.75		102		15	15	7.08E+01	1.20E+02	N (a)			---
Nickel	1 / 5	20	6.2	J	6.2	J	40	40	1.72E+01	2.90E+01	N (a)			---
Potassium	5 / 5	100	2900		4400	J	10000	20000	3.42E+03	Nutrient	N (b)			---
Sodium	5 / 5	100	30300		34800		10000	20000	3.26E+04	Nutrient	N (b)			---
Vanadium	5 / 5	100	1.65	JJ	3.1	J	50	50	2.23E+00	1.20E+01	N (a)			---
Zinc	5 / 5	100	8.1	J	12.4	J	20	20	1.06E+01	6.57E+01	N (a)			---
Semivolatile Organic Compounds														
Bis(2-ethylhexyl)phthalate	1 / 5	20	2	J	2	J	4.8	4.8	2.32E+00	1.20E-01	Y	Nonparametric	2.49E+00	2.00E+00

ESV - Ecological screening value.
EPC - Exposure point concentration.
COPEC - Chemical of potential ecological concern.
µg/L - Micrograms per liter.
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] ESVs and their sources are in Appendix B.
[b] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = essential nutrient.
[c] Y = Chemical is chosen as COPEC.
[u] 95% UCL determined using ProUCL Version 4.00.04 (EPA, 2009, ProUCL Version 4.00.04, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April, on line at http://www.epa.gov/esd/tsc/form.htm). UCLs are calculated only for chemicals selected as COPECs
[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

Table 2-10

Statistical Summary and COPEC Selection of Chemicals Detected in Sediment
Power House 2 Ash Pits, 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	ESV [b] mg/kg	COPC? [c,d]	Distribution [e]	95% UCL [e] (mg/kg)	EPC [f] mg/kg
Inorganics															
Aluminum	5 / 5	100	3.64E+03		7.42E+03		1.20E+01	1.50E+01	5.86E+03	1.55E+04	NSV	N (b)			---
Arsenic	5 / 5	100	3.90E+00		1.01E+01	J	4.75E-01	9.50E-01	6.35E+00	3.65E+01	9.79E+00	N (b)			---
Barium	5 / 5	100	2.28E+01		6.71E+01	J	1.20E+01	1.50E+01	4.63E+01	8.26E+02	NSV	N (b)			---
Beryllium	5 / 5	100	3.60E-01		5.60E-01		3.00E-01	3.60E-01	4.70E-01	1.00E+00	NSV	N (b)			---
Cadmium	4 / 5	80	2.40E-01	J	5.65E-01		2.40E-01	4.80E-01	3.35E-01	NA	9.90E-01	N (a)			---
Calcium	5 / 5	100	7.66E+03		2.70E+04		3.00E+02	3.60E+02	1.67E+04	5.23E+04	NSV	N (c)			---
Chromium	5 / 5	100	6.40E+00		1.17E+01		5.95E-01	7.30E-01	8.97E+00	2.90E+01	4.34E+01	N (a)			---
Cobalt	5 / 5	100	6.20E+00	J	1.20E+01		3.00E+00	3.60E+00	8.19E+00	1.16E+02	5.00E+01	N (a)			---
Copper	5 / 5	100	9.60E+00		2.21E+01		1.50E+00	1.80E+00	1.51E+01	5.62E+01	3.16E+01	N (b)			---
Iron	5 / 5	100	1.04E+04		3.91E+04	J	5.95E+00	1.20E+01	1.85E+04	2.34E+05	NSV	N (b)			---
Lead	5 / 5	100	7.90E+00		1.22E+01	JJ	5.95E+00	1.20E+01	9.65E+00	4.86E+01	3.58E+01	N (a)			---
Magnesium	5 / 5	100	1.95E+03		7.47E+03	J	3.00E+02	3.60E+02	5.08E+03	1.04E+04	NSV	N (c)			---
Manganese	5 / 5	100	1.27E+02		6.08E+02		9.90E-01	4.45E+00	2.90E+02	3.51E+03	4.60E+02	N (b)			---
Mercury	4 / 5	80	1.60E-02	J	2.50E-02	J	9.80E-02	1.20E-01	2.62E-02	8.50E-02	1.80E-01	N (a)			---
Nickel	5 / 5	100	1.57E+01		2.51E+01		2.40E+00	2.90E+00	1.81E+01	5.51E+01	2.27E+01	N (b)			---
Potassium	5 / 5	100	4.98E+02	J	1.66E+03		6.00E+02	1.50E+03	1.03E+03	3.39E+03	NSV	N (c)			---
Selenium	5 / 5	100	3.90E-01	J	1.00E+00	J	5.95E+00	1.20E+01	7.85E-01	2.00E+00	NSV	N (b)			---
Silver	1 / 5	20	8.30E-02	J	8.30E-02	J	5.95E-01	7.30E-01	2.79E-01	1.11E+01	5.00E-01	N (a)			---
Sodium	5 / 5	100	5.48E+01	J	1.64E+02	JJ	6.00E+02	1.50E+03	1.17E+02	NA	NSV	N (c)			---
Vanadium	5 / 5	100	9.40E+00		1.52E+01		3.00E+00	6.00E+00	1.26E+01	4.09E+01	NSV	N (b)			---
Zinc	5 / 5	100	2.70E+01	J	5.73E+01		1.20E+00	1.50E+00	4.06E+01	3.22E+02	1.21E+02	N (a)			---
Explosives															
2,4,6-Trinitrotoluene	1 / 5	20	6.47E-02	J	6.47E-02	J	1.55E-01	1.90E-01	8.14E-02		NSV	Y	Normal	9.22E-02	6.47E-02
Semivolatiles Organic Compounds															
Fluoranthene	2 / 5	40	5.25E-02	J	5.47E-02	J	2.05E-01	2.60E-01	8.49E-02		4.23E-01	N (a)			---

BSC - Background screening criterion. The soil BSC is used for sediment in this evaluation. See text for details.
COPEC - Chemical of potential ecological concern.
EPC - Exposure point concentration.
ESV - Ecological screening value.
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.
NSV - No screening value available.
VQ - Validation qualifier.

[a] Soil background screening concentrations are used for sediment. See text for details.
[b] ESVs and their sources are in Appendix B.
[c] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
[d] Y = Chemical is chosen as COPEC.
[e] 95% UCL determined using ProUCL Version 4.00.04 (EPA, 2009, ProUCL Version 4.00.04, Office of Research and Development, Technology Support Center Characterization and Monitoring Branch, Las Vegas, Nevada, April, on line at http://www.epa.gov/esd/tsc/form.htm). UCLs are calculated only for chemicals selected as COPECs.
[f] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

Table 3-1

Data Used to Model Exposure in the Indicator Wildlife Species
Power House 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Indicator Species	Class/ Order	Average Body Weight[a] (kg)	Average Home Range[a] (ha)	Dietary Intake[a] (kg[dw]/day)	Soil/Sed. Intake (kg[dw]/day)	Water Intake (L/day)[b]	Trophic Level	Dietary Composition[a] (percent)
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	0.0148	0.062	0.0028[d]	0.000056 (2%)	0.0022	Omnivore	Terr. Inverts. : 39 Plants: 61
Eastern cottontail *(Sylvilagus floridanus)*	Mammalia/ Lagomorpha	1.132	3.1	0.096[d]	0.006 (6.3%)	0.11	Herbivore	Plants: 100
Short-tailed shrew *(Blarina brevicauda)*	Mammalia/ Insectivora	0.015	0.39	0.0022[d]	0.00023 (10.4%)	0.0023	Insectivore	Terr. Inverts.: 100
White-tailed deer (*Odocoileus virginianus*)	Mammalia/ Artiodactyla	61[c]	518[c]	2.0[d]	0.04 (2%)	4	Herbivore	Plants: 100
Marsh wren (*Cistothorus palustris*)	Aves/ Passeriformes	0.01	0.054	0.0029[d]	0.000058 (2%)	0.0027	Insectivore	Terr. Inverts.: 100
Red-tailed hawk (*Buteo jamaicensis*)	Aves/ Falconiformes	0.957	842	0.057[d]	0.00114 (2%)	0.057	Carnivore	Rabbits: 25.3 Shrews: 25.3 Mice: 25.3 Birds: 24
Muskrat[e] (*Ondata zibethicus*)	Mammalia/ Rodentia	1.174	0.13	0.352	negligible	0.11	Herbivore	Aquatic plants: 100
Raccoon (*Procyon lotor*)	Mammalia/ Carnivora	5.1	156	0.26[d]	0.024 (9.4%) (assumed 50% soil and 50% sediment)	0.43	Omnivore	Aq. Inverts.: 21 Terr. Inverts.: 30 Mice: 5 Plants: 42 (50% terrestrial, 50% aquatic) Fish: 2

[a] From EPA (1993), except as noted.

[b] Allometric equations for mammals and birds from EPA (1993), as follows:

Mammals: WI (water ingestion; L/day) = 0.099 $Wt^{0.90}$ (kg), where Wt = body weight.

Birds: WI (L/day) = 0.059 $Wt^{0.67}$ (kg).

[c] Information is from *A Guide to the Mammals of Ohio* (Gottschang, 1981).

[d] Allometric equation for mammals: FI (kg/day) = 0.0687 $Wt^{0.822}$ for shrew, deer, and raccoon; FI (g/day) = 0.621 $Wt^{0.564}$ for rodents (deer mouse); and FI (g/day) = 0.577 $Wt^{0.727}$ for small herbivores (cottontail). Allometric equation for birds: FI (kg/day) = 0.0582 Wt0.651 (EPA, 1993), where FI = food ingestion (dry weight) and Wt = body weight. Allometric equations from EPA (1993).

[e] Exposure parameters obtained from OEPA-DERR (2008) Ecological Risk Assessment Guidance Document, Revised April 2008, On line: http://www.epa.ohio.gov/portals/30/rules/RR-031.pdf.

References

U.S. Environmental Protection Agency (EPA), 1993, Wildlife Exposure Factors Handbook, Vols. I and II, Office of Research and Development, Washington, DC, EPA/600/R-93/187a.

Table 3-2

Bioaccumulation Factors or Regression
Equations Utilized for the Soil-to-Plant and Sediment-to-Aquatic Plant Pathways
Power House 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

COPEC in Soil	EPA, 2005				Other		Regression	Recommended	Source
	Minimum BAF/BCF	Median BAF/BCF	90th Percentile BAF/BCF[b]	Maximum BAF/BCF	BAF/BCF (1)		Equation (2)	BAF/BCF	
Inorganics									
Cadmium	0.0087	0.59	3.3	23	0.35	a	ln (AGP)=0.546(ln[soil])-0.475	Regression Equation	EPA (2008), Table 4a
Mercury	0.0015	0.65	5.0	12	0.55	a	ln (AGP)=0.54(ln[soil])-1.00	Regression Equation	Efroymson et al. (2001)
Selenium	0.02	0.67	3	77	0.025	a	ln (AGP)=1.104(ln[soil])-0.677	Regression Equation	EPA (2008), Table 4a
Thallium	--	--	--	--	0.0022	d	--	0.0022	Baes (1984)
Nitroaromatics									
2,4,6-Trinitrotoluene	--	--	--	--	4.23	b	--	4.23	EPA (2008), Table 4a

Notes:
1. For inorganic chemicals without BAF/BCF data, BAF/BCFs were derived from the Baes et al. (1984) and IAEA (1994) data.
2. Efroymson, R.A., et. al., 2001, *Uptake of Inorganic Chemicals from Soil by Plant Leaves: Regressions of Field Data*, Environ. Tox. Chem., 20:2561-2571 for AGP (above ground plant tissue concentration) and Travis and Arms (1988) for BCF.

-- indicates that a BAF/BCF or regression equation is not available.

[a] Average of the vegetative and reproductive transfer factors presented in Baes et al. (1984); note: value from this reference used if no appropriate value available from IAEA (1994).
[b] From USEPA (2008).
[c] IAEA (1994); note: value from this reference used, compared with Baes et al. (1984), as IAEA (1994) is more current.
International Atomic Energy Agency (IAEA), 1994, Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments, Technical Report Series No. 364, Vienna.
[d] Average of the vegetative and reproductive transfer factors presented in Baes et al. (1984); note: value from this reference used if no appropriate value available from IAEA (1994).

References:

Baes, C. F., R.D. Sharp, A.L. Sjoreen and R. W. Shor (1984). A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture. ORNL-5786, September 1984.
Efroymson, R.A., et. al., 2001, *Uptake of Inorganic Chemicals from Soil by Plant Leaves: Regressions of Field Data*, Environ. Tox. Chem., 20:2561-2571
EPA, 2008, *Guidance for Developing Ecological Soil Screening Levels (Eco-SSL)*, Office of Solid Waste and Emergency Response, Directive 92857.7-55, Washington, D.C.

Table 3-3

Bioaccumulation Factors or Regressions Equations Utilized for the Soil-to-Earthworm Pathway
Power House 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Constituent	PBOW Site-Specific BCF [a]	Sample, et al. 1998			Beyer, 1990 BAF/BCF	Regression Equation	Recommended BAF/BCF	Source of BAF/BCF	Rationale for BAF/BCF
		Median BAF/BCF	90th Percentile BAF/BCF	Maximum BAF/BCF					
Inorganics									
Cadmium	--	7.708	40.69	190	--	ln (EW)=0.795(ln[soil])+2.114	Regression Equation	USEPA 2008, Table 4a	Chemical-specific regression equation
Mercury	--	1.693	20.625	33	--	ln (EW)=0.33(ln[soil])+0.078	Regression Equation	Sample et al. 1998	Chemical-specific regression equation
Selenium	--	0.985	1.34	13.733	--	ln (EW)=0.733(ln[soil])-0.075	Regression Equation	USEPA 2008, Table 4a	Chemical-specific regression equation
Thallium	--	--	--	--	--	--	0.3	See Footnote b.	Median value for inorganics from Sample et al., 1998.

-- indicates that a BAF/BCF or regression equation is not available.
BAF - Bioaccumulation factor.
BCF - Bioconcentration factor.
PAH - Polynuclear aromatic hydrocarbon

[a] IT Corporation (IT), 2001, *Redwater Pond Areas Baseline Ecological Risk Assessment, Plum Brook Ordnance Works, Sandusky, Ohio*, prepared for U.S. Army Corps of Engineers, Nashville District, April.

[b] For inorganic chemials lacking BAFs, the geometric mean of available inorganic chemical Median BAF/BCFs from Sample et al. (1998) were calculated based on the data provided below, and used as surrogate values:

	Median BAF/BCF
Aluminum	0.043
Arsenic	0.224
Barium	0.091
Beryllium	0.045
Cadmium	7.708
Chromium	0.306
Cobalt	0.122
Copper	0.515
Iron	0.036
Lead	0.266
Manganese	0.054
Mercury	1.693
Molybdenum	0.953
Nickel	1.059
Selenium	0.985
Silver	2.045
Strontium	0.087
Vanadium	0.042
Zinc	3.201
Geometric Mean	**0.30**

References:

Sample, B. E, et. al., 1998, *Development and Validation of Bioaccumulation Models for Earthworms,* ES/ER/TM-220.

EPA, 2008, *Guidance for Developing Ecological Soil Screening Levels (Eco-SSL)*, Office of Solid Waste and Emergency Response, Directive 92857.7-55, Washington, D.C

Table 3-4

Bioaccumulation Factors or Regression Equations Utilized for the
Soil-to-Mammal/Bird[a] Pathway
Power House 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Constituent	Sample et al., (1998)						USEPA (1999)	Other BAF/BCF		Regression Equation	Recommended BAF/BCF	Rationale for Recommended BAF
	Insectivore Median BAF/BCF	Herbivore Median BAF/BCF	Omnivore Median BAF/BCF	General[b] Median BAF/BCF	General[b] Maximum BAF/BCF	General[b] 90th percentile BAF/BCF	Maximum BAF/BCF Avian or Mammal					
Inorganics												
Cadmium	2.105	0.1258	0.1217	0.3333	69.561	3.9905	--	--	--	ln (M)=0.4723(ln[soil]) -1.2571	Regression	USEPA (2008)-Attach 4-1, Table 4a
Mercury	1.046	0.0239 [d]	0.0543	0.0543	1.046	0.192	--	--	--	--	0.192	"General: 90th Percentile" used because of uncertainties regarding the type of mammalian prey items.
Selenium	0.7241	0.0221 [e]	0.2062	0.1619	1.754	1.1867	--			ln (M)=0.3764(ln[soil]) -0.4158	Regression	USEPA (2008)-Attach 4-1, Table 4a
Thallium	--	--	0.1124	0.1124	0.123	0.1227	--	--	--	--	0.1227	"General: 90th Percentile" used because of uncertainties regarding the type of mammalian prey items.

-- indicates that a BAF/BCF is not available.
BAF - Bioaccumulation factor.
BCF - Bioconcentration factor.

[a] Bird BAF/BCF values were based on the recommended small mammal BAF/BCF values, as bird uptake values are not readily available.
[b] "General" indicates that the combination dataset used for insectivore, herbivore, and omnivore receptors was used to estimate a "general" receptor BAF/BCF value.
[d] Only one BAF/BCF value available for exposure to mercury in soil (median is also 90th percentile value and maximum value).
[e] Mean value presented, as median value not given in Sample et al. (1998).

References:

Sample et al., 1998, *Development and Validation of Bioaccumulation Models for Small Mammals,* ES/ER/TM-219.
EPA, 2008, *Guidance for Developing Ecological Soil Screening Levels (Eco-SSL)* , Office of Solid Waste and Emergency Response, Directive 92857.7-55, Washington, D.C.
EPA, 1999, *Screening level ecological risk assessment protocol for hazardous waste combustion facilities* , August, EPA530-D-99-001A.

Table 3-5

Bioaccumulation Factors Utilized
for the Sediment-to-Benthic Invertebrate Pathway
Power House 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

Constituent	PBOW Site-Specific BCFs [a]	Bechtel Jacobs (1998)			EPA (1999) BAF/BCF (dry weight)	Other BAF/BCF (dry weight)	Recommended BAF/BCF (dry weight)	Rationale for Recommended BAF/BCF
		Median BAF/BCF (dry weight)	90th Percentile BAF/BCF (dry weight)	Maximum BAF/BCF (dry weight)				
Explosives								
2,4,6-Trinitrotoluene	--	--	--	--	--	--	4.67	Conservative default based on the median value for PCBs from Bechtel (1998)

-- indicates that a BAF/BCF or regression equation is not available.
BAF - Bioaccumulation factor.
BCF - Bioconcentration factor.

[a] IT Corporation (IT), 2001, *Redwater Pond Areas Baseline Ecological Risk Assessment, Plum Brook Ordnance Works, Sandusky, Ohio*, prepared for U.S. Army Corps of Engineers, Nashville District, April.

References:

Bechtel Jacobs Company LLC, 1998, *Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation*, BJC/OR-112.
(Depurated and nondepurated results used).

Table 3-6

Bioaccumulation Factors and Regression Equations Utilized for the Surface Water-to-Fish Pathway Power House 2 Ash Pits, Plum Brook Ordnance Works Sandusky, Ohio

Constituent	PBOW Site-Specific BCFs [a]	EPA (1999) BAF/BCF [b] (dry weight)	EPA (1989) BAF/BCF [c] (dry weight)	RAIS Database [d] (dry weight)	Regression Equation	Recommended BCF	Rationale for Recommended BAF/BCF
Inorganic Chemicals							
Aluminum	780	13.5	--	2,500	--	780	Site specific BCF used (IT, 2001)
Barium	146	3165	--	20	--	146	Site specific BCF used (IT, 2001)
Lead	63.8	0.45	895	1,500	--	63.8	Site specific BCF used (IT, 2001)
Semivolatile Organics							
bis(2-Ethylhexyl)phthalate	--	350	--	2,940	--	350	EPA (1999)

-- indicates that a BAF/BCF or regression equation is not available.
BAF - Bioaccumulation factor.
BCF - Bioconcentration factor.

[a] Values are from IT, 2001. The listed BCF is the average of the West Area Red Water Pond reasonable maximum exposure value, and the average of the BCFs for the three aquatic organisms evaluated for the Pentolite Road area.

[b] Values are from EPA, 1999, adjusted to dry weight by multiplying by a factor of 5.

[c] Values are from EPA, 1989, and assumed to be in wet weight; adjusted to dry weight by multiplying by a factor of 5.

[d] Values are from Risk Assessment Information System (RAIS), current as of June 2010. Values were assumed to be in wet weight and were adjusted to dry weight by multiplying by a factor of 5.

References:

EPA, 1999, *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*, EPA530-D-99-001A (Peer Review Draft).

EPA, 1989, *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish*, EPA503-8-89-002.

Risk Assessment Information System (RAIS), on-line database, current as of June 2007, http://rais.ornl.gov

Bintein, S., and J. Devillers, 1992, *Nonlinear Dependence of Fish Bioconcentration on n-Octanol/Water Partition Coefficient*, CTIS.

IT Corporation (IT), 2001, *Redwater Pond Areas Baseline Ecological Risk Assessment, Plum Brook Ordnance Works, Sandusky, Ohio*, prepared for U.S. Army Corps of Engineers, Nashville District, April.

Table 4-1

Toxicity Reference Values for Mammals
Power House 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference
Inorganics								
Aluminum	--	1.93	mouse	Sample, et al. (1996)	--	19.30	mouse	Sample, et al. (1996)
Barium	--	5.1	rat	Sample, et al. (1996)	--	19.8	rat	Sample, et al. (1996)
Cadmium	--	1.0	rat	Sample, et al. (1996)	--	10	rat	Sample, et al. (1996)
Lead	--	8.0	rat	Sample, et al. (1996)	--	80	rat	Sample, et al. (1996)
Mercury (mink)	--	1.0	mink	Sample, et al. (1996)	1.0 (NOAEL)	5.0	mink	Sample, et al. (1996)
Mercury (mouse)	--	13.2	mouse	Sample, et al. (1996)	--	132.0	mouse	Sample, et al. (1996)
Selenium	--	0.2	rat	Sample, et al. (1996)	--	0.33	rat	Sample, et al. (1996)
Thallium	--	0.0074	rat	Sample, et al. (1996)	--	0.074	rat	Sample, et al. (1996)
Organics								
2,4,6-Trinitrotoluene (2,4,6-TNT)	--	0.2	dog (beagle)	USACHPPM (2000)	--	2.0	dog (beagle)	USACHPPM (2000)
Bis(2-ethylhexyl)phthalate	--	18.3	mouse	Sample, et al. (1996)	--	183		Sample, et al. (1996)

REFERENCES

Sample, B. E., D. M. Opresko, and G. W. Suter II. 1996, Toxicological Benchmarks for Wildlife, 1996 Revision, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

USACHPPM, 2000, Standard Practice for Wildlife Toxicity Reference Values, Environmental Health Risk Assessment Program and Health Risk Assessment Program and Health Effects Research Program, Aberdeen Proving Ground, Maryland, October.

Table 4-2

Toxicity Reference Values for Birds
Power House 2 Ash Pits, Plum Brook Ordnance Works
Sandusky, Ohio

COPEC	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference
Inorganics								
Aluminum	--	110	ringed dove	Sample, et al. (1996)	--	1100	ringed dove	Sample, et al. (1996)
Barium	--	20.8	chicks	Sample, et al. (1996)	--	41.7	chicks	Sample, et al. (1996)
Cadmium	--	1.45	mallard duck	Sample, et al. (1996)	--	20	mallard duck	Sample, et al. (1996)
Lead (quail)	--	1.13	Japanese quail	Sample, et al. (1996)	--	11.3	Japanese quail	Sample, et al. (1996)
Lead (kestrel)	--	3.85	Am. Kestrel	Sample, et al. (1996)	--	38.50	Am. Kestrel	Sample, et al. (1996)
Mercury	--	0.45	Japanese quail	Sample, et al. (1996)	--	0.90	Japanese quail	Sample, et al. (1996)
Selenium (duck)	--	0.5	mallard duck	Sample, et al. (1996)	--	1.0	mallard duck	Sample, et al. (1996)
Selenium (owl)		0.44	screech owl	Sample, et al. (1996)		1.5	screech owl	Sample, et al. (1996)
Thallium	--	0.35	starling	LANL (2005)		3.5	starling	LANL (2005)
Organics								
2,4,6-Trinitrotoluene (2,4,6-TNT)	7	0.7	Bobwhite quail	USACHPPM (2000)	178	17.8	Bobwhite quail	USACHPPM (2000)
Bis(2-ethylhexyl)phthalate	--	1.11	ringed dove	Sample, et al. (1996)	--	11.10	ringed dove	Sample, et al. (1996)

REFERENCES

Los Alamos National Laboratory (LANL), 2005, ECORISK Database (Release 2.2), Environmental Restoration Project, Los Alamos National Laboratory, Los Alamos, NM, September.

Sample, B. E., D. M. Opresko, and G. W. Suter II, 1996, Toxicological Benchmarks for Wildlife, 1996 Revision, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

USACHPPM, 2000, Standard Practice for Wildlife Toxicity Reference Values, Environmental Health Risk Assessment Program and Health Effects Research Program, Aberdeen Proving Ground, Maryland, October.

Table 5-1

Wildlife EEQs for All Food Chain Receptors
Power House 2 Ash Pits
Plum Brook Ordnance Works
Sandusky, Ohio

COPEC	Deer Mouse		Short-tailed Shrew		Cottontail Rabbit		Marsh Wren		White-tailed Deer		Raccoon		Red-Tailed Hawk		Muskrat	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals																
Aluminum	6.70E-02	6.70E-03	6.91E-02	6.91E-03	2.86E-02	2.86E-03	2.13E-03	2.13E-04	1.15E-04	1.15E-05	5.15E-03	5.15E-04	1.13E-06	1.13E-07	4.22E-02	4.22E-03
Barium	1.45E-03	3.73E-04	1.49E-03	3.84E-04	6.17E-04	1.59E-04	6.44E-04	3.21E-04	2.49E-06	6.42E-07	2.95E-05	7.59E-06	3.42E-07	1.70E-07	9.12E-04	2.35E-04
Cadmium	4.93E-01	4.93E-02	7.44E-01	7.44E-02	2.95E-02	2.95E-03	1.18E+00	8.54E-02	5.78E-05	5.78E-06	1.26E-03	1.26E-04	2.42E-05	1.75E-06	0.00E+00	0.00E+00
Lead	5.34E-05	5.34E-06	5.51E-05	5.51E-06	2.28E-05	2.28E-06	6.86E-04	6.86E-05	9.20E-08	9.20E-09	6.97E-07	6.97E-08	1.07E-07	1.07E-08	3.36E-05	3.36E-06
Mercury	3.46E-03	3.46E-04	4.61E-03	4.61E-04	4.14E-04	4.14E-05	3.03E-01	1.52E-01	7.39E-07	7.39E-08	1.09E-04	2.18E-05	5.37E-06	2.68E-06	0.00E+00	0.00E+00
Selenium	1.04E+00	6.28E-01	8.78E-01	5.32E-01	2.73E-01	1.66E-01	7.99E-01	3.99E-01	4.18E-04	2.53E-04	2.34E-03	1.42E-03	2.70E-04	7.93E-05	0.00E+00	0.00E+00
Thallium	**5.95E+00**	5.95E-01	**1.34E+01**	1.34E+00	8.21E-01	8.21E-02	4.46E-01	4.46E-02	6.42E-04	6.42E-05	2.16E-02	2.16E-03	9.82E-05	9.82E-06	0.00E+00	0.00E+00
Explosives																
2,4,6-Trinitrotoluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.10E-04	4.10E-05	0.00E+00	0.00E+00	4.10E-01	4.10E-02
Semivolatile Organics																
Bis(2-ethylhexyl) phthalate	1.62E-05	1.62E-06	1.67E-05	1.68E-06	6.92E-06	6.93E-07	4.86E-04	4.86E-05	2.79E-08	2.80E-09	6.25E-07	6.26E-08	2.58E-07	2.58E-08	1.02E-05	1.02E-06

COPEC - Chemical of potential ecological concern
LOAEL - Lowest observed adverse effect level
NOAEL - No observed adverse effect level

Shaded cells indicate a hazard quotient greater than 1, when rounded.

FIGURES

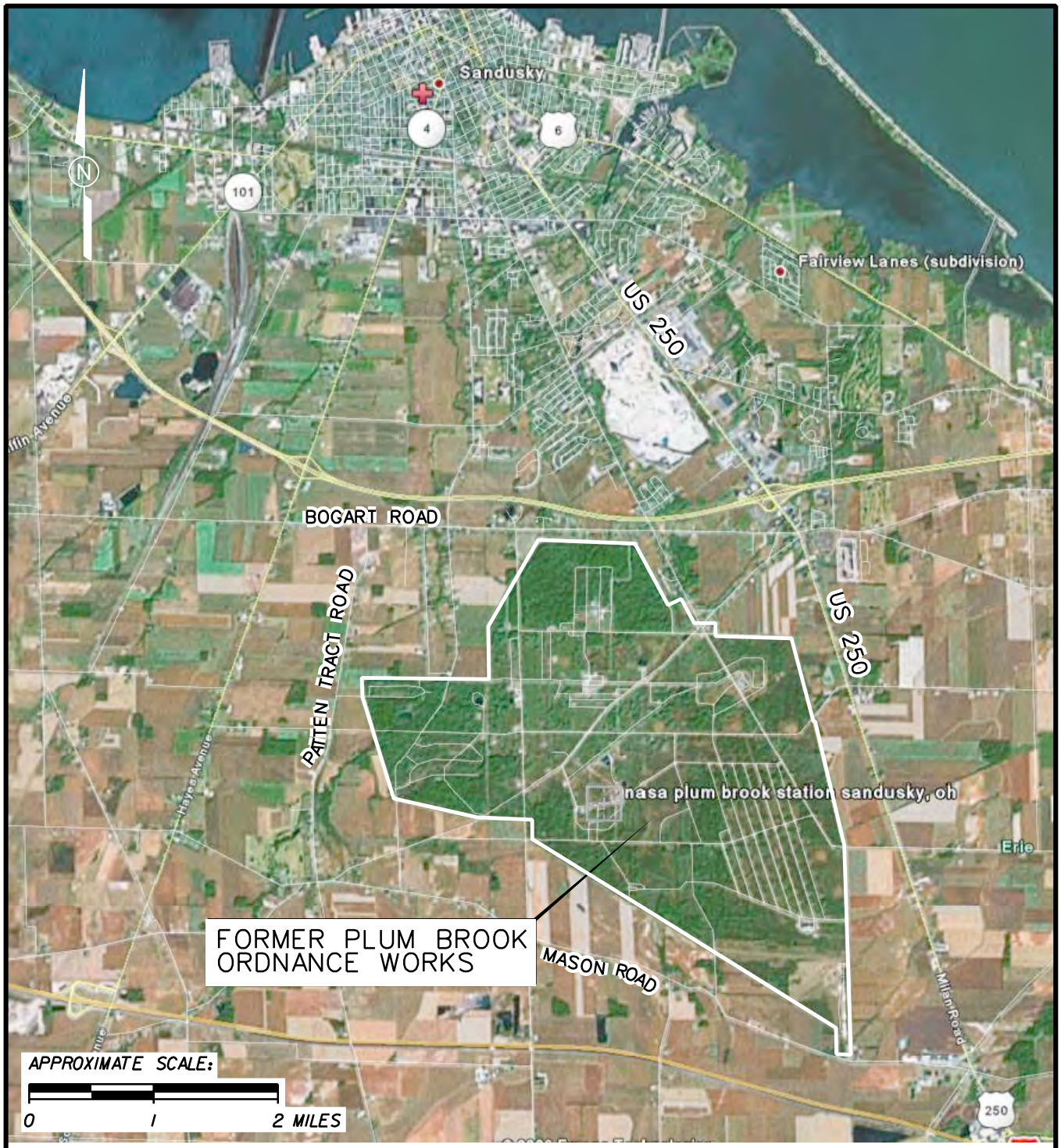

FIGURE 1-1
PBOW VICINITY MAP

POWERHOUSE 2 ASH PITS
SCREENING LEVEL ECOLOGICAL
RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® a world of Solutions™

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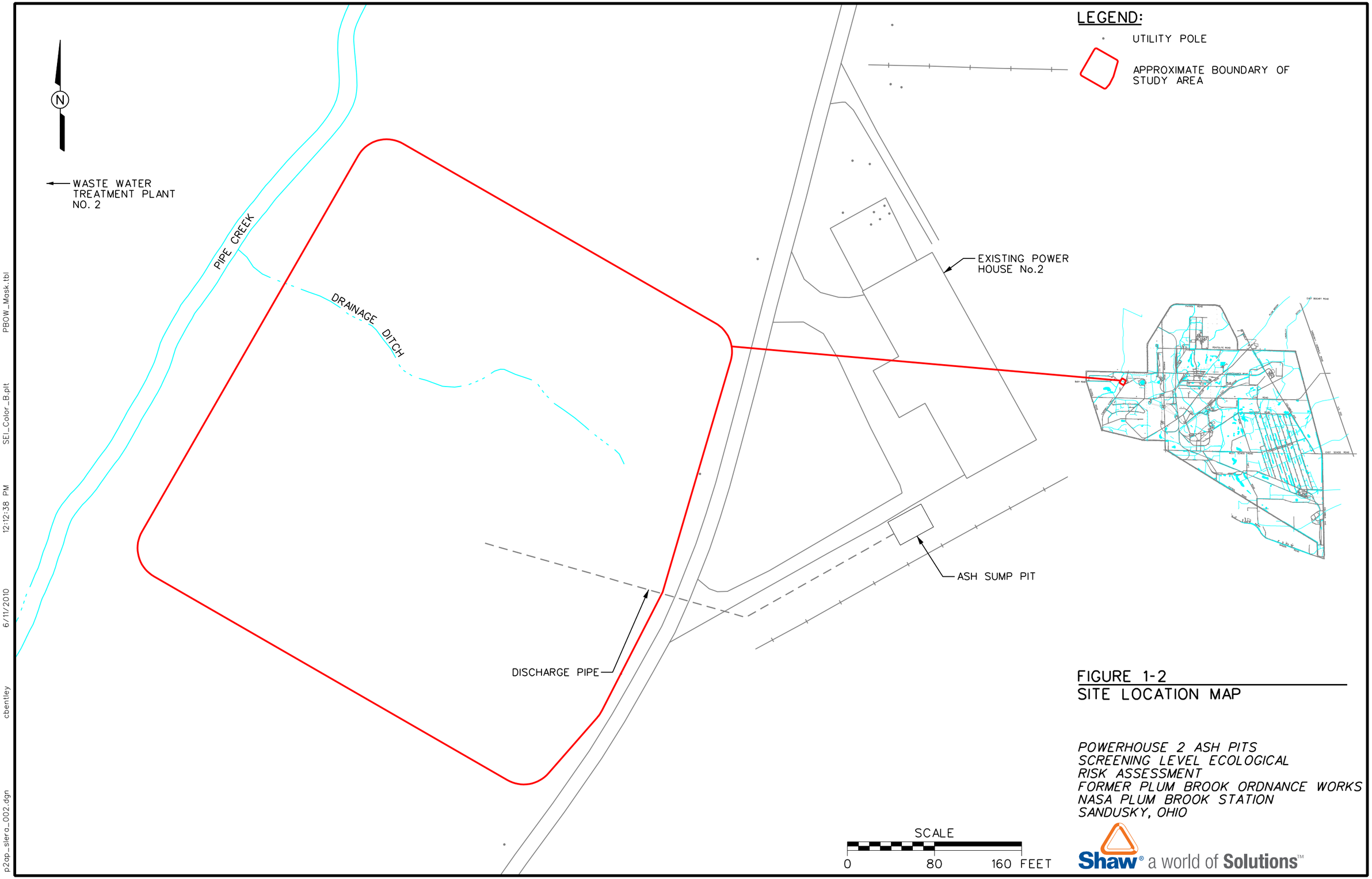

FIGURE 1-2
SITE LOCATION MAP

POWERHOUSE 2 ASH PITS
SCREENING LEVEL ECOLOGICAL
RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® a world of Solutions™

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Figure 2-1

Photo 1. Edge of forest at Power House 2 Ash Pits (September, 2009).

Photo 2. Edge of forest at Power House 2 Ash Pits (September, 2009).

Figure 2-1

Photo 3. Forest and understory at Power House 2 Ash Pits, showing disturbed understory from well installation and other remedial investigation activities (May, 2009).

Photo 4. Forest and understory at Power House 2 Ash Pits, showing disturbed understory resulting from well installation and other remedial investigation activities (June, 2009).

Figure 2-1

Photo 5. Understory of forest at Power House 2 Ash Pits (September, 2009).

Photo 6. Canopy of forest at Power House 2 Ash Pits (September, 2009).

Figure 2-1

Photo 7. Forest and understory at Power House 2 Ash Pits, showing ponded water (May, 2009).

Photo 8. Ponded water at Power House 2 Ash Pits (May, 2009).

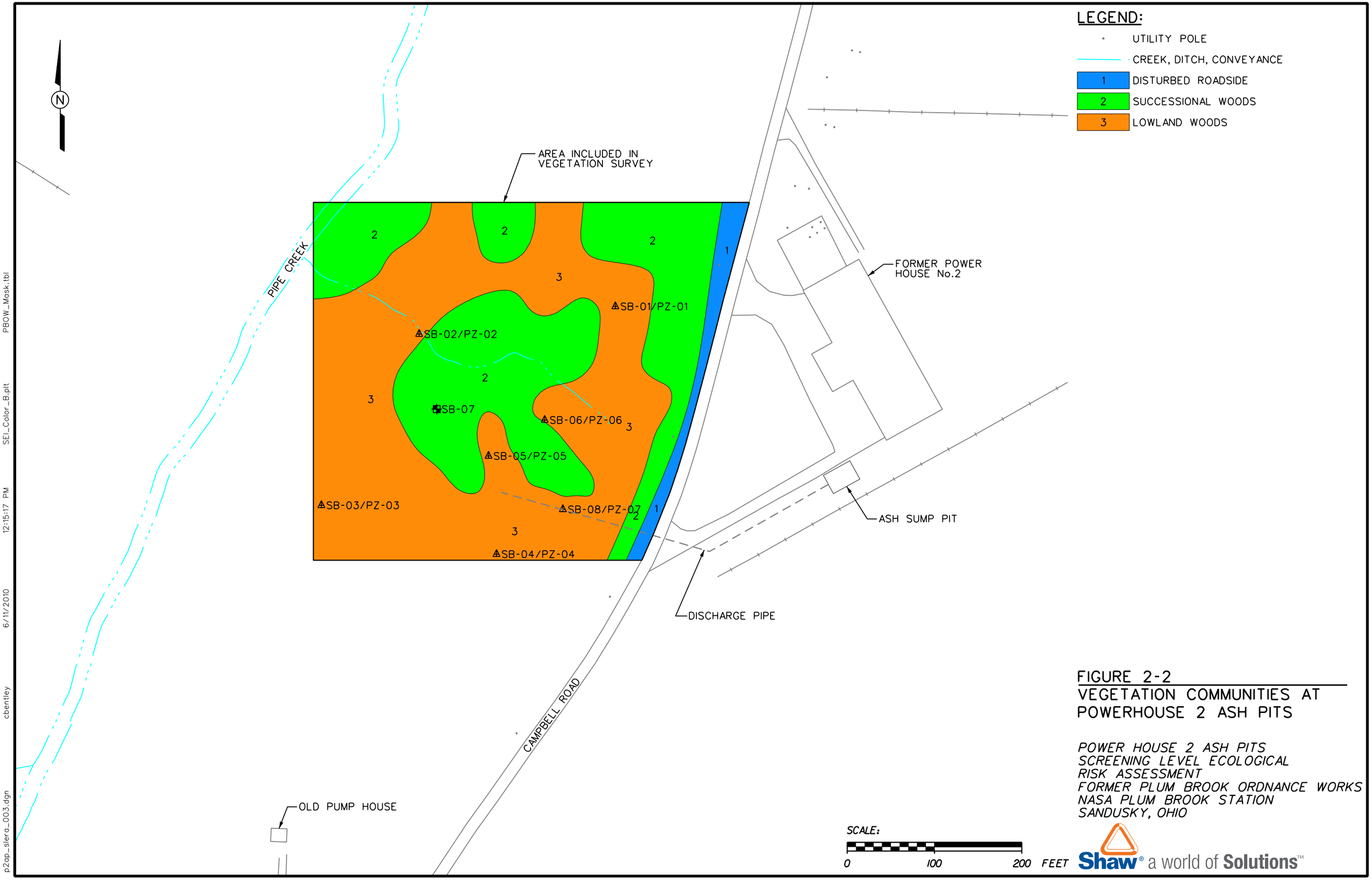

FIGURE 2-2
VEGETATION COMMUNITIES AT POWERHOUSE 2 ASH PITS

POWER HOUSE 2 ASH PITS
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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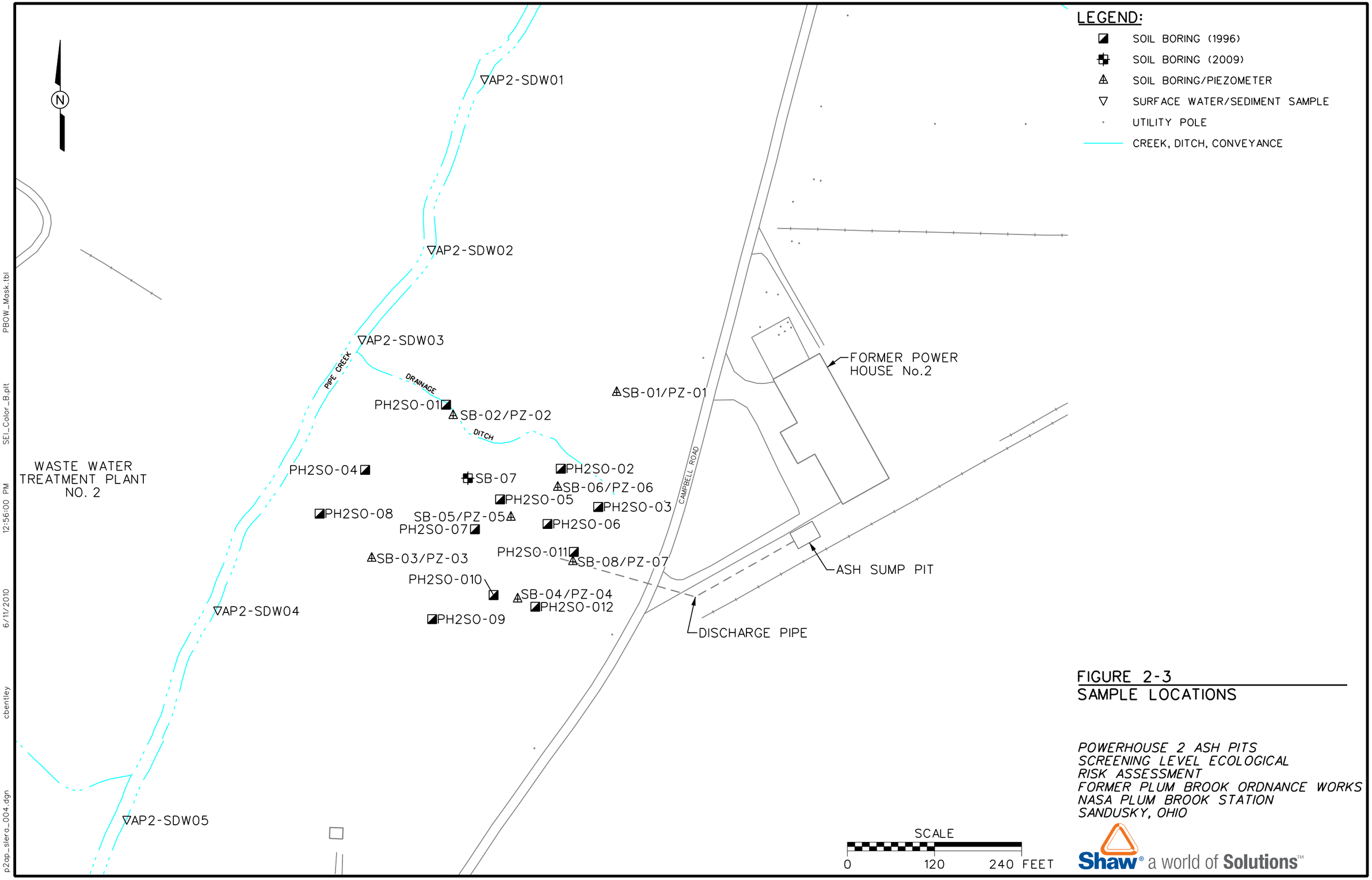

FIGURE 2-3
SAMPLE LOCATIONS

POWERHOUSE 2 ASH PITS
SCREENING LEVEL ECOLOGICAL
RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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Figure 2-4

Simplified Terrestrial Food Web Conceptual Site Model (CSM)
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

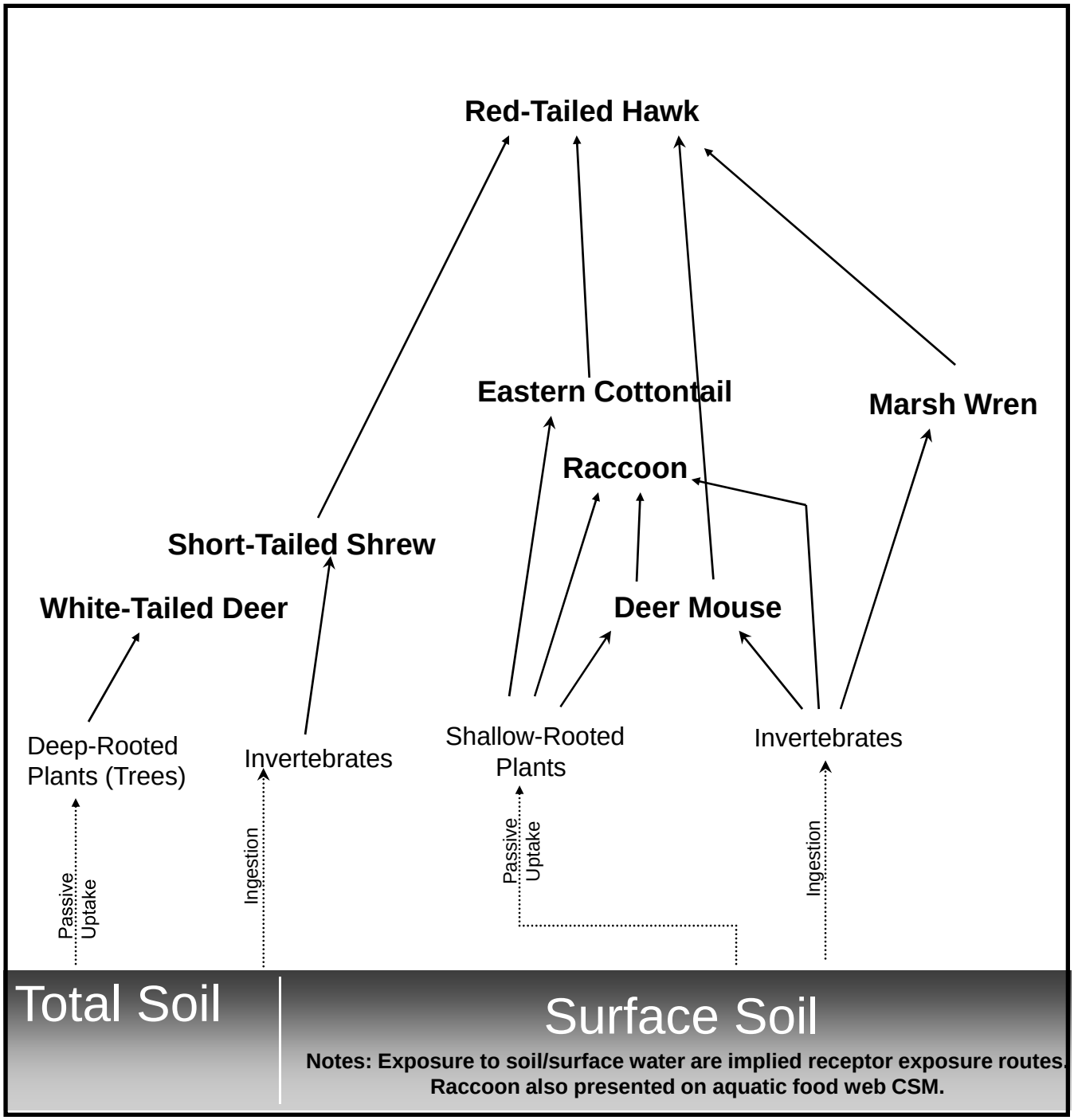
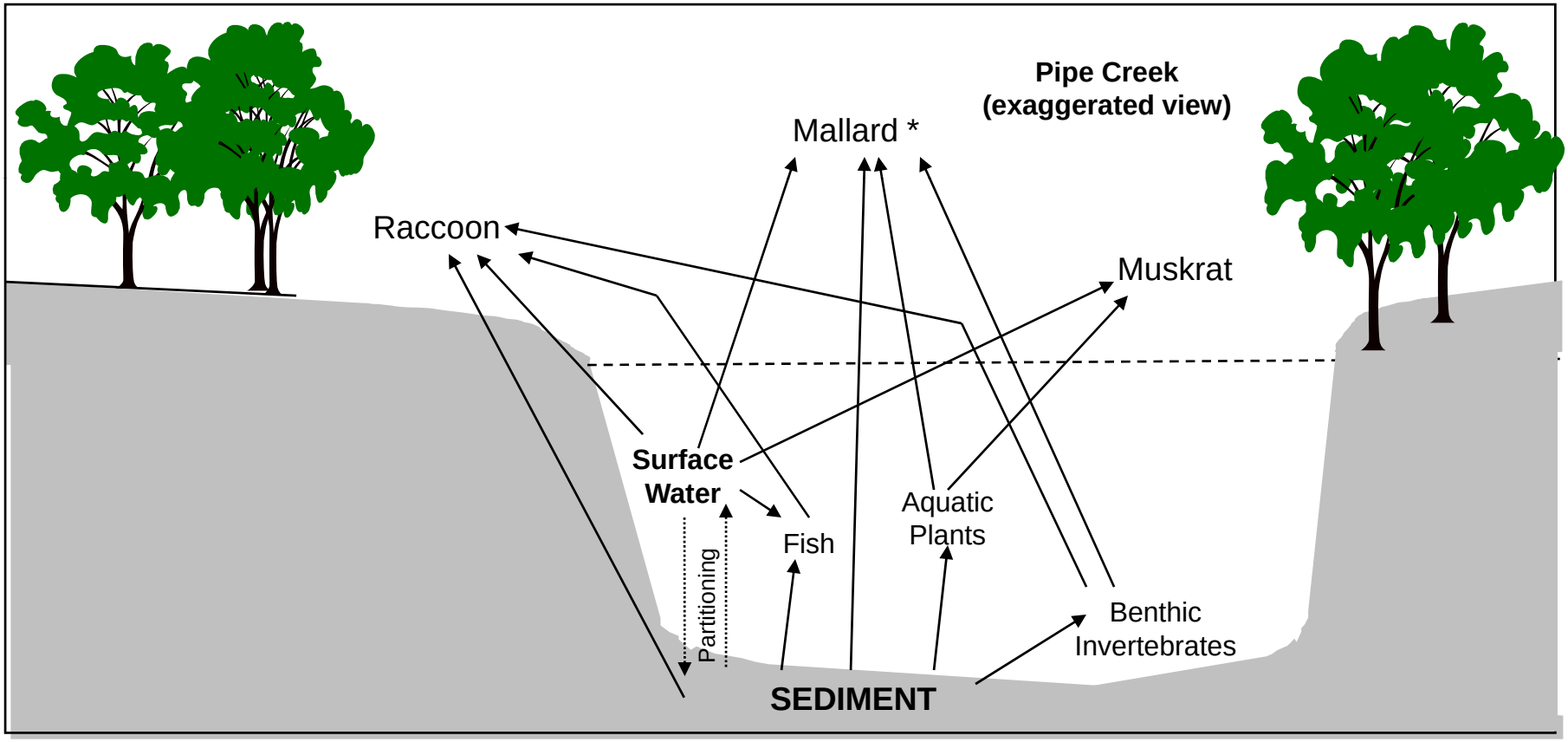


Figure 2-5

Simplified Aquatic Food Web Conceptual Site Model (CSM)
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

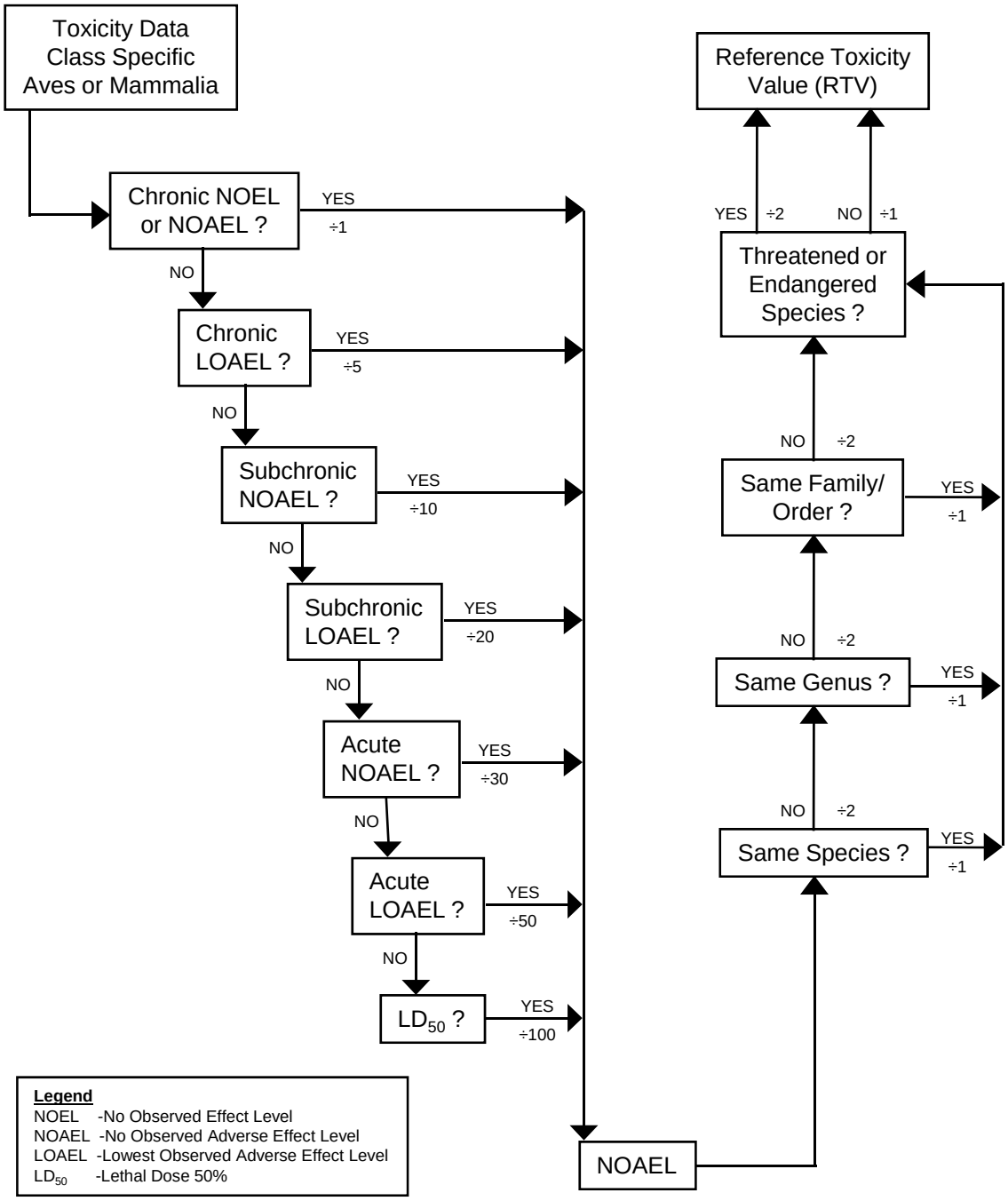


Note: The raccoon is also presented on terrestrial food web CSM.

*** = The mallard is not evaluated in the risk assessment.**

Figure 4-1

Procedural Flow Chart for Deriving Toxicity Reference Values (TRV) from Class-Specific Toxicity Data Plum Brook Ordnance Works, Sandusky, Ohio



Credit: Adapted from Ford et al. (1992) in *Tri-Service Procedural Guidelines for Ecological Risk Assessments*, 1996

KN/4466/ECO-RA/fig4-1.ppt/10/22/01

APPENDIX A

VASCULAR PLANT SPECIES DOCUMENTED ON SITE

Appendix A

Vascular Plant Species Documented On Site
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Acalypha rhomboidea	Three-seeded mercury	NA		NA	2
Acer negundo	box-elder maple	Frequent		Stream banks, ditches, and moist woods	1,2
**Acer platanoides*	Norway maple	Occasional		Disturbed woods	1
Acer rubrum	red maple	Common		Dry to moist woods	1
Acer saccharinum	Silver maple	Rare		Dry to moist woods	3
Acer saccharum	Sugar maple	Occasional		Dry to moist woods	3
**Achillea millefolium*	Yarrow	Frequent		Dry fields, roadsides, and about buildings	1
Acorus calamus	Sweet flag	Rare		Wet ditches	3
Agalinis purpurea	purple false-foxglove	Frequent		Moist openings and ditches	1
Agrimonia parviflora	southern agrimony	Frequent		Moist fields and ditches	1,2
**Agropyron repens*	Quack grass	Frequent		Old fields and roadsides	3
Agrostis hyemalis	Ticklegrass	Occasional		Dry, grassy fields and shaley openings	1
**Agrostis gigantea*	Redtop	Common		Moist fields, ditches, and roadsides	1
Agrostis perennans	autumn bent-grass	Frequent		Dry woods and borders on shale	1
Ailanthus altissima	tree of heaven	NA		NA	2
Alisma subcordatum	water-plantain	Occasional		Ponds and ditches	1
**Alliaria petiolata*	garlic mustard	Frequent		Dry to moist wood lots	1,2
Allium canadense	Wild garlic	Occasional		Successional woods	3
Allium canadense	Field garlic	NA		NA	2
Ambrosia artemisiifolia	common ragweed	Frequent, occasional		Dry fields and roadsides	1,2
Ambrosia trifida	giant ragweed	Occasional		Dry fields and roadsides	1
Andropogon gerardii	big bluestem	Frequent, 0ccasional		Dry to moist fields and roadsides	1
**Andropogon virginicus*	broom-sedge	Occasional, frequent		Dry fields and roadsides	1

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Antennaria parlinii	pussy-toes	Occasional		Dry fields and openings, especially on shale	1
**Anthoxanthum odoratum*	vernal-grass	Occasional		Dry fields and openings, especially on shale	1
Apocynum cannabinum	Dogbane	Frequent		Dry to moist fields and roadsides	1,2
**Arabidopsis thaliana*	mouse-ear cress	Occasional		Road berms and about buildings	1
**Arctium minus*	Burdock	Occasional		Disturbed fields and about buildings	1
Arenaria lateriflora	grove sandwort	Rare	T	Woods along Ransom Brook north of reactor	1
Arisaema triphyllum	Jack-in-the-pulpit	Rare		Moist to dry woods	3
Aristida dichotoma	Churchmouse grass	Occasional		Dry fields and openings	1
Aristida longespica	slimspike triple-awned grass	Common		Dry fields and openings	1
Aristida oligantha	prairie triple-awned grass	Occasional		Dry openings and roadsides	1
**Artemisia ludoviciana var. gnaphaloides*	white sage	Occasional		Grassy roadsides	1
Asclepias hirtella	prairie milkweed	Common		Dry to moist openings	1
Asclepias incarnata	Swamp milkweed	Occasional		Wet ditches	3
Asclepias sullivantii	Sullivant's milkweed	Rare		Moist field along Patrol Road south of Scheid Road	1
Asclepias syriaca	common milkweed	Frequent		Dry to moist fields and roadsides	1,2
Asclepias tuberosa	butterfly-weed	Occasional		Dry openings and roadsides	1
Aster ericoides	white heath aster	Rare, frequent		Grassy strip along Patrol Road southeast of Taft Road	1
Aster laevis	smooth aster	Rare		White oak grove on Taft Road	1
Aster lateriflorus	calico aster	Common, frequent		Moist woods and thickets	1,2
Aster novae-angliae	New England aster	Occasional		Dry fields and roadsides	1
Aster pilosus	common white aster	Common		Dry fields, roadsides, and about buildings	1
Aster sagittifolius	Arrow-leaved aster	Frequent		Woods and fields	3

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Aster umbellatus	flat-top aster	Frequent, rare		Dry to moist fields and roadsides	1
Baptisia lactea	prairie false indigo	Occasional	P	Dry openings in bunker area	1
Baptisia tinctoria	yellow false indigo	Occasional		Dry openings in bunker area	1
**Berberis thunbergii*	Japanese barberry	Occasional, rare		Woodland borders	1
Bidens coronata	northern tickseed-sunflower	Common		Moist fields and ditches	1
Bidens frondosa	Beggar ticks	Rare		Ditches	3
Boehmeria cylindrica	false nettle	Occasional		Ponds and ditches	1,2
Botrychium virginianum	Rattlesnake fern	Occasional		Successional woods	3
**Brassica nigra*	black mustard	Occasional		Roadsides	1
**Bromus inermis*	smooth brome	Frequent		Dry to moist fields and roadsides	1,2
Bromus pubescens	Brome	Occasional		Dry fields	3
**Bromus tectorum*	downy chess	Occasional		Dry openings and roadsides on shale	1
Cacalia atriplicifolia	pale Indian-plantain	Occasional		Dry fields and roadsides; woods	1
Calamagrostis canadensis	blue-joint	Occasional		Moist fields and ditches	1
Callitriche heterophylla	water-starwort	Occasional		Pond margins and seasonally-moist depressions	1
Calystegia sepium	Hedge bindweed	Occasional		Fields	3
**Campsis radicans*	trumpet-vine	Occasional		Disturbed openings and roadsides	1
**Capsella bursa-pastoris*	shepherd's-purse	Occasional		Roadsides and about buildings	1
**Cardamine hirsuta*	bitter-cress	Occasional		Roadsides and about buildings	1
**Carduus nutans*	musk-thistle	Occasional, frequent		Dry fields and roadsides	1
Carex aggregata	sedge	Occasional		Moist woods	3

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Carex alata	broad-winged sedge	Rare	P	Grassy field along Patrol Road south of Scheid Road, also in grassy strip between Patrol Road and artificial pond southeast of Taft Road	1
Carex amphibola	NA	Occasional		Thickets and woods borders	1
Carex annectens var. annectens	NA	Occasional		Moist, grassy fields	1
Carex annectens var. xanthocarpa	yellow-fruited sedge	Occasional		Moist, grassy fields	1
Carex blanda	NA	Frequent		Moist woods	1
Carex bromoides	Brome-like sedge	NA		NA	2
Carex cephaloidea	thin-leaf sedge	Rare	E	Woods border along Pentolite Road west of reactor	1
Carex complanata var. hirsutella	NA	Frequent		Dry fields and woods borders	1
Carex conoidea	field sedge	Rare	T	Grassy depression along Taft Road south of North Magazine Road	1
Carex cristatella	NA	Occasional		Moist fields and ditches	1
Carex festucacea	fescue sedge	Occasional		Moist, grassy fields	1
Carex gracillima	NA	Occasional		Moist woods	1
Carex granularis	meadow sedge	Common		Moist, grassy fields and ditches	1
Carex hirtifolia	NA	Rare		Disturbed oak woods along angling road	1
Carex hystericina	Bottlebrush sedge	Rare		Moist depression along Taft Road	1
Carex pensylvanica	Pennsylvania sedge	Common		Dry woods	1
Carex radiata	Eastern star sedge	NA		NA	2
Carex rosea	NA	Frequent		Dry to moist woods	1
Carex scoparia	NA	Frequent		Moist, grassy fields	1
Carex stipata	NA	Frequent		Moist fields and ditches	1

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Carex stricta	tussock sedge	Occasional		Moist fields and ditches	1
Carex swanii	Swan's sedge	Occasional		Dry, grassy fields	1
Carex tribuloides	NA	Occasional		Moist, grassy fields and ditches	1,2
Carex umbellata	NA	Occasional		Well-drained, grassy fields on sandy soil	1
Carex vulpinoidea	fox sedge	Common		Moist fields, ditches, and about ponds	1
Carya ovata	shagbark hickory	Rare		Sandy soil along fence at far southeast boundary	1,2
Catalpa speciosa	Catalpa	NA		NA	2
Celastrus orbiculatus	Bittersweet	Occasional		Thickets and woods borders	3
Celtis occidentalis	Hackberry	Occasional		dry to moist woods and borders	1,2
Cephalanthus occidentalis	Buttonbush	Occasional		Moist depressions and ditches	1,2
Cerastium arvense	field chickweed	Rare		White oak grove along Taft Road	1
**Cerastium fontanum*	mouse-ear chickweed	Frequent		Road berms and about buildings	1
**Cerastium semidecandrum*	NA	Occasional		Road berms and about buildings	1
**Chaenorrhinum minus*	dwarf snapdragon	Occasional		Road berms and about buildings	1
Chamaecrista fasciculata	partridge-pea	Occasional		Dry openings on shale	1
**Chrysanthemum leucanthemum*	ox-eye daisy	Frequent		Dry to moist fields and roadsides	1
**Cichorium intybus*	Chicory	Occasional		Roadsides	1,2
Circaea lutetiana	Southern broad-leaved enchanter's nightshade	Frequent		Woods	3
Cinna arundinacea	Wood reed grass	Occasional		Woods	2
Circaea lutetiana	southern broad-leaved enchanters nightshade	NA		NA	2
**Cirsium arvense*	Canada thistle	Common		Disturbed fields and roadsides	1,2
Cirsium discolor	prairie thistle	Frequent, occasional		Grassy fields and roadsides	1

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
**Cirsium vulgare*	bull thistle	Frequent		Disturbed fields and roadsides	1
Clinopodium vulgaris	wild basil	Occasional		Dry roadsides and openings	1
**Confolvulus arvensis*	field bindweed	Occasional		Disturbed fields and roadsides	1,2
**Convallaria majalis*	lilly-of-the-valley	Rare		Grassy field along Columbus Avenue	1
Conyza canadensis	Horseweed	Frequent		Dry fields and roadsides	1
Cornus amomum	swamp dogwood	Frequent, occasional		Moist fields and thickets	1
Cornus drummondii	rough-leaved dogwood	Frequent		Moist borders, thickets, and roadsides	1,2
Cornus florida	flowering dogwood	Occasional		Woodland borders and roadsides	1
Cornus racemosa	gray dogwood	Frequent		Dry fields and roadsides	1
**Coronilla varia*	crown-vetch	Occasional, common		Grassy fields and roadsides	1
Crataegus mollis	downy hawthorn	Frequent		Thickets and woodland borders	1
Crataegus punctata	dotted hawthorn	Frequent		Thickets and woodland borders	1
Cryptotaenia canadensis	honewort	Occasional, rare		Dry to moist woods	1
Cuscuta gronovii	dodder	Frequent		Moist fields and ditches	1
**Cyperus esculentus*	yellow nutgrass	Occasional, frequent		Moist, disturbed openings	1
Cyperus flavescens	Umbrella sedge	occasional		Old fields and waste places	3
Cyperus strigosus	umbrella-sedge	Frequent		Moist openings, ponds, and ditches	1
**Dactylis glomerata*	orchard-grass	Occasional		Dry to moist fields and roadsides	1,2
Danthonia spicata	poverty-grass	Occasional		Dry openings over shale	1
Datura stramonium	jimson-weed	Occasional		Disturbed openings and roadsides	1
**Daucus carota*	wild carrot	Frequent		Dry fields and roadsides	1
Desmodium canescens	Tick trefoil	Occasional		Fields	3
**Dianthus armeria*	Deptford pink	Occasional, rare		Dry openings and roadsides on shale	1

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Digitaria cognatum (Leptoloma cognatum)	N/A	Occasional		Old fields	3
Diodia teres	buttonweed	Occasional		Dry openings over shale	1
**Dipsacus fullonum*	common teasel	Frequent		Dry, disturbed openings and roadsides	1
**Draba verna*	early whitlow-wort	Occasional		Dry roadsides and about buildings	1
Dryopteris carthusiana	spinulose woodfern	Frequent		Moist woods and shaded borders	1
**Eleagnus umbellata*	autumn-olive	Occasional		Roadsides and woodland borders	1,2
Eleocharis acicularis	needle spikerush	Frequent		Margins of artificial pond	1
Eleocharis erythropoda	red-footed spikerush	Occasional		Moist openings and ditches	1
Eleocharis obtusa	NA	Common		Moist openings and ditches	1
Eleocharis smallii	Small's spikerush	Frequent		Margins of artificial pond	1
Eleocharis tenuis	NA	Frequent		Moist openings and ditches	1
Elymus virginica	Wild rye	Occasional		Moist to dry woods	2
**Elytrigia repens*	quack-grass	Frequent		Dry fields and roadsides	1
Equisetum arvense	horsetail	Frequent		Moist openings, roadsides, and ditches	1,2
Equisetum hyemale	scouring-rush	Occasional		Moist roadsides and ditches	1
Eragrostis frankii	NA	Occasional		Moist openings and ditches	1
Eragrostis spectabilis	showy lovegrass	Occasional		Dry to moist fields	1
Erechtites hieracifolia	Pilewort	Common		Disturbed woods, borders, and roadsides	1
Erigeron anuus	Fleabane	NA		NA	2
Erigeron philadelphicus	Philadelphia fleabane	Frequent, occasional		Roadsides and borders	1
Erigeron strigosus	smooth fleabane	Occasional		Dry openings and roadsides	1
Eupatorium perfoliatum	Boneset	Occasional, frequent		Moist fields, ponds, and ditches	1
Eupatorium purpureum	purple joe-pye-weed	Occasional		Borders of moist woods, fields	1,2

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Eupatorium rugosum	White snake root	Common		Woods and fields	2
Euphorbia corollata	Flowering spurge	Occasional		Dry fields	1
Euphorbia maculata	Prostrate spurge	Occasional		Dry openings, road berms, and about buildings	1
Euphorbia supina	Milk purslane	NA		NA	2
Euthamia graminifolia	grass-leaved goldenrod	Common		Dry to moist fields and roadsides	1
**Festuca elatior*	tall fescue	Occasional		Roadsides and grassy fields	1
**Festuca obtusa*	Fescue	Common		Old fields	3
Fragaria virginiana	wild strawberry	Frequent		Dry to moist fields and roadsides	1
Fraxinus americana	white ash	Frequent		Dry to moist woods and borders	1
Fraxinus pensylvanica	green ash	Frequent, common		Moist woods and stream banks	1,2
Galine aparine	Cleavers	Occasional		Moist woods and borders	1,2
Galium asperellum	Rough bedstraw	NA		NA	2
Galium circaezans	wild licorice	Rare		Dry woods	1
Galium tinctorium	Southern bedstraw	Rare		Moist depression along Taft Road	1
Gentianopsis crinita	Fringed gentian	Occasional	P	Old fields along ditch banks, small groups and scattered individuals in northeast portion of TNT area A	3
Gerardia tenuifolia	Slender gerardia	Frequent		Disturbed fields	3
Geranium maculatum	Wild geranium	Occasional		Successional woods	3
Geum vernum	spring avens	Occasional		Moist woods and borders	1
Geum virginianum	white avens	Occasional		Woods borders and roadsides	1
**Glecoma hederacea*	ground-ivy	Frequent		Moist openings, roadsides, and about buildings	1,2
Gleditsia triacanthos	honey-locust	Occasional, rare		Dry to moist woods and borders	1,2
Glyceria striata	manna-grass	Occasional		Moist woods and about ponds	1,2

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Gnaphalium obtusifolium	Cudweed	Frequent, occasional		Dry openings on shale, fields	1
Gratiola virginiana	round-fruited hedge-hyssop	Rare	P	ca 20 plants; moist, shaded ground by pond west of Snake Road	1
Hackelia virginiana	Virginia stickseed	Rare		Woods	3
Hedyotis caerula	Bluets	Occasional		Dry openings and roadsides on shale	1
Helenium autumnale	Sneezeweed	Occasional		Disturbed fields	3
Helenium flexuosum	Southern sneezeweed	Occasional		Moist, open ground and ditches	1
Helianthus mollis	ashy sunflower	Rare	T	ca 200 plants in grassy field south and southwest of junction of Fox and Patrol Roads; the exact number of individuals in this popula-tion is uncertain since excessive browsing by deer has reduced the plants to leafy tufts.	1
Helianthus tuberosus	Jerusalem artichoke	Occasional		Old fields	3
Hemerocallus fulva	Daylily	NA		NA	2
Hesperis matronalis	Dame's rocket	NA		NA	2
Hibiscus moscheutos	rose-mallow	Rare		Moist swale along Ransom Road	1
**Hieracium piloselloides*	king-devil	Frequent		Dry openings on shale, fields	1
Hypericum gentianoides	orange-grass	Frequent		Dry openings	1
Hypericum gymnanthum	least St. John's-wort	Rare	E	ca 50 plants; moist, open ground along Patrol Road south of Fox Road	1
Hypericum majus	tall St. John's-wort	Rare	P	Moist, shaded ground by pond west of Snake Road	1
Hypericum mutilum	little St. John's-wort	Frequent		Moist openings, ponds, and ditches	1
**Hypericum perforatum*	dotted St. John's-wort	Frequent		Disturbed fields and roadsides	1
Hypericum punctatum	St. Johns wort	Rare		Fields	3

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Hypoxis hirsuta	yellow-eyed-grass	Occasional		Grassy fields	1
Hystrix patula	Bottlebrush grass	Occasional		Woods	3
Impatiens capensis	Jewelweed	NA		NA	2
**Inula helenium*	Elecampane	Rare		Moist roadside along Taft Road	1
Ipomoea pandurata	wild sweet-potato	Occasional		Dry openings over shale	1
Iris versicolor	Northern blue flag	Occasional		Moist woods and ditches	1
Isanthus brachiatus	false pennyroyal	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Juglans nigra	black walnut	Rare		A few young trees at edge of grassy field southwest of junction of Fox and Patrol Roads, woods (2b)	1
Juncus acuminatus	NA	Common		Moist openings and ditches	1
Juncus biflorus	NA	Occasional		Moist openings and ditches	1
Juncus brachycarpus	NA	Occasional		Moist openings	1
Juncus canadensis	Canada rush	Frequent		Moist openings	1
Juncus dudleyi	Dudley's rush	Frequent		Moist openings	1
Juncus effusus	Common rush	Frequent		Moist openings, ponds, and ditches	1
Juncus marginatus	NA	Occasional		Moist openings	1
Juncus nodosus	rush	Occasional		Old fields and ditches	3
Juncus tenuis	path rush	Frequent, occasional		Dry openings, road berms, and about buildings	1
Juncus torreyi	Torrey's rush	Occasional		Moist fields	3
**Lamium purpureum*	dead-nettle	Frequent		Disturbed fields, roadsides, and about buildings	1
Laportea Canadensis	Wood nettle	NA		NA	2
*Lathyrus latifolius**	Everlasting pea	Occasional		Old fields	3
Leersia oryzoides	rice cutgrass	Occasional		Moist fields and ditches	1

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Leersia virginica	White grass	NA		NA	2
Lemna minor	little duckweed	Occasional		Ponds and standing water	1
**Lepidium campestre*	field-cress	Occasional		Roadsides and about buildings	1
Lepidium virginicum	poor man's pepper	Frequent		Roadsides, disturbed openings, and about buildings	1
Leptoloma cognatum	fall witch grass	NA		NA	2
Lespedeza capitata	bush-clover	Occasional		Dry fields	1
Leucospora multifida	NA	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Liatris scariosa var. novae-angliae	northern blazing-star	Rare		Dry ground along Patrol Road at Olemacher Ditch	1
Liatris spicata	spiked blazing-star	Occasional		Moist openings	1
**Linaria vulgaris*	butter-and-eggs	Occasional		Roadsides and about buildings	1
Lindernia dubia	false pimpernel	Occasional		Moist openings, ditches, and pond margins	1
Linum medium	wild flax	Frequent		Dry to moist openings	1
Linum virginianum	Virginia flax	Rare		About pond in northern bunker area	1
Lobelia siphilitica	Great lobelia	Frequent		Moist fields	3
Lonicera japonica	Japanese honeysuckle	Occasional		Fields and disturbed areas	2
**Lonicera maackii*	Amur honeysuckle	Rare		Roadsides and thickets along Columbus Avenue near Scheid Ditch	1
**Lonicera morrowii*	Asiatic honeysuckle	Frequent		Thickets, borders, and roadsides	1
**Lonicera tatarica*	Tatarian honeysuckle	Frequent, common		Thickets, borders, and roadsides	1
**Lotus corniculatus*	bird's-foot trefoil	Occasional		Grassy fields and road berms	1
Ludwigia alternifolia	rattlebox	Occasional		Ponds and ditches	1
Ludwigia palustris	water-purslane	Frequent, occasional		Ponds and ditches	1

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Ludwigia polycarpa	NA	Rare		Moist, shaded ground by pond on Snake Road	1
Lycopus americanus	American water-horehound	Frequent		Ponds and ditches	1
Lycopus uniflorus	northern water-horehound	Frequent		Moist woods and shaded borders	1
Lysimachia terrestris	swamp loosestrife	Occasional		Moist openings	1,2
Lythrum alatum	prairie loosestrife	Occasional		Moist openings	1
Maclura pomifera	osage-orange	Occasional		Disturbed woods and borders	1,2
**Matricaria matricarioides*	pineapple-weed	Occasional		Roadsides and about buildings	1
**Medicago lupulina*	Black medic	Occasional		Old fields and disturbed areas	2
**Melilotus alba*	white sweet-clover	Occasional, frequent		Disturbed fields and roadsides	1
**Melilotus officinalis*	yellow sweet-clover	Occasional		Disturbed fields and roadsides	1,2
Mentha piperita	peppermint	NA		NA	2
Mentha spicata	Spearmint	Occasional		Moist fields	3
Mimulus ringens	monkey-flower	Occasional, rare		Moist openings and ditches	1
Monarda fistulosa	bergamont	Occasional		Grassy fields	1
Morus alba	Mulberry	Occasional		Fields and thickets	3
Muhlenbergia frondosa	muhly grass	Frequent		Moist fields and ditches	1
Myrica pensylvanica	Bayberry	Rare	E	One individual in old field in northern portion of area	3
Najas flexilis	northern naiad	Occasional		Artificial ponds	1
**Najas minor*	Eurasian naiad	Frequent		Artificial ponds	1
**Nepeta cataria*	catnip	Occasional, frequent		Roadsides and weedy openings	1
Nyssa sylvatica	blackgum	Occasional		Thickets and woods borders	1
Oenothera biennis	evening-primrose	Frequent		Dry fields, roadsides, and about buildings	1
Oenothera tetragona	northern sundrops	Frequent		Moist, grassy fields	1

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Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Onoclea sensibilis	Sensitive fern	frequent		Wet areas	2
Osmunda cinnamomea	cinnamon fern	Rare		Depressions in moist woods along angling road	1
Osmunda regalis	royal fern	Occasional		Depressions in moist woods	1
**Oxalis europea*	Sorrel	Common		Old fields and disturbed areas	3
Oxalis stricta	sorrel	NA		NA	2
Oxalis violacea	purple wood-sorrel	Occasional		Drier oak woods and borders on shale	1
Panicum dichotomiflorum	Panic grass	Frequent		Fields	3
Panicum flexile	wiry witch-grass	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Panicum lanuginosum	hairy panic-grass	common		Dry, grassy fields and roadsides	1
Panicum oligosanthes	sand panic-grass	Occasional		Dry, grassy fields	1
Panicum rigidulum	stiff panic-grass	Frequent		Moist openings and ditches	1
Panicum virgatum	switch-grass	Occasional		Dry fields	1,2
Parietaria pensylvanica	pellitory	Occasional		Dry, disturbed wood lots and borders	1
Paronychia fastigata	forked chickweed	Occasional		Dry woods and borders on shale	1
Parthenocissus quinquefolia	Virginia-creeper	Occasional		Dry to moist woods borders and thickets	1,2
Parthenocissus vitacea	grape-woodbine	Rare		Dry opening north of Center Magazine Road	1
**Pastinaca sativa*	wild parsnip	Occasional		Roadsides	1
Penstemon digitalis	tall white beard-tongue	Frequent		Grassy fields and roadsides	1
Phalaris arundinacea	reed canary-grass	Common		Moist fields and ditches	1
**Phleum pratense*	timothy	Frequent		Disturbed fields and roadsides	1
Phragmites australis	reed-grass	Occasional, rare		Moist openings and ditches	1

Appendix A

Vascular Plant Species Documented On Site
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Phryma leptostachya	lopseed	Rare		Edge of woods along Scheid Ditch near Columbus Avenue; successional woods	1
Phytolacca americana	pokeberry	Occasional, rare		Moist woods and borders	1
Pilea pumila	clearweed	NA		NA	2
**Plantago lanceolata*	English plantain	Frequent		Disturbed openings and about buildings	1
**Plantago major*	broad-leaved plantain	Frequent		Road berms and about buildings (1) disturbed areas and old fields (2a)	1
Platanthera lacera	ragged fringe-orchid	Rare		Ditch along south Patrol Road	1
Platanus occidentalis	sycamore	Occasional, frequent		Moist woods and stream banks, fields and waste areas	1,2
**Poa annua*	early bluegrass	Common		Road berms and about buildings	1
**Poa compressa*	Canada bluegrass	Frequent		Dry openings, especially on shale, and roadsides	1,2
Podophyllum peltatum	may-apple	Occasional		Dry to moist woods	1
Polygala sanguinea	blood milkwort	Frequent		Moist openings	1
Polygala verticillata	whorled milkwort	Occasional		Moist openings	1
**Polygonum caespitosum*	NA	Rare		Moist, shaded ground in bunker area	1
**Polygonum hydropiper*	water-pepper	Occasional		Margins of ponds	1,2
Polygonum hydropiperoides	false water-pepper	Occasional		Wet ditches and pond margins	1
Polygonum pennsylvanicum	Pennsylvania smartweed	NA		NA	2
Polygonum sagittatum	arrow-leaved tearthumb	Occasional		Moist thickets and ditches	1
Polygonum scandens	climbing false buckwheat	Occasional		Thickets and roadsides	1
Polygonum virginianum	Virginia knotweed	Common		Moist to dry woods	2
Populus deltoides	cottonwood	Frequent, common		Moist woods, borders, and stream banks	1,2
Potamogeton diversifolius	snailseed pondweed	Frequent		Artificial ponds	1

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Vascular Plant Species Documented On Site
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Potamogeton foliosus	leafy pondweed	Occasional		Artificial ponds	1
Potamogeton nodosus	longleaf pondweed	Occasional		Artificial ponds	1
Potentilla simplex	cinquefoil	Frequent		Dry openings and roadsides on shale	1
Prunella vulgaris	self-heal	Occasional, frequent		Roadsides and about buildings	1
Prunus americana	wild plum	Occasional		Thickets and roadsides	1
Prunus serotina	wild black cherry	Frequent, common		Dry to moist woods and borders	1
Pycnanthemum tenuifolium	narrow-leaved mountain-mint	Frequent, common		Moist openings, especially on shale, old fields	1
Pycnanthemum virginianum	Virginia mountain-mint	Occasional		Moist openings and ditches	1
Pyrus coronaria	crab-apple	Frequent		Thickets and borders	1,2
Quercus alba	white oak	Occasional		Dry woods and sandy ridges; a small grove on Taft Road has an unusually pure stand of this species	1
Quercus bicolor	swamp white oak	Frequent		Moist woodlands	1
Quercus imbricaria	shingle oak	Frequent, occasional		Moist to dry woodlands	1,2
Quercus macrocarpa	bur oak	Rare		ca 5 trees on sandy ridge in bunker area south of North Magazine Road; a few trees in area 2a	1
Quercus palustris	pin oak	Common, frequent		Moist woods	1,2
Ranunculus sceleratus	cursed crowfoot	NA		NA	2
Ratibida pinnata	green-headed coneflower	Occasional, frequent		Roadsides and dry fields	1
Rhexia virginica	Virginia meadow-beauty	Occasional	P	Moist openings and pond margins, south of North Magazine Road and along the angling road	1
Ribes americanum	American currant	NA		NA	2
Ribes cynosbati	Gooseberry	Rare		Woods	3
Riccia sp.	liverwort	NA		NA	2

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Vascular Plant Species Documented On Site
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Robinia pseudoacacia	Black locust	Rare		Old fields and thickets	3
Rosa carolina	pasture rose	Occasional		Dry fields	1
**Rosa multiflora*	multiflora rose	Occasional		Disturbed openings, borders, and thickets	1,2
Rosa setigera	prairie rose	Rare		Grassy roadside and thickets along Patrol Road at Olemacher Ditch	1
Rotala ramosior	toothcup	Occasional		Moist openings and about ponds	1
Rubus allegheniensis	blackberry	Common		Woods, fields, and borders	3
Rubus flagellaris	dewberry	Frequent, common		Dry openings and roadsides on shale, old fields	1
Rubus occidentalis	Black raspberry	common		Dry woods, and borders	2
Rudbeckia hirta	black-eyed susan	Frequent		Dry fields and roadsides	1
**Rumex acetosella*	red sorrel	Occasional		Dry openings over shale	1
**Rumex crispus*	curly dock	Occasional		Roadsides and about buildings	1
Rumex verticillatus	Swamp dock	Rare		Ditches	3
Sagittaria latifolia	broad-leaved arrowhead	Occasional		Ponds and ditches	1
Salix amygdaloides	peachleaf willow	Occasional		Ditches and about ponds	1
Salix discolor	pussy willow	Occasional		Moist openings, ponds, and ditches	1
Salix exigua	sandbar willow	Frequent		Moist openings, stream banks, and ditches	1
Salix nigra	black willow	Common		Moist woods, stream banks, and ditches	1,2
Sambucus canadensis	elder-berry	Frequent, occasional		Moist openings, stream banks, and ditches	1
**Saponaria officinalis*	soapwort	Frequent, occasional		Dry fields, roadsides, and about buildings	1
Sassafras albidum	sassafras	Occasional		Dry woods and borders	1
Schizachyrium scoparium	little bluestem	Frequent		Dry fields and roadsides	1
Scirpus acutus	hardstem bulrush	Rare		Moist depression west of Taft Road	1

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Vascular Plant Species Documented On Site
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Scirpus americanus	Three square	rare		Ditches	3
Scirpus atrovirens	dark green bulrush	Common, occasional		Moist openings, roadsides, and ditches	1
Scirpus cyperinus	woolgrass	Occasional		About artificial ponds	1
Scirpus fluviatilis	river bulrush	Rare		Moist depression west of Taft Road	1
Scirpus pendulus	NA	Occasional		Moist openings	1
Scirpus validus	softstem bulrush	Occasional		Moist openings, ponds, and ditches	1
Scleria triglomerata	tall nut-rush	Rare	P	Moist swale in northern bunker area	1
Scutellaria lateriflora	mad-dog skullcap	Occasional		Moist depressions and ditches	1,2
Senecio aureus	golden ragwort	Occasional		Moist woods borders	1
**Setaria faberi*	nodding foxtail-grass	Occasional, common		Grassy roadsides in the bunker area	1,2
Setaria glauca	Yellow foxtail-grass	NA		NA	2
**Setaria viridis*	green foxtail-grass	Frequent, common		Dry roadsides and about buildings	1
Silphium terebinthinaceum	prairie-dock	Rare		Dry openings at crossing of Patrol Road and Olemacher Ditch	1
Sisyrinchium albidum	prairie blue-eyed-grass	Frequent		Grassy fields	1
Sisyrinchium angustifolium	common blue-eyed-grass	Frequent		Grassy fields	1
**Solanum caroliniense*	horse-nettle	Occasional, common		Dry openings and roadsides	1
**Solanum dulcamara*	bittersweet-nightshade	Occasional		Roadsides, ditches, thickets, and about buildings	1
Solanum nigrum	Black nightshade	Occasional		Fields and waste areas	2
Solidago canadensis	Canada goldenrod	Common		Grassy fields	1
Solidago juncea	early goldenrod	Frequent		Dry to moist fields and roadsides	1
Solidago nemoralis	gray goldenrod	Common		Dry fields and roadsides	1

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Vascular Plant Species Documented On Site
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Solidago riddellii	Riddell's goldenrod	Rare		Moist opening over limestone, west of Snake Road and south of North Magazine Road	1
Sparganium eurycarpum	giant bur-reed	Rare		Wet ditch along Ransom Road	1
Spartina pectinata	prairie cord-grass	Frequent, occasional		Moist depressions, fields, and ditches	1
Spiranthes ochroleuca	creamy ladies'-tresses	Occasional, rare		Ditches and moist openings	1
Sporobolus asper	tall dropseed	Rare		A single stand in dry opening along angling road	1
Sporobolus neglectus	NA	Frequent		Dry openings and road berms	1
Stachys tenuifolia	Hedge nettle	Occasional		Fields	3
Stellaria longifolia	long-leaved stitchwort	Occasional		Moist, grassy fields	1
**Stellaria media*	chickweed	Common		Road berms and about buildings	1
Symphoricarpos orbiculatus	coralberry	Occasional		Thickets, woods borders, and roadsides	1
**Taraxacum officinalis*	dandelion	Frequent, occasional		Roadsides and about buildings	1
Teucrium canadense	American germander	Occasional		Moist openings	1,2
Thelypteris palustris	marsh fern	Occasional, frequent		Moist depressions and roadsides	1
Toxicodendron radicans	Poison ivy	Frequent		Upland and facultative woods, old fields	2
Tradescantia ohioensis	Ohio spiderwort	Occasional		Old fields	2
**Tragopogon pratensis*	Yellow goatsbeard	Rare		Old fields	3
Triadenum virgnianum	pink St. John's-wort	Rare		Moist swale in northern bunker area	1
Tridens flavus	purpletop	Occasional		Moist fields and roadsides	1
Trifolium hybridum	Alsike clover	Occasional		Fields	3
**Trifolium pratense*	red clover	Occasional		Grassy fields and roadsides	1
**Trifolium repens*	common white clover	Common		Grassy roadsides and about buildings	1,2
Triosteum perfoliatum	Wild coffee	Rare		Fields	2

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Vascular Plant Species Documented On Site
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Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Tussilago farfara	coltsfoot	NA		NA	2
Typha angustifolia	Narrow-leaved cattail	frequent		Ditches	3
Typha latifolia	broad-leaved cattail	Frequent		Moist openings, ponds, and ditches	1
Ulmus americana	American elm	Occasional		Moist woods and stream banks	1,2
Ulmus rubra	slippery elm	Occasional		Moist woods and stream banks	1
Urtica dioica var. procera	American stinging nettle	Occasional, common		Moist fields and openings	1
**Verbascum blattaria*	moth-mullein	Occasional, rare		Disturbed fields and roadsides	1
**Verbascum thapsus*	common mullein	Frequent, occasional		Disturbed fields	1
Verbena hastata	purple vervain	Frequent		Moist fields, stream banks, and ditches	1
Verbena simplex	prairie vervain	Rare		A single stand in dry opening along angling road	1
Verbena stricta	Vervain	Occasional		Fields	3
Verbena urticifolia	white vervain	Occasional, frequent		Moist woods borders and roadsides	1,2
Verbesina alternifolia	wingstem	Frequent, occasional		Moist woods borders, stream banks, and ditches	1,2
Vernonia gigantea	tall ironweed	Occasional, frequent		Dry to moist fields	1
**Veronica officinalis*	common speedwell	Occasional		Dry openings on shale	1
**Veronica serpyllifolia*	thyme-leaved speedwell	Occasional		Roadsides and about buildings	1
Viburnum lentago	nannyberry	Frequent		Moist thickets and borders	1
Vicia americana	American vetch	Rare		Old field	3
Viola canadensis	Canada violet	NA		NA	2
Viola cucullata	violet	NA		NA	2
Viola lanceolata	lance-leaved violet	Frequent	P	Ditches and moist openings	1
Viola sagittata	arrow-leaved violet	Frequent		Grassy fields and dry banks	1
Viola sororia	common blue violet	Common, occasional		Grassy fields, roadsides, and about buildings	1

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Vascular Plant Species Documented On Site
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Vitis aestivalis	summer grape	NA		NA	2
Vitis riparia	riverbank grape	Frequent		Woods borders, thickets, and stream banks	1,2
Vitis vulpina	fox grape	Occasional		Woods borders and thickets	1
Zanichellia palustris	horned pondweed	Rare		Artificial pond west of Snake Road	1
Zizia aurea	Golden alexanders	Rare		Old fields	3

[a] Common = Species which occur in large numbers throughout.
[b] T = Ohio Threatened Species.
[c] 1 = Biological Inventory of Plum Brook Station (Ohio Department of Natural Resources, 1994).

Frequent = Species regularly encountered, but occurring in lesser numbers than common ones.
Occasional = Species found in several places, but never present in large numbers.
Rare = Species found in few places and in low numbers.
P = Ohio Potentially Threatened Species.
E = Ohio Endangered Species.
2 =Shaw site reconnaissance September 11 and 12, 2000 and May 21, 2001.
3=Observed during a site reconnaissance at another Plum Brook site.
NA – Not available

* Non-native species.

APPENDIX B

ECOLOGICAL SCREENING VALUES

Table B-1

Ecological Screening Values for Soil
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	EPA Eco-SSLs [a] (mg/kg)	Eco Endpoints PRGs [b] (mg/kg)	EPA Region V ESL [c] (mg/kg)	Tox. Benchmark [d] (earthworm only) (mg/kg)	Tox Benchmarks [e] Terrestrial Plants (mg/kg)	Selected ESV (mg/kg)	Reference
Inorganic Analytes								
Aluminum	7429-90-5	pH Dependent	NSV	NSV	NSV	50	pH Dependent	a
Antimony	7440-36-0	0.27	5	0.142	NSV	5	0.27	a
Arsenic	7440-38-2	18	9.9	5.7	60	10	18	a
Barium	7440-39-3	330	283	1.04	NSV	500	330	a
Beryllium	7440-41-7	21	10	1.06	NSV	10	21	a
Cadmium	7440-43-9	0.36	4	0.00222	20	4	0.36	a
Calcium	7440-70-2	NSV	NSV	NSV	NSV	NSV	Nutrient	
Chromium	7440-47-3	26	0.4	0.4	0.4	1	26	a
Chromium, hexavalent	18540-29-9	81	NSV	NSV	NSV	NSV	81	a
Cobalt	7440-48-4	13	20	0.14	NSV	20	13	a
Copper	7440-50-8	28	60	5.4	50	100	28	a
Iron	7439-89-6	pH Dependent	NSV	NSV	NSV	NSV	pH Dependent	a
Lead	7439-92-1	11	40.5	0.0537	500	50	11	a
Magnesium	7439-95-4	NSV	NSV	NSV	NSV	NSV	Nutrient	
Manganese	7439-96-5	220	NSV	NSV	NSV	500	220	a
Mercury	7439-97-6	NSV	0.00051	0.1	0.1	0.3	0.00051	b
Nickel	7440-02-0	38	30	13.6	200	30	38	a
Potassium	7440-09-7	NSV	NSV	NSV	NSV	NSV	Nutrient	
Selenium	7782-49-2	0.52	0.21	0.0276	70	1	0.52	a
Silver	7440-22-4	4.2	2	4.04	NSV	2	4.2	a
Sodium	7440-23-5	NSV	NSV	NSV	NSV	NSV	Nutrient	
Thallium	7440-28-0	NSV	1	0.0569	NSV	1	1	b
Vanadium	7440-62-2	7.8	2	1.59	NSV	2	7.8	a
Zinc	7440-66-6	46	8.5	6.62	200	50	46	a
Cyanide								
Cyanide, Total	57-12-5	NSV	NSV	1.33	NSV	NSV	1.33	c
Polychlorinated Biphenyls								
Aroclor 1016	12674-11-2	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371	b
Aroclor 1260	11096-82-5	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371	b
Organochlorine Pesticides								
4,4'-DDE	72-55-9	0.021 [g]	NSV	0.596	NSV	NSV	0.021	a
4,4'-DDT	50-29-3	0.021 [g]	NSV	0.0035	NSV	NSV	0.021	a
Methoxychlor	72-43-5	NSV	NSV	0.0199	NSV	NSV	0.0199	c
Semivolatile Organic Compounds								
Acenaphthylene	208-96-8	29	NSV	682	NSV	NSV	29	a
Anthracene	120-12-7	29	NSV	1480	NSV	NSV	29	a
Benzo(a)anthracene	56-55-3	1.1	NSV	5.21	NSV	NSV	1.1	a
Benzo(a)pyrene	50-32-8	1.1	NSV	1.52	NSV	NSV	1.1	a
Benzo(b)fluoranthene	205-99-2	1.1	NSV	59.8	NSV	NSV	1.1	a
Benzo(ghi)perylene	191-24-2	1.1	NSV	119	NSV	NSV	1.1	a
Benzo(k)fluoranthene	207-08-9	1.1	NSV	148	NSV	NSV	1.1	a

Table B-1

Ecological Screening Values for Soil
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	EPA Eco-SSLs [a] (mg/kg)	Eco Endpoints PRGs [b] (mg/kg)	EPA Region V ESL [c] (mg/kg)	Tox. Benchmark [d] (earthworm only) (mg/kg)	Tox Benchmarks [e] Terrestrial Plants (mg/kg)	Selected ESV (mg/kg)	Reference
Benzoic acid	65-85-0	NSV	NSV	NSV	NSV	NSV	NSV	
bis(2-Ethylhexyl)phthalate	117-81-7	NSV	NSV	0.925	NSV	NSV	0.925	c
Chrysene	218-01-9	1.1	NSV	4.73	NSV	NSV	1.1	a
Di-n-butyl phthalate	84-74-2	NSV	200	0.15	NSV	200	200	b
Fluoranthene	206-44-0	1.1	NSV	122	NSV	NSV	1.1	a
Indeno(1,2,3-cd)pyrene	193-39-5	1.1	NSV	109	NSV	NSV	1.1	a
Naphthalene	91-20-3	29	NSV	0.0994	NSV	NSV	29	a
Phenanthrene	85-01-8	29	NSV	45.7	NSV	NSV	29	a
Pyrene	129-00-0	1.1	NSV	78.5	NSV	NSV	1.1	a
Volatile Organic Compounds								
Acetone	67-64-1	NSV	NSV	2.5	NSV	NSV	2.5	c
Bromomethane	74-83-9	NSV	NSV	0.235	NSV	NSV	0.235	c
Methylene chloride	75-09-2	NSV	NSV	4.05	NSV	NSV	4.05	c
Toluene	108-88-3	NSV	200	5.45	NSV	200	200	b
Xylene, Total	1330-20-7	NSV	NSV	10	NSV	NSV	10	c

EPA = U.S. Environmental Protection Agency
ESV = Ecological screening value
NSV = No screening value available
mg/kg = milligrams per kilogram

Priority for Selection of ESVs:
1) EPA Eco-SSL
2) PRG for Eco Endpoints, (Efroymson, et.al, 1997a);
3) EPA Region 5 Ecological Screening Levels;
4) Efroymson, 1997b.

[a] EPA, 2008, Ecological Soil Screening Level (SSL) guidance. On-line at: http://www.epa.gov/ecotox/ecossl/index.html
[b] Efroymson, 1997a, *Preliminary Remediation Goals for Ecological Endpoints*. www.esd.ornl.gov/programs/ecorisk/documents/tm162r2.pdf .
[c] Screening value based on: EPA , 2003, *Region 5 Ecological Screening Level (ESL)*, Website version last updated August 22, 2003: http://www.epa.gov/Region5/rcraca/edql.htm.
[d] Efroymson, R.A., M.E. Will, G.W. Suter, 1997b, Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision, ES/ER/TM-126/R2 (microbial screening values are not included). http://www.esd.ornl.gov/programs/ecorisk/documents/tm126r21.pdf.
[e] Efroymson, R.A., M.E. Will, G.W. Suter, 1997c, Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision, ES/ER/TM-85/R3. http://www.esd.ornl.gov/programs/ecorisk/documents/tm85r3.pdf
[f] Based on the screening value for total PCBs.
[g] Based on the screening value for DDT and metabolites.

Table B-2

Ecological Screening Values for Surface Water
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	Ohio Water Quality Criteria [a] µg/L		Eco PRG [b] µg/L	EPA Region 5 ESV [c] µg/L	Selected Surface Water ESV [d] µg/L
Inorganic Analytes						
Aluminum	7429-90-5	NSV		87	NSV	87
Barium	7440-39-3	220		4	220	4
Calcium	7440-70-2	NSV		NSV	NSV	Nutrient
Cobalt	7440-48-4	24		23	24	23
Iron	7439-89-6	NSV		1000	NSV	1000
Lead	7439-92-1	21	e	3.2	1.17	1.17
Magnesium	7439-95-4	NSV		NSV	NSV	Nutrient
Manganese	7439-96-5	NSV		120	NSV	120
Nickel	7440-02-0	130	e	160	28.9	28.9
Potassium	7440-09-7	NSV		NSV	NSV	Nutrient
Sodium	7440-23-5	NSV		NSV	NSV	Nutrient
Vanadium	7440-62-2	44		20	12	12
Zinc	7440-66-6	300	e	110	65.7	65.7
Semivolatile Organic Compounds						
bis(2-Ethylhexyl)phthalate	117-81-7	NSV		0.12	0.3	0.12

COPEC = Chemical of potential ecological concern
ESV = Ecological screening value
µg/L = microgram per liter
NSV = No screening value available

[a] Ohio Environmental Protection Agency (OEPA, 2002), Division of Surface Water, Water Quality Standards, Chapter 3745-1 of the Ohio Administrative Code, Dec 30. http://www.epa.state.oh.us/dsw/rules/3745-1.html. Value is the Outside Mixing Zone Average value.

[b] *Preliminary Remediation Goals (PRG) for Ecological Endpoints* , (Efroymson et. al., 1997).

[c] Screening value based on: EPA , 2003, *Region 5 Ecological Screening Level* , Website version last updated August 22, 2003: http://www.epa.gov/Region5/rcraca/edql.htm.

[d] Surface water ESVs are selected by choosing the minimum screening value based on the three sources provided.

Table B-3

Ecological Screening Values for Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	TEC [a] mg/kg	EPA Region 5 ESV [b] mg/kg	Ecological PRG [c] mg/kg	Ontario Sediment Quality Guidelines [d] mg/kg	Selected ESV [e] mg/kg
Inorganic Analytes						
Aluminum	7429-90-5	NSV	NSV	NSV	NSV	NSV
Arsenic	7440-38-2	9.79	9.79	42	6	9.79
Barium	7440-39-3	NSV	NSV	NSV	NSV	NSV
Beryllium	7440-41-7	NSV	NSV	NSV	NSV	NSV
Cadmium	7440-43-9	0.99	0.99	4.2	0.6	0.99
Calcium	7440-70-2	NSV	NSV	NSV	NSV	NSV
Chromium	7440-47-3	43.4	43.4	159	26	43.4
Cobalt	7440-48-4	NSV	50	NSV	50	50
Copper	7440-50-8	31.6	31.6	77.7	16	31.6
Iron	7439-89-6	NSV	NSV	NSV	NSV	NSV
Lead	7439-92-1	35.8	35.8	110	31	35.8
Magnesium	7439-95-4	NSV	NSV	NSV	NSV	NSV
Manganese	7439-96-5	NSV	NSV	NSV	460	460
Mercury	7439-97-6	0.18	0.174	0.7	0.2	0.18
Nickel	7440-02-0	22.7	22.7	38.5	16	22.7
Potassium	7440-09-7	NSV	NSV	NSV	NSV	NSV
Selenium	7782-49-2	NSV	NSV	NSV	NSV	NSV
Silver	7440-22-4	NSV	0.5	1.8	0.5	0.5
Sodium	7440-23-5	NSV	NSV	NSV	NSV	NSV
Vanadium	7440-62-2	NSV	NSV	NSV	NSV	NSV
Zinc	7440-66-6	121	121	270	120	121
Nitroaromatics						
2,4,6-Trinitrotoluene	118-96-7	NSV	NSV	NSV	NSV	NSV
Semivolatile Organic Compounds						
Fluoranthene	206-44-0	NSV	0.423	0.834	0.75	0.423

ESV = Ecological screening value
mg/kg = milligrams per kilogram
NSV = No screening value available

Priority for Selection of ESVs:

1. Threshold effect concentrations (MacDonald et al., 2000)
2. EPA Region 5 ESLs (EPA, 2003)
3. Sediment PRGs (Efroymson, 1997)
4. Sediment quality criteria (OME, 1993)

Table B-3

Ecological Screening Values for Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

[a] Threshold Effect Concentrations (TECs), MacDonald, et al., 2000 (MacDonald, 2000). Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch Environ Contam Toxicol 39:20-31.

[b] Screening value based on: EPA , 2003, *Region 5 Ecological Screening Level* , Website version last updated August 22, 2003: http://www.epa.gov/Region5/rcraca/edql.htm.

[c] Efroymson,et. al., 1997, *Preliminary Remediation Goals for Ecological Endpoints* .

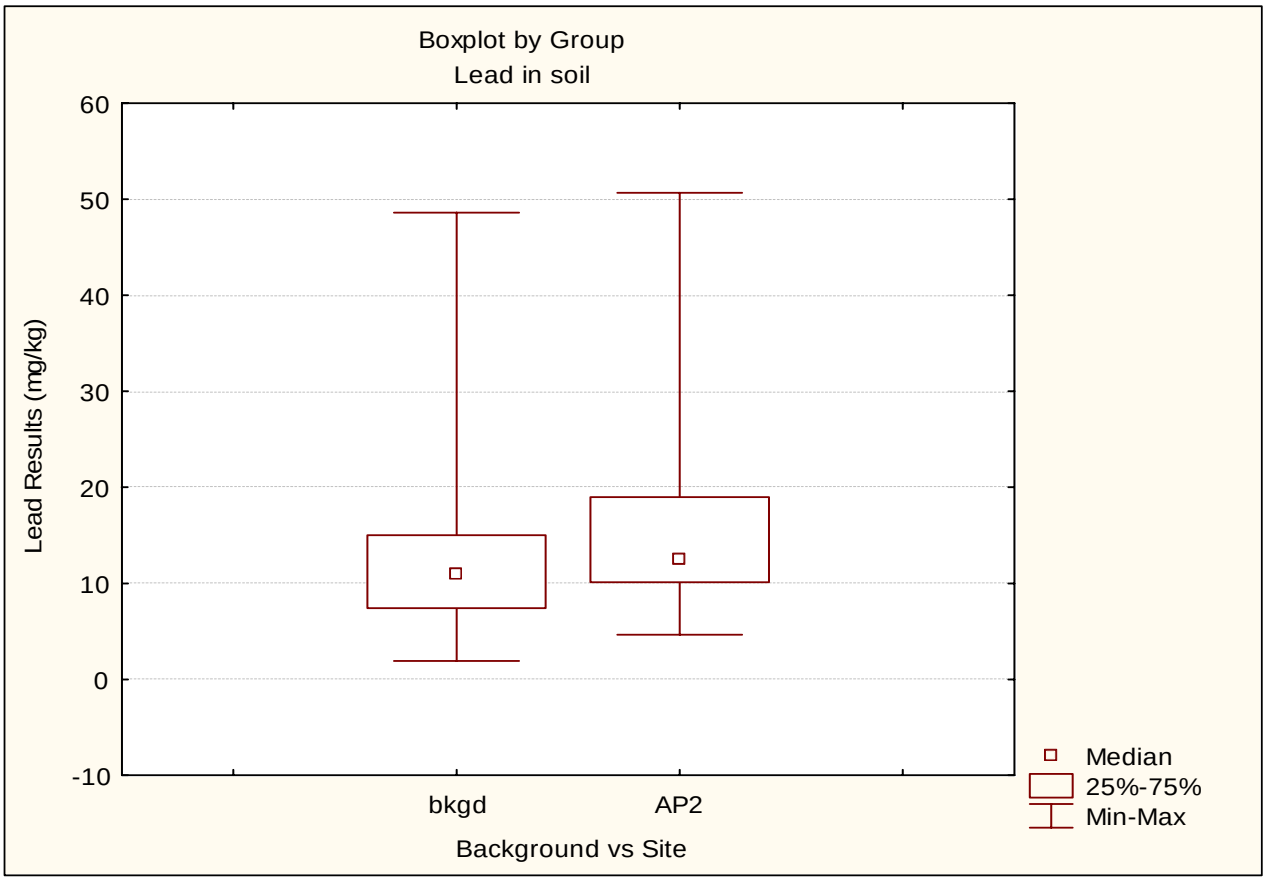
[d] Ontario Ministry of the Environment, 1993 (OME, 1993). Persaud, et al. *Guidelines for the Protection and Management of Aquatic* Sediment Quality in Ontario. August.

APPENDIX C

WILCOXON RANK SUM TEST RESULTS AND BOX PLOTS FOR LEAD

Appendix C

Wilcoxon Rank Sum Test Results and Box Plots for Concentrations of Lead in Background Samples Vs. Power House 2 Ash Pits



Summary Statistics for the Wilcoxon Rank Sum Test for Lead in Background Compared With Ash Pit 2

	Rank Sum	Rank Sum	U	Z	p-level	Z	p-level	Valid N	Valid N	2*1sided
Lead	730.0000	1481.000	379.0000	-1.85036	0.064263	-1.85059	0.064230	26	40	0.064944

APPENDIX D

ASSESSMENT RECEPTOR PROFILES

Appendix D

Assessment Receptor Profiles

Eastern Cottontail (Sylvilagus floridanus). These medium-size grazing herbivores are found over most of the eastern half of the United States and southern Canada, and have been widely introduced into the western U.S. Environmental Protection Agency ([EPA], 1993). The eastern cottontail is unique to the genus because of the large variety of habitats that it occupies, including glades and woodlands, deserts, swamps, prairies, hardwood forests, rain forests, and boreal forests (EPA, 1993). Open grassy areas are generally are used for grazing at night, whereas dense, heavy cover typically is used for shelter during the day (EPA, 1993). During the summer seasons these rabbits consume herbaceous plants (e.g. grasses, clover, timothy, and alfalfa), whereas winter diet typically consists of woody vines, shrubs and trees (e.g.. birch, maple, and apple) (EPA, 1993). Home range is 3 to 20 acres, with larger ranges in the summer and smaller ranges in the winter (Burt and Grossenheider, 1980). Populations fluctuate from 1 to 4 cottontail per four acres to several per acre in winter conditions (Burt and Grossenheider, 1980). The eastern cottontail breeds from February through September and usually produces 3 to 4 litters per year of 1 to 9 young (usually 4 to 5); however, this rabbit's' death rate vies with its birth rate, and few rabbits live for more than one year (Whitaker, 1995). The average longevity is 1.25 years (EPA, 1993).

References:

Burt, W. H. and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

Deer Mouse (Peromyscus maniculatus). This medium-sized mouse is found in the eastern United States from the Hudson Bay to Pennsylvania, the southern Appalachians, central Arkansas, and central Texas. In the west it is found from Mexico to the south Yukon and north-west territories (Whitaker, 1995). Deer mice habitat includes nearly every dry land habitat within its range, including forest, grasslands, or a mixture of the two (Burt and Grossenheider, 1980). Nocturnal and active year-round, these mice construct nests in the ground, trees, stumps,

and buildings (Burt and Grossenheider, 1980). Omnivorous, the deer mouse feeds on nuts and seeds (e.g., jewel weed and black cherry pits), fruits, beetles, caterpillars, and other insects. Deer mice may cache their food during the fall and winter in the more northern parts of their range (EPA, 1993). Home range is 0.15 to 3 acres (Burt and Grossenheider, 1980; EPA, 1993). Density of populations is 4 to 12 mice per acre, and average life span is 2 years in the wild (Burt and Grossenheider, 1980). The breeding season is from February to November, depending on latitude. Three to five young are born in each of two to four litters per year (Burt and Grossenheider, 1980). They are greyish to reddish-brown with a white belly, with a distinctly short-haired, bicolor tail (Whitaker, 1995). Weight range is 14.8 (EPA, 1993) to 33 grams (Whitaker, 1995).

References:

Burt, W. H. and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

Mallard Duck (Anas platyrhynchos). The mallard duck is widespread throughout most of the United States and is the most abundant of the United States ducks. It is large, migratory duck with an average body size of 58 centimeters from bill to tail tip. Wintering mallards prefer the natural bottom-land wetlands and rivers where water depths are 20 to 40 centimeters. The primary habitat requirement for nesting is thought to be dense grassy vegetation. Nests are generally located within a few kilometers of water (EPA, 1993).

In winter, mallards feed primarily on seeds, invertebrates, agricultural grains and, to a limited extent, leaves, stems, buds, rootlets, and tubers. In spring, females shift mostly to a diet of invertebrates to support molting and egg laying activities. Ducklings also feed mainly on invertebrates to help support their rapid growth rates. Mallards are serially monogamous and remate annually. Each pair of mallards establishes a territory and the drake defends it against other mallards. Average home range size varies, depending upon the type of habitat available. High rates of nest failure require the females to renest persistently, with average clutch size decreasing as the breeding season progresses. Annual adult mortality rates vary with year,

depending on location, hunting pressure, age, and sex. Females suffer greater natural mortality rates than do males (EPA, 1993).

The typical home range of the mallard is from 540 to 620 hectares (ha) for adult female and male birds, respectively, for wetlands and river habitat in Minnesota (USEPA, 1993). For the current ERA, an average home range of 580 ha was used. The typical migration schedule is from mid-March through mid-May for the spring migration. The fall migration typically starts in mid-October, and peaks in November (USEPA, 1993).

References:

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Red-Tailed Hawk (Buteo jamacensis). This carnivorous hawk is one of the most common and widespread members of the genus *Buteo* in the continental United States and Canada (Brown and Amadon, 1968). Red-tailed hawks live in a variety of habitats, such as farmlands, woodlands, mountains, and deserts, as long as there is open country interdispersed with woods, bluffs, or streamside trees. They are primarily carnivorous, feeding on (greater than 85 percent) small rodents, as well as fish. Other prey items include amphibians, reptiles, crayfish, and other birds (Adamcik, et al., 1979; Ehrlich, et al., 1988). Home range has been reported as approximately 66.8 acres, with a population density of 0.16 pairs per acre (Janes, 1984), although EPA (1993) reports an average territory size of 842 hectares (2,080 acres). Breeding population density is one nest per 0.009 acre or one individual per 0.004 acre. Body weight for male red-tails is 1,028.6 to 1,142.9 grams, and for females 1,371.4 to 1,600 grams (Brown and Amadon, 1968), although EPA (1993) reports an average body weight of 957 grams. They typically mate for life or until one of the pair dies, with pairs clinging to territories year after year (Austing, 1964).

References:

Adamcik, R. S., A. W. Todd, and L. B. Keith, 1979, "Demographic and Dietary Responses of Red-Tailed Hawks During a Snowshoe Hare Fluctuation," ***Canadian Field Naturalist***, Vol. 93, pp. 16-27.

Austing, G. R., 1964, ***The World of the Red-Tailed Hawk***, J. B. Lippincott Co., Philadelphia.

Brown, L. and D. Amadon, 1968, ***Eagles, Hawks, and Falcons of the World***, Vol. 1, McGraw-Hill Book Company, New York.

Ehrlich, P. R., D. S. Dobkin, and D. Wheye, 1988, ***The Birder's Handbook: A field guide to the Natural History of North American Birds***, Simon and Shuster, Inc., New York.

Janes, S. W., 1984, "Influences of Territory Composition and Interspecific Competition on Red-Tailed Hawk Reproductive Success," ***Ecology***, 65:862-870.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Raccoon (Procyon lotor). Raccoons are native only in the Americas. Their range extends from the southern edge of the southern provinces of Canada and most of the United States, except for portions of the Rocky Mountain states, central Nevada, and Utah (Whitaker, 1995). The raccoon weighs from 3 to 15 kilograms (Merritt, 1987; EPA, 1993) and has a head and body length of 46 to 71 centimeters and a tail length of 20 to 30 centimeters (Burt and Grossenheider, 1980). The raccoon is nocturnal and solitary, except when breeding or caring for its young. During particularly cold spells, the raccoon may sleep for several days at a time but does not hibernate (Whitaker, 1995). The raccoon is found along lakes near wooded areas or rock cliffs (Burt and Grossenheider, 1980), but prefers wooded streams (Whitaker, 1995). The raccoon is highly omnivorous and is an opportunistic feeder, consuming virtually any animal or plant matter that is available (Merritt, 1987; EPA, 1993). Animal matter predominates the diet during the spring and early summer; plant matter predominates during late summer, autumn, and winter (Merritt, 1987; EPA, 1993). The home range of the raccoon extends up to 3.2 kilometers across, but usually it is less than 1.6 kilometers. Population densities range from one per acre (highest) to one per 15 acres (considered high) (Burt and Grossenheider, 1980). Captive raccoons live for approximately 14 years (Burt and Grossenheider, 1980). Average body weight is 5.1 kilograms (EPA, 1993).

References:

Burt, W. H., and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

Merritt, J. F., 1987, ***Guide to the Mammals of Pennsylvania***, University of Pittsburgh Press, Pennsylvania.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook, Volume I of II***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

Short-tailed Shrew (Blarina brevicauda). This shrew is the largest found in North America. It is solid grey above and below, with a short tail, and weighs between 15 and 29 grams (Whitaker, 1995). Total length of this shrew is 76 to 102 millimeters (Burt and Grossenheider, 1980). The range of this shrew extends from southeastern Canada and the northeastern U.S. to Nebraska, Missouri, Kentucky, and in the mountains to Alabama (Whitaker, 1995). Preferable habitat for the shrew includes forests, grasslands, marshes, and brushy areas. It will make a nest of dry leaves, grass, and hair beneath logs, stumps, rocks, or debris (Burt and Grossenheider, 1980). This underground tunneler may burrow as deep as 6 feet, and has a voracious appetite, eating one half of its own body weight per day of earthworms, other terrestrial vertebrates, and sometimes young mice (Whitaker, 1995). Mean population densities range from 5.7 in the winter, to 28 per acre in the summer (EPA, 1993). Their home range varies from 0.5 to 1 acre (Burt and Grossenheider, 1980). Longevity is typically around 20 months (EPA, 1993), with five to eight young born to each of two to three litters (Burt and Grossenheider, 1980).

References:

Burt, W. H. and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

White-tailed Deer (Odocoileus virginianus). The white-tailed deer is a member of the Family Cervidae. They are large, even-toed, hoofed mammals with long legs. Their coat is predominantly light brown or chestnut colored, with the underparts being white. Deer are primarily herbivorous grazers and browsers, constantly moving from one food source to the next. The deer's diet changes seasonally. When available, farm crops such as winter wheat, corn, alfalfa, soy beans, and hay are important components of the species diet. Other top food items include wild crab apples, sumac, grasses, green briar, clover, jewelweed, acorns, and dogwood. In regions where the climate varies from season to season, deer may make annual migrations of 10 to 20 miles in the search for food. However, in Ohio, deer typically have rather small home ranges (2 to 3 square miles) and are reluctant to leave this range. The average weight for the species is 88 kilograms for males and 61 kilograms for females. Breeding season ranges from November through February, with the young offspring born in May and early June. Virtually

all yearling and adult does conceive each year, and in Ohio usually carry twins. Triplets and quadruplets have also been recorded Gottschang (1981).

References:

Gottschang, J. L., 1981, ***A Guide to the Mammals of Ohio***, The Ohio State University Press, pp. 143-149.

Marsh Wren (Cistothorus palustris). The marsh wren is a small bird (4 to 4.5 inches in length) which inhabits freshwater cattail marshes and salt marshes. Nesting pairs are not likely to occupy other habitats and the species avoids the wet meadow and sedge meadow habitats preferred by sedge wrens. Marsh wrens breed throughout most of the northern half of the United States and in coastal areas as far south as Florida. The species eats mostly insects, and occasionally snails and other invertebrates. The average body weight is 0.01 kilograms, and the average home range for the species is 0.054 hectares. Because the species is polygamous, there may be more females than males inhabiting a breeding marsh. Densities as high as 120 birds per hectare have been recorded (EPA, 1993). Marsh wrens' nests are globular structures placed at heights of 2 to 5 feet in dense vegetation. The males commonly build dummy nests in addition to the one where the eggs will be laid (Peterjohn and Rice, 1991).

References:

U.S. Environmental Protection Agency (EPA), Office of Research and Development, 1993, ***Wildlife Exposure Factors Handbook***, EPA/600/R-93/187a.

Peterjohn, B. G., and Rice, D. L., 1991, ***The Ohio Breeding Bird Atlas***, The Ohio Department of Natural Resources.

Muskrat (Ondata zibethicus). The muskrat is a member of the Family Muridaee. Muskrats are the most aquatic of this family of rodents, and spend much of their lives in or near bogs, marshes, lakes or streams. Their diet consists primarily of aquatic vegetation (in particular the roots or basal portions of aquatic plants), although they can be omnivorous if other food sources are more common. Marsh grasses, sedges, and cattails are important muskrat food items. They are indigenous and common throughout most of the United States. Muskrats have relatively small home ranges that vary in configuration based on the physical attributes of their aquatic habitat. The average weight for the species is approximately 1.3 kilograms for males and 1.2 kilograms for females during the winter, and 0.9 kg for males and 0.8 kg for females during the spring. Muskrats typically breed during the first spring after birth, and typically

produce 1-12 pups, with southern populations producing more litters, but fewer pups per litter compared with northern populations (EPA, 1993).

References:

U.S. Environmental Protection Agency (EPA), Office of Research and Development, 1993, ***Wildlife Exposure Factors Handbook***, EPA/600/R-93/187a.

APPENDIX E

FOOD CHAIN MODEL EXPOSURE DOSES AND HAZARD QUOTIENTS

Table E-1

Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Deer Mouse
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	
Metals																													
Aluminum	8.70E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	780							1.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-01	1.93E+00	6.70E-02	1.93E+01	6.70E-03
Barium	4.97E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	146							7.38E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.38E-03	5.10E+00	1.45E-03	1.98E+01	3.73E-04
Cadmium	0.00E+00	mg/L	0.00E+00	mg/kg	6.50E-01	mg/kg	1.00E+00			9.05E+00	NA	7.56E-01	3.57E-01	3.57E-01	0.00E+00	0.00E+00	2.46E-03	0.00E+00	0.00E+00	4.34E-01	NA	5.67E-02	0.00E+00	0.00E+00	4.93E-01	1.00E+00	4.93E-01	1.00E+01	4.93E-02
Lead	2.87E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							4.27E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.27E-04	8.00E+00	5.34E-05	8.00E+01	5.34E-06
Mercury	0.00E+00	mg/L	0.00E+00	mg/kg	7.96E-02	mg/kg	1.00E+00			5.89E+00	NA	1.18E+00	1.92E-01	1.92E-01	0.00E+00	0.00E+00	3.01E-04	0.00E+00	0.00E+00	3.46E-02	NA	1.08E-02	0.00E+00	0.00E+00	4.57E-02	1.32E+01	3.46E-03	1.32E+02	3.46E-04
Selenium	0.00E+00	mg/L	0.00E+00	mg/kg	1.66E+00	mg/kg	1.00E+00			8.11E-01	NA	5.33E-01	4.81E-01	4.81E-01	0.00E+00	0.00E+00	6.27E-03	0.00E+00	0.00E+00	9.92E-02	NA	1.02E-01	0.00E+00	0.00E+00	2.07E-01	2.00E-01	1.04E+00	3.30E-01	6.28E-01
Thallium	0.00E+00	mg/L	0.00E+00	mg/kg	1.68E+00	mg/kg	1.00E+00			3.00E-01		2.20E-03	1.23E-01	1.23E-01	0.00E+00	0.00E+00	6.37E-03	0.00E+00	0.00E+00	3.73E-02	0.00E+00	4.27E-04	0.00E+00	0.00E+00	4.40E-02	7.40E-03	5.95E+00	7.40E-02	5.95E-01
Explosives																													
2,4,6-Trinitrotoluene	0.00E+00	mg/L	6.47E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		4.67E+00		4.23E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	2.00E+00	0.00E+00
Semivolatile Organics																													
Bis(2-ethylhexyl) phthalate	2.00E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	350							2.97E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E-04	1.83E+01	1.62E-05	1.83E+02	1.62E-06

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ =Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0.61	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0.39	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.000056	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.0028	kg/d
Body weight =	0.0148	kg
Home range =	0.153	acres
Water intake rate =	0.0022	L/d
Site Area =	5	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table E-2

Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Short-Tailed Shrew
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Total Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV_{NOAEL}	HQ_{NOAEL}	TRV_{LOAEL}	HQ_{LOAEL}
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	8.70E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	780							1.33E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.33E-01	1.93E+00	6.91E-02	1.93E+01	6.91E-03
Barium	4.97E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	146							7.61E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.61E-03	5.10E+00	1.49E-03	1.98E+01	3.84E-04
Cadmium	0.00E+00	mg/L	0.00E+00	mg/kg	5.32E-01	mg/kg	1.00E+00			9.43E+00	NA	8.28E-01	3.97E-01	3.97E-01	0.00E+00	0.00E+00	8.11E-03	0.00E+00	0.00E+00	7.35E-01	NA	0.00E+00	0.00E+00	0.00E+00	7.44E-01	1.00E+00	7.44E-01	1.00E+01	7.44E-02
Lead	2.87E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							4.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.41E-04	8.00E+00	5.51E-05	8.00E+01	5.51E-06
Mercury	0.00E+00	mg/L	0.00E+00	mg/kg	5.28E-02	mg/kg	1.00E+00			7.76E+00	NA	1.42E+00	1.92E-01	1.92E-01	0.00E+00	0.00E+00	8.05E-04	0.00E+00	0.00E+00	6.01E-02	NA	0.00E+00	0.00E+00	0.00E+00	6.09E-02	1.32E+01	4.61E-03	1.32E+02	4.61E-04
Selenium	0.00E+00	mg/L	0.00E+00	mg/kg	1.22E+00	mg/kg	1.00E+00			8.81E-01	NA	5.17E-01	5.84E-01	5.84E-01	0.00E+00	0.00E+00	1.85E-02	0.00E+00	0.00E+00	1.57E-01	NA	0.00E+00	0.00E+00	0.00E+00	1.76E-01	2.00E-01	8.78E-01	3.30E-01	5.32E-01
Thallium	0.00E+00	mg/L	0.00E+00	mg/kg	1.67E+00	mg/kg	1.00E+00			3.00E-01		2.20E-03	1.23E-01	1.23E-01	0.00E+00	0.00E+00	2.55E-02	0.00E+00	0.00E+00	7.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.91E-02	7.40E-03	1.34E+01	7.40E-02	1.34E+00
Explosives																													
2,4,6-Trinitrotoluene	0.00E+00	mg/L	6.47E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		4.67E+00		4.23E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	2.00E+00	0.00E+00
Semivolatile Organics																													
Bis(2-ethylhexyl) phthalate	2.00E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	350							3.07E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.07E-04	1.83E+01	1.67E-05	1.83E+02	1.68E-06

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi\,x\,Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ =Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	1	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.0002288	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.0022	kg/d
Body weight =	0.015	kg
Home range =	0.96	acres
Water intake rate =	0.0023	L/d
Site Area =	5	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table E-3

Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Cottontail Rabbit
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	8.70E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	780							5.52E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.52E-02	1.93E+00	2.86E-02	1.93E+01	2.86E-03
Barium	4.97E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	146							3.15E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.15E-03	5.10E+00	6.17E-04	1.98E+01	1.59E-04
Cadmium	0.00E+00	mg/L	0.00E+00	mg/kg	6.50E-01	mg/kg	1.00E+00			9.05E+00	NA	7.56E-01	3.57E-01	3.57E-01	0.00E+00	0.00E+00	2.27E-03	0.00E+00	0.00E+00	0.00E+00	NA	2.72E-02	0.00E+00	0.00E+00	2.95E-02	1.00E+00	2.95E-02	1.00E+01	2.95E-03
Lead	2.87E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							1.82E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.82E-04	8.00E+00	2.28E-05	8.00E+01	2.28E-06
Mercury	0.00E+00	mg/L	0.00E+00	mg/kg	7.96E-02	mg/kg	1.00E+00			5.89E+00	NA	1.18E+00	1.92E-01	1.92E-01	0.00E+00	0.00E+00	2.78E-04	0.00E+00	0.00E+00	0.00E+00	NA	5.19E-03	0.00E+00	0.00E+00	5.47E-03	1.32E+01	4.14E-04	1.32E+02	4.14E-05
Selenium	0.00E+00	mg/L	0.00E+00	mg/kg	1.66E+00	mg/kg	1.00E+00			8.11E-01	NA	5.33E-01	4.81E-01	4.81E-01	0.00E+00	0.00E+00	5.78E-03	0.00E+00	0.00E+00	0.00E+00	NA	4.89E-02	0.00E+00	0.00E+00	5.47E-02	2.00E-01	2.73E-01	3.30E-01	1.66E-01
Thallium	0.00E+00	mg/L	0.00E+00	mg/kg	1.68E+00	mg/kg	1.00E+00			3.00E-01		2.20E-03	1.23E-01	1.23E-01	0.00E+00	0.00E+00	5.87E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-04	0.00E+00	0.00E+00	6.07E-03	7.40E-03	8.21E-01	7.40E-02	8.21E-02
Explosives																													
2,4,6-Trinitrotoluene	0.00E+00	mg/L	6.47E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		4.67E+00		4.23E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	2.00E+00	0.00E+00
Semivolatile Organics																													
Bis(2-ethylhexyl) phthalate	2.00E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	350							1.27E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E-04	1.83E+01	6.92E-06	1.83E+02	6.93E-07

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ =Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	1	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.006048	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.096	kg/d
Body weight =	1.132	kg
Home range =	7.66	acres
Water intake rate =	0.11	L/d
Site Area =	5	acres
Area Use Factor (AUF) =	0.65274151	unitless

Table E-4

Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Marsh Wren
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	8.70E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	780							2.35E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-01	1.10E+02	2.13E-03	1.10E+03	2.13E-04
Barium	4.97E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	146							1.34E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-02	2.08E+01	6.44E-04	4.17E+01	3.21E-04
Cadmium	0.00E+00	mg/L	0.00E+00	mg/kg	6.50E-01	mg/kg	1.00E+00			9.05E+00	NA	7.56E-01	3.57E-01	3.57E-01	0.00E+00	0.00E+00	3.77E-03	0.00E+00	0.00E+00	1.71E+00	NA	0.00E+00	0.00E+00	0.00E+00	1.71E+00	1.45E+00	1.18E+00	2.00E+01	8.54E-02
Lead	2.87E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							7.76E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.76E-04	1.13E+00	6.86E-04	1.13E+01	6.86E-05
Mercury	0.00E+00	mg/L	0.00E+00	mg/kg	7.96E-02	mg/kg	1.00E+00			5.89E+00	NA	1.18E+00	1.92E-01	1.92E-01	0.00E+00	0.00E+00	4.62E-04	0.00E+00	0.00E+00	1.36E-01	NA	0.00E+00	0.00E+00	0.00E+00	1.36E-01	4.50E-01	3.03E-01	9.00E-01	1.52E-01
Selenium	0.00E+00	mg/L	0.00E+00	mg/kg	1.66E+00	mg/kg	1.00E+00			8.11E-01	NA	5.33E-01	4.81E-01	4.81E-01	0.00E+00	0.00E+00	9.62E-03	0.00E+00	0.00E+00	3.90E-01	NA	0.00E+00	0.00E+00	0.00E+00	3.99E-01	5.00E-01	7.99E-01	1.00E+00	3.99E-01
Thallium	0.00E+00	mg/L	0.00E+00	mg/kg	1.68E+00	mg/kg	1.00E+00			3.00E-01		2.20E-03	1.23E-01	1.23E-01	0.00E+00	0.00E+00	9.76E-03	0.00E+00	0.00E+00	1.46E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.56E-01	3.50E-01	4.46E-01	3.50E+00	4.46E-02
Explosives																													
2,4,6-Trinitrotoluene	0.00E+00	mg/L	6.47E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		4.67E+00		4.23E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E-01	0.00E+00	1.78E+01	0.00E+00
Semivolatile Organics																													
Bis(2-ethylhexyl) phthalate	2.00E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	350							5.40E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.40E-04	1.11E+00	4.86E-04	1.11E+01	4.86E-05

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ =Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	1	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.000058	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.0029	kg/d
Body weight =	0.01	kg
Home range =	0.13	acres
Water intake rate =	0.0027	L/d
Site Area =	5	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table E-5

Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the White-Tailed Deer
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Total Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV_{NOAEL}	HQ_{NOAEL}	TRV_{LOAEL}	HQ_{LOAEL}
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	
Metals																													
Aluminum	8.70E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	780							2.23E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-04	1.93E+00	1.15E-04	1.93E+01	1.15E-05
Barium	4.97E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	146							1.27E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E-05	5.10E+00	2.49E-06	1.98E+01	6.42E-07
Cadmium	0.00E+00	mg/L	0.00E+00	mg/kg	5.32E-01	mg/kg	1.00E+00			9.43E+00	NA	8.28E-01	3.97E-01	3.97E-01	0.00E+00	0.00E+00	1.36E-06	0.00E+00	0.00E+00	0.00E+00	NA	5.64E-05	0.00E+00	0.00E+00	5.78E-05	1.00E+00	5.78E-05	1.00E+01	5.78E-06
Lead	2.87E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							7.36E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.36E-07	8.00E+00	9.20E-08	8.00E+01	9.20E-09
Mercury	0.00E+00	mg/L	0.00E+00	mg/kg	5.28E-02	mg/kg	1.00E+00			7.76E+00	NA	1.42E+00	1.92E-01	1.92E-01	0.00E+00	0.00E+00	1.35E-07	0.00E+00	0.00E+00	0.00E+00	NA	9.62E-06	0.00E+00	0.00E+00	9.76E-06	1.32E+01	7.39E-07	1.32E+02	7.39E-08
Selenium	0.00E+00	mg/L	0.00E+00	mg/kg	1.22E+00	mg/kg	1.00E+00			8.81E-01	NA	5.17E-01	5.84E-01	5.84E-01	0.00E+00	0.00E+00	3.11E-06	0.00E+00	0.00E+00	0.00E+00	NA	8.05E-05	0.00E+00	0.00E+00	8.36E-05	2.00E-01	4.18E-04	3.30E-01	2.53E-04
Thallium	0.00E+00	mg/L	0.00E+00	mg/kg	1.67E+00	mg/kg	1.00E+00			3.00E-01		2.20E-03	1.23E-01	1.23E-01	0.00E+00	0.00E+00	4.28E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.71E-07	0.00E+00	0.00E+00	4.75E-06	7.40E-03	6.42E-04	7.40E-02	6.42E-05
Explosives																													
2,4,6-Trinitrotoluene	0.00E+00	mg/L	6.47E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		4.67E+00		4.23E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	2.00E+00	0.00E+00
Semivolatile Organics																													
Bis(2-ethylhexyl) phthalate	2.00E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	350							5.12E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.12E-07	1.83E+01	2.79E-08	1.83E+02	2.80E-09

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ =Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	1	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.04	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	2	kg/d
Body weight =	61	kg
Home range =	1280	acres
Water intake rate =	4	L/d
Site Area =	5	acres
Area Use Factor (AUF) =	0.00390625	unitless
Exposure Frequency (EF) =	1	unitless

Table E-6

Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Raccoon
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV_{NOAEL}	HQ_{NOAEL}	TRV_{LOAEL}	HQ_{LOAEL}
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	8.70E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	780							2.23E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-04	1.93E+00	1.15E-04	1.93E+01	1.15E-05
Barium	4.97E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	146							1.27E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E-05	5.10E+00	2.49E-06	1.98E+01	6.42E-07
Cadmium	0.00E+00	mg/L	0.00E+00	mg/kg	5.32E-01	mg/kg	1.00E+00			9.43E+00	NA	8.28E-01	3.97E-01	3.97E-01	0.00E+00	0.00E+00	1.36E-06	0.00E+00	0.00E+00	0.00E+00	NA	5.64E-05	0.00E+00	0.00E+00	5.78E-05	1.00E+00	5.78E-05	1.00E+01	5.78E-06
Lead	2.87E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							7.36E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.36E-07	8.00E+00	9.20E-08	8.00E+01	9.20E-09
Mercury	0.00E+00	mg/L	0.00E+00	mg/kg	5.28E-02	mg/kg	1.00E+00			7.76E+00	NA	1.42E+00	1.92E-01	1.92E-01	0.00E+00	0.00E+00	1.35E-07	0.00E+00	0.00E+00	0.00E+00	NA	9.62E-06	0.00E+00	0.00E+00	9.76E-06	1.32E+01	7.39E-07	1.32E+02	7.39E-08
Selenium	0.00E+00	mg/L	0.00E+00	mg/kg	1.22E+00	mg/kg	1.00E+00			8.81E-01	NA	5.17E-01	5.84E-01	5.84E-01	0.00E+00	0.00E+00	3.11E-06	0.00E+00	0.00E+00	0.00E+00	NA	8.05E-05	0.00E+00	0.00E+00	8.36E-05	2.00E-01	4.18E-04	3.30E-01	2.53E-04
Thallium	0.00E+00	mg/L	0.00E+00	mg/kg	1.67E+00	mg/kg	1.00E+00			3.00E-01		2.20E-03	1.23E-01	1.23E-01	0.00E+00	0.00E+00	4.28E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.71E-07	0.00E+00	0.00E+00	4.75E-06	7.40E-03	6.42E-04	7.40E-02	6.42E-05
Explosives																													
2,4,6-Trinitrotoluene	0.00E+00	mg/L	6.47E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		4.67E+00		4.23E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	2.00E+00	0.00E+00
Semivolatile Organics																													
Bis(2-ethylhexyl) phthalate	2.00E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	350							5.12E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.12E-07	1.83E+01	2.79E-08	1.83E+02	2.80E-09

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi\,x\,Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ =Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0.21	unitless
Aquatic plant diet fraction =	0.21	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0.02	unitless
Aq. Invert diet fraction =	0.21	unitless
Terr. Invert diet fraction =	0.3	unitless
Mammal diet fraction =	0.05	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.01222	kg/d
Sediment ingestion rate =	0.01222	kg/d
Food ingestion rate =	0.26	kg/d
Body weight =	5.1	kg
Home range =	385	acres
Water intake rate =	0.43	L/d
Site Area =	5	acres
Area Use Factor (AUF) =	0.013	unitless
Exposure Frequency (EF) =	1	unitless

Table E-7

Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Red-Tailed Hawk
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	8.70E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	780							1.24E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-04	1.10E+02	1.13E-06	1.10E+03	1.13E-07
Barium	4.97E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	146							7.11E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.11E-06	2.08E+01	3.42E-07	4.17E+01	1.70E-07
Cadmium	0.00E+00	mg/L	0.00E+00	mg/kg	6.50E-01	mg/kg	1.00E+00			9.05E+00	NA	7.56E-01	3.57E-01	3.57E-01	0.00E+00	0.00E+00	1.86E-06	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	2.53E-05	7.98E-06	3.51E-05	1.45E+00	2.42E-05	2.00E+01	1.75E-06
Lead	2.87E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							4.11E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.11E-07	3.85E+00	1.07E-07	3.85E+01	1.07E-08
Mercury	0.00E+00	mg/L	0.00E+00	mg/kg	7.96E-02	mg/kg	1.00E+00			5.89E+00	NA	1.18E+00	1.92E-01	1.92E-01	0.00E+00	0.00E+00	2.28E-07	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	1.66E-06	5.25E-07	2.42E-06	4.50E-01	5.37E-06	9.00E-01	2.68E-06
Selenium	0.00E+00	mg/L	0.00E+00	mg/kg	1.66E+00	mg/kg	1.00E+00			8.11E-01	NA	5.33E-01	4.81E-01	4.81E-01	0.00E+00	0.00E+00	4.75E-06	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	8.68E-05	2.74E-05	1.19E-04	4.40E-01	2.70E-04	1.50E+00	7.93E-05
Thallium	0.00E+00	mg/L	0.00E+00	mg/kg	1.68E+00	mg/kg	1.00E+00			3.00E-01		2.20E-03	1.23E-01	1.23E-01	0.00E+00	0.00E+00	4.82E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-05	7.11E-06	3.44E-05	3.50E-01	9.83E-05	3.50E+00	9.83E-06
Explosives																													
2,4,6-Trinitrotoluene	0.00E+00	mg/L	6.47E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		4.67E+00		4.23E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E-01	0.00E+00	1.78E+01	0.00E+00
Semivolatile Organics																													
Bis(2-ethylhexyl) phthalate	2.00E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	350							2.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.86E-07	1.11E+00	2.58E-07	1.11E+01	2.58E-08

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ =Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0.76	unitless
Bird diet fraction =	0.24	unitless
Soil ingestion rate =	0.00114	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.057	kg/d
Body weight =	0.957	kg
Home range =	2080	acres
Water intake rate =	0.057	L/d
Site Area =	5	acres
Area Use Factor (AUF) =	0.00240385	unitless
Exposure Frequency (EF) =	1	unitless

Table E-8

Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Muskrat
Power House 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV_{NOAEL}	HQ_{NOAEL}	TRV_{LOAEL}	HQ_{LOAEL}
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	8.70E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	780							8.15E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.15E-02	1.93E+00	4.22E-02	1.93E+01	4.22E-03
Barium	4.97E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	146							4.65E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.65E-03	5.10E+00	9.12E-04	1.98E+01	2.35E-04
Cadmium	0.00E+00	mg/L	0.00E+00	mg/kg	6.50E-01	mg/kg	1.00E+00			9.05E+00	NA	7.56E-01	3.57E-01	3.57E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	1.00E+01	0.00E+00
Lead	2.87E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							2.69E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-04	8.00E+00	3.36E-05	8.00E+01	3.36E-06
Mercury	0.00E+00	mg/L	0.00E+00	mg/kg	7.96E-02	mg/kg	1.00E+00			5.89E+00	NA	1.18E+00	1.92E-01	1.92E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	5.00E+00	0.00E+00
Selenium	0.00E+00	mg/L	0.00E+00	mg/kg	1.66E+00	mg/kg	1.00E+00			8.11E-01	NA	5.33E-01	4.81E-01	4.81E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	3.30E-01	0.00E+00
Thallium	0.00E+00	mg/L	0.00E+00	mg/kg	1.68E+00	mg/kg	1.00E+00			3.00E-01		2.20E-03	1.23E-01	1.23E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E-03	0.00E+00	7.40E-02	0.00E+00
Explosives																													
2,4,6-Trinitrotoluene	0.00E+00	mg/L	6.47E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		4.67E+00		4.23E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-02	0.00E+00	0.00E+00	0.00E+00	8.21E-02	2.00E-01	4.10E-01	2.00E+00	4.10E-02
Semivolatile Organics																													
Bis(2-ethylhexyl) phthalate	2.00E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	350							1.87E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.87E-04	1.83E+01	1.02E-05	1.83E+02	1.02E-06

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi\,x\,Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ =Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	1	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.352	kg/d
Body weight =	1.174	kg
Home range =	0.32	acres
Water intake rate =	0.11	L/d
Site Area =	5	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

RESPONSE TO COMMENTS

Response to Comments
Screening Level Ecological Risk Assessment (SLERA)
for Powerhouse 2 Ash Pits
Plum Brook Ordnance Works, Sandusky, Ohio,
Dated June 21, 2010

Comments by Janusz Byczkowski, Risk Assessor, Ohio Environmental Protection Agency, received August 9, 2010. The reviewer included comments on the baseline human health risk assessment (BHHRA) with those of the SLERA. Responses to comments pertaining solely to the BHHRA are attached to the revised final BHHRA, but are not provided below. The SLERA comments below have been re-numbered accordingly. Comment No. 1 below (Comment No. 4 in the BHHRA and the original comment letter) pertains to both the BHHRA and the SLERA. A longer version of this Response No. 1 that more completely addresses the specific human health examples is included in the Response to Comments that is attached to the BHHRA.

Comment 1: **<u>BHHRA Tables 2-3 to 2-9 and A-2; also SLERA Table 2-9</u>. Some chemicals, whose reporting limits (RL) exceed screening levels (RBSC), have not been selected as chemicals of potential concern (COPC), and thus, they are not included in baseline risk assessment – for example: *"Indeno(1,2,3-cd)pyrene"* in Table 2-4; or *"Cadmium"* in Table 2-7; etc. All chemicals whose RL>RBSC should not be just eliminated from the data set used for baseline risk assessment. Instead, it should be assumed that each of them may be present at a concentration equal to ½ RL, and thus, it should be processed as COPC. Similarly in SLERA, the chemicals whose RL>ESV should be included as COPECs, assuming their concentration = ½ of RL. Please check the data tables for cases of RL>RBSC and/or ESV, and evaluate those that exceed screening levels as COPC in the BHHRA and/or as COPEC in SLERA, assuming that their concentration = ½ of RL.**

Response 1: The data evaluation protocols used in the BHHRA and SLERA are consistent with those which has been performed for PBOW human health and ecological risk assessments for the past decade. These protocols are described in the approved site-specific risk assessment work plans (Shaw, 2010). Further, these approaches are clearly consistent with EPA (1989) guidance which emphasizes the use of positive data and recognizes that the state of the practice is such that achieving RLs that are lower than screening values is not possible for certain chemicals. This guidance even recommends that individual samples with elevated RLs be excluded from the quantitative risk assessment.

The focus of the BHHRA and SLERA is quantitative risk assessment. Please note that the MDCs are used for screening, and that this is the most conservative value that is reasonable to consider in quantitative evaluation as an exposure point concentration (EPC). The ProUCL statistical program, used to estimate EPCs, weighs nondetects differently and will typically not recommend a value that exceeds the MDC. The method that has been used in

the BHHRA and SLERA, as described the work plan, ensures that the EPC will not exceed the MDC. Therefore, the use of the MDC as the screening value reflects the "worst case" of the quantitative portion of the risk assessment.

Comment 2: **<u>Page ES-1, Line 7</u>: document states: "*...The primary objective of the assessment was to determine whether the potential for unacceptable risks are posed to ecological receptors as a result of potential hazardous substance releases...*" This statement seems to be *potentially* unclear, especially that the next sentence says: "*...hazardous substances being released from the site...*" Please rephrase the statement of primary objective.**

Response 2: The sentence in question will be changed to state the following: "The primary objective of the assessment was to determine the potential for unacceptable risks to ecological receptors as a result of exposure to chemicals detected at the site."

Comment 3: **<u>Page ES-2, Line 23</u>. This document states: "*...estimate of the likelihood [...] of adverse effects to environmental stressors present at the site...*" The meaning of this statement is unclear (it seems to suggest "*effects to stressors*" rather than effects to ecological receptors). Please rephrase this statement.**

Response 3: The sentence in question will be changed to the following: "The result is an estimate of the likelihood, severity, and characteristics of adverse effects to ecological receptors resulting from exposure to environmental stressors present at the site."

Comment 4: **<u>Page ES-3, Line 18; Section 2.4.2, Page 2-18, Line 32; and Appendix D, Page D-4</u>. This document states: "*...Ecological risk from surface water and sediment was primarily evaluated using a food chain model for the selected aquatic assessment receptor (i.e., the raccoon)...*" and then: "*...Potential uptake through the food chain is evaluated for the raccoon (also considered as a terrestrial receptor)...*"**

According to OEPA-DERR (2008), one of the preferred species useful in the generic food web model for surface water and wetland on this Site, would be the aquatic herbivore Muskrat. The muskrat is listed in this document as "*likely to be found in Erie County*" (Table 2-2). On the other hand, the raccoon - actually observed on this Site omnivore, may be not very sensitive as a surface water and wetland -associated receptor. Please add muskrat as the aquatic assessment receptor.

Reference:

OEPA-DERR (2008) ECOLOGICAL RISK ASSESSMENT Guidance Document. Revised April 2008. On line:

http://www.epa.ohio.gov/portals/30/rules/RR-031.pdf

Response 4: The Muskrat will be added as an aquatic receptor.

References Used in Responses

Shaw Environmental, Inc. (Shaw), 2010, ***Baseline Human Health Risk Assessment Work Plan, Garage Maintenance Area (Locomotive Building Area), Plum Brook Ordnance Works, Sandusky, Ohio***, May.

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, D.C., EPA/540/1-89/002.

APPENDIX D

POWERHOUSE NO. 2 ASH PITS SCR ADDENDUM FOR COAL YARD NO. 2

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Final
September 2012

Powerhouse No. 2 Ash Pits
Site Characterization Report Addendum for Coal Yard No. 2

Former Plum Brook Ordnance Works
Sandusky, Ohio

US Army Corps of Engineers
Nashville District

FUDS Project No. G05OH001822

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Final
September 2012

Powerhouse No. 2 Ash Pits
Site Characterization Report Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

FUDS Project No.
G05OH001822

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September 28, 2012

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

Submittal of the Final Powerhouse 2 Ash Pits
Site Characterization Report Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio
Contract No. W912QR-08-D-0013: Shaw Project Number 132457

Dear Ms. McClanahan:

In accordance with the requirements of Delivery Order No. DX02 of Contract No. W912QR-08-D-0013, Shaw is pleased to submit this Final Powerhouse 2 Ash Pits Site Characterization Report Addendum for Coal Yard No. 2 at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio.

Enclosed are four copies of this final report. Copies have also been sent to those on the distribution list, as indicated. As requested, the document was sent to the Center of Expertise and RAB 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

Enclosures

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Mr. Jeffrey G. Leach U.S. Army Public Health Command ATTN: MCHB-IP-REH, Bldg. 1675 APG-EA, MD 21010-5403	12

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DISCIPLINE SIGN-OFF REVIEW

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

Project Description: Powerhouse 2 Ash Pits Site Characterization Report Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Contract No. W912QR-08-D-0013 Delivery Order No. DX02

Project No. 132457 Task/Phase Number: 41000000

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

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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

Powerhouse No. 2 Ash Pits
Site Characterization Report Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Prepared for:

Commander
U.S. Army Engineer District, Nashville
Post Office Box 1070
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September 2012

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List of Acronyms

bgs	below ground surface
BHRRA	baseline human health risk assessment
BSC	background screening concentration
DNT	dinitrotoluene
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FADL	field activity daily log
IDW	investigation-derived waste
mg/kg	milligrams per kilogram
MK	Morrison Knudsen Corporation
NASA	National Aeronautics and Space Administration
PBOW	Plum Brook Ordnance Works
PCB	polychlorinated biphenyl
PETN	pentolite
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RBSC	risk-based screening concentration
SCR	site characterization report
Shaw	Shaw Environmental and Infrastructure, Inc.
SI	site inspection
SLERA	screening level ecological risk assessment
SWSAP	site-wide sampling and analysis plan
SVOC	semivolatile organic compound
TAL	target analyte list
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound

Executive Summary

The U.S. Army Corps of Engineers is investigating the former Plum Brook Ordnance Works (PBOW) in Sandusky, Erie County, Ohio, under the Defense Environmental Restoration Program's Formerly Used Defense Sites authorization and funding. The PBOW site was used for the manufacture of explosives during World War II. The former PBOW site is currently operated and maintained by the National Aeronautics and Space Administration as Plum Brook Station, an active testing and research installation associated with the John H. Glenn Research Center of Cleveland, Ohio. The U.S. Army Corps of Engineers contracted Shaw Environmental and Infrastructure, Inc. (Shaw) to conduct an addendum to the existing Powerhouse No. 2 Ash Pits Site Characterization Report (SCR) documenting soil conditions of the associated coal yard (Coal Yard No. 2). The specific investigation site is located immediately adjacent to (northeast) of Powerhouse No. 2, which is located in the western, central part of PBOW.

During PBOW explosives manufacturing operations from 1941 to 1945, three power stations, Powerhouse No. 1, Powerhouse No. 2, and Powerhouse No. 3, were present to support the nitroaromatic manufacturing process. Each power station consisted of a main powerhouse, a coal storage area (coal yard), and two aboveground fuel storage tanks. Each power house building consisted of a boiler house, compressor room, electrical room, filter room, and locker room. The buildings also contained two to four large coal-burning boilers, a turboelectric generator, a feed water treatment system, and several steam-driven or electric air compressors. The generated steam was used for space heating, driving compressors, and generating electrical power. As mentioned, the coal yards were used as storage areas providing coal to be used in the powerhouse's boilers. The coal was brought into the yards via train. Chemical contamination (increase of inorganic compounds) of the soil resulting from the leaching of precipitation through the coal stored in Coal Yard No. 2 is expected to be primarily semivolatile organic compounds (SVOC) and target analyte list metals, although nitroaromatics and volatile organic compounds (VOC) could be possible. Groundwater for this area of the PBOW was investigated under a previous effort.

This Site Characterization Report Addendum is an addendum to the SCR for the Powerhouse No. 2 Ash Pits which was submitted as a final report in September 2010, and is one of three planned reports for the Coal Yard No. 2 Site. It currently details site-specific remedial investigation activities, and comprises text, tables, figures, appendices, final evaluations, and recommendations. It should be noted that groundwater for this area of the PBOW site was

investigated under a previous effort. Subsequent site-specific reports will consist of the Baseline Human Health Risk Assessment (BHHRA) Addendum and the Screening Level Ecological Risk Assessment Report (SLERA) Addendum. Each report will be submitted under separate cover.

One previous investigation at Coal Yard No. 2 was conducted by Morrison Knudsen Corporation in 1993 during a PBOW Site Investigation in which the former coal yard was mistakenly identified as "Burn Ground 1." Two surface (0-2 feet) soil samples, MK01SS06 and MK01SS07, were collected using a hand auger and sampled for nitroaromatics, VOCs, SVOCs, and inorganics. No nitroaromatic compounds were detected in either of the surface soil samples. Analytical detections of VOCs were measured in MK01SS06 (toluene) and MK01SS07 (acetone, toluene, and total xylenes), and results were below quantitation limits. SVOCs were detected only in MK01SS06 (naphthalene, phenanthrene, 2-methylnaphthalene, and benzo[b]fluoranthene) and results were below quantitation limits. A total of 17 inorganics were also detected in the surface soil samples, and results were below maximum contaminant levels.

Remedial investigation activities were conducted by Shaw for the Powerhouse No. 2 Coal Yard SCR addendum in October 2011. Field activities included hand auger operation with soil sampling, soil borehole lithologic logging, paperwork completion, surveying, and disposal of investigation-derived waste.

Four soil boring locations were chosen based upon ground surface coal thicknesses and fairly equal representation of the former coal yard area. Selected areas were chosen by scraping the surface with a pickaxe and measuring the coal thickness, if present. From each boring location, collection of soil samples was conducted from three distinct intervals to provide evidence of possible soil contamination as a result from leaching of precipitation through the former stockpiled coal. Collection of surface soil samples, representing the 0 to 1 foot depth interval, was from soil below the coal material, if present. The second soil sample was collected from a depth below ground surface representing the 3 to 5 feet interval. The third sample was collected at a depth of 8 to 10 feet below the existing ground surface. Each soil sample from the selected interval was transferred to a new resealable plastic bag and homogenized. Soil was analyzed for nitroaromatics, SVOCs, and target analyte list metals. Soil from the 0 to1 and 3 to 5 feet intervals was also analyzed for polychlorinated biphenyls. Hand auger drilling and soil sample collection was completed on October 26 and 27, 2011.

Analytical results from the various media collected were compared to risk-based screening concentrations (RBSC) derived from November 2011 U.S. Environmental Protection Agency regional screening levels (RSLs) for a residential land-use scenario. These screening levels were used as points of comparison in this SCR addendum. Site contaminants will be further evaluated in risk assessments. In addition, the analytical results for the metals in the 2011 soil samples were compared to soil background screening concentrations (BSC).

Significant conclusions from the surface and subsurface soil analytical results are as follows:

- No nitroaromatics or polychlorinated biphenyls were detected in either the surface or subsurface soil samples.
- No SVOCs were detected above the RBSCs in subsurface soil samples but one parameter (benzo[a]pyrene) was detected above the RBSC in one surface soil sample (field duplicate sample). No surface soil samples were above any BSC values.
- No inorganics were above both the RBSCs and BSCs.

Both the surface and subsurface soil at Coal Yard No. 2 appear to be unimpacted by the previous storage of coal for operation of Powerhouse No. 2. Analytical evidence provides no indication of increasing inorganics concentrations (or decreasing concentrations) in subsurface soil as a possible result of precipitation leaching through stored coal.

1.0 Introduction

The U.S. Army is conducting studies of the environmental impact of suspected waste sites at previously owned U.S. Department of Defense properties. The former Plum Brook Ordnance Works (PBOW) is located in Sandusky, Erie County, Ohio (Figure 1-1). PBOW is being investigated under the Defense Environmental Restoration Program for Formerly Used Defense Sites. The investigation is being managed and technically overseen by the Nashville, Tennessee, and Huntington, West Virginia, District Offices of the U.S. Army Corps of Engineers (USACE). This 9,000-acre facility was used for the manufacture of explosives during World War II. The site is currently controlled and maintained by the National Aeronautics and Space Administration (NASA) and is operated as the Plum Brook Station of the John H. Glenn Research Center at Lewis Field.

Fieldwork and reporting for Powerhouse No. 2 Coal Yard (Coal Yard No. 2) was performed under Delivery Order DX02 for the USACE Louisville Architecture/Engineering Environmental Services Indefinite Delivery/Indefinite Quantity, Contract Number W912DR-08-D-0013.

During a previous investigation, an overburden/shale groundwater monitoring well was installed upgradient of Ash Pit 1. Groundwater samples from that well indicated elevated manganese in the groundwater. Based on interpreted groundwater flow for Ash Pit 1, a former powerhouse coal yard (Coal Yard No. 1) was located immediately upgradient of this well. Evaluation of site information suggested that leaching of the coal in the former coal yard may have impacted the groundwater. Therefore, additional soil sampling was recommended to evaluate the former PBOW coal yards as potential sources of contamination. The field activities completed by Shaw Environmental and Infrastructure, Inc. (Shaw) for investigation of Coal Yard No. 2 were conducted pursuant to the following documents:

- Site-Wide Health and Safety Plan (Shaw, 2008a)
- Site-Wide Sampling and Analysis Plan (SWSAP) (Shaw, 2008b)
- Site-Wide Quality Assurance Project Plan (QAPP) (Shaw, 2008c).
- Site-Specific Sampling and Analysis Plan (Shaw, 2011).

The current document, *Powerhouse No. 2 Ash Pits Site Characterization Report Addendum for Coal Yard No. 2, Former Plum Brook Ordnance Works, Sandusky, Ohio,* is one of three planned reports for the Coal Yard No. 2 Site. This Site Characterization Report Addendum comprises

text, tables, figures, appendices, final evaluations, and recommendations. Subsequent reports will consist of the Baseline Human Health Risk Assessment (BHHRA) Addendum and the Screening Level Ecological Risk Assessment Report (SLERA) Addendum. Each report will be submitted under separate cover.

1.1 Scope of Work and Project Objectives

The scope of this site characterization report (SCR) addendum (USACE, 2011) included updating the existing quality control plan, addition of site-specific addenda to the site-wide health and safety plan and SWSAP, implementation of soil sampling, surveying, analytical work, and investigation-derived waste (IDW) management and disposal. Figure 1-2 identifies the location of Coal Yard No. 2 in relation to other areas of concern and site features.

The objectives of this investigation to address data gaps in soil samples include the following:

- Conduct soil sampling and lithologic logging
- Conduct laboratory analysis of soil
- Management and dispose of IDW
- Submit an SCR addendum
- Update the baseline human health risk assessment and ecological risk assessment
- Prepare and submit a geographic information system deliverable.

1.2 Report Organization

Chapter 2.0 of this report describes PBOW and the Coal Yard No. 2 site, its physical setting, geology, and hydrogeology features. Sampling strategy and field procedures are described in Chapter 3.0. The analytical program and background comparison data are presented in Chapter 4.0. Chapter 5.0 describes specific-site information and historical and current analytical data. Chapter 6.0 presents media conclusions. Recommendations are provided in Chapter 7.0. References that were used in preparing the report are listed in Chapter 8.0.

Sample collection logs, soil boring logs, and land survey data are provided in Appendices A, B, and C, respectively. An IDW manifest is included in Appendix D. Appendix E through H contain analytical data pertinent to the soil sampling event. Appendix I presents the chains of custody for laboratory analysis and Appendix J presents a response to comments.

1.3 Facility Location and Description

The former PBOW site is currently utilized and maintained by NASA and is operated as the Plum Brook Station, a satellite office of the NASA John H. Glenn Research Center, located at Lewis Field in Cleveland, Ohio. Most of the aerospace testing facilities built at the site in the 1960s are on standby or inactive status. The site is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland. Although primarily in Perkins and Oxford Townships, the eastern edge of the site 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. Public access is restricted at PBOW except during the annual deer hunting season.

1.4 PBOW Site History

The PBOW site was built in early 1941 and manufactured 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite (PETN). Production of explosives began in December 1941 and continued until 1945. During operation, three areas (TNT Area A [TNTA], TNT Area B [TNTB], and TNT Area C [TNTC]) manufactured TNT and DNT, and one area manufactured PETN. TNTA consisted of manufacturing lines 1 through 4, TNTB consisted of lines 5 through 7, and TNTC consisted of lines 8 through 12. TNTA is located on the northeast side of PBOW, TNTB is located at the southern-central part, and TNTC is located at the southwestern side of PBOW. The PETN manufacturing area is located in the north-central portion of PBOW and lies within the boundaries of Ransom Road on the west, Pentolite Road on the south, and Patrol Road on the north and east. The central portion of the former PETN manufacturing area is currently occupied by NASA's inactive nuclear reactor, which is presently in the process of being decommissioned.

It is estimated that more than one billion pounds of explosives were manufactured during the 4-year operating period. After the plant was shut down, decontamination of TNT, acid, PETN, and DNT processing lines began. Decontamination was considered complete during the last quarter of 1945. The property was initially transferred to the Ordnance Department after it was certified by the Army to be decontaminated in 1946. This transfer did not include the 2,800 acres comprising the Plum Brook area. The War Assets Administration accepted custody of the remaining acreage (approximately 3,230 acres) in 1946. The Department of the Army reacquired the 3,230 acres in 1954 and performed cleanup efforts during the 1950s through 1963.

Two property use agreements were entered into by the National Advisory Committee of Aeronautics, the predecessor of NASA, and the Army in 1956 and 1958. On March 15, 1963, accountability for and custody of the entire PBOW property (6,030 acres) was transferred to NASA by the Department of the Army. NASA performed further decontamination during 1964. The NASA decontamination process was accomplished in five steps (Dames and Moore, Inc., 1997a):

1. Inspecting and removing contaminated surface soil above the drain tiles, flumes, etc.

2. Spot checking of subsurface soil in the vicinity of drain tiles, flumes, etc., to determine where the contaminated tiles and flumes were located. Where contamination was found, the flumes, tiles, etc., were removed in sections.

3. Removal of some items previously decontaminated to Level 3X (XXX-military decontamination level established primarily for worker safety that indicates potentially contaminated material or previously contaminated material that has been decontaminated to a zero residual contamination level) condition to a storage facility and additional decontamination of the remainder of the items to a 5X (XXXXX – level that indicates a decontaminated material with no detectable residual contamination) condition in order to be sold ("X" indicates the Army's specific decontamination level).

4. Destruction of all buildings by fire followed by removal of all debris and concrete foundations. All the materials, including the earth, in those areas was flashed and the area was then rough graded.

5. Decontamination of all sump basins and removal of the concrete.

The decontamination process also included burning of nitroaromatic-filled flumes that were excavated. As shown in the records review (Dames and Moore, Inc., 1997b) this was performed on July 10, 1963, near the intersection of Fox Road and Snake Road and is suspected to have also occurred at the Additional Burning Ground area.

On April 18, 1978, NASA declared approximately 2,152 acres of land as excess. This excess acreage included former buffer areas that were not formerly used by the Army and were not subject to decontamination efforts. The Perkins Township Board of Education acquired 46 acres of the excess for use as a bus transportation center. The General Services Administration retains the remaining acreage and currently has a use agreement with the Ohio National Guard for 604 acres of the land. NASA presently controls about 6,400 acres and is using the site to conduct

space research as a satellite operation of the John Glenn Research Center based in Cleveland, Ohio. The details of these land transactions are listed in the site management plan (International Consultants Incorporated, 1995) and can be found at NASA Plum Brook Station.

1.5 Powerhouse No. 2 Coal Yard Site History

As noted previously, PBOW was built in early 1941 and manufactured acid, 2,4,6-TNT, DNT, and PETN until 1945. Three power stations, Powerhouse No. 1, Powerhouse No. 2, and Powerhouse No. 3, were constructed and utilized to support the manufacturing processes. Each power station consisted of a main powerhouse, a coal storage area (coal yard), and two aboveground fuel storage tanks. The fuel storage tanks were surrounded by a berm to contain any potential spills or leaks. Each powerhouse building consisted of a boiler house, compressor room, electrical room, filter room, and locker room. The buildings also contained two to four large coal-burning boilers, a turboelectric generator, a feed water treatment system, and several steam-driven or electric air compressors. The generated steam was used for space heating, driving compressors, and generating electrical power. As mentioned previously, the coal yards were used as storage areas providing coal to be used in the powerhouse's boilers. The coal was brought into the yards via train. Figure 1-2 shows the location of Coal Yard No. 2 and other investigative sites on PBOW property.

Coal Yard No. 2 is located immediately to the northeast of Powerhouse No. 2. The historical former coal yard is estimated to have been approximately 200-feet wide by 290-feet in length or nearly 1.4 acres. The area has recently been filled and graded. The site was observed to be covered with bare soil during a site visit on September 1, 2011, but shoots of plants were observed to be emerging from the ground, suggesting the site will naturally re-vegetate in the near future. Recent demolition of the former Powerhouse No. 2 building by NASA resulted in some disturbance of surface soil and vegetation, primarily in areas outside of the footprint of the former coal yard. Minor amounts of coal were observed on the ground surface in isolated areas during previous site walks. Figure 1-3 shows a historical photograph of the coal yard along with the associated powerhouse.

Coal Yard No. 2 was first investigated by Morrison Knudsen Corporation (MK) in 1993 during a site inspection (SI) when the coal yard was mistaken as a former burning ground and called "Burn Ground 1"for the SI report (MK, 1994). Two surface soil samples (MK01SS06 and MK01SS07) were collected with a hand auger from the first 2 feet of soil and analyzed for nitroaromatics, volatile organic compounds (VOC), semivolatile organic compounds (SVOC),

and inorganics. Table 1-1 presents historical analytical results and Figure 1-4 shows 1993 MK investigation area. The locations are approximate because the soil borings were not surveyed. From the SI report, the soil sample collection area was said to “exhibit no visual limits” and was estimated to be less than 3 acres in size. It also mentioned that the soil samples were collected on the northeast side of the building in an area of tall grass, and in addition to being a burning ground, based on small piles of coal, the area must have also been used as a coal storage area.

No nitroaromatic compounds were detected in either of the surface soil samples collected in Coal Yard No. 2. VOCs were detected in MK01SS06 (toluene) and MK01SS07 (acetone, toluene, and total xylenes) and SVOCs were detected only in MK01SS06 (naphthalene, phenanthrene, 2-methylnaphthalene, and benzo[b]fluoranthene). A total of 17 metals were also detected in the surface soil samples (MK, 1994). The MK study concluded that all detected organic and inorganic constituents were below quantitation and maximum contaminant levels.

2.0 Physical Setting

As noted in Section 1.5, Coal Yard No. 2 is located immediately adjacent to (northeast) of Powerhouse No. 2. Figure 1-4 shows the specific site location and general site features with ground surface topography. Descriptions and information regarding the local geography, topography, surface drainage, regional and local geology and hydrogeology characteristics, and precipitation influence effects on local water levels has been prepared and is included in the final Powerhouse No. 2 Ash Pits SCR (Shaw, 2010). The following sections describe the current site conditions for the Coal Yard No. 2 relative to this investigation.

During a recent field visit performed on September 1, 2011, the majority of the Coal Yard No. 2 area was noted as having recently been filled and graded. Small pieces of coal were observed in the soil. The northern border of the coal yard is comprised of an early-successional forest. As noted during the initial site staking before any grading or backfilling had taken place, the former Coal Yard No. 2 area was low lying with minimal relief and contained standing water. This water eventually percolated into the soil or evaporated prior to soil sampling. The presence of standing water and minimal relief suggests that limited site runoff occurs.

3.0 Field Activities

3.1 Introduction

Field activities at Coal Yard No. 2 were performed in accordance with the updated and revised SWSAP (Shaw, 2008b) and site-specific sampling and analysis plan (Shaw, 2011), as noted in Chapter 1.0. Activities included hand auger operation with soil sampling, soil borehole logging, documentation of fieldwork activities (sample collection logs, field activity daily logs [FADL], etc), surveying, and disposal of IDW.

Prior to any intrusive work, a NASA authorized dig permit was obtained for Coal Yard No. 2. The dig permit process included review of utility maps for any underground utilities, including storm water, sewer, electrical, natural gas, telephone, cable, or fiber optic lines in the area.

3.2 Soil Sampling

Prior to soil boring drilling, excavation of the upper foot of surface soil was removed with a pickaxe throughout the former coal yard area to determine optimal placement for the soil borings. Removal of the surface soil was used to determine both the boundary of the former coal yard and the thicknesses of any remaining coal. From results, soil boring locations were chosen based on the interpreted extent of the former coal yard. Four soil borings (CY2-SB01, CY2-SB02, CY2-SB03, and CY2-SB04) were drilled at Coal Yard No. 2 using either a 2-inch or 3-inch stainless-steel hand auger. Soil collected from a sample interval was transferred to a new, resealable storage bag and thoroughly homogenized, and the sample bottles filled. All hand drilling activities were conducted by Shaw personnel on October 26 and 27, 2011. Figure 1-4 shows the location of the soil borings.

Three soil samples were collected from each soil boring from approximate depths of 0 to 1, 3 to 5, and 8 to 10 feet below ground surface (bgs) and analyzed for nitroaromatics, SVOCs, and target analyte list (TAL) metals. Also, soil samples from the upper and middle sample collection intervals (0 to 1 or 0.5 to 1, and 3 to 5 feet) were analyzed for polychlorinated biphenyls (PCB). A single surface soil sample was scheduled to be analyzed for total organic carbon (TOC) but was inadvertently overlooked during sample collection. Table 3-1 presents a summary of soil samples collected. Soil sample collection logs are included in Appendix A. Continuous lithologic logs were recorded for all soil borings during the drilling. Hazardous, toxic, and radiological waste drilling logs for each borehole are included in Appendix B.

Each borehole was abandoned after all soil sampling activities at Coal Yard No. 2 were complete. Bentonite granules were emptied into the 10-foot-deep borehole and brought to a depth of approximately 3 feet bgs. Remaining borehole soil from initial hand auger operations was emptied back into the open borehole portion and brought to ground surface.

3.3 Decontamination Procedures

Decontamination of the hand auger and sampling equipment was performed in accordance with Section 5.0 of the SWSAP (Shaw, 2008b). Specifically, sampling equipment was decontaminated by rinsing in sequence with phosphate-free soapy water, tap water, nitric acid, methanol, hexane, and deionized water. Equipment was then air dried, if possible, before use. The bucket augers were decontaminated prior to each boring.

3.4 Land Survey

In early November 2011, an Ohio-registered professional land surveyor surveyed the soil boring locations. Horizontal coordinates were surveyed to the closest 0.1 foot and referenced to the Ohio State Plane Coordinate System. The land surface elevation was surveyed to the nearest 0.01 foot and referenced to the 1929 National Geodetic Vertical Datum. Land survey data reports are included in Appendix C.

3.5 Investigation-Derived Waste Management

IDW generated during investigation activities included decontamination water and personal protective equipment. All IDW was managed and handled in accordance with procedures described in the SWSAP (Shaw, 2008b).

All decontamination fluids generated during field activities, except the nitric acid, methanol, and hexane rinse, were stored in a labeled 55-gallon drum. The nitric acid, methanol, and hexane rinse fluids were collected in a stainless-steel pan, heated on a hot plate burner, and disposed of by evaporation to prevent disposal as a hazardous waste liquid. Decontamination water was placed into a 55-gallon storage drum. Decontamination water from other PBOW operations was also placed in the drum and sampled to determine if it should be classified as a hazardous or nonhazardous material. Soil generated during hand auger operations was placed back into the borehole. Personal protective equipment (Tyvek® suits, latex gloves, etc.) and general refuse were double bagged and disposed in an on-site, Shaw-contracted industrial dumpster.

Following analytical determination that the waste water was nonhazardous, in October 2011, the IDW decontamination water was transported by Triad Transport, Inc. to the Environmental Quality Company in Detroit, Michigan, for disposal. The waste manifest for disposal of the decontamination fluid is included as Appendix D.

4.0 Analytical Program

The following sections present the analytical program used in this investigation. This review includes the laboratories used for all samples, the analytical methods used, data quality evaluation, and blank analysis. In addition, a description and derivation of risk-based screening concentrations (RBSC) is presented in Section 4.2.1. The derivation and use of background screening concentrations (BSC) and the analytical results are presented in Section 4.2.2.

4.1 Analytical Program and Methodologies

4.1.1 Sample Analysis and Data Validation

Primary and quality control (QC) project samples, or field duplicates, collected in October 2011 were analyzed by Accutest Laboratories of Orlando, Florida. Quality assurance (QA) samples, or field split samples, were analyzed by Test America, Inc., of Canton, Ohio. Analysis for nitroaromatic field split samples was performed by Test America of Sacramento, California. Shaw performed the data validation. The validation summaries are provided in Appendix E. The analytical results are summarized in Appendix F. Tables of detected hits (Section 4.1.4) data are included in Appendix G. A data quality evaluation is located in Appendix H.

All data analyzed were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following the guidelines in the U.S. Environmental Protection Agency (EPA) *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (EPA, 2008) and EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2004), the QAPP (Shaw, 2008c), and specific analytical method requirements. Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness, and comparability goals established to meet the project data quality objectives (DQO). The criteria for blank evaluation were based on those detailed in *Region 3 Modifications to National Functional Guidelines for Evaluating Organic Analyses* (EPA, 1994) and *Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1993).

4.1.2 Analytical Methods

Chemical analyses for the investigation were performed in accordance with guidelines detailed in EPA's *Test Methods for Evaluating Solid Waste (SW-846), Physical/Chemical Methods* (EPA, 1986) and subsequent revisions. The soil samples and associated QA/QC samples were analyzed for PCBs, SVOCs, nitroaromatics, and inorganics. Methods used for analysis are summarized in Table 4-1.

4.1.3 Data Quality Evaluation

The reliability of the sampling and analytical procedures used during the investigation was demonstrated by implementing the project-specific QA procedures specified in the SWSAP (Shaw, 2008b) and QAPP (Shaw, 2008c) and its site-specific attachments. Successful execution of these procedures provides strong supporting evidence that the data are representative of the areas under investigation.

The DQOs for this project were to produce scientifically valid data of known accuracy and precision that were complete with respect to identified critical samples, comparable with similar data types, and representative of the media sampled so as to be useful for the cited purposes. Evaluation of the data using the DQOs and the data validation process resulted in the determination that the data set is valid and of sufficient quality to meet the objectives of the investigation.

A complete evaluation of the analytical results is given in the data quality evaluation found in Appendix H.

4.1.4 Blank Evaluation

The purpose of blank analysis is to detect contamination resulting from laboratory and field activities. For this site, field blanks were not required. Only laboratory method blanks were analyzed. Blank evaluation involves qualification of data based on the results of the laboratory method blanks. The criteria for blank evaluation are as follows:

- If a parameter is found in a blank but not detected in the sample, no action is taken.
- For organics, if the sample result is less than 5 times (most analytes) or 10 times (common laboratory contaminants) that of the blank result, the sample result is qualified "B."

- For inorganics, if the sample result is greater than the instrument detection limit but less than 5 times the blank result, the sample result is qualified "B."
- If the sample result is greater than 5 times (most analytes) or 10 times (common laboratory contaminants) the blank result, no action is taken.

In instances where more than one blank is associated with a given sample, qualification is based upon a comparison with the associated blank having the highest concentration of a contaminant. Blank results are not subtracted from sample concentrations. Note that data with “B” validation qualifiers are included in the Chapter 5.0 tables, but the associated concentrations are not included in the tables’ “maximum detected concentration” columns because “B” qualified data are not regarded as detected and are not used in PBOW risk assessments. Note that no blank contamination was found in CY2 data.

4.2 Comparison to Screening Criteria

The analytical result tables presented in Chapter 5.0 include a comparison to RBSCs and BSCs as points of reference only. Concentrations of analytes that exceed the RBSCs are highlighted in the tables. RBSCs do not infer a regulatory limit or mandated cleanup level, nor is the identification of an exceedance intended to indicate an unacceptable human health risk or a need for remedial action. Formal evaluation of human health risks will be performed in the baseline human health risk assessment (BHHRA). Concentrations in individual samples that exceed the respective BSCs are identified by bold type in the Chapter 5.0 result tables.

4.2.1 Risk-Based Screening Concentrations

The RBSCs are derived from November 2011 regional screening levels (EPA, 2011) using the methodology described in the Ash Pit 2 baseline human health risk assessment (BHHRA) work plan (Shaw, 2009). Only soil samples were collected. Because the area surrounding PBOW is agricultural and residential and because other PBOW sites have been remediated based on unrestricted land use, risk-based screening has been performed based on residential exposure. This assumption is appropriate because the area surrounding the former PBOW facility is rural and residential, and if/when the property is excessed the land will likely become residential. The soil RBSCs are based on a long-term residential land-use scenario that assumes use by a young child for noncancer effects and use by the combined young child and adult life stages for carcinogenic effects. Together, these capture a plausible case for future land use. The soil RBSCs

are based on an incremental lifetime cancer risk of 1E-6 and a hazard quotient of 0.1. As stated in Section 4.2, laboratory analytical results are compared to RBSCs only as a point of reference. Further details on the RBSCs and their derivation are provided in the BHHRA work plan.

4.2.2 Background Screening Concentrations

Derivation and BSC values for PBOW soil are presented in the acid areas site investigation report (IT Corporation, 1998). Table 4-2 presents a complete list for metals in soil. The BSCs were derived from concentrations of these analytes found in PBOW background groundwater monitoring wells and soil data sets. The background soil samples were collected from near the property boundary, away from any potential source areas, and the background groundwater wells were installed in off-site areas upgradient of PBOW sources. Each BSC is the calculated 95th percent upper tolerance limit or the maximum detected concentration of the background data set, whichever value is lower, for each relevant analyte (IT Corporation, 1998). It is noted that the method agreed upon for the development of BSCs by OEPA and USACE, as recorded in the September 11, 2002 PBOW team meeting minutes, differs from that shown in current OEPA (2009) guidance. This PBOW team agreement, which has been used for all PBOW risk assessments to date, takes precedence over the subsequent OEPA (2009) guidance.

5.0 Investigation Results

On October 26 and 27, 2011, four soil borings (CY2-SB01, CY2-SB02, CY2-SB03 and CY2-SB04) were completed within Coal Yard No. 2. Soil samples were collected from 0 to 1, 3 to 5 and 8 to 10 feet bgs. Findings of the soil sampling are discussed in the following sections.

5.1 Site-Specific Soils

As noted in the Powerhouse 2 SCR (Shaw, 2010), fill sand was used at the close of PBOW and during remediation tasks to cover concrete foundations, demolition scars, and promote a natural landscape appearance. At Coal Yard No. 2, no fill sand was encountered in any of the four soil borings drilled for this investigation. The ground surface at three of the four soil borings was covered with a mixture of coal, silt, and sand to a depth of approximately 0.5 foot. A thin (0.2 foot) coal layer was encountered near the surface of the fourth boring (CY2-SB04) at a depth of 0.5 foot. The surface material at this location consisted of clay. Figure 1-4 shows a Coal Yard No. 2 site map with soil boring locations.

Below the coal layer or coal containing layer, native soil was present which consisted of glacial till, glacial outwash, or possibly a glacial lacustrine (lake) deposit. In three (CY2-SB01, CY2-SB02, and CY2-SB03) of the four soil borings, a medium stiff silt with clay was encountered to the total boring depth of 10 feet. The color of the silt changed from a yellowish brown to a gray color at a depth of approximately 8 feet bgs in the three borings. In soil boring CY2-SB04, a medium stiff, yellowish-brown silt with clay was again encountered to a depth of approximately 6 feet bgs. Below 6 feet bgs, a higher clay content was interpreted to be present to the total depth of 10 feet. Groundwater was encountered in all four soil borings at a depth of 5 feet.

5.2 Soil Analytical Results

A total of 14 soil samples were collected from the four borings. Five surface soil samples (including one QC and one QA sample) were collected and nine subsurface samples (including one QC and one QA sample) were collected from depths of 3 to 5 and 8 to 10 feet. Four of the surface soil samples including one duplicate, were collected below a 0.5-foot coal containing layer; the remaining surface soil sample, from CY2-SB04 encountered no coal on the ground surface, so the sample was collected from a depth of 0 to 1 foot. Soil samples were analyzed for nitroaromatics, SVOCs, and inorganics. Also, the 0 to 1, 0.5 to 1, and 3 to 5 feet soil samples were analyzed for PCBs. One surface soil sample should have been analyzed for TOC but

collection of the sample was inadvertently omitted. Table 5-1 summarizes the soil concentrations above RBSCs and/or BSCs. A figure is not included because only one analyte exceeded its RBSC.

5.2.1 2011 Surface Soil Samples

No nitroaromatics or PCBs were detected in any of the surface soil samples at Coal Yard No. 2. Seventeen SVOCs were detected in the six surface soil samples and only benzo[a]pyrene was detected above the RBSC screening level in one sample (QA sample). It was detected at a concentration of 0.039 milligrams per kilogram (mg/kg) in the QA sample from boring CY2-SB01, which exceeds the RBSC of 0.015 mg/kg. Benzo[a]pyrene was not detected in the regular sample or field duplicate from this location. The lack detections in the regular and QC samples indicate that benzo(a)pyrene is not prevalent in site soils. Further, the reported concentration in the QA sample is far less than the anthropogenic background concentrations found in background soil samples from a local community (Ohio Department of Health, 2011).

No inorganics exceeded both the RBSC and BSC in surface soil samples at Coal Yard No. 2.

5.2.2 2011 Subsurface Soil Samples

No nitroaromatics or PCBs were detected in the subsurface (3 to 5 and 8 to 10 feet) soil samples at Coal Yard No. 2. Only six SVOC compounds were detected in 2 of 10 subsurface soil samples, and all were below RBSC values.

No inorganics exceeded both the RBSC and BSC in subsurface soil samples at Coal Yard No. 2.

6.0 Soil Sample Summary and Conclusions

To determine possible contamination to soil caused by the storage of coal, four soil borings (CY2-SB01, CY2-SB02, CY2-SB03, and CY2-SB04) were completed within Coal Yard No. 2.

Field activities at Coal Yard No. 2 were conducted mainly in October 2011 with hand auger operation, soil sample collection, lithologic logging, paperwork completion, and surveying. Disposal of IDW occurred in January 2012. A total of six surface soil (includes one QA and one QC sample) and nine subsurface soil (includes 1 QA and 1 QC sample) samples were collected. Soil samples were collected from depths of 0 to 1 or 0.5 to 1, 3 to 5, and 8 to 10 feet bgs. All samples except CY0028 (0-1 foot sample from boring CY2-SB04) were collected below the existing coal-containing layer if present. Soil samples were analyzed for nitroaromatics, SVOCs, and inorganics. In addition, the 0 to 1, 0.5 to 1 and 3 to 5 feet intervals were analyzed for PCBs. Analytical results obtained from each soil sample were screened against RBSC and BSC values. RBSC values do not infer a regulatory limit or mandated cleanup level, nor does an exceedance necessarily represent an unacceptable human health risk. They are used in the report only as points of reference.

Major findings from Coal Yard No. 2 soil sample results are summarized as follows:

- No nitroaromatics or PCBs were detected in the surface or subsurface soil samples.
- Benzo(a)pyrene was detected at a concentration of 0.039 mg/kg in one QA surface soil sample and was the only SVOC to exceed RBSCs. It was not detected in the associated regular or field duplicate sample.
- No inorganics were detected at concentrations exceeding both the RBSCs and BSCs.

The soil data collected for Coal Yard No. 2 does not indicate an appreciable impact due to the storage of coal at the site.

7.0 Recommendations

The surface and subsurface soil of Coal Yard No. 2 appears to be adequately characterized. Because the maximum detected concentration of none of the analytes exceeded both the corresponding RBSC and the BSC values, no BHHRA is needed because all analytes would be screened out, leaving no chemicals of potential concern for evaluation. Ecological risks will be discussed in the remedial investigation report, which will describe that based on low concentrations of analytes in Coal Yard No. 2, no screening-level ecological risk assessment is required.

Planned Activities. Completion of a remedial investigation report, which is anticipated for completion in 2013.

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TABLES

Table 1-1

Coal Yard No. 2 - Historical Soil Analytical Detections
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

		LOCATION	MK-PMU1-SS06		MK-PMU1-SS07	
		SAMPLE NO	MK01SS06		MK01SS07	
		DATE	6/29/1993		6/29/1993	
		DEPTH	0 - 2 Ft		0 - 2 Ft	
		PURPOSE	REG		REG	
Parameter	**Units**	**MDC**	**Result**	**VQ**	**Result**	**VQ**
VOLATILES						
Acetone	mg/kg	0.01	--	-	0.01	J
Toluene	mg/kg	0.019	0.004	J	0.019	
Xylenes, total	mg/kg	0.001	--	-	0.001	J
SEMIVOLATILES						
Benzo(b)fluoranthene	mg/kg	0.046	0.046	J	--	-
Methylnaphthalene, 2-	mg/kg	0.32	0.32	J	--	-
Naphthalene	mg/kg	0.24	0.24	J	--	-
Phenanthrene	mg/kg	0.13	0.13	J	--	-
METALS						
Aluminum	mg/kg	11900	9730		11900	
Barium	mg/kg	80.6	72.9		80.6	
Beryllium	mg/kg	0.39	--	-	0.39	B
Cadmium	mg/kg	0.8	0.22	BN	0.8	BN
Calcium	mg/kg	24000	19900	B	24000	B
Chromium	mg/kg	20.1	16.9		20.1	
Cobalt	mg/kg	15	10.7		15	
Copper	mg/kg	12.6	5.7		12.6	
Iron	mg/kg	31700	25200		31700	
Magnesium	mg/kg	9120	9120	*	7690	*
Manganese	mg/kg	1190	677		1190	
Mercury	mg/kg	0.03	--	-	0.03	
Nickel	mg/kg	39.3	29.5		39.3	
Potassium	mg/kg	1480	1460		1480	
Sodium	mg/kg	209	209	B	197	B
Vanadium	mg/kg	32.8	25.7	*	32.8	B*
Zinc	mg/kg	99.5	61.4	*	99.5	*

mg/kg - Milligrams per kilogram.
"-" - Not detected.
SCR - Site characterization report.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is estimated.
N - MS/MSD accuracy and/or precision outside criteria.
B - Estimated result below the reporting limit but above the instrument detection limit.
* - Serial dilution outside quality control criteria.

Source: Morrison Knudsen Corporation (MK), 1994, Site Inspection Report,
Plum Brook Station, Sandusky, Ohio, Volume 1, January.

Table 3-1

Summary of Soil Samples Collected
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Type	Sample Location	Sample Number	Sample Date	Sample Purpose	SDG Number
SS	CY2-SB01	CY0015	27-Oct-11	REG	F87352
SS	CY2-SB01	CY0016	27-Oct-11	FD	F87352
SS	CY2-SB01	CY0017	27-Oct-11	FS	240-5522-1
DS	CY2-SB01	CY0018	27-Oct-11	REG	F87352
DS	CY2-SB01	CY0019	27-Oct-11	REG	F87353
SS	CY2-SB02	CY0020	27-Oct-11	REG	F87353
DS	CY2-SB02	CY0021	27-Oct-11	REG	F87353
DS	CY2-SB02	CY0022	27-Oct-11	REG	F87352
DS	CY2-SB02	CY0023	27-Oct-11	FD	F87352
DS	CY2-SB02	CY0024	27-Oct-11	FS	240-5520-1
SS	CY2-SB03	CY0025	26-Oct-11	REG	F87353
DS	CY2-SB03	CY0026	26-Oct-11	REG	F87353
DS	CY2-SB03	CY0027	26-Oct-11	REG	F87352
SS	CY2-SB04	CY0028	26-Oct-11	REG	F87353
DS	CY2-SB04	CY0029	26-Oct-11	REG	F87353
DS	CY2-SB04	CY0030	26-Oct-11	REG	F87352

Notes:

SDG - Sample Delivery Group.

SS - Surface Soil.

CY2 - Coal Yard 2.

REG - Regular Sample.

FD - Field Duplicate.

FS - Field Split.

DS - Deep Soil (subsurface).

Table 4-1

Summary of Soil and Groundwater Analytical Parameters and Methods
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Matrix	Analytical Parameters[a]	Analytical Method[b]
Soil	TCL Semivolatile Organic Compounds	SW-846 3550C/8270D
	Nitroaromatic Compounds	SW-846 8330A
	Polychlorinated Biphenyls	SW-846 3550C/8082A
	TAL Metals	SW-846 3050B/6010C/7471B
	Total Organic Carbon	Walkley-Black
Liquid IDW	Target Compound List Volatile Organic Compound	SW-846 8260B
	Target Compound List Semivolatile Organic Compound	SW-846 3510C/8270D
	Nitroaromatics	SW-846 8330A
	TAL Metals	SW-846 3010A/6010C/7470A
	Ignitability	SW-846 1010A
	pH	SW-846 9040C
	Corrosivity	SW-846 1110A
	Reactive Cyanide	7.3.3/7.3.4
	Reactive Sulfide	7.3.3/7.3.4
Soil IDW	TCLP Volatile Organic Compounds	SW-846 1311/8260B
	TCLP Semivolatile Organic Compounds	SW-846 1311/3510C/8270C
	TCLP Metals	SW-846 1311/3010A/6010C/7470A
	Ignitability	SW-846 1010A
	Corrosivity	SW-846 1110A
	Reactivity	7.3.3.2/7.3.4.2

[a]Target analyte list (TAL) and target compound list (TCL) are used to designate parameter lists with no requirements for Contract Laboratory Program method quality control or data reporting packages.
[b]Analyses found in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* EPA Publication, Third Edition, and *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, March 1983 and subsequent revisions, except as noted.
[c]Water quality parameter.
[d]Field testing will use an appropriate field test kit or method according to EPA 600/4-79-020: Method for Chemical Analysis of Water and Wastes in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA Publication, Third Edition.

IDW - Investigation-derived waste.
SCR - Site characterization report.
TCLP - Toxicity characteristic leaching procedure.
TOC - Total organic compound.

Table 4-2

Background Screening Concentrations of Metals in Soil[a]
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UTL [b]	Background Screening Criterion [c]
Aluminum	12 / 12	3520 - 15500	NA	L	8.43E+03	2.69E+04	1.55E+04
Antimony	9 / 25	5.9 - 9.3	5.4 - 74	NP	4.68E+00	NA	9.30E+00
Arsenic	23 / 26	2.1 - 36.5	1.2 - 3.7	L	1.08E+01	7.10E+01	3.65E+01
Barium	9 / 12	35.6 - 826	23.2 - 24.7	L	1.16E+02	1.30E+03	8.26E+02
Beryllium	6 / 25	0.57 - 1	0.57 - 1.2	L	5.65E-01	1.17E+00	1.00E+00
Cadmium	0 / 25	NA	0.57 1.2	L	4.49E-01	NA	NA
Calcium	12 / 12	735 - 52300	NA	L	1.13E+04	2.18E+05	5.23E+04
Chromium	25 / 26	4.4 - 29	12.3 - 12.3	NP	1.34E+01	NA	2.90E+01
Cobalt	9 / 12	9.6 - 116	5.8 - 6.2	L	2.26E+01	2.48E+02	1.16E+02
Copper	23 / 26	2.3 - 56.2	2.2 - 2.9	L	1.70E+01	1.47E+02	5.62E+01
Iron	12 / 12	5880 - 234000	NA	L	4.01E+04	3.58E+05	2.34E+05
Lead	26 / 26	1.9 - 48.6	NA	L	1.28E+01	5.13E+01	4.86E+01
Magnesium	12 / 12	629 - 10400	NA	L	3.26E+03	3.08E+04	1.04E+04
Manganese	26 / 26	21 - 13300	NA	L	7.29E+02	3.51E+03	3.51E+03
Mercury	2 / 26	0.085 - 0.085	0.037 - 0.3	L	9.06E-02	5.60E-01	8.50E-02
Nickel	26 / 26	5.4 - 55.1	NA	L	2.28E+01	7.79E+01	5.51E+01
Potassium	11 / 12	579 - 3390	617 - 617	L	1.24E+03	6.08E+03	3.39E+03
Selenium	5 / 25	0.61 - 2	0.57 - 4.9	NP	1.55E+00	NA	2.00E+00
Silver	2 / 26	1.1 - 11.1	1.1 - 1.3	NP	1.00E+00	NA	1.11E+01
Sodium	0 / 12	NA	566 - 663	L	3.03E+02	NA	NA
Thallium	2 / 25	1.2 - 1.3	1.1 - 6.1	NP	1.91E+00	NA	1.30E+00
Vanadium	11 / 12	9 - 40.9	61.7 - 61.7	L	2.48E+01	8.31E+01	4.09E+01
Zinc	26 / 26	6.6 - 655	NA	L	7.30E+01	3.22E+02	3.22E+02

mg/kg - Milligrams per kilogram
NA - Not applicable; not available.
SCR - Site characterization repott.

[a] Data used to determine soil background are based on sampling from IT, 1998, ***Site Investigation of Acid Areas, Plum Brook Ordnance Works, Sandusky, Ohio.***

[b] 95% UTL - 95 Percent upper tolerance limit calculated as described in Section 2.1.4 and rounded to 3 significant figures.

[c] The maximum detected concentration is used as the background screening criterion for nonparametric data sets; for normal or lognormal data sets, the 95% UTL or the maximum detected concentration, whichever is less, is used.

Note: Detection limits from sample 6990 were deleted when calculating results for antimony, beryllium, cadmium, selenium and thallium. The detection limits were elevated by dilution factors which greatly exceed any detected concentration and would bias results unrealistically high.

Table 5-1

Soil Samples Above RBSCs and/or BSCs
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

				LOCATION	CY2-SB01										CY2-SB02									
				SAMPLE NO	CY0015		CY0016		CY0017		CY0018		CY0019		CY0020		CY0021		CY0022		CY0023		CY0024	
				DATE	27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11		27-Oct-11	
				DEPTH	0.5 - 1 Ft		0.5 - 1 Ft		0.5 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0.5 - 1 Ft		3 - 5 Ft		8 - 10 Ft		8 - 10 Ft		8 - 10 Ft	
				PURPOSE	REG		FD		FS		REG		REG		REG		REG		REG		FD		FS	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES																								
Acenaphthylene	mg/kg	NE	NE	0.013	-	-	-	-	0.013		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acetophenone	mg/kg	780	NE	0.047	-	-	-	-	0.047	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	1,700	NE	0.02	-	-	-	-	0.02		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.15	NE	0.043	-	-	-	-	0.043		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)flouranthene	mg/kg	0.15	NE	0.039	-	-	-	-	0.039		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)flouroanthene	mg/kg	1.5	NE	0.018	-	-	-	-	0.018		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	NE	NE	0.024	-	-	-	-	0.024		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.039	-	-	-	-	0.039		-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1'-Biphenyl	mg/kg	5.1	NE	0.034	-	-	-	-	0.034	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	mg/kg	35	NE	0.321	-	-	-	-	-	-	0.321	J	-	-	-	-	-	-	-	-	-	-	0.025	J
Chrysene	mg/kg	15	NE	0.055	-	-	-	-	0.055		-	-	-	-	-	-	-	-	-	-	-	-	0.028	
Dibenzofuran	mg/kg	7.8	NE	0.14	-	-	-	-	0.14		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.051	-	-	0.0293	J	0.051		-	-	-	-	0.031	J	-	-	-	-	-	-	-	-
Flourene	mg/kg	230	NE	0.018	-	-	-	-	0.018		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methylnaphthalene, 2-	mg/kg	31	NE	0.65	-	-	-	-	0.65		-	-	-	-	-	-	-	-	-	-	-	-	0.025	
Naphthalene	mg/kg	3.6	NE	0.4	-	-	-	-	0.4		-	-	-	-	-	-	-	-	-	-	-	-	0.015	
Phenanthrene	mg/kg	NE	NE	0.22	-	-	-	-	0.22		-	-	-	-	0.0292	J	-	-	-	-	-	-	0.02	
Pyrene	mg/kg	170	NE	0.054	-	-	0.0268	J	0.054		-	-	-	-	-	-	-	-	-	-	-	-	0.013	
METALS																								
Aluminum	mg/kg	7,700	15,500	14,500	8,000	J	14,500	J	14,000		5,150		6,090		7,330		8,500		7,090		5,780		8,400	
Antimony	mg/kg	3.1	9.3	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	mg/kg	0.39	36.5	13.5	10		10		12		5.8		3.2		13.5		2.1		4.3	J	8	J	7.3	
Barium	mg/kg	1,500	826	86.6	49.2	J	86.6	J	85		35.2		53.8		57.3		67.6		72.1		50.4		52	
Beryllium	mg/kg	16	1	0.87	0.67	J	0.87	J	0.48	J	0.36	J	0.44	J	0.36	J	0.49	J	0.46	J	0.4	J	0.32	J
Cadmium	mg/kg	7	NE	0.89	-	-	-	-	0.063	J	0.81		0.89		-	-	-	-	0.83	J	0.17	J	0.24	J
Calcium	mg/kg	NE	52,300	60,700	3,260	J	9,300	J	4,700		**52,500**		**60,700**		1,270		34,600		49,500		51,200		52,000	
Chromium	mg/kg	NE	29	22	16.7		19.1		19		9.8		13		14.9		12.9		13.8		12.6		15	
Cobalt	mg/kg	2.3	116	15.1	11.4		10.6	J	8.7		5.5		6.5		4.7	J	9.6	J	6.9		10		11	
Copper	mg/kg	310	56.2	26.4	24.6		24.2		24		18.8		23.9		22.5		20.6		23		22.2		24	
Iron	mg/kg	5,500	234,000	34,300	28,700		27,700		31,000	B	17,100		19,800		23,800		17,100		22,700		17,800		21,000	B
Lead	mg/kg	40	48.6	15.3	13.4		13		14		12.8		13		11		11		12.9		12.2		12	
Magnesium	mg/kg	NE	10,400	23,700	3,000		4,370		4,300	B	**15,300**		**17,300**		1,810		**14,600**		**14,800**		**13,800**		**17,000**	B
Manganese	mg/kg	180	3,506	816	249		199		200		454		538		81.1		492		413		450		420	
Mercury	mg/kg	1	0.09	0.054	0.038	J	0.052	J	0.054	J B	0.019	J	0.021	J	0.043	J	0.04	J	0.016	J	0.015	J	0.029	J B
Nickel	mg/kg	150	55.1	40	26.6		30		25		16.1		17.3		19.2		26.8		18.8		25.3		27	
Potassium	mg/kg	NE	3,390	1,540	599	J	815	J	850		1,020	J	1,440	J	567	J	990	J	1,540		1,160		1,400	
Selenium	mg/kg	39	2	1.1	1	J	-	-	-	-	0.43	J	-	-	0.91	J	-	-	0.65	J	-	-	-	-
Silver	mg/kg	39	11.1	0.088	-	-	-	-	-	-	0.053	J	0.086	J	-	-	0.063	J	0.079	J	-	-	-	-
Sodium	mg/kg	NE	NE	150	-	-	-	-	-	-	124	J	-	-	-	-	-	-	150	J	135	J	-	-
Thallium	mg/kg	0.078	1.3	0.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	mg/kg	39	40.9	32.4	26.4		28		27		11.5		11.4		24.8		17.5		13.8		16.7		19	
Zinc	mg/kg	2,300	321.75	70	-	-	-	-	70		-	-	-	-	-	-	-	-	-	-	-	-	57	

Table 5-1

Soil Samples Above RBSCs and/or BSCs
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

				LOCATION	CY2-SB03						CY2-SB04					
				SAMPLE NO	CY0025		CY0026		CY0027		CY0028		CY0029		CY0030	
				DATE	26-Oct-11		26-Oct-11		26-Oct-11		26-Oct-11		26-Oct-11		26-Oct-11	
				DEPTH	0.5 - 1 Ft		3 - 5 Ft		8 - 10 Ft		0 - 1 Ft		3 - 5 Ft		8 - 10 Ft	
				PURPOSE	REG		REG		REG		REG		REG		REG	
Parameter	Units	RBSC	BSC	MDC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
SEMIVOLATILES																
Acenaphthylene	mg/kg	NE	NE	0.013	-	-	-	-	-	-	-	-	-	-	-	-
Acetophenone	mg/kg	780	NE	0.047	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	1,700	NE	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.15	NE	0.043	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)flouranthene	mg/kg	0.15	NE	0.039	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)flouroanthene	mg/kg	1.5	NE	0.018	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	NE	NE	0.024	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.015	NE	0.039	-	-	-	-	-	-	-	-	-	-	-	-
1,1'-Biphenyl	mg/kg	5.1	NE	0.034	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	mg/kg	35	NE	0.321	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	mg/kg	15	NE	0.055	-	-	-	-	-	-	-	-	-	-	-	-
Dibenzofuran	mg/kg	7.8	NE	0.14	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	mg/kg	230	NE	0.051	-	-	-	-	-	-	-	-	-	-	-	-
Flourene	mg/kg	230	NE	0.018	-	-	-	-	-	-	-	-	-	-	-	-
Methylnaphthalene, 2-	mg/kg	31	NE	0.65	-	-	-	-	-	-	0.0429	J	-	-	-	-
Naphthalene	mg/kg	3.6	NE	0.4	-	-	-	-	-	-	0.0321	J	-	-	-	-
Phenanthrene	mg/kg	NE	NE	0.22	-	-	-	-	-	-	-	-	-	-	-	-
Pyrene	mg/kg	170	NE	0.054	-	-	-	-	-	-	-	-	-	-	-	-
METALS																
Aluminum	mg/kg	7,700	15,500	14,500	9,880		7,300		6,660		6,650		5,140		5,510	
Antimony	mg/kg	3.1	9.3	0.25	-	-	-	-	-	-	0.25	J	-	-	-	-
Arsenic	mg/kg	0.39	36.5	13.5	12.2		10.8		2		6.1		11.5		5.4	
Barium	mg/kg	1,500	826	86.6	68		63.8		37.1		35.2		70.9		40.3	
Beryllium	mg/kg	16	1	0.87	0.48	J	0.49		0.46	J	0.27		0.42	J	0.46	J
Cadmium	mg/kg	7	NE	0.89	-	-	0.28	J	0.73		0.72		0.24	J	-	-
Calcium	mg/kg	NE	52,300	60,700	1,740		43,200		45,200		3,380		39,900		**54,100**	
Chromium	mg/kg	NE	29	22	22		16.7		12.9		10.4		11.8		12.7	
Cobalt	mg/kg	2.3	116	15.1	6.8	J	15.1		6.9		3.5		9.9	J	9.1	
Copper	mg/kg	310	56.2	26.4	23.5		26.4		21.6		11.2		20.9		21.8	
Iron	mg/kg	5,500	234,000	34,300	34,300		18,800		20,400		16,400		20,200		17,500	
Lead	mg/kg	40	48.6	15.3	9.6		15.3		12.7		7.4		8.3		13.2	
Magnesium	mg/kg	NE	10,400	23,700	3,100		**14,100**		**14,700**		2,430		**16,300**		**23,700**	
Manganese	mg/kg	180	3,506	816	121		816		514		103		672		488	
Mercury	mg/kg	1	0.09	0.054	0.035	J	0.011	J	0.023	J	0.034	J	0.017	J	0.012	J
Nickel	mg/kg	150	55.1	40	23.5		40		19.3		10.7		25.7		25.3	
Potassium	mg/kg	NE	3,390	1,540	698	J	1,210		1,450		472		848	J	1,220	J
Selenium	mg/kg	39	2	1.1	1.1	J	-	-	0.72	J	-	-	-	-	-	-
Silver	mg/kg	39	11.1	0.088	-	-	-	-	0.087	J	0.088	J	-	-	-	-
Sodium	mg/kg	NE	NE	150	-	-	114	J	146	J	52.6	J	-	-	-	-
Thallium	mg/kg	0.078	1.3	0.39	-	-	0.39	J	-	-	-	-	-	-	-	-
Vanadium	mg/kg	39	40.9	32.4	32.4		24.9		13.4		16.1		20		12.3	
Zinc	mg/kg	2,300	321.75	70	-	-	-	-	-	-	24.2		-	-	-	-

mg/kg - Milligrams per kilogram.
RBSC - Values reflect an incremental lifetime cancer risk (ICLR) of 1E-6 or a noncancer hazard quotient (HQ) of 0.1. For chemicals that exhibit both cancer and noncancer effects, whichever type of effect results in a lower concentration (using an ICLR of 1E-6 and an HQ of 0.1), that concentration is selected as the RBSC.
BSC - Background screening concentration.
MDC - Maximum detected concentration for the area of concern.
Shaded cell indicates value is greater than RBSC.
Bolded text indicates values are greater than BSC.
NE - Not established (RBSCs), not evaluated (BSCs).
SCR - Site characterization report.
"-" - Not detected.

Validation Qualifiers (VQ)
J - The analyte was positively identified; the reported value is estimated.
B - The analyte was not detected significantly above the levels found in the associated method blank or field blanks.

Note:
Nitroaromatics and PCBs (PCBs from only the 0-1 and 3-5 feet intervals) were also analyzed but were not detected.

FIGURES

FIGURE 1-1
PBOW VICINITY MAP

POWERHOUSE No.2 COAL YARD SCR ADDENDUM
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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SEI_TEXTSUB_ONLY.TBL
pdf_with_levels.plt
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4/16/2012
cbentley
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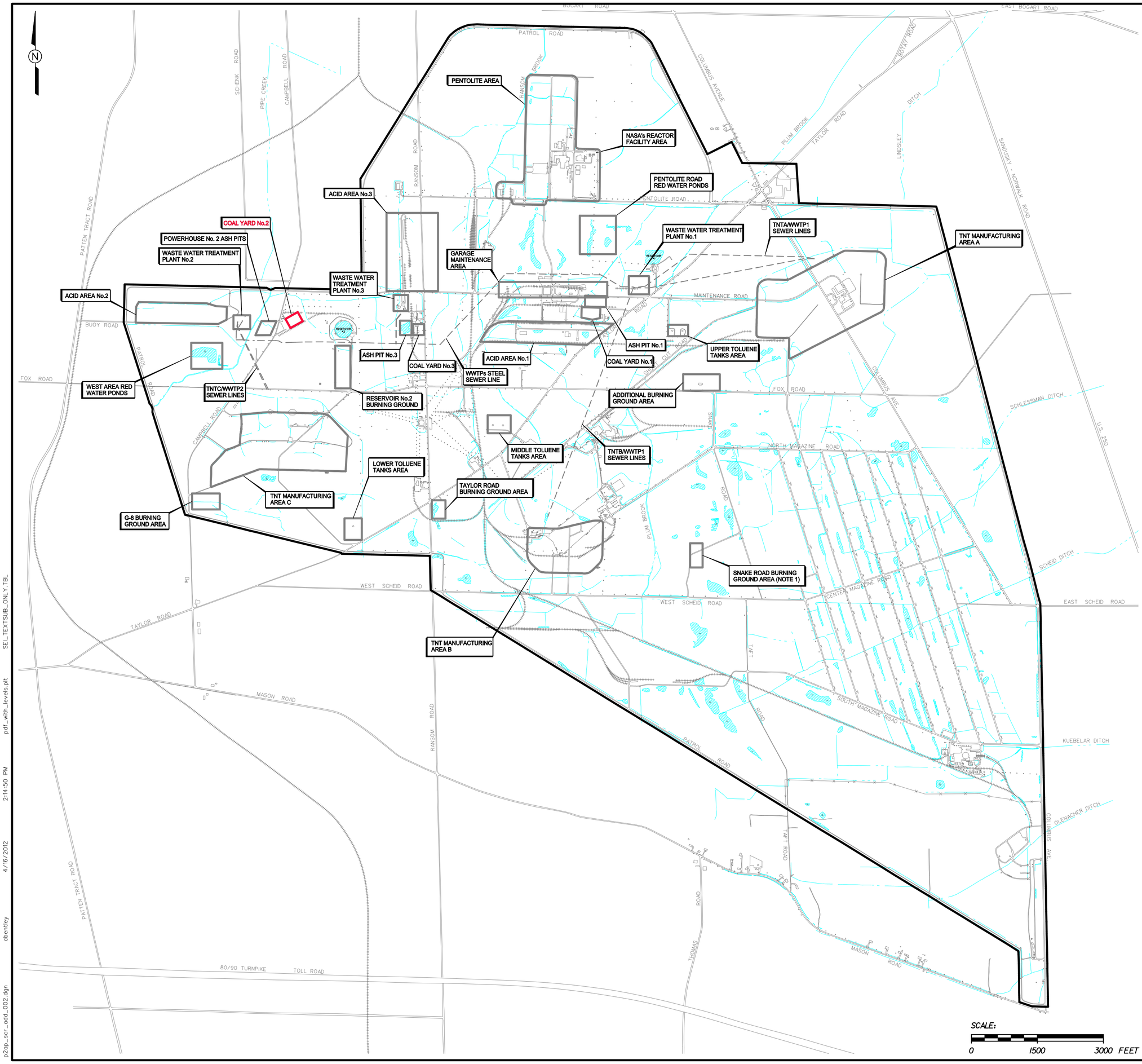

LEGEND:

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

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. REACTOR FACILITY CONSTRUCTED BY NASA POST WWII AND IS IDENTIFIED FOR LOCATION PURPOSES ONLY.

SCALE:

0 1500 3000 FEET

FIGURE 1-2
LOCATION OF COAL YARD No.2 AT PBOW

POWERHOUSE No.2 COAL YARD SCR ADDENDUM
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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p2sp_scr_add_002.dgn 4/16/2012 2:14:50 PM cbentley pdf_with_levels.plt SEI_TEXTSUB_ONLY.TBL

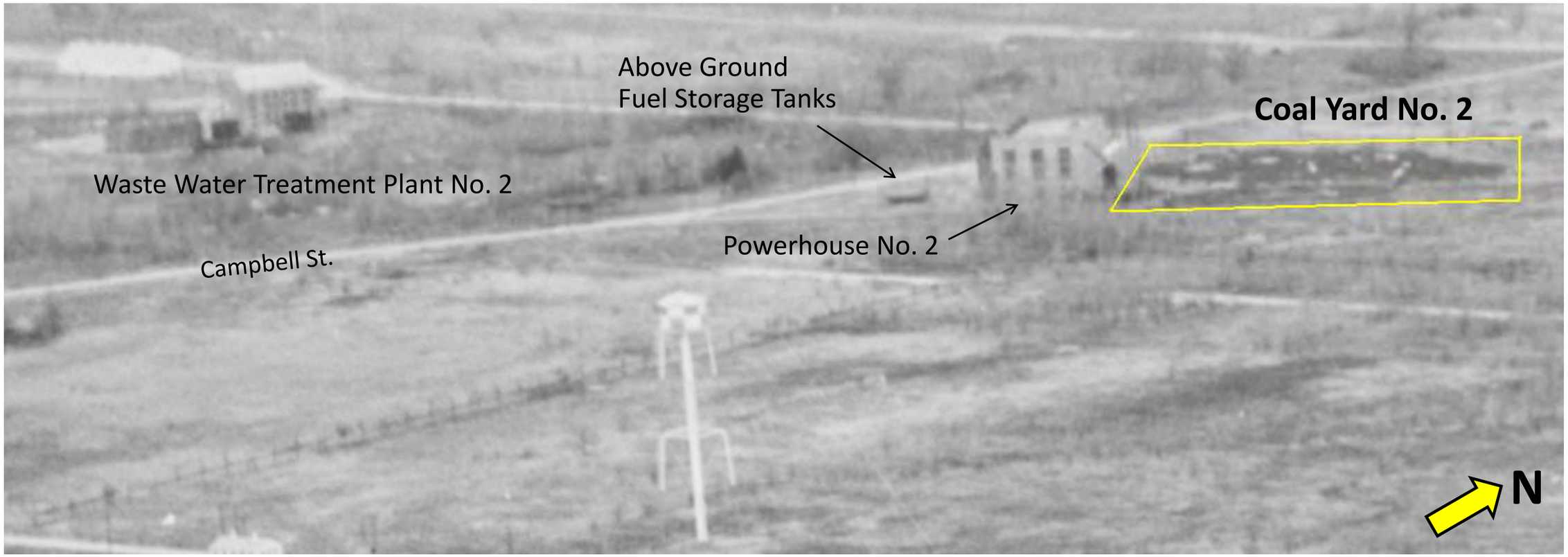
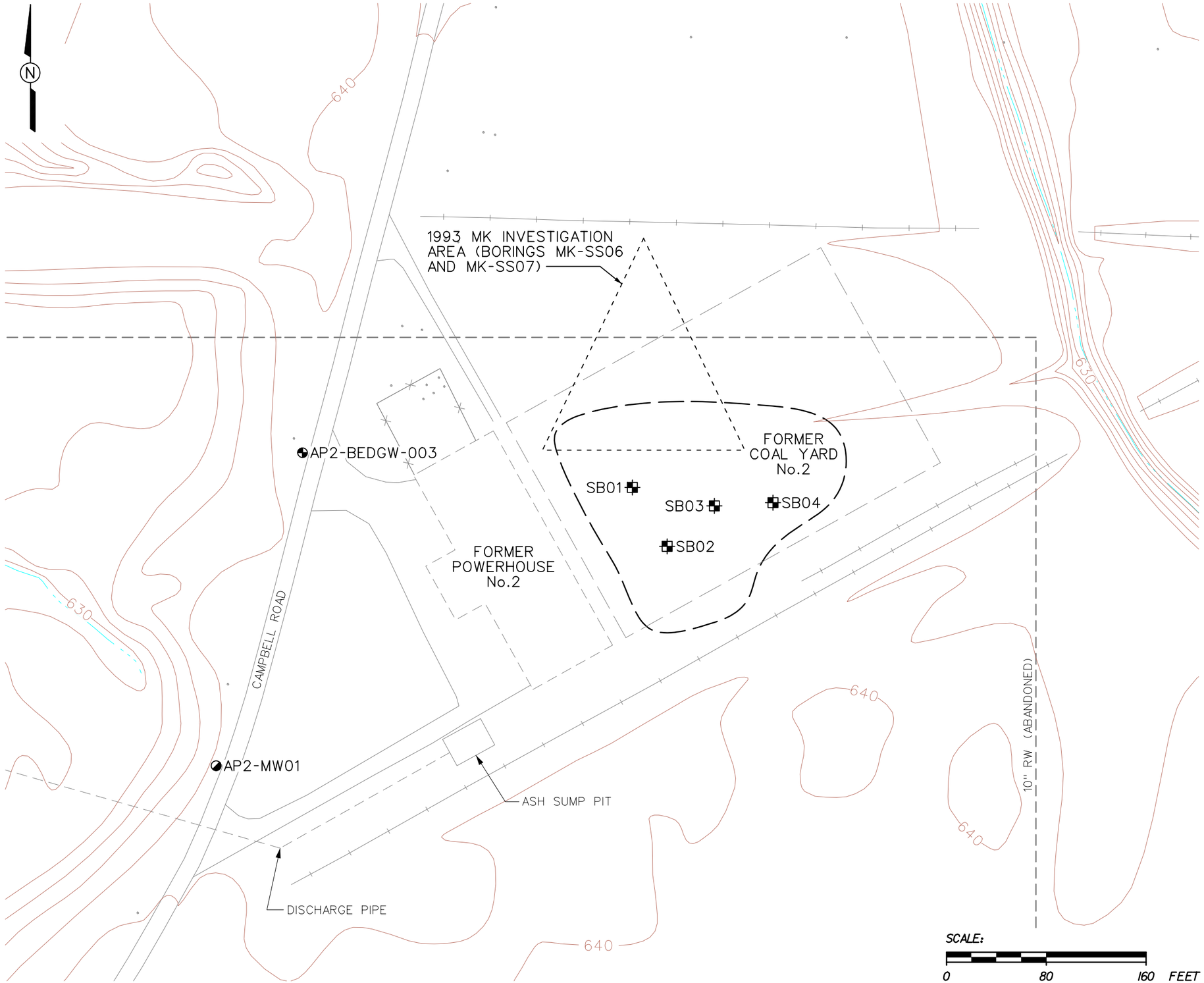


Figure 1-3
Coal Yard No. 2, Circa 1958 Photo
(View is to the Northwest)



LEGEND:

- OVERBURDEN MONITORING WELL (SCREENED IN SHALE)
- BEDROCK MONITORING WELL (SCREENED IN LIMESTONE)
- SOIL BORING
- UTILITY POLE
- TOPOGRAPHIC CONTOUR (2 FT. INTERVAL)
- CREEK, DITCH, CONVEYANCE
- ABANDONED RAILROAD
- ROAD
- APPROXIMATE LOCATION OF FORMER STRUCTURES
- RAW WATER LINE (RW)
- APPROXIMATE HISTORICAL COAL STORAGE PERIMETER BASED ON AERIAL PHOTO
- APPROXIMATE COAL STORAGE PERIMETER BASED ON OCTOBER 2011 FIELD FINDINGS AND EXISTING COAL THICKNESS

NOTES:

1. SPECIFIC HISTORICAL SAMPLING LOCATIONS MK-SS06 AND MK-SS07 ARE NOT SHOWN DUE TO LACK OF SURVEY DATA.
2. SOURCE OF 1993 MK SOIL BORINGS: MORRISON KNUDSEN CORPORATION (MK), 1994, SITE INSPECTION REPORT, PLUM BROOK STATION, SANDUSKY, OHIO, VOLUME 1, JANUARY.

SCALE:

0 80 160 FEET

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FIGURE 1-4
GENERAL SITE FEATURES WITH SITE TOPOGRAPHY

POWERHOUSE No.2 COAL YARD SCR ADDENDUM
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

p2gp_scr_add_003.dgn cbentley 7/18/2012 9:34:20 AM pdf_with_levels.plt SEL_TEXTSUB_ONLY.TBL

APPENDIX A

SOIL BORING SAMPLE COLLECTION LOGS

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811ACCT

Location Code: CY2-SB0~~8~~4 EW

Sample Number: CY0028

Sample Name: PB11-SS-CY2-SB0~~8~~4-CY0028-(0-1)-REG EW

Sampling Method: HA

Sample Type: SS *Sample Purpose:* REG

Sampling Equip: Stainless Steel bucket auger

Task: GMA_OCT2011

Collection Date: 10-26-11

Collection Time: 1410

Start Depth: 0

End Depth: 1'

Sample Matrix: SOIL

Sample Team: EW/JB/MG

QC Partners:

(TB) (ER) (FB)

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

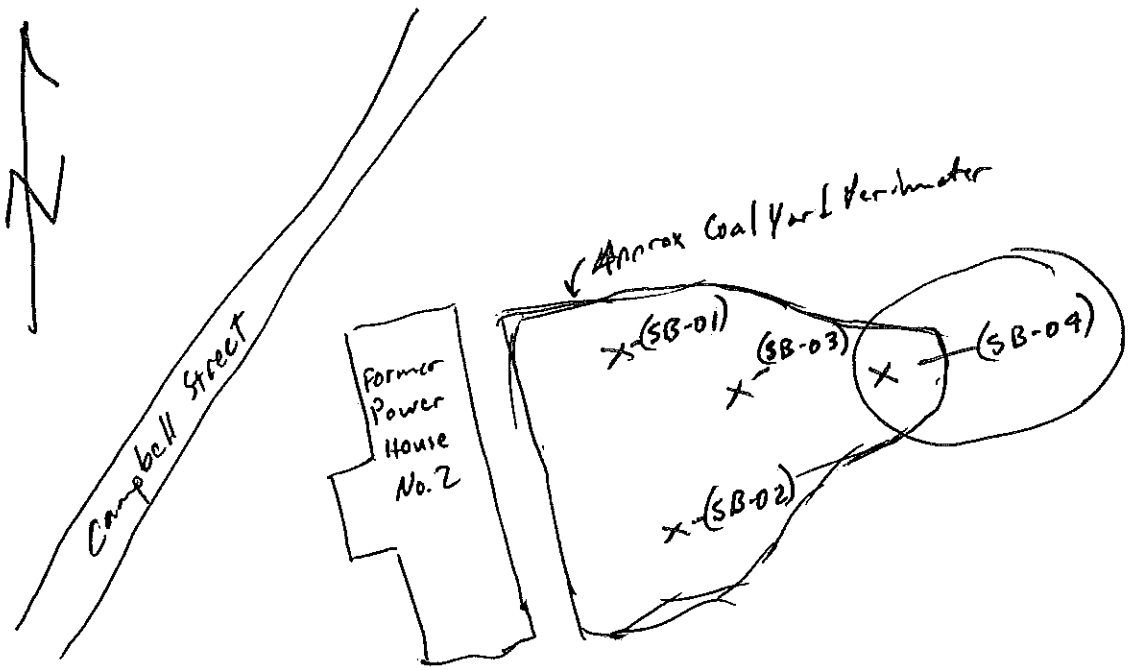
ERPIMS Values:

Sacode:

Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: E. W. Wenner 10-26-11

Reviewed BY / Date: Edward Gallion 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811 ACCT

Location Code: CY2-SB0~~8~~ 4 EW
Sample Number: CY0029
Sample Name: PB11-DS-CY2-SB0~~8~~ 4 EW-CY0029-(3-5)-REG
Sampling Method: SS
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: Stainless Steel bucket auger

Task: GMA_OCT2011
Collection Date: 10-26-11
Collection Time: 1430
Start Depth: 3'
End Depth: 5'
Sample Matrix: SOIL

QC Partners:
(TB) (ER) (FB)

Sample Team: EW/JB/MG

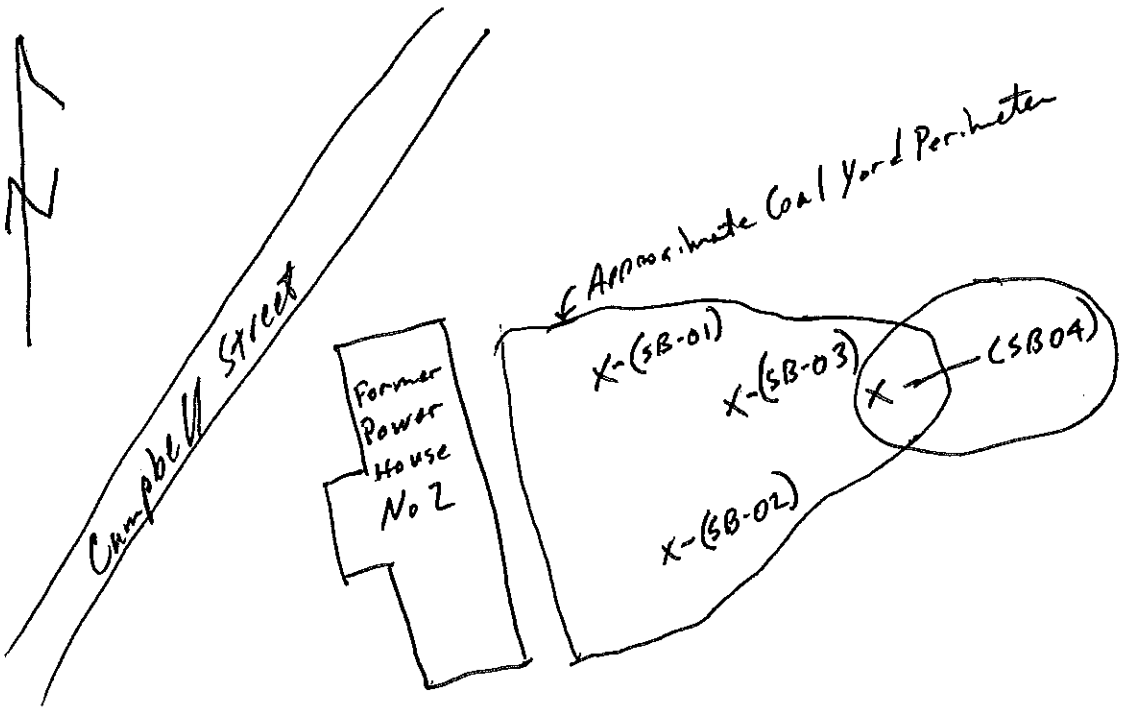
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: Eric W. Werner 10-26-11 *Reviewed BY / Date:* Edward [illegible] 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811ACCT

Location Code: CY2-SB0~~8~~4 EW

Sample Number: CY0030

Sample Name: PB11-DS-CY2-SB0~~8~~4-CY0030-(8-10)-REG EW

Sampling Method: SS

Sample Type: DS *Sample Purpose:* REG

Sampling Equip: Stainless Steel bucket auger

Task: GMA_OCT2011

Collection Date: 10-26-11

Collection Time: 1450

Start Depth: 8'

End Depth: 10'

Sample Matrix: SOIL

Sample Team: EW/JB/MG

QC Partners:

(TB) (ER) (FB)

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

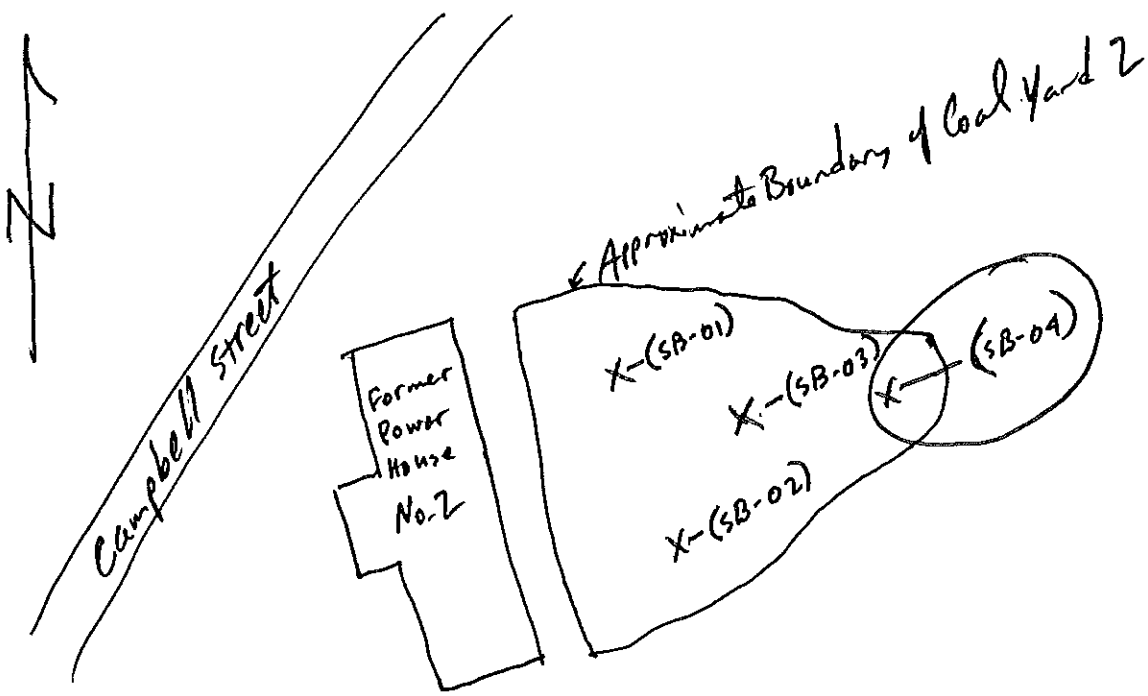
ERPIMS Values:

Sacode:

Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: Eric W. Weaver 10-26-11 *Reviewed BY / Date:* Edward L. Weaver 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811ACCT

Location Code: CY2-SB03 EW

Sample Number: CY0025

Sample Name: PB11-SS-CY2-SB03 EW-CY0025-(0-1)-REG

Sampling Method: HA

Sample Type: SS *Sample Purpose:* REG

Sampling Equip: Stainless Steel bucket auger

Task: GMA_OCT2011

Collection Date: 10-26-11

Collection Time: 1540

Start Depth: 0.5

End Depth: 1.0'

Sample Matrix: SOIL

Sample Team: EW/JB/MG

QC Partners:

(TB) (ER) (FB)

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

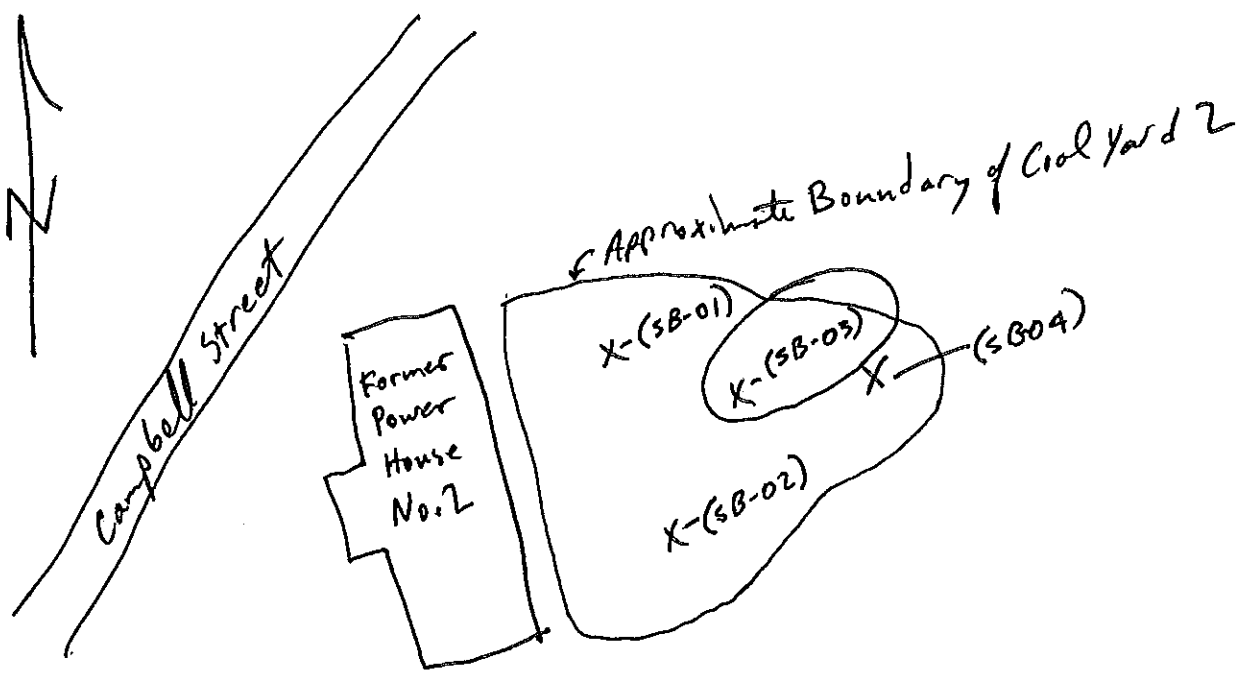
ERPIMS Values:

Sacode:

Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: Eric W. Weaver 10-26-11

Reviewed BY / Date: Edward Wilson 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811 ACCT

Location Code: CY2-SB0~~4~~3 EW

Sample Number: CY0026

Sample Name: PB11-DS-CY2-SB0~~4~~3 EW-CY0026-(3-5)-REG

Sampling Method: SS

Sample Type: DS *Sample Purpose:* REG

Sampling Equip: Stainless ~~Steel~~ EW Steel bucket auger

Task: GMA_OCT2011

Collection Date: 10-26-11

Collection Time: 1555

Start Depth: 3'

End Depth: 5'

Sample Matrix: SOIL

Sample Team: EW/JB/MG

QC Partners:

(TB) _____ (ER) _____ (FB) _____

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

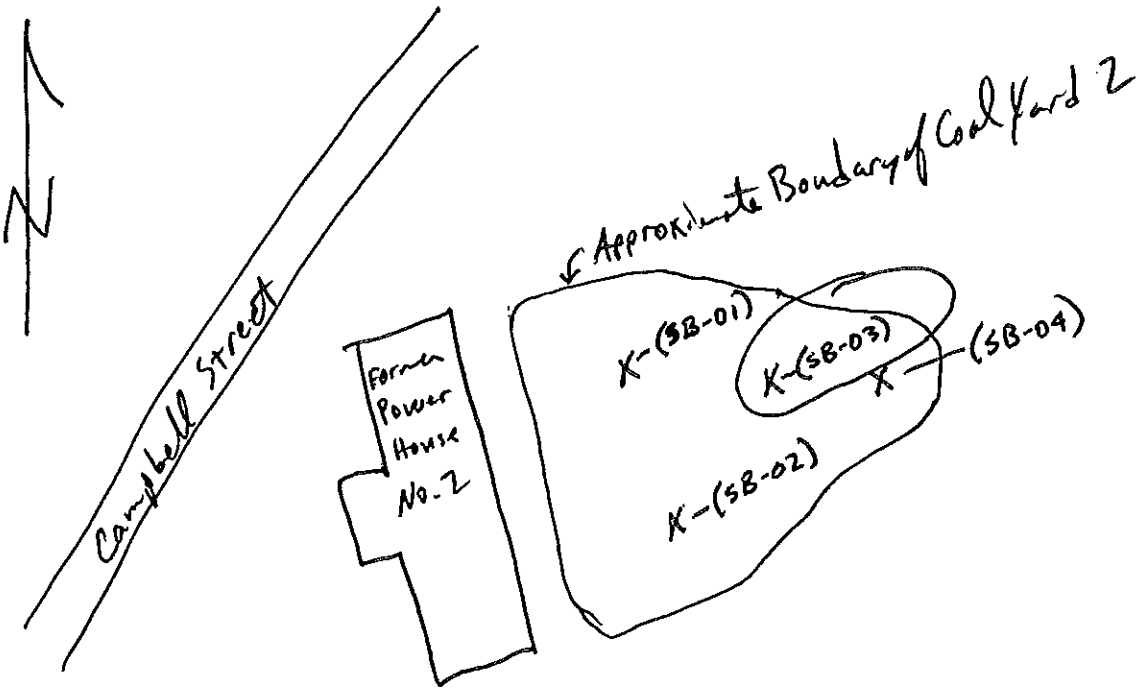
ERPIMS Values:

Sacode:

Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: Eric W. Werner 10-26-11

Reviewed BY / Date: Edward E. Klaus 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811ACCT

Location Code: CY2-SB03 EW
Sample Number: CY0027
Sample Name: PB11-DS-CY2-SB03-CY0027-(8-10)-REG EW
Sampling Method: SS
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: Stainless Steel bucket auger

Task: GMA_OCT2011
Collection Date: 10-26-11
Collection Time: 1615
Start Depth: 8'
End Depth: 10'
Sample Matrix: SOIL
Sample Team: EW/JB/MG

QC Partners:
(TB) (ER) (FB)

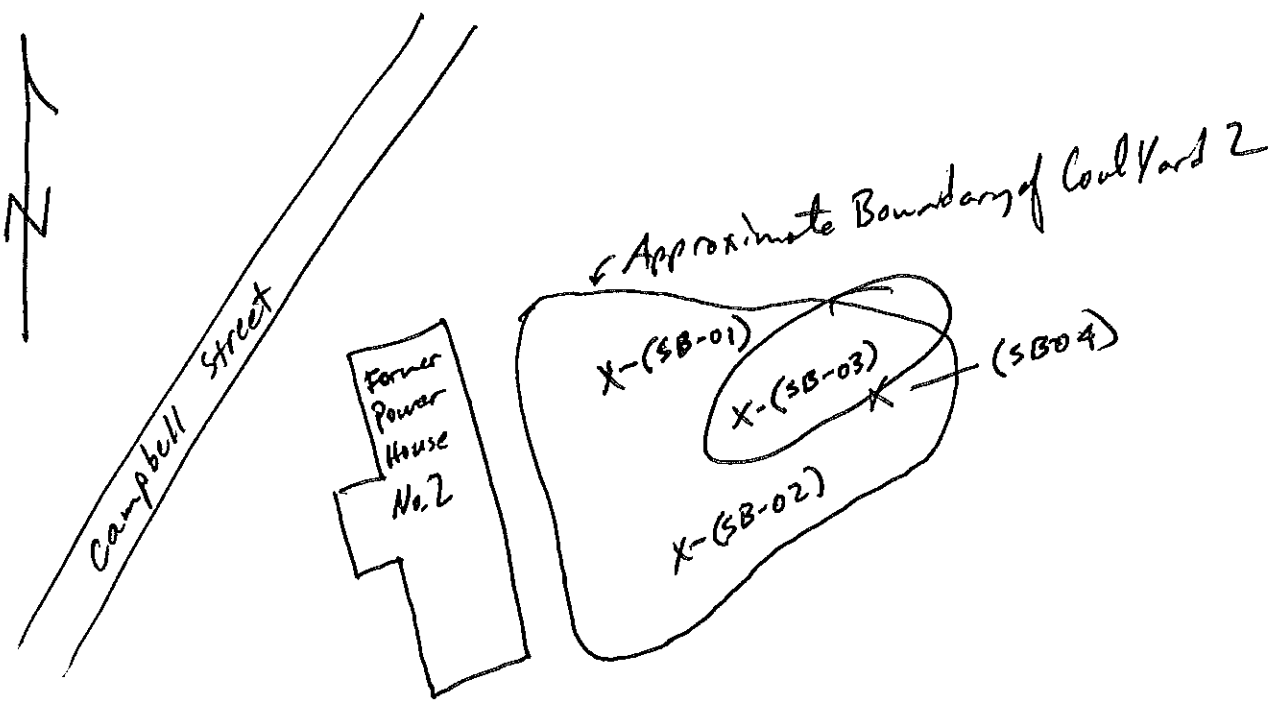
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: E. W. Wenzel 10-26-11 *Reviewed BY / Date:* Edward E. Weaver 1-4-12

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Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811ACCT

Location Code: CY2-SB02 EW
Sample Number: CY0020
Sample Name: PB11-SS-CY2-SB02 EW-CY0020-(0-1)-REG
Sampling Method: HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: stainless Steel bucket auger

Task: GMA_OCT2011
Collection Date: 10-27-11
Collection Time: 0830
Start Depth: 0.5
End Depth: 1.0'
Sample Matrix: SOIL
Sample Team: EW/JB/MG

QC Partners:
(TB) (ER) (FB)

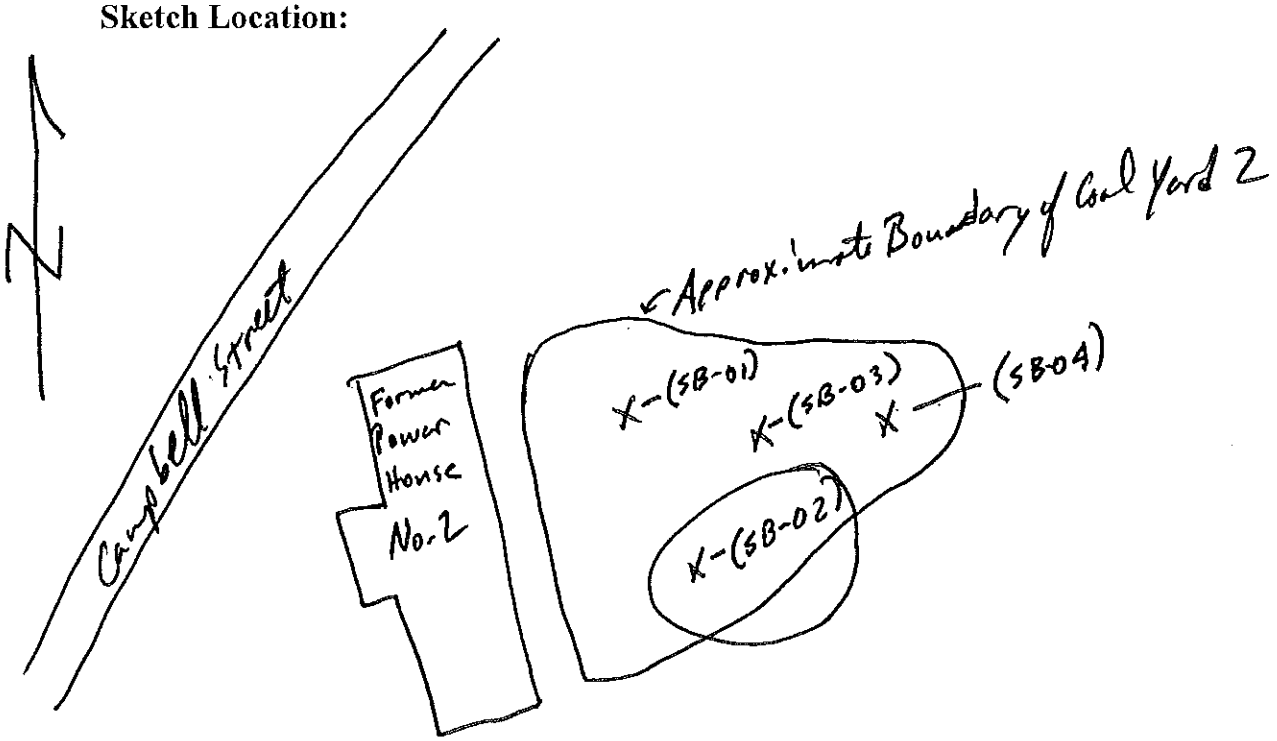
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: E. W. Weaver 10-27-11 *Reviewed BY / Date:* Edward W. Weaver 1-4-12

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Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811 ACCT

Location Code: CY2-SB02

Sample Number: CY0021

Sample Name: PB11-DS-CY2-SB02-CY0021-(3-5)-REG

Sampling Method: SS

Sample Type: DS *Sample Purpose:* REG

Sampling Equip: Stainless ~~Steel~~ steel bucket auger

Task: GMA_OCT2011

Collection Date: 10-27-11

Collection Time: 0850

Start Depth: 3'

End Depth: 5'

Sample Matrix: SOIL

Sample Team: EW/JB/MG

QC Partners:

(TB) (ER) (FB)

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

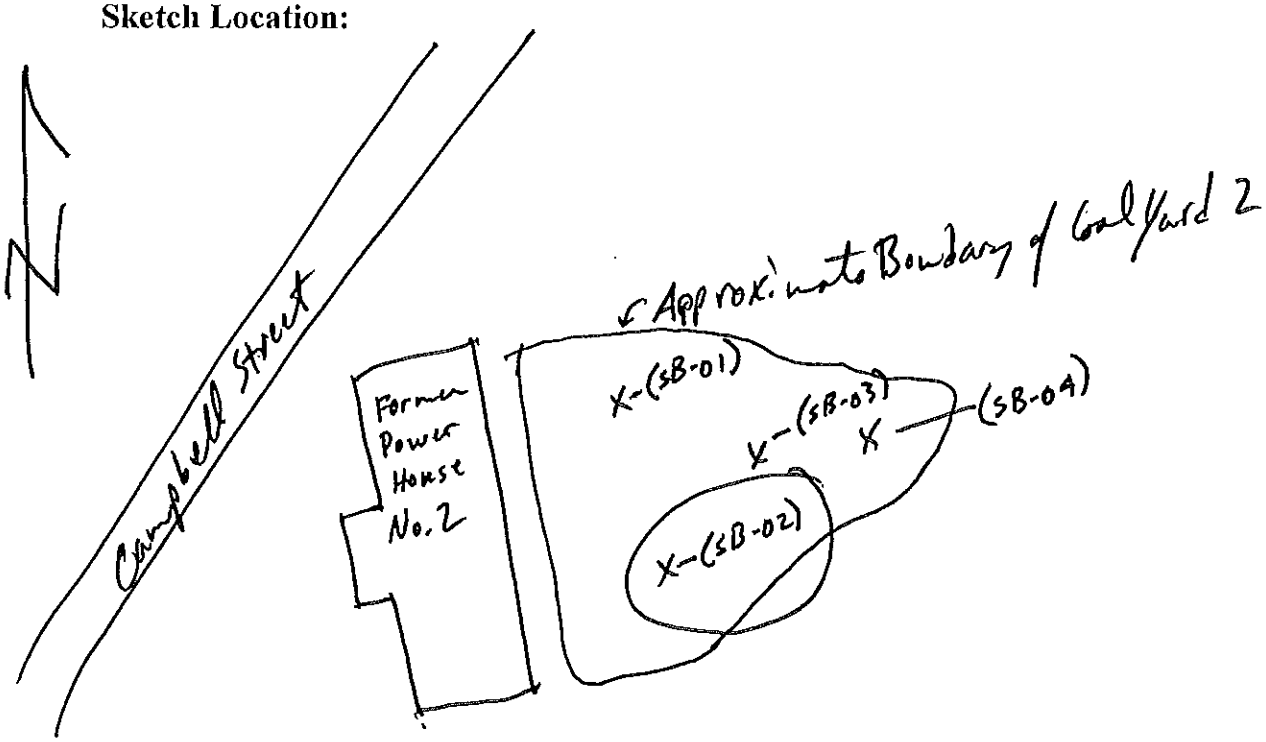
ERPIMS Values:

Sacode:

Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: E. W. Wenta 10-27-11

Reviewed BY / Date: Edward Jackson 1-4-12

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811ACCT

Location Code: CY2-SB02 EW
Sample Number: CY0022
Sample Name: PB11-DS-CY2-SB02 EW-CY0022-(8-10)-REG
Sampling Method: SS
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: Stainless Steel bucket auger

Task: GMA_OCT2011
Collection Date: 10-27-11
Collection Time: 0915
Start Depth: 8'
End Depth: 10'
Sample Matrix: SOIL
Sample Team: EW/JB/MG

QC Partners:
(TB) (ER) (FB)

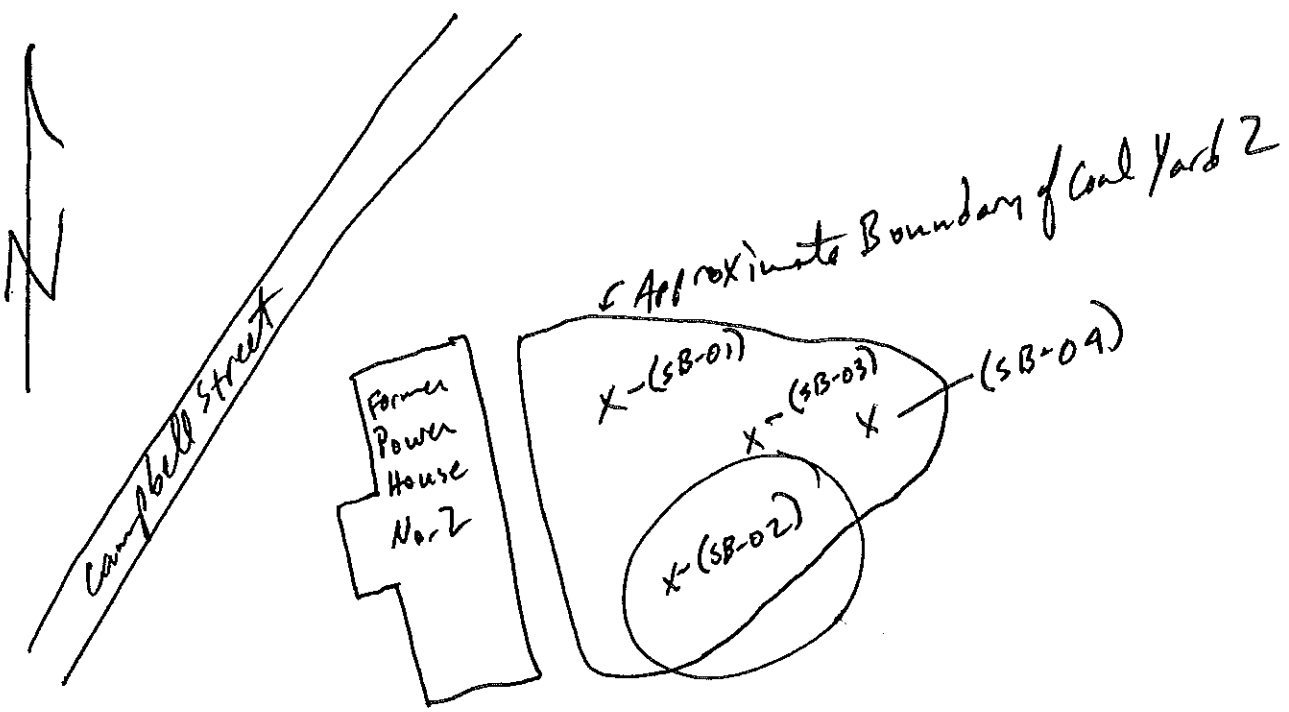
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: Also collected FD (CY0023) and FS (CY0024) at this location.

Sketch Location:



Logged BY / Date: E. W. Weaver 10-27-11 *Reviewed BY / Date:* Edward Schlaeny 1-4-12

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Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB 102811 ACCT

Location Code: CY2-SB0~~1~~2 EW

Sample Number: CY0023

Sample Name: PB11-DS-CY2-SB0~~1~~2-CY0023-(8-10)-FD EW

Sampling Method: SS

Sample Type: DS *Sample Purpose:* FD

Sampling Equip: Stainless Steel bucket auger

QC Partners:

(TB) (ER) (FB)

Task: GMA_OCT2011

Collection Date: 10-27-11

Collection Time: 0915

Start Depth: 8'

End Depth: 10'

Sample Matrix: SOIL

Sample Team: EW/JB/MG

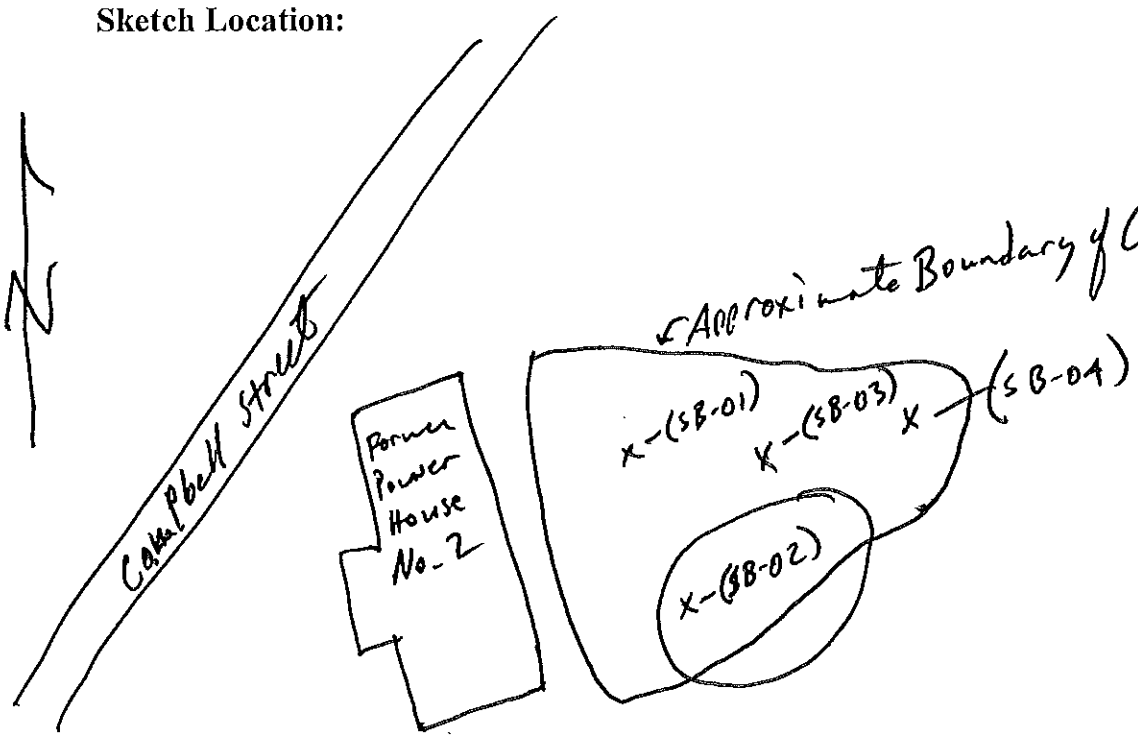
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: Also collected regular sample (CY0022) and FS (CY0024) at this location.

Sketch Location:



Logged BY / Date: E. W. Wenner 10-28-11

Reviewed BY / Date: Edward E. Wenner 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811TA

Location Code: CY2-SB0~~1~~2 EW

Sample Number: CY0024

Sample Name: PB11-DS-CY2-SB0~~1~~2-CY0024-(8-10)-FS EW

Sampling Method: SS

Sample Type: DS *Sample Purpose:* FS

Sampling Equip: Stainless Steel bucket auger

Task: GMA_OCT2011

Collection Date: 10-27-11

Collection Time: 0915

Start Depth: 8'

End Depth: 10'

Sample Matrix: SOIL

Sample Team: EW/JB/MG

QC Partners:

(TB) (ER) (FB)

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	4	oz	CWM
METALS3	N	B	1	8	oz	CWM
SEMIVOLATILES3	N	B	1	8	oz	CWM

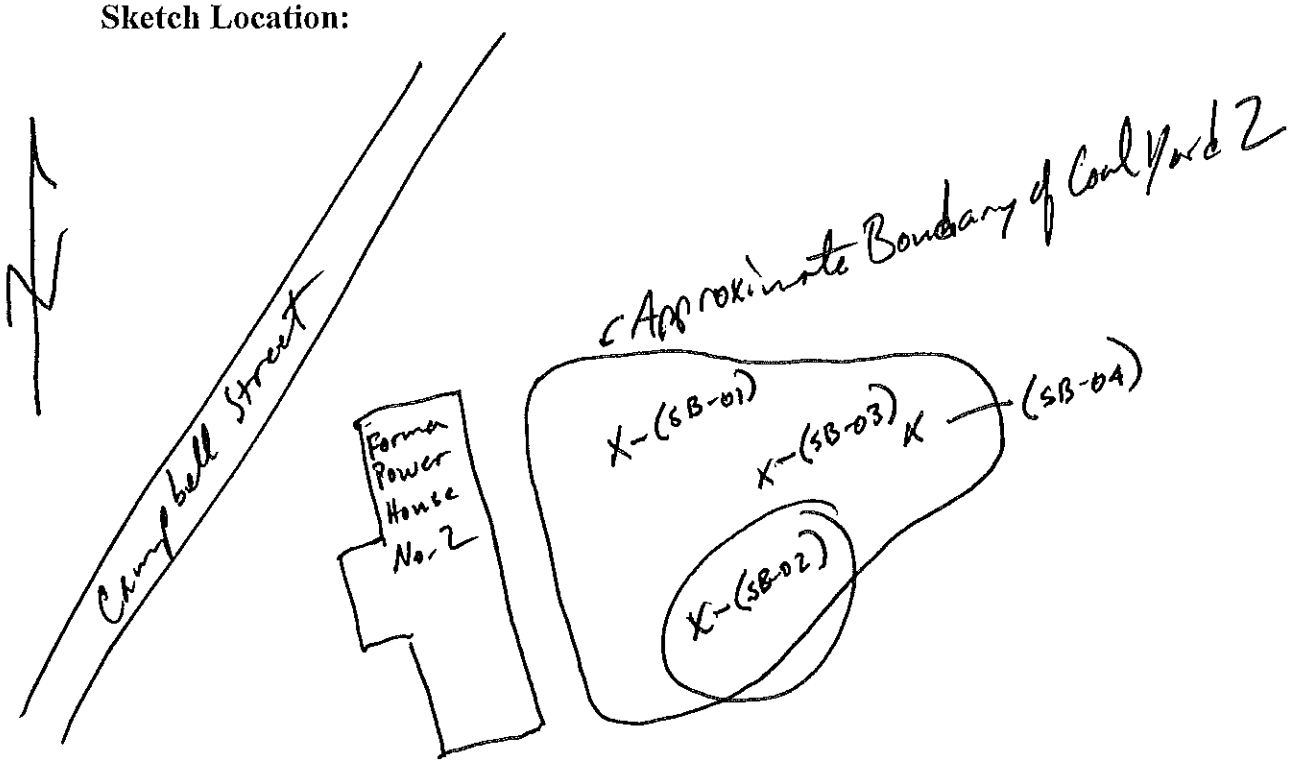
ERPIMS Values:

Sacode:

Lot Control#:

Comments: Also collected regular sample (CY0022) and FD (CY0023) at this location.

Sketch Location:



Logged BY / Date: Eric W. Weaver 10-28-11 *Reviewed BY / Date:* Edward E. Macon 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811 ACCT

Location Code: CY2-SB0~~8~~1 RW
Sample Number: CY0015
Sample Name: PB11-SS-CY2-SB0~~8~~1-CY0015-(0-1)-REG RW
Sampling Method: HA
Sample Type: SS *Sample Purpose:* REG
Sampling Equip: Stainless Steel Bucket Auger

Task: GMA_OCT2011
Collection Date: 10-27-11
Collection Time: 0940
Start Depth: 0.5'
End Depth: 1.0'
Sample Matrix: SOIL
Sample Team: EW/JB/MG

QC Partners:
(TB) (ER) (FB)

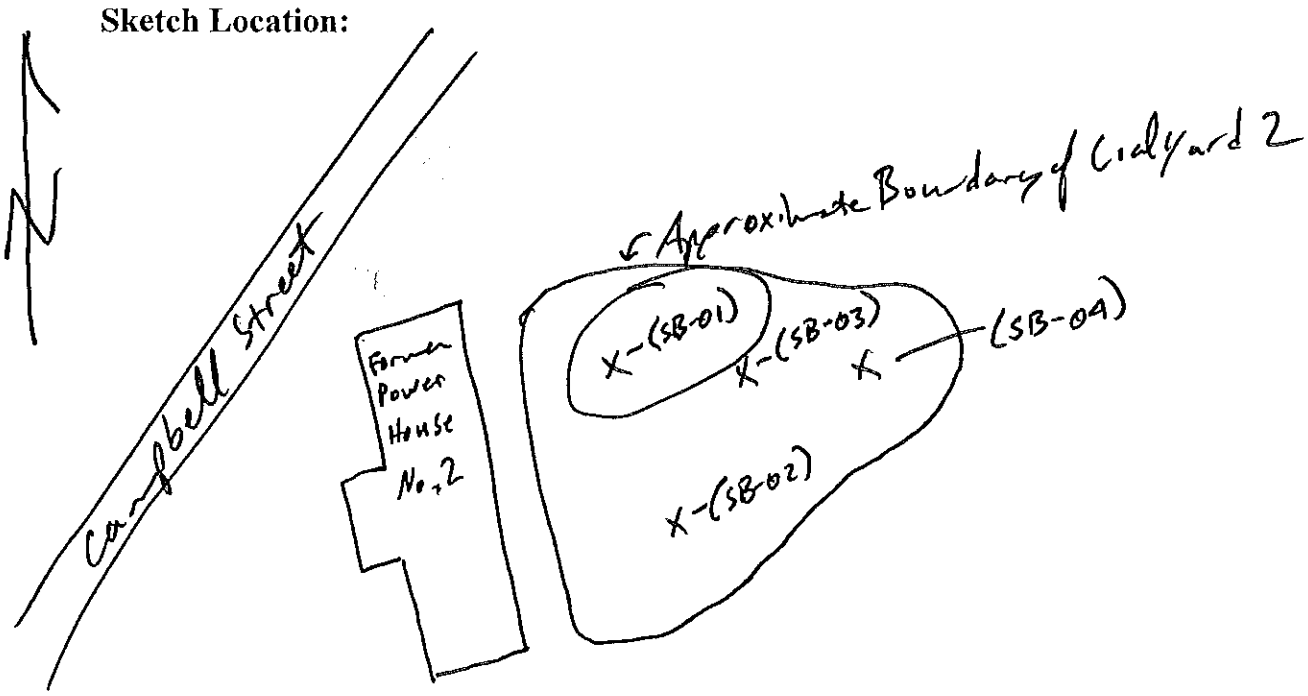
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM
TOC	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: Also collected FD (CY0016) and FS (CY0017) at this location.

Sketch Location:



Logged BY / Date: Erin W. Wellman 10-27-11 *Reviewed BY / Date:* Edward C. Weaver 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811 ACCT

Location Code: CY2-SB0~~8~~1 GW
Sample Number: CY0016
Sample Name: PB11-SS-CY2-SB0~~8~~1-CY0016-(0-1)-FD GW
Sampling Method: HA
Sample Type: SS *Sample Purpose:* FD
Sampling Equip: Stainless Steel Bucket Auger

Task: GMA_OCT2011
Collection Date: 10-27-11
Collection Time: 0940
Start Depth: 0.5'
End Depth: 1.0'
Sample Matrix: SOIL
Sample Team: EW/JB/MG

QC Partners:
(TB) (ER) (FB)

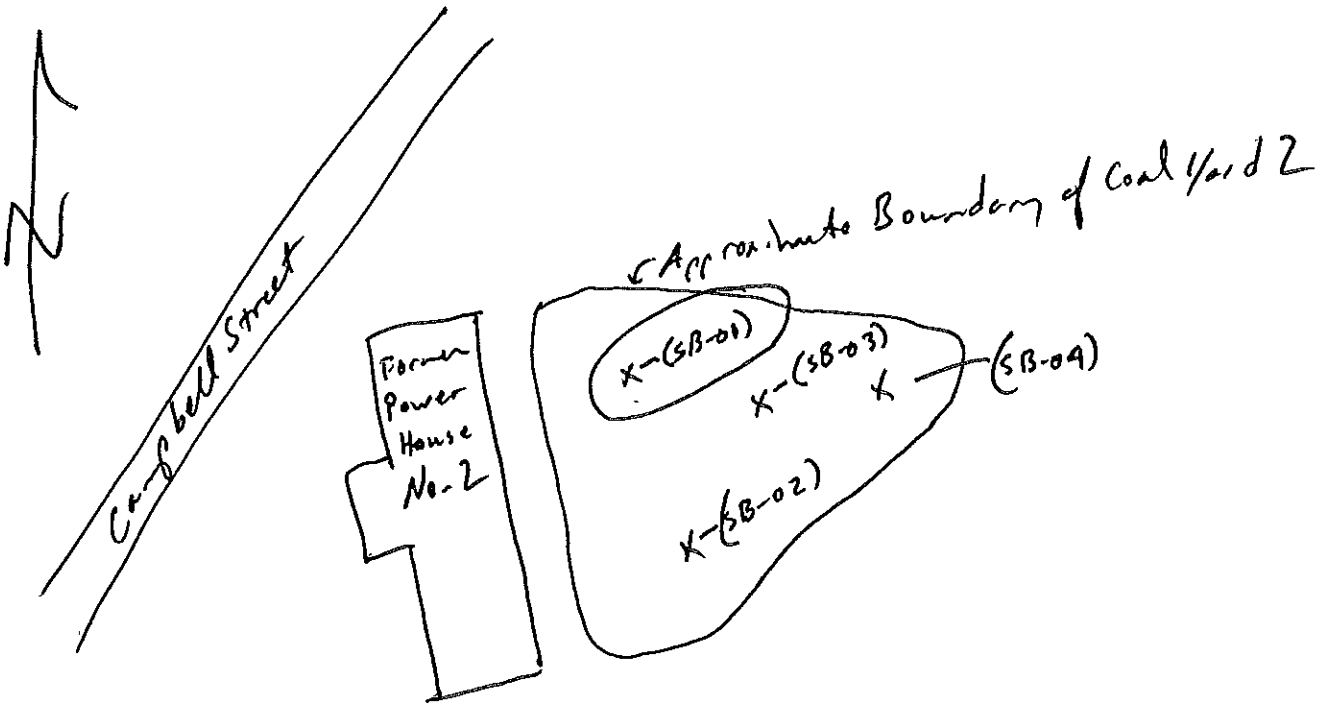
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: Also collected regular sample (CY0015) and FS (CY0017) at this location

Sketch Location:



Logged BY / Date: E. W. Wenner 10-27-11 *Reviewed BY / Date:* Edward Mason 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811 TA

Location Code: CY2-SB0~~2~~1 EW
Sample Number: CY0017
Sample Name: PB11-SS-CY2-SB0~~2~~1-CY0017-(0-1)-FS EW
Sampling Method: HA
Sample Type: SS *Sample Purpose:* FS
Sampling Equip: ~~Hand Auger~~ EW Stainless Steel Bucket Auger

Task: GMA_OCT2011
Collection Date: 10-27-11
Collection Time: 0940
Start Depth: 0.5'
End Depth: 1.0'
Sample Matrix: SOIL

QC Partners:
(TB) (ER) (FB)

Sample Team: EW/JB/MG

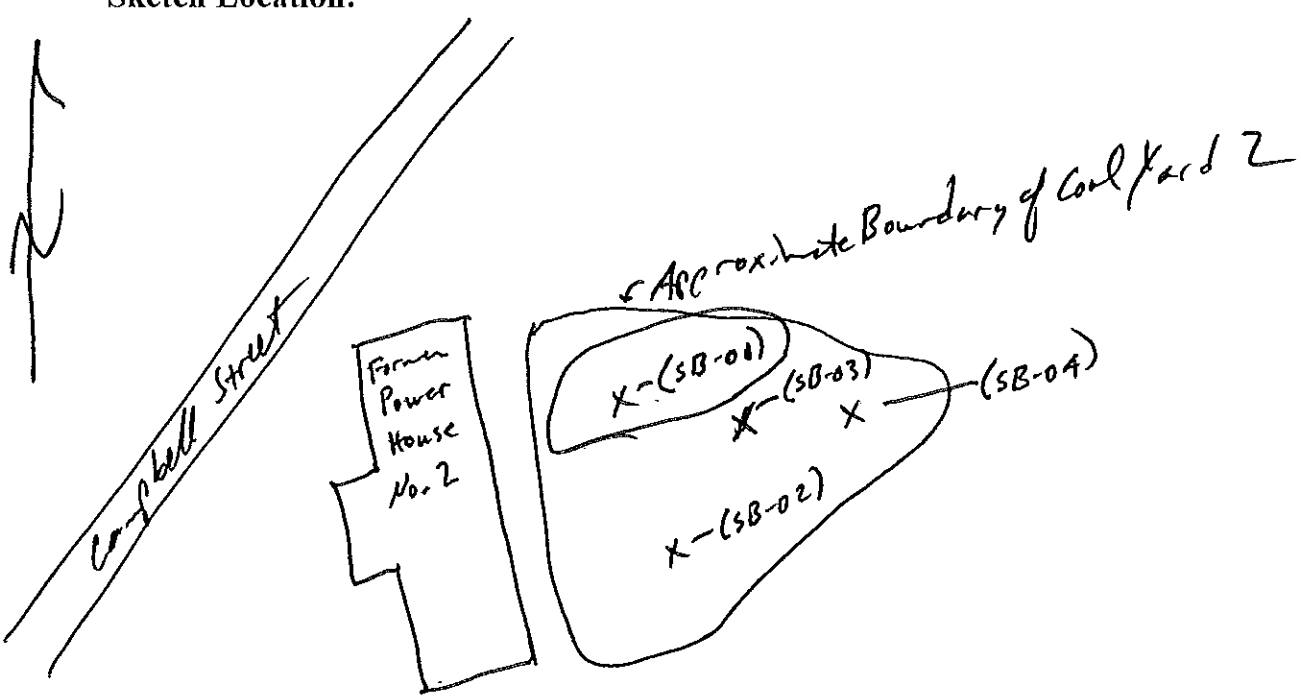
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	1	4	oz	CWM
METALS3	N	B	1	8	oz	CWM
PCB3	N	B	1	8	oz	CWM
SEMIVOLATILES3	N	B	1	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments: Also collected regular sample (CY0015) and FD (CY0016) at this location.

Sketch Location:



Logged BY / Date: E. W. Wenn 10-27-11 *Reviewed BY / Date:* Edward E. Wenn 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 - PLUM BROOK ORDNANCE WKS

Manager: Steve Downey

RFA / COC Number: PB102811 ACCT

Location Code: CY2-SB0~~8~~1 EW
Sample Number: CY0018
Sample Name: PB11-DS-CY2-SB0~~8~~1-CY0018-(3-5)-REG EW
Sampling Method: SS
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: ~~Hand Auger~~ EW Stainless Steel Bucket Auger

Task: GMA_OCT2011
Collection Date: 10-27-11
Collection Time: 0955
Start Depth: 3'
End Depth: 5'
Sample Matrix: SOIL

QC Partners:
(TB) (ER) (FB)

Sample Team: EW/JB/MG

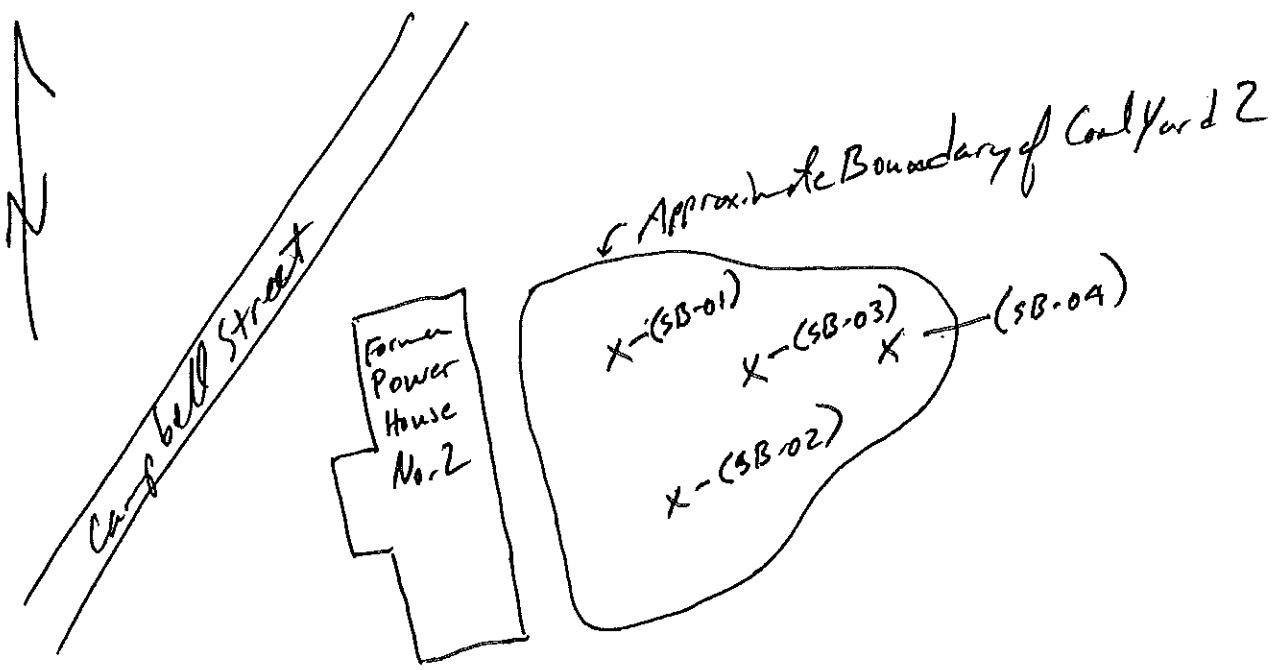
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
PCB3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: EW, 10-27-11 *Reviewed BY / Date:* Edward W. Lawrence 1-4-12

Shaw™
Shaw E & I, Inc.

Sample Collection Log

132457 PLUM BROOK ORDNANCE WKS
Manager: Steve Downey

RFA / COC Number: PB102811 ACCT

Location Code: CY2-SB0~~3~~1 GW
Sample Number: CY0019
Sample Name: PB11-DS-CY2-SB0~~3~~1-CY0019-(8-10)-REG GW
Sampling Method: SS
Sample Type: DS *Sample Purpose:* REG
Sampling Equip: ~~Hand Auger~~ GW Stainless Steel Bucket Auger

Task: GMA_OCT2011
Collection Date: 10-27-11
Collection Time: 1020
Start Depth: 8'
End Depth: 10'
Sample Matrix: SOIL

QC Partners:
(TB) (ER) (FB)

Sample Team: GW/JB/MG

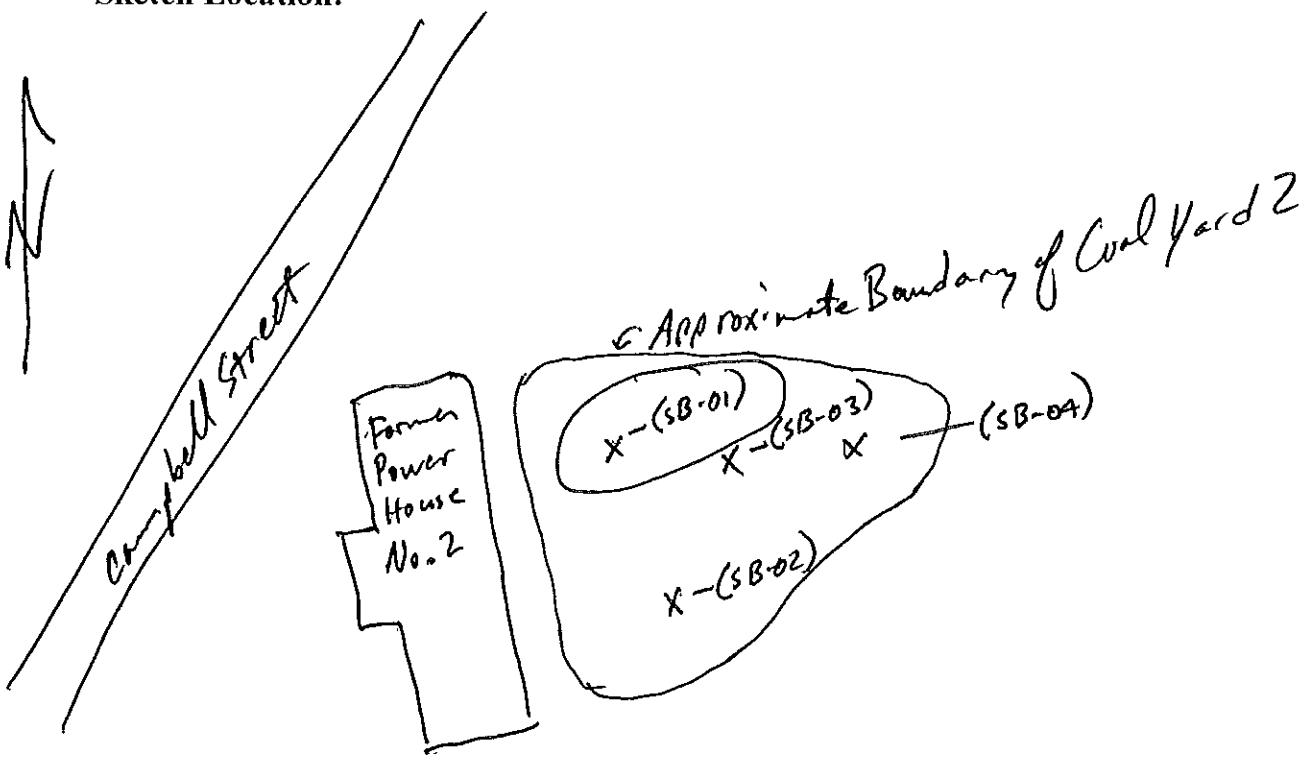
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
EXPLOSIVES	N	A	2	8	oz	CWM
METALS3	N	A	2	8	oz	CWM
SEMIVOLATILES3	N	A	2	8	oz	CWM

ERPIMS Values:
Sacode:
Lot Control#:

Comments:

Sketch Location:



Logged BY / Date: E. W. Weaver 10-27-11 *Reviewed BY / Date:* Edward E. Moore 1-4-12

APPENDIX B

SOIL BORING HAZARDOUS, TOXIC, AND RADIOLOGICAL WASTE DRILL LOGS

HTRW DRILLING LOG

DISTRICT	Nashville
HOLE NUMBER	CYZ-SB01
SHEET / SHEETS	1 of 2
1. COMPANY NAME	Shaw E+I
2. DRILL SUBCONTRACTOR	NA
3. PROJECT	PBOW
4. LOCATION	Sandusky, Ohio
5. NAME OF DRILLER	NA
6. MANUFACTURER'S DESIGNATION OF DRILL	NA
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3" Stainless Steel Bucket Auger and 2" Stainless Steel Bucket Auger
8. HOLE LOCATION	Coal Yard #2
9. SURFACE ELEVATION	637.87 N-623081.60 E-1911875.80
10. DATE STARTED	10-27-11
11. DATE COMPLETED	10-27-11
12. OVERBURDEN THICKNESS	>10'
15. DEPTH GROUNDWATER ENCOUNTERED	5'
13. DEPTH DRILLED INTO ROCK	0
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	>10'
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	—

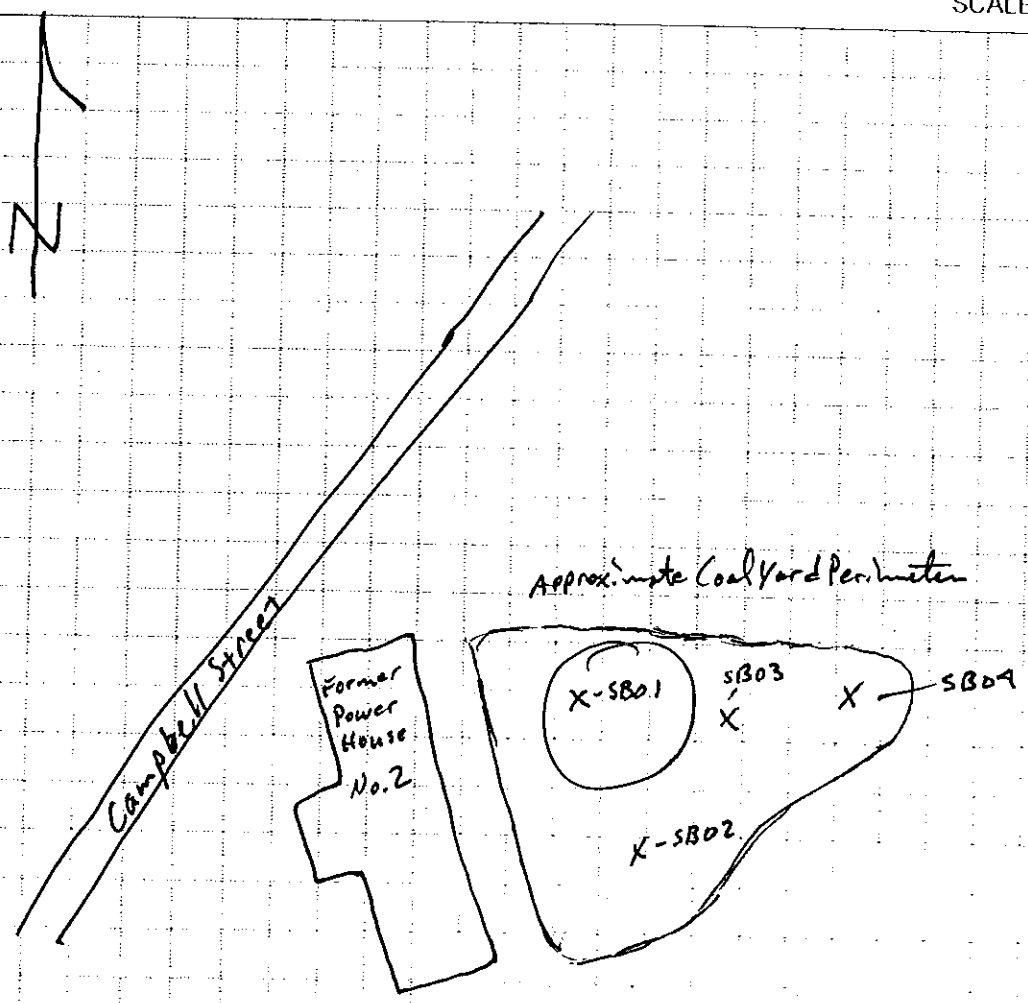
18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
NA	—	—	—

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
✓	—	✓	Explosives	SVOC's	PCBs	— %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	✓	—	—	Eric W. Weaver

LOCATION SKETCH/COMMENTS

SCALE: None



PROJECT PBOW

HOLE NO. CYZ-SB01

DCK

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: CY2-SB01

Project: PBOW

Geologist: E. Weaver

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or Core Box No.~~ Time	Analytical Sample No.	Recovery (ft)	Remarks
		Coal 0.5'						
	1	Yellowish brown (10YR5/6) silt with clay, moist, medium stiff.	ML		0940	0.5-1.0' CY0015 CY0016		CY0017
	2							
	3					3.0-5.0 CY0018		
	4				0955			
	5	- wet						
	6							
	7	7.5'						
	8	Gray (10YR5/1) silt with clay, wet, medium stiff.	ML			8.0-10.0 CY0019		
	9				1020			
	10	Total Depth = 10 ft						

Project: PBOW

Hole Number: CY2-SB01

DFK

HTRW DRILLING LOG

DISTRICT	Nashville
HOLE NUMBER	CY2-SB02
SHEET / SHEETS	1 OF 2
1. COMPANY NAME	Shaw E&I
2. DRILL SUBCONTRACTOR	NA
3. PROJECT	PBOW
4. LOCATION	Sandusky, Ohio
5. NAME OF DRILLER	NA
6. MANUFACTURER'S DESIGNATION OF DRILL	NA
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3" Stainless Steel Bucket Auger and 2" Stainless Steel Bucket Auger
8. HOLE LOCATION	Coal Yard #2
9. SURFACE ELEVATION	638.12 N-623034.37 E-1911903.68
10. DATE STARTED	10-27-11
11. DATE COMPLETED	10-27-11
12. OVERBURDEN THICKNESS	>10'
15. DEPTH GROUNDWATER ENCOUNTERED	5'
13. DEPTH DRILLED INTO ROCK	0
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	10'
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	—

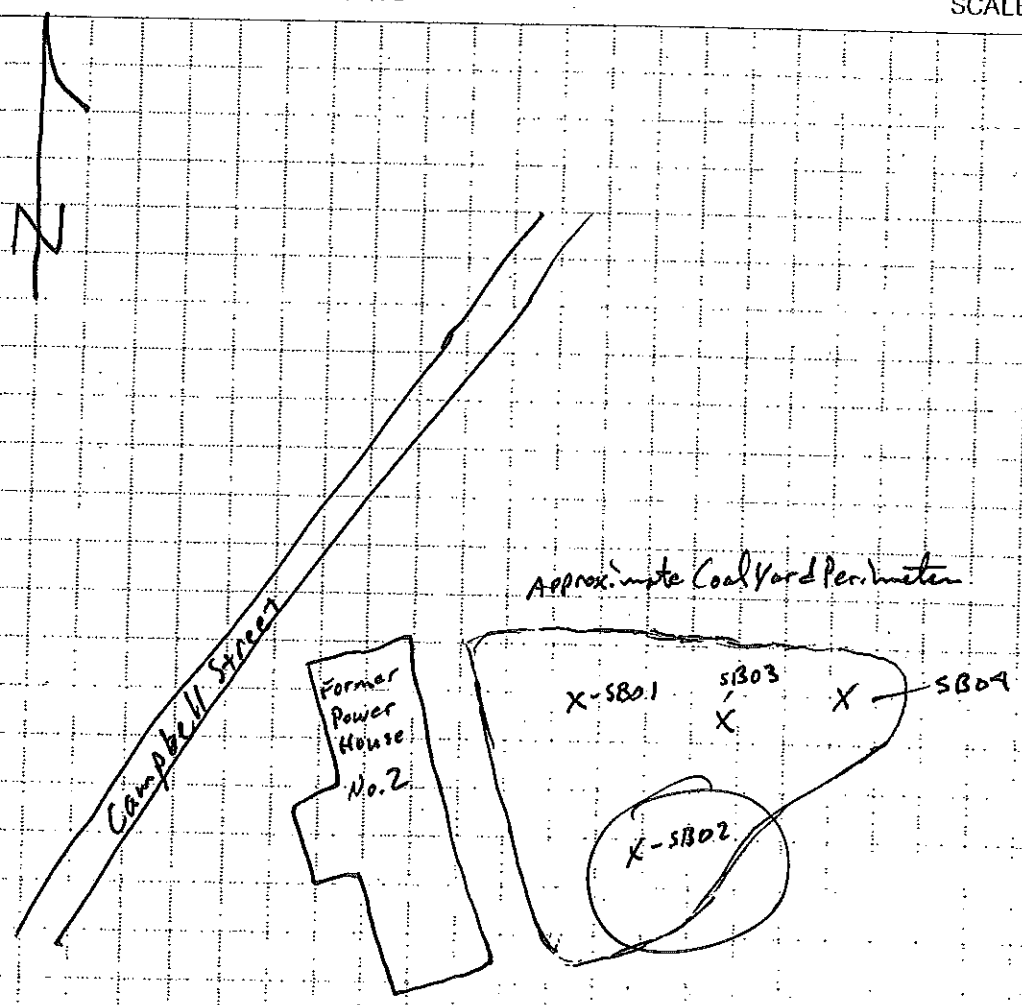
18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
—	—	—	—

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
✓	—	✓	Explosives	SVOC's	PCBs	— %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	✓	—	—	Eric W. Weaver

LOCATION SKETCH/COMMENTS

SCALE: None



PROJECT PBOW

HOLE NO. CY2-SB02

DICK

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: SB02

Project: PBOW

Geologist: G. Weaver

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	~~Geotech. Sample or Core Box No.~~	Analytical Sample No.	Recovery (ft)	Remarks
		Coal 0.5'			7.[illegible]			
	1	Yellowish brown (10YR5/6) Silt with clay, moist, medium stiff.	ML		0830	0.5-1.0' CY0020		
	2							
	3					3.0-5.0' CY0021		
	4				0850			
	5	— wet						
	6							
	7							
	8	8' Gray (10YR5/1) Silt with clay, wet, medium stiff.			0915	8.0-10.0' CY0022 CY0023 CY0024		
	9							
	10	Total Depth = 10 ft						

Project: PBOW

Hole Number: CY2-SB02

HTRW DRILLING LOG

DISTRICT	Nashville
HOLE NUMBER	CY2-SB03
SHEET / SHEETS	1 OF 2
1. COMPANY NAME	Shaw E+I
2. DRILL SUBCONTRACTOR	NA
3. PROJECT	PBOW
4. LOCATION	Sandusky, Ohio
5. NAME OF DRILLER	NA
6. MANUFACTURER'S DESIGNATION OF DRILL	NA
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3" Stainless Steel Bucket Auger and 2" Stainless Steel Bucket Auger
8. HOLE LOCATION	Coal Yard #2
9. SURFACE ELEVATION	638.10 N-623066.83 E-1911941.56
10. DATE STARTED	10-26-11
11. DATE COMPLETED	10-26-11
12. OVERBURDEN THICKNESS	>10'
15. DEPTH GROUNDWATER ENCOUNTERED	5'
13. DEPTH DRILLED INTO ROCK	0
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
14. TOTAL DEPTH OF HOLE	10'
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	—

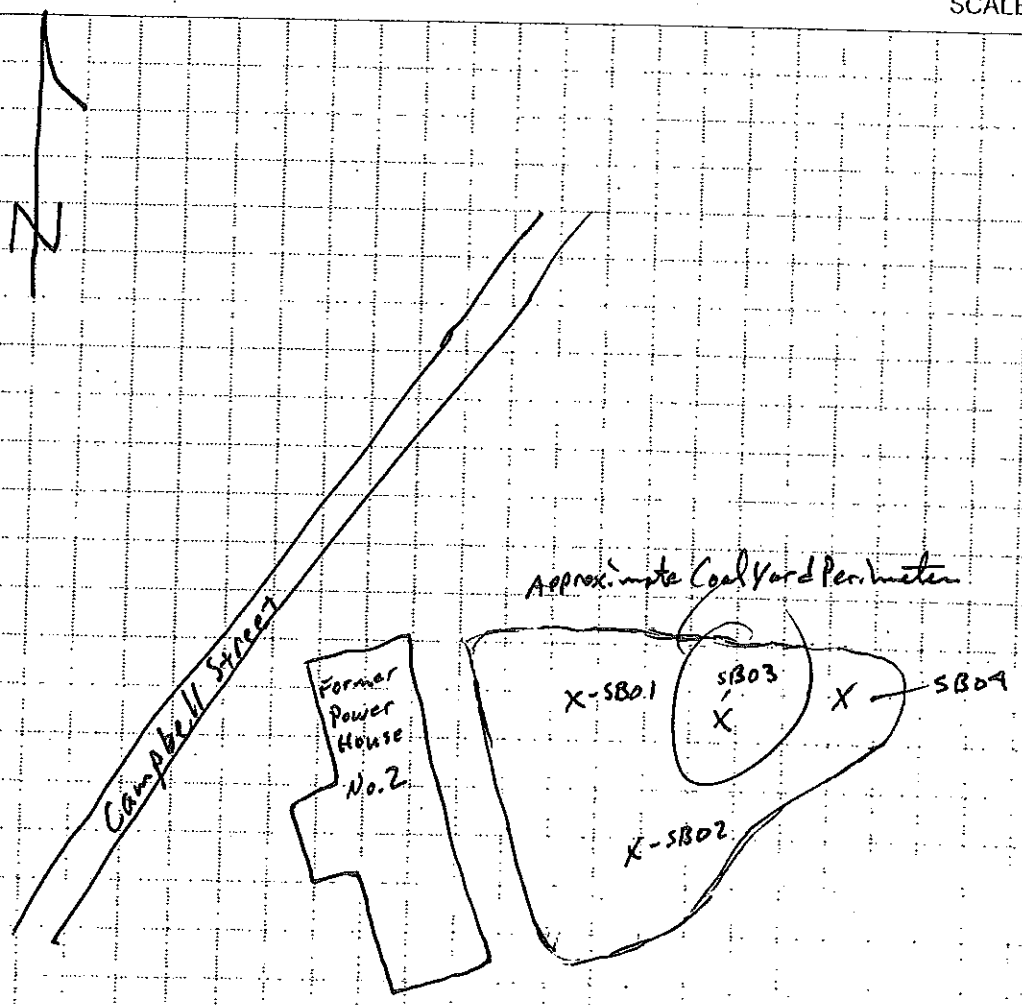
18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
—	—	—	—

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
✓	—	✓	Explosives	SVOC's	PCB's	— %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	✓	—	—	Eric W. Weaver

LOCATION SKETCH/COMMENTS

SCALE: None



PROJECT PBOW

HOLE NO. CY2-SB03

DEL

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: CY2-SB03

Project: PBOW

Geologist: E. Weaver

Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		Coal 0.5'			time			
	1	Yellowish brown (10YR 5/6) silt with clay, moist, medium stiff.	ML		1540	0.5-1.0' CY0025		
	2							
	3					3.0-5.0' CY0026		
	4				1555			
	5	- wet						
	6							
	7							
	8	8' Gray (10YR 5/1) silt with clay, moist, medium stiff.				8.0-10.0' CY0027		
	9				1615			
	10	Total Depth = 10 Ft						

Project: PBOW

Hole Number: CY2-SB03

HTRW DRILLING LOG

DISTRICT	Nashville
HOLE NUMBER	CY2-SB04
SHEET / SHEETS	1 of 2
1. COMPANY NAME	Shaw E&I
2. DRILL SUBCONTRACTOR	NA
3. PROJECT	PBOW
4. LOCATION	Sandusky, Ohio
5. NAME OF DRILLER	NA
6. MANUFACTURER'S DESIGNATION OF DRILL	NA
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	3" Stainless Steel Bucket Auger and 2" Stainless Steel Bucket Auger
8. HOLE LOCATION	Coal Yard #2
9. SURFACE ELEVATION	637.94 N-623069.44 E-1911988.57
10. DATE STARTED	10-26-11
11. DATE COMPLETED	10-26-11
12. OVERBURDEN THICKNESS	>10'
13. DEPTH DRILLED INTO ROCK	0
14. TOTAL DEPTH OF HOLE	10'
15. DEPTH GROUNDWATER ENCOUNTERED	5'
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	—
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	—

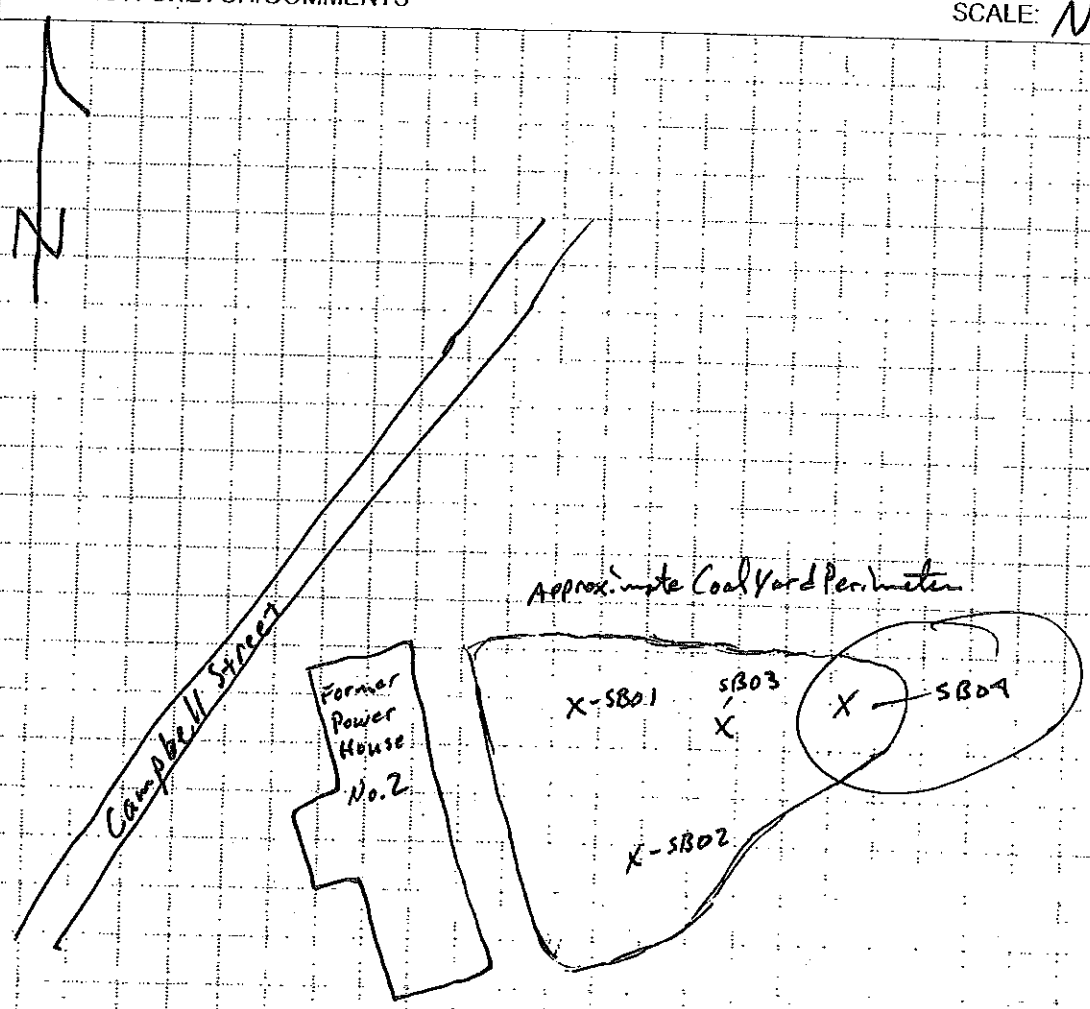
18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
—	—	—	—

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
✓	—	✓	Explosives	SVOC's	PCB's	— %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	✓	—	—	Eric W. Weaver

LOCATION SKETCH/COMMENTS

SCALE: None



PROJECT PBOW

HOLE NO. CY2-SB04

DVK

Shaw
Shaw E&I, Inc.

HTRW DRILLING LOG (continuation sheet)

Hole Number: CY2-SB04

Project: PBOW | Geologist: E. Weaver | Sheet 2 of 2 Sheets

Elev (ft)	Depth (ft) bgs	Description of Materials	USCS	Field Screening Results (ppm)	Geotech. Sample or Core Box No.	Analytical Sample No.	Recovery (ft)	Remarks
		Dark gray (10YR4/1) clay with silt, moist, medium stiff. -0.5-0.7 - coal seam 0.7'	CL		1410	0.0-1.0' CY0028		
	1	Yellowish brown (10YR5/6) silt with clay, moist, medium stiff.	ML					
	2							
	3					3.0'-5.0' CY0029		
	4				1430			
	5							
	6	6'						
		Grayish brown (10YR5/2) clay with silt, ~~[illegible]~~ 6.7' medium stiff.	CL					
	7							
	8	8'						
		Gray (10YR5/1) clay with silt, trace sand, wet, medium stiff.				8.0'-10.0' CY0030		
	9				1450			
	10	Total Depth = 10 Ft						

Project: PBOW | Hole Number: CY2-SB04

DFE

APPENDIX C

LAND SURVEY DATA

FINAL REPORT
of
SURVEYING SERVICES PERFORMED
by
SACKS SURVEYING & MAPPING, P.C. / KUSMER & ASSOCIATES J.V.
at the
PLUMBROOK ORDNANCE WORKS, SANDUSKY, OH
for
SHAW E & I
MAY - NOVEMBER, 2011

SUMMARY OF WORK PERFORMED

Between May, 2011 and November, 2011, Sacks Surveying & Mapping, PC, in joint venture with Kusmer & Associates, Inc., surveyed a total of 255 environmental sampling locations (soil samples, soil bores, test pits, sediment samples, piezometers, and monitoring wells) throughout the Plumbrook Ordnance Works facility. Surveying was performed over the course of three separate mobilizations, described more particularly as follows:

1st Mobilization (23-27 May, 2011) - 44 survey points: Unloading Area (12 points); Sellite Area (11 points); Wastewater Treatment Plant #2 site (10 points); and TNT C Sewer Line (11 points).
2ND Mobilization (26-30 September, 2011) – 176 survey points: Wastewater Treatment Plant #2 site (4 points); TNT C Sewer Line (3 points); Steel Sewer Line (40 points); Sellite Area (23 points); Unloading Area (3 points); TNT A Sewer Line (24 points); Ash Pit #3 (3 points); and Acid Area #1 (76 points).
3RD Mobilization (7-10 November, 2011) – 35 survey points: Acid Area #1 (12 points); Sellite Area (11 points); Coal Yard #1 (4 points); Coal yard 32 (4 points); and Coal Yard #3 (4 points)

Work was performed in accordance with Shaw E & I surveying specifications under purchase orders #680616-000 OP, 680686-000 OP, 680702-000 OP, and 680711-000 OP.

KEY PERSONNEL

W. Robert Kusmer – Ohio Land Surveyor S-6754
Stanley Robert Sacks – North Carolina Surveyor L-2913
Michael A. McKibbin – North Carolina Surveyor L-4519, Hazmat Project Manager
Jeff Bucholtz – On-site Party Chief *
Paul Lewis – Survey Technician *
* all on-site personnel for this project are OSHA 29 CFR 1910.120 40-hour trained and medically monitored in accordance with Shaw E & I requirements.

FIELD PROCEDURES

All sampling locations reported below were surveyed with a Topcon GTS-235 Total Station using conventional angle and distance measurements to determine the horizontal and vertical position thereof. Survey control used meets or exceeds the standards for a Third Order, Class II horizontal and Third Order vertical survey as defined in the Standards and Specifications for Geodetic Control Networks (1984). The survey control points used in this operation were established by this firm, presently or previously (January, 2009), by direct static differential GPS observation using three Ashtech Promark II GPS receivers with reference to NGS Monument

"Sky D" as a fixed horizontal reference and NGS Monument "J-318" (a first order benchmark) as a fixed vertical reference. The horizontal datum is NAD 83(1995). The vertical datum is NGVD 29. Values were scaled to the Ohio State Plane Coordinate System (North Zone) using a combined scale and ellipsoid factor of 0.999927034.

SKY D:	J-318:
Northing (y) 196,085.494 m	Northing (y) 196,170 m +/-
Easting (x) 586,761.658 m	Easting (x) 583,400 m +/-
Orthometric Elevation 175.30 m +/-	Orthometric Elevation 182.801 m
(SKYD not used as vertical control)	(First Order Class II NGVD 29 Benchmark)

CERTIFICATION

I, Warren Robert Kusmer, Ohio Professional Surveyor #S-6754, hereby certify that the information in this survey report is true to the best of my knowledge and belief.

W Robert Kusmer

Warren Robert Kusmer,
Ohio Professional Surveyor #S-6754

12/29/2011

Date

SAMPLE LOCATIONS:

Sellite Area (May 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
176	623869.42	1916750.44	637.70	636.3	PZ-01/SB-01
190	624014.07	1916719.34	635.50	633.5	PZ-02/SB-02
188	624020.14	1916786.02	635.51	632.9	PZ-03/SB-08
178	623929.48	1916752.25	639.51	636.6	PZ-04/SB-11
184	623934.02	1916892.19	634.43	633.7	PZ-05/SB-12
182	623872.51	1916884.23	634.37	633.8	PZ-06/SB-14
186	623895.85	1916986.31	634.44	632.9	PZ-07
193	623956.38	1916636.65	637.76	634.9	PZ-08
174	623798.08	1916683.07	636.59		SB-06
173	623786.75	1916777.79	636.27		SB-07
194	623888.92	1916843.75	636.95		SB-13

Sellite Area (September 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
1351	623784.44	1916774.54	639.23	636.3	FSB MW-01
1339	623876.91	1916738.07	638.99	635.9	FSB MW-02
1335	624104.10	1916731.84	637.31	634.5	FSB MW-03
1341	624087.55	1916684.17	634.67		FSBSB-15
1347	623629.46	1917087.66	633.09		FSBSD-01
1346	623776.17	1917073.42	631.57		FSBSD-02
1365	623907.05	1917011.31	630.62		FSBSD-03
1364	624003.39	1916967.91	630.28		FSBSD-04
1362	624042.36	1916741.69	632.46		FSBSD-05
1363	623994.37	1916632.10	630.44		FSBSD-06
1357	623902.10	1916716.24	636.31		FSBSS-01
1359	623901.30	1916753.54	636.35		FSBSS-02
1358	623885.21	1916694.10	636.85		FSBSS-03
1360	623890.92	1916784.72	636.34		FSBSS-04
1356	623857.12	1916694.62	636.61		FSBSS-05
1361	623859.54	1916784.34	636.24		FSBSS-06
1355	623830.07	1916703.62	636.60		FSBSS-07
1354	623807.59	1916713.95	636.40		FSBSS-08
1353	623801.60	1916743.43	636.21		FSBSS-09
1352	623808.70	1916775.45	636.09		FSBSS-10
1445	623865.15	1916885.40	633.95		FSBTOC-01
1446	623932.91	1916885.13	633.99		FSBTOC-02
1447	624015.89	1916713.76	633.89		FSBTOC-03

Sellite Area (November 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
1573	623883.26	1916668.05	637.11		SELSS-14
1575	623923.25	1916681.43	636.44		SELSS-15
1576	623943.21	1916722.42	636.04		SELSS-16
1577	623921.93	1916798.71	636.90		SELSS-17
1567	623853.57	1916821.88	636.27		SELSS-18
1568	623810.03	1916811.69	636.44		SELSS-19
1569	623759.95	1916739.76	636.59		SELSS-20
1566	623813.26	1916892.50	634.84		SELSS-21
1570	623813.21	1916632.33	637.07		SELSS-22
1571	623834.86	1916668.04	637.22		SELSS-23
1572	623890.63	1916627.56	636.31		SELSS-24

Unloading Area (May 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
165	623921.17	1917391.09	637.81	634.9	PZ-01/SB-01
163	623922.42	1917456.71	639.09	635.6	PZ-02/SB-04
151	623746.08	1917524.35	639.19	637.5	PZ-03/SB-11
154	623845.17	1917437.12	636.83	636.0	PZ-04/SB-02
161	623948.26	1917535.43	639.75	636.9	PZ-05
171	623948.78	1917093.30	634.92	633.9	PZ-06
169	623972.05	1917234.56	636.91	634.1	PZ-07
156	623752.04	1917199.54	633.98	633.3	PZ-08
166	623930.55	1917322.87	633.71		SB-06
167	623924.05	1917228.33	634.30		SB-07
170	623913.67	1917151.13	633.88		SB-09
152	623770.64	1917492.33	637.19		SB-12

Unloading Area (September 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
1345	623759.93	1917202.98	636.19	633.2	ULA MW-01
1326	623917.73	1917163.13	636.97	633.9	ULA MW-02
1330	624017.95	1917082.01	636.80	633.7	ULA MW-03

Wastewater Treatment Plant #2 (May 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
554	623195.57	1911020.62	632.24	631.0	PZ-01
540	623108.02	1910684.85	641.47	638.4	PZ-02/SB-02
537	623144.69	1910827.50	640.32	637.8	PZ-03/SB-03
544	623058.08	1910992.40	633.38	631.7	PZ-04
549	623080.30	1910781.11	640.60	637.9	PZ-05/SB-05
564	622607.16	1910804.90	634.71	631.6	PZ-06/SB-06
541	623187.47	1910808.30	637.72		SB-01
538	623097.30	1910811.38	638.67		SB-04
542	623033.63	1910866.71	633.10		SB-07
550	622983.08	1910735.71	637.95		SB-08

Wastewater Treatment Plant #2 (September 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
1429	623207.36	1910619.96	644.37	641.7	WWTP2 MW-01
1433	623085.26	1910791.36	640.39	637.8	WWTP2 MW-02
1437	623147.10	1910834.46	640.06	637.5	WWTP2 MW-03
1441	623044.98	1910991.57	635.02	631.9	WWTP2 MW-04

TNT Area C Sewer Line (May 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
552	622788.18	1910747.40	637.23	634.8	PZ-01/SB-01
556	622453.95	1910931.11	634.16	631.7	PZ-02/SB-02
558	622398.23	1910961.31	633.76	631.2	PZ-03/SB-03
560	622308.19	1910977.84	632.98	631.0	PZ-04/SB-04
562	622256.01	1911033.31	637.05	634.5	PZ-05/SB-05
570	621987.34	1911159.29	642.27	640.6	PZ-06/SB-06
572	621977.78	1911141.29	642.43	640.5	PZ-07/SB-07
566	621963.90	1911117.11	643.00	641.1	PZ-08/SB-08
574	621870.49	1911217.73	642.81	641.4	PZ-09/SB-09
576	621787.53	1911234.38	643.08	641.1	PZ-10/SB-10
578	621653.06	1911296.36	643.26	641.0	PZ-11/SB-11

TNT Area C Sewer Line (September 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
1419	622408.93	1910955.79	634.01	631.4	TNTCSL MW-01
1414	621962.33	1911149.14	643.24	640.4	TNTCSL MW-02
1410	621457.27	1911382.57	645.19	642.6	TNTCSL MW-03

Steel Sewer Line (September 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
1314	624207.78	1918010.06	635.11	631.7	SSL MW-01
1715	622883.53	1915564.71	638.96	635.9	SSL MW-02
1403	622637.39	1912719.90	640.63	637.7	SSL MW-03
1303	623886.12	1919381.30	636.39		SSL-TP1
1302	624009.95	1919173.97	638.01		SSL-TP2
1301	624073.83	1919068.79	636.98		SSL-TP3
1309	624152.86	1918928.22	633.47		SSL-TP4
1308	624153.15	1918615.50	633.86		SSL-TP5
1307	624159.13	1918372.96	632.97		SSL-TP6
1310	624163.81	1918020.97	632.14		SSL-TP7
1318	624175.91	1917084.86	632.51		SSL-TP8
1319	624177.58	1916916.80	633.52		SSL-TP9
1368	623956.34	1916571.69	634.21		SSL-TP11
1371	623585.64	1916234.80	632.54		SSL-TP12
1716	622874.51	1915562.57	636.12		SSL-TP13
1719	622755.28	1915453.34	638.07		SSL-TP14
1722	622571.26	1915283.29	639.46		SSL-TP15
1723	622574.78	1915168.09	637.75		SSL-TP16
1394	622605.96	1913620.05	640.77		SSL-TP17
1404	622623.59	1912721.64	637.37		SSL-TP18
1405	622632.23	1912646.98	637.76		SSL-TP19
1406	622629.17	1912619.75	638.07		SSL-TP20
1422	622610.61	1911714.53	639.71		SSL-TP21
1421	622652.39	1911593.26	639.63		SSL-TP22
1420	622656.36	1911533.51	640.26		SSL-TP23
1423	622655.95	1911264.17	630.28		SSL-TP24
1424	622657.42	1911187.19	631.10		SSL-TP25
1425	622658.15	1911118.09	631.57		SSL-TP26
1444	622674.01	1910717.04	634.20		SSL-TP27
1443	622674.85	1910643.89	634.22		SSL-TP28
1442	622861.59	1910645.64	642.45		SSL-TP30
1300	623927.48	1919565.67	638.27		SSLUTL-01
1369	623778.12	1916411.67	636.87		SSLUTL-02
1370	623694.24	1916334.79	635.88		SSLUTL-03
1706	623047.03	1915726.29	634.04		SSLUTL-04
1707	622976.47	1915659.23	633.97		SSLUTL-05
1709	623104.14	1915779.14	638.54	636.2	SSL-PZ02
1710	622891.58	1915551.55	638.84	635.8	SSL-PZ03
1718	622800.09	1915490.11	640.81	638.3	SSL-PZ04
1721	622733.22	1915418.55	640.92	638.9	SSL-PZ05

TNT Area A Sewer Line (September 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
1457	624602.74	1921705.79	628.82		SLSB-02
1471	624326.70	1922541.92	630.17		SLSB-05
1472	624321.95	1922542.98	630.72		SLSB-11
1473	624328.53	1922551.60	630.25		SLSB-12
1474	624331.64	1922540.29	630.69		SLSB-13
1475	624325.12	1922532.16	630.64		SLSB-14
1452	624603.71	1921686.40	628.85		SLSB-15
1453	624608.61	1921697.12	628.87		SLSB-16
1454	624600.16	1921695.20	628.85		SLSB-17
1455	624608.15	1921706.14	628.70		SLSB-18
1456	624598.59	1921705.76	629.12		SLSB-19
1458	624605.09	1921717.51	628.79		SLSB-20
1459	624595.56	1921714.41	628.80		SLSB-21
1460	624600.20	1921724.09	628.47		SLSB-22
1461	624321.46	1922512.67	630.73		SLSB-23
1462	624333.58	1922551.28	630.73		SLSB-24
1463	624323.74	1922552.17	630.74		SLSB-25
1464	624336.76	1922570.87	630.79		SLSB-26
1465	624331.95	1922571.35	630.29		SLSB-27
1466	624327.14	1922571.94	630.66		SLSB-28
1467	624340.09	1922589.79	630.68		SLSB-29
1468	624335.01	1922590.95	630.37		SLSB-30
1469	624330.01	1922591.43	630.57		SLSB-31
1470	624338.73	1922610.57	630.27		SLSB-32

Ash Pit #3 (September 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29)	Adjacent Ground Elev.	Shaw Designation
1382	622910.53	1914684.10	638.03	638.5	AP3 MW-01
1379	622958.84	1914572.39	640.24	637.3	AP3 MW-02
1388	623077.56	1914421.69	639.28	636.2	AP3 MW-03

Acid Area #1 (September 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29) Adjacent Ground Elev.	Shaw Designation
1503	623078.28	1917106.10	638.42	AA1SS-01
1502	623076.73	1917171.83	638.44	AA1SS-02
1501	623075.70	1917246.79	638.55	AA1SS-03
1500	623039.17	1917293.39	638.66	AA1SS-04
1499	622984.40	1917293.03	638.45	AA1SS-05
1512	622954.08	1917229.01	639.05	AA1SS-06
1511	622955.77	1917164.58	639.23	AA1SS-07
1508	622956.83	1917089.10	639.38	AA1SS-08
1510	623001.76	1917066.77	638.34	AA1SS-09
1515	622887.69	1917172.92	639.32	AA1SS-10
1516	622907.05	1917233.67	639.03	AA1SS-11
1517	622881.62	1917304.26	637.83	AA1SS-12
1518	622814.45	1917329.70	638.00	AA1SS-13
1520	622707.29	1917340.43	638.81	AA1SS-14
1521	622704.30	1917231.64	639.59	AA1SS-15
1496	622975.86	1917587.10	638.45	AA1SS-16
1495	623037.08	1917589.53	637.75	AA1SS-17
1480	623064.78	1917704.91	639.12	AA1SS-18
1479	623065.08	1917637.67	638.31	AA1SS-19
1481	623061.83	1917804.59	638.68	AA1SS-20
1484	623034.78	1917834.69	638.79	AA1SS-21
1485	622967.39	1917835.92	638.45	AA1SS-22
1491	622930.15	1917771.74	639.63	AA1SS-23
1492	622932.71	1917708.65	639.61	AA1SS-24
1493	622932.60	1917633.33	639.48	AA1SS-25
1604	622853.23	1917648.95	637.16	AA1SS-26
1528	622885.14	1917706.18	638.86	AA1SS-27
1531	622854.06	1917806.49	638.63	AA1SS-28
1539	622847.55	1917891.08	638.74	AA1SS-29
1540	622856.20	1917976.35	638.90	AA1SS-30
1541	622842.99	1918045.69	638.99	AA1SS-31
1563	622887.57	1918118.44	639.50	AA1SS-32
1564	622871.73	1918216.54	639.13	AA1SS-33
1553	622718.83	1918169.12	639.00	AA1SS-34
1551	622689.36	1918097.34	639.17	AA1SS-35
1538	622734.26	1917941.52	638.97	AA1SS-36
1536	622731.20	1917882.54	638.98	AA1SS-37
1532	622745.39	1917809.30	639.30	AA1SS-38
1533	622743.92	1917731.23	639.22	AA1SS-39
1534	622680.36	1917678.76	638.85	AA1SS-40
1530	622763.83	1917641.77	637.77	AA1SS-41
1556	622682.28	1918569.02	640.38	AA1SS-42

Acid Area #1 (September 2011) <cont.>

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29) Adjacent Ground Elev.	Shaw Designation
1559	622763.35	1918563.10	639.48	AA1SS-43
1560	622863.21	1918513.54	639.33	AA1SS-44
1561	622877.63	1918588.87	640.14	AA1SS-45
1562	622835.66	1918657.90	641.27	AA1SS-46
1554	622762.05	1918053.62	639.05	AA1SS-47
1519	622766.70	1917335.77	638.24	AA1SS-48
1509	622993.80	1917064.17	634.75	AA1SS-49
1498	623073.71	1917303.80	638.33	AA1SS-50
1513	622960.42	1917323.23	634.30	AA1SS-51
1524	622880.86	1917372.21	636.65	AA1SS-52
1525	622817.11	1917387.41	636.81	AA1SS-53
1523	622718.26	1917391.44	637.72	AA1SS-54
1522	622654.66	1917361.08	639.01	AA1SS-55
1497	623070.51	1917436.15	638.27	AA1SS-56
1514	622976.12	1917448.41	635.40	AA1SS-57
1527	622789.91	1917432.10	636.82	AA1SS-58
1526	622860.52	1917484.11	636.20	AA1SS-59
1478	623066.03	1917555.87	638.37	AA1SS-60
1494	622947.89	1917558.68	639.17	AA1SS-61
1529	622821.39	1917639.93	637.26	AA1SS-62
1482	623057.97	1917895.33	638.61	AA1SS-63
1486	623007.09	1917906.72	637.40	AA1SS-64
1487	622973.47	1917899.89	637.77	AA1SS-65
1490	622942.18	1917877.79	638.98	AA1SS-66
1535	622691.85	1917886.00	639.52	AA1SS-67
1483	623053.10	1917979.40	638.31	AA1SS-68
1488	623006.56	1917959.29	636.95	AA1SS-69
1489	622941.52	1917963.82	638.03	AA1SS-70
1537	622690.45	1917944.62	639.31	AA1SS-71
1552	622678.71	1918186.89	638.95	AA1SS-72
1565	622869.25	1918282.09	638.99	AA1SS-73
1555	622685.10	1918492.13	640.51	AA1SS-74
1557	622618.06	1918574.96	640.05	AA1SS-75
1558	622699.47	1918653.16	640.08	AA1SS-76

Acid Area #1 (November 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29) Adjacent Ground Elev.	Shaw Designation
1596	622702.09	1917439.32	637.52	AA1SS-77
1595	622650.07	1917422.19	638.74	AA1SS-78
1598	622648.39	1917885.23	639.34	AA1SS-79
1597	622650.25	1917964.73	638.95	AA1SS-80
1600	622745.55	1918688.23	639.71	AA1SS-81
1601	622692.32	1918741.84	640.68	AA1SS-82
1602	622639.59	1918661.45	640.79	AA1SS-83
1592	623121.40	1917266.85	639.48	AA1SS-84
1591	623133.18	1917184.05	639.34	AA1SS-85
1594	622575.71	1917360.29	637.60	AA1SS-86
1599	622560.41	1917915.86	637.94	AA1SS-87
1603	622637.03	1918781.36	640.23	AA1SS-88

Coal Yard #1 (November 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29) Adjacent Ground Elev.	Shaw Designation
1586	623312.31	1918693.70	640.31	COAL1-SB01
1587	623317.59	1918784.80	640.42	COAL1-SB02
1589	623280.45	1918610.43	636.99	COAL1-SB03
1590	623344.70	1918544.11	636.46	COAL1-SB04

Coal Yard #2 (November 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29) Adjacent Ground Elev.	Shaw Designation
1585	623081.60	1911875.80	637.87	COAL2-SB01
1584	623034.37	1911903.68	638.12	COAL2-SB02
1582	623066.83	1911941.56	638.10	COAL2-SB03
1583	623069.44	1911988.57	637.94	COAL2-SB04

Coal Yard #3 (November 2011)

SS&M Pt. #	N(y) - NAD 83/95 Ohio State Plane	E(x) - NAD 83/95 North Zone	Elev (NGVD 29) Adjacent Ground Elev.	Shaw Designation
1580	622941.18	1914858.88	639.33	COAL3-SB01
1578	622897.02	1914797.95	639.11	COAL3-SB02
1579	622921.16	1914832.59	639.18	COAL3-SB03
1581	622870.43	1914828.65	639.16	COAL3-SB04

APPENDIX D

INVESTIGATION-DERIVED WASTE MANIFEST

009108643JJK

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: OH3 800 015 379
2. Page 1 of 1
3. Emergency Response Phone: (800) 255-3924
4. Manifest Tracking Number: 009108643 JJK

5. Generator's Name and Mailing Address: NASA - PLUMBROOK STATION
6100 COLUMBUS AVE
SANDUSKY, OH 44870
Generator's Phone: (419) 621-3234

Generator's Site Address (if different than mailing address):
6100 COLUMBUS AVE
SANDUSKY, OH 44870

6. Transporter 1 Company Name: TRIAD TRANSPORT, INC.
U.S. EPA ID Number: OKD 981 588 791

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address: EQ DETROIT, INC.
1923 FREDERICK
DETROIT, MI 48211
Facility's Phone: (313) 347-1300
U.S. EPA ID Number: MID 980 991 566

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1. NON DOT HAZARDOUS, NON RCRA REGULATED	35	DM	1800	G	029L
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information
01. D098220DET / NON HAZARDOUS IDW WATER

NASA # N12002

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Robert F. Lallier Jr.
Signature: Robert Lallier on behalf of NASA GRC
Month 12 Day 26 Year 12

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S.
Transporter signature (for exports only):
Port of entry/exit:
Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: MARK R. SMEALLIE
Signature: Mark R Smeallie
Month 1 Day 26 Year 12

Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

DESIGNATED FACILITY

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

18b. Alternate Facility (or Generator)
Manifest Reference Number:
U.S. EPA ID Number
Facility's Phone:

18c. Signature of Alternate Facility (or Generator)
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. LIW 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Julie Denzich
Signature:
Month 1 Day 10 Year 12

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

APPENDIX E

DATA VALIDATION SUMMARIES

MAY 2012
COAL YARD 2
DATA QUALITY EVALUATION

List of Acronyms

CCAL	continuing calibration
CLP	Contract Laboratory Program
EPA	US Environmental Protection Agency
FD	field duplicate
FS	field split
GC/MS	gas chromatography/mass spectrometry
ICAL	initial calibration
ICS	interference check sample
LCS	laboratory control sample
MDL	method detection limit
MS/MSD	matrix spike/matrix spike duplicate
PCB	polychlorinated biphenyl
QC	quality control
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SOP	standard operating procedure

Data Validation Summary Report
Coal Yard 2 October 2011 Sampling
Former Plum Brook Ordnance Works
Sandusky, Ohio

1.0 Introduction

Level IV data validation was performed on 100 percent of the environmental soil samples collected for the October 2011 sampling events at Coal Yard 2 area. The analytical data consisted of two sample delivery groups (SDG) (F87352 and F87353) analyzed by Accutest of Orlando, Florida. In addition, validation of the field split data, which consisted of two SDGs (240-5520-1 and 240-5522-1) and was analyzed by Test America of North Canton, Ohio, was performed and findings are discussed in section 5.0 of this report.

The following samples were validated for this investigation:

SDG Number	Sample Number
F87352	CY0015, CY0016, CY0018, CY0022, CY0023, CY0027, CY0030
F87353	CY0019, CY0020, CY0021, CY0025, CY0026, CY0028, CY0029
240-5520-1	CY0024
240-5522-1	CY0017

The chemical parameters, for which the samples were analyzed, are identified below:

Parameter (Prep/Analytical Method)
Semivolatile Organics by GC/MS SW846 3550C/8270D
Total Recoverable and Dissolved Metals by SW846 3050B/6010C and 7471B
Nitroaromatic and Nitramine Explosives by SW846 8330A
PCBs by SW846 3550C/8082A

GC/MS – Gas chromatography/mass spectrometry

2.0 Procedures

The sample data were validated following the logic identified in the U.S. Environmental Protection Agency (EPA) Contract Laboratory Program (CLP) National Functional Guidelines for Inorganic Data Review (January 2010) and the EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Review (June 2008) for all areas except blanks. EPA Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses (April 1993) and Region III Modifications to National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration (September 1994) were applied to the areas associated with blank contamination. Specific quality control (QC) criteria as identified in the quality assurance plan, analytical methods, and laboratory standard operating procedures (SOP) were applied to all sample results. As a result of the use of Update III SW846 test methods for the analytical data and the application of the CLP guidelines during the validation process, there were instances where the specific QC requirements for all target compounds were not defined. This primarily occurred in the organic, GC/MS calibration areas and is due to the fact that the analytical methods are performance-based and allow the use of average calibration responses in lieu of individual responses, which are defined by CLP protocol.

In light of applying CLP guidelines to SW846 methods and evaluating the usability of the data during the validation process, specific QC criteria were determined to address all target compounds and are identified in this report for each parameter, as well as in the validation checklists, which function as worksheets. For those analytical methods not addressed by the CLP and Region III guidelines, the validation was based on the method requirements (i.e., SW846, Code of Federal Regulations, SOPs) and technical judgment, following the logic of the CLP validation guidelines. Lab-specific criteria may be found in Attachment A.

3.0 Summary of Data Validation Findings

The overall quality of the data was determined to be acceptable with minimal qualifications. An individual validation report has been prepared for the parameters analyzed, and the overall results of the validation findings are summarized in this report. A listing of the validation qualifiers and the reason codes, along with their definitions, is found in Attachment A. The following section highlights the key findings of the data validation process. No data were rejected.

4.0 Analysis-Specific Data Validation Summaries

4.1 Semivolatile Organics by GC/MS SW846 8270C

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples

Sample Preservation

Sample preservation criteria were met for all samples.

Initial and Continuing Calibration

The initial calibration (ICAL) and continuing calibrations (CCAL) associated with the project samples met QC criteria with the following exceptions:

SDG Number	Sample(s) Affected	Analyte(s)	Validation Qualifier
F87352	CY0015, CY0016, CY0018, CY0022, CY0023, CY0027, CY0030	Bis(2-Chloroethyl)ether, Hexachlorocyclopentadiene	UJ
F87353	CY0019, CY0020, CY0021, CY0025, CY0026, CY0029,	Bis(2-Chloroethyl)ether, Hexachlorocyclopentadiene	
	CY0028	Bis(2-chloroisopropyl)ether	

Blanks

The 5X/10X rule for contaminants found in the associated equipment rinses and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries

All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
Matrix Spike/Matrix Spike Duplicate (MS/MSD) analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
Laboratory Control Sample (LCS) analysis was performed for the project samples and all QC criteria were met.

Field Duplicates
Original and field duplicate (FD) results were evaluated and no problems were identified.

Internal Standards
All internal standards met QC criteria.

Quantitation
Results quantitated between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.2 Total and Dissolved Metals by SW846 6010B/7470A/7471

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times
Technical holding time criteria were met for all samples.

Sample Preservation
Sample preservation criteria were met for all samples.

Initial and Continuing Calibration
The ICAL and CCALs associated with the project samples met QC criteria.

Blanks
The 5X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Matrix Spike/Matrix Spike Duplicate
MS/MSD analysis was performed for the project samples, and all QC criteria were met.

Laboratory Duplicate Sample Analysis
A Laboratory Duplicate Sample analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
LCS analysis was performed for the project samples and all QC criteria were met.

Interference Check Sample
All Interference Check Sample (ICS) percent recoveries were met.

Inductively Coupled Plasma Serial Dilutions
All QC criteria were met for the serial dilutions associated with the project samples.

Field Duplicates
Original and FD results were evaluated and no problems were identified with the following exceptions:

SDG	Samples Affected	Analyte(s)	Validation Qualifier
F87352	CY0015 (original), CY0016 (FD)	Aluminum, Barium, Calcium	J
	CY0022 (original), CY0023 (FD)	Arsenic, Cadmium	

Quantitation
Results quantitated between the MDL and the RL, which the lab qualified as "B", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.3 Nitroaromatic and Nitroamine Explosives by SW846 8330
Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times
Technical holding time criteria were met for all samples.

Sample Preservation
Sample preservation criteria were met for all samples.

Initial and Continuing Calibration
The ICAL and CCALs associated with the project samples met QC criteria.

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
MS/MSD analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
LCS analysis was performed for the project samples and all QC criteria were met.

Field Duplicates
Original and FD results were evaluated and no problems were identified.

Second Column Confirmation
Samples having analytes with positive detects were verified on a second confirmation column; QC criteria (40% relative percent difference [RPD]) were met.

Quantitation
Results quantitated between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.4 Polychlorinated Biphenyls (PCBs) by SW846 8082

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times
Technical holding time criteria were met for all samples.

Sample Preservation
Sample preservation criteria were met for all samples.

Initial and Continuing Calibration
The ICAL and CCALs associated with the project samples met QC criteria.

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits for all the project samples.

Matrix Spike/Matrix Spike Duplicate
MS/MSD analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
LCS analysis was performed for the project samples and all QC criteria were met.

Field Duplicates
Original and FD results were evaluated and no problems were identified.

Second Column Confirmation
Samples having analytes with positive detects were verified on a second confirmation column; QC criteria (40% RPD) were met.

Quantitation
Results quantitated between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.0 Quality Assurance Field Split Sample Data Evaluation

Data from the quality assurance split samples, CY0024 (SDG: 240-5520-1) and CY0017 (SDG: 240-5522-1) were validated. The field split (FS) samples were analyzed for Semivolatiles by SW846 8270C, Explosives by SW846 8330, PCBs by SW846 8280 and Total and Dissolved Metals by SW 846 6010B and 7471A. The following section highlights the key findings of the data validation for each analysis.

The following samples were validated for this site investigation:

SDG Number	Sample Number
240-5520-1	CY0024
240-5522-1	CY0017

Sample/FD/FS
CY0015 (Original) / CY0016 (FD) / CY0017 (FS)
CY0022 (Original) / CY0023 (FD) / CY0024 (FS)

5.1 Semivolatile Organics by GC/MS SW846 8270C

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times

Technical holding time criteria were met for all samples.

Sample Preservation

Sample preservation criteria were met for all samples.

Initial and Continuing Calibration

The ICAL and CCALs associated with the project samples met QC criteria.

Blanks

The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries

All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate

MS/MSD analysis was performed for the project samples, and all QC criteria were met with the following exceptions:

SDG Number	Sample(s) Affected	Analyte(s)	Validation Qualifier
240-5520-1	CY0024	3,3'-Dichlorobenzidine, Pentachlorophenol	UJ
		2-Methylnaphthalene, Naphthalene, Phenanthrene	J

Laboratory Control Sample
LCS analysis was performed for the project samples and all QC criteria were met.

Internal Standards
All internal standards met QC criteria.

Field Splits
Table 2 shows the Regular/FD/FS comparison of the data. An RPD calculated for the analytes that were positive detects.

Quantitation
Results quantitated between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.2 Total and Dissolved Metals by SW846 6010B/7470A/7471

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times
Technical holding time criteria were met for all samples.

Sample Preservation
Sample preservation criteria were met for all samples.

Initial and Continuing Calibration
The ICAL and CCALs associated with the project samples met QC criteria.

Blanks
The 5X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable with the following exceptions:

SDG Number	Sample(s) Affected	Analyte(s)	Validation Qualifier
240-5522-1	CY0017	Mercury	B
240-5520-1	CY0024		

Matrix Spike/Matrix Spike Duplicate
MS/MSD analysis was performed for the project samples, and all QC criteria were met with the following exception(s):

SDG Number	Sample(s) Affected	Analyte(s)	Validation Qualifier
240-5522-1	CY0017	Calcium, Manganese, Antimony	J/UJ

Laboratory Control Sample
LCS analysis was performed for the project samples and all QC criteria were met.

Interference Check Sample
All ICS percent recoveries were acceptable. All QC criteria were met.

Inductively Coupled Plasma Serial Dilutions
All QC criteria were met for the serial dilutions associated with the project samples.

Field Splits
Table 2 shows the Regular/FD/FS comparison of the data. An RPD is calculated for the analytes that were positive detects.

Quantitation
Results quantitated between the MDL and the RL, which the lab qualified as "B", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.3 Nitroaromatic and Nitroamine Explosives by SW846 8330

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times
Technical holding time criteria were met for all samples.

Sample Preservation
Sample preservation criteria were met for all samples.

Initial and Continuing Calibration
The ICAL and CCALs associated with the project samples met QC criteria.

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits for the project samples.

Matrix Spike/Matrix Spike Duplicate
MS/MSD analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
LCS analysis was performed for the project samples and all QC criteria were met.

Second Column Confirmation
Samples having analytes with positive detects were verified on a second confirmation column; QC criteria (40% RPD) were met.

Field Splits
Table 2 shows the Regular/FD/FS comparison of the data. An RPD is calculated for the analytes that were positive detects.

Quantitation
Results quantitated between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

5.4 PCBs by SW846 8082

Overall, the data are of good quality and are usable as reported by the laboratory with the exceptions noted below. Data were reviewed for the following:

Holding Times
Technical holding time criteria were met for all samples.

Sample Preservation
Sample preservation criteria were met for all samples.

Initial and Continuing Calibration
The ICAL and CCALs associated with the project samples met QC criteria.

Blanks
The 5X/10X rule for contaminants found in the associated equipment rinses, trip blanks, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries
All surrogate recoveries were within QC limits.

Matrix Spike/Matrix Spike Duplicate
MS/MSD analysis was performed for the project samples, and all QC criteria were met.

Laboratory Control Sample
LCS analysis was performed for the project samples and all QC criteria were met.

Second Column Confirmation
Samples having analytes with positive detects were verified on a second confirmation column; QC criteria (40% RPD) were met.

Field Splits

Table 2 shows the Regular/FD/FS comparison of the data. An RPD is calculated for the analytes that were positive detects.

Quantitation

Results quantitated between the MDL and the RL, which the lab qualified as "J", were qualified as estimated "J" unless blank contamination was present or the results were rejected.

ATTACHMENT A

SUMMARY OF DATA VALIDATION REASON CODES

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Reason Code	Description
01	Sample received outside of 4+/-2 degrees Celsius
01A	Improper sample preservation
02	Holding Time Exceeded
02A	Extraction
02B	Analysis
03	Instrument Performance - Outside Criteria
03A	BFB
03B	DFTPP
03C	DDT and/or Endrin % breakdown exceeds criteria
03D	retention time windows
03E	Resolution
04	Initial Calibration results outside specified criteria
04A	Compound mean RRF<0.05
04B	Compound %RSD>30
04C	Correlation Coefficient<0.995
05	Continuing Calibration results outside specified criteria
05A	Compound mean RRF<0.05
05B	Compound %D>25
06	Result qualified as a result of the 5x/10x blank correction
06A	Method or Preparation Blank
06B	ICB or CCB
06C	ER
06D	TB
06E	FB
07	Surrogate Recoveries outside control limits
07A	Sample
07B	Associated method blank or LCS
08	MS/MSD/Duplicate results outside criteria
08A	MS and/or MSD recovery not within control limits (accuracy)
08B	%RPD outside acceptance criteria (precision)
09	Post Digestion Spike outside criteria (GFAA)
10	Internal Standards outside specified control limits
10A	Recovery
10B	Retention Time
11	Laboratory Control Sample recoveries outside specified control limits
11A	Recovery
11B	%RPD (if run in duplicate)
12	Interference Check Standard
13	Serial Dilution
14	Tentatively Identified Compounds
15	Quantitation
16	Multiple results available; alternate analysis preferred
17	Field duplicate RPD criteria exceeded
18	Percent difference between original and second column > 25%
19	Professional judgement was used to qualify the data
20	Pesticide clean-up checks
21	Target compound identification
22	Radiological calibration
23	Radiological quantitation
24	Reported result and/or lab qualifier revised to reflect validation findings
999	See hard copy for details.

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Work Order	Sample Number	Analysis	Parameter	Reason Codes				
				VQ	R1	R2	R3	R4
F87352	CY0015	METALS3	Aluminum	J	17			
F87352	CY0015	METALS3	Potassium	J	15			
F87352	CY0015	METALS3	Barium	J	17			
F87352	CY0015	METALS3	Beryllium	J	15			
F87352	CY0015	METALS3	Calcium	J	17			
F87352	CY0015	METALS3	Selenium	J	15			
F87352	CY0015	METALS3	Mercury	J	15			
F87352	CY0015	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0015	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0016	METALS3	Aluminum	J	17			
F87352	CY0016	METALS3	Potassium	J	15			
F87352	CY0016	METALS3	Barium	J	17			
F87352	CY0016	METALS3	Beryllium	J	15			
F87352	CY0016	METALS3	Cobalt	J	15			
F87352	CY0016	METALS3	Calcium	J	17			
F87352	CY0016	METALS3	Mercury	J	15			
F87352	CY0016	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0016	SEMIVOLATILES3	Pyrene	J	15			
F87352	CY0016	SEMIVOLATILES3	Fluoranthene	J	15			
F87352	CY0016	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
240-5522-1	CY0017	METALS3	Manganese	J	08A			
240-5522-1	CY0017	METALS3	Antimony	UJ	08A			
240-5522-1	CY0017	METALS3	Beryllium	J	15			
240-5522-1	CY0017	METALS3	Cadmium	J	15			
240-5522-1	CY0017	METALS3	Calcium	J	08A			
240-5522-1	CY0017	METALS3	Mercury	B	06A	15		
240-5522-1	CY0017	SEMIVOLATILES3	BIBENZENE	J	15			
240-5522-1	CY0017	SEMIVOLATILES3	ACETOPHENONE	J	15			
F87352	CY0018	METALS3	Potassium	J	15			
F87352	CY0018	METALS3	Silver	J	15			
F87352	CY0018	METALS3	Sodium	J	15			
F87352	CY0018	METALS3	Beryllium	J	15			
F87352	CY0018	METALS3	Selenium	J	15			
F87352	CY0018	METALS3	Mercury	J	15			
F87352	CY0018	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0018	SEMIVOLATILES3	Bis(2-ethylhexyl)phthalate	J	15			
F87352	CY0018	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0019	METALS3	Potassium	J	15			
F87353	CY0019	METALS3	Silver	J	15			
F87353	CY0019	METALS3	Beryllium	J	15			
F87353	CY0019	METALS3	Mercury	J	15			
F87353	CY0019	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0019	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0020	METALS3	Potassium	J	15			
F87353	CY0020	METALS3	Beryllium	J	15			
F87353	CY0020	METALS3	Cobalt	J	15			
F87353	CY0020	METALS3	Selenium	J	15			
F87353	CY0020	METALS3	Mercury	J	15			
F87353	CY0020	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0020	SEMIVOLATILES3	Fluoranthene	J	15			
F87353	CY0020	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0020	SEMIVOLATILES3	Phenanthrene	J	15			
F87353	CY0021	METALS3	Potassium	J	15			

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Work Order	Sample Number	Analysis	Parameter	Reason Codes				
				VQ	R1	R2	R3	R4
F87353	CY0021	METALS3	Silver	J	15			
F87353	CY0021	METALS3	Beryllium	J	15			
F87353	CY0021	METALS3	Cobalt	J	15			
F87353	CY0021	METALS3	Mercury	J	15			
F87353	CY0021	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0021	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0022	METALS3	Silver	J	15			
F87352	CY0022	METALS3	Sodium	J	15			
F87352	CY0022	METALS3	Arsenic	J	17			
F87352	CY0022	METALS3	Beryllium	J	15			
F87352	CY0022	METALS3	Cadmium	J	17			
F87352	CY0022	METALS3	Selenium	J	15			
F87352	CY0022	METALS3	Mercury	J	15			
F87352	CY0022	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0022	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0023	METALS3	Sodium	J	15			
F87352	CY0023	METALS3	Arsenic	J	17			
F87352	CY0023	METALS3	Beryllium	J	15			
F87352	CY0023	METALS3	Cadmium	J	15	17		
F87352	CY0023	METALS3	Mercury	J	15			
F87352	CY0023	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0023	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
240-5520-1	CY0024	METALS3	Beryllium	J	15			
240-5520-1	CY0024	METALS3	Cadmium	J	15			
240-5520-1	CY0024	METALS3	Mercury	B	06A	15		
240-5520-1	CY0024	SEMIVOLATILES3	Bis(2-ethylhexyl)phthalate	J	15			
240-5520-1	CY0024	SEMIVOLATILES3	Phenanthrene	J	08A			
240-5520-1	CY0024	SEMIVOLATILES3	Pentachlorophenol	UJ	08A			
240-5520-1	CY0024	SEMIVOLATILES3	Naphthalene	J	08A			
240-5520-1	CY0024	SEMIVOLATILES3	Methylnaphthalene, 2-	J	08A			
240-5520-1	CY0024	SEMIVOLATILES3	Dichlorobenzidine, 3,3'-	UJ	08A			
F87353	CY0025	METALS3	Potassium	J	15			
F87353	CY0025	METALS3	Beryllium	J	15			
F87353	CY0025	METALS3	Cobalt	J	15			
F87353	CY0025	METALS3	Selenium	J	15			
F87353	CY0025	METALS3	Mercury	J	15			
F87353	CY0025	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0025	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0026	METALS3	Sodium	J	15			
F87353	CY0026	METALS3	Thallium	J	15			
F87353	CY0026	METALS3	Cadmium	J	15			
F87353	CY0026	METALS3	Mercury	J	15			
F87353	CY0026	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0026	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0027	METALS3	Silver	J	15			
F87352	CY0027	METALS3	Sodium	J	15			
F87352	CY0027	METALS3	Beryllium	J	15			
F87352	CY0027	METALS3	Selenium	J	15			
F87352	CY0027	METALS3	Mercury	J	15			
F87352	CY0027	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0027	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0028	METALS3	Silver	J	15			
F87353	CY0028	METALS3	Sodium	J	15			

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Work Order	Sample Number	Analysis	Parameter	Reason Codes				
				VQ	R1	R2	R3	R4
F87353	CY0028	METALS3	Antimony	J	15			
F87353	CY0028	METALS3	Mercury	J	15			
F87353	CY0028	SEMIVOLATILES3	Bis(2-chloroisopropyl)ether	UJ	05B			
F87353	CY0028	SEMIVOLATILES3	Naphthalene	J	15			
F87353	CY0028	SEMIVOLATILES3	Methylnaphthalene, 2-	J	15			
F87353	CY0029	METALS3	Potassium	J	15			
F87353	CY0029	METALS3	Beryllium	J	15			
F87353	CY0029	METALS3	Cadmium	J	15			
F87353	CY0029	METALS3	Cobalt	J	15			
F87353	CY0029	METALS3	Mercury	J	15			
F87353	CY0029	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0029	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0030	METALS3	Potassium	J	15			
F87352	CY0030	METALS3	Beryllium	J	15			
F87352	CY0030	METALS3	Mercury	J	15			
F87352	CY0030	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0030	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Qualifier	Definition
Laboratory	
B	Indicates the analyte is found in associated method blank.
J	Indicates the analyte result is an estimated value.
ND	Not detected. The compound was analyzed for, but not detected above the associated reporting limit.
MDL	Method detection limit.
RL	Reporting limit.
E	Indicates the value exceeds the calibration range.
ND	Indicates presumptive evidence of a compound

Validation	
B	The compound/analyte was detected in a lab or field blank.
J	The compound/analyte was positively identified; the reported value is an estimated concentration.
U	Not detected. The compound/analyte was analyzed for, but not detected above the associated reporting limit.
UJ	The analyte is not detected; the result is an estimated value.
R	Analyte is rejected.

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Spiked Compound	Accutest				Test America		
	Soil - LCS	Soil - MS/MSD			Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)		% Recovery Range	% Recovery Range	Precision RPD (%)
Volatile Organic Compounds, SW846 8260B							
Acetone	61 - 144	61 - 144	29		N/A	N/A	N/A
Acrolein	N/A	N/A	N/A		N/A	N/A	N/A
Acrylonitrile	N/A	N/A	N/A		N/A	N/A	N/A
Benzene	78 - 130	78 - 130	25		75 - 129	75 - 129	N/A
Bromobenzene	N/A	N/A	N/A		N/A	N/A	N/A
Bromochloromethane	N/A	N/A	N/A		N/A	N/A	N/A
Bromodichloromethane	73 - 122	73 - 122	25		N/A	N/A	N/A
Bromoform	70 - 139	70 - 139	26		N/A	N/A	N/A
Bromomethane	N/A	N/A	N/A		N/A	N/A	N/A
2-Butanone	N/A	N/A	N/A		N/A	N/A	N/A
Chlorobenzene	83 - 122	83 - 122	23		75 - 127	75 - 127	N/A
Chloroethane	61 - 153	61 - 153	31		N/A	N/A	N/A
Chloromethane	N/A	N/A	N/A		N/A	N/A	N/A
Chloroform	79 - 129	79 - 129	27		N/A	N/A	N/A
2-Chlorotoluene	N/A	N/A	N/A		N/A	N/A	N/A
4-Chlorotoluene	N/A	N/A	N/A		N/A	N/A	N/A
Carbon disulfide	61 - 142	61 - 142	27		N/A	N/A	N/A
Carbon tetrachloride	79 - 135	79 - 135	29		N/A	N/A	N/A
1,2-Dibromoethane	N/A	N/A	N/A		N/A	N/A	N/A
1,2-Dibromo-3-chloropropane	N/A	N/A	N/A		N/A	N/A	N/A
1,1-Dichloroethane	77 - 132	77 - 132	26		N/A	N/A	N/A
1,1-Dichloroethylene	66 - 132	66 - 132	27		55 - 142	55 - 142	N/A
1,2-Dichloroethane	78 - 129	78 - 129	24		N/A	N/A	N/A
1,2-Dichloropropane	74 - 127	74 - 127	27		N/A	N/A	N/A
1,3-Dichloropropane	N/A	N/A	N/A		N/A	N/A	N/A
2,2-Dichloropropane	N/A	N/A	N/A		N/A	N/A	N/A
1,1-Dichloropropene	N/A	N/A	N/A		N/A	N/A	N/A
1,2-Dichlorobenzene	N/A	N/A	N/A		N/A	N/A	N/A
1,3-Dichlorobenzene	N/A	N/A	N/A		N/A	N/A	N/A
1,4-Dichlorobenzene	N/A	N/A	N/A		N/A	N/A	N/A
Dibromochloromethane	78 - 117	78 - 117	27		N/A	N/A	N/A
Dibromomethane	N/A	N/A	N/A		N/A	N/A	N/A
Dichlorodifluoromethane	N/A	N/A	N/A		N/A	N/A	N/A
cis-1,2-Dichloroethylene	74 - 123	74 - 123	26		N/A	N/A	N/A
cis-1,3-Dichloropropene	79 - 130	79 - 130	23		N/A	N/A	N/A
trans-1,2-Dichloroethylene	77 - 129	77 - 129	27		N/A	N/A	N/A
trans-1,3-Dichloropropene	87 - 131	87 - 131	27		N/A	N/A	N/A
Ethylbenzene	82 - 124	82 - 124	25		N/A	N/A	N/A
2-Hexanone	67 - 130	67 - 130	29		N/A	N/A	N/A
Hexachlorobutadiene	N/A	N/A	N/A		N/A	N/A	N/A
Isopropylbenzene	N/A	N/A	N/A		N/A	N/A	N/A
4-Isopropyltoluene	N/A	N/A	N/A		N/A	N/A	N/A
4-Methyl-2-pentanone	69 - 125	69 - 125	24		N/A	N/A	N/A
Methyl bromide	60 - 146	60 - 146	31		N/A	N/A	N/A
Methyl chloride	58 - 163	58 - 163	26		N/A	N/A	N/A
Methylene chloride	62 - 140	62 - 140	25		N/A	N/A	N/A
Methyl ethyl ketone	66 - 134	66 - 134	23		N/A	N/A	N/A
Methyl tert-Butyl ether	N/A	N/A	N/A		N/A	N/A	N/A
Naphthalene	N/A	N/A	N/A		N/A	N/A	N/A

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Spiked Compound	Accutest			Test America		
	Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
n-Butylbenzene	N/A	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	N/A	N/A	N/A	N/A	N/A	N/A
Styrene	79 - 123	79 - 123	28	N/A	N/A	N/A
sec-Butylbenzene	N/A	N/A	N/A	N/A	N/A	N/A
1,1,1-Trichloroethane	80 - 133	80 - 133	27	N/A	N/A	N/A
1,2,3-Trichloropropane	N/A	N/A	N/A	N/A	N/A	N/A
1,1,1,2-Tetrachloroethane	N/A	N/A	N/A	N/A	N/A	N/A
1,1,2,2-Tetrachloroethane	70 - 128	70 - 128	30	N/A	N/A	N/A
1,1,2-Trichloroethane	76 - 118	76 - 118	28	N/A	N/A	N/A
1,3,5-Trimethylbenzene	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3-Trichlorobenzene	N/A	N/A	N/A	N/A	N/A	N/A
1,2,4-Trichlorobenzene	N/A	N/A	N/A	N/A	N/A	N/A
1,2,4-Trimethylbenzene	N/A	N/A	N/A	N/A	N/A	N/A
tert-Butylbenzene	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethylene	79 - 132	79 - 132	27	N/A	N/A	N/A
Toluene	80 - 123	80 - 123	26	71 - 130	71 - 130	N/A
Trichloroethylene	78 - 132	78 - 132	28	70 - 131	70 - 131	N/A
Trichlorofluoromethane	N/A	N/A	N/A	N/A	N/A	N/A
Vinyl acetate	N/A	N/A	N/A	N/A	N/A	N/A
Vinyl chloride	60 - 145	60 - 145	29	N/A	N/A	N/A
m-Xylene/p-Xylene	N/A	N/A	N/A	N/A	N/A	N/A
o-Xylene	N/A	N/A	N/A	N/A	N/A	N/A
Xylene (total)	83 - 127	83 - 127	24	N/A	N/A	N/A
Surrogates						
Dibromofluoromethane	80 - 121	80 - 121	N/A	68-110	68-110	N/A
Toluene-D8	71 - 130	71 - 130	N/A	69-128	69-128	N/A
4-Bromofluorobenzene	59 - 148	59 - 148	N/A	64-130	64-130	N/A
1,2-Dichloroethane-D4	77 - 123	77 - 123	N/A	64-130	64-130	N/A
Semivolatile Organic Compounds, SW-846 8270C						
Benzoic Acid	44 - 116	44 - 116	36	N/A	N/A	N/A
2-Chlorophenol	54 - 97	54 - 97	31	32 - 110	32 - 110	30
4-Chloro-3-methyl phenol	59 - 102	59 - 102	27	32 - 117	32 - 117	30
2,4-Dichlorophenol	60 - 101	60 - 101	30	N/A	N/A	N/A
2,4-Dimethylphenol	49 - 89	49 - 89	31	N/A	N/A	N/A
2,4-Dinitrophenol	39 - 107	39 - 107	40	N/A	N/A	N/A
4,6-Dinitro-o-cresol	58 - 109	58 - 109	37	N/A	N/A	N/A
2-Methylphenol	53 - 94	53 - 94	29	N/A	N/A	N/A
3&4-Methylphenol	54 - 95	54 - 95	31	N/A	N/A	N/A
4-Methylphenol	N/A	N/A	N/A	N/A	N/A	N/A
2-Nitrophenol	55 - 96	55 - 96	30	N/A	N/A	N/A
4-Nitrophenol	56 - 106	56 - 106	29	10 - 125	10 - 125	30
Pentachlorophenol	50 - 115	50 - 115	33	10 - 182	10 - 182	30
Phenol	55 - 99	55 - 99	28	10 - 144	10 - 144	30
2,4,5-Trichlorophenol	60 - 101	60 - 101	28	N/A	N/A	N/A
2,4,6-Trichlorophenol	60 - 100	60 - 100	27	N/A	N/A	N/A
Acenaphthene	59 - 97	59 - 97	29	10 - 200	10 - 200	30
Acenaphthylene	58 - 98	58 - 98	30	N/A	N/A	N/A
Anthracene	61 - 104	61 - 104	29	N/A	N/A	N/A
Benzo(a)anthracene	60 - 106	60 - 106	31	N/A	N/A	N/A
Benzo(a)pyrene	59 - 102	59 - 102	32	N/A	N/A	N/A

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Spiked Compound	Accutest			Test America		
	Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
Benzo(b)fluoranthene	60 - 107	60 - 107	31	N/A	N/A	N/A
Benzo(g,h,i)perylene	56 - 103	56 - 103	32	N/A	N/A	N/A
Benzo(k)fluoranthene	61 - 107	61 - 107	30	N/A	N/A	N/A
4-Bromophenol phenyl ether	60 - 104	60 - 104	26	N/A	N/A	N/A
Butyl benzyl phthalate	57 - 110	57 - 110	28	N/A	N/A	N/A
Benzyl Alcohol	N/A	N/A	N/A	N/A	N/A	N/A
Butyl Alcohol	51 - 102	51 - 102	34	N/A	N/A	N/A
2-Chloronaphthalene	57 - 95	57 - 95	28	N/A	N/A	N/A
4-Chloroaniline	19 - 85	19 - 85	34	N/A	N/A	N/A
Carbazole	60 - 106	60 - 106	30	N/A	N/A	N/A
Chrysene	60 - 107	60 - 107	31	N/A	N/A	N/A
bis(2-Chloroethyoxy)methane	51 - 89	51 - 89	30	N/A	N/A	N/A
bis(2-Chloroethyl)ether	50 - 96	50 - 96	33	N/A	N/A	N/A
bis(2-Chloroisopropyl)ether	44 - 94	44 - 94	32	N/A	N/A	N/A
4-Chlorophenyl phenyl ether	60 - 101	60 - 101	26	N/A	N/A	N/A
1,2-Dichlorobenzene	47 - 91	47 - 91	35	N/A	N/A	N/A
1,3-Dichlorobenzene	45 - 86	45 - 86	36	N/A	N/A	N/A
1,4-Dichlorobenzene	45 - 88	45 - 88	36	26 - 110	26 - 110	30
2,4-Dinitrotoluene	59 - 103	59 - 103	30	42 - 118	42 - 118	30
2,6-Dinitrotoluene	57 - 99	57 - 99	30	N/A	N/A	N/A
3,3'-Dichlorobenzidine	34 - 88	34 - 88	31	N/A	N/A	N/A
Dibenzo(a,h)antracene	57 - 105	57 - 105	29	N/A	N/A	N/A
Dibenzofuran	58 - 103	58 - 103	27	N/A	N/A	N/A
Di-n-butyl phthalate	59 - 105	59 - 105	27	N/A	N/A	N/A
Di-n-octyl phthalate	59 - 117	59 - 117	28	N/A	N/A	N/A
Diethyl phthalate	59 - 106	59 - 106	27	N/A	N/A	N/A
Dimethyl phthalate	60 - 100	60 - 100	26	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	57 - 111	57 - 111	29	N/A	N/A	N/A
Fluoranthene	60 - 110	60 - 110	32	N/A	N/A	N/A
Fluorene	60 - 99	60 - 99	30	N/A	N/A	N/A
Hexachlorobenzene	58 - 103	58 - 103	27	N/A	N/A	N/A
Hexachlorobutadiene	49 - 95	49 - 95	33	N/A	N/A	N/A
Hexachlorocyclopentadiene	36 - 94	36 - 94	41	N/A	N/A	N/A
Hexachloroethane	44 - 89	44 - 89	38	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	57 - 104	57 - 104	33	N/A	N/A	N/A
Isophorone	58 - 97	58 - 97	30	N/A	N/A	N/A
2-Methylnaphthalene	57 - 103	57 - 103	32	N/A	N/A	N/A
2-Nitroaniline	53 - 106	53 - 106	29	N/A	N/A	N/A
3-Nitroaniline	29 - 85	29 - 85	31	N/A	N/A	N/A
4-Nitroaniline	49 - 104	49 - 104	31	N/A	N/A	N/A
Naphthalene	54 - 93	54 - 93	32	N/A	N/A	N/A
Nitrobenzene	53 - 92	53 - 92	32	N/A	N/A	N/A
N-Nitroso-di-n-propylamine	49 - 94	49 - 94	28	30 - 121	30 - 121	30
N-Nitrosodimethylamine	N/A	N/A	N/A	N/A	N/A	N/A
N-Nitrosodiphenylamine	53 - 107	53 - 107	28	N/A	N/A	N/A
Phenanthrene	61 - 103	61 - 103	32	N/A	N/A	N/A
Pyrene	58 - 109	58 - 109	33	10 - 200	10 - 200	30
Diphenylamine	N/A	N/A	N/A	N/A	N/A	N/A
1,2,4-Trichlorobenzene	52 - 93	52 - 93	32	33 - 110	33 - 110	30
Surrogates						

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Spiked Compound	Accutest			Test America		
	Soil - LCS	Soil - MS/MSD		Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)	% Recovery Range	% Recovery Range	Precision RPD (%)
2-Fluorophenol	40 - 102	40 - 102	N/A	35-105	35-105	N/A
Phenol-d5	41 - 100	41 - 100	N/A	40-100	40-100	N/A
2,4,6-Tribromophenol	42 - 108	42 - 108	N/A	35-125	35-125	N/A
Nitrobenzene-d5	40 - 105	40 - 105	N/A	35-100	35-100	N/A
2-Fluorobiphenyl	43 - 107	43 - 107	N/A	45-105	45-105	N/A
Terphenyl-d14	45 - 119	45 - 119	N/A	30-125	30-125	N/A
Nitroaromatics and Nitroamines, SW-846 8330						
HMX	75 - 156	75 - 156	27	75 - 125	75 - 125	N/A
RDX	77 - 131	77 - 131	28	70 - 135	70 - 135	N/A
1,3-Dinitrobenzene	82 - 134	82 - 134	20	80 - 125	80 - 125	N/A
2,6-Dinitrotoluene	86 - 142	86 - 142	17	80 - 120	80 - 120	N/A
2,4-Dinitrotoluene	74 - 129	74 - 129	18	80 - 125	80 - 125	N/A
2-amino-4,6-Dinitrotoluene	83 - 123	83 - 123	22	80 - 125	80 - 125	N/A
4-amino-2,6-Dinitrotoluene	85 - 137	85 - 137	18	80 - 125	80 - 125	N/A
Nitrobenzene	82 - 138	82 - 138	19	75 - 125	75 - 125	N/A
o-Nitrotoluene	85 - 129	85 - 129	21	75 - 120	75 - 120	N/A
m-Nitrotoluene	85 - 136	85 - 136	22	80 - 125	80 - 125	N/A
p-Nitrotoluene	86 - 133	86 - 133	19	75 - 125	75 - 125	N/A
Tetryl	53 - 124	53 - 124	22	10 - 150	10 - 150	N/A
1,3,5-Trinitrobenzene	81 - 138	81 - 138	24	75 - 125	75 - 125	N/A
2,4,6-Trinitrotoluene	70 - 137	70 - 137	29	55 - 140	55 - 140	N/A
Surrogates						
3,4-Dinitrotoluene	72 - 145	72 - 145	N/A	78-108	78-108	N/A
PCBs, SW-846 8082						
Aroclor-1016	69 - 117	69 - 117	26	10 - 199	10 - 199	30
Aroclor-1260	71 - 121	71 - 121	30	10 - 199	10 - 199	30
Surrogates						
Tetrachloro-m-xylene	44 - 126	44 - 126	N/A	40-140	40-140	N/A
Decachlorobiphenyl	39 - 157	39 - 157	N/A	60-125	60-125	N/A
Metals, SW-846 6010B/7470A						
Aluminum	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Antimony	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Arsenic	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Barium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Beryllium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Cadmium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Calcium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Chromium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Cobalt	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Copper	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Iron	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Lead	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Magnesium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Manganese	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Nickel	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Potassium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Selenium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Silver	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Sodium	80 - 120	80 - 120	20	80 - 120	75 - 125	20
Thallium	80 - 120	80 - 120	20	80 - 120	75 - 125	20

Attachment A

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Spiked Compound	Accutest				Test America		
	Soil - LCS	Soil - MS/MSD			Soil - LCS	Soil - MS/MSD	
	% Recovery Range	% Recovery Range	Precision RPD (%)		% Recovery Range	% Recovery Range	Precision RPD (%)
Vanadium	80 - 120	80 - 120	20		80 - 120	75 - 125	20
Zinc	80 - 120	80 - 120	20		80 - 120	75 - 125	20
Mercury	80 - 120	80 - 120	20		80 - 120	75 - 125	20
Total Organic Carbon (TOC) SW-846 9060							
TOC			25				

LCS - Laboratory Control Sample
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
N/A - Not Applicable

APPENDIX F

CHEMICAL ANALYTICAL DATA SUMMARY

Appenidix F

Chemical Analytical Summaries
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location:		CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB02			CY2-SB02			CY2-SB02		
Sample Number:		CY0015			CY0016			CY0017			CY0018			CY0019			CY0020			CY0021			CY0022		
Sample Date:		27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11		
Sample Depth:		.5 - 1 Ft			.5 - 1 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
Sample Purpose:		REG			FD			FS			REG			REG			REG			REG			REG		
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Explosives																									
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Dinitrobenzene, 1,3-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Dinitrotoluene, 2,4-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Dinitrotoluene, 2,6-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
HMX	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Nitrobenzene	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Nitrotoluene, 2-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Nitrotoluene, 3-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Nitrotoluene, 4-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
RDX	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Tetryl	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.17	U	U	0.18	U	U	0.099	U	U	0.15	U	U	0.17	U	U	0.15	U	U	0.15	U	U	0.16	U	U
Semivolatiles																									
3-Methylphenol and 4-Methylphenol	mg/kg	0.2	U	U	0.2	U	U	0.49	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Acenaphthene	mg/kg	0.2	U	U	0.2	U	U	0.0082	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Acenaphthylene	mg/kg	0.2	U	U	0.2	U	U	0.013			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Acetophenone	mg/kg	0			-	-	-	0.047	J	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	0.2	U	U	0.2	U	U	0.02			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Atrazine	mg/kg	0			-	-	-	0.25	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzaldehyde	mg/kg	0			-	-	-	0.12	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.2	U	U	0.2	U	U	0.043			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Benzo(a)pyrene	mg/kg	0.2	U	U	0.2	U	U	0.039			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Benzo(b)fluoranthene	mg/kg	0.2	U	U	0.2	U	U	0.039			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Benzo(ghi)perylene	mg/kg	0.2	U	U	0.2	U	U	0.024			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Benzo(k)fluoranthene	mg/kg	0.2	U	U	0.2	U	U	0.018			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Benzoic acid	mg/kg	0.98	U	U	1	U	U	-	-	-	1	U	U	1	U	U	0.96	U	U	1.1	U	U	1.1	U	U
Benzyl alcohol	mg/kg	0.2	U	U	0.2	U	U	-	-	-	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Bibenzene	mg/kg	0			-	-	-	0.034	J	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.2	U	U	0.2	U	U	0.12	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Bis(2-chloroethyl)ether	mg/kg	0.2	U	UJ	0.2	U	UJ	0.12	U	U	0.2	U	UJ	0.2	U	UJ	0.19	U	UJ	0.22	U	UJ	0.22	U	UJ
Bis(2-chloroisopropyl)ether	mg/kg	0.2	U	U	0.2	U	U	0.12	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.39	U	U	0.4	U	U	0.061	U	U	0.321	J	J	0.41	U	U	0.39	U	U	0.43	U	U	0.44	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Butyl benzyl phthalate	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Caprolactam	mg/kg	0			-	-	-	0.41	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appenidix F

Chemical Analytical Summaries
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location:		CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB02			CY2-SB02			CY2-SB02		
Sample Number:		CY0015			CY0016			CY0017			CY0018			CY0019			CY0020			CY0021			CY0022		
Sample Date:		27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11		
Sample Depth:		.5 - 1 Ft			.5 - 1 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
Sample Purpose:		REG			FD			FS			REG			REG			REG			REG			REG		
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Carbazole	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.2	U	U	0.2	U	U	0.18	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Chloroaniline, 4-	mg/kg	0.2	U	U	0.2	U	U	0.18	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Chloronaphthalene, 2-	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Chlorophenol, 2-	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Chrysene	mg/kg	0.2	U	U	0.2	U	U	0.055			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Dibenz(a,h)anthracene	mg/kg	0.2	U	U	0.2	U	U	0.0082	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Dibenzofuran	mg/kg	0.2	U	U	0.2	U	U	0.14			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Dichlorobenzene, 1,2-	mg/kg	0.2	U	U	0.2	U	U	-	-	-	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Dichlorobenzene, 1,3-	mg/kg	0.2	U	U	0.2	U	U	-	-	-	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Dichlorobenzene, 1,4-	mg/kg	0.2	U	U	0.2	U	U	-	-	-	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.39	U	U	0.4	U	U	0.12	U	U	0.41	U	U	0.41	U	U	0.39	U	U	0.43	U	U	0.44	U	U
Dichlorophenol, 2,4-	mg/kg	0.2	U	U	0.2	U	U	0.18	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Diethyl phthalate	mg/kg	0.39	U	U	0.4	U	U	0.061	U	U	0.41	U	U	0.41	U	U	0.39	U	U	0.43	U	U	0.44	U	U
Dimethyl phthalate	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Dimethylphenol, 2,4-	mg/kg	0.2	U	U	0.2	U	U	0.18	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Di-n-butyl phthalate	mg/kg	0.39	U	U	0.4	U	U	0.061	U	U	0.41	U	U	0.41	U	U	0.39	U	U	0.43	U	U	0.44	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.39	U	U	0.4	U	U	0.18	U	U	0.41	U	U	0.41	U	U	0.39	U	U	0.43	U	U	0.44	U	U
Dinitrophenol, 2,4-	mg/kg	0.98	U	U	1	U	U	0.41	U	U	1	U	U	1	U	U	0.96	U	U	1.1	U	U	1.1	U	U
Dinitrotoluene, 2,4-	mg/kg	0.2	U	U	0.2	U	U	0.25	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Dinitrotoluene, 2,6-	mg/kg	0.2	U	U	0.2	U	U	0.25	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Di-n-octyl phthalate	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Fluoranthene	mg/kg	0.2	U	U	0.0293	J	J	0.051			0.2	U	U	0.2	U	U	0.031	J	J	0.22	U	U	0.22	U	U
Fluorene	mg/kg	0.2	U	U	0.2	U	U	0.018			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Hexachlorobenzene	mg/kg	0.2	U	U	0.2	U	U	0.0082	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Hexachlorobutadiene	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Hexachlorocyclopentadiene	mg/kg	0.2	U	UJ	0.2	U	UJ	0.41	U	U	0.2	U	UJ	0.2	U	UJ	0.19	U	UJ	0.22	U	UJ	0.22	U	UJ
Hexachloroethane	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	U	U	0.2	U	U	0.017			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Isophorone	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Methylnaphthalene, 2-	mg/kg	0.2	U	U	0.2	U	U	0.65			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Methylphenol, 2-	mg/kg	0.2	U	U	0.2	U	U	0.25	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Naphthalene	mg/kg	0.2	U	U	0.2	U	U	0.4			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Nitroaniline, 2-	mg/kg	0.2	U	U	0.2	U	U	0.25	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Nitroaniline, 3-	mg/kg	0.2	U	U	0.2	U	U	0.25	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Nitroaniline, 4-	mg/kg	0.2	U	U	0.2	U	U	0.25	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Nitrobenzene	mg/kg	0.2	U	U	0.2	U	U	0.12	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U

Appenidix F

Chemical Analytical Summaries
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location:		CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB02			CY2-SB02			CY2-SB02		
Sample Number:		CY0015			CY0016			CY0017			CY0018			CY0019			CY0020			CY0021			CY0022		
Sample Date:		27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11		
Sample Depth:		.5 - 1 Ft			.5 - 1 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
Sample Purpose:		REG			FD			FS			REG			REG			REG			REG			REG		
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Nitrophenol, 2-	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Nitrophenol, 4-	mg/kg	0.98	U	U	1	U	U	0.41	U	U	1	U	U	1	U	U	0.96	U	U	1.1	U	U	1.1	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
n-Nitrosodiphenylamine	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Pentachlorophenol	mg/kg	0.98	U	U	1	U	U	0.18	U	U	1	U	U	1	U	U	0.96	U	U	1.1	U	U	1.1	U	U
Phenanthrene	mg/kg	0.2	U	U	0.2	U	U	0.22			0.2	U	U	0.2	U	U	0.0292	J	J	0.22	U	U	0.22	U	U
Phenol	mg/kg	0.2	U	U	0.2	U	U	0.061	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Pyrene	mg/kg	0.2	U	U	0.0268	J	J	0.054			0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.2	U	U	0.2	U	U	-	-	-	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.2	U	U	0.2	U	U	0.18	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.2	U	U	0.2	U	U	0.18	U	U	0.2	U	U	0.2	U	U	0.19	U	U	0.22	U	U	0.22	U	U
Pesticides/PCBs																									
Aroclor 1016	mg/kg	-	-	-	-	-	-	0.079	U	U	-	-	-	0.02	U	U	0.019	U	U	0.022	U	U	-	-	-
Aroclor 1221	mg/kg	-	-	-	-	-	-	0.061	U	U	-	-	-	0.02	U	U	0.019	U	U	0.022	U	U	-	-	-
Aroclor 1232	mg/kg	-	-	-	-	-	-	0.055	U	U	-	-	-	0.02	U	U	0.019	U	U	0.022	U	U	-	-	-
Aroclor 1242	mg/kg	-	-	-	-	-	-	0.049	U	U	-	-	-	0.02	U	U	0.019	U	U	0.022	U	U	-	-	-
Aroclor 1248	mg/kg	-	-	-	-	-	-	0.067	U	U	-	-	-	0.02	U	U	0.019	U	U	0.022	U	U	-	-	-
Aroclor 1254	mg/kg	-	-	-	-	-	-	0.067	U	U	-	-	-	0.02	U	U	0.019	U	U	0.022	U	U	-	-	-
Aroclor 1260	mg/kg	-	-	-	-	-	-	0.067	U	U	-	-	-	0.02	U	U	0.019	U	U	0.022	U	U	-	-	-
Metals - Unfiltered																									
Aluminum	mg/kg	8000		J	14500		J	14000			5150			6090			7330			8500			7090		
Antimony	mg/kg	4	U	U	4.8	U	U	3.5	U	UJ	2.1	U	U	4.3	U	U	3.8	U	U	4.5	U	U	2.2	U	U
Arsenic	mg/kg	10			10			12			5.8			3.2			13.5			2.1			4.3		J
Barium	mg/kg	49.2		J	86.6		J	85			35.2			53.8			57.3			67.6			72.1		
Beryllium	mg/kg	0.67	B	J	0.87	B	J	0.48	J	J	0.36	B	J	0.44	B	J	0.36	B	J	0.49	B	J	0.46	B	J
Cadmium	mg/kg	0.81	U	U	0.96	U	U	0.063	J	J	0.81			0.89			0.76	U	U	0.9	U	U	0.83		J
Calcium	mg/kg	3260		J	9300		J	4700		J	52500			60700			1270			34600			49500		
Chromium	mg/kg	16.7			19.1			19			9.8			13			14.9			12.9			13.8		
Cobalt	mg/kg	11.4			10.6	B	J	8.7			5.5			6.5			4.7	B	J	9.6	B	J	6.9		
Copper	mg/kg	24.6			24.2			24			18.8			23.9			22.5			20.6			23		
Iron	mg/kg	28700			27700			31000	B		17100			19800			23800			17100			22700		
Lead	mg/kg	13.4			13			14			12.8			13			11			11			12.9		
Magnesium	mg/kg	3000			4370			4300	B		15300			17300			1810			14600			14800		
Manganese	mg/kg	249			199			200		J	454			538			81.1			492			413		
Mercury	mg/kg	0.038	B	J	0.052	B	J	0.054	J B	B	0.019	B	J	0.021	B	J	0.043	B	J	0.04	B	J	0.016	B	J
Nickel	mg/kg	26.6			30			25			16.1			17.3			19.2			26.8			18.8		
Potassium	mg/kg	599	B	J	815	B	J	850			1020	B	J	1440	B	J	567	B	J	990	B	J	1540		
Selenium	mg/kg	1	B	J	4.8	U	U	2.3	U	U	0.43	B	J	4.3	U	U	0.91	B	J	4.5	U	U	0.65	B	J

Appenidix F

Chemical Analytical Summaries
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Location:	CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB02			CY2-SB02			CY2-SB02		
	Sample Number:	CY0015			CY0016			CY0017			CY0018			CY0019			CY0020			CY0021			CY0022		
	Sample Date:	27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11		
	Sample Depth:	.5 - 1 Ft			.5 - 1 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
	Sample Purpose:	REG			FD			FS			REG			REG			REG			REG			REG		
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Silver	mg/kg	2	U	U	2.4	U	U	0.58	U	U	0.053	B	J	0.086	B	J	1.9	U	U	0.063	B	J	0.079	B	J
Sodium	mg/kg	2000	U	U	2400	U	U	580	U	U	124	B	J	2200	U	U	1900	U	U	2200	U	U	150	B	J
Thallium	mg/kg	20	U	U	9.6	U	U	3.5	U	U	1.1	U	U	2.2	U	U	15	U	U	9	U	U	1.1	U	U
Vanadium	mg/kg	26.4			28			27			11.5			11.4			24.8			17.5			13.8		
Zinc	mg/kg	64.3			71.3			70			46			57.6			50.9			52.8			53.1		
Water Quality Parameters																									
% Solids	Percent	84.9			83.6			-	-	-	80.8			81.3			86			77			76		

Appenidix F

Chemical Analytical Summaries
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location:		CY2-SB02			CY2-SB02			CY2-SB03			CY2-SB03			CY2-SB03			CY2-SB04			CY2-SB04			CY2-SB04		
Sample Number:		CY0023			CY0024			CY0025			CY0026			CY0027			CY0028			CY0029			CY0030		
Sample Date:		27-Oct-11			27-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11		
Sample Depth:		8 - 10 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
Sample Purpose:		FD			FS			REG			REG			REG			REG			REG			REG		
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Explosives																									
Amino-2,6-dinitrotoluene, 4-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Dinitrobenzene, 1,3-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Dinitrotoluene, 2,4-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Dinitrotoluene, 2,6-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
HMX	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Nitrobenzene	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Nitrotoluene, 2-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Nitrotoluene, 3-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Nitrotoluene, 4-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
RDX	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Tetryl	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.15	U	U	0.1	U	U	0.19	U	U	0.15	U	U	0.15	U	U	0.16	U	U	0.18	U	U	0.17	U	U
Semivolatiles																									
3-Methylphenol and 4-Methylphenol	mg/kg	0.21	U	U	0.51	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Acenaphthene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Acenaphthylene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Acetophenone	mg/kg	-	-	-	0.13	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Atrazine	mg/kg	-	-	-	0.25	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzaldehyde	mg/kg	-	-	-	0.13	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)anthracene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Benzo(a)pyrene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Benzo(b)fluoranthene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Benzo(ghi)perylene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Benzo(k)fluoranthene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Benzoic acid	mg/kg	1	U	U	-	-	-	0.99	U	U	1.1	U	U	1	U	U	0.97	U	U	1	U	U	1.1	U	U
Benzyl alcohol	mg/kg	0.21	U	U	-	-	-	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Bibenzene	mg/kg	-	-	-	0.063	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-chloroethoxy)methane	mg/kg	0.21	U	U	0.13	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Bis(2-chloroethyl)ether	mg/kg	0.21	U	UJ	0.13	U	U	0.2	U	UJ	0.21	U	UJ	0.21	U	UJ	0.19	U	U	0.21	U	UJ	0.21	U	UJ
Bis(2-chloroisopropyl)ether	mg/kg	0.21	U	U	0.13	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	UJ	0.21	U	U	0.21	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.42	U	U	0.025	J	J	0.4	U	U	0.43	U	U	0.42	U	U	0.39	U	U	0.41	U	U	0.43	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Butyl benzyl phthalate	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Caprolactam	mg/kg	-	-	-	0.42	U	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appenidix F

Chemical Analytical Summaries
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location:		CY2-SB02			CY2-SB02			CY2-SB03			CY2-SB03			CY2-SB03			CY2-SB04			CY2-SB04			CY2-SB04		
Sample Number:		CY0023			CY0024			CY0025			CY0026			CY0027			CY0028			CY0029			CY0030		
Sample Date:		27-Oct-11			27-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11		
Sample Depth:		8 - 10 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
Sample Purpose:		FD			FS			REG			REG			REG			REG			REG			REG		
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Carbazole	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.21	U	U	0.19	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Chloroaniline, 4-	mg/kg	0.21	U	U	0.19	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Chloronaphthalene, 2-	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Chlorophenol, 2-	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Chrysene	mg/kg	0.21	U	U	0.028			0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Dibenz(a,h)anthracene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Dibenzofuran	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Dichlorobenzene, 1,2-	mg/kg	0.21	U	U	-	-	-	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Dichlorobenzene, 1,3-	mg/kg	0.21	U	U	-	-	-	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Dichlorobenzene, 1,4-	mg/kg	0.21	U	U	-	-	-	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.42	U	U	0.13	U	UJ	0.4	U	U	0.43	U	U	0.42	U	U	0.39	U	U	0.41	U	U	0.43	U	U
Dichlorophenol, 2,4-	mg/kg	0.21	U	U	0.19	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Diethyl phthalate	mg/kg	0.42	U	U	0.063	U	U	0.4	U	U	0.43	U	U	0.42	U	U	0.39	U	U	0.41	U	U	0.43	U	U
Dimethyl phthalate	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Dimethylphenol, 2,4-	mg/kg	0.21	U	U	0.19	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Di-n-butyl phthalate	mg/kg	0.42	U	U	0.063	U	U	0.4	U	U	0.43	U	U	0.42	U	U	0.39	U	U	0.41	U	U	0.43	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.42	U	U	0.19	U	U	0.4	U	U	0.43	U	U	0.42	U	U	0.39	U	U	0.41	U	U	0.43	U	U
Dinitrophenol, 2,4-	mg/kg	1	U	U	0.42	U	U	0.99	U	U	1.1	U	U	1	U	U	0.97	U	U	1	U	U	1.1	U	U
Dinitrotoluene, 2,4-	mg/kg	0.21	U	U	0.25	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Dinitrotoluene, 2,6-	mg/kg	0.21	U	U	0.25	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Di-n-octyl phthalate	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Fluoranthene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Fluorene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Hexachlorobenzene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Hexachlorobutadiene	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Hexachlorocyclopentadiene	mg/kg	0.21	U	UJ	0.42	U	U	0.2	U	UJ	0.21	U	UJ	0.21	U	UJ	0.19	U	U	0.21	U	UJ	0.21	U	UJ
Hexachloroethane	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	U	U	0.0084	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Isophorone	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Methylnaphthalene, 2-	mg/kg	0.21	U	U	0.025		J	0.2	U	U	0.21	U	U	0.21	U	U	0.0429	J	J	0.21	U	U	0.21	U	U
Methylphenol, 2-	mg/kg	0.21	U	U	0.25	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Naphthalene	mg/kg	0.21	U	U	0.015		J	0.2	U	U	0.21	U	U	0.21	U	U	0.0321	J	J	0.21	U	U	0.21	U	U
Nitroaniline, 2-	mg/kg	0.21	U	U	0.25	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Nitroaniline, 3-	mg/kg	0.21	U	U	0.25	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Nitroaniline, 4-	mg/kg	0.21	U	U	0.25	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Nitrobenzene	mg/kg	0.21	U	U	0.13	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U

Appenidix F

Chemical Analytical Summaries
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location:		CY2-SB02			CY2-SB02			CY2-SB03			CY2-SB03			CY2-SB03			CY2-SB04			CY2-SB04			CY2-SB04		
Sample Number:		CY0023			CY0024			CY0025			CY0026			CY0027			CY0028			CY0029			CY0030		
Sample Date:		27-Oct-11			27-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11		
Sample Depth:		8 - 10 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
Sample Purpose:		FD			FS			REG			REG			REG			REG			REG			REG		
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Nitrophenol, 2-	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Nitrophenol, 4-	mg/kg	1	U	U	0.42	U	U	0.99	U	U	1.1	U	U	1	U	U	0.97	U	U	1	U	U	1.1	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
n-Nitrosodiphenylamine	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Pentachlorophenol	mg/kg	1	U	U	0.19	U	UJ	0.99	U	U	1.1	U	U	1	U	U	0.97	U	U	1	U	U	1.1	U	U
Phenanthrene	mg/kg	0.21	U	U	0.02		J	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Phenol	mg/kg	0.21	U	U	0.063	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Pyrene	mg/kg	0.21	U	U	0.013			0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.21	U	U	-	-	-	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.21	U	U	0.19	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.21	U	U	0.19	U	U	0.2	U	U	0.21	U	U	0.21	U	U	0.19	U	U	0.21	U	U	0.21	U	U
Pesticides/PCBs																									
Aroclor 1016	mg/kg	-	-	-	-	-	-	0.02	U	U	0.021	U	U	-	-	-	0.02	U	U	0.02	U	U	-	-	-
Aroclor 1221	mg/kg	-	-	-	-	-	-	0.02	U	U	0.021	U	U	-	-	-	0.02	U	U	0.02	U	U	-	-	-
Aroclor 1232	mg/kg	-	-	-	-	-	-	0.02	U	U	0.021	U	U	-	-	-	0.02	U	U	0.02	U	U	-	-	-
Aroclor 1242	mg/kg	-	-	-	-	-	-	0.02	U	U	0.021	U	U	-	-	-	0.02	U	U	0.02	U	U	-	-	-
Aroclor 1248	mg/kg	-	-	-	-	-	-	0.02	U	U	0.021	U	U	-	-	-	0.02	U	U	0.02	U	U	-	-	-
Aroclor 1254	mg/kg	-	-	-	-	-	-	0.02	U	U	0.021	U	U	-	-	-	0.02	U	U	0.02	U	U	-	-	-
Aroclor 1260	mg/kg	-	-	-	-	-	-	0.02	U	U	0.021	U	U	-	-	-	0.02	U	U	0.02	U	U	-	-	-
Metals - Unfiltered																									
Aluminum	mg/kg	5780			8400			9880			7300			6660			6650			5140			5510		
Antimony	mg/kg	3.3	U	U	3.3	U	U	5.1	U	U	4.9	U	U	2.2	U	U	0.25	B	J	4.3	U	U	3.6	U	U
Arsenic	mg/kg	8		J	7.3			12.2			10.8			2			6.1			11.5			5.4		
Barium	mg/kg	50.4			52			68			63.8			37.1			35.2			70.9			40.3		
Beryllium	mg/kg	0.4	B	J	0.32	J	J	0.48	B	J	0.49			0.46	B	J	0.27			0.42	B	J	0.46	B	J
Cadmium	mg/kg	0.17	B	J	0.24	J	J	1	U	U	0.28	B	J	0.73			0.72			0.24	B	J	0.73	U	U
Calcium	mg/kg	51200			52000			1740			43200			45200			3380			39900			54100		
Chromium	mg/kg	12.6			15			22			16.7			12.9			10.4			11.8			12.7		
Cobalt	mg/kg	10			11			6.8	B	J	15.1			6.9			3.5			9.9	B	J	9.1		
Copper	mg/kg	22.2			24			23.5			26.4			21.6			11.2			20.9			21.8		
Iron	mg/kg	17800			21000	B		34300			18800			20400			16400			20200			17500		
Lead	mg/kg	12.2			12			9.6			15.3			12.7			7.4			8.3			13.2		
Magnesium	mg/kg	13800			17000	B		3100			14100			14700			2430			16300			23700		
Manganese	mg/kg	450			420			121			816			514			103			672			488		
Mercury	mg/kg	0.015	B	J	0.029	J B	B	0.035	B	J	0.011	B	J	0.023	B	J	0.034	B	J	0.017	B	J	0.012	B	J
Nickel	mg/kg	25.3			27			23.5			40			19.3			10.7			25.7			25.3		
Potassium	mg/kg	1160			1400			698	B	J	1210			1450			472			848	B	J	1220	B	J
Selenium	mg/kg	3.3	U	U	2.2	U	U	1.1	B	J	4.9	U	U	0.72	B	J	9.3	U	U	4.3	U	U	3.6	U	U

Appenidix F

Chemical Analytical Summaries
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Location:	CY2-SB02			CY2-SB02			CY2-SB03			CY2-SB03			CY2-SB03			CY2-SB04			CY2-SB04			CY2-SB04		
	Sample Number:	CY0023			CY0024			CY0025			CY0026			CY0027			CY0028			CY0029			CY0030		
	Sample Date:	27-Oct-11			27-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11		
	Sample Depth:	8 - 10 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
	Sample Purpose:	FD			FS			REG			REG			REG			REG			REG			REG		
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Silver	mg/kg	1.7	U	U	0.55	U	U	2.5	U	U	2.5	U	U	0.087	B	J	0.088	B	J	2.1	U	U	1.8	U	U
Sodium	mg/kg	135	B	J	550	U	U	2500	U	U	114	B	J	146	B	J	52.6	B	J	2100	U	U	1800	U	U
Thallium	mg/kg	1.7	U	U	3.3	U	U	20	U	U	0.39	B	J	1.1	U	U	9.2	U	U	8.6	U	U	1.8	U	U
Vanadium	mg/kg	16.7			19			32.4			24.9			13.4			16.1			20			12.3		
Zinc	mg/kg	52.2			57			57.6			63.7			55.3			24.2			50.8			50.1		
Water Quality Parameters																									
% Solids	Percent	78.9			-	-	-	83.5			77.3			79.2			84.8			81.9			77.1		

Notes:
1) "-" = Not Analyzed.
2) "U" = Not Detected.
3) LQ = Laboratory Qualifier.
4) VQ = Validation Qualifier.
5) Laboratory and data validation qualifier definitions are presented in Table 5 of Appendix H.

APPENDIX G

DETECTED HITS SUMMARY

Appendix G

Detected Hits Summary
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Locaiton:	CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB02			CY2-SB02			CY2-SB02			CY2-S
	Sample Number:	CY0015			CY0016			CY0017			CY0018			CY0019			CY0020			CY0021			CY0022			CY0
	Sample Date:	27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oc
	Sample Depth:	.5 - 1 Ft			.5 - 1 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			8 - 1
	Sample Purpose:	REG			FD			FS			REG			REG			REG			REG			REG			FD
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result
Semivolatiles																										
Acenaphthylene	mg/kg	U	U	U	U	U	U	0.013			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Acetophenone	mg/kg	U	U	U	U	U	U	0.047	J	J	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Anthracene	mg/kg	U	U	U	U	U	U	0.02			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(a)anthracene	mg/kg	U	U	U	U	U	U	0.043			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(a)pyrene	mg/kg	U	U	U	U	U	U	0.039			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(b)fluoranthene	mg/kg	U	U	U	U	U	U	0.039			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(ghi)perylene	mg/kg	U	U	U	U	U	U	0.024			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(k)fluoranthene	mg/kg	U	U	U	U	U	U	0.018			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Bibenzene	mg/kg	-	-	-	-	-	-	0.034	J	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2Uethylhexyl)phthalate	mg/kg	U	U	U	U	U	U	U	U	U	0.321	J	J	U	U	U	U	U	U	U	U	U	U	U	U	U
Chrysene	mg/kg	U	U	U	U	U	U	0.055			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Dibenzofuran	mg/kg	U	U	U	U	U	U	0.14			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fluoranthene	mg/kg	U	U	U	0.0293	J	J	0.051			U	U	U	U	U	U	0.031	J	J	U	U	U	U	U	U	U
Fluorene	mg/kg	U	U	U	U	U	U	0.018			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Indeno(1,2,3Ucd)pyrene	mg/kg	U	U	U	U	U	U	0.017			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Methylnaphthalene, 2U	mg/kg	U	U	U	U	U	U	0.65			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Naphthalene	mg/kg	U	U	U	U	U	U	0.4			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Phenanthrene	mg/kg	U	U	U	U	U	U	0.22			U	U	U	U	U	U	0.0292	J	J	U	U	U	U	U	U	U
Pyrene	mg/kg	U	U	U	0.0268	J	J	0.054			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metals - Unfiltered																										
Aluminum	mg/kg	8000		J	14500		J	14000			5150			6090			7330			8500			7090			5780
Antimony	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Arsenic	mg/kg	10			10			12			5.8			3.2			13.5			2.1			4.3		J	8
Barium	mg/kg	49.2		J	86.6		J	85			35.2			53.8			57.3			67.6			72.1			50.4
Beryllium	mg/kg	0.67	B	J	0.87	B	J	0.48	J	J	0.36	B	J	0.44	B	J	0.36	B	J	0.49	B	J	0.46	B	J	0.4
Cadmium	mg/kg	U	U	U	U	U	U	0.063	J	J	0.81			0.89			U	U	U	U	U	U	0.83		J	0.17
Calcium	mg/kg	3260		J	9300		J	4700		J	52500			60700			1270			34600			49500			51200
Chromium	mg/kg	16.7			19.1			19			9.8			13			14.9			12.9			13.8			12.6
Cobalt	mg/kg	11.4			10.6	B	J	8.7			5.5			6.5			4.7	B	J	9.6	B	J	6.9			10
Copper	mg/kg	24.6			24.2			24			18.8			23.9			22.5			20.6			23			22.2
Iron	mg/kg	28700			27700			31000	B		17100			19800			23800			17100			22700			17800
Lead	mg/kg	13.4			13			14			12.8			13			11			11			12.9			12.2
Magnesium	mg/kg	3000			4370			4300	B		15300			17300			1810			14600			14800			13800
Manganese	mg/kg	249			199			200		J	454			538			81.1			492			413			450
Mercury	mg/kg	0.038	B	J	0.052	B	J	0.054	J B	B	0.019	B	J	0.021	B	J	0.043	B	J	0.04	B	J	0.016	B	J	0.015
Nickel	mg/kg	26.6			30			25			16.1			17.3			19.2			26.8			18.8			25.3
Potassium	mg/kg	599	B	J	815	B	J	850			1020	B	J	1440	B	J	567	B	J	990	B	J	1540			1160

Appendix G

Detected Hits Summary
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Locaiton:	CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB01			CY2-SB02			CY2-SB02			CY2-SB02			CY2-S
	Sample Number:	CY0015			CY0016			CY0017			CY0018			CY0019			CY0020			CY0021			CY0022			CY0
	Sample Date:	27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oct-11			27-Oc
	Sample Depth:	.5 - 1 Ft			.5 - 1 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			8 - 1
	Sample Purpose:	REG			FD			FS			REG			REG			REG			REG			REG			FD
Parameter	Units	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result
Selenium	mg/kg	1	B	J	U	U	U	U	U	U	0.43	B	J	U	U	U	0.91	B	J	U	U	U	0.65	B	J	U
Silver	mg/kg	U	U	U	U	U	U	U	U	U	0.053	B	J	0.086	B	J	U	U	U	0.063	B	J	0.079	B	J	U
Sodium	mg/kg	U	U	U	U	U	U	U	U	U	124	B	J	U	U	U	U	U	U	U	U	U	150	B	J	135
Thallium	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Vanadium	mg/kg	26.4			28			27			11.5			11.4			24.8			17.5			13.8			16.7
Zinc	mg/kg	64.3			71.3			70			46			57.6			50.9			52.8			53.1			52.2
Water Quality Parameters																										
% Solids	Percent	84.9			83.6			-	-	-	80.8			81.3			86			77			76			78.9

Appendix G

Detected Hits Summary
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Locaiton:		SB02		CY2-SB02			CY2-SB03			CY2-SB03			CY2-SB03			CY2-SB04			CY2-SB04			CY2-SB04		
Sample Number:		023		CY0024			CY0025			CY0026			CY0027			CY0028			CY0029			CY0030		
Sample Date:		ct-11		27-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11		
Sample Depth:		0 Ft		8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
Sample Purpose:		D		FS			REG			REG			REG			REG			REG			REG		
Parameter	Units	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Semivolatiles																								
Acenaphthylene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Acetophenone	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Anthracene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(a)anthracene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(a)pyrene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(b)fluoranthene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(ghi)perylene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo(k)fluoranthene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Bibenzene	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2Uethylhexyl)phthalate	mg/kg	U	U	0.025	J	J	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Chrysene	mg/kg	U	U	0.028			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Dibenzofuran	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fluoranthene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Fluorene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Indeno(1,2,3Ucd)pyrene	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Methylnaphthalene, 2U	mg/kg	U	U	0.025		J	U	U	U	U	U	U	U	U	U	0.0429	J	J	U	U	U	U	U	U
Naphthalene	mg/kg	U	U	0.015		J	U	U	U	U	U	U	U	U	U	0.0321	J	J	U	U	U	U	U	U
Phenanthrene	mg/kg	U	U	0.02		J	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Pyrene	mg/kg	U	U	0.013			U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Metals - Unfiltered																								
Aluminum	mg/kg			8400			9880			7300			6660			6650			5140			5510		
Antimony	mg/kg	U	U	U	U	U	U	U	U	U	U	U	U	U	U	0.25	B	J	U	U	U	U	U	U
Arsenic	mg/kg		J	7.3			12.2			10.8			2			6.1			11.5			5.4		
Barium	mg/kg			52			68			63.8			37.1			35.2			70.9			40.3		
Beryllium	mg/kg	B	J	0.32	J	J	0.48	B	J	0.49			0.46	B	J	0.27			0.42	B	J	0.46	B	J
Cadmium	mg/kg	B	J	0.24	J	J	U	U	U	0.28	B	J	0.73			0.72			0.24	B	J	U	U	U
Calcium	mg/kg			52000			1740			43200			45200			3380			39900			54100		
Chromium	mg/kg			15			22			16.7			12.9			10.4			11.8			12.7		
Cobalt	mg/kg			11			6.8	B	J	15.1			6.9			3.5			9.9	B	J	9.1		
Copper	mg/kg			24			23.5			26.4			21.6			11.2			20.9			21.8		
Iron	mg/kg			21000	B		34300			18800			20400			16400			20200			17500		
Lead	mg/kg			12			9.6			15.3			12.7			7.4			8.3			13.2		
Magnesium	mg/kg			17000	B		3100			14100			14700			2430			16300			23700		
Manganese	mg/kg			420			121			816			514			103			672			488		
Mercury	mg/kg	B	J	0.029	J B	B	0.035	B	J	0.011	B	J	0.023	B	J	0.034	B	J	0.017	B	J	0.012	B	J
Nickel	mg/kg			27			23.5			40			19.3			10.7			25.7			25.3		
Potassium	mg/kg			1400			698	B	J	1210			1450			472			848	B	J	1220	B	J

Appendix G

Detected Hits Summary
Powerhouse No. 2 Ash Pits SCR Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Locaiton:		SB02		CY2-SB02			CY2-SB03			CY2-SB03			CY2-SB03			CY2-SB04			CY2-SB04			CY2-SB04		
Sample Number:		023		CY0024			CY0025			CY0026			CY0027			CY0028			CY0029			CY0030		
Sample Date:		ct-11		27-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11			26-Oct-11		
Sample Depth:		0 Ft		8 - 10 Ft			.5 - 1 Ft			3 - 5 Ft			8 - 10 Ft			0 - 1 Ft			3 - 5 Ft			8 - 10 Ft		
Sample Purpose:		D		FS			REG			REG			REG			REG			REG			REG		
Parameter	Units	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
Selenium	mg/kg	U	U	U	U	U	1.1	B	J	U	U	U	0.72	B	J	U	U	U	U	U	U	U	U	U
Silver	mg/kg	U	U	U	U	U	U	U	U	U	U	U	0.087	B	J	0.088	B	J	U	U	U	U	U	U
Sodium	mg/kg	B	J	U	U	U	U	U	U	114	B	J	146	B	J	52.6	B	J	U	U	U	U	U	U
Thallium	mg/kg	U	U	U	U	U	U	U	U	0.39	B	J	U	U	U	U	U	U	U	U	U	U	U	U
Vanadium	mg/kg			19			32.4			24.9			13.4			16.1			20			12.3		
Zinc	mg/kg			57			57.6			63.7			55.3			24.2			50.8			50.1		
Water Quality Parameters																								
% Solids	Percent			-	-	-	83.5			77.3			79.2			84.8			81.9			77.1		

Notes:
1) "-" = Not Analyzed.
2) "U" = Not Detected.
3) LQ = Laboratory Qualifier.
4) VQ = Validation Qualifier.
5) Laboratory and data validation qualifier definitions are presented in Table 5 of Appendix H.

APPENDIX H

DATA QUALITY EVALUATIONS

DATA QUALITY EVALUATION

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List of Acronyms

AR/COC	analysis request/chain of custody
CCAL	continuing calibration
CFR	Code of Federal Regulations
CI	chemical investigation
DI	deionized
DQO	data quality objectives
EPA	U.S. Environmental Protection Agency
ICAL	initial calibration
ICS	Interference Check Sample
ID	identification
LCS	laboratory control sample
MB	material blank or method blank
MDL	method detection limit
MQL	method quantitation limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
NFG	national functional guidelines
PBOW	Plum Brook Ordnance Works
PQL	practical quanitation limit
QA/QC	quality assurance/quality control
SAP	quality assurance project plan
RI	remedial investigation
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SOP	standard operating procedures
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compounds

1.0 Introduction

This appendix presents results of the quality assurance/quality control (QA/QC) measures implemented for the sampling and analysis activities at the Plum Brook Ordnance Works (PBOW), Sandusky, Ohio. The quality indicators from every aspect of the data collection were reviewed, and an assessment of the data with regard to project-specific objectives is presented. Successful execution of project-specific objectives and procedures provides strong support for the acceptance of the data generated as adequate for the purpose of evaluating the analytical results from this assessment at PBOW.

Shaw Environmental, Inc. (Shaw) conducted investigative work at the Coal Yard 2 area; sampling was performed October 2011. Primary and field duplicate project samples were analyzed by Accutest Laboratories, of Orlando, Florida. Field Split samples were submitted to Test America Laboratories, Inc. of North Canton, Ohio for analysis. All data analyzed were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following the guidelines in the *EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, June 2008 (EPA, 2008), the QAPP (Shaw, 2008c), and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses,* (April 1993). Since these documents specify procedures for Contract Laboratory Program (CLP) data, they are used as guidelines only. Method and laboratory quality assurance and quality control requirements supercede these guidelines, where applicable. Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness and comparability goals established to meet the project data quality objectives (DQO). To verify that these DQOs were met, field measurements, sampling and handling procedures, laboratory analysis and reporting, and all nonconformances and discrepancies in the data were examined to determine compliance with the appropriate and applicable procedures defined in the SAP. The results of this review are presented in the following sections, with all analytical outliers or nonconformances discussed where they occurred.

This report is divided into three subsections. Section 2.0 discusses the field investigation and QC procedures used during the sampling effort. Section 3.0 outlines the analytical program and the associated QC activities performed. The final part of this document, Section 4.0, summarizes the data findings and their overall impact on the usability of the analytical data.

2.0 Field Sampling and QC Activities

Shaw was retained by the U. S. Army Corps of Engineers, Nashville District to conduct investigative and sampling activities at PBOW. Field activities at this site included collection of soil samples. The collection of these samples and their associated QC samples are discussed in this section of the Data Quality Evaluation (DQE). Twelve project samples and two field duplicate soil samples were submitted to Accutest for analysis. Sample shipments from the field were performed under custody and documented using standard Shaw Analysis Request/Chain of Custody (AR/COC) forms. These forms provided project-specific analytical specifications and QC instructions to the laboratory. A formal COC transfer record was prepared and included with these forms to document custody during sample transportation, storage, and disposition by the laboratory. Table 1 summarizes the field sample number, location, sample type, date of collection, lot number, and laboratory for each sample collected.

2.1 Equipment Rinsates

Equipment rinsates are used to assess the effectiveness of the decontamination procedures used by the sampling team on reusable sampling equipment. No equipment rinsate samples were collected during this sampling event.

2.2 Field Duplicates

Field duplicate samples are collected and submitted to the laboratory for analysis along with their corresponding original sample. The data generated from the analysis of field duplicate samples are used to evaluate the precision of the sample collection and analysis procedures. It is difficult to collect and analyze soil samples in duplicate due to the heterogeneous nature of soil. High relative percent difference (RPD) between an original sample and its field duplicate may indicate a difference in sample matrix or sample collection rather than true problems with precision of sample analysis. Also, when estimated “J” or nondetected “U” results are reported, there is a potential for increased variability between the primary and duplicate sample results.

Field duplicate samples were collected at a frequency of one for every ten samples (10 percent). Two field duplicate soil samples were collected during this sampling event. Table 2 compares the original and field duplicate results and shows the RPDs calculated for those detected compounds. Compounds not presented in the table were not detected in either the original or field duplicate samples. Sample sets with no detections are not presented in the table. In cases where duplicates were performed and one result is less than the reporting limit but greater than

the method detection limit, the RPD is reported, but is of limited value. Only samples with detections in both the regular and the duplicate were qualified for high RPDs.

The acceptance criterion of 30 percent RPD for waters and 50 percent RPD for soils was used to evaluate these sample results. Overall, the data compared well when detected concentrations were greater than the reporting limit. Data that fell outside acceptable criteria are listed in the following table:

SDG	Samples Affected	Analyte(s)	Validation Qualifier
F87352	CY0015 (original), CY0016 (FD)	Aluminum, Barium, Calcium	J
	CY0022 (original), CY0023 (FD)	Arsenic, Cadmium	

RPD is calculated by using the following formula:

$$RPD = \left| \frac{A - B}{(A + B)/2} \right| \quad x \quad 100$$

where:

RPD = relative percent difference
A = original result
B = field duplicate result.

2.3 Field Split Samples

Split samples were collected in conjunction with field duplicate samples and sent to Test America Laboratories, Inc. of North Canton. The split samples were submitted to the laboratory for the same analysis as their corresponding field duplicates and original field samples. The split samples are used to determine if data results are reproducible when analyzed by two different laboratories. Results are also evaluated to determine if a contracted laboratory's preparation and analysis procedures are in control and meet the approved method criteria.

Field split samples were collected at a frequency of approximately one for every ten regular samples. Two soil field split samples were collected during this sampling event. Table 2 compares the original and field split results and shows the RPDs calculated for those detected compounds. Compounds not presented in the table were not detected in either the original or

field split samples. Samples with no detections are not presented in the table. Field split samples were not qualified for RPD criterion.

3.0 Analytical Program and QC Activities

The project QA/QC program described in the SAP was followed for the collection and laboratory analysis of samples. Each of the analytical methods used require that method-specific QA/QC protocols be followed during sample analysis. These protocols are a critical part of the methods employed and were followed by the laboratory during sample analysis. Specific measures included detailed record keeping procedures, instrument calibrations, and analysis of method blanks, blank spikes, MS/MSD, surrogates, and internal standards. The following SW-846 and USEPA methods were used to analyze PBOW samples:

Analysis	Method
Semivolatiles	SW-846 3550C/8270D
Nitroaromatics	SW-846 8330A
Metals	SW-846 3050B/6010C/7471B
Polychlorinated Biphenyls	SW-846 3550C/8082A

The validator used the QA/QC criteria defined in the SAP, laboratory-derived acceptance criteria, and analytical method criteria to qualify data. Any qualifiers added to these data by the data validator are included in the data summary report.

3.1 Laboratory QA/QC Procedures

The following sections discuss specific QA/QC protocols required and performed by the laboratory during this investigation.

3.1.1 Calibration

The calibration of instruments is required to ensure that the instruments are operating properly. Calibration is achieved when instrument response can be related to the concentration of an analyte. The criteria used to evaluate the data are: individual ICAL percent relative standard deviation <+/- 30% and/or CCAL percent difference <+/- 20% (volatile and semivolatile organics); <+/- 15% (explosives); for metals, individual ICAL/CCAL percent relative standard deviation +/- 10%; and for mercury, individual ICAL/CCAL percent relative standard deviation <+/- 20%. All analytes met QC criteria for ICAL percent relative standard deviation and/or CCAL percent difference associated with the project samples with the following exceptions:

SDG Number	Sample(s) Affected	Analyte(s)	Validation Qualifier
F87352	CY0015, CY0016, CY0018, CY0022, CY0023, CY0027, CY0030	Bis(2-Chloroethyl)ether, Hexachlorocyclopentadiene	UJ
F87353	CY0019, CY0020, CY0021, CY0025, CY0026, CY0029,	Bis(2-Chloroethyl)ether, Hexachlorocyclopentadiene	
	CY0028	Bis(2-chloroisopropyl)ether	

3.1.2 Method/Calibration Blanks

Method blanks are analyzed with each analytical "batch" processed on a per matrix (i.e., soil and water) basis. Method blanks are carried step-wise through the same analytical procedure as their associated field samples including the addition of solvents, surrogate and standard spikes, and reagents as required in the analysis process. The purpose of a method blank is to identify any contaminants that may be introduced to the sample as a result of the analytical process. The method blank is considered acceptable by the laboratory if the concentration of any target analyte is less than ½ the reporting limit and less than 1/10 the amount measure in any sample or regulatory limit (whichever is greater). The data validator evaluated all blank data associated with each sample. The data validators evaluated all blank data associated with each sample. The third party data validation evaluation criteria for method blanks are as follows:

- If a parameter is found in a blank but not detected in the sample, no action is taken.
- For organics, if the sample result is less than 5 times (most analytes) or 10 times (common laboratory contaminants) that of the blank result, the sample result is qualified “B.”
- For inorganics, if the sample result is greater than the instrument detection limit but less than 5 times the blank result, the sample result is qualified "B."

If the sample result is greater than 5 times (most analytes) or 10 times (common laboratory contaminants) the blank result, no action is taken.

All method blanks were found to be acceptable with the following exceptions:

SDG Number	Sample(s) Affected	Analyte(s)	Validation Qualifier
240-5522-1	CY0017	Mercury	B
240-5520-1	CY0024		

3.1.3 Surrogate Recoveries

Surrogate standards are defined as non-target compounds added to standards, blanks, and samples prior to extraction or purging. They are used in organic analyses to monitor the percent recovery efficiencies of the sample preparation and analytical procedures. Surrogate recoveries for the project samples all fell within acceptable QC criteria.

The surrogate control limits for this project can be found in Attachment A of Appendix E. The surrogate control limits used for evaluation are the laboratory established in-house surrogate criteria.

3.1.4 Matrix Spikes and Laboratory Control Spikes

Two types of spikes were performed for all analyses: matrix spikes (MS) and laboratory control samples (LCS). MS compounds are spiked into an aliquot of a field sample. LCS compounds are spiked into a blank matrix. The spiked compounds are representative compounds that are quantified during performance of the method. Recovery of the spiked compound is used as an assessment of analytical accuracy for the sample matrix analyzed. These results are useful in distinguishing sample matrix interferences from analysis interferences through a comparison of MS and LCS recovery data. Often, spikes are performed in duplicate as a matrix spike duplicate (MSD) or LCS duplicate. In this manner, the precision of the assessment can be quantified as the RPD of the original and duplicate spike.

Matrix spikes were assigned at a frequency of at least 1 for every 20 field samples collected. Five MS/MSD pairs (CY0017-MS/MSD, CY0020-MS/MSD, CY0021-MS/MSD, CY0023-MS/MSD and CY0024-MS/MSD) were assigned to samples. Additional sample volume was provided to the laboratory for the MS/MSD analyses. This sampling frequency meets the collection criteria for this program as specified in the SAP. In addition to the overall collection frequency, the analytical method requires that the laboratory analyze 1 set of spikes per analytical batch. To comply with this method requirement, the laboratory may analyze additional MS/MSD pairs. The validator evaluated all batch QC. The laboratory's statistically determined target acceptance limits were used to assess the spike recovery and RPD.

The following MS/MSD recoveries are outside of established QC criteria:

SDG Number	Sample(s) Affected	Analyte(s)	Validation Qualifier
240-5520-1	CY0024	3,3'-Dichlorobenzidine, Pentachlorophenol	UJ
		2-Methylnaphthalene, Naphthalene,	J

SDG Number	Sample(s) Affected	Analyte(s)	Validation Qualifier
		Phenanthrene	
240-5522-1	CY0017	Calcium, Manganese, Antimony	J/UJ

LCS results are used to evaluate lab method performance in the same manner as the MS/MSD results except the LCS is not performed on an actual field sample matrix. The LCS is prepared for each analytical batch and for each parameter and matrix analyzed. All LCS recoveries met QC criteria.

The LCS and MS/MSD control limits for this project can be found in Attachment A of Appendix E. The LCS and MS/MSD control used for evaluation are the laboratory established in-house control limits. Detected constituents with associated MS/MSD or LCS recoveries above or below the QC limits were qualified as estimated “J”. Sample results with associated MS/MSD or LCS recoveries below the QC limits were qualified as estimated non-detects “UJ”.

3.1.5 Laboratory Duplicate Sample Analysis

Laboratory Duplicate determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate sample analyses are also performed to generate data in order to determine the long-term precision of the analytical method on various matrices. Laboratory duplicates are not required for nitoraromatic analysis. All laboratory duplicate sample analysis met QC criteria.

3.1.6 Column Agreement

For high performance liquid chromatography (HPLC) analyses, sample results are confirmed using two dissimilar columns. In order for an analyte to be reported, it must be detected on both columns. Results differing by greater than 40 percent are qualified estimated, "J"; however, for this sampling event, all detections were in agreement.

3.1.7 Interference Check Sample and Post Digestion Spike

The ICP Interference Check Sample (ICS) verifies the contract laboratory’s interelement and background correction factors. The ICS consists of two solutions: Solution A and Solution AB. Solution A consists of the interferents, and solution AB consists of the analytes mixed with the interferents. An ICS analysis consists of analyzing both solutions consecutively, starting with solution A, for all wavelengths used for each analyte reported by ICP. Results for the ICP analysis of the ICS solution AB must fall within the control limits of $\pm$ 20% of the true value for

the analytes included in the solution. All Interference Check Sample (ICS) percent recoveries were acceptable.

Post Digestion spikes are elements added to a portion of a prepared sample to verify the absence or presence of matrix effects for ICP and ICP/MS analysis. To verify the absence of interference, the spike recovery must be between 75% and 125%. Results outside the acceptance limits require a method of standard additions (MSA) for all samples within the batch. All post digestion spike recoveries were found to be acceptable.

3.1.8 Inductively Coupled Plasma Serial Dilutions

The ICP serial dilution analysis is performed to determine whether or not significant physical or chemical interferences exist due to sample matrix. All QC criteria were met for the serial dilutions associated with the project samples.

3.2 Reporting Limits

Limits have been established to describe project sensitivity requirements. Each laboratory is required to demonstrate method performance through method detection limit (MDL) studies for every method employed. These studies are required to be laboratory-specific so that individual laboratory variables such as equipment brands, reagent suppliers, and chemist technique are factored into the performance study. MDLs are established using controlled matrices (i.e., DI water). Practical quantitation limits (PQL) or method quantitation limits (MQL), used for this project are those statistically determined by the laboratories. The analytical program executed for this project required the use of SW-846 methods, which specify the procedure for calculating the MDLs. The PQL/MQL calculation adjusts the limit by a predetermined mathematical factor for the analysis of actual environmental sample matrices (i.e. soil, groundwater, etc.). Method reporting limits (MRL) are based on the project action or decision levels.

These limits are generally defined as follows:

- ***MDL.*** The minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the concentration is greater than zero.
- ***MQL/PQL.*** The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. It is set at the lowest standard used for the calibration curve.

- ***MRL.*** A threshold value below which the laboratory reports a result as non-detected. Ideally, the MRL will be established anywhere between the MDL and 1/2 the project action levels.

An MDL is the lower limit at which the laboratory can differentiate a measurement from background. The MDL is determined in accordance with the procedures in 40 CFR Part 136. If project action levels are near or below the MDL, it is unlikely the sensitivity of the method will be achievable. A compromise must be reached. The PQL/MQL is the lower limit at which a measurement becomes meaningful. This measurement (the PQL or the RL) is generally a multiple of three to five times the MDL. Most samples were handled and analyzed as expected without significant changes to the anticipated project MQLs.

3.3 Holding Times/Preservation

All laboratory results submitted for this investigation have been reviewed with respect to laboratory adherence to extraction and analysis holding times. All hold times and preservation requirements were met. No qualification required.

4.0 Data Evaluation and Usability

The analytical data review process identified a few analytical nonconformance issues that were noted during this analytical program. These anomalies have been discussed in the previous sections of this appendix. Table 3 summarizes all compounds requiring qualifier application due to anomalies discovered during data validation. Table 4 defines the reason codes for qualification and Table 5 defines the data validation qualifiers.

The following definitions are used for defining precision, accuracy, representativeness, completeness, and comparability as they have been applied to this evaluation.

Precision. Precision is a measurement of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision data were obtained through the analysis and evaluation of duplicate QA samples. Accuracy was determined through the analysis and evaluation of method blanks, LCSs, trip blanks, equipment rinsates, and MS samples.

Accuracy. Accuracy is a measurement of bias in a system and is expressed as a percent recovery. These QA samples were collected and/or analyzed at the frequency established in the

SAP, verifying the completeness element of the DQOs along with the evaluation of holding times and reporting limits. Percent recovery is calculated as follows:

$$Percent\ \mathrm{Re}\,\mathrm{cov}ery = \left(\frac{(x-s)}{T}\right) * 100$$

Where:

X = the lab determined concentration of a spiked sample

S = the sample native concentration prior to spike

T = the true concentration of the spike

Relative Percent Difference is calculated as follows:

$$\mathrm{Re}\,lative\ Percent\ Difference = \left[\frac{|D1 - D2|}{\frac{D1 + D2}{2}}\right] * 100$$

Where:

D1 and D2 = the results of duplicate measurements

Representativeness. Representativeness is a qualitative parameter that expresses the degree to which sample data actually represent the matrix and site conditions. For example, in conducting ground water monitoring, representativeness requires proper location of wells and the collection of samples under consistent, documented procedures. Wells are located based upon the results of the hydrological study in progress and are designed to provide maximum coverage of the flow conditions. Requirements and procedures for sample collection and handling are designed to maximize sample representativeness. Representativeness also can be monitored by reviewing field documentation and by performing field audits.

The samples were collected using Shaw SOPs and were fully documented through the use of standard Shaw field forms. Samples are representative of the matrix and site sampled.

Completeness. Completeness is a measure of the amount of valid data that are obtained during a sampling event as compared to the amount of data planned to be collected under optimum conditions. Some data for this project were qualified as estimated in the validation process because of the outliers noted in the MS recoveries, duplicate results for certain elements, and various other calibration and column confirmation percent difference results. Completeness is calculated as follows:

$$Completeness\ \% = \left(\frac{D_r}{D_c}\right) X\ 100$$

Where:

D_r = the number of data points for which valid results are reported

D_c = the number of valid samples/data points that are collected and reach the laboratory for analysis.

During this task, twelve regular project samples, two field duplicate and two field split samples were collected resulting in approximately 1982 targeted analytical records. No results were rejected. Using the above calculation, 100% completeness was achieved for the task.

Comparability. Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Comparability ensures that results for the sampling event can be compared with data from other past and/or future sampling programs. Comparability for this sampling event was achieved through the use of established and recognized techniques and accepted standard EPA methods. All samples collected and analyzed were subjected to the same sampling, handling, preparation, analysis, reporting, and validation criteria for the purpose of achieving comparability goals within the data set.

4.1 Statement of Data Usability

The overall results of the analyses, as discussed in this evaluation, suggest that representative samples were collected and analyzed, and the results are indicative of the media analyzed, with the exception of the few anomalies noted. The data do reflect expected site conditions and are usable for their intended purpose.

Tables 1, 2, 3, 4 and 5 summarize the analytical program and the results for the data validation effort for all samples collected by Shaw at PBOW Coal Yard 2 area.

Table 1

Sample Cross Reference
Former Plum Brook Ordnance Works
Sandusky, Ohio

Sample Type	Sample Location	Sample Number	Sample Date	Sample Purpose	SDG Number	Laboratory
SS	CY2-SB01	CY0015	27-Oct-11	REG	F87352	Accutest
SS	CY2-SB01	CY0016	27-Oct-11	FD	F87352	Accutest
SS	CY2-SB01	CY0017	27-Oct-11	FS	240-5522-1	Test America
DS	CY2-SB01	CY0018	27-Oct-11	REG	F87352	Accutest
DS	CY2-SB01	CY0019	27-Oct-11	REG	F87353	Accutest
SS	CY2-SB02	CY0020	27-Oct-11	REG	F87353	Accutest
DS	CY2-SB02	CY0021	27-Oct-11	REG	F87353	Accutest
DS	CY2-SB02	CY0022	27-Oct-11	REG	F87352	Accutest
DS	CY2-SB02	CY0023	27-Oct-11	FD	F87352	Accutest
DS	CY2-SB02	CY0024	27-Oct-11	FS	240-5520-1	Test America
SS	CY2-SB03	CY0025	26-Oct-11	REG	F87353	Accutest
DS	CY2-SB03	CY0026	26-Oct-11	REG	F87353	Accutest
DS	CY2-SB03	CY0027	26-Oct-11	REG	F87352	Accutest
SS	CY2-SB04	CY0028	26-Oct-11	REG	F87353	Accutest
DS	CY2-SB04	CY0029	26-Oct-11	REG	F87353	Accutest
DS	CY2-SB04	CY0030	26-Oct-11	REG	F87352	Accutest

Table 2

Summary of Original, Field Duplicate, and Field Split Hits with Relative Percent Difference Calculations
Former Plum Brook Ordnance Works
Sandusky, Ohio

		Location:	CY2-SB01		CY2-SB01		CY2-SB01			
		Sample Number:	CY0015		CY0016		CY0017		Relative	Relative
		Sample Date:	27-Oct-11		27-Oct-11		27-Oct-11		Percent	Percent
		Sample Depth:	0.5 - 1 Ft		0.5 - 1 Ft		0.5 - 1 Ft		Difference	Difference
		Sample Purpose:	REG		FD		FS		REG and FD	REG and FS
Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual		
Aluminum	N	mg/kg	8000	J	14500	J	14000		57.78	54.55
Arsenic	N	mg/kg	10		10		12		0.00	18.18
Barium	N	mg/kg	49.2	J	86.6	J	85		55.08	53.35
Beryllium	N	mg/kg	0.67	J	0.87	J	0.48	J	25.97	33.04
Cadmium	N	mg/kg	0.02	U	0.02	U	0.063	J	-	-
Calcium	N	mg/kg	3260	J	9300	J	4700	J	96.18	36.18
Chromium	N	mg/kg	16.7		19.1		19		13.41	12.89
Cobalt	N	mg/kg	11.4		10.6	J	8.7		7.27	26.87
Copper	N	mg/kg	24.6		24.2		24		1.64	2.47
Iron	N	mg/kg	28700		27700		31000		3.55	7.71
Lead	N	mg/kg	13.4		13		14		3.03	4.38
Magnesium	N	mg/kg	3000		4370		4300		37.18	35.62
Manganese	N	mg/kg	249		199		200	J	22.32	21.83
Mercury	N	mg/kg	0.038	J	0.052	J	0.054	B	31.11	34.78
Nickel	N	mg/kg	26.6		30		25		12.01	6.20
Potassium	N	mg/kg	599	J	815	J	850		30.55	34.64
Selenium	N	mg/kg	1	J	0.4	U	0.56	U	-	-
Vanadium	N	mg/kg	26.4		28		27		5.88	2.25
Zinc	N	mg/kg	64.3		71.3		70		10.32	8.49

		Location:	CY2-SB02		CY2-SB02		CY2-SB02			
		Sample Number:	CY0022		CY0023		CY0024		Relative	Relative
		Sample Date:	27-Oct-11		27-Oct-11		27-Oct-11		Percent	Percent
		Sample Depth:	8 - 10 Ft		8 - 10 Ft		8 - 10 Ft		Difference	Difference
		Sample Purpose:	REG		FD		FS		REG and FD	REG and FS
Parameter	Filtered	Units	Result	ValQual	Result	ValQual	Result	ValQual		
Aluminum	N	mg/kg	7090		5780		8400		20.36	16.91
Arsenic	N	mg/kg	4.3	J	8	J	7.3		60.16	51.72
Barium	N	mg/kg	72.1		50.4		52		35.43	32.39
Beryllium	N	mg/kg	0.46	J	0.4	J	0.32	J	13.95	35.90
Cadmium	N	mg/kg	0.83	J	0.17	J	0.24	J	132.00	110.28
Calcium	N	mg/kg	49500		51200		52000		3.38	4.93
Chromium	N	mg/kg	13.8		12.6		15		9.09	8.33
Cobalt	N	mg/kg	6.9		10		15		36.69	73.97
Copper	N	mg/kg	23		22.2		24		3.54	4.26
Iron	N	mg/kg	22700		17800		21000		24.20	7.78
Lead	N	mg/kg	12.9		12.2		12		5.58	7.23
Magnesium	N	mg/kg	14800		13800		17000		6.99	13.84
Manganese	N	mg/kg	413		450		420		8.57	1.68
Mercury	N	mg/kg	0.016	J	0.015	J	0.029	B	6.45	57.78
Nickel	N	mg/kg	18.8		25.3		27		29.48	35.81
Potassium	N	mg/kg	1540		1160		1400		28.15	9.52
Selenium	N	mg/kg	0.65	J	0.33	U	0.53	U	-	-
Silver	N	mg/kg	0.079	J	0.17	U	0.16	U	-	-
Sodium	N	mg/kg	150	J	135	J	93	U	10.53	-
Vanadium	N	mg/kg	13.8		16.7		19		19.02	31.71
Zinc	N	mg/kg	53.1		52.2		57		1.71	7.08

Table 3

Summary of Data Validation Reason Codes
Former Plum Brook Ordnance Works
Sandusky, Ohio

Reason Code	Description
01	Sample received outside of 4+/-2 degrees Celsius
01A	Improper sample preservation
02	Holding Time Exceeded
02A	Extraction
02B	Analysis
03	Instrument Performance - Outside Criteria
03A	BFB
03B	DFTPP
03C	DDT and/or Endrin % breakdown exceeds criteria
03D	retention time windows
03E	Resolution
04	Initial Calibration results outside specified criteria
04A	Compound mean RRF<0.05
04B	Compound %RSD>30
04C	Correlation Coefficient<0.995
05	Continuing Calibration results outside specified criteria
05A	Compound mean RRF<0.05
05B	Compound %D>25
06	Result qualified as a result of the 5x/10x blank correction
06A	Method or Preparation Blank
06B	ICB or CCB
06C	ER
06D	TB
06E	FB
07	Surrogate Recoveries outside control limits
07A	Sample
07B	Associated method blank or LCS
08	MS/MSD/Duplicate results outside criteria
08A	MS and/or MSD recovery not within control limits (accuracy)
08B	%RPD outside acceptance criteria (precision)
09	Post Digestion Spike outside criteria (GFAA)
10	Internal Standards outside specified control limits
10A	Recovery
10B	Retention Time
11	Laboratory Control Sample recoveries outside specified control limits
11A	Recovery
11B	%RPD (if run in duplicate)
12	Interference Check Standard
13	Serial Dilution
14	Tentatively Identified Compounds
15	Quantitation
16	Multiple results available; alternate analysis preferred
17	Field duplicate RPD criteria exceeded
18	Percent difference between original and second column > 25%
19	Professional judgement was used to qualify the data
20	Pesticide clean-up checks
21	Target compound identification
22	Radiological calibration
23	Radiological quantitation
24	Reported result and/or lab qualifier revised to reflect validation findings
999	See hard copy for details.

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Former Plum Brook Ordnance Works
Sandusky, Ohio

Work Order	Sample Number	Analysis	Parameter	Reason Codes				
				VQ	R1	R2	R3	R4
F87352	CY0015	METALS3	Aluminum	J	17			
F87352	CY0015	METALS3	Potassium	J	15			
F87352	CY0015	METALS3	Barium	J	17			
F87352	CY0015	METALS3	Beryllium	J	15			
F87352	CY0015	METALS3	Calcium	J	17			
F87352	CY0015	METALS3	Selenium	J	15			
F87352	CY0015	METALS3	Mercury	J	15			
F87352	CY0015	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0015	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0016	METALS3	Aluminum	J	17			
F87352	CY0016	METALS3	Potassium	J	15			
F87352	CY0016	METALS3	Barium	J	17			
F87352	CY0016	METALS3	Beryllium	J	15			
F87352	CY0016	METALS3	Cobalt	J	15			
F87352	CY0016	METALS3	Calcium	J	17			
F87352	CY0016	METALS3	Mercury	J	15			
F87352	CY0016	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0016	SEMIVOLATILES3	Pyrene	J	15			
F87352	CY0016	SEMIVOLATILES3	Fluoranthene	J	15			
F87352	CY0016	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
240-5522-1	CY0017	METALS3	Manganese	J	08A			
240-5522-1	CY0017	METALS3	Antimony	UJ	08A			
240-5522-1	CY0017	METALS3	Beryllium	J	15			
240-5522-1	CY0017	METALS3	Cadmium	J	15			
240-5522-1	CY0017	METALS3	Calcium	J	08A			
240-5522-1	CY0017	METALS3	Mercury	B	06A	15		
240-5522-1	CY0017	SEMIVOLATILES3	BIBENZENE	J	15			
240-5522-1	CY0017	SEMIVOLATILES3	ACETOPHENONE	J	15			
F87352	CY0018	METALS3	Potassium	J	15			
F87352	CY0018	METALS3	Silver	J	15			
F87352	CY0018	METALS3	Sodium	J	15			
F87352	CY0018	METALS3	Beryllium	J	15			
F87352	CY0018	METALS3	Selenium	J	15			
F87352	CY0018	METALS3	Mercury	J	15			
F87352	CY0018	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0018	SEMIVOLATILES3	Bis(2-ethylhexyl)phthalate	J	15			
F87352	CY0018	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0019	METALS3	Potassium	J	15			
F87353	CY0019	METALS3	Silver	J	15			
F87353	CY0019	METALS3	Beryllium	J	15			
F87353	CY0019	METALS3	Mercury	J	15			
F87353	CY0019	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0019	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Former Plum Brook Ordnance Works
Sandusky, Ohio

Work Order	Sample Number	Analysis	Parameter	Reason Codes				
				VQ	R1	R2	R3	R4
F87353	CY0020	METALS3	Potassium	J	15			
F87353	CY0020	METALS3	Beryllium	J	15			
F87353	CY0020	METALS3	Cobalt	J	15			
F87353	CY0020	METALS3	Selenium	J	15			
F87353	CY0020	METALS3	Mercury	J	15			
F87353	CY0020	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0020	SEMIVOLATILES3	Fluoranthene	J	15			
F87353	CY0020	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0020	SEMIVOLATILES3	Phenanthrene	J	15			
F87353	CY0021	METALS3	Potassium	J	15			
F87353	CY0021	METALS3	Silver	J	15			
F87353	CY0021	METALS3	Beryllium	J	15			
F87353	CY0021	METALS3	Cobalt	J	15			
F87353	CY0021	METALS3	Mercury	J	15			
F87353	CY0021	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0021	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0022	METALS3	Silver	J	15			
F87352	CY0022	METALS3	Sodium	J	15			
F87352	CY0022	METALS3	Arsenic	J	17			
F87352	CY0022	METALS3	Beryllium	J	15			
F87352	CY0022	METALS3	Cadmium	J	17			
F87352	CY0022	METALS3	Selenium	J	15			
F87352	CY0022	METALS3	Mercury	J	15			
F87352	CY0022	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0022	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0023	METALS3	Sodium	J	15			
F87352	CY0023	METALS3	Arsenic	J	17			
F87352	CY0023	METALS3	Beryllium	J	15			
F87352	CY0023	METALS3	Cadmium	J	15	17		
F87352	CY0023	METALS3	Mercury	J	15			
F87352	CY0023	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0023	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
240-5520-1	CY0024	METALS3	Beryllium	J	15			
240-5520-1	CY0024	METALS3	Cadmium	J	15			
240-5520-1	CY0024	METALS3	Mercury	B	06A	15		
240-5520-1	CY0024	SEMIVOLATILES3	Bis(2-ethylhexyl)phthalate	J	15			
240-5520-1	CY0024	SEMIVOLATILES3	Phenanthrene	J	08A			
240-5520-1	CY0024	SEMIVOLATILES3	Pentachlorophenol	UJ	08A			
240-5520-1	CY0024	SEMIVOLATILES3	Naphthalene	J	08A			
240-5520-1	CY0024	SEMIVOLATILES3	Methylnaphthalene, 2-	J	08A			
240-5520-1	CY0024	SEMIVOLATILES3	Dichlorobenzidine, 3,3'-	UJ	08A			
F87353	CY0025	METALS3	Potassium	J	15			
F87353	CY0025	METALS3	Beryllium	J	15			

Table 4

Summary of Data Validation Qualifiers Assigned and Reason Codes for Qualification
Former Plum Brook Ordnance Works
Sandusky, Ohio

Work Order	Sample Number	Analysis	Parameter	Reason Codes				
				VQ	R1	R2	R3	R4
F87353	CY0025	METALS3	Cobalt	J	15			
F87353	CY0025	METALS3	Selenium	J	15			
F87353	CY0025	METALS3	Mercury	J	15			
F87353	CY0025	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0025	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0026	METALS3	Sodium	J	15			
F87353	CY0026	METALS3	Thallium	J	15			
F87353	CY0026	METALS3	Cadmium	J	15			
F87353	CY0026	METALS3	Mercury	J	15			
F87353	CY0026	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0026	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0027	METALS3	Silver	J	15			
F87352	CY0027	METALS3	Sodium	J	15			
F87352	CY0027	METALS3	Beryllium	J	15			
F87352	CY0027	METALS3	Selenium	J	15			
F87352	CY0027	METALS3	Mercury	J	15			
F87352	CY0027	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0027	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87353	CY0028	METALS3	Silver	J	15			
F87353	CY0028	METALS3	Sodium	J	15			
F87353	CY0028	METALS3	Antimony	J	15			
F87353	CY0028	METALS3	Mercury	J	15			
F87353	CY0028	SEMIVOLATILES3	Bis(2-chloroisopropyl)ether	UJ	05B			
F87353	CY0028	SEMIVOLATILES3	Naphthalene	J	15			
F87353	CY0028	SEMIVOLATILES3	Methylnaphthalene, 2-	J	15			
F87353	CY0029	METALS3	Potassium	J	15			
F87353	CY0029	METALS3	Beryllium	J	15			
F87353	CY0029	METALS3	Cadmium	J	15			
F87353	CY0029	METALS3	Cobalt	J	15			
F87353	CY0029	METALS3	Mercury	J	15			
F87353	CY0029	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87353	CY0029	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			
F87352	CY0030	METALS3	Potassium	J	15			
F87352	CY0030	METALS3	Beryllium	J	15			
F87352	CY0030	METALS3	Mercury	J	15			
F87352	CY0030	SEMIVOLATILES3	Bis(2-chloroethyl)ether	UJ	05B			
F87352	CY0030	SEMIVOLATILES3	Hexachlorocyclopentadiene	UJ	05B			

Table 5

Laboratory and Validation Qualifier Definitions
Former Plum Brook Ordnance Works
Sandusky, Ohio

Qualifier	Definition
Laboratory	
B	Indicates the analyte is found in associated method blank.
J	Indicates the analyte result is an estimated value.
ND	Not detected. The compound was analyzed for, but not detected above the associated reporting limit.
MDL	Method detection limit.
RL	Reporting limit.
E	Indicates the value exceeds the calibration range.
ND	Indicates presumptive evidence of a compound

Validation	
B	
J	The compound/analyte was positively identified; the reported value is an estimated concentration.
U	Not detected. The compound/analyte was analyzed for, but not detected above the associated reporting limit.
UJ	The analyte is not detected; the result is an estimated value.
R	Analyte is rejected.

APPENDIX I

CHAINS OF CUSTODY

F87352

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB10 28 11ACCT

PAGE 1 OF 1

Project Name/No: PBOW
Sample Team Member: Mike Gunderson
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457 Coal Yards
Required Report Date: 21 DAYS

Sample Shipment Date: 10-28-11
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8759 1992 2848

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884
Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1	CY0030	SOIL	10-26-11/1450	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
2	CY0027	SOIL	10-26-11/1615	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
3	CY0022	SOIL	10-27-11/0915	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
4	CY0023	SOIL	10-27-11/0915	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
5	CY0015	SOIL	10-27-11/0940	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
6	CY0016	SOIL	10-27-11/0940	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
7	CY0018	SOIL	10-27-11/0955	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL	EW	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		
		SOIL		2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: Eric W. Weaver	Date: 10-28-11 Time: 1200	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 10-29-11 Time: 0900	2. Received by: R Willem ALSE	Date: 10-29-11 Time: 0900
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

3-2

ACCUTEST LABORATORIES SAMPLE RECEIPT CONFIRMATION

ACCUTEST'S JOB NUMBER: F87352 CLIENT: Shaw PROJECT: PBOW

DATE/TIME RECEIVED: 10-29-11 0900 {MM/DD/YY 24:00} NIMBER OF COOLERS RECEIVED: 1

METHOD OF DELIVERY: FEDEX UPS ACCUTEST COURIER GREYHOUND DELIVERY OTHER

AIRBILL NUMBERS: 8759 1992 2848

COOLER INFORMATION

- [ ] CUSTODY SEAL NOT PRESENT OR NOT INTACT
- [ ] CHAIN OF CUSTODY NOT RECEIVED (COC)
- [ ] ANALYSIS REQUESTED IS UNCLEAR OR MISSING
- [ ] SAMPLE DATES OR TIMES UNCLEAR OR MISSING
- [ ] TEMPERATURE CRITERIA NOT MET
- [ ] WET ICE PRESENT

TRIP BLANK INFORMATION

- [ ] TRIP BLANK PROVIDED
- [x] TRIP BLANK NOT PROVIDED
- [x] TRIP BLANK NOT ON COC
- [ ] TRIP BLANK INTACT
- [ ] TRIP BLANK NOT INTACT
- [ ] RECEIVED WATER TRIP BLANK
- [ ] RECEIVED SOIL TRIP BLANK

MISC. INFORMATION

NUMBER OF ENCORES ? 25-GRAM _____ 5-GRAM _____

NUMBER OF 5035 FIELD KITS ? _____

NUMBER OF LAB FILTERED METALS ? _____

TEMPERATURE INFORMATION

- [ ] IR THERM ID 1 CORR. FACTOR +0.2
- [ ] OBSERVED TEMPS: 3.0
- [ ] CORRECTED TEMPS: 3.2

SAMPLE INFORMATION

- [ ] SAMPLE LABELS PRESENT ON ALL BOTTLES
- [ ] INCORRECT NUMBER OF CONTAINERS USED
- [ ] SAMPLE RECEIVED IMPROPERLY PRESERVED
- [ ] INSUFFICIENT VOLUME FOR ANALYSIS
- [ ] DATES/TIMES ON COC DO NOT MATCH SAMPLE LABEL
- [ ] ID'S ON COC DO NOT MATCH LABEL
- [ ] VOC VIALS HAVE HEADSPACE (MACRO BUBBLES)
- [ ] BOTTLES RECEIVED BUT ANALYSIS NOT REQUESTED
- [ ] NO BOTTLES RECEIVED FOR ANALYSIS REQUESTED
- [ ] UNCLEAR FILTERING OR COMPOSITING INSTRUCTIONS
- [ ] SAMPLE CONTAINER(S) RECEIVED BROKEN
- [ ] % SOLIDS JAR NOT RECEIVED
- [ ] 5035 FIELD KIT FROZEN WITHIN 48 HOUR'S
- [ ] RESIDUAL CHLORINE PRESENT

{APPICABLE TO EPA 600 SERIES OR NORTH CAROLINA ORGANICS}

SUMMARY OF COMMENTS: _____

TECHNICIAN SIGNATURE/DATE R. Wilson 10-29-11 REVIEWER SIGNATURE/DATE Scott Hill 10/29/11

F87353

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB10 28 11ACCT

PAGE 1 OF 1

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: Mike Gunderson
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457 Coal Yards
Required Report Date: 21 DAYS

Sample Shipment Date: 10-28-11
Laboratory Destination: Accutest
Laboratory Contact: Sue Bell
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8759 1992 2848

	Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
1	CY0028	SOIL	10-26-11/1410	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
2	CY0029	SOIL	10-26-11/1430	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
3	CY0025	SOIL	10-26-11/1540	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
4	CY0026	SOIL	10-26-11/1555	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
5	CY0020	SOIL	10-27-11/0830	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
6	CY0021	SOIL	10-27-11/0850	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
7	CY0019	SOIL	10-27-11/1020	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL		2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
		SOIL	EW	2-Wide Mouth Glass Jar	8 oz	Cool	Explosives by 8330, SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: Eric W. Weaver	Date: 10-28-11 Time: 1200	1. Received by: FX	Date: Time:
2. Relinquished by: FX	Date: 10-29-11 Time: 0900	2. Received by: [illegible] ALSE	Date: 10-29-11 Time: 0900
3. Relinquished by:	Date: Time:	2. Received by:	Date: Time:

Comments:

3.2

ACCUTEST LABORATORIES SAMPLE RECEIPT CONFIRMATION

ACCUTEST'S JOB NUMBER: F87353 CLIENT: Shaw PROJECT: PBOW

DATE/TIME RECEIVED: 10-29-11 0900 {MM/DD/YY 24:00} NIMBER OF COOLERS RECEIVED: 1

METHOD OF DELIVERY: (FEDEX) UPS ACCUTEST COURIER GREYHOUND DELIVERY OTHER

AIRBILL NUMBERS: 8759 1992 2848

COOLER INFORMATION

- [ ] CUSTODY SEAL NOT PRESENT OR NOT INTACT
- [ ] CHAIN OF CUSTODY NOT RECEIVED (COC)
- [ ] ANALYSIS REQUESTED IS UNCLEAR OR MISSING
- [ ] SAMPLE DATES OR TIMES UNCLEAR OR MISSING
- [ ] TEMPERATURE CRITERIA NOT MET
- [ ] WET ICE PRESENT

TRIP BLANK INFORMATION

- [ ] TRIP BLANK PROVIDED
- [x] TRIP BLANK NOT PROVIDED
- [x] TRIP BLANK NOT ON COC
- [ ] TRIP BLANK INTACT
- [ ] TRIP BLANK NOT INTACT
- [ ] RECEIVED WATER TRIP BLANK
- [ ] RECEIVED SOIL TRIP BLANK

MISC. INFORMATION

NUMBER OF ENCORES ? 25-GRAM _____ 5-GRAM _____

NUMBER OF 5035 FIELD KITS ? _____

NUMBER OF LAB FILTERED METALS ? _____

TEMPERATURE INFORMATION

- [ ] IR THERM ID 1 CORR. FACTOR +0.2
- [ ] OBSERVED TEMPS: 3.0
- [ ] CORRECTED TEMPS: 3.2

SAMPLE INFORMATION

- [ ] SAMPLE LABELS PRESENT ON ALL BOTTLES
- [ ] INCORRECT NUMBER OF CONTAINERS USED
- [ ] SAMPLE RECEIVED IMPROPERLY PRESERVED
- [ ] INSUFFICIENT VOLUME FOR ANALYSIS
- [ ] DATES/TIMES ON COC DO NOT MATCH SAMPLE LABEL
- [ ] ID'S ON COC DO NOT MATCH LABEL
- [ ] VOC VIALS HAVE HEADSPACE (MACRO BUBBLES)
- [ ] BOTTLES RECEIVED BUT ANALYSIS NOT REQUESTED
- [ ] NO BOTTLES RECEIVED FOR ANALYSIS REQUESTED
- [ ] UNCLEAR FILTERING OR COMPOSITING INSTRUCTIONS
- [ ] SAMPLE CONTAINER(S) RECEIVED BROKEN
- [ ] % SOLIDS JAR NOT RECEIVED
- [ ] 5035 FIELD KIT FROZEN WITHIN 48 HOUR'S
- [ ] RESIDUAL CHLORINE PRESENT

{APPICABLE TO EPA 600 SERIES OR NORTH CAROLINA ORGANICS}

SUMMARY OF COMMENTS: _____

TECHNICIAN SIGNATURE/DATE R. Wellen 10-29-11 REVIEWER SIGNATURE/DATE Scott Hill 10/29/11

NF 12/10

receipt confirmation 122910.xls

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB10 28 11TA

PAGE 1 OF 1

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: Mke Gunderson
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457 Coal Yards
Required Report Date: 21 DAYS

Sample Shipment Date: 10-28-11
Laboratory Destination: Test America
Laboratory Contact: Denise Pohl
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8754 2216 5668

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
CY0017	Soil	10-27-11 / 0940	Wide Mouth Glass Jar	1X8oz EW	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				1x8oz	Cool	Explosives by 8330A		
	Soil		Wide Mouth Glass Jar	2 X 4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				4 oz	Cool	Explosives by 8330A		
	Soil	EW	Wide Mouth Glass Jar	2 X 4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				4 oz	Cool	Explosives by 8330A		
	Soil		Wide Mouth Glass Jar	2 X 4 oz	Cool	SVOC by 8270, TAL Metals by 6010/7471, PCBs by 8082		
				4 oz	Cool	Explosives by 8330A		

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: Eric W. Weaver Date: 10-28-11 Time: 1200
2. Relinquished by: Date: Time:
3. Relinquished by: Date: Time:

1. Received by: Date: 10/29/11 Time: 945
2. Received by: Date: Time:
2. Received by: Date: Time:

Comments:

Shaw
Shaw E & I, Inc.

ANALYSIS REQUEST AND CHAIN-OF-CUSTODY RECORD

REFERENCE COC NO.: PB10 28 11TA

PAGE 1 OF 1

Bill To: Attn: Accounts Payable Dept.
Shaw Environmental
P.O. Box 98519
Baton Rouge, LA 70884

Report To: Eddie Weaver
Shaw E & I
312 Directors Drive
Knoxville, TN 37923

Project Name/No: PBOW
Sample Team Member: Mke Gunderson
Profit Center: Knoxville
Project Manager: Steve Downey
Project No.: 132457 Coal Yards
Required Report Date: 21 DAYS

Sample Shipment Date: 10-28-11
Laboratory Destination: Test America
Laboratory Contact: Denise Pohl
Project Contact/Phone: Eddie Weaver/865-690-3211
Carrier Waybill No.: 8754 2216 5668

Sample Number	Sample Type/ Description	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Testing Program	Condition on Receipt	Disposal Record
CY0024	Soil	10-27-11 / 0915	Wide Mouth Glass Jar	1 X 8 oz EW	Cool	SVOC by 8270, TAL Metals by 6010/7471		
				1 X 8 oz	Cool	Explosives by 8330A		
			EW					

Special Instructions:

Possible Hazard Identification:
Non-haz: ____ Flammable: ____ Poison B: ____ Unknown: X

Sample Disposal:
Return to Client: ____ Disposal by Lab: X Archive: ____

Turnaround Time:
Normal: X Rush: ____

Level of QC Required:
Definitive: X Project Specific: ____

1. Relinquished by: Eric W. Weaver Date: 10-28-11 Time: 1200
1. Received by: [signature] Date: 10/29/11 Time: 945
2. Relinquished by: Date: Time:
2. Received by: Date: Time:
3. Relinquished by: Date: Time:
2. Received by: Date: Time:

Comments:

APPENDIX J

RESPONSE TO COMMENTS

Response to Comments - OEPA
Draft Powerhouse No. 2 Ash Pits
Site Characterization Report Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Report dated May 2012)

Reference: Comments from Dr. Janusz Z. Byczkowski, DERR, CO, email dated June 27, 2012.

Comment 1: **<u>Sec. 4.2.2, P4-4, L #7 and Table 5-1</u>. The described method of background level (BSC) calculation is currently not recommended by OEPA – DERR (2009). Actually, the Table 5-1 may illustrate inadequacy of BSCs to this area of concern (in many cases BSCs are more than an order of magnitude higher than the upper confidence limits of the respective concentrations detected in this AOC). The use of methodology not recommended by OEPA-DERR should be emphasized and justified.**

Please emphasize the different background screening approach than currently recommended by OEPA-DERR and provide justification.

Response 1: Text consistent with the following will be added to this text: *"It is noted that the method agreed upon for the development of BSCs by OEPA and USACE, as recorded in the September 11, 2002 PBOW team meeting minutes, differs from that shown in current OEPA (2009) guidance. This PBOW team agreement, which has been used for all PBOW risk assessments to date, takes precedence over the subsequent OEPA (2009) guidance.*" We note that the concentrations of inorganics in Coal Yard No. 2 soil are low relative to other PBOW sites.

Reference used in the Response:

Ohio Environmental Protection Agency (OEPA), 2009***, Use of Background for Remedial Response Sites***, Technical Decision Compendium, Division of Environmental Response and Revitalization, August 21.

APPENDIX E

POWERHOUSE NO. 2 ASH PITS BHHRA ADDENDUM FOR COAL YARD NO. 2

Shaw Environmental
& Infrastructure, Inc.

Final
July 2013

Powerhouse No. 2 Ash Pits
Baseline Human Health Risk Assessment
Addendum for Coal Yard No. 2
FUDS Project No. G05OH001822

Former Plum Brook Ordnance Works
Sandusky, Ohio

US Army Corps
of Engineers
Nashville District

CB&I
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Knoxville, TN 37923
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Steven.Downey@CBIfederalservices.com

July 31, 2013

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 Powerhouse No. 2 Ash Pits Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment Addenda for Coal Yard No. 2***
Former Plum Brook Ordnance Works, Sandusky, Ohio
Contract No. W912QR-08-D-0013: Shaw Project Number 132457

Dear Ms. Coleman:

In accordance with the requirements of Delivery Order No. DX02 of Contract No. W912QR-08-D-0013 awarded to Shaw Environmental & Infrastructure, Inc., a CB&I company, we are pleased to submit the Final Addenda to the Powerhouse No. 2 Ash Pits (AP2) Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment for Coal Yard No. 2 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 AP2 risk assessment work plan.

Enclosed for your records 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

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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: Powerhouse No. 2 Ash Pits BHHRA Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Contract No. W912QR-08-D-0013 Delivery Order No. DX02

Project No. 132457 Task/Phase Number: 44000000

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☐ Contract / Subcontract		☐ Client Furnished
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X Report	BHHRA Addendum	**Document Status**
☐ Risk Assessment / Evaluation		☐ Preliminary
☐ Specifications & Plans		☐ Internal Draft
☐ Design Calculations		☐ Draft
☐ Tables		☐ Draft Final
☐ Drawings / Figures		X Final
☐ Other:		☐ Other:

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Project Manager	Steven Downey		7-31-13

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
Powerhouse No. 2 Ash Pits
Baseline Human Health Risk Assessment Addendum
For Coal Yard No. 2
FUDS No. G05OH001822

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.
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Shaw Project No. 132457

July 2013

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List of Acronyms

AP2	Powerhouse No. 2 Ash pits
BHHRA	baseline human health risk assessment
BSC	background screening concentration
COPC	chemical of potential concern
DERP	Defense Environmental Restoration Program
DNT	dinitrotoluene
EPA	U.S. Environmental Protection Agency
FUDS	Formerly Used Defense Sites
GSA	General Services Administration
HQ	hazard quotient
ICI	International Consultants Incorporated
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	incremental lifetime cancer risk
IT	IT Corporation
MDC	maximum detected concentration
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
MK	Morrison Knudsen Corporation
NASA	National Aeronautics and Space Administration
OEPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works
PDT	Project Delivery Team
RBSC	risk-based screening concentration
RSL	regional screening level
Shaw	Shaw Environmental & Infrastructure, Inc.
SI	site inspection
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
USACE	U.S. Army Corps of Engineers
WRS	Wilcoxon Rank Sum

Executive Summary

A baseline human health risk assessment (BHHRA) addendum was conducted to evaluate risks associated with exposure to surface soil and subsurface soil at the Coal Yard associated with Powerhouse No. 2, located at the Plum Brook Ordnance Works (PBOW), Sandusky, Ohio. This coal yard site is referred to as "Coal Yard No. 2." This BHHRA is an addendum to the Powerhouse No. 2 Ash Pits BHHRA. The approach used in the BHHRA Addendum 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 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 (TNT), 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 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.

Three power stations, Powerhouse No. 1, Powerhouse No. 2, and Powerhouse No. 3, were constructed and utilized to support the TNT manufacturing processes. Coal Yard No. 2 was used as a storage area to provide coal for the Powerhouse No. 2 boilers. The coal was brought into the coal yard via train. The generated steam was used for space heating, driving compressors, and

generating electrical power. Coal Yard No. 2 is located immediately to the northeast of former Powerhouse No. 2. The former coal yard is estimated to have been approximately 200 feet wide by 290 feet in length, or approximately 1.3 acres. Demolition of the former Powerhouse No. 2 building by NASA in the fall of 2010 resulted in some disturbance of surface soil and vegetation, as the area has been filled and graded, primarily in areas outside the footprint of the former coal yard. The site was observed to be covered with bare soil during a site visit on September 1, 2011, but plant shoots were observed to be emerging, suggesting that the site will likely naturally revegetate in the near future.

Approach. The BHHRA Addendum evaluated exposure to chemicals in Coal Yard No. 2 surface soil and subsurface soil. Validated analytical data are from samples collected during 2010, 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 inorganics, a background screening. The background screening protocol used for Coal Yard No. 2 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.

Results/Conclusions. None of the chemicals detected in Coal Yard No. 2 surface soil or subsurface soil were identified as COPCs. The results of the COPC screening indicate that the risks/hazards associated with chemicals detected in Coal Yard No. 2 soils are negligible and/or are related to background soil conditions. Accordingly, a quantitative risk assessment beyond the COPC screening is unnecessary for Coal Yard No. 2 soils.

1.0 Introduction

This baseline human health risk assessment (BHHRA) Addendum evaluates potential human health risks associated with exposure to soil at the Powerhouse No. 2 Coal Yard (Coal Yard No. 2), which is located at the former Plum Brook Ordnance Works (PBOW), Sandusky, Erie County, Ohio. This site is administered as part of Defense Environmental Restoration Program (DERP)-Formerly Used Defense Sites (FUDS) Project No. G05OH001822, Powerhouse No. 2 Ash Pits (AP2). This work is being conducted by Shaw Environmental & Infrastructure, Inc. (Shaw) (a CB&I company) for the U.S. Army Corps of Engineers (USACE) under the DERP-FUDS program, managed by the USACE Huntington District, and technically overseen by the USACE Nashville District. This BHHRA Addendum is consistent with U.S. Environmental Protection Agency (EPA) guidance and with the procedures established in the BHHRA for TNT Area A (TNTA) and TNT Area C (TNTC) soil (IT Corporation [IT], 2001), and, most specifically, the AP2 BHHRA work plan (Shaw, 2010a).

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 (DNT), 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 explosive manufacturing areas were designated TNTA, TNT Area B (TNTB), and 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 structures, equipment, and manufacturing debris were either removed and salvaged or removed and burned. 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 (GSA). This transfer did not include the 2,800-acre Plum Brook Depot area, which is also known as the Magazine Area. 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 building 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; then 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., 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 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. 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 thus were 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 GSA 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 Coal Yard No. 2 Site History

Three power stations, Powerhouse No. 1, Powerhouse No. 2, and Powerhouse No. 3, were constructed and utilized to support the TNT manufacturing processes. Each power station consisted of a main powerhouse, a coal storage area (coal yard), and two aboveground fuel storage tanks. The fuel storage tanks were surrounded by a berm to contain any potential spills or leaks. Each powerhouse building consisted of a boiler house, compressor room, electrical room, filter room, and locker room. Each building also contained two to four large coal-burning boilers, a turboelectric generator, a feed water treatment system, and several steam-driven or electric air compressors. The generated steam was used for space heating, driving compressors, and generating electrical power. The coal yards were used as storage areas to provide coal for the powerhouse boilers. The coal was brought into the yards via train. Figure 1-2 shows the location of Coal Yard No. 2 and other investigative sites on PBOW property.

Coal Yard No. 2 is located immediately to the northeast of Powerhouse No. 2. The former coal yard is estimated to have been approximately 200 feet wide by 290 feet in length, or approximately 1.3 acres. Demolition of the former Powerhouse No. 2 building by NASA in fall of 2010 resulted in some disturbance of surface soil and vegetation, and the area has been filled and regraded, primarily in areas outside of the footprint of the former coal yard. The site was observed to be covered with bare soil during a site visit on September 1, 2011, but plant shoots were observed to be emerging, suggesting that the site will likely naturally revegetate in the near future. Small amounts of coal were observed on the ground surface of Coal Yard No. 2 in isolated areas during previous site walks.

The vicinity of Coal Yard No. 2 was first investigated by Morrison Knudsen Corporation (MK) in 1993 during a site inspection (SI), when the coal yard was mistaken as a former burning ground and called “Burn Ground 1” (MK, 1994). Two surface soil samples were collected with a hand auger from the first 2 feet of soil and analyzed for nitroaromatics, volatile organic compounds, semivolatile organic compounds, and inorganics. The MK study concluded that all detected organic and inorganic constituents were below quantitation limits or otherwise at low concentrations.

1.4 Protocol for the Baseline Human Health Risk Assessment

The BHHRA Addendum was performed consistent with the AP2 BHHRA work plan (Shaw, 2010a). The AP2 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:

- 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.

- 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.

- USACE, 1999, ***Risk Assessment Handbook, Volume I: Human Health Evaluation***, Engineer Manual EM 200-1-4.

- EPA, 1989, ***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.

- 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.

- 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.

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

- 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.

- 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.

2.0 Data Evaluation

Data evaluation consists of a description of the appropriate data sources for Coal Yard No. 2 soil, a discussion of data quality, a description of the methodology used for identification of the chemicals of potential concern (COPC), and a summary of the COPCs.

2.1 Data Sources

All soil samples from which the validated analytical data used in the BHHRA Addendum were derived are presented in Table 2-1. The sample summary table identifies each sample used in the BHHRA Addendum and the associated analytical suite, which are those collected as part of the remedial investigation in 2011 and described in the Coal Yard No. 2 site characterization report (Shaw, 2012). The results from the SI samples described in Section 1.3 were not used in the BHRRA because of uncertainty as to the sample locations, the age of the sample results (20 years), and the observation that the analytes detected in these SI samples were each reported at concentrations less than concentrations observed in the samples collected for this remedial investigation . All Coal Yard No. 2 sampling locations are shown on Figure 1-3.

2.2 Organization of the Analytical Data

Prior to initiation of BHHRA calculations, a database of chemicals present in site soil samples was compiled. This database includes all chemicals detected as described in the site characterization report. The surface soil and subsurface soil are considered separate media. Surface and subsurface soil data are typically combined to assess exposures under the construction worker, future groundskeeper, and hypothetical future residential site-use scenarios, which would likely occur after surface and subsurface soil had been excavated and/or mixed, assuming that COPCs are identified for surface and/or subsurface soil in the BHHRA Addendum. Combined surface and subsurface soil data are generally termed “total soil” in the BHHRA. If a chemical is either a surface soil COPC or a subsurface soil COPC (or both), then that chemical is a total soil COPC.

Generally, surface soil is defined as samples collected from within the interval of 0 to 1 foot below ground surface, and subsurface soil is defined as samples collected from depths greater than 1 foot below ground surface per the work plan (Shaw, 2011). All Coal Yard No. 2 surface soil samples were collected within the 0-to-1-foot interval and subsurface soil samples were collected from either the 3-to-5-foot or 8-to-10-foot interval.

2.3 Evaluation of Data Quality

The quality of the analytical data was evaluated to select data for inclusion in the BHHRA Addendum. 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, 1989):

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 the 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 Addendum as detected concentrations; "R" data and "B" qualified chemical data are not used. "U" qualified data (nondetects) are treated in the BHHRA Addendum 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 is reasonably high that the chemical is present 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 DNT isomers are analyzed by EPA Method 8330 for nitroaromatics as well as EPA Method

8270C for semivolatile organic compounds. As appropriate, risks associated with the reported values from both analyses are typically considered in the risk characterization and discussed as appropriate in the uncertainty analysis, 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 which also considers status as a human nutrient (Section 2.4.1), a frequency-of-detection evaluation (Section 2.4.2), and a background 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 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. For Coal Yard No. 2, only soil is evaluated; therefore, all MDCs and RBSCs are in units of milligrams per kilogram (mg/kg).

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. Where no COPCs for an environmental medium are identified, that medium is not quantitatively evaluated in the BHHRA. 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. RBSCs for both surface and subsurface soil are derived from EPA regional screening level (RSL) "residential soil" values (EPA, 2012a). This is a change in the source of the RBSCs for PBOW BHHRA work plans begun prior to March 2009 based on discussion between USACE and OEPA (2009c), and this change is consistent with current OEPA (2009a) guidelines. Previously, the RBSCs were derived from the EPA (2004b) Region 9 preliminary remediation goals.

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, 2012b). This 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 Addendum. The National Oil and Hazardous Substances Pollution Contingency Plan under the Comprehensive Environmental Response, Compensation, and Liability Act 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). 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 is a special case. Lead exposure and risk is evaluated separately from other chemicals using the EPA (2004c) Integrated Exposure Uptake Biokinetic (IEUBK) model. This IEUBK model includes cumulative lead exposure from multiple media, primarily soil and drinking water exposure. The residential RSL for lead in soil is 400 mg/kg, which is used in the BHHRA as the RBSC. The selection of the action level for lead in drinking water (EPA, 2012c) as the drinking water RSL is based partly on the IEUBK model. Section 5.2 of the RSL user's guide (EPA, 2012b) states that if the average tap water concentration exceeds 15 micrograms per liter (µg/L) and the average soil concentration exceeds 250 mg/kg, then more than the IEUBK target (EPA, 2004c) of 5 percent of the population of exposed children may exceed 10 micrograms per deciliter of lead in blood. It is possible that the residential soil RSL of 400 mg/kg, which is selected as the soil RBSC, may not be protective of 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 the drinking water action level for lead is exceeded, then the IEUBK blood-lead model is run using both average soil and groundwater concentrations, and 2) if the average soil concentration exceeds 250 mg/kg, then the IEUBK model is run, even if neither the soil RBSC nor the drinking water action level is exceeded, using average concentrations of lead in both soil and groundwater. Although groundwater is not evaluated specifically in this BHHRA Addendum, the average lead concentration in AP2 overburden/shale (2.5 µg/L) is less than 15 µg/L, and lead was not detected in AP2 bedrock groundwater (Shaw, 2010b).

For Coal Yard No. 2 soil, the MDCs for lead in surface soil (13.2 mg/kg) and subsurface soil (15.3 mg/kg) are both less than the RBSC (400 mg/kg) and the criterion for average concentration (250 mg/kg).

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 is high that a given chemical is present, the data generally are used in the BHHRA. For most chemicals, their detection is presumptive evidence of their presence. As suggested by EPA (1989), 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 soils 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.

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. The results of the statistical data testing are discussed in the uncertainty analysis.

Inorganics and organics are treated similarly from a quantitative perspective. However, all organics not eliminated on the basis of RBSC exceedance (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 with an MDC in soil exceeding 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 IT (1998) (Table 2-2). The background screening protocol used for Coal Yard No. 2 is based on PBOW Project Delivery Team (PDT) agreements (PBOW PDT, 2000) and differs somewhat from the current OEPA (2009d) guidance. Use of this PBOW PDT method for the development of BSCs and as part of the COPC screening process ensures consistency between all of the PBOW FUDS project sites. Summary tables of the background soil data set for soil are provided as Table 2-2. The background soil samples were collected from near the property boundary, away from any potential source areas. Briefly, BSCs were calculated for use at PBOW based on concentrations found in these background soil samples. Each BSC is either the MDC or the calculated 95th percent upper tolerance limit of the background data set, whichever value is lower (IT, 1998; PBOW PDT, 2000).

The background screening consists of comparing the MDC of the site soil 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. The background data set for soil is described in Section 2.4.3.1 and presented in the site investigation for the acid areas (IT, 1998). 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). WRS testing is performed for inorganics having MDCs that exceed the respective BSCs and are identified as COPCs based on RBSC comparison (Section 2.4.1) and frequency of detection (Section 2.4.2). All COPCs are carried through the risk characterization process; thus, statistical testing results are not used to screen out any chemicals. WRS testing is used only to evaluate inorganic COPCs and is not used to evaluate non-COPC inorganics.

2.4.3.3 Treatment of Organic Compounds

Certain organic compounds (e.g., PAHs) in site media may be attributable to background conditions. However, no organic compounds are summarily screened out. Instead, all detected organic compounds are carried through the risk assessment process (i.e., exposure assessment, toxicity assessment, 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 Coal Yard No. 2 surface soil in Table 2-3 and for Coal Yard No. 2 subsurface soil in Table 2-4. These tables provide the following information for each detected chemical as applicable:

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

As shown in Tables 2-3 and 2-4, none of the chemicals detected in Coal Yard No. 2 surface soil or subsurface soil are COPCs. RBSCs are used to screen for human health risks at an ILCR of 1E-6 and an HQ of 0.1. Chemicals with ILCRs and HQs less than these respective levels are identified in the work plan (Shaw, 2010a) as having insignificant contributions to risk/hazard. This indicates that the cancer risks and noncancer hazards associated with exposure to Coal Yard No. 2 soils are negligible and/or are not greater than those associated with background soils. Therefore, a quantitative risk assessment (exposure assessment, toxicity assessment, and risk characterization [EPA, 1989]) is not necessary and was not performed.

3.0 Summary and Conclusions

3.1 Summary

The BHHRA Addendum was conducted to evaluate cancer risk and noncancer hazards associated with Coal Yard No. 2 surface soil and subsurface soil. A COPC identification process, which includes both risk-based screening and background screening components, was performed to identify chemicals detected in Coal Yard No. 2 soil that may contribute appreciably to risk or hazard. The chemicals detected in surface and subsurface soil were screened against the respective residential exposure-based RBSCs, and inorganics in soil were also screened against BSCs. COPCs for the various media are typically identified based on this screening.

3.2 Conclusions

None of the chemicals detected in Coal Yard No. 2 surface soil or subsurface soil were identified as COPCs. The results of the COPC screening indicate that the risks/hazards associated with chemicals detected in Coal Yard No. 2 soils are negligible and/or are related to background soil conditions. Accordingly, a quantitative risk assessment beyond the COPC screening is unnecessary for Coal Yard No. 2 soils.

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TABLES

Table 2-1

Soil SampleSummary
Baseline Human Health Risk Assessment Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location	Sample Number	Sample Purpose	Sample Date	Depth of Sample (ft bgs)			Analysis
CY2-SB01	CY0015	REG	10/27/2011	0.5	-	1	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0016	FD	10/27/2011	0.5	-	1	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0016	FS	10/27/2011	0.5	-	1	PCB [a]
CY2-SB01	CY0018	REG	10/27/2011	3	-	5	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0019	REG	10/27/2011	8	-	10	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB02	CY0020	REG	10/27/2011	0.5	-	1	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB02	CY0021	REG	10/27/2011	3	-	5	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB02	CY0022	REG	10/27/2011	8	-	10	Explosives, Gen Chem, Metals, SVOC
CY2-SB02	CY0023	FD	10/27/2011	8	-	10	Explosives, Gen Chem, Metals, SVOC
CY2-SB03	CY0025	REG	10/26/2011	0.5	-	1	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB03	CY0026	REG	10/26/2011	3	-	5	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB03	CY0027	REG	10/26/2011	8	-	10	Explosives, Gen Chem, Metals, SVOC
CY2-SB04	CY0028	REG	10/26/2011	0	-	1	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB04	CY0029	REG	10/26/2011	3	-	5	Explosives, Gen Chem, Metals, Pest, PCB, SVOC
CY2-SB04	CY0030	REG	10/26/2011	8	-	10	Explosives, Gen Chem, Metals, SVOC

[a] The field split sample PCB results were used for surface soil location CY2-SB01 because PCBs were inadvertently not analyzed in the original sample as the result of a paperwork error.
ft bgs - feet below ground surface
FD - Field duplicate; averaged with regular sample.
Exp - Explosives.
PCB - Polychlorinated biphenyls.
REG - Regular sample.
SVOC - Semivolatile organic compounds.

Table 2-2

Background Screening Concentrations of Inorganics in Soil
Baseline Human Health Risk Assessment for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits [a]	Statistical Distribution	Arithmetic Mean	95% UTL [b]	Background Screening Concentration [c]
Aluminum	12 / 12	3520 - 15500	22.6 - 26.5	L	8.43E+03	2.69E+04	15500
Antimony	9 / 25	5.9 - 9.3	5.4 - 8.0	NP	4.68E+00	NA	9.30
Arsenic	23 / 26	2.1 - 36.5	1.1 - 24.7	L	1.08E+01	7.10E+01	36.5
Barium	9 / 12	35.6 - 826	22.6 - 26.5	L	1.16E+02	1.30E+03	826
Beryllium	6 / 25	0.57 - 1	0.57 - 1.2	L	5.65E-01	1.17E+00	1.00
Cadmium	0 / 25	NA	0.57 1.2	L	4.49E-01	NA	NA
Calcium	12 / 12	735 - 52300	566 - 663	L	1.13E+04	2.18E+05	52300
Chromium	25 / 26	4.4 - 29	1.1 - 12.3	NP	1.34E+01	NA	29.0
Cobalt	9 / 12	9.6 - 116	5.7 - 61.7	L	2.26E+01	2.48E+02	116
Copper	23 / 26	2.3 - 56.2	2.2 - 3.3	L	1.70E+01	1.47E+02	56.2
Iron	12 / 12	5880 - 234000	11.3 - 123	L	4.01E+04	3.58E+05	234000
Lead	26 / 26	1.9 - 48.6	0.34 - 7.4	L	1.28E+01	5.13E+01	48.6
Magnesium	12 / 12	629 - 10400	566 - 663	L	3.26E+03	3.08E+04	10400
Manganese	26 / 26	21 - 13300	1.7 - 18.5	L	7.29E+02	3.51E+03	3506
Mercury	2 / 26	0.085 - 0.085	0.037 - 0.3	L	9.06E-02	5.60E-01	0.085
Nickel	26 / 26	5.4 - 55.1	4.5 - 5.3	L	2.28E+01	7.79E+01	55.1
Potassium	11 / 12	579 - 3390	566 - 663	L	1.24E+03	6.08E+03	3390
Selenium	5 / 25	0.61 - 2	0.57 - 4.9	NP	1.55E+00	NA	2.00
Silver	2 / 26	1.1 - 11.1	1.1 - 1.3	NP	1.00E+00	NA	11.1
Sodium	0 / 12	NA	566 - 663	L	3.03E+02	NA	NA
Thallium	2 / 25	1.2 - 1.3	1.1 - 6.1	NP	1.91E+00	NA	1.30
Vanadium	11 / 12	9 - 40.9	5.7 - 61.7	L	2.48E+01	8.31E+01	40.9
Zinc	26 / 26	6.6 - 655	0.57 - 12.3	L	7.30E+01	3.22E+02	322

L - Lognormal; mg/kg - milligrams per kilogram; NP - nonparametric; NA - not applicable; not available.

[a] A single background sample had to be diluted such that the reporting limits of this sample (BCG-SB01, 6990) were elevated 10 or 20 times higher than they would have been if not diluted. This affects the maximum reporting limit shown for arsenic, chromium, cobalt, iron, lead, manganese, and vanadium. Reporting limits for these analytes in all other samples were much lower, approximately by an order of magnitude or more in each case.

[b] 95% UTL - 95% upper tolerance limit calculated as described in IT Corporation (IT), 1998, *Site Investigation of Acid Areas, Plum Brook Ordnance Works, Sandusky, Ohio* , August.

[c] The maximum detected concentration is used as the background screening criterion for nonparametric data sets; for normal or lognormal data sets, the 95% UTL or the maximum detected concentration, whichever is less, is used. This approach was agreed upon for all future risk assessments by the Plum Brook Ordnance Works Project Delivery Team (PDT) during the May 10, 2000 PDT meeting.

Note: Detection limits from sample 6990 were deleted when calculating results for antimony, beryllium, cadmium, selenium, and thallium. The detection limits were elevated by dilution factors which greatly exceed any detected concentration and would bias results unrealistically high.

Source: IT, 2001, *TNT Areas A and C Remedial Investigation, Volume 2 Baseline Human Health Risk Assessment* , Final, Former Plum Brook Ordnance Works, Sandusky, Ohio,November, and reports referenced therein, including IT (1998).

Table 2-3

Statistical Summary and Selection of Chemicals of Potential Concern in Surface Soil
Baseline Human Health Risk Assessment Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Range of Values, mg/kg										
	Detection	Percent	Detected Concentrations				Method Detection Limit		Mean	BSC [a]	RBSC [b]		
Chemical	Frequency	Detection	Minimum	VQ	Maximum	VQ	Minimum	Maximum	mg/kg	mg/kg	mg/kg		COPC? [c,d]
Inorganics													
Aluminum	4 / 4	100	6.65E+03		1.13E+04	J	9.10E-01	3.34E+00	8.78E+03	1.55E+04	7700		N (b)
Antimony	1 / 4	25	2.50E-01	J	2.50E-01	J	4.60E-02	2.50E-01	2.28E-01	9.30E+00	3.1		N (b)
Arsenic	4 / 4	100	6.10E+00		1.35E+01		4.60E-02	2.50E-01	1.05E+01	3.65E+01	0.39		N (b)
Barium	4 / 4	100	3.52E+01		6.80E+01		1.90E-01	1.00E+00	5.71E+01	8.26E+02	1500		N (b)
Beryllium	4 / 4	100	2.70E-01		7.70E-01	J	4.60E-03	2.50E-02	4.70E-01	1.00E+00	16		N (b)
Cadmium	1 / 4	25	7.20E-01		7.20E-01		4.60E-03	2.50E-02	1.97E-01	NA	7		N (a)
Calcium	4 / 4	100	1.27E+03		6.28E+03	J	2.30E+00	1.30E+01	3.17E+03	5.23E+04	Nutrient		N (c)
Chromium	4 / 4	100	1.04E+01		2.20E+01		4.60E-02	2.50E-01	1.63E+01	2.90E+01	0.29		N (b)
Cobalt	4 / 4	100	3.50E+00		1.10E+01	J	4.60E-02	2.50E-01	6.50E+00	1.16E+02	2.3		N (b)
Copper	4 / 4	100	1.12E+01		2.44E+01		4.60E-02	2.50E-01	2.04E+01	5.62E+01	310		N (b)
Iron	4 / 4	100	1.64E+04		3.43E+04		1.10E+00	5.80E+00	2.57E+04	2.34E+05	5500		N (b)
Lead	4 / 4	100	7.40E+00		1.32E+01		3.80E-02	5.10E-02	1.03E+01	4.86E+01	400		N (b)
Magnesium	4 / 4	100	1.81E+03		3.69E+03		2.30E+00	1.30E+01	2.76E+03	1.04E+04	Nutrient		N (c)
Manganese	4 / 4	100	8.11E+01		2.24E+02		4.60E-02	2.50E-01	1.32E+02	3.51E+03	180		N (b)
Mercury	4 / 4	100	3.40E-02	J	4.50E-02	J	6.20E-03	6.90E-03	3.93E-02	8.50E-02	2.3		N (b)
Nickel	4 / 4	100	1.07E+01		2.83E+01		4.60E-02	2.50E-01	2.04E+01	5.51E+01	150		N (b)
Potassium	4 / 4	100	4.72E+02		7.07E+02	J	2.30E+00	1.30E+01	6.11E+02	3.39E+03	Nutrient		N (c)
Selenium	3 / 4	75	9.10E-01	J	1.70E+00	J	3.80E-01	4.65E+00	2.09E+00	2.00E+00	39		N (b)
Silver	1 / 4	25	8.80E-02	J	8.80E-02	J	4.60E-02	2.50E-01	1.87E-01	1.11E+01	39		N (b)
Sodium	1 / 4	25	5.26E+01	J	5.26E+01	J	3.90E+01	2.20E+02	1.54E+02	NA	Nutrient		N (c)
Vanadium	4 / 4	100	1.61E+01		3.24E+01		4.60E-02	2.50E-01	2.51E+01	4.09E+01	39		N (b)
Zinc	4 / 4	100	2.42E+01		6.78E+01		4.60E-02	2.50E-01	5.01E+01	3.22E+02	2300		N (b)
Semivolatile Organic Compounds													
Fluoranthene	2 / 4	50	3.10E-02	J	6.47E-02	J	1.90E-02	2.00E-02	3.37E-02		230		N (a)
Methylnaphthalene, 2-	1 / 4	25	4.29E-02	J	4.29E-02	J	1.90E-02	2.00E-02	2.55E-02		23		N (a)
Naphthalene	1 / 4	25	3.21E-02	J	3.21E-02	J	3.10E-02	3.20E-02	3.18E-02		3.6		N (a)
Phenanthrene	1 / 4	25	2.92E-02	J	2.92E-02	J	1.90E-02	2.00E-02	2.21E-02		170	e	N (a)
Pyrene	1 / 4	25	6.34E-02	J	6.34E-02	J	1.90E-02	2.00E-02	3.04E-02		170		N (a)

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] Value is either the 95th percent upper tolerance limit or the maximum detcted value of the background data set, whichever is less. Source: IT Corporation (IT), 2000, *TNT Areas A and C Remedial Investigation, Volume 2 Baseline Human Health Risk Assessment* , Final, Former Plum Brook Ordnance Works, November, and reports
[b] Risk-Based Screening Concentrations based on USEPA Regional Screening Level Table (November 2012) 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] RBSC based on acenapthene.

Table 2-4

Statistical Summary and Selection of Chemicals of Potential Concern in Subsurface Soil
Baseline Human Health Risk Assessment Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

			Range of Values, mg/kg									
			Detected Concentrations				Reporting Limits					
Chemical	Detection Frequency	Percent Detection	Minimum	VQ	Maximum	VQ	Minimum	Maximum	Mean mg/kg	BSC [a] mg/kg	RBSC [b] mg/kg	COPC? [c,d]
Inorganics												
Aluminum	8 / 8	100	5.14E+03		8.50E+03		1.00E+00	5.40E+00	6.35E+03	1.55E+04	7700	N (b)
Arsenic	8 / 8	100	2.00E+00		1.15E+01		4.50E-02	2.50E-01	5.87E+00	3.65E+01	0.39	N (b)
Barium	8 / 8	100	3.52E+01		7.09E+01		1.80E-01	9.00E-01	5.37E+01	8.26E+02	1500	N (b)
Beryllium	8 / 8	100	3.60E-01	J	4.90E-01		9.65E-03	2.20E-02	4.44E-01	1.00E+00	16	N (b)
Cadmium	6 / 8	75	2.40E-01	J	8.90E-01		5.30E-03	2.50E-02	4.36E-01	NA	7	N (a)
Calcium	8 / 8	100	3.46E+04		6.07E+04		4.90E+00	1.10E+01	4.76E+04	5.23E+04	Nutrient	N (c)
Chromium	8 / 8	100	9.80E+00		1.67E+01		1.10E-01	2.50E-01	1.29E+01	2.90E+01	0.29	N (b)
Cobalt	8 / 8	100	5.50E+00		1.51E+01		5.30E-02	2.50E-01	8.88E+00	1.16E+02	2.3	N (b)
Copper	8 / 8	100	1.88E+01		2.64E+01		1.10E-01	2.50E-01	2.21E+01	5.62E+01	310	N (b)
Iron	8 / 8	100	1.71E+04		2.04E+04		2.25E+00	5.20E+00	1.89E+04	2.34E+05	5500	N (b)
Lead	8 / 8	100	8.30E+00		1.53E+01		4.30E-02	2.20E-01	1.24E+01	4.86E+01	400	N (b)
Magnesium	8 / 8	100	1.41E+04		2.37E+04		4.90E+00	1.10E+01	1.63E+04	1.04E+04	Nutrient	N (c)
Manganese	8 / 8	100	4.32E+02		8.16E+02		1.40E-01	2.50E-01	5.51E+02	3.51E+03	180	N (b)
Mercury	8 / 8	100	1.10E-02	J	4.00E-02	J	6.40E-03	7.70E-03	1.98E-02	8.50E-02	2.3	N (b)
Nickel	8 / 8	100	1.61E+01		4.00E+01		5.30E-02	2.50E-01	2.41E+01	5.51E+01	150	N (b)
Potassium	8 / 8	100	8.48E+02	J	1.45E+03		4.90E+00	1.10E+01	1.19E+03	3.39E+03	Nutrient	N (c)
Selenium	3 / 8	38	4.30E-01	J	1.15E+00	J	2.10E-01	4.90E-01	5.58E-01	2.00E+00	39	N (b)
Silver	5 / 8	63	5.30E-02	J	4.65E-01	J	4.50E-02	2.50E-01	1.74E-01	1.11E+01	39	N (b)
Sodium	4 / 8	50	1.14E+02	J	1.46E+02	J	8.35E+01	1.90E+02	1.53E+02	NA	Nutrient	N (c)
Thallium	1 8	13	3.90E-01	J	3.90E-01	J	1.50E-01	6.70E+00	1.83E+00	1.30E+00	0.078	N (b)
Vanadium	8 / 8	100	1.14E+01		2.49E+01		4.50E-02	2.50E-01	1.58E+01	4.09E+01	39	N (b)
Zinc	8 / 8	100	4.60E+01		6.37E+01		1.10E-01	2.50E-01	5.36E+01	3.22E+02	2300	N (b)
Semivolatile Organic Compounds												
Bis(2-ethylhexyl)phthalate	1 / 8	13	3.21E-01	J	3.21E-01	J	8.10E-02	8.60E-02	1.14E-01		35	N (a)

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] Value is either the 95th percent upper tolerance limit or the maximum detcted value of the background data set, whichever is less. Source: IT Corporation (IT), 2000, *TNT Areas A and C Remedial Investigation, Volume 2 Baseline Human Health Risk Assessment* , Final, Former Plum Brook Ordnance Works, November, and reports referenced therein.
[b] Risk-Based Screening Concentrations based on USEPA Regional Screening Level Table (November 2012) 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.

FIGURES

FIGURE 1-1
PBOW VICINITY MAP

POWERHOUSE No. 2 ASH PITS BASELINE HUMAN HEALTH RISK ASSESSMENT ADDENDUM FOR COAL YARD No. 2 FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

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

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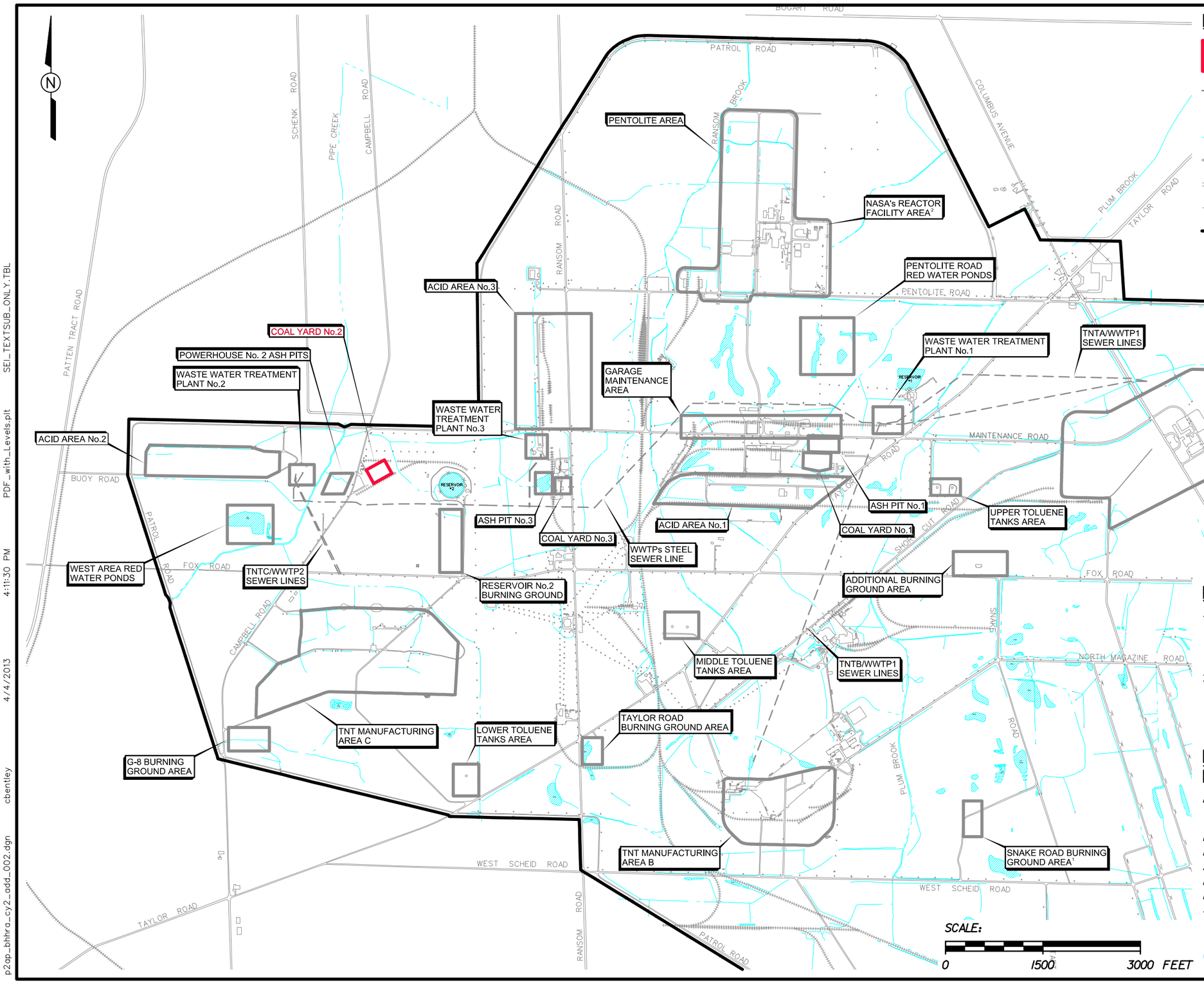

LEGEND:

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

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. REACTOR FACILITY CONSTRUCTED BY NASA POST WWII AND IS IDENTIFIED FOR LOCATION PURPOSES ONLY. DEMOLITION COMPLETED IN 2012.

FIGURE 1-2
LOCATION OF COAL YARD No. 2 AT PBOW

POWERHOUSE No. 2 ASH PITS BASELINE HUMAN HEALTH RISK ASSESSMENT ADDENDUM FOR COAL YARD No. 2 FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

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

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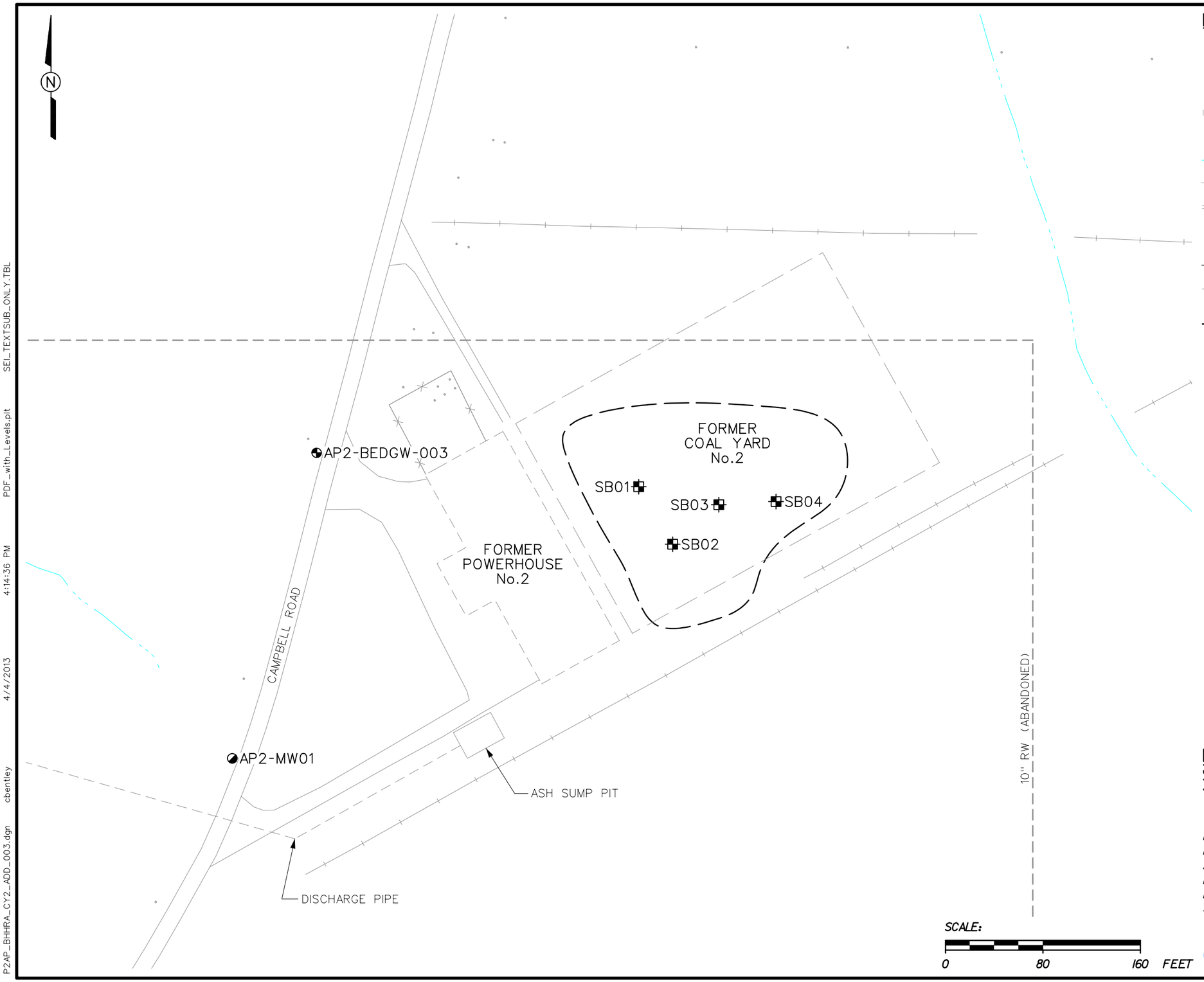

LEGEND:

- OVERBURDEN MONITORING WELL (SCREENED IN SHALE)
- BEDROCK MONITORING WELL (SCREENED IN LIMESTONE)
- SOIL BORING
- UTILITY POLE
- CREEK, DITCH, CONVEYANCE
- FORMER RAILROAD
- ROAD
- APPROXIMATE LOCATION OF FORMER STRUCTURES
- RAW WATER LINE (RW)
- APPROXIMATE HISTORICAL COAL STORAGE PERIMETER BASED ON AERIAL PHOTO
- APPROXIMATE COAL STORAGE PERIMETER BASED ON OCTOBER 2011 FIELD FINDINGS AND EXISTING COAL THICKNESS.

FIGURE 1-3
SAMPLE LOCATIONS AT COAL YARD No. 2

POWERHOUSE No. 2 ASH PITS BASELINE HUMAN HEALTH RISK ASSESSMENT ADDENDUM FOR COAL YARD No. 2
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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

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RESPONSE TO COMMENTS

Responses to Ohio Environmental Protection Agency Comments on the Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment for Powerhouse No. 2 Ash Pits Addendum for Coal Yard No. 2 Former Plum Brook Ordnance Works, Sandusky, Ohio, Dated April 11, 2013

Comments by Janusz Byczkowski, Risk Assessor, Ohio Environmental Protection Agency, received May 17, 2013.

BHHRA Comments

Comment 1: **Section ES-1, Line 6.** The BHHRA document states: "*…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…*"

The issue of determining background and the "agreement" was already discussed in previous reviews. Please note that no legally binding agreement has been made between OEPA and ACE or Shaw Environmental Inc., regarding risk assessment methodology at the NASA Plum Brook Site. Please delete reference to "agreements" with Ohio Environmental Protection Agency.

Response 1: The words "and agreements" will be removed from the indicated text.

BHHRA and SLERA Comments

Comment 2: **BHHRA Table 2-4 and SLERA Table 2-2.** From comparison of maximum detected concentrations of cadmium in soil in BHHRA Table 2-4 versus SLERA Table 2-2 (8.90E-01 vs. 8.10E-01 mg/kg, respectively) it is not clear which numerical value is correct.

Please verify and correct maximum detected concentration of cadmium in soil.

Response 2: The BHHRA and SLERA use different soil datasets to select COPCs/COPECs. The cadmium MDC for the BHHRA in Table 2-4 of 0.89 mg/kg was detected in sample CY0019, which was collected from the 8 to10 feet below ground surface (bgs) interval. Soil at this depth is not included in the SLERA, which only evaluates soil up to 6 feet bgs. Thus, the MDCs in the BHHRA and SLERA are different for chemicals such as cadmium that have higher concentrations in soil samples collected from a depth greater than 6 feet bgs.

APPENDIX F

POWERHOUSE NO. 2 ASH PITS SLERA ADDENDUM FOR COAL YARD NO. 2

Shaw Environmental
& Infrastructure, Inc.

Final
July 2013

Powerhouse No. 2 Ash Pits Screening-Level Ecological Risk Assessment Addendum for Coal Yard No. 2 FUDS Project No. G05OH001822

Former Plum Brook Ordnance Works Sandusky, Ohio

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Nashville District

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July 31, 2013

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 Powerhouse No. 2 Ash Pits Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment Addenda for Coal Yard No. 2***
Former Plum Brook Ordnance Works, Sandusky, Ohio
Contract No. W912QR-08-D-0013: Shaw Project Number 132457

Dear Ms. Coleman:

In accordance with the requirements of Delivery Order No. DX02 of Contract No. W912QR-08-D-0013 awarded to Shaw Environmental & Infrastructure, Inc., a CB&I company, we are pleased to submit the Final Addenda to the Powerhouse No. 2 Ash Pits (AP2) Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment for Coal Yard No. 2 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 AP2 risk assessment work plan.

Enclosed for your records 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
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DISCIPLINE SIGN-OFF REVIEW

Shaw Environmental & Infrastructure, Inc.

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

Project Description: Powerhouse No. 2 Ash Pits SLERA Addendum for Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Contract No. W912QR-08-D-0013 Delivery Order No. DX02

Project No. 132457 Task/Phase Number: 45000000

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☐	Work Plans	
X	Report	SLERA Addendum
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☐	Design Calculations	
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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
Powerhouse No. 2 Ash Pits
Screening-Level Ecological Risk Assessment Addendum
for Coal Yard No. 2
FUDS Project No. G05OH001822

Former Plum Brook Ordnance Works,
Sandusky, Ohio

Prepared for:

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Shaw Project Number 132457

July 2013

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List of Acronyms

AP2	Powerhouse No. 2 Ash Pits
bgs	below ground surface
BSC	background screening concentration
COPEC	chemical of potential ecological concern
D&M	Dames and Moore, Inc.
EPA	U.S. Environmental Protection Agency
ESV	ecological screening value
IT	IT Corporation
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NASA	National Aeronautics and Space Administration
NWI	National Wetlands Inventory
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
PBOW	Plum Brook Ordnance Works
PCB	polychlorinated biphenyl
Shaw	Shaw Environmental & Infrastructure, Inc.
SLERA	screening-level ecological risk assessment
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers

Executive Summary

A screening-level ecological risk assessment (SLERA) was performed to provide an estimate of current and future ecological hazard associated with potential hazardous substance releases within the Powerhouse No. 2 Coal Yard (Coal Yard No.2) site at Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio. Coal Yard No.2 is associated with Powerhouse No. 2 Ash Pits (AP2) at PBOW, and this SLERA is an addendum to the AP2 SLERA. Because of the small size of the site, the site is not spatially relevant to any significant degree for most ecological receptors. The site-specific SLERA was performed to satisfy administrative requirements, including Defense Environmental Restoration Program-Formerly Used Defense Sites regulations. The results of the SLERA contribute to the overall characterization of the site and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives, if necessary. The objective of the SLERA is to present information for risk managers regarding the potential for adverse impacts to occur to ecological receptors as a result of site-related releases. Although the term "ecological risk assessment" is commonly used in guidance documents and available technical literature, it should be noted that ecological "risk" is not calculated in the SLERA, as no statistical probabilities of toxicological effects are generated in the SLERA. The assessment addresses the potential for adverse effects to the vegetation, wildlife, aquatic life, and endangered and threatened species.

The maximum detected concentrations of chemicals in soil were compared with risk-based screening ecotoxicity values during an initial screening step. Chemicals that exceeded the screening values or for which no screening values were available and that did not meet additional screening criteria (e.g., comparison with background data, nutrient status, frequency of detection, etc.) were retained as chemicals of potential ecological concern (COPEC) and assessed further. The background screening protocol used for Coal Yard No. 2 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 COPEC screening process ensures consistency between all of the PBOW Formerly Used Defense Sites project sites. Only one chemical, cadmium, was identified as a COPEC. Because it was detected at low concentrations only marginally above its conservative screening value, and because it is not a known or suspected contaminant based on site history, cadmium was not recommended for further investigation. Therefore, the SLERA for the Coal Yard No. 2 concluded after the COPEC selection stage.

Based on the findings of the SLERA, the potential for adverse effects to populations of ecological receptors exposed to chemicals in soil at the Coal Yard No. 2 is expected to be negligible.

1.0 Introduction

This screening-level ecological risk assessment (SLERA) Addendum evaluates the potential for adverse effects posed to ecological receptors from potential releases at the Powerhouse No. 2 Coal Yard (Coal Yard No. 2) at the former Plum Brook Ordnance Works (PBOW). Coal Yard No.2 is associated with Powerhouse No. 2 Ash Pits (AP2) at PBOW, and this SLERA is an addendum to the AP2 SLERA (Shaw Environmental & Infrastructure [Shaw] [a CB&I company], 2010). The approaches used to evaluate the potential for ecological risk are described in the Powerhouse No. 2 Ash Pit SLERA work plan (Shaw, 2009). This SLERA is consistent with the ecological risk assessment process described in U.S. Environmental Protection Agency (EPA) guidance (e.g., EPA [1997]), with Ohio Environmental Protection Agency (OEPA) Division of Emergency and Remedial Response guidance (OEPA, 2008), and with the procedures established in previous ecological risk assessments performed at PBOW (e.g., IT Corporation [IT], 2001; Shaw, 2010), with some adjustments to accommodate current practices in the field of ecological risk assessment.

This work is being conducted by Shaw for the U.S. Army Corps of Engineers (USACE) under the Defense Environmental Restoration Program-Formerly Used Defense Sites and managed by the USACE Huntington District, with technical oversight provided by the USACE Nashville District.

1.1 Facility Description and Location

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-dinitrotoluene, and pentolite (USACE, 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 explosive 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, including 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 War Department in late 1945. During decontamination, all structures, equipment, and manufacturing debris were either removed and salvaged or removed and burned. After decontamination, 3,230 acres of the property was initially transferred to the Ordnance Department, then to the War Assets Administration after it was certified by the U.S. Army to be decontaminated. In 1949, PBOW was transferred to the General Services Administration. This transfer did not include the 2,800 acres comprising the Plum Brook Depot area, also known as the Magazine Area. The Department of the Army reacquired the 3,230 acres in 1954 and performed remedial efforts from the mid-1950s until 1963. In 1955, the Army completed further decontamination of manufacturing process lines. This effort included removal of contaminated surface and subsurface soil around the building 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.

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 likewise buried. 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 nitroaromatic-filled flumes that were excavated (Dames and 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 Glenn Research Center at Lewis Field,

Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the facility are currently on standby or inactive status. On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. 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 (USACE, 1995).

1.3 Powerhouse No. 2 Coal Yard Description and History

Three power stations, Powerhouse No. 1, Powerhouse No. 2, and Powerhouse No. 3, were constructed and utilized to support the acid, 2,4,6-TNT, dinitrotoluene, and pentolite manufacturing processes. Each power station consisted of a main powerhouse, a coal storage area (coal yard), and two aboveground fuel storage tanks. The fuel storage tanks were surrounded by a berm to contain any potential spills or leaks. Each powerhouse building consisted of a boiler house, compressor room, electrical room, filter room, and locker room. Each building also contained two to four large coal-burning boilers, a turboelectric generator, a feed water treatment system, and several steam-driven or electric air compressors. The generated steam was used for space heating, driving compressors, and generating electrical power. As mentioned previously, the coal yards were used as storage areas providing coal to be used in the powerhouse's boilers. The coal was brought into the yards via train. Figure 1-2 shows the location of the three coal yards on PBOW property.

Coal Yard No. 2 is located immediately to the northeast of Powerhouse No. 2. The former coal yard is estimated to have been approximately 200 feet wide by 290 feet in length, or approximately 1.3 acres. The area is currently covered with grass and brush along with some hydrophilic vegetation indicative of wetlands. Demolition of the former Powerhouse No. 2 building by NASA in 2010 resulted in some disturbance of surface soil and vegetation, primarily in areas outside of the footprint of the former coal yard. Minor amounts of coal were observed on the ground surface in isolated areas during previous site walks. No permanent or semipermanent water bodies are present at this site; therefore, soil is the only medium evaluated in the SLERA.

1.4 Scope and Objectives

The objective of this SLERA is to provide an estimate of the potential for adverse ecological effects associated with contamination resulting from former PBOW activities at Coal Yard No. 2. The results of the SLERA will contribute to the overall characterization of the site and may be used to determine the need for additional investigations or to develop, evaluate, and select appropriate remedial alternatives. Guidance documents used to perform the SLERA include the

general guidelines of the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel, et al., 1996), as well as the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA, 1997), *Region 5 Biological Technical Assistance Group (BTAG) Ecological Risk Assessment Guidance Bulletin No. 1* (EPA, 1996), and *Guidance for Conducting Ecological Risk Assessments* (OEPA, 2008). The SLERA fits into Steps 1 and 2 of the ecological risk assessment guidance for Superfund process (EPA, 1997), and Level I through a maximum of Level III evaluation using the OEPA (2008) process.

The goal of the SLERA is to evaluate the potential for adverse ecological effects to ecological receptors from site-related contaminants at Coal Yard No. 2. This objective is met by characterizing the ecological communities in the vicinity of the site, determining the particular contaminants present, identifying pathways for receptor exposure, and estimating the potential for adverse effects to identified receptors. The SLERA addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (e.g., sediment-dwelling organisms), threatened and endangered species, and wetlands or other sensitive habitats associated with the site.

The SLERA evaluates the chemicals of potential ecological concern (COPEC), the ecosystems and receptors at risk, the ecotoxicity of the contaminants known or suspected to be present, and observed or anticipated ecological effects. This evaluation is conducted in two steps: (1) a screening assessment step, which is described in Chapter 2.0 as part of the problem formulation, and (2) a predictive assessment step. Ecological endpoints to be addressed in both steps are identified. The results and conclusions of the screening assessment determine whether a predictive assessment is needed. The criteria by which the need for a predictive assessment is measured are formalized as null hypotheses to be accepted (in which case a predictive assessment is not needed) or rejected (in which case a predictive assessment is needed). The predictive assessment includes the exposure characterization, ecological effects characterization, and risk characterization. Because of the lack of contamination detected at the site, the SLERA process was terminated after the initial screening assessment step during the problem formulation stage, and the predictive assessment was not performed.

2.0 Problem Formulation

The screening assessment null hypotheses are stated as follows:

- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of viable habitat for potential ecological receptors.
- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential ecological receptors.
- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential exposure pathways.
- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential chemical stressors.

If one or more of these null hypotheses are accepted, a predictive assessment is not triggered. All four null hypotheses must be rejected for a predictive assessment to be triggered. The first three null hypotheses are tested with the results of the ecological site description, the pre-assessment reconnaissance, the documentation of potential receptors of special concern and critical habitats, and the determination of significant ecological threats (Section 2.1). The fourth null hypothesis is tested with the results of COPEC selection (Section 2.2).

If a predictive assessment is triggered, terrestrial ecological conceptual site models are developed, as appropriate, and additional problem formulation tasks are performed.

2.1 Ecological Site Description

This ecological site description includes a general discussion of site background and the area of concern, surface water resources (if any), wetlands, and vegetative communities; a species inventory; and a discussion of threatened and endangered species. Ecological characterization of the study area was based on a compilation of existing ecological information and site reconnaissance activities.

Because Coal Yard No. 2 is in such close proximity to the Powerhouse No. 2 Ash Pits, a formal ecological reconnaissance was not performed for Coal Yard No. 2. Rather, the habitat description, sensitive ecological resources, and faunal assemblages (including potential threatened and endangered species) described in the Powerhouse No. 2 Ash Pits SLERA (Shaw, 2010) were determined to also be relevant for the Coal Yard No. 2 site. Also, a trained ecologist specifically visited Coal Yard No. 2 in June and September of 2011 to make general

observations of site conditions. Photographs taken during these visits are presented on Figure 2-1.

General Site Background. PBOW, approximately 6,400 acres in size, is located within the Eastern Lake Plains physiographic region of the Eastern Huron/Erie Lake Plain Ecoregion (Lafferty, 1979; Omernik, 1986). This region is generally characterized as containing flat plains as the predominant land surface form and as having a dominant natural vegetation of elm and ash in undisturbed areas. Approximately two-thirds of Erie County was once covered by a glacial lake that produced features such as beach ridges and wave-cut cliffs. Much of the region is poorly drained due to the flat topography and low stream gradients. Many of the wetlands adjacent to Lake Erie in this region have been preserved by various federal, state, and private organizations (Peterjohn and Rice, 1991), thereby providing important wetland habitat for wildlife.

Across PBOW, the land slopes gently to the north-northeast towards Lake Erie. Elevations range from 675 feet above mean sea level at the southwest edge of the site to 625 feet above mean sea level in the northern portion of the property at Bogart Road, resulting in an average slope of approximately 0.3 percent. The Lake Plains region itself is over 69 percent cropland, 2.7 percent pasture land, and 10.5 percent forest (Ohio Department of Natural Resources [ODNR], 1985). However, since the U.S. Army acquired the site in 1941 and removed the land from agricultural production, undeveloped portions of the former PBOW have become second-generation forest and open fields. This has resulted in PBOW becoming an island of forest and open fields within a sea of agricultural and residential land in north-central Ohio.

As noted in Section 1.3, Coal Yard No. 2 is located immediately adjacent to (northeast) of Powerhouse No. 2. Figure 1-2 shows the specific site location. Descriptions and information regarding the local geography, topography, surface drainage, regional and local geology and hydrogeology characteristics, and precipitation influence effects on local water levels have been prepared and included in the final Powerhouse No. 2 Ash Pits Site Characterization Report (Shaw, 2012). Descriptions of the ecological resources in the vicinity of the Coal Yard No. 2, including common flora and fauna species in the area, discussion of threatened or endangered species, and habitat descriptions of the locality, are included in the Powerhouse No. 2 Ash Pits SLERA (Shaw, 2010).

During a recent field visit performed on September 1, 2011, the majority of the Coal Yard No. 2 area was noted as having recently been filled and graded. Small pieces of coal were observed in the soil. The northern border of the coal yard consists of an early successional forest. As noted

during the initial site staking before any grading or backfilling had taken place, the former Coal Yard No. 2 area was low lying with minimal relief and contained standing water. This water eventually percolated into the soil or evaporated prior to soil sampling. The presence of standing water and minimal relief suggests that limited site runoff occurs.

According to the National Wetland Inventory (NWI) maps for the area (U.S. Fish and Wildlife Service, 2013), there are no designated wetlands at the Coal Yard No. 2 site. It should be noted that the accuracy of NWI maps is limited, especially in relatively flat landscapes such as PBOW, because minor depressions often contain isolated wetlands not easily identified through aerial photograph interpretation (the process used by the U.S. Fish and Wildlife Service in preparing NWI maps). NASA is currently performing a wetland delineation study at PBOW. This delineation effort was not complete at the time of this SLERA's submittal. The delineation effort will better identify locations and extent of sensitive wetland habitat throughout the installation.

2.2 Selection of Chemicals of Potential Ecological Concern

A list of the Coal Yard No. 2 soil samples used for the SLERA is presented in Table 2-1. Sample locations are presented on Figure 2-2. From the chemical results of samples in Table 2-1, a COPEC selection process was performed to develop a subset of chemicals detected at the site that are potentially site-related. Selected COPECs are also present at sufficient frequencies, concentrations, and spatial areas to pose a potential risk to ecological receptors. Examples of screening criteria that were used include the following: analytical detection limit, frequency of detection less than 5 percent, comparability with background, status as a nutrient, and comparison with risk-based screening ecotoxicity values. The COPEC selection process is described in more detail in Section 2.2.3.

2.2.1 Data Organization

Chemical analytical data were reviewed and evaluated for quality, usefulness, and uncertainty. Data identified as being of acceptable quality for use in the SLERA were summarized in a manner that presents the pertinent information to be applied in the SLERA. Any data rejected during the data evaluation as a result of the data evaluation ("R"-qualified data) were identified along with the rejection rationale. All data used in the SLERA were validated.

For ecological impacts, soil from 0 to 6 feet below ground surface (bgs) was used. The 0 to 6 feet depth interval was selected for three primary reasons: (1) to maintain consistency with other PBOW ecological risk assessments (e.g., IT [2001]), (2) to include potential exposure to ecological receptors that may be exposed to deeper soil, and (3) to increase the size of the total

soil database by including samples collected from up to 6 feet bgs. The data used for the SLERA are presented in Appendix A.

Polychlorinated biphenyls (PCB) were scheduled to be collected from sample location CY2-SB01 for the 0.5 to 1 foot and 3 to 5 feet depth ranges, but a paperwork error resulted in a failure to analyze for PCBs in these depth intervals for this sample location. Although field split samples are typically not used for risk assessment purposes, the field split sample for this location did analyze for PCBs. Therefore, the data for field split sample CY0017 were used to represent the 0.5 to 1 foot bgs depth at CY2-SB01.

Chemicals not detected at least once in soil were not included in the risk assessment. Available background data were determined for soil. Potential sources of background information include data from previous and current investigations as well as monitoring wells in areas unaffected by site activities.

The analytical data included qualifiers from the analytical laboratory quality control or from the data validation process that reflect the level of confidence in the data. Some of the data qualifiers reported in the data evaluated for this SLERA and their meanings are as follows (EPA, 1989):

- U - Chemical was analyzed for but not detected; the associated value is the sample quantitation limit.
- J - Value is estimated, concentration reported above the method detection limit and below the contract-required quantitation limit.
- R - Quality control indicates that the data are unusable (chemical may or may not be present).
- B - Concentration of chemical in the sample is not sufficiently higher than concentration in the blank. If the concentration in the sample is less than 5 times the blank concentration or less than 10 times the concentration of a common laboratory contaminant, the result is given a B-qualifier and is not used in the risk assessment. Common laboratory contaminants include acetone, 2-butanone, methylene chloride, toluene, and phthalate esters (EPA, 1989).

"J"-qualified data are used in the risk assessment; "R"- and "B"-qualified data are not. The handling of "U"-qualified data (nondetects) is described in the following sections.

2.2.2 Descriptive Statistical Calculations

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the 95 percent upper confidence limit of the mean (UCL) are usually estimated for COPECs. As described in Section 2.2.4, 95 percent UCLs were not calculated for Coal Yard No. 2. The means of detected chemicals are presented in Table 2-2, however, and these values were calculated using the method detection limit as a surrogate concentration for nondetect results.

Analytical data from field duplicates were joined with parent sample results to yield one result for use in the generation of mean concentrations, as follows:

- The average of field duplicate and parent sample was used if both were positive detections or if both were nondetects.
- The detected value was used if one sample was a positive detection and the other was a nondetect.

2.2.3 COPEC Selection Criteria

The criteria used to identify COPECs in the SLERA are described in the following sections.

2.2.3.1 Comparison to Ecological Screening Values

Maximum detected concentrations (MDC) of chemicals detected in soil were compared with ecological screening values (ESV) for ecological endpoints following recommendations received from OEPA and as discussed in EPA *Region 5 Biological Technical Assistance Group (BTAG) Ecological Risk Assessment Bulletin No. 1* (EPA, 1996). Chemicals that exceed the ESVs, or for which no ESVs are available, were retained as COPECs if other COPEC selection criteria were also met. The following ESVs, or ESV hierarchy (as noted), were used for the ecological evaluation:

- ***Soil.*** Soil screening values were selected using the following hierarchy: (1) EPA ecological soil screening levels (EPA, 2008), (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson, et al., 1997a), (3) EPA Region 5 ecological screening levels (EPA, 2003), (4) *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process* (Efroymson, et al., 1997b), and (5) *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants* (Efroymson, et al., 1997c). It should be noted that effects on heterotrophic processes may not be relevant to ecological receptors of concern at the site.

The development of the ESVs used for the former PBOW SLERAs is presented in Appendix B.

2.2.3.2 Frequency of Detection

Chemicals that are detected infrequently may be artifacts in the data that may not reflect site-related activity or disposal practices. These chemicals are not evaluated further in the risk assessment. Generally, chemicals that are detected only at low concentrations in 5 percent or less of the samples from a given medium (if at least 20 samples are analyzed) are dropped from further consideration, unless their presence is expected based on historical information about the site. Because fewer than 20 soil samples were collected for Coal Yard No. 2 soil, this screening criterion was not used in the SLERA.

2.2.3.3 Background Evaluation

Chemical concentrations were compared to site-specific background concentrations (see next paragraph for details) as an indication of whether a chemical is present from site-related activity or as natural background. This comparison is generally valid for inorganic chemicals but not for organic chemicals, because inorganic chemicals are naturally occurring and most organic chemicals related to potential releases are not. Statistical techniques are used as tools to aid the exercise of professional judgment in resolving site-related issues for metals, because metals are naturally present in most environmental media. The statistical techniques generally involve comparing the site data with background data.

The first statistical technique used for the background screen is the comparison of the MDC of the site data set to the PBOW background screening concentration (BSC). BSCs are considered representative concentrations of naturally occurring inorganic constituents; therefore, a comparison between the BSC and concentrations detected on site provides an indication of whether exposure to on-site media exceeds ambient levels. The background screening protocol used for Coal Yard No. 2 is based on PBOW Project Delivery Team agreements (PBOW Project Delivery Team, 2000) and differs somewhat from the current OEPA (2009) guidance. Use of this PBOW team method, which has been used for all PBOW risk assessments to date, ensures consistency between all of the PBOW investigative sites. The background data set and derivation of soil BSCs for all PBOW soil investigations are described in IT (1998). The background soil samples were collected from near the property boundary, away from any potential source areas. BSCs were calculated for use at PBOW based on concentrations found in these background soil samples. Each BSC is either the MDC of the concentrations found in these background soil samples or the calculated 95th percent upper tolerance limit of the background data set, whichever value is lower (PBOW Project Delivery Team, 2000). The upper tolerance limit is the concentration, with a probability of 0.95 (or a confidence of 95 percent), that would cover 95 percent of background population if a larger number of samples were collected. Chemicals with

MDCs less than their respective BSCs are consistent with background concentrations and are eliminated from further consideration. Use of this method for the development of BSCs and as part of the COPEC screening process ensures consistency between all of the PBOW Formerly Used Defense Sites project sites.

If the MDC of a chemical exceeds the BSC, the chemical is retained as a COPEC, or a more detailed statistical analysis may be performed to determine if the background data and the site data are drawn from the same population. The Wilcoxon Rank Sum test can be used for this purpose; however, that test was not used in the Coal Yard No. 2 SLERA because the one metal that was selected as a COPEC had insufficient background data to perform it.

Chemicals that fail the background evaluation are assumed to be site-related and are not eliminated at this point of the screening process.

2.2.3.4 Essential Nutrients

Evaluating essential nutrients is a special form of risk-based screening applied to certain ubiquitous elements that are generally considered to be required nutrients. Essential nutrients such as calcium, iron, magnesium, potassium, and sodium are usually eliminated as COPECs because they are generally considered to be innocuous in environmental media. Other essential nutrients, including chloride, iodine, and phosphorus, may be eliminated as COPECs, provided that their presence in a particular medium is shown to be unlikely to cause adverse effects to biological health.

2.2.4 Summary of COPEC Selection

The results of the COPEC screening for soil are presented in Table 2-2. The table presents the following information:

- Chemical name
- Frequency of detection
- Range of detected concentrations
- Range of detection limits
- Arithmetic mean (average) of site concentrations
- Distribution type
- Appropriate ESV
- BSC
- COPEC selection conclusion: NO (with rationale for exclusion) or YES (selected).

Ninety-five percent UCLs are also typically presented for COPECs, but computing a UCL was not considered necessary for the one chemical identified as a COPEC. Footnotes in the table provide the rationale for selecting or rejecting a chemical as a COPEC.

Cadmium was the only chemical identified as a COPEC in soil (Table 2-2). Cadmium was detected in four out of eight samples at concentrations ranging from 0.24 to 0.81 milligrams per kilogram (mg/kg). Concentrations from two samples (CY0028 = 0.72 mg/kg, and CY0018 = 0.81 mg/kg) exceed the ESV of 0.36 mg/kg. No BSC is available for cadmium because it was nondetect in all 25 soil background samples (IT, 1998). However, the reporting limits in the background data set (range = 0.57 to 1.2 mg/kg) exceeded the detected concentrations at Coal Yard No. 2. Therefore, although possibly associated with remnant pieces of coal at the site, the detected concentrations of cadmium could also be naturally occurring. Further, the ESV of 0.36 mg/kg is based on an ecological soil screening level that is protective of a shrew receptor (EPA, 2008). Because of the very small area affected, the low concentrations detected, and the natural population dynamics for small mammals that can rapidly compensate for localized impacts, it is highly unlikely that adverse population-level effects to shrews or other small mammals are occurring at this site. Therefore, cadmium is not recommended for further evaluation.

As discussed in Chapter 2.0, the SLERA null hypotheses state that potential for adverse ecological effects is minimal or nonexistent due to the lack of viable habitat, potential ecological receptors, potential exposure pathways, and/or potential chemical stressors. Because no COPECs are recommended for further evaluation at Coal Yard No. 2, a predictive assessment is not triggered, and no further action for the protection of ecological receptors is considered necessary.

3.0 Risk Summary and Conclusions

Chemicals detected in soil were screened against conservative benchmark values and other criteria to identify COPECs at Coal Yard No. 2. Because of the small size of the site, the site is not spatially relevant to any significant degree for most ecological receptors. The site-specific SLERA was performed to satisfy administrative requirements, including Formerly Used Defense Sites regulations (USACE, 2004).

Cadmium was the only chemical in soil that was identified as a COPEC. However, because cadmium was detected in two samples at concentrations that marginally exceeded its ESV, and because of the very limited spatial size of the site as well as the area where the slightly elevated cadmium was detected, it was judged that the presence of cadmium is either naturally occurring, inconsequential from an ecological standpoint, or both. Therefore, no further investigation of cadmium is considered necessary for the purposes of environmental protection, and the potential for ecological hazard associated with cadmium exposure is considered negligible.

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TABLES

Table 2-1

Summary of Surface Soil Samples Evaluated in the Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location	Sample Number	Sample Purpose	Sample Date	Depth of Sample (ft bgs)	Analysis
CY2-SB01	CY0015	REG	10/27/2011	0.5 - 1	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0016	FD	10/27/2011	0.5 - 1	Explosives, Gen Chem, Metals, SVOC
CY2-SB01	CY0017	FS [a]	10/27/2011	0.5 - 1	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB01	CY0018	REG	10/27/2011	3 - 5	Explosives, Gen Chem, Metals, SVOC
CY2-SB02	CY0020	REG	10/27/2011	0.5 - 1	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB02	CY0021	REG	10/27/2011	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB03	CY0025	REG	10/26/2011	0.5 - 1	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB03	CY0026	REG	10/26/2011	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB04	CY0028	REG	10/26/2011	0 - 1	Explosives, Gen Chem, Metals, PCB, SVOC
CY2-SB04	CY0029	REG	10/26/2011	3 - 5	Explosives, Gen Chem, Metals, PCB, SVOC

[a] The PCB data for this field split sample were used for location CY2-SB01 because PCBs were inadvertently not analyzed for in the original or field duplicate samples for the 0.5 to 1 foot depth range.

ft bgs - Feet below ground surface.
FD - Field duplicate.
FS - Field split.
PCB - Polychlorinated biphenyls.
REG - Regular sample.
SVOC - Semivolatile organic compound.

Table 2-2

Statistical Summary and COPEC Selection of Chemicals Detected in Soil (0 to 6 Feet Below Ground Surface)
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Method Detection Limit Minimum	Maximum	Mean (mg/kg)	BSC [a] (mg/kg)	ESV [b] (mg/kg)	COPEC? [c,d]
Inorganics												
Aluminum	8 / 8	100	5.14E+03		1.13E+04	J	9.10E-01	5.40E+00	7.65E+03	1.55E+04	pH Dependent	N (b)
Antimony	1 / 8	13	2.50E-01	J	2.50E-01	J	4.60E-02	2.50E-01	2.13E-01	9.30E+00	0.27	N (a)
Arsenic	8 / 8	100	2.10E+00		1.35E+01		4.50E-02	2.50E-01	9.00E+00	3.65E+01	18	N (a)
Barium	8 / 8	100	3.52E+01		7.09E+01		1.90E-01	1.00E+00	5.82E+01	8.26E+02	330	N (a)
Beryllium	8 / 8	100	2.70E-01		7.70E-01	J	4.60E-03	2.50E-02	4.55E-01	1.00E+00	21	N (a)
Cadmium	4 / 8	50	2.40E-01	J	8.10E-01		4.60E-03	2.50E-02	2.67E-01	NA	0.36	Y
Calcium	8 / 8	100	1.27E+03		5.25E+04		2.30E+00	1.30E+01	2.29E+04	5.23E+04	Nutrient	N (c)
Chromium	8 / 8	100	9.80E+00		2.20E+01		4.60E-02	2.50E-01	1.46E+01	2.90E+01	26	N (a)
Cobalt	8 / 8	100	3.50E+00		1.51E+01		4.60E-02	2.50E-01	8.26E+00	1.16E+02	13	N (b)
Copper	8 / 8	100	1.12E+01		2.64E+01		4.60E-02	2.50E-01	2.10E+01	5.62E+01	28	N (a)
Iron	8 / 8	100	1.64E+04		3.43E+04		1.10E+00	5.80E+00	2.20E+04	2.34E+05	pH Dependent	N (b)
Lead	8 / 8	100	7.40E+00		1.53E+01		3.80E-02	1.10E-01	1.11E+01	4.86E+01	11	N (b)
Magnesium	8 / 8	100	1.81E+03		1.63E+04		2.30E+00	1.30E+01	8.92E+03	1.04E+04	Nutrient	N (c)
Manganese	8 / 8	100	8.11E+01		8.16E+02		4.60E-02	2.50E-01	3.70E+02	3.51E+03	220	N (b)
Mercury	8 / 8	100	1.10E-02	J	4.50E-02	J	6.20E-03	7.70E-03	3.05E-02	8.50E-02	0.00051	N (b)
Nickel	8 / 8	100	1.07E+01		4.00E+01		4.60E-02	2.50E-01	2.38E+01	5.51E+01	38	N (b)
Potassium	8 / 8	100	4.72E+02		1.21E+03		2.30E+00	1.30E+01	8.14E+02	3.39E+03	Nutrient	N (c)
Selenium	4 / 8	50	4.30E-01	J	1.70E+00	J	2.10E-01	4.65E+00	1.27E+00	2.00E+00	0.52	N (b)
Silver	3 / 8	38	5.30E-02	J	8.80E-02	J	4.50E-02	2.50E-01	1.66E-01	1.11E+01	4.2	N (a)
Sodium	3 / 8	38	5.26E+01	J	1.24E+02	J	3.90E+01	2.20E+02	1.53E+02	NA	Nutrient	N (c)
Thallium	1 / 8	13	3.90E-01	J	3.90E-01	J	1.50E-01	7.60E+00	5.08E+00	1.30E+00	1	N (a)
Vanadium	8 / 8	100	1.15E+01		3.24E+01		4.60E-02	2.50E-01	2.18E+01	4.09E+01	7.8	N (b)
Zinc	8 / 8	100	2.42E+01		6.78E+01		4.60E-02	2.50E-01	5.17E+01	3.22E+02	46	N (b)
Semivolatile Organic Compounds												
Bis(2-ethylhexyl)phthalate	1 / 8	13	3.21E-01	J	3.21E-01	J	7.70E-02	8.60E-02	1.11E-01		0.925	N (a)
Fluoranthene	2 / 8	25	3.10E-02	J	6.47E-02	J	1.90E-02	2.20E-02	2.73E-02		1.1	N (a)
Methylnaphthalene, 2-	1 / 8	13	4.29E-02	J	4.29E-02	J	1.90E-02	2.20E-02	2.32E-02		3.24	N (a)
Naphthalene	1 / 8	13	3.21E-02	J	3.21E-02	J	3.10E-02	3.40E-02	3.25E-02		29	N (a)
Phenanthrene	1 / 8	13	2.92E-02	J	2.92E-02	J	1.90E-02	2.20E-02	2.15E-02		29	N (a)
Pyrene	1 / 8	13	6.34E-02	J	6.34E-02	J	1.90E-02	2.20E-02	2.57E-02		1.1	N (a)

BSC - Background screening concentration.
COPEC - Chemical of potential ecological concern.
ESV - Ecological screening value.
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.
NA - Not available.
VQ - Validation qualifier.

[a] IT Corporation (IT), 1998, ***Site Investigation of Acid Areas***, Plum Brook Ordnance Works, Sandusky, Ohio, August.
[b] ESVs and their sources are in Appendix A.
[c] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
[d] Y = Chemical is chosen as COPEC.

FIGURES

FIGURE 1-1
PBOW VICINITY MAP

POWER HOUSE No. 2 ASH PITS SLERA ADDENDUM FOR COAL YARD No. 2
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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

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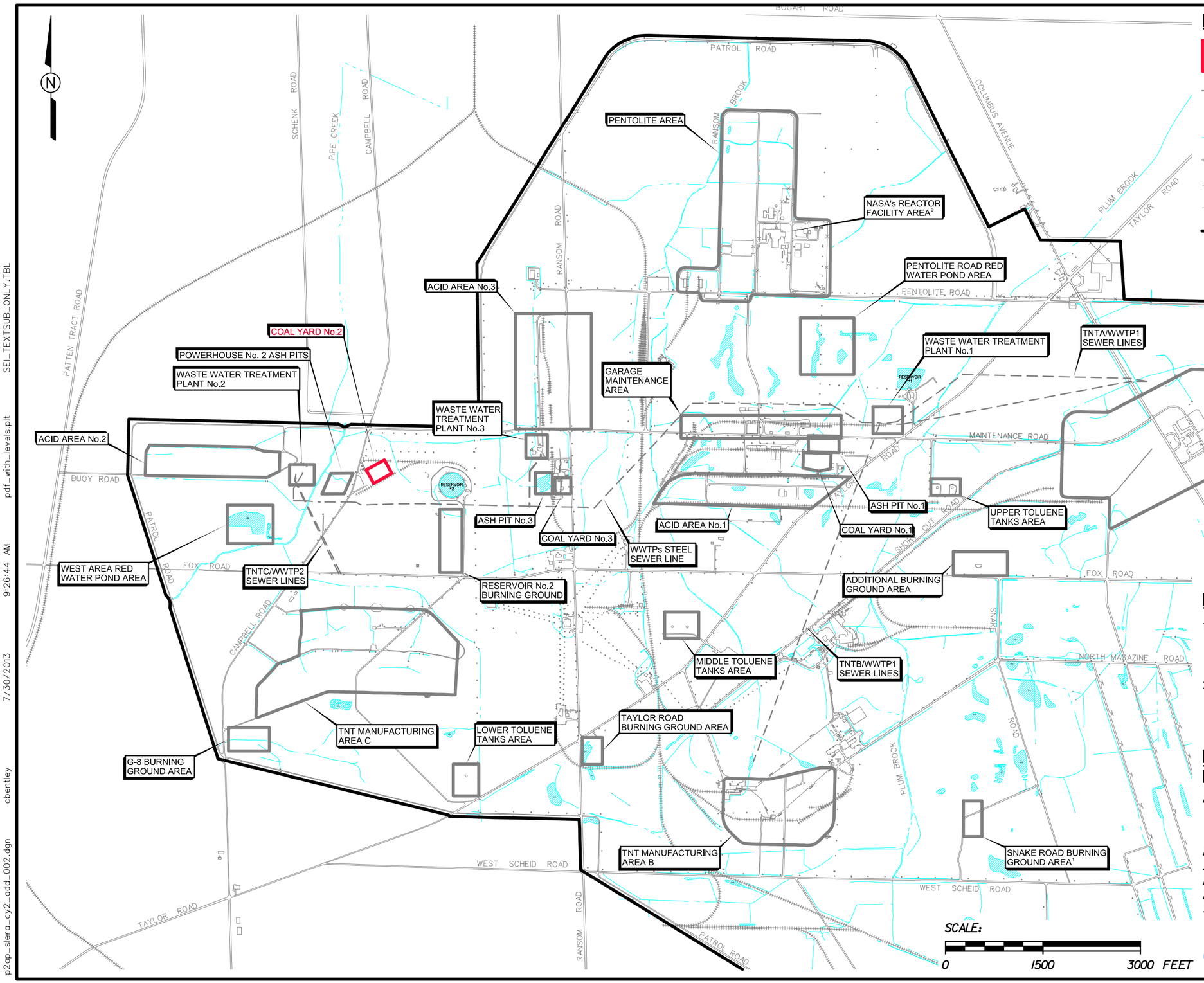

LEGEND:

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

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. REACTOR FACILITY CONSTRUCTED BY NASA POST WWII AND IS IDENTIFIED FOR LOCATION PURPOSES ONLY. DEMOLITION COMPLETED IN 2012.

FIGURE 1-2
LOCATION OF COAL YARD No. 2 AT PBOW

POWER HOUSE No. 2 ASH PITS SLERA ADDENDUM FOR COAL YARD No. 2
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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

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Figure 2-1

Photo Log of Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Photo 1. Grassy area adjacent to former building pad at Coal Yard No. 2.

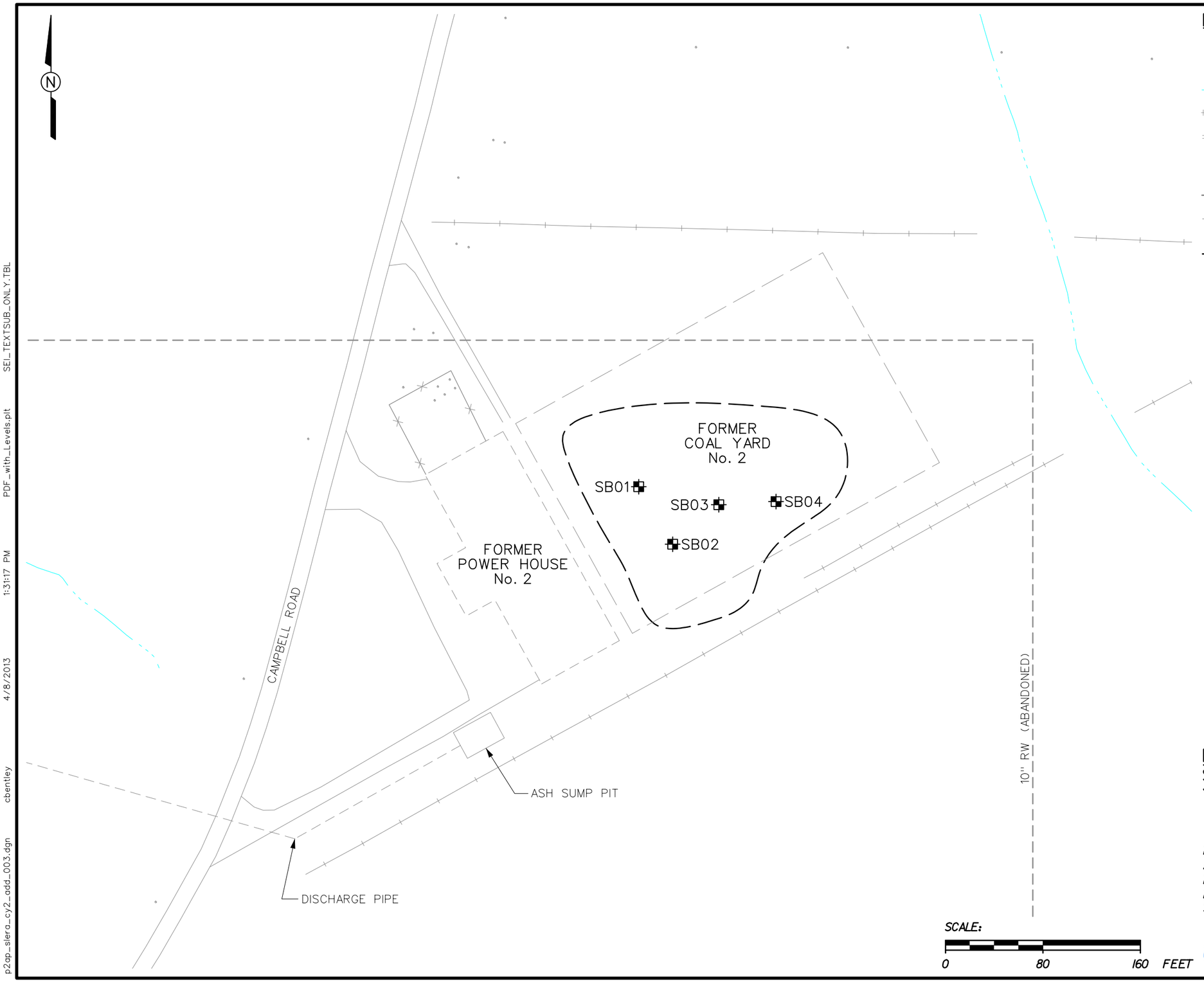
Photo 2. Vegetation at a low-lying area at Coal Yard No. 2.

Figure 2-1

Photo Log of Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Photo 3. Bare ground at the coal yard following removal of pad.

Photo 4. Small piece of coal on the bare ground following removal of pad.



LEGEND:

- SOIL BORING
- UTILITY POLE
- CREEK, DITCH, CONVEYANCE
- ABANDONED RAILROAD
- ROAD
- APPROXIMATE LOCATION OF FORMER STRUCTURES
- RAW WATER LINE (RW)
- APPROXIMATE HISTORICAL COAL STORAGE PERIMETER BASED ON AERIAL PHOTO
- APPROXIMATE COAL STORAGE PERIMETER BASED ON OCTOBER 2011 FIELD FINDINGS AND EXISTING COAL THICKNESS

FIGURE 2-2
SAMPLE LOCATIONS AT COAL YARD No. 2

POWER HOUSE No. 2 ASH PITS SLERA ADDENDUM FOR COAL YARD No. 2
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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

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APPENDIX A

SOIL DATA USED IN THE SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Location Code	CY2-SB01					CY2-SB01					CY2-SB01					CY2-SB01				
	Sample Number	CY0015					CY0016					CY0017					CY0018				
	Sample Date	10/27/2011					10/27/2011					10/27/2011					10/27/2011				
	Depth	.5 - 1 Ft					.5 - 1 Ft					.5 - 1 Ft					3 - 5 Ft				
	Sample Purpose	REG					FD					FS					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	0.18	0.18	0.073	U	U	0.099	0.25	0.02	U	U	0.15	0.15	0.061	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.099	U	U	0.15	0.15	0.061	U	U
Dinitrobenzene, 1,3-	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.05	U	U	0.15	0.15	0.061	U	U
Dinitrotoluene, 2,4-	mg/kg	0.17	0.17	0.081	U	U	0.18	0.18	0.089	U	U	0.099	0.25	0.02	U	U	0.15	0.15	0.073	U	U
Dinitrotoluene, 2,6-	mg/kg	0.17	0.17	0.073	U	U	0.18	0.18	0.08	U	U	0.099	0.25	0.03	U	U	0.15	0.15	0.066	U	U
HMX	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.03	U	U	0.15	0.15	0.061	U	U
Nitrobenzene	mg/kg	0.17	0.17	0.078	U	U	0.18	0.18	0.085	U	U	0.099	0.25	0.05	U	U	0.15	0.15	0.07	U	U
Nitrotoluene, 2-	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.079	U	U	0.15	0.15	0.061	U	U
Nitrotoluene, 3-	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.069	U	U	0.15	0.15	0.061	U	U
Nitrotoluene, 4-	mg/kg	0.17	0.17	0.085	U	U	0.18	0.18	0.093	U	U	0.099	0.25	0.079	U	U	0.15	0.15	0.077	U	U
RDX	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.04	U	U	0.15	0.15	0.061	U	U
Tetryl	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.05	U	U	0.15	0.15	0.061	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.02	U	U	0.15	0.15	0.061	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.17	0.17	0.067	U	U	0.18	0.18	0.073	U	U	0.099	0.25	0.02	U	U	0.15	0.15	0.061	U	U
GEN CHEMISTRY																					
% Solids	Percent	84.9	0				83.6	0									80.8	0			
Metals																					
Aluminum	mg/kg	8000	8.1	0.97		J	14500	48	5.7		J	14000	35	8.2			5150	11	1.3		
Antimony	mg/kg	4	4	0.2	U	U	4.8	4.8	0.24	U	U	3.5	3.5	0.9	U	UJ	2.1	2.1	0.11	U	U
Arsenic	mg/kg	10	2	0.2			10	2.4	0.24			12	2.3	0.43			5.8	0.53	0.053		
Barium	mg/kg	49.2	8.1	0.16		J	86.6	48	0.96		J	85	23	0.44			35.2	11	0.21		
Beryllium	mg/kg	0.67	1	0.02	B	J	0.87	1.2	0.024	B	J	0.48	0.58	0.059	J	J	0.36	0.53	0.011	B	J
Cadmium	mg/kg	0.81	0.81	0.02	U	U	0.96	0.96	0.024	U	U	0.063	0.58	0.034	J	J	0.81	0.21	0.0053		
Calcium	mg/kg	3260	1000	10		J	9300	1200	12		J	4700	580	57		J	52500	530	5.3		
Chromium	mg/kg	16.7	2	0.2			19.1	2.4	0.24			19	1.2	0.26			9.8	1.1	0.11		
Cobalt	mg/kg	11.4	10	0.2			10.6	12	0.24	B	J	8.7	1.2	0.13			5.5	2.7	0.053		
Copper	mg/kg	24.6	5	0.2			24.2	6	0.24			24	2.9	0.52			18.8	2.7	0.11		
Iron	mg/kg	28700	61	4.6			27700	72	5.5			31000	58	13	B		17100	32	2.5		
Lead	mg/kg	13.4	0.81	0.04			13	0.96	0.048			14	1.2	0.27			12.8	2.1	0.11		
Magnesium	mg/kg	3000	1000	10			4370	1200	12			4300	580	11	B		15300	530	5.3		
Manganese	mg/kg	249	3	0.2			199	3.6	0.24			200	1.7	0.33		J	454	3.2	0.21		
Mercury	mg/kg	0.038	0.097	0.0069	B	J	0.052	0.096	0.0068	B	J	0.054	0.11	0.016	J B	B	0.019	0.1	0.0073	B	J
Nickel	mg/kg	26.6	8.1	0.2			30	9.6	0.24			25	4.7	0.38			16.1	2.1	0.053		
Potassium	mg/kg	599	2000	10	B	J	815	2400	12	B	J	850	580	31			1020	1100	5.3	B	J
Selenium	mg/kg	1	4	0.4	B	J	4.8	4.8	0.48	U	U	2.3	2.3	0.56	U	U	0.43	2.1	0.21	B	J
Silver	mg/kg	2	2	0.2	U	U	2.4	2.4	0.24	U	U	0.58	0.58	0.17	U	U	0.053	0.53	0.053	B	J
Sodium	mg/kg	2000	2000	170	U	U	2400	2400	200	U	U	580	580	99	U	U	124	1100	91	B	J
Thallium	mg/kg	20	20	6.1	U	U	9.6	9.6	7.2	U	U	3.5	3.5	0.89	U	U	1.1	1.1	0.16	U	U
Vanadium	mg/kg	26.4	10	0.2			28	12	0.24			27	1.2	0.14			11.5	2.7	0.053		
Zinc	mg/kg	64.3	4	0.2			71.3	4.8	0.24			70	5.8	1.7			46	2.1	0.11		

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Location Code	CY2-SB01					CY2-SB01					CY2-SB01					CY2-SB01				
	Sample Number	CY0015					CY0016					CY0017					CY0018				
	Sample Date	10/27/2011					10/27/2011					10/27/2011					10/27/2011				
	Depth	.5 - 1 Ft					.5 - 1 Ft					.5 - 1 Ft					3 - 5 Ft				
	Sample Purpose	REG					FD					FS					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
PEST/PCB																					
Aroclor 1016	mg/kg											0.079	0.079	0.026	U	U					
Aroclor 1221	mg/kg											0.061	0.061	0.02	U	U					
Aroclor 1232	mg/kg											0.055	0.055	0.017	U	U					
Aroclor 1242	mg/kg											0.049	0.049	0.016	U	U					
Aroclor 1248	mg/kg											0.067	0.067	0.021	U	U					
Aroclor 1254	mg/kg											0.067	0.067	0.021	U	U					
Aroclor 1260	mg/kg											0.067	0.067	0.021	U	U					
Semivolatiles																					
3-Methylphenol and 4-Methylphe	mg/kg	0.2	0.2	0.028	U	U	0.2	0.2	0.029	U	U	0.49	0.49	0.025	U	U	0.2	0.2	0.029	U	U
Acenaphthene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U	0.2	0.2	0.02	U	U
Acenaphthylene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.013	0.0082	0.0041			0.2	0.2	0.02	U	U
Acetophenone	mg/kg											0.047	0.12	0.011	J	J					
Anthracene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.02	0.0082	0.0041			0.2	0.2	0.02	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	0.2	0.2	0.02	U	U	0.043	0.0082	0.0041			0.2	0.2	0.02	U	U
Benzo(a)pyrene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.039	0.0082	0.0041			0.2	0.2	0.02	U	U
Benzo(b)fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.039	0.0082	0.0041			0.2	0.2	0.02	U	U
Benzo(ghi)perylene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.024	0.0082	0.0041			0.2	0.2	0.02	U	U
Benzo(k)fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.018	0.0082	0.0041			0.2	0.2	0.02	U	U
Benzoic acid	mg/kg	0.98	0.98	0.35	U	U	1	1	0.35	U	U						1	1	0.36	U	U
Benzyl alcohol	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U						0.2	0.2	0.041	U	U
Bibenzene	mg/kg											0.034	0.061	0.033	J	J					
Bis(2-chloroethoxy)methane	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.12	0.12	0.027	U	U	0.2	0.2	0.02	U	U
Bis(2-chloroethyl)ether	mg/kg	0.2	0.2	0.02	U	UJ	0.2	0.2	0.02	U	UJ	0.12	0.12	0.0025	U	U	0.2	0.2	0.02	U	UJ
Bis(2-chloroisopropyl)ether	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.12	0.12	0.012	U	U	0.2	0.2	0.02	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.39	0.39	0.079	U	U	0.4	0.4	0.08	U	U	0.061	0.061	0.023	U	U	0.321	0.41	0.081	J	J
Bromophenyl phenyl ether, 4-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.016	U	U	0.2	0.2	0.02	U	U
Butyl benzyl phthalate	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.061	0.061	0.012	U	U	0.2	0.2	0.041	U	U
Caprolactam	mg/kg											0.41	0.41	0.045	U	U					
Carbazole	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.033	U	U	0.2	0.2	0.02	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.026	U	U	0.2	0.2	0.02	U	U
Chloroaniline, 4-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.021	U	U	0.2	0.2	0.02	U	U
Chloronaphthalene, 2-	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.061	0.061	0.0041	U	U	0.2	0.2	0.041	U	U
Chlorophenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.033	U	U	0.2	0.2	0.02	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.016	U	U	0.2	0.2	0.02	U	U
Chrysene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.055	0.0082	0.0014			0.2	0.2	0.02	U	U
Dibenz(a,h)anthracene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0041	U	U	0.2	0.2	0.02	U	U
Dibenzofuran	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.14	0.061	0.0041			0.2	0.2	0.02	U	U
Dichlorobenzene, 1,2-	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U						0.2	0.2	0.041	U	U
Dichlorobenzene, 1,3-	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U						0.2	0.2	0.041	U	U
Dichlorobenzene, 1,4-	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U						0.2	0.2	0.041	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.39	0.39	0.039	U	U	0.4	0.4	0.04	U	U	0.12	0.12	0.022	U	U	0.41	0.41	0.041	U	U

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location Code		CY2-SB01					CY2-SB01					CY2-SB01					CY2-SB01				
Sample Number		CY0015					CY0016					CY0017					CY0018				
Sample Date		10/27/2011					10/27/2011					10/27/2011					10/27/2011				
Depth		.5 - 1 Ft					.5 - 1 Ft					.5 - 1 Ft					3 - 5 Ft				
Sample Purpose		REG					FD					FS					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Dichlorophenol, 2,4-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.025	U	U	0.2	0.2	0.02	U	U
Diethyl phthalate	mg/kg	0.39	0.39	0.079	U	U	0.4	0.4	0.08	U	U	0.061	0.061	0.02	U	U	0.41	0.41	0.081	U	U
Dimethyl phthalate	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.061	0.061	0.021	U	U	0.2	0.2	0.041	U	U
Dimethylphenol, 2,4-	mg/kg	0.2	0.2	0.025	U	U	0.2	0.2	0.025	U	U	0.18	0.18	0.025	U	U	0.2	0.2	0.026	U	U
Di-n-butyl phthalate	mg/kg	0.39	0.39	0.079	U	U	0.4	0.4	0.08	U	U	0.061	0.061	0.018	U	U	0.41	0.41	0.081	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.39	0.39	0.079	U	U	0.4	0.4	0.08	U	U	0.18	0.18	0.098	U	U	0.41	0.41	0.081	U	U
Dinitrophenol, 2,4-	mg/kg	0.98	0.98	0.39	U	U	1	1	0.4	U	U	0.41	0.41	0.098	U	U	1	1	0.41	U	U
Dinitrotoluene, 2,4-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.25	0.25	0.033	U	U	0.2	0.2	0.02	U	U
Dinitrotoluene, 2,6-	mg/kg	0.2	0.2	0.023	U	U	0.2	0.2	0.024	U	U	0.25	0.25	0.026	U	U	0.2	0.2	0.024	U	U
Di-n-octyl phthalate	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.061	0.061	0.033	U	U	0.2	0.2	0.041	U	U
Fluoranthene	mg/kg	0.2	0.2	0.02	U	U	0.0293	0.2	0.02	J	J	0.051	0.0082	0.0041			0.2	0.2	0.02	U	U
Fluorene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.018	0.0082	0.0041			0.2	0.2	0.02	U	U
Hexachlorobenzene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.0082	0.0082	0.0026	U	U	0.2	0.2	0.02	U	U
Hexachlorobutadiene	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.061	0.061	0.033	U	U	0.2	0.2	0.041	U	U
Hexachlorocyclopentadiene	mg/kg	0.2	0.2	0.087	U	UJ	0.2	0.2	0.088	U	UJ	0.41	0.41	0.033	U	U	0.2	0.2	0.089	U	UJ
Hexachloroethane	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.061	0.061	0.011	U	U	0.2	0.2	0.041	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.017	0.0082	0.0041			0.2	0.2	0.02	U	U
Isophorone	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.016	U	U	0.2	0.2	0.02	U	U
Methylnaphthalene, 2-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.65	0.0082	0.0041			0.2	0.2	0.02	U	U
Methylphenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.25	0.25	0.098	U	U	0.2	0.2	0.02	U	U
Naphthalene	mg/kg	0.2	0.2	0.032	U	U	0.2	0.2	0.032	U	U	0.4	0.0082	0.0041			0.2	0.2	0.032	U	U
Nitroaniline, 2-	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.25	0.25	0.011	U	U	0.2	0.2	0.041	U	U
Nitroaniline, 3-	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.25	0.25	0.02	U	U	0.2	0.2	0.041	U	U
Nitroaniline, 4-	mg/kg	0.2	0.2	0.039	U	U	0.2	0.2	0.04	U	U	0.25	0.25	0.032	U	U	0.2	0.2	0.041	U	U
Nitrobenzene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.12	0.12	0.0027	U	U	0.2	0.2	0.02	U	U
Nitrophenol, 2-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.033	U	U	0.2	0.2	0.02	U	U
Nitrophenol, 4-	mg/kg	0.98	0.98	0.16	U	U	1	1	0.16	U	U	0.41	0.41	0.098	U	U	1	1	0.16	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.033	U	U	0.2	0.2	0.02	U	U
n-Nitrosodiphenylamine	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.026	U	U	0.2	0.2	0.02	U	U
Pentachlorophenol	mg/kg	0.98	0.98	0.24	U	U	1	1	0.24	U	U	0.18	0.18	0.098	U	U	1	1	0.24	U	U
Phenanthrene	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.22	0.0082	0.0041			0.2	0.2	0.02	U	U
Phenol	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.061	0.061	0.033	U	U	0.2	0.2	0.02	U	U
Pyrene	mg/kg	0.2	0.2	0.02	U	U	0.0268	0.2	0.02	J	J	0.054	0.0082	0.0041			0.2	0.2	0.02	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U						0.2	0.2	0.02	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.031	U	U	0.2	0.2	0.02	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.2	0.2	0.02	U	U	0.2	0.2	0.02	U	U	0.18	0.18	0.098	U	U	0.2	0.2	0.02	U	U

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Location Code	CY2-SB02					CY2-SB02					CY2-SB03					CY2-SB03				
	Sample Number	CY0020					CY0021					CY0025					CY0026				
	Sample Date	10/27/2011					10/27/2011					10/26/2011					10/26/2011				
	Depth	.5 - 1 Ft					3 - 5 Ft					.5 - 1 Ft					3 - 5 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	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Dinitrobenzene, 1,3-	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Dinitrotoluene, 2,4-	mg/kg	0.15	0.15	0.073	U	U	0.15	0.15	0.074	U	U	0.19	0.19	0.09	U	U	0.15	0.15	0.074	U	U
Dinitrotoluene, 2,6-	mg/kg	0.15	0.15	0.065	U	U	0.15	0.15	0.067	U	U	0.19	0.19	0.081	U	U	0.15	0.15	0.066	U	U
HMX	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Nitrobenzene	mg/kg	0.15	0.15	0.07	U	U	0.15	0.15	0.071	U	U	0.19	0.19	0.086	U	U	0.15	0.15	0.071	U	U
Nitrotoluene, 2-	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Nitrotoluene, 3-	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Nitrotoluene, 4-	mg/kg	0.15	0.15	0.076	U	U	0.15	0.15	0.077	U	U	0.19	0.19	0.094	U	U	0.15	0.15	0.077	U	U
RDX	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Tetryl	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.15	0.15	0.06	U	U	0.15	0.15	0.061	U	U	0.19	0.19	0.074	U	U	0.15	0.15	0.061	U	U
GEN CHEMISTRY																					
% Solids	Percent	86	0				77	0				83.5	0				77.3	0			
Metals																					
Aluminum	mg/kg	7330	7.6	0.91			8500	45	5.4			9880	10	1.2			7300	9.9	1.2		
Antimony	mg/kg	3.8	3.8	0.19	U	U	4.5	4.5	0.22	U	U	5.1	5.1	0.25	U	U	4.9	4.9	0.25	U	U
Arsenic	mg/kg	13.5	1.9	0.19			2.1	0.45	0.045			12.2	2.5	0.25			10.8	2.5	0.25		
Barium	mg/kg	57.3	38	0.76			67.6	45	0.9			68	51	1			63.8	20	0.4		
Beryllium	mg/kg	0.36	0.94	0.019	B	J	0.49	1.1	0.022	B	J	0.48	1.3	0.025	B	J	0.49	0.49	0.0099		
Cadmium	mg/kg	0.76	0.76	0.019	U	U	0.9	0.9	0.022	U	U	1	1	0.025	U	U	0.28	0.99	0.025	B	J
Calcium	mg/kg	1270	940	9.4			34600	1100	11			1740	1300	13			43200	490	4.9		
Chromium	mg/kg	14.9	1.9	0.19			12.9	2.2	0.22			22	2.5	0.25			16.7	2.5	0.25		
Cobalt	mg/kg	4.7	9.4	0.19	B	J	9.6	11	0.22	B	J	6.8	13	0.25	B	J	15.1	12	0.25		
Copper	mg/kg	22.5	4.7	0.19			20.6	5.6	0.22			23.5	6.3	0.25			26.4	6.2	0.25		
Iron	mg/kg	23800	57	4.3			17100	67	5.2			34300	76	5.8			18800	30	2.3		
Lead	mg/kg	11	0.76	0.038			11	0.9	0.045			9.6	1	0.051			15.3	2	0.099		
Magnesium	mg/kg	1810	940	9.4			14600	1100	11			3100	1300	13			14100	490	4.9		
Manganese	mg/kg	81.1	2.8	0.19			492	3.4	0.22			121	3.8	0.25			816	3.7	0.25		
Mercury	mg/kg	0.043	0.094	0.0067	B	J	0.04	0.1	0.0074	B	J	0.035	0.097	0.0069	B	J	0.011	0.11	0.0077	B	J
Nickel	mg/kg	19.2	7.6	0.19			26.8	9	0.22			23.5	10	0.25			40	9.9	0.25		
Potassium	mg/kg	567	1900	9.4	B	J	990	2200	11	B	J	698	2500	13	B	J	1210	990	4.9		
Selenium	mg/kg	0.91	3.8	0.38	B	J	4.5	4.5	0.45	U	U	1.1	5.1	0.51	B	J	4.9	4.9	0.49	U	U
Silver	mg/kg	1.9	1.9	0.19	U	U	0.063	0.45	0.045	B	J	2.5	2.5	0.25	U	U	2.5	2.5	0.25	U	U
Sodium	mg/kg	1900	1900	160	U	U	2200	2200	190	U	U	2500	2500	220	U	U	114	990	84	B	J
Thallium	mg/kg	15	15	5.7	U	U	9	9	6.7	U	U	20	20	7.6	U	U	0.39	0.99	0.15	B	J
Vanadium	mg/kg	24.8	9.4	0.19			17.5	11	0.22			32.4	13	0.25			24.9	12	0.25		
Zinc	mg/kg	50.9	3.8	0.19			52.8	4.5	0.22			57.6	5.1	0.25			63.7	4.9	0.25		

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location Code		CY2-SB02					CY2-SB02					CY2-SB03					CY2-SB03				
Sample Number		CY0020					CY0021					CY0025					CY0026				
Sample Date		10/27/2011					10/27/2011					10/26/2011					10/26/2011				
Depth		.5 - 1 Ft					3 - 5 Ft					.5 - 1 Ft					3 - 5 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**
PEST/PCB																					
Aroclor 1016	mg/kg	0.019	0.019	0.0078	U	U	0.022	0.022	0.0086	U	U	0.02	0.02	0.008	U	U	0.021	0.021	0.0086	U	U
Aroclor 1221	mg/kg	0.019	0.019	0.0097	U	U	0.022	0.022	0.011	U	U	0.02	0.02	0.01	U	U	0.021	0.021	0.011	U	U
Aroclor 1232	mg/kg	0.019	0.019	0.0097	U	U	0.022	0.022	0.011	U	U	0.02	0.02	0.01	U	U	0.021	0.021	0.011	U	U
Aroclor 1242	mg/kg	0.019	0.019	0.0078	U	U	0.022	0.022	0.0086	U	U	0.02	0.02	0.008	U	U	0.021	0.021	0.0086	U	U
Aroclor 1248	mg/kg	0.019	0.019	0.0078	U	U	0.022	0.022	0.0086	U	U	0.02	0.02	0.008	U	U	0.021	0.021	0.0086	U	U
Aroclor 1254	mg/kg	0.019	0.019	0.0078	U	U	0.022	0.022	0.0086	U	U	0.02	0.02	0.008	U	U	0.021	0.021	0.0086	U	U
Aroclor 1260	mg/kg	0.019	0.019	0.0078	U	U	0.022	0.022	0.0086	U	U	0.02	0.02	0.008	U	U	0.021	0.021	0.0086	U	U
Semivolatiles																					
3-Methylphenol and 4-Methylphe	mg/kg	0.19	0.19	0.028	U	U	0.22	0.22	0.031	U	U	0.2	0.2	0.029	U	U	0.21	0.21	0.031	U	U
Acenaphthene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acenaphthylene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Acetophenone	mg/kg																				
Anthracene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	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	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(a)pyrene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(b)fluoranthene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(ghi)perylene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzo(k)fluoranthene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Benzoic acid	mg/kg	0.96	0.96	0.34	U	U	1.1	1.1	0.38	U	U	0.99	0.99	0.35	U	U	1.1	1.1	0.37	U	U
Benzyl alcohol	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Bibenzene	mg/kg																				
Bis(2-chloroethoxy)methane	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroethyl)ether	mg/kg	0.19	0.19	0.019	U	UJ	0.22	0.22	0.022	U	UJ	0.2	0.2	0.02	U	UJ	0.21	0.21	0.021	U	UJ
Bis(2-chloroisopropyl)ether	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.39	0.39	0.077	U	U	0.43	0.43	0.086	U	U	0.4	0.4	0.079	U	U	0.43	0.43	0.085	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Butyl benzyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Caprolactam	mg/kg																				
Carbazole	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloroaniline, 4-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Chlorophenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Chrysene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenz(a,h)anthracene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dibenzofuran	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dichlorobenzene, 1,2-	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Dichlorobenzene, 1,3-	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Dichlorobenzene, 1,4-	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.39	0.39	0.039	U	U	0.43	0.43	0.043	U	U	0.4	0.4	0.04	U	U	0.43	0.43	0.043	U	U

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Location Code		CY2-SB02					CY2-SB02					CY2-SB03					CY2-SB03				
Sample Number		CY0020					CY0021					CY0025					CY0026				
Sample Date		10/27/2011					10/27/2011					10/26/2011					10/26/2011				
Depth		.5 - 1 Ft					3 - 5 Ft					.5 - 1 Ft					3 - 5 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**
Dichlorophenol, 2,4-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Diethyl phthalate	mg/kg	0.39	0.39	0.077	U	U	0.43	0.43	0.086	U	U	0.4	0.4	0.079	U	U	0.43	0.43	0.085	U	U
Dimethyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Dimethylphenol, 2,4-	mg/kg	0.19	0.19	0.024	U	U	0.22	0.22	0.027	U	U	0.2	0.2	0.025	U	U	0.21	0.21	0.027	U	U
Di-n-butyl phthalate	mg/kg	0.39	0.39	0.077	U	U	0.43	0.43	0.086	U	U	0.4	0.4	0.079	U	U	0.43	0.43	0.085	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.39	0.39	0.077	U	U	0.43	0.43	0.086	U	U	0.4	0.4	0.079	U	U	0.43	0.43	0.085	U	U
Dinitrophenol, 2,4-	mg/kg	0.96	0.96	0.39	U	U	1.1	1.1	0.43	U	U	0.99	0.99	0.4	U	U	1.1	1.1	0.43	U	U
Dinitrotoluene, 2,4-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Dinitrotoluene, 2,6-	mg/kg	0.19	0.19	0.023	U	U	0.22	0.22	0.025	U	U	0.2	0.2	0.023	U	U	0.21	0.21	0.025	U	U
Di-n-octyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Fluoranthene	mg/kg	0.031	0.19	0.019	J	J	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Fluorene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobenzene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Hexachlorobutadiene	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Hexachlorocyclopentadiene	mg/kg	0.19	0.19	0.085	U	UJ	0.22	0.22	0.095	U	UJ	0.2	0.2	0.087	U	UJ	0.21	0.21	0.094	U	UJ
Hexachloroethane	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Isophorone	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylnaphthalene, 2-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Methylphenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Naphthalene	mg/kg	0.19	0.19	0.031	U	U	0.22	0.22	0.034	U	U	0.2	0.2	0.032	U	U	0.21	0.21	0.034	U	U
Nitroaniline, 2-	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Nitroaniline, 3-	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Nitroaniline, 4-	mg/kg	0.19	0.19	0.039	U	U	0.22	0.22	0.043	U	U	0.2	0.2	0.04	U	U	0.21	0.21	0.043	U	U
Nitrobenzene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 4-	mg/kg	0.96	0.96	0.15	U	U	1.1	1.1	0.17	U	U	0.99	0.99	0.16	U	U	1.1	1.1	0.17	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
n-Nitrosodiphenylamine	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pentachlorophenol	mg/kg	0.96	0.96	0.23	U	U	1.1	1.1	0.26	U	U	0.99	0.99	0.24	U	U	1.1	1.1	0.26	U	U
Phenanthrene	mg/kg	0.0292	0.19	0.019	J	J	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Phenol	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Pyrene	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.19	0.19	0.019	U	U	0.22	0.22	0.022	U	U	0.2	0.2	0.02	U	U	0.21	0.21	0.021	U	U

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Location Code	CY2-SB04					CY2-SB04				
	Sample Number	CY0028					CY0029				
	Sample Date	10/26/2011					10/26/2011				
	Depth	0 - 1 Ft					3 - 5 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	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Amino-4,6-dinitrotoluene, 2-	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Dinitrobenzene, 1,3-	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Dinitrotoluene, 2,4-	mg/kg	0.16	0.16	0.08	U	U	0.18	0.18	0.089	U	U
Dinitrotoluene, 2,6-	mg/kg	0.16	0.16	0.072	U	U	0.18	0.18	0.08	U	U
HMX	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Nitrobenzene	mg/kg	0.16	0.16	0.077	U	U	0.18	0.18	0.085	U	U
Nitrotoluene, 2-	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Nitrotoluene, 3-	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Nitrotoluene, 4-	mg/kg	0.16	0.16	0.083	U	U	0.18	0.18	0.093	U	U
RDX	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Tetryl	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Trinitrobenzene, 1,3,5-	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
Trinitrotoluene, 2,4,6-	mg/kg	0.16	0.16	0.066	U	U	0.18	0.18	0.073	U	U
GEN CHEMISTRY											
% Solids	Percent	84.8	0				81.9	0			
Metals											
Aluminum	mg/kg	6650	9.3	1.1			5140	8.5	1		
Antimony	mg/kg	0.25	0.93	0.046	B	J	4.3	4.3	0.21	U	U
Arsenic	mg/kg	6.1	0.46	0.046			11.5	2.1	0.21		
Barium	mg/kg	35.2	9.3	0.19			70.9	43	0.85		
Beryllium	mg/kg	0.27	0.23	0.0046			0.42	1.1	0.021	B	J
Cadmium	mg/kg	0.72	0.19	0.0046			0.24	0.85	0.021	B	J
Calcium	mg/kg	3380	230	2.3			39900	1100	11		
Chromium	mg/kg	10.4	0.46	0.046			11.8	2.1	0.21		
Cobalt	mg/kg	3.5	2.3	0.046			9.9	11	0.21	B	J
Copper	mg/kg	11.2	1.2	0.046			20.9	5.3	0.21		
Iron	mg/kg	16400	14	1.1			20200	64	4.9		
Lead	mg/kg	7.4	0.93	0.046			8.3	0.85	0.043		
Magnesium	mg/kg	2430	230	2.3			16300	1100	11		
Manganese	mg/kg	103	0.7	0.046			672	3.2	0.21		
Mercury	mg/kg	0.034	0.087	0.0062	B	J	0.017	0.09	0.0064	B	J
Nickel	mg/kg	10.7	1.9	0.046			25.7	8.5	0.21		
Potassium	mg/kg	472	460	2.3			848	2100	11	B	J
Selenium	mg/kg	9.3	9.3	4.65	U	U	4.3	4.3	0.43	U	U
Silver	mg/kg	0.088	0.46	0.046	B	J	2.1	2.1	0.21	U	U
Sodium	mg/kg	52.6	460	39	B	J	2100	2100	180	U	U
Thallium	mg/kg	9.2	9.2	7	U	U	8.6	8.6	6.4	U	U
Vanadium	mg/kg	16.1	2.3	0.046			20	11	0.21		
Zinc	mg/kg	24.2	0.93	0.046			50.8	4.3	0.21		

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Location Code	CY2-SB04					CY2-SB04				
	Sample Number	CY0028					CY0029				
	Sample Date	10/26/2011					10/26/2011				
	Depth	0 - 1 Ft					3 - 5 Ft				
	Sample Purpose	REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
PEST/PCB											
Aroclor 1016	mg/kg	0.02	0.02	0.0079	U	U	0.02	0.02	0.0082	U	U
Aroclor 1221	mg/kg	0.02	0.02	0.0099	U	U	0.02	0.02	0.01	U	U
Aroclor 1232	mg/kg	0.02	0.02	0.0099	U	U	0.02	0.02	0.01	U	U
Aroclor 1242	mg/kg	0.02	0.02	0.0079	U	U	0.02	0.02	0.0082	U	U
Aroclor 1248	mg/kg	0.02	0.02	0.0079	U	U	0.02	0.02	0.0082	U	U
Aroclor 1254	mg/kg	0.02	0.02	0.0079	U	U	0.02	0.02	0.0082	U	U
Aroclor 1260	mg/kg	0.02	0.02	0.0079	U	U	0.02	0.02	0.0082	U	U
Semivolatiles											
3-Methylphenol and 4-Methylphe	mg/kg	0.19	0.19	0.028	U	U	0.21	0.21	0.03	U	U
Acenaphthene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Acenaphthylene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Acetophenone	mg/kg										
Anthracene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Atrazine	mg/kg										
Benzaldehyde	mg/kg										
Benzo(a)anthracene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Benzo(a)pyrene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Benzo(b)fluoranthene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Benzo(ghi)perylene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Benzo(k)fluoranthene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Benzoic acid	mg/kg	0.97	0.97	0.34	U	U	1	1	0.36	U	U
Benzyl alcohol	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Bibenzene	mg/kg										
Bis(2-chloroethoxy)methane	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Bis(2-chloroethyl)ether	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	UJ
Bis(2-chloroisopropyl)ether	mg/kg	0.19	0.19	0.019	U	UJ	0.21	0.21	0.021	U	U
Bis(2-ethylhexyl)phthalate	mg/kg	0.39	0.39	0.078	U	U	0.41	0.41	0.082	U	U
Bromophenyl phenyl ether, 4-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Butyl benzyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Caprolactam	mg/kg										
Carbazole	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Chloro-3-methylphenol, 4-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Chloroaniline, 4-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Chloronaphthalene, 2-	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Chlorophenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Chlorophenyl phenyl ether, 4-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Chrysene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Dibenz(a,h)anthracene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Dibenzofuran	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Dichlorobenzene, 1,2-	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Dichlorobenzene, 1,3-	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Dichlorobenzene, 1,4-	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Dichlorobenzidine, 3,3'-	mg/kg	0.39	0.39	0.039	U	U	0.41	0.41	0.041	U	U

Table A-1

Soil Data Used in the Screening-Level Ecological Risk Assessment
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Location Code	CY2-SB04					CY2-SB04				
	Sample Number	CY0028					CY0029				
	Sample Date	10/26/2011					10/26/2011				
	Depth	0 - 1 Ft					3 - 5 Ft				
	Sample Purpose	REG					REG				
Parameter	**Units**	**Result**	**RL**	**MDL**	**LQ**	**VQ**	**Result**	**RL**	**MDL**	**LQ**	**VQ**
Dichlorophenol, 2,4-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Diethyl phthalate	mg/kg	0.39	0.39	0.078	U	U	0.41	0.41	0.082	U	U
Dimethyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Dimethylphenol, 2,4-	mg/kg	0.19	0.19	0.025	U	U	0.21	0.21	0.026	U	U
Di-n-butyl phthalate	mg/kg	0.39	0.39	0.078	U	U	0.41	0.41	0.082	U	U
Dinitro-2-methylphenol, 4,6-	mg/kg	0.39	0.39	0.078	U	U	0.41	0.41	0.082	U	U
Dinitrophenol, 2,4-	mg/kg	0.97	0.97	0.39	U	U	1	1	0.41	U	U
Dinitrotoluene, 2,4-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Dinitrotoluene, 2,6-	mg/kg	0.19	0.19	0.023	U	U	0.21	0.21	0.024	U	U
Di-n-octyl phthalate	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Fluoranthene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Fluorene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Hexachlorobenzene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Hexachlorobutadiene	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Hexachlorocyclopentadiene	mg/kg	0.19	0.19	0.086	U	U	0.21	0.21	0.09	U	UJ
Hexachloroethane	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Indeno(1,2,3-cd)pyrene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Isophorone	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Methylnaphthalene, 2-	mg/kg	0.0429	0.19	0.019	J	J	0.21	0.21	0.021	U	U
Methylphenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Naphthalene	mg/kg	0.0321	0.19	0.031	J	J	0.21	0.21	0.033	U	U
Nitroaniline, 2-	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Nitroaniline, 3-	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Nitroaniline, 4-	mg/kg	0.19	0.19	0.039	U	U	0.21	0.21	0.041	U	U
Nitrobenzene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 2-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Nitrophenol, 4-	mg/kg	0.97	0.97	0.16	U	U	1	1	0.16	U	U
n-Nitroso-di-n-propylamine	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
n-Nitrosodiphenylamine	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Pentachlorophenol	mg/kg	0.97	0.97	0.23	U	U	1	1	0.25	U	U
Phenanthrene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Phenol	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Pyrene	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Trichlorobenzene, 1,2,4-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,5-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U
Trichlorophenol, 2,4,6-	mg/kg	0.19	0.19	0.019	U	U	0.21	0.21	0.021	U	U

FD - Field duplicate.
FS - Field split.
LQ - Laboratory qualifier.
MDL - Method detection limit.
mg/kg - Milligrams per kilogram.
REG - Regular sample.
RL - Reporting limit.
VQ - Validation qualifier.
Gray cells had no data.

APPENDIX B

ECOLOGICAL SCREENING VALUES FOR SOIL

Table B-1

Ecological Screening Values for Soil
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	EPA Eco-SSLs [a] (mg/kg)	Eco Endpoints PRGs [b] (mg/kg)	EPA Region V ESL [c] (mg/kg)	Tox. Benchmark [d] (earthworm only) (mg/kg)	Tox Benchmarks [e] Terrestrial Plants (mg/kg)	Selected ESV (mg/kg)
Inorganic Analytes							
Aluminum	7429-90-5	pH Dependent	NSV	NSV	NSV	50	pH Dependent
Antimony	7440-36-0	0.27	5	0.142	NSV	5	0.27
Arsenic	7440-38-2	18	9.9	5.7	60	10	18
Barium	7440-39-3	330	283	1.04	NSV	500	330
Beryllium	7440-41-7	21	10	1.06	NSV	10	21
Cadmium	7440-43-9	0.36	4	0.00222	20	4	0.36
Calcium	7440-70-2	NSV	NSV	NSV	NSV	NSV	Nutrient
Chromium	7440-47-3	26	0.4	0.4	0.4	1	26
Chromium, hexavalent	18540-29-9	81	NSV	NSV	NSV	NSV	81
Cobalt	7440-48-4	13	20	0.14	NSV	20	13
Copper	7440-50-8	28	60	5.4	50	100	28
Iron	7439-89-6	pH Dependent	NSV	NSV	NSV	NSV	pH Dependent
Lead	7439-92-1	11	40.5	0.0537	500	50	11
Magnesium	7439-95-4	NSV	NSV	NSV	NSV	NSV	Nutrient
Manganese	7439-96-5	220	NSV	NSV	NSV	500	220
Mercury	7439-97-6	NSV	0.00051	0.1	0.1	0.3	0.00051
Nickel	7440-02-0	38	30	13.6	200	30	38
Potassium	7440-09-7	NSV	NSV	NSV	NSV	NSV	Nutrient
Selenium	7782-49-2	0.52	0.21	0.0276	70	1	0.52
Silver	7440-22-4	4.2	2	4.04	NSV	2	4.2
Sodium	7440-23-5	NSV	NSV	NSV	NSV	NSV	Nutrient
Thallium	7440-28-0	NSV	1	0.0569	NSV	1	1
Vanadium	7440-62-2	7.8	2	1.59	NSV	2	7.8
Zinc	7440-66-6	46	8.5	6.62	200	50	46
Cyanide							
Cyanide, Total	57-12-5	NSV	NSV	1.33	NSV	NSV	1.33
Polychlorinated Biphenyls							
Aroclor 1016	12674-11-2	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371
Aroclor 1221	11104-28-2	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371
Aroclor 1232	11141-16-5	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371
Aroclor 1242	53469-21-9	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371
Aroclor 1254	11097-69-1	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371
Aroclor 1260	11096-82-5	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371

Table B-1

Ecological Screening Values for Soil
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	EPA Eco-SSLs [a] (mg/kg)	Eco Endpoints PRGs [b] (mg/kg)	EPA Region V ESL [c] (mg/kg)	Tox. Benchmark [d] (earthworm only) (mg/kg)	Tox Benchmarks [e] Terrestrial Plants (mg/kg)	Selected ESV (mg/kg)
Organochlorine Pesticides							
4,4'-DDE	72-55-9	0.021 [g]	NSV	0.596	NSV	NSV	0.021
4,4'-DDT	50-29-3	0.021 [g]	NSV	0.0035	NSV	NSV	0.021
Methoxychlor	72-43-5	NSV	NSV	0.0199	NSV	NSV	0.0199
Nitroaromatics							
Amino-2,6-dinitrotoluene, 4-	19406-51-0	NSV	NSV	0.0328 [i]	NSV	NSV	0.0328
Amino-4,6-dinitrotoluene, 2-	35572-78-2	NSV	NSV	0.0328 [i]	NSV	NSV	0.0328
Dinitrobenzene, 1,3-	99-65-0	NSV	NSV	0.655	NSV	NSV	0.655
Dinitrotoluene, 2,4-	121-14-2	NSV	NSV	1.28	NSV	NSV	1.28
Dinitrotoluene, 2,6-	606-20-2	NSV	NSV	0.0328	NSV	NSV	0.0328
RDX	121-82-4	NSV	NSV	NSV	NSV	NSV	NSV
Tetryl	479-45-8	NSV	NSV	NSV	NSV	NSV	NSV
Trinitrobenzene, 1,3,5-	99-35-4	NSV	NSV	0.376	NSV	NSV	0.376
Trinitrotoluene, 2,4,6-	118-96-7	NSV	NSV	NSV	NSV	NSV	NSV
Semivolatile Organic Compounds							
Acenaphthene	83-32-9	29	20	682	NSV	20	29
Acenaphthylene	208-96-8	29	NSV	682	NSV	NSV	29
Anthracene	120-12-7	29	NSV	1480	NSV	NSV	29
Benzo(a)anthracene	56-55-3	1.1	NSV	5.21	NSV	NSV	1.1
Benzo(a)pyrene	50-32-8	1.1	NSV	1.52	NSV	NSV	1.1
Benzo(b)fluoranthene	205-99-2	1.1	NSV	59.8	NSV	NSV	1.1
Benzo(ghi)perylene	191-24-2	1.1	NSV	119	NSV	NSV	1.1
Benzo(k)fluoranthene	207-08-9	1.1	NSV	148	NSV	NSV	1.1
Benzoic acid	65-85-0	NSV	NSV	NSV	NSV	NSV	NSV
bis(2-Ethylhexyl)phthalate	117-81-7	NSV	NSV	0.925	NSV	NSV	0.925
Carbazole	86-74-8	NSV	NSV	NSV	NSV	NSV	NSV
Chrysene	218-01-9	1.1	NSV	4.73	NSV	NSV	1.1
Dibenz(a,h)anthracene	53-73-3	1.1	NSV	18.4	NSV	NSV	1.1
Dibenzofuran	132-64-9	NSV	NSV	NSV	NSV	NSV	NSV
Di-n-butyl phthalate	84-74-2	NSV	200	0.15	NSV	200	200

Table B-1

Ecological Screening Values for Soil
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	EPA Eco-SSLs [a] (mg/kg)	Eco Endpoints PRGs [b] (mg/kg)	EPA Region V ESL [c] (mg/kg)	Tox. Benchmark [d] (earthworm only) (mg/kg)	Tox Benchmarks [e] Terrestrial Plants (mg/kg)	Selected ESV (mg/kg)
Fluoranthene	206-44-0	1.1	NSV	122	NSV	NSV	1.1
Fluorene	86-73-7	1.1	NSV	122	30	NSV	1.1
Indeno(1,2,3-cd)pyrene	193-39-5	1.1	NSV	109	NSV	NSV	1.1
Methylnaphthalene, 2-	91-57-6	29	NSV	3.24	NSV	NSV	3.24
Naphthalene	91-20-3	29	NSV	0.0994	NSV	NSV	29
Nitroaniline, 3-	99-09-2	NSV	NSV	3.16	NSV	NSV	3.16
Phenanthrene	85-01-8	29	NSV	45.7	NSV	NSV	29
Pyrene	129-00-0	1.1	NSV	78.5	NSV	NSV	1.1
Volatile Organic Compounds							
Acetone	67-64-1	NSV	NSV	2.5	NSV	NSV	2.5
Benzene	71-43-2	NSV	NSV	0.255	NSV	NSV	0.255
Bromomethane	74-83-9	NSV	NSV	0.235	NSV	NSV	0.235
Butanone, 2-	78-93-3	NSV	NSV	89.6	NSV	NSV	89.6
Carbon disulfide	75-15-0	NSV	NSV	0.0941	NSV	NSV	0.0941
Dichloroethane, 1,1-	75-34-3	NSV	NSV	20.1	NSV	NSV	20.1
Dichloroethene, 1,1-	75-35-4	NSV	NSV	8.28	NSV	NSV	8.28
Dichloroethene, cis-1,2-	156-59-2	NSV	NSV	0.784 [h]	NSV	NSV	0.784
Methylene chloride	75-09-2	NSV	NSV	4.05	NSV	NSV	4.05
Toluene	108-88-3	NSV	200	5.45	NSV	200	200
Trichloroethane, 1,1,1-	79-00-5	NSV	NSV	29.8	NSV	NSV	29.8
Trichloroethene	79-01-6	NSV	NSV	12.4	NSV	NSV	12.4
Trimethylbenzene, 1,2,4-	95-63-6	NSV	NSV	NSV	NSV	NSV	NSV
Xylene, Total	1330-20-7	NSV	NSV	10	NSV	NSV	10

Table B-1

Ecological Screening Values for Soil
Coal Yard No. 2
Former Plum Brook Ordnance Works, Sandusky, Ohio

EPA - U.S. Environmental Protection Agency.
Eco-SSL - Ecological soil screening level.
ESL - Ecological screening level.
ESV - Ecological screening value.
NSV - No screening value available.
mg/kg - Milligrams per kilogram.

Priority for Selection of ESVs:
1) EPA Eco-SSL
2) PRG for Eco Endpoints, (Efroymson, et.al, 1997a)
3) EPA Region 5 Ecological Screening Levels
4) Efroymson, 1997b
5) Efroymson, 1997c

[a] EPA, 2008, Ecological Soil Screening Level (SSL) guidance. On-line at: http://www.epa.gov/ecotox/ecossl/index.html
[b] Efroymson, 1997a, *Preliminary Remediation Goals for Ecological Endpoints* . www.esd.ornl.gov/programs/ecorisk/documents/tm162r2.pdf .
[c] Screening value based on: EPA , 2003, *Region 5 Ecological Screening Level (ESL)* , Website version last updated August 22, 2003: http://www.epa.gov/Region5/rcraca/edql.htm.
[d] Efroymson, R.A., M.E. Will, G.W. Suter, 1997b, Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision, ES/ER/TM-126/R2 (microbial screening values are not included). http://www.esd.ornl.gov/programs/ecorisk/documents/tm126r21.pdf.
[e] Efroymson, R.A., M.E. Will, G.W. Suter, 1997c, Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision, ES/ER/TM-85/R3. http://www.esd.ornl.gov/programs/ecorisk/documents/tm85r3.pdf
[f] Based on the screening value for total PCBs.
[g] Based on the screening value for DDT and metabolites.
[h] Based on the screening value for dichloroethylene [trans-1,2].
[i] Based on the screening value for 2,6-dinitrotoluene.

RESPONSE TO COMMENTS

Responses to Ohio Environmental Protection Agency Comments on the Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment for Powerhouse No. 2 Ash Pits Addendum for Coal Yard No. 2 Former Plum Brook Ordnance Works, Sandusky, Ohio, Dated April 11, 2013

Comments by Janusz Byczkowski, Risk Assessor, Ohio Environmental Protection Agency, received May 17, 2013.

BHHRA Comments

Comment 1: **Section ES-1, Line 6.** The BHHRA document states: "*…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…*"

The issue of determining background and the "agreement" was already discussed in previous reviews. Please note that no legally binding agreement has been made between OEPA and ACE or Shaw Environmental Inc., regarding risk assessment methodology at the NASA Plum Brook Site. Please delete reference to "agreements" with Ohio Environmental Protection Agency.

Response 1: The words "and agreements" will be removed from the indicated text.

BHHRA and SLERA Comments

Comment 2: **BHHRA Table 2-4 and SLERA Table 2-2.** From comparison of maximum detected concentrations of cadmium in soil in BHHRA Table 2-4 versus SLERA Table 2-2 (8.90E-01 vs. 8.10E-01 mg/kg, respectively) it is not clear which numerical value is correct.

Please verify and correct maximum detected concentration of cadmium in soil.

Response 2: The BHHRA and SLERA use different soil datasets to select COPCs/COPECs. The cadmium MDC for the BHHRA in Table 2-4 of 0.89 mg/kg was detected in sample CY0019, which was collected from the 8 to10 feet below ground surface (bgs) interval. Soil at this depth is not included in the SLERA, which only evaluates soil up to 6 feet bgs. Thus, the MDCs in the BHHRA and SLERA are different for chemicals such as cadmium that have higher concentrations in soil samples collected from a depth greater than 6 feet bgs.

APPENDIX A THROUGH F

ELECTRONIC DELIVERABLE ONLY