Final Report
Risk Assessment and Direct-Push Investigation of Red Water Pond Areas Former Plum Brook Ordnance Works Sandusky, Ohio

Volume I - Text, Tables, and Figures

Submitted to:

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Nashville District
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IT Project No. 773701

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Revision 2

August 2000

Draft Report
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Volume II - Appendices

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List of Acronyms

ABS	absorption factor
AF	adherence factor
AOC	area of concern
AR/COC	analysis request/chain of custody
ARAR	applicable or relevant and appropriate requirement
ARP	assessment receptor profile
ASTM	American Society for Testing and Materials
AT	averaging time
BAF	bioaccumulation factor
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
BNA	base neutral/acid extractable compound
BSC	background screening criterion
BTAG	Biological Technical Assistance Group
BTEX	benzene, toluene, ethyl benzene, and xylene
BW	body weight
CDI	chronic daily intake
CLP	Contract Laboratory Program
cm/hr	centimeters per hour
COC	chemical(s) of concern
COPC	chemical(s) of potential concern
COPEC	chemical(s) of potential ecological concern
CRQL	contract-required quantitation limit
CSEM	conceptual site exposure model
CT	central tendency
D&M	Dames & Moore, Inc.
DA	dose absorbed
DERP	Defense Environmental Restoration Program
DNAP	Ohio Division of Natural Areas & Preserves

List of Acronyms *(Continued)*

DNB	dinitrobenzene
DNT	dinitrotoluene
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DPI	direct-push investigation
DQE	data quality evaluation
ED	exposure duration
EF	exposure frequency
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ESBSNP	Erie Sand Barrens State Nature Preserve
ESCM	ecological site conceptual model
ET	exposure time
FCM	food chain multiplier
FI	fractional term
FRL	late forest
FRM	moderate forest
FUDS	formerly used defense sites
g/m^3	grams per cubic meter
GAF	gastrointestinal absorption factor
GSA	General Services Administration
GWI	groundwater investigation
HEAST	Health Effects Summary Assessment Table
HI	hazard index
HHRA	human health risk assessment
HQ	hazard quotient
ICI	International Consultants Incorporated
IDL	instrument detection limit
IDW	investigation-derived waste
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
IT	IT Corporation

List of Acronyms *(Continued)*

kg	kilogram
K_{oc}	organic carbon/water partition coefficient
K_{ow}	octanol/water partition coefficient
LOAEL	lowest-observed-adverse-effects level
: g	microgram
: g/kg	micrograms per kilogram
: g/L	micrograms per liter
m^3	cubic meter
m^3/day	cubic meters per day
MDC	maximum detected concentration
mg/cm^2	milligrams per square centimeter
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
MK	Morrison-Knudsen Ferguson Corporation
msl	mean sea level
NASA	National Aeronautics and Space Administration
NCEA	National Center for Environmental Assessment
NOAEL	no-observed-adverse-effects level
NWI	National Wetland Inventory
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OFE	early old field
OME	Ontario Ministry of the Environment and Energy
PAH	polynuclear aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works
PBS	Plum Brook Station
PC	permeability coefficient
PCB	polychlorinated biphenyl
PCDD/PCDF	polychlorinated dibenzo-p-dioxin/dibenzofuran
PEF	particulate emission factor
PEL	probable effect level

List of Acronyms *(Continued)*

POW	palustrine open water
ppb	parts per billion
PPE	personnel protective equipment
ppm	parts per million
PRG	preliminary remediation goal
PRRWP	Pentolite Road Red Water Ponds
QAPP	quality assurance project plan
QC	quality control
RBRC	risk-based remediation criteria
RBSC	risk-based screening concentration
RBSEV	risk-based screening ecotoxicity value
RfC	reference concentration
RfD	reference dose
RME	reasonable maximum exposure
RTE	rare, threatened, or endangered
RTV	reference toxicity value
SA	surface area
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SF	slope factor
SOW	scope of work
SQL	sample quantitation limit
SSAP	site-specific sampling and analysis plan
SVOC	semivolatile organic compound
T&E	threatened and endangered
TAL	target analyte list
TCL	target compound list
TEL	threshold effect level
TF	transfer factor
TNB	trinitrobenzene
TNT	trinitrotoluene
TOC	total organic carbon

List of Acronyms *(Continued)*

UCL	upper confidence limit
URF	unit risk factor
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USCS	U.S. Soil Conservation Service
UTL	upper tolerance limit
VOC	volatile organic compound
WARWP	West Area Red Water Ponds

1.0 Introduction

The U.S. Army is conducting studies of the environmental impact of suspected hazardous waste sites at properties previously owned by the U.S. Department of Defense (DOD). The U.S. Army Corps of Engineers (USACE) is pursuing this work under the Defense Environmental Restoration Program (DERP) for formerly used defense sites (FUDS). The former Plum Brook Ordnance Works (PBOW) located in the city of Sandusky, Erie County, Ohio is a DERP FUDS project and is being managed and technically overseen by the Nashville District of USACE. Figure 1-1 shows the geographic location of the former PBOW site. IT Corporation (IT) performed a direct-push investigation (DPI) of soil and groundwater at two Red Water Pond Areas (the West Area Red Water Ponds [WARWP] and the Pentolite Road Red Water Ponds [PRWWP]) on PBOW in June and November 1998. This work was performed under Delivery Order 0016 of Contract No. DACA62-94-D-0031.

1.1 Scope of Work and Project Objectives

As specified in the scope of work (SOW) (USACE, 1997), the DPI included preparation of site-specific work plans, completion of various field investigation activities, evaluation of analytical results from samples collected during the field investigation, preparation and submittal of reports characterizing activities, conclusions, and recommendations for further actions. Based on the findings of previous investigations, this DPI acquired supplemental data soil and groundwater contamination in both Red Water Ponds Areas. As nitroaromatic compounds have historically been detected primarily in the overburden water-bearing zone, particular focus was placed on this zone. Figure 1-2 identifies both areas investigated in relation to other site features. Specific objectives of the DPI were to:

- Delineate the vertical and lateral extent of contamination in the overburden water-bearing zone in the Red Water Ponds Areas to support a potential future remedial action.
- Collect data for use in fate and transport modeling of the subject areas.

Activities completed during the field investigation included direct-push sampling of soil and groundwater, a land survey, and handling investigation-derived waste (IDW). Groundwater and soil samples collected for chemical analysis included primary samples and field quality control (QC) samples. Soil samples were also collected for geotechnical testing. To address identified data gaps

from preliminary risk assessment evaluations, IT returned to PBOW to collect ten collocated surface water and sediment samples from the two Red Water Ponds Areas in November 1998.

1.2 Site History and Potential for Contamination

The 9,009-acre PBOW site was built in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Production of explosives began on December 16, 1941 and continued until 1945. It is estimated that more than 1 billion pounds of explosives were manufactured during the 4-year operating period.

After plant operations ceased in 1945, decontamination of TNT, acid, pentolite, and DNT processing lines began; decontamination of the lines was completed during the last quarter of 1945. The property was initially transferred to the Ordnance Department, then to the War Assets Administration after it was certified decontaminated by the U.S. Army. In 1949, PBOW was transferred to the General Services Administration (GSA).

The National Aeronautics and Space Administration (NASA) acquired PBOW on March 15, 1963 and is presently utilizing the site. On April 18, 1978, NASA declared approximately 2,152 acres of land as excess. The Perkins Township Board of Education acquired 46 acres of the excess and uses this area as a bus transportation center. GSA retains the remaining acreage and currently has a use agreement with the Ohio National Guard for 604 acres of the land. NASA presently controls approximately 6,400 acres and is using the site to conduct space research as a satellite operation of NASA's Glenn Research Center in Cleveland, Ohio. The details of these land transactions are listed in the site management plan and can be found at the NASA Plum Brook Station (PBS).

Potential contaminants in the groundwater at PBOW, based on review of historical use of the site and findings of previous investigations, may include nitroaromatic compounds (explosive residuals), volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides/polychlorinated biphenyls (PCB), cyanide, and dissolved metals.

1.3 Summary of Previous Environmental Studies

The following sections summarize results from previous investigations at the two Red Water Ponds Areas. Identified sample locations may be referenced on figures in Chapter 2.0.

1.3.1 West Area Red Water Ponds

In 1984, Battelle Laboratories collected a surface soil sample from the spoils area at the WARWP area. Concentrations of nitroaromatics were detected in the low-parts per million (ppm) range using a now obsolete analytical method (International Consultants Incorporated [ICI], 1995).

Prior to 1985, a number of studies were conducted on the surface water and sediment from the Red Water Pond Areas. In the western pond at the WARWP area, 34 bottom sediment samples were collected in a grid pattern by Ohio National Guard environmental health personnel and screened for TNT and DNT derivatives. The highest values of TNT and DNT found in the sediment were less than 1 ppm. In 1989, IT conducted an investigation to confirm or deny the presence of residual chemical contamination from PBOW operations. Six surface soil samples were collected from 0 to 2 feet below ground surface (bgs) from borings IT-MW02, IT-SB07, IT-SB09, IT-SB10, IT-SB11, and IT-SB12 located at the WARWP area. No VOCs or SVOCs were detected. Four nitroaromatic compounds (1,3-dinitrobenzene [DNB], 1,3,5-trinitrobenzene [TNB], 2,4-DNT, and 2,4,6-TNT) were detected, with the highest concentrations (greater than 600 micrograms per kilogram [：g/kg]) detected at IT-SB12. Manganese was also detected at a concentration exceeding that of the background sample. Monitoring well IT-MW02 was installed downgradient from the WARWP area. A groundwater sample was collected for analysis of VOCs, SVOCs, nitroaromatic compounds, nitrates, sulfates, pH, and metals. Analytical results indicated concentrations of some VOCs and SVOCs were detected in the low (less than 20 micrograms per liter [：g/L]) parts per billion (ppb) range. Nitroaromatics (up to 160 ：g/L), chromium (0.12 ：g/L), manganese (3.0 ：g/L), and sulfate (950 ：g/L) were also detected.

In 1991, Science Applications International Corporation (SAIC) conducted a preliminary assessment to evaluate past waste management and hazardous material handling processes. Based on this assessment, SAIC determined that hazardous substances had been released to the environment at the WARWP area (USACE, 1997).

In 1993, a site inspection was conducted by Morrison-Knudsen Ferguson Corporation (MK) to assess the threat posed by the site on human health and the environment, and to determine the need for additional investigations. MK analyzed sediment and surface water from Pipe Creek near the WARWP area for VOCs, SVOCs, and nitroaromatics. The surface water had no detectable contaminants, but the sediment had a few VOCs and SVOCs in the low-ppb range. No nitroaromatics were detected (ICI, 1995). Four monitoring wells (MK-MW09, MK-MW10, MK-MW11, and

MK-MW12) were installed in the vicinity of the WARWP area (MK, 1994). Groundwater was collected from the four new wells and IT-MW02 for analyses of VOCs, SVOCs, nitroaromatic compounds, nitrates, sulfates, and metals. VOCs, SVOCs, and nitroaromatics were not detected in any groundwater samples (ICI, 1995).

In 1994, Dames & Moore, Inc. (D&M) conducted an investigation to evaluate groundwater occurrence and flow conditions in the overburden and bedrock water-bearing zones; assess groundwater quality in the overburden water-bearing zone; and investigate the baseline groundwater quality of the bedrock water-bearing zone to evaluate the necessity of additional work at PBOW (D&M, 1997a). Two bedrock wells (BED-MW14 and BED-MW19) and two overburden wells (WA-MW01 and WA-MW02) were installed in the vicinity of the WARWP area. Hydrogeologic data indicated that groundwater flow in the overburden exhibited a strong downward vertical component and the presence of groundwater was strongly seasonally dependent. The general groundwater flow in both water-bearing zones was determined to be to the north toward Lake Erie. Groundwater samples were analyzed for VOCs, base neutral/acid extractable compounds (BNA), nitroaromatics, and metals. Significant concentrations of nitroaromatics were determined to be present adjacent to the ponds in both the overburden and the bedrock aquifers. VOCs and BNAs were also present in the bedrock wells. Some metals (antimony, manganese, and nickel) were also detected at concentrations exceeding their maximum contaminant levels (D&M, 1997a).

In 1996, IT conducted a groundwater investigation (GWI) focusing on the western portion of the facility; the investigation consisted of installing three overburden monitoring wells, redeveloping existing monitoring wells, and collecting groundwater samples for laboratory analysis. In addition, one monitoring well (IT-MW10) and one temporary piezometer (IT-MW07) were installed in the vicinity of the Red Water Ponds Area. It was determined that the overburden material had been impacted by nitroaromatic compounds in the central portion of the WARWP area and that inorganic compounds were present at concentrations exceeding the risk-based screening concentrations throughout the area (IT, 1997). It was recommended that further evaluation of the metals in the groundwater be performed to determine whether they were derived from an on-site source of contamination or were related to background conditions. IT determined that the bedrock water-bearing zone was impacted by nitroaromatics and other organic compounds north of the WARWP area, but the bedrock aquifer did not exhibit impacts by any of these constituents in the central portion of the area. Inorganic compounds were also present north of this area. It is concluded that further evaluation would be needed to

determine the nature and extent of contamination in these areas, after background levels are established for metals in groundwater.

During a November 1997 groundwater sampling event, IT discovered that two of the overburden wells at the WARWP area (IT-MW02 and WA-MW02) and one bedrock well (PB-BED-MW14) had red-colored water, suggesting the presence of nitroaromatics. The latest (May, 1998) analytical results for these wells indicate elevated concentrations of nitroaromatics. The analytical results of these samples were documented in a separate report (IT, 1999).

1.3.2 Pentolite Road Red Water Ponds

In 1989, IT conducted an evaluation to determine whether residual chemical contamination was present (IT, 1991). A shallow monitoring well (IT-MW05) was installed on the northern edge of the Red Water Ponds, in the suspected downgradient direction. Soil borings IT-SB13 through IT-SB18 were also drilled, and soil samples were collected. 2,4-DNT and 2,6-DNT were detected in the soil at concentrations of at least 0.740 ppm and sodium concentrations in samples from six of the borings exhibited concentrations significantly above the measured background levels (ICI, 1995).

A site inspection was conducted by MK from June through July 1993 to assess the threat posed to human health and the environment and to determine the need for any additional investigation. MK collected and analyzed surface and sediment samples from a drainage ditch along Pentolite Road north of the PRRWP area. Samples were analyzed for VOCs, SVOCs, and nitroaromatic compounds. No samples from the Pentolite Road ditch showed detectable levels of contaminants (MK, 1994).

From May to June of 1994, D&M conducted a GWI to evaluate groundwater conditions in several areas at PBOW. The SOW included an assessment of groundwater quality in the overburden and bedrock water-bearing zones at the PRRWP area. Overburden monitoring wells PR-MW7, PR-MW8, and PR-MW9 and bedrock monitoring wells BED-15 and BED-16 were installed. The investigation found that the groundwater flow in the overburden exhibited a strong downward vertical component, and the presence of groundwater in the overburden was seasonally dependent. Groundwater sample results indicated that nitroaromatics were present in the overburden water-bearing zone, while lower levels of nitroaromatics were present in the bedrock water-bearing zone (D&M, 1997a).

From the sitewide GWI performed by IT in September through October of 1996, it was determined that the overburden water-bearing zone in the PRRWP area had been impacted by nitroaromatic compounds. The bedrock water-bearing zone was also determined to exhibit impacts by benzene, toluene, ethyl benzene, and total xylenes (BTEX), SVOCs, and nitroaromatic compounds (IT, 1997).

During the November 1997 groundwater sampling event, IT discovered that three of the overburden wells at the PRRWP area (PR-MW07, PR-MW08, and PR-MW09) had red-colored water, suggesting the presence of nitroaromatics. The analytical results from the latest samples (May, 1998) exhibited elevated concentrations of nitroaromatic compounds. The analytical results of these samples are reported in a separate report (IT, 1999) addressing the GWI.

1.4 Summary of Existing Site Conditions

The former PBOW site is currently owned by the NASA and is operated as the PBS of the NASA Glenn Research Center in Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the site are on standby or inactive status. The site is located approximately 4 miles south of Sandusky, Ohio and is specifically located in the Perkins, Oxford, Huron, and Milan Townships. The site is bounded on the north by Bogart Road, on the south by Mason Road, on the west by County Road 43, and on the east by U.S. Highway 250. The areas surrounding PBOW is mostly agricultural and residential.

The topography of PBOW site is characterized by a fairly flat ground surface that slopes gradually northward toward Lake Erie at an average gradient of less than 2 percent. Elevations at the site range from 675 feet above mean sea level (msl) along the southeast edge of the site to about 625 feet msl in the northern portion of the installation at Bogart Road. Eleven streams exist within the site and flow toward Lake Erie. Plum Brook, Ransom Brook, and Pipe Creek are the three major streams and are being monitored by NASA PBS. The climate in north central Ohio is a typical continental climate showing significant influence by Lake Erie. Mean annual precipitation is 33.90 inches. The average monthly precipitation is approximately 1.65 inches for February and 3.70 inches for the month of July.

Devonian and Silurian carbonate and clastic rocks, generally dipping to the southeast, characterize bedrock geology at PBOW. The thickness of glacial till or lacustrine deposits range from approximately 5 feet or less for most of the site to approximately 20 feet in the northern border of the site. In many locations, bedrock is exposed on the ground surface. According to the PBOW

preliminary assessment (SAIC, 1991) some karst features are present in the carbonate rocks forming the water-bearing formation underneath the soil cover.

2.0 Field Activities

Field activities were conducted by IT personnel and IT-retained subcontractors during June and November 1998. Mr. Keith Peecook, the environmental coordinator for NASA PBS, acted as the project contact and approved drilling/digging permits and extended work hours during the course of the project. Mr. Ron Nabors of Ohio Environmental Protection Agency (OEPA) visited the site on June 25, 1998.

2.1 Direct-Push Soil Sampling

Direct-push drilling and sampling procedures were used for collection of surface and subsurface soil at 48 locations (39 boring locations for chemical analysis and 9 boring locations for geotechnical testing) (Table 2-1 and Figures 2-1 and 2-2). The direct-push technique used (i.e., Geoprobe™) consists of a hydraulic drive unit, a stainless-steel sampling point, and sampling rods. The hydraulic drive unit was positioned at the selected boring location. A hydraulically powered percussion hammer drove a 1.5-inch outside diameter sampling core to the required depth. When the probe reached the desired depth, the point was retracted, the soil sampler driven forward, and a liner filled. The core barrel was stainless-steel with an inner acetate™ liner. Sample recovery was recorded on the sample collection log (Appendix A). If there was insufficient soil recovery, the sample was collected from another borehole immediately adjacent to (less than 1 foot away from) the original location. The distance was noted, along with the general direction, on the Sample Collection Log. After the samples were collected, the hole was backfilled with any soil remaining from probe activities and grouted to the surface.

The liner was extruded from the sample tube and Teflon™ tape and vinyl end caps (red cap on the top, black cap on the bottom) were placed on each end of the liner. The field geologist described the soil sample on the Sample Collection Log and noted the headspace reading. The liner was sealed with Teflon™ tape placed on each end and covered by vinyl end caps. The sample location identification and depth was written on the upper (red) vinyl end cap. As specified in the site-specific sampling and analysis plan (SSAP) (IT, 1998a), all soil samples were analyzed for VOCs, SVOCs, target analyte list (TAL) metals, PCBs, and nitroaromatics.

2.2 Direct-Push Groundwater Sampling

Direct-push drilling and sampling procedures were used for collection of groundwater at 34 locations (14 boring locations at WARWP and 20 boring locations at PRRWP). Groundwater, when present, was collected from all the borings in which soil had been collected for chemical analysis. If groundwater was encountered before the bedrock was reached and the field geologist believed a sufficient quantity of water could be obtained, a temporary groundwater piezometer was constructed into the formation. A groundwater sample was then collected with a peristaltic pump. As specified in the SSAP, all groundwater samples were to be analyzed for VOCs, SVOCs, total TAL metals, dissolved TAL metals, nitroaromatics, PCBs, hardness, alkalinity, total organic carbon (TOC), total dissolved solids, total suspended solids, chloride, cyanide (total), nitrate, and sulfate. However, due to limited yield at some locations, not all analyses could be completed (see Section 2.7). Table 2-2 contains a summary of primary surface water and sediment for the direct-push investigation.

2.3 Surface Water/Sediment Sampling

Following completion of the direct-push investigation, IT, in consultation with the USACE, determined that collection of surface water and sediment samples at the two Red Water Ponds Areas would provide additional data needed in the ecological risk assessment (ERA) and human health risk assessment (HHRA). Therefore, IT collected collocated surface water and sediment samples from the two areas in November 1998. Four surface water and sediment samples were collected at the PRRWP area, while six surface water and sediment samples were analyzed for VOCs, SVOCs, nitroaromatics, metals, and PCBs. Surface water samples were also analyzed for hardness, and sediment samples were analyzed for TOC.

2.4 Decontamination Procedures

Decontamination of sampling equipment was performed in accordance with the procedures prescribed in Section 4.4.3 of the sitewide SAP (IT, 1996a). A decontamination pad for the drill rig and drilling equipment was set up east of Campbell Street. Specifically, the drill rig and augers were steam-cleaned before and after each use. The sampling equipment was decontaminated according to the following procedures:

- Rinse with potable water obtained from the PBS fire station.
- Wash and scrub using a brush with nonphosphatic detergent.
- Rinse with potable water.

- Rinse with deionized water (American Society for Testing and Materials [ASTM]) Type II).
- Rinse with methanol followed by a hexane rinse.
- Final rinse with deionized water (ASTM Type II). The rinse volume was at least five times the volume of methanol used.
- Air dry.
- Wrap in aluminum foil for transport to sampling locations.

2.5 Investigation-Derived Wastes

A limited amount of IDW generated during the DPI includes decontamination water and disposable personnel protective equipment (PPE). IDW was managed and handled in accordance with procedures described in the SSAP (IT, 1996a).

Decontamination water was collected in drums prior to removal of the decontamination pad. All drums were labeled with the contained materials, content volume, date of generation, and source of origin as applicable. IDW drums were staged in the IDW storage area north of the Pentolite Road pending disposal. PPE was doubled-bagged and placed in the on-site industrial dumpster.

2.6 Land Surveying

All direct-push and surface water/sediment sampling locations were surveyed in late June and November 1998 by an Ohio registered professional land surveyor. Horizontal coordinates were surveyed to the closest 1.0 foot and referenced to the Ohio State Plane Coordinate System. Vertical coordinates (land surface elevation and top of casing elevation) were surveyed to the nearest 0.01 foot and referenced to the 1929 National Geodetic Vertical Datum. The complete survey data are presented in Appendix B.

2.7 Variances/Nonconformance

Variances are defined as necessary changes to the standard operating procedures employed in the field or office activities and modification to the original SOW as specified in the SSAP (IT, 1996a) and the quality assurance project plan (QAPP) (IT, 1996b). Variances do not significantly affect the quality of the data or process being changed. However, nonconformances are defined as malfunctions,

deficiencies, or deviations that may render the quality of information or data unacceptable or indeterminate. Nonconformances were not reported during the field sampling. However, a total of 32 variances were generated as summarized in Table 2-3. The majority of the variances recorded are related to the low yield of some direct-push boreholes that did not produce sufficient quantity of groundwater for all analyses. Twelve direct-push boreholes in PRRWP area and sixteen boreholes (four were completely dry) in the WARWP did not produce enough water for the analyses of all required parameters. In addition, two direct-push locations in the WARWP area were not completed due to equipment failure following consultation with the USACE. Therefore, no soil and groundwater samples were collected from WARP-DP14, and no water sample was collected from WARP-DP10. Soil samples were collected from WARP-DP10 at 0- to 2- and 6- to 8-foot-depth intervals only. All variance logs were prepared by IT field personnel and are retained in the project files.

3.0 Analytical Program

All primary direct-push groundwater and soil samples, as well as surface water and sediment samples for chemical analysis were analyzed by Quanterra Environmental Services located in Knoxville, Tennessee. The data quality evaluation (DQE) report was prepared by an IT project chemist and is provided in Appendix C. An independent third party contractor performed data validation and the results are presented in Appendix D. The laboratory analytical data packages are included in Appendix E (complete data package) and Appendix F (blank corrected data).

3.1 Analytical Parameters and Methodologies

Chemical analyses for the DPI were performed in accordance with guidelines in the U.S. Environmental Protection Agency (EPA) document entitled *Test Methods for Evaluating Solid Waste* (SW-846) (EPA, 1986a). Methods used for analysis by the laboratory are shown in Table 3-1. All analytical data were reported in accordance with the EPA Level IV Contract Laboratory Program (CLP)-like data package and were in compliance with the EPA definitive data requirements. The regulatory compound/analyte list reported was the target compound list (TCL) for organics and the TAL for inorganics as defined by the most recent CLP SOW. These data packages have been reviewed for completeness, accuracy, and representativeness as prescribed in the QAPP (IT, 1996b). All analytical data presented in this report were validated and blank corrected. An independent subcontractor performed data validation and the validation summary is presented in Appendix D. All samples were submitted to the laboratory accompanied by an analysis request/chain of custody (AR/COC) form. The AR portion of the form provides project-specific analytical specifications and QC instruction to the laboratories. A formal COC record was included as part of the document, ensuring documentation of custody for sample transportation, storage, and eventual disposition by the laboratory. Copies of all custody documentation are included in the data packages submitted. An assessment of the analytical data with regard to the project-specific objectives is presented in Appendix B in the DQE report. In the DQE, all elements of data evaluation were compiled and used to determine the usability and overall applicability of the resulting data. Evaluation of the data using the specific data quality objectives established for the project resulted in the determination that the data set is valid and of sufficient quality to meet the objectives of the investigation. There were no significant problems observed that would adversely affect the application of the data or the success of the overall investigation.

3.2 Blank Correction

The purpose of blank analysis is to determine the existence of 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. Each sample in the database has a list of associated field and laboratory blanks that are used in the evaluation process. The criteria for blank evaluation are detailed in *Region III Modifications to National Functional Guidelines for Organic Data Review* (EPA, 1994) and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA, 1993a) and summarized 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 (CRQL), but is less than the 5X or 10X multiple of the blank result, the sample result is qualified "B."
- For organics, if the sample result is less than the CRQL and less than the 5X or 10X multiple of 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 (IDL) but less than the 5X multiple of the blank result, the sample result is qualified "B."
- If the sample result is greater than the 5X or 10X multiple of 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. The results are never corrected by subtracting blank values.

4.0 Analytical Results

A total of 115 soil samples, 34 direct-push groundwater samples, 10 surface water samples, and 10 sediment samples were collected at the two Red Water Ponds Areas during the DPI. Of the soil samples, 39 are surface soil samples collected between 0 and 2 feet bgs and 76 are subsurface soil samples collected at depths between 2 feet and 10 feet bgs. As discussed in Section 2.7, not all groundwater samples could be analyzed for all parameters specified in the SSAP due to insufficient water yield. The laboratory analytical data packages are included in Appendix E (complete data package) and Appendix F (blank corrected data).

4.1 West Area Red Water Ponds

4.1.1 Surface and Subsurface Soils

A total of 19 surface soil samples and 37 subsurface soil samples were collected within the WARWP area from 19 direct-push boring locations. As previously discussed, soil samples could not be collected at the 8- to 10-foot depth in DP-10 or any sample in DP-14 due to equipment failure. The following subsections discuss detected constituents in soil samples by chemical groups. Screening and interpretation of this data is presented in Chapters 5.0 and 6.0.

4.1.1.1 Volatile Organic Compounds

Three VOCs (acetone, methylene chloride, and toluene) were detected in a small percentage of the surface and subsurface soil samples (Table 4-1). Acetone was detected in only one surface soil sample (DP-08) at a low concentration of 0.035 milligrams per kilogram (mg/kg). Low levels of methylene chloride were detected in three samples, ranging from 0.002 mg/kg to 0.0023 mg/kg, while toluene exhibited detections ranging from 0.0015 to 0.0032 mg/kg in eight samples. At least one VOC was detected in 11 borings, including DP-01, -02, -04, -06, -08, -11, -12, -13, -15, -17, and -20 (Figure 4-1).

4.1.1.2 Semivolatile Organic Compounds

A total of 13 SVOCs were detected at low concentrations in up to three surface and subsurface soil samples collected from four borings (DP-09, -11, -13, and -20) at the WARWP (Table 4-1). Fluoranthene and pyrene were the most frequently detected SVOCs, with three detections each, with detected concentrations ranging from 0.058 to 0.76 mg/kg and 0.043 to 0.55 mg/kg, respectively. Ten

SVOCs, including acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd) pyrene, and phenanthrene, were each detected in two soil samples. 2,4-DNT was only detected in one sample, the 0- to 2-foot sample collected from DP-11 (0.043 mg/kg).

4.1.1.3 Nitroaromatic Compounds

Four nitroaromatic compounds, 1,3,5-TNB, 2,4,6-TNT, 2,4-DNT, and 2,6-DNT, were detected in up to six subsurface soil samples (Figure 4-1); nitroaromatic compounds were not detected in surface samples collected at the WARWP. 1,3,5-TNB was detected in six samples from DP-03 (8 to 10 feet), DP-09 (8 to 10 feet), DP-10 (4 to 6 ft), DP-11 (8 to 10 feet), DP-13 (8 to 10 feet), and DP-18 (8 to 10 feet) at concentrations ranging from 0.28 to 4.4 mg/kg (Table 4-1). 2,4,6-TNT (0.38 mg/kg) and 2,6-DNT (1.5 mg/kg) were detected in only one sample, the 4- to 6-foot sample in DP-10. 2,4-DNT was detected in the 8- to 10-foot samples collected from DP-09, DP-10, and DP-13, with concentrations ranging from 0.49 to 6.3 mg/kg.

4.1.1.4 PCBs

There were no detected PCBs in any of the soil samples collected at the WARWP.

4.1.1.5 Inorganic Compounds

Twenty-one metals were detected in at least one soil sample collected during the DPI at the WARWP (Table 4-2). Each of the 56 soil samples exhibited detectable concentrations of aluminum, arsenic, calcium, chromium, iron, lead, manganese, nickel, vanadium, and zinc. Other metals detected in more than 80 percent of the soil samples included barium, cobalt, copper, magnesium, and potassium. Less frequently detected metals included antimony (2 samples), beryllium (22 samples), cadmium (2 samples), mercury (4 samples), selenium (1 sample), and sodium (7 samples).

4.1.1.6 Total Cyanide

Cyanide was not detected in any of the soil samples from the WARWP area.

4.1.1.7 Geotechnical Testing Results

Four soil samples were collected and analyzed for geotechnical properties, including grain size distribution, moisture content, and Atterberg limits. Soil samples were classified based on the geotechnical testing data using U.S. Soil Conservation Service (USCS) nomenclature. Geotechnical

soil samples were not collected from DP-25 due to equipment failure. The geotechnical testing results are provided in Appendix G.

4.1.2 Groundwater

A total of 14 groundwater samples were collected from direct-push borings in the WARWP area. As previously discussed, groundwater samples could not be collected from six boring locations due to insufficient water yield. In addition, limited water yield in DP-01 permitted analyses for explosives and VOCs only; neither analysis detected any constituents. The following sections discuss detected constituents in the 13 overburden groundwater samples with positive detections by chemical groups.

4.1.2.1 Volatile Organic Compounds

Five VOCs, including 2-butanone, benzene, carbon disulfide, ethyl benzene, and tetrachloroethene, were detected at low concentrations in at least one of the groundwater samples collected from seven direct-push locations (Table 4-3 and Figure 4-2). Ethyl benzene was detected only in the sample from DP-13 at a concentration of 0.19 ：g/L. The remaining four VOCs were each detected in two samples; 2-butanone was detected in DP-15 (1.2 ：g/L) and DP-19 (1.8 ：g/L), benzene in DP-02 (0.15 ：g/L) and DP-11 (0.13 ：g/L), carbon disulfide in DP-08 (0.15 ：g/L) and DP-19 (0.18 ：g/L), and tetrachloroethene in DP-08 (0.2 ：g/L) and DP-09 (0.15 ：g/L).

4.1.2.2 Semivolatile Organic Compounds

Five nitroaromatic compounds were detected under the SVOC analyses in groundwater samples collected at the WARWP, including 2,4-DNT, 2,6-DNT, 3-nitroaniline, 4,6-dinitro-2-methylphenol, and 4-nitrophenol (Table 4-3). 2,4-DNT was detected in five samples (DP-09, DP-11, DP-13, DP-16, and DP-17), with concentrations ranging from 1.8 ：g/L in DP-11 to 660 ：g/L in DP-13 (Figure 4-2). 2,6-DNT was detected in DP-09 (6.3 ：g/L), DP-13 (56 ：g/L), DP-16 (15 ：g/L), and DP-17 (18 ：g/L), while 3-nitroaniline was detected in DP-04 (3.2 ：g/L), DP-09 (5.1 ：g/L), DP-11 (2.1 ：g/L), DP-13 (15 ：g/L), DP-16 (43 ：g/L), and DP-17 (49 ：g/L). 4,6-Dinitro-2-methylphenol and 4-nitrophenol were only detected in DP-09, at concentrations of 24 and 2.4 ：g/L, respectively.

4.1.2.3 Nitroaromatic Compounds

Five nitroaromatic compounds (1,3,5-TNB, 1,3-DNB, 2,4,6-TNT, 2,4-DNT, and 2,6-DNT) were detected in groundwater samples collected from 10 of 13 direct-push locations (Table 4-3). As presented on Figure 4-2, 1,3,5-TNB was detected at five locations, with concentrations ranging from

7.2 to 680 ：g/L; 1,3-DNB at six locations ranging from 0.2 to 56 ：g/L; 2,4-DNT at six locations ranging from 1.1 to 950 ：g/L; and 2,6-DNT at three locations ranging from 0.25 to 2.7 ：g/L. 2,4,6-TNT was detected only at DP-11 with a concentration of 7.1 ：g/L.

4.1.2.4 PCBs

PCBs were not detected in any of the WARWP direct-push groundwater samples.

4.1.2.5 Inorganic Compounds

As shown on Table 4-4, a total of 21 total metals were detected in the unfiltered groundwater samples. Excluding the nutritionally essential elements of calcium, iron, magnesium, potassium, and sodium, only nine dissolved metals (filtered samples) were detected. These include aluminum, cadmium, chromium, cobalt, copper, lead, manganese, nickel, and zinc.

4.1.2.6 Total Cyanide

Cyanide was not detected in any of the direct-push groundwater samples from the WARWP.

4.1.2.7 Water Quality Parameters

Results of water quality analyses, including alkalinity, hardness, total suspended solids, total dissolved solids, TOC, nitrate, and sulfate, are presented for reference on Table 4-4.

4.1.3 Sediments

Six sediment samples were collected at the WARWP in November 1998; four samples were collected within Pipe Creek (SD-01, -02, -03, and -04) and two from the west pond (SD-05 and -06) (Figure 4-3). Each of the six samples was collected at depths of 0 to 0.5 feet below the top of sediment and was analyzed for VOCs, SVOCs, nitroaromatic compounds, metals, PCBs, and TOC. The following paragraphs discuss analytical results for these sediment samples by chemical groups.

4.1.3.1 Volatile Organic Compounds

Two VOCs were detected at low, estimated concentrations in three of the four sediment samples collected from Pipe Creek and the west pond. Acetone was detected in SD-05 (0.11 mg/kg) and SD-06 (0.071 mg/kg), and 2-butanone was detected in SD-03 (0.029 mg/kg) and SD-05 (0.021 mg/kg) (Figure 4-3).

4.1.3.2 Semivolatile Organic Compounds

Two sediment samples exhibited SVOCs at estimated concentrations (Table 4-5). Seven SVOCs (benzo[a]anthracene, benzo[a]pyrene, benzo[k]fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene) were detected in SD-01 collected from Pipe Creek, while SD-04, also collected from Pipe Creek, exhibited only fluoranthene.

4.1.3.3 Nitroaromatic Compounds

Nitroaromatic compounds were not detected in any of the WARWP sediment samples.

4.1.3.4 PCBs

PCBs were not detected in any of the sediment samples collected at the WARWP.

4.1.3.5 Inorganic Compounds

Fifteen metals were detected in at least one of the six sediment samples (Table 4-5). Aluminum, arsenic, calcium, chromium, copper, iron, lead, magnesium, manganese, nickel, and zinc were detected in each of the six samples. Barium and cobalt were detected in four samples each, with concentrations ranging from 26.6 to 65 mg/kg and 6.4 to 10.9 mg/kg, respectively. Potassium was detected in SD-03 (821 mg/kg) and vanadium was detected in SD-06 (25 mg/kg).

4.1.3.6 Total Organic Carbon

Results for TOC ranged from 3,960 to 93,400 mg/kg in the six samples (Table 4-5). The two samples collected from the west pond (SD-05 and SD-06) exhibited concentrations an order of magnitude greater than those observed in other samples collected from Pipe Creek.

4.1.4 Surface Water

Six surface water samples collocated with the sediment samples previously discussed were collected at the WARWP in November 1998 (Figure 4-3). Each of the six samples was analyzed for VOCs, SVOCs, nitroaromatic compounds, metals, PCBs, and hardness. The following paragraphs discuss analytical results for these sediment samples by chemical groups.

4.1.4.1 Volatile Organic Compounds

One VOC was detected at low, estimated concentrations in five of the six surface water samples; VOCs were not detected in SW-02 (Table 4-5). Bromomethane was detected in SW-01, -03, -04, -05, and -06 at concentrations ranging from 0.16 to 0.22 ：g/L (Figure 4-3).

4.1.4.2 Semivolatile Organic Compounds

One surface water sample exhibited one SVOC at an estimated concentration (Table 4-5); di-n-octyl phthalate was detected in SW-05 (7.8 ：g/L) collected from the west pond.

4.1.4.3 Nitroaromatic Compounds

Nitroaromatic compounds were not detected in any of the WARWP surface water samples.

4.1.4.4 PCBs

PCBs were not detected in the WARWP surface water samples.

4.1.4.5 Inorganic Compounds

Twelve total metals and eleven dissolved metals were detected in at least one of the six surface water samples (Table 4-5). Excluding the nutritionally essential elements, dissolved metals were limited to aluminum, arsenic, chromium, lead, manganese, and zinc.

4.1.4.6 Hardness

Results for hardness ranged from 372,000 to 592,000 ：g/L in the six samples (Table 4-5).

4.2 Pentolite Road Red Water Ponds

4.2.1 Surface and Subsurface Soils

A total of 20 surface soil samples and 39 subsurface soil samples were collected within the PRRWP area from 20 direct-push boring locations; 1 soil sample could not be collected at the 8- to 10-foot depth in DP-03. The following subsections discuss detected constituents in soil samples by chemical groups.

4.2.1.1 Volatile Organic Compounds

Three VOCs (acetone, methylene chloride, and toluene) were detected in a small percentage of the surface and subsurface soil samples (Table 4-6). Acetone was detected in only one subsurface soil

sample (4 to 6 feet in DP-07) at an estimated concentration of 0.0082 mg/kg (Figure 4-4). Estimated levels of methylene chloride were detected in two samples: at 0.0021 mg/kg in the 8- to 10-foot sample in DP-16 and 0.0018 mg/kg in the surface sample from DP-19. Toluene was also detected at an estimated concentration of 0.0017 mg/kg at 4 to 6 feet in DP-09.

4.2.1.2 Semivolatile Organic Compounds

Three nitroaromatic compounds were detected under the SVOC analysis in six of the soil samples. 2,4-DNT was detected in one surface soil sample (0.16 mg/kg in DP-11) and five subsurface soil samples (DP-02, DP-03, DP-09, DP-15, and DP-16), while 2,6-DNT was also detected in the surface sample from DP-11 (0.05 mg/kg) and in two subsurface samples (DP-03 and DP-16). Only the 8- to 10-foot sample from DP-15 exhibited a detectable concentration of 3-nitroaniline (0.053 mg/kg) (Table 4-6).

4.2.1.3 Nitroaromatic Compounds

Six nitroaromatic compounds, 1,3,5-TNB, 1,3-DNB, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, and 4-amino-2,6-DNT, were detected in up to 11 soil samples (Table 4-6). 1,3,5-TNB was detected in nine samples from DP-01 (4 to 6 and 8 to 10 feet), DP-03 (4 to 5 feet), DP-06 (9 to 10 feet), DP-09 (8 to 10 feet), DP-10 (9 to 10 feet), DP-11 (4 to 6 and 8 to 10 feet), and DP-16 (8 to 10 feet) at concentrations ranging from 0.43 to 43 mg/kg (Table 4-6). 1,3-DNB was detected in five subsurface soil samples (DP-03, DP-10, two in DP-11, and DP-16), ranging from 0.25 to 9.3 mg/kg. Detections of 2,4,6-TNT were limited to two samples: 8 to 10 feet in DP-02 (0.38 mg/kg) and 0 to 2 feet in DP-11 (0.27 mg/kg).

2,4-DNT was detected in 11 samples ranging from 0.28 to 25 mg/kg, while 2,6-DNT was detected in 5 samples with concentrations ranging from 0.29 to 1.7 mg/kg. 4-amino-2,6-DNT was detected in one sample at a concentration of 2.7 mg/kg (0 to 2 feet in DP-11).

4.2.1.4 PCBs

There were no detected PCBs in any of the soil samples collected at the PRRWP.

4.2.1.5 Inorganic Compounds

Twenty-one metals were detected in at least one soil sample collected during the DPI at the PRRWP (Table 4-7). Each of the 59 soil samples exhibited detectable concentrations of aluminum, arsenic, chromium, copper, iron, lead, magnesium, manganese, nickel, vanadium, and zinc. Other metals detected in a majority of the soil samples included barium, cobalt, and potassium. Less frequently detected metals were limited to antimony (4 samples), beryllium (10 samples), cadmium (1 sample), mercury (3 samples), selenium (8 samples), and sodium (12 samples).

4.2.1.6 Total Cyanide

Cyanide was not detected in any of the soil samples from the PRRWP area.

4.2.1.7 Geotechnical Testing Results

Five soil samples were collected and analyzed for geotechnical properties, including grain size distribution, moisture content, and Atterberg limits. Soil samples were classified based on the geotechnical testing data using USCS nomenclature. The geotechnical testing results are provided in Appendix G.

4.2.2 Groundwater

A total of 20 groundwater samples were collected from direct-push borings in the PRRWP area. As previously discussed, some sample parameters could not be collected from all boring locations due to insufficient water yield. The following sections discuss detected constituents in the overburden groundwater samples by chemical groups.

4.2.2.1 Volatile Organic Compounds

Nine VOCs, including 2-butanone, 2-hexanone, acetone, benzene, carbon disulfide, ethyl benzene, tetrachloroethene, total xylenes, and trichloroethene, were detected at low concentrations in at least one of the groundwater samples collected from direct-push locations at the PRRWP (Table 4-8). Six of the detected VOCs (2-butanone, 2-hexanone, acetone, benzene, ethyl benzene, and total xylenes) were detected only in the sample from DP-03 at estimated concentrations (Figure 4-5). Carbon disulfide was detected at estimated concentrations in DP-04, DP-08, and DP-12, while tetrachloroethene was detected in five samples (DP-02, DP-03, DP-05, DP-07, and DP-19), also at estimated concentrations. Trichloroethene was detected at estimated concentrations in two samples, DP-07 and DP-08.

4.2.2.2 Semivolatile Organic Compounds

Ten SVOCs, including eight nitroaromatic compounds, were detected under the SVOC analyses in groundwater samples collected at the PRRWP (Table 4-8). 2,4-Dinitrophenol was detected in four samples ranging from an estimated concentration of 8.3 ：g/L in DP-01 to 5,900 ：g/L in DP-10; note that DP-03 exhibited a concentration of 5,800 ：g/L. Ten samples have positive results for 2,4-DNT, ranging from 1.5 ：g/L in DP-17 to 9,200 ：g/L in DP-03, while 2,6-DNT was detected in four samples ranging from 3.3 ：g/L in DP-01 to 550 ：g/L in DP-03. 2-Nitroaniline was detected at low concentrations (1.3 and 3.2 ：g/L) in two samples. Three compounds (2-nitrophenol, 3-nitroaniline, and naphthalene) were detected in one sample each: DP-16 at 2.1 ：g/L, DP-01 at 88 ：g/L, and DP-05 at 1.9 ：g/L, respectively. 4,6-Dinitro-2-methylphenol was detected in three samples (DP-03, DP-10, and DP-15) ranging from 830 ：g/L in DP-15 to 2,300 ：g/L in DP-03. Similarly, 4-nitrophenol was detected in DP-03 (290 ：g/L) and DP-10 (210 ：g/L), as well as DP-16 (5 ：g/L). Two samples (DP-12 at 10 ：g/L and DP-14 at 3.2 ：g/L) also exhibited bis(2-ethylhexyl)phthalate.

4.2.2.3 Nitroaromatic Compounds

Five nitroaromatic compounds (1,3,5-TNB, 1,3-DNB, 2,4-DNT, 2,6-DNT, and tetryl) were detected in groundwater samples collected from direct-push locations in the PRRWP area (Table 4-8). As presented on Figure 4-5, 1,3,5-TNB was detected at DP-11 at a concentration of 600 ：g/L and tetryl at DP-13 at a concentration of 0.2 ：g/L. 1,3-DNB was detected in 11 samples, with detected concentrations ranging from 0.28 ：g/L in DP-04 to 4800 ：g/L in DP-03, while 2,4-DNT ranged from 0.47 ：g/L in DP-04 to 6800 ：g/L in DP-03 in a total of 12 samples. Seven samples exhibited 2,6-DNT, ranging from 0.28 ：g/L in DP-08 to 400 ：g/L in DP-10.

4.2.2.4 PCBs

PCBs were not detected in any of the PRRWP direct-push groundwater samples.

4.2.2.5 Inorganic Compounds

As shown on Table 4-9, a total of 20 total metals were detected in the unfiltered groundwater samples. Excluding the nutritionally essential elements of calcium, iron, magnesium, and sodium, only nine dissolved metals (filtered samples) were detected. These include arsenic, barium, chromium, cobalt, copper, lead, manganese, nickel, and zinc.

4.2.2.6 Total Cyanide

Cyanide was detected in three of the direct-push groundwater samples (DP-03, DP-09, and DP-11) from the PRRWP, ranging from 23 to 780 ：g/L (Table 4-9).

4.2.2.7 Water Quality Parameters

Results of water quality analyses, including alkalinity, hardness, total suspended solids, total dissolved solids, TOC, nitrate, and sulfate, are presented for reference on Table 4-9.

4.2.3 Sediments

Four sediment samples were collected at the PRRWP in November 1998: two within the east-west drainage ditch located adjacent to Pentolite Road and two from the ditch located on the east-southeast side of the PRRWP (Figure 4-6). Each of the four samples was collected at depths of 0 to 0.5 feet below the top of sediment and was analyzed for VOCs, SVOCs, nitroaromatic compounds, metals, PCBs, and total organic carbon. The following paragraphs discuss analytical results for these sediment samples by chemical groups.

4.2.3.1 Volatile Organic Compounds

Two VOCs were detected at low, estimated concentrations in two of the four sediment samples collected at the PRRWP (Table 4-10). Acetone was detected in SD-01 (0.051 mg/kg) and SD-03 (0.049 mg/kg) and 2-butanone was detected in SD-01 (0.011 mg/kg) and SD-03 (0.01 mg/kg) (Figure 4-6).

4.2.3.2 Semivolatile Organic Compounds

Two sediment samples exhibited SVOCs at estimated concentrations (Table 4-10). Fifteen SVOCs were detected in SD-02 and/or SD-04, including acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, carbazole, chrysene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene.

4.2.3.3 Nitroaromatic Compounds

Nitroaromatic compounds were not detected in any of the PRRWP sediment samples.

4.2.3.4 PCBs

PCBs were not detected in the PRRWP sediment samples.

4.2.3.5 Inorganic Compounds

Fourteen metals were detected in at least one of the four sediment samples (Table 4-10). Aluminum, arsenic, calcium, chromium, copper, iron, lead, magnesium, manganese, nickel, vanadium, and zinc were detected in each of the four samples. Barium was detected in three samples with concentrations ranging from 30.9 to 53.4 mg/kg, while potassium was detected in SD-03 (1,040 mg/kg).

4.2.3.6 Total Organic Carbon

Results for TOC ranged from 5,450 to 33,000 mg/kg in the four samples (Table 4-9).

4.2.4 Surface Water

Four surface water samples collocated with the sediment samples previously discussed were collected at the PRRWP in November 1998 (Figure 4-6). Each of the four samples was analyzed for VOCs, SVOCs, nitroaromatic compounds, metals, PCBs, and hardness. The following paragraphs discuss analytical results for these sediment samples by chemical groups.

4.2.4.1 Volatile Organic Compounds

Five VOCs were detected at low concentrations in the four surface water samples (Table 4-10). Acetone was detected in each sample, chloroform and bromomethane in SW-01 and SW-02, while bromodichloromethane and dibromochloromethane were detected only in SW-01 (Figure 4-6).

4.2.4.2 Semivolatile Organic Compounds

Two SVOCs were detected in three of the four surface water samples (Table 4-10). Phenol was detected in SW-01 (2.2 ：g/L), -02 (1.9 ：g/L), and -03 (2.3 ：g/L), while bis(2-ethylhexyl) phthalate was only detected in SW-02 (2.1 ：g/L).

4.2.4.3 Nitroaromatic Compounds

Nitroaromatic compounds were not detected in any of the PRRWP surface water samples.

4.2.4.4 PCBs

PCBs were not detected in the PRRWP surface water samples.

4.2.4.5 Inorganic Compounds

Seven total metals and twelve dissolved metals were detected in at least one of the four surface water samples (Table 4-10). Excluding the nutritionally essential elements, dissolved metals were limited to aluminum, barium, chromium, lead, manganese, vanadium, and zinc.

4.2.4.6 Hardness

Results for hardness ranged from 284,000 to 488,000 ：g/L in the four samples (Table 4-10).

5.0 Human Health Risk Assessment

5.1 Introduction

This introduction provides basic information regarding water- and land-use in the vicinity of PBOW, followed by an overview of the basis, scope, and organization of the HHRA provided by this chapter.

Two groundwater aquifer systems are utilized for drinking water in the vicinity of PBOW: a carbonate aquifer to the west and a shale aquifer to the east (USACE, 1997). PBOW is located at the approximate confluence of these two systems. There are more than 170 private drinking water wells within a 4-mile radius of PBOW that have permits from the Erie County Health Department. Unpermitted wells may also exist. Agricultural wells are also present in the vicinity of PBOW. The number of agricultural wells is uncertain, because agricultural wells in this area do not require permits.

Surface water in the immediate vicinity of PBOW consists of seeps, ponds, and creeks. The Erie County Health Department does not permit local surface water resources to be used as private drinking water sources. These surface water bodies eventually drain into Lake Erie and Sandusky Bay, which are used for recreational swimming, fishing, and boating.

Current land use is classified as industrial and future land use is classified as residential for the purpose of identifying plausible human receptors and exposure pathways in this HHRA.

The USACE (1997) describes potential future land uses of all or portions of the facility as:

- Continued industrial use (NASA activities and programs)
- Recreational use of portions of the site by hunters and fishermen
- Sale of portions of the site to state or local government or private individuals (no land-use restrictions were mentioned)
- Possible use of parts of the facility for residential or agricultural purposes
- Possible use of parts of the facility for training by the National Guard.

Construction activities may take place at this site in the future, if and when portions of the site are developed further.

This basis for this HHRA is the *Baseline Human Health Risk Assessment (BHHRA) Work Plan and Ecological Risk Assessment Work Plan* (IT, 1998b). This work plan provides the protocol for evaluating human health and ecological risks at the Red Water Ponds, which include the WARWP and the PRRWP.

This BHHRA and the underlying work plan are based upon EPA, USACE, and OEPA guidance, including, but not limited to:

- OEPA, 1993, *Closure Plan Review Guidance for RCRA Facilities*, Interim Final, OEPA Division of Hazardous Waste Management, September 1.

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

- 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, 1992a, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9285.7-081.

- EPA, 1992b, *Dermal Exposure Assessment: Principles and Applications*, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, including Supplemental Guidance dated August 18, 1992.

- EPA, 1992c, "Guidance on Risk Characterization for Risk Managers and Risk Assessors," Memorandum from F. Henry Habicht II, Deputy Administrator, to Assistant Administrators, Regional Administrators, February 26, 1992.

- USACE, 1995, *Risk Assessment Handbook, Volume I: Human Health Evaluation*, Engineer Manual EM 200-1-4.

The scope of this HHRA is based upon an understanding of: current and potential future land use in the area of PBOW; potentially contaminated environmental media at the site; plausible contaminant transport mechanisms and pathways; and plausible current and future exposure receptor scenarios at, or in the vicinity of PBOW.

Earlier investigations summarized by USACE indicate that subsurface soil, surface water, the shallow or overburden groundwater and the bedrock groundwater aquifer are contaminated with organic compounds including explosives (predominantly TNT degradation products), VOCs, SVOCs, and possibly metals. Contaminated media evaluated in this HHRA are limited to surface water, sediment, and soil. Both shallow and deep groundwater associated with the Red Water Ponds Areas will be evaluated under a forthcoming sitewide HHRA, following additional groundwater characterization at PBOW. It is assumed that the deep groundwater aquifer could be developed as a source of potable water in the future. The shallow groundwater is not considered a source of potable water under either current or future receptor scenarios. Incidental contact with shallow groundwater (dermal contact and inhalation of VOC emissions), however, is plausible during construction projects. Therefore, incidental contact with shallow groundwater, and the potential development of the deep groundwater as a source of potable water, will be developed and evaluated as plausible exposure scenarios in a sitewide HHRA to be developed in the future.

There are a number potential human health receptor scenarios at PBOW. The group of scenarios considered in this HHRA was selected on the basis of requirements in the work plan and other regulatory and human health considerations, as discussed in Section 5.3. The receptor scenarios evaluated in this HHRA include the current and future groundskeeper, the current and future construction worker, the future indoor worker, and the future on-site resident.

The remaining sections of this HHRA are organized as follows. Section 5.2 describes the selection of chemicals of potential concern (COPC) for each medium of interest, and the estimation of source-term concentrations for each COPC in each medium. Section 5.3 describes the exposure scenarios and the rationale by which plausible receptors have been selected, the pathways by which they may be exposed, the exposure-point concentrations of COPC, and the estimated dose or contact rates for each of the COPC. Section 5.4 describes the hazard evaluation, i.e., the adverse health effects associated with each of the COPC, and the dose-response evaluation, i.e., the relationship between dose or contact rate and the magnitude of the adverse effect. Section 5.5 combines the output of the

exposure analysis and the toxicity analysis to quantify cancer risk and noncancer hazard to each receptor; identifies chemicals of concern (COC), which are the chemicals responsible for unacceptable risk or hazard estimates; develops applicable or relevant and appropriate requirements (ARAR) for the COC; and develops risk-based remediation criteria (RBRC) for the COC. Section 5.6 describes the uncertainty associated with the components of the HHRA, and discusses Monte Carlo simulation as an approach to illustrate the uncertainty about the point risk and hazard estimates. Section 5.7 briefly summarizes the protocol of the HHRA and interprets the results. References used in the preparation of this chapter are presented in Chapter 8.0.

5.2 Data Evaluation

5.2.1 Identification of COPC

As the first step in the preparation of the BHHRA, a list of chemicals present in site samples was compiled. This initial list includes all chemicals detected in any site medium. From this list, COPC have been selected as described in the following sections.

5.2.1.1 Sorting the Analytical Data

The chemicals evaluated in a given medium are limited to those detected in that medium. Chemicals for which all samples yield nondetects are considered not to be present and are not evaluated further. The data for each chemical are sorted by medium. Surface soil (generally 0 to 1 feet bgs) and subsurface soil (generally 1 to 10 feet bgs for direct exposure pathways) are considered separate media. During the DPI, several soil samples were taken from depth intervals of 0 to 2 feet or 0 to 3 feet bgs. These data were combined with data from 0 to 0.5 feet in order to achieve a sufficiently large surface soil data set from which to calculate source-term concentrations. Samples from 2 to 4 feet, and deeper intervals, were considered representative of subsurface soil. Therefore, surface soils include samples from 0 to 3 feet, while subsurface soils include data from 2 to 10 feet. No sample results were included in either the surface soil or subsurface soil data sets.

Certain receptors, e.g., the construction worker and the on-site resident, are likely to be exposed to a combination of surface and subsurface soil, which is called “total soil” in this HHRA. The construction worker may engage in projects requiring excavation to depths as great as 10 feet bgs. Residential development may include excavation and grading subsurface soil over the top of existing surface soil. The combination, however, is unlikely to be a perfect blend of surface and subsurface soil, making it

difficult to create a representative data set for total soil. In fact, the material at the surface may well be the original surface soil at one location, and newly excavated and graded subsurface soil a few inches or a few feet distant. The potential exists for the receptor to be exposed to the higher concentrations of chemicals in either surface or subsurface soil. Therefore, the total soil data set consists of the higher source-term concentration for each COPC from the surface soil and subsurface soil evaluations.

5.2.1.2 Evaluating Data Quality

The analytical data may have qualifiers from the analytical laboratory QC 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 (EPA, 1989b):

- U - Chemical was analyzed for but not detected; the associated value is the sample quantitation limit (SQL).
- J - Value is estimated, probably below the contract-required quantitation limit.
- R - QC indicates that the data are unusable (chemical may or may not be present).
- B - Inorganic chemicals: the concentration is less than the contract-required detection limit but greater than the instrument detection limit. Organic chemicals: the concentration in the sample is not sufficiently higher than concentration in the blank, using the five-times, ten-times (5x, 10x) rule. A chemical is considered a nondetect unless its concentration exceeds five 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 ten times the blank concentration.

"J" qualified data are used in the HHRA; "R" and "B" qualified data are not. The handling of "U" and “UJ” qualified data (nondetects) in the HHRA is described in Section 5.2.2. 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 HHRA. If confidence is high that the chemical is present, but the actual concentration is somewhat in question, the data generally are used in the HHRA.

Two chemicals, 2,4-DNT and 2,6-DNT, were analyzed under two different analytical methods: Method 8330 for explosives and Method 8270B for SVOCs. Generally, Method 8330 provides greater sensitivity for these two compounds, as reflected in slightly lower reporting limits for Method

8330 compared with Method 8270B. Therefore, only data from Method 8330 were used for evaluating 2,4- and 2,6-DNT in the risk assessment.

5.2.1.3 Identifying Site-Related Chemicals

Identifying site-related chemicals is a matter of professional judgement that must be addressed for each chemical individually.

Chemicals that are reasonably likely to be related to operations at the Red Water Pond Areas are termed site-related chemicals in this HHRA. Chemicals present at naturally occurring concentrations or those present because of human activity entirely unrelated to former army activity are termed background chemicals. Chemicals identified as site-related were evaluated in site-related risk; chemicals identified as background were evaluated in background risk. All chemicals identified as COPC (site-related and background) were evaluated in total site risk. These designations are explained more fully in Section 5.5.

For most organic chemicals, their identification at concentrations above levels in blanks (considering the 5x, 10x rule; see Section 5.2.1.2) is presumptive evidence of site-related activity. However, there are exceptions. Inorganic or organic chemicals that are detected infrequently may be artifacts in the data that do not reflect site-related activity and are not included in the HHRA. 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. For example, nitroaromatics are expected to be site-related, but no detected nitroaromatics have been dropped from the HHRA even if their detection frequency was less than 5 percent. Chemicals detected infrequently at high concentrations may identify the existence of "hot spots" and are retained in the evaluation, unless other information exists to suggest that their presence is unlikely to be related to site activities.

Some organic chemicals may occur as a result of activity not associated with site-related releases. Such chemicals, designated anthropogenic background, may include herbicides in agricultural areas where crops are grown, and polynuclear aromatic hydrocarbons (PAH), which form by natural or anthropogenic combustion of organic matter, including fossil fuels. PAHs were detected in samples collected at the Red Water Pond Areas. However, the data are not sufficient to determine whether the concentrations measured represent anthropogenic background or site-related releases. In the absence

of sufficient background data, all the PAHs in all media are considered to be site-related chemicals and are included in site-related risk.

In addition, any class of organic compound may be considered to be of anthropogenic background if site concentrations are comparable to upgradient concentrations. For example, if concentrations of 2,4-DNT in the water of a creek meandering across (hypothetical) Site A are comparable to upgradient concentrations, it is probably appropriate to conclude that 2,4-DNT is not a site-related chemical. Although the chemical is clearly related to former PBOW activities, its presence at Site A probably does not reflect the activities that took place at that particular site. Since the 2,4-DNT in surface water does not reflect activities at Site A, it is inappropriate to select the compound as a COC for Site A and to develop RBRC for it, because remediation at Site A will not address the source of the contamination. Organic chemicals identified as anthropogenic background will not be eliminated from the HHRA; instead, they are included and evaluated in total site risk and background risk, but not in site-related risk. These designations are described fully in Section 5.5.

Identifying site-related metals is complicated by the natural background occurrence of metals in most environmental media. Background concentrations of metals reported previously (IT, 1998c) were used to identify site-related chemicals by comparing site analytical data with background data. The comparisons were based on statistical techniques and professional judgement.

The primary approach involves comparing the maximum detected concentration (MDC) from site data with a background screening criterion (BSC). The BSC represents a theoretical upper limit on background; i.e., if the MDC of site data does not exceed the BSC, it is likely that site concentrations reflect background conditions rather than a site-related release, and the chemical is considered a "background chemical." Development of the BSC depends on the nature of the background data set, which is tested for normality or lognormality with the Shapiro-Wilk test (EPA, 1992d) if the data set includes five or more samples. If the background data set fits neither a normal nor a lognormal distribution, it is considered nonparametric. Nonparametric distributions fit no reliably predictable pattern, which means that an upper limit on background cannot be predicted with confidence. Therefore, the MDC of the background data set is conservatively selected as the BSC for nonparametric background data sets. Normal and lognormal distributions, however, are somewhat more predictable, and an upper limit on background, called an upper tolerance limit (UTL), can be estimated at a quantifiable level of confidence. The background UTL is the concentration, with a

probability of 0.95 (or a confidence of 95 percent), that will capture (or cover) 95 percent of background samples if a large number of samples were taken. Chemicals with MDCs less than the background UTL are considered to represent a natural background metal for the HHRA.

The UTLs for normally distributed background data sets are calculated as follows (EPA, 1989b):

$$UTL = \bar{x} + k(\sigma) \qquad \text{Eq. 5.1}$$

where:

UTL	=	upper tolerance limit of background concentration (confidence factor of 0.95 and coverage of 95 percent)
$\bar{x}$	=	arithmetic mean
σ	=	standard deviation
k	=	tolerance factor (Appendix B, EPA, 1989b).

The same equation is used to estimate the UTL for lognormal background data sets, but the data are log-transformed before the arithmetic mean and standard deviation are calculated.

If the MDC exceeds the BSC, the chemical is considered a site-related COPC or the more rigorous Wilcoxon Rank Sum test (EPA, 1992d) was applied when the assignment of a chemical was equivocal. The more rigorous statistical analysis consists of comparing the site and background data sets to determine if both are drawn from the same population. The Wilcoxon Rank Sum test is used for this purpose because it is applicable to all data distributions, including nonparametric.

Statistical analysis was used in this HHRA as a tool to aid the exercise of professional judgement. Site data from uncontaminated areas with concentrations at the high end of background may "fail" statistical testing. The probability of this error is 5 percent under the assumptions of this 95 percent confidence, and is usually caused by limitations of sample size; i.e., the full range of actual background and site variation was not captured. The identification of metals as a site-related or background chemical is discussed in detail for each medium in the following text.

Metals and organic chemicals identified as anthropogenic background were not eliminated from the HHRA; instead, they were included and evaluated in total site risk and background risk, but not in site-related risk. These designations are described fully in Section 5.5.

The UTL method previously described was applied to the background soil data to develop BSC for soil (Table 5-1). Insufficient data were available for application of the UTL method to develop BSCs for surface water and sediment; therefore, the MDC of each metal was selected as the BSC (Tables 5-2, 5-3).

5.2.1.4 Risk-Based Screening

Risk-based screening for human health was used to focus the assessment on the site-related chemicals that may contribute significantly to overall risk. In this screen, chemical concentrations were compared with very conservative levels derived for standard exposure scenarios. The MDC was compared with the appropriate risk-based screening concentration (RBSC). If the MDC was less than or equal to the RBSC, the chemical in this medium was not considered further. If the MDC exceeded the RBSC, the chemical was considered to be a COPC.

Chemicals whose concentrations were below the RBSCs were not selected as COPC for the HHRA because it is very unlikely that they would cause significant risk. RBSCs for soil were EPA Region IX "residential soil" preliminary remediation goal (PRG) values EPA (1999) adjusted to reflect an incremental lifetime cancer risk (ILCR) of 1E-7 and a hazard index (HI) of 0.1. Because the PRG value for lead is not based on a risk calculation (EPA, 1999), the value of 400 ppm was used without modification in the screening of soil and sediment data. Because a few chemicals detected in soil are not listed among EPA Region IX PRG values, PRG values were calculated using EPA (1999) methodology to provide screening criteria (Appendix H.1).

The mechanisms by which receptors are exposed to sediment are similar to those for soil, but exposure to sediment is likely to be far less intensive. Therefore, the soil RBSCs are adjusted upward by an order of magnitude for application to sediment. In other words, the unadjusted EPA (1999) residential soil PRGs are considered to reflect an ILCR of 1E-7 and an HI of 0.1 when used for screening chemical concentrations in sediment. Similarly, exposure to surface water is likely to be far less intensive than exposure to tap water. Therefore, the tap water RBSCs are adjusted upward by an order of magnitude for application to surface water. The unadjusted EPA (1999) tap water PRGs are

considered to reflect an ILCR of 1E-7 and an HI of 0.1 when used for screening chemical concentrations in surface water.

Concern has arisen regarding potential effects on human health from inhalation of VOCs in indoor air from volatilization from subsurface soil or shallow groundwater. Potential receptors for these pathways include the on-site resident and an indoor worker. Indoor airborne concentrations of VOCs from subsurface soil, estimated as described in Section 5.3.2, were screened against the EPA (1999) ambient air PRGs adjusted to reflect an ILCR of 1E-7 and an HI of 0.1.

It is assumed that VOC concentrations that might accumulate in a building from shallow groundwater would be no higher than those encountered by a construction worker in a utilities ditch. Therefore, airborne concentrations of VOC in a utilities ditch, estimated as described in Section 3.2, will be subjected to risk-based screening to determine the need for evaluating this pathway. RBSCs for indoor air will be the EPA (1999) ambient air PRGs adjusted to reflect an ILCR of 1E-7 and an HI of 0.1. This evaluation will be performed in the forthcoming sitewide HHRA when groundwater data become available.

The risk-based screening previously described assumes that the RBSCs reflect a sufficiently conservative evaluation of the relevant exposure pathways. The sediment RBSCs may not be sufficiently conservative to screen sediment in water bodies from which fish could be harvested and consumed because they do not address bioaccumulation by fish. Similarly, the surface water RBSCs may not be sufficiently conservative to screen surface water from which fish are taken. These concerns pertain specifically to chemicals known to bioaccumulate in aquatic food chains (i.e., PCBs and mercury). However, fish consumption is not a concern at the Red Water Pond Areas because the surface water bodies do not support sport or subsistence fishing. Therefore, PCBs and mercury were subjected to the same screening criteria used for other chemicals.

5.2.1.5 Evaluating Essential Nutrients

Essential nutrients such as calcium, iron, magnesium, potassium, and sodium are usually eliminated as COPC because they are generally considered innocuous in environmental media. Other essential nutrients including chloride, iodine, and phosphorus, may be eliminated as COPC, provided that their presence in a particular medium is judged to be unlikely to cause adverse effects on human health.

5.2.2 Developing Source-Term Concentrations

5.2.2.1 Soil, Surface Water, and Sediment

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the upper confidence limit (UCL) on the mean are usually estimated for each COPC in each medium of interest. The upper 95 percent UCL on the mean is generally referred to as the UCL. In general, unusually high values are included in the calculation of the UCL because high values seldom appear as statistical outliers in environmental data. Inclusion of outliers increases the overall conservatism of the risk estimate, or may identify areas that require evaluation as hot spots.

Data sets consisting of five or more data points are tested for normality and lognormality with the Shapiro-Wilk test (EPA, 1992d) using the software package STATISTICA™, , or equivalent. Either a normal or lognormal UCL is calculated, whichever provided the better fit in the Shapiro-Wilk test. A nonparametric confidence limit is used when the data fit neither a normal or lognormal distribution.

The UCL is calculated for a normal distribution as follows (EPA, 1992a):

$$UCL = \bar{x} + t_{1-\alpha,n-1} \times (s/\sqrt{n}) \qquad \text{Eq. 5.2}$$

where:

UCL = upper 95th confidence limit on the arithmetic mean concentration (calculated)
6 = sample arithmetic mean
t_1 = critical value for Student's *t*-test
" = 0.05 (95 percent confidence limit for a one-tailed test)
n = number of samples in the data set
s = sample standard deviation.

The UCL is calculated for a lognormal distribution as follows (Gilbert, 1987):

$$UCL = e^{\left(\bar{y} + (0.5 \cdot s_y^2) + \left[H_{0.95} \cdot \frac{s_y}{(n-1)^{0.5}}\right]\right)} \qquad \text{Eq. 5.3}$$

where:

UCL = upper 95th confidence limit on the arithmetic mean concentration (calculated)

$\bar{y}$ = $\sum y/n$ = sample arithmetic mean of the log-transformed data, y = ln x
s_y = sample standard deviation of the log-transformed data
n = number of samples in the data set
$H_{0.95}$ = value for computing the one-sided upper 95 percent confidence limit on a lognormal mean from standard statistical tables (Land, 1975).

The data point selected as the nonparametric UCL is the 95 percent UCL rank order on the arithmetic mean of the data set. It is estimated by ranking the data observations from smallest to largest. The UCL is converted to a percentile by interpolation. The rank order of the data point selected as the UCL is estimated from the following equation (Gilbert, 1987).

$$u = p(n+1) + Z_{1-\alpha}\sqrt{np(1-p)} \qquad \text{Eq. 5.4}$$

where:

u = rank order of value selected as upper confidence limit, calculated
p = percentile corresponding to the arithmetic mean (50th percentile or 0.5)
n = number of samples in the data set
α = confidence limit (95 percent)
$Z_{1-\alpha}$ = normal deviate variable.

Analytical results are presented as "nondetects" ("U" qualifier) whenever chemical concentrations in samples do not exceed the detection limit or SQL for the analytical procedures for those samples. Generally, the detection limit is the lowest concentration of a chemical that can be "seen" above the normal, random noise of an analytical instrument or method. To apply the previously mentioned statistical procedures to a data set with nondetects, a concentration value must be assigned to nondetects. Nondetects are assumed to be present at one-half the SQL (EPA, 1989a), although judgement may be used in those cases where matrix interference or other phenomena drive the SQL unusually high.

The most common cause of elevated SQL is sample dilution, usually necessitated because one or more chemicals are present at concentrations exceeding the range of the method calibration curve. SQLs are typically designated as unusually high when they are above the highest positive detection. Their use in the data set may result in the 95 percent UCL exceeding the MDC, which would impart a bias to the HHRA. Unusually high SQL results such as these are typically deleted from the data set.

During the HHRA calculations, it was observed that several of the lognormal COPC data sets in subsurface soil yielded UCL estimates lower than expected. In some cases, the UCL was less than the arithmetic mean, which is not logical. These observations triggered a detailed examination, which revealed that, in every case of a suspicious UCL, the number of nondetects (included at one-half the SQL) exceeded 50 percent of the data set. In effect, statistical testing showed that the SQLs are lognormally distributed; the few detections contributed only to the tail of the distribution. Therefore, the UCL calculation based on a lognormal distribution effectually returned the UCL of the SQLs (actually, of one-half the SQLs), influenced relatively little by the few detections included in the data set. This situation was remedied by applying the recommendation of EPA (1992d), which is to override the UCL method previously described, and to consider all data sets that consist of more than 50 percent nondetects to be nonparametric, regardless of the outcome of the Shapiro-Wilk test.

The exposure unit concept was applied to create data sets and develop source-term concentrations for certain receptors. The exposure unit represents the area to which a receptor would be exposed, within which his exposure is assumed to be random. For example, the groundskeeper is assumed to work randomly at any location on the entire site and is not expected to work at any single location for the entire time assumed for exposure (25 years). Therefore, all site data were used to develop source-term concentrations to assess risks to the groundskeeper. On the other hand, a typical residence or the area of exposure for a construction worker may not exceed 1 acre and a subset of the total data might be more appropriate to assess the associated risks. Application of the unit exposure concept is discussed further in Section 5.5.3.3.

For this HHRA, the groundskeeper was assumed to be exposed to surface soil in the current and future site-use evaluations. Therefore, data from all surface soil samples were used to calculate the source concentration for the groundskeeper exposure assessment. The resident was assumed to be exposed to total soil, a combination of surface soil and subsurface soil, because residential development of the site would involve excavation and grading, which would distribute subsurface soil on the surface and obscure the distinction between surface and subsurface soil. It was assumed that the future resident would reside at a randomly chosen lot on the site. The construction worker was assumed to be exposed to total soil, a combination of surface soil and subsurface soil, in both the current and future site-use scenarios, because construction activities are expected to involve excavation and grading.

The UCL or MDC, whichever is smaller, is selected as the source-term concentration, and is understood to represent a conservative estimate of average for use in the HHRA or in various transport models used to estimate exposure-point concentrations. If the data set consists of fewer than five data points, the MDC is generally selected as the source-term concentration.

5.2.2.2 Groundwater

As previously noted in Section 5.1, it is anticipated that bedrock groundwater and associated risks will be evaluated on a sitewide basis in additional studies to be completed at a later date. At that time, risk from potential groundwater contamination may be evaluated under both current conditions (at the time of the field investigation) and under estimated future conditions.

5.2.3 Summary of COPC Selection

Summay tables have been prepared for each medium, by site, with the following information:

- Chemical name
- Frequency of detection
- Arithmetic mean of site concentrations
- Range of detected concentrations
- Range of detection limits
- Statistical distribution
- UCL on the arithmetic mean
- Background screening criterion, if available
- Appropriate RBSC, if available
- Selection as COPC
- Rationale for consideration as COPC, including whether or not COPC is background related
- Representative exposure concentration used in HHRA.

Footnotes in the tables provide the rationale for rejection of a chemical as a COPC.

5.2.3.1 West Area Red Water Ponds

COPC for surface soil (Table 5-4) include four metals, one nitroaromatic TNT impurity or degradation product, and four PAHs, all present at concentrations below reporting limits. The metals are present at levels comparable to background except for chromium, which is present at levels slightly higher than background, as confirmed by the Wilcoxon Rank Sum Test (Appendix H.2). COPC for subsurface soil (Table 5-5) include five metals, all of which are present at levels comparable to background; six nitroaromatic TNT impurities or degradation products; and four PAHs, all present at concentrations below reporting limits. Concentrations of nitroaromatic compounds are much higher in subsurface soil than surface soil, reflecting the general mobility of these chemicals and their tendencies to leach and infiltrate to greater depths. No VOCs in indoor air from subsurface soil were selected as COPC because their modeled concentrations were far below their RBSCs for ambient air (Table 5-6). COPC in total soil include all the COPC in surface and subsurface soil (Table 5-7). All the metal COPC are attributed to background except for chromium.

COPC identified in surface water at the WARWP (Table 5-8) include three metals and three nitroaromatic compounds. All were judged to be site-related, which probably reflects the small size of the background data set for metals in surface water. COPC in sediment (Table 5-9) are limited to arsenic, which was judged to be site-related. It should be noted that the MDC of arsenic in the sediment (11.3 mg/kg) is substantially less than the BSC for arsenic in soil (71 mg/kg). This suggests that the selection of arsenic as site-related probably reflects deficiencies in the sediment background data set rather than an actual site-related release.

5.2.3.2 Pentolite Road Red Water Ponds

COPC for surface soil (Table 5-10) include three metals, all of which are present at levels comparable to background, and five nitroaromatic TNT impurity or degradation products. PAHs were not detected in surface soil at the PRRWP. COPC for subsurface soil (Table 5-11) include five metals, all of which are present at levels comparable to background, and six nitroaromatic compounds, including TNT. PAHs were not detected in subsurface soil at the PRRWP. Concentrations of nitroaromatic compounds are higher in subsurface soil than surface soil, reflecting the general mobility of these chemicals and their tendency to migrate to greater depths.

No VOCs in indoor air from subsurface soil were selected as COPC because their modeled concentrations were far below their RBSCs for ambient air (Table 5-12). COPC in total soil include all the COPC in surface and subsurface soil (Table 5-13). All the metal COPC are attributed to background.

No COPC identified were in surface water at the PRRWP (Table 5-14). COPC in sediment are limited to arsenic, which was judged to be present at background levels (Table 5-15).

5.3 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 COPC 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.

5.3.1 Conceptual Site Exposure Model

The conceptual site exposure model (CSEM) provides the basis for identifying and evaluating the potential risks to human health in the BHHRA. The CSEM (Figure 5-1) includes the receptors appropriate to all plausible land-use scenarios, and the potential exposure pathways. Graphically presenting 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 ensure that potential pathways are not overlooked. The elements of a CSEM include:

- Source (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.

The receptors and pathways in Figure 5-1 reflect plausible scenarios developed from information regarding site background and history, topography, climate, and demographics as presented in the work plan (IT, 1998b). Asterisks identify exposure pathways that are complete and addressed in the HHRA. Justification for exclusion of other pathways is provided in the figure footnotes.

5.3.1.1 Physical Setting

The physical setting of the Red Water Ponds Areas is summarized in Chapter 1.0 of this document. Selected features relevant to site HHRA work are described in Section 5.1 of this chapter. Although brief, the description supports the receptors and exposure pathways illustrated in Figure 5-1. Greater detail is provided in documents by USACE (1997) and IT (1997).

5.3.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways

Contaminant sources, release mechanisms, and migration pathways are presented in Figure 5-1. Briefly, red water from the TNT manufacturing process was pumped to the Red Water Ponds. Contaminants in water may partition to sediment. Overflow and runoff may have spread contamination over the surrounding surface soil. Infiltration may have carried contaminants into the subsurface soil or groundwater. Contaminated shallow groundwater may discharge to the surface water, returning contaminants to the Red Water Ponds.

5.3.1.3 Receptors and Exposure Pathways

Receptors, selected to represent the upper-bound on exposure from all plausibly exposed groups of people at the Red Water Ponds Areas, and the pathways by which they may be exposed, are summarized in Figure 5-1 and Table 5-16. The exposure variable values used in the contaminant intake models are compiled in Table 5-17.

Most HHRAs are based on a reasonable maximum exposure (RME) assumption. The intent of the RME assumption is to estimate the highest exposure level that could reasonably be expected to occur, but not necessarily the worst possible case (EPA, 1989a, 1991). It is interpreted as reflecting the 90 to 95th percentile on exposure. In keeping with EPA (1991) guidance, variables chosen for a baseline

RME scenario for intake or contact rate, exposure frequency (EF), and exposure duration (ED) are generally upper-bounds. Other variables, e.g., body weight (BW) and exposed skin surface area (SA), 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 (PC) and exposure time (ET) for water, only one variable, ABS or PC needs to be an upper-bound. The conservatism built into the individual variables ensures that the entire estimate for contact rate is more than sufficiently conservative.

The averaging time (AT) for noncancer evaluation is the product of ED (years) times 365 days per year, to estimate an average daily dose over the entire exposure period (EPA, 1989a). For cancer evaluation, AT is the product of 70 years, the assumed human lifetime, times 365 days per year, to estimate an average daily dose prorated over a lifetime, regardless of the EF or ED. This methodology 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 consistent with current EPA (1986b) policy of carcinogen evaluation, although it introduces considerable uncertainty into the cancer HHRA.

A fractional term (FI) is introduced into the COPC 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, so that a groundskeeper may spend only one-half of his working time at the site, an FI of 0.5 is applied to the soil ingestion and dermal intake equations. An FI is used also if a receptor's exposure is split between two comparable media. For example, if a construction worker is exposed to both soil and pond sediment, FIs are introduced that apportion his exposure between the two media. The default value of FI is 1.0.

5.3.1.3.1 Groundskeeper

The groundskeeper scenario was designed to evaluate the upper-bound for site worker exposure to surface soil in the current and future site-use scenario. Direct exposure pathways include incidental ingestion and dermal contact with soil. Inhalation of dust, raised by operating lawn mowers or other equipment, was also evaluated. It was assumed that relatively high dust concentrations would be produced within the groundskeeper's breathing zone, with little opportunity for dilution by the large volume of ambient air. In the future, the groundskeeper may be exposed to groundwater developed as

a source of potable water. Scenarios and pathways for exposure to groundwater will be developed in the sitewide HHRA when groundwater data become available.

Generally, in IT's experience, surface soil that has been in place for extended periods and has not been recently contaminated is not a significant source of airborne VOCs because infiltration and dissipation over time would have reduced residues at the surface to toxicologically insignificant levels. VOCs, however, were detected in surface soil, albeit at concentrations below RBSCs, probably from soil at the bottom of the 0 to 1 foot bgs depth range from which surface soil samples were taken. Had VOCs in surface soil been identified as COPC, it would have been assumed that concentrations in air estimated by the activity-based dust emissions model would have been sufficiently conservative for the HHRA.

It was assumed that any contact with surface water or sediment would be infrequent, and grounds-keeper exposure to these media is not considered.

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 the site, for a total of 250 days per year for 25 years (EPA, 1991). The respiratory rate for the groundskeeper is assumed to be 20 cubic meters (m^3)/8-hour workday (2.5 m^3/hour), and the soil incidental ingestion rate is assumed to be 100 milligrams per day (mg/day).

Recent studies evaluating soil adherence that consider the nature of the activity performed and the different body regions were reviewed by EPA (1997a). Measurements of soil adherence to hands, arms, legs, feet, and face for 29 groundskeepers revealed AFs ranging from 8E-4 milligrams per square centimeter (mg/cm^2) (legs) to 1.5E-1 (hands). The AF weight-averaged across these body regions (i.e., adjusted to reflect the different surface areas of the different body regions) for males and females is 9E-3 mg/cm^2, which is used in this evaluation. The surface area of body regions evaluated for groundskeepers include approximately 11,300 cm^2 (EPA, 1997a).

5.3.1.3.2 Construction Worker

The construction worker scenario was created to evaluate short-term exposure to subsurface, as well as surface soil (total soil) in either a current or future land-use scenario. Relevant exposure pathways include incidental ingestion and dermal contact. Inhalation of VOC vapor and dust raised by operating

construction equipment was also evaluated. Construction activity may uncover subsurface soil concentrations of VOCs, facilitating emission of the vapors into the construction worker's breathing zone.

The construction worker may also be exposed to surface water and sediment during projects such as installation of underground utilities or work on or near the ponds. 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 volumes of outdoor air and natural air currents are expected to dilute airborne concentrations so that this pathway is expected to less significant than dermal contact, which is quantified. For these reasons, incidental ingestion and inhalation of VOCs are not quantified.

The construction worker may be exposed to shallow groundwater by dermal contact during construction projects. Inhalation of VOCs that volatilize from shallow groundwater is another plausible exposure pathway. In the future, the construction worker may be exposed to deep groundwater developed as a source of potable water. Scenarios and pathways for exposure to shallow and deep groundwater will be developed in the sitewide HHRA when groundwater data become available.

The construction worker was assumed to be a 70-kg adult who works 8 hours per day, approximately 5 days per week on the site, for a total of 6 months (EPA, 1991). The respiratory rate for the construction worker was assumed to be 20 m^3/8-hour workday (2.5 m^3/hour) (EPA, 1991). Excavation, grading, installation, or repair of underground utilities and similar activities requiring constant contact with the soil or earth-moving or grading equipment result in intensive exposure to soil and were assumed to last for 3 months. Construction activities such as building erection result in less intensive exposure to soil and were also assumed to last for 3 months. Soil ingestion rates of 480 (EPA, 1993b) and 100 mg/day (EPA, 1991) were assumed for the intensive and less intensive soil contact periods, respectively resulting in a time-weighted average rounded to 290 mg/day.

An AF for a construction worker of 8E-2 mg/cm^2 is estimated using the same method as previously described for the groundskeeper, combining EPA (1997a) data for construction workers, utility workers, and equipment operators to capture the full range of activities likely to be performed by this receptor. The body regions evaluated for construction workers include the hands, arms, legs, feet, and face, which total approximately 11,300 cm^2.

As previously noted, the construction worker may be exposed to surface water and sediment during the 6-month construction period. Dermal exposure to surface water and sediment is assumed to occur on 4 hours per day, or one-half the normal workday. An FI of 0.5 is assumed for both the soil and sediment pathways to apportion the construction worker's time equally between the two media. The incidental ingestion rate for sediment is assumed to be 480 mg/day, because contact with sediment during the construction period may be intense. It is assumed that the arms, forearms, and hands, an SA of approximately 3,100 cm^2 (EPA, 1997a), is exposed to surface water and sediment. An AF for sediment of 0.24 mg/cm^2 (EPA, 1997a) is estimated for the hands and arms using the same method as described for the groundskeeper exposure to soil, using data for construction workers, utility workers, and equipment operators.

5.3.1.3.3 On-Site Resident

The on-site resident scenario was created to evaluate the upper-bound for exposure to surface water, sediment, and soil under the future land-use scenario. The resident was assumed to be exposed to total surface and subsurface soil because residential development of the site would involve excavation and grading, which would mix surface and subsurface soil. Relevant pathways for soil exposure include incidental ingestion, dermal contact, and inhalation of VOC vapors and dust. For evaluating inhalation exposure to dust, it is assumed that 80 percent of the surface is covered with pavement or vegetation. Inhalation of VOCs released from subsurface soil and entrapped in indoor air is also evaluated. In the future, the resident may be exposed to groundwater developed as a source of potable water. Scenarios and pathways for exposure to groundwater will be developed in the sitewide HHRA when groundwater data become available.

Airborne concentrations of VOCs from soil are not evaluated separately from levels generated by the wind erosion model because it is assumed that the topmost layer of soil, from which volatilization would be most significant, will remain relatively undisturbed and that most VOCs would have dissipated by the time construction is finished and occupation is established.

The resident could have access to the ponds and could be exposed to surface water and sediment. It was assumed that the resident would visit the ponds for 8 hours per day, 2 days per week during the warmer half of the year (i.e., 52 days per year), during which time he would be in contact with sediment. The resident was assumed to wade for 3 hours per day on 52 days per year, exposing his feet, lower legs, hands and forearms, or approximately 30 percent of his body SA to surface water

(EPA, 1997a). Plausible exposure pathways include dermal contact with surface water, inhalation of VOC vapors released from surface water, and incidental ingestion and dermal contact with sediment. Incidental ingestion of surface water in a wading scenario was assumed to be negligible.

Inhalation of VOC emissions from surface water is also possible, but the large volumes of outdoor air and natural air currents are expected to dilute airborne concentrations so that this pathway is expected to less significant than dermal contact, which is quantified. For these reasons, inhalation of VOC emissions from surface water is not quantified separately from dermal contact.

The on-site residential scenario was evaluated using both adults and children. Cancer risk was estimated as the sum of the risks calculated for the adult and the child. The child was used for the noncancer evaluation. This approach captures the greater conservatism of the larger incidental soil and sediment ingestion rates for the child, when normalized for BW.

The adult resident was assumed to be a 70-kg person with an incidental soil/sediment ingestion rate of 100 mg/day and an inhalation rate of 20 cubic meters per day (m^3/day) (0.83 m^3/hour) (EPA, 1991). Approximately 30 percent of his total body SA, or 5,450 cm^2, was assumed to be exposed to surface water while wading (EPA, 1992b). Body SA exposed to soil or sediment was assumed to be 25 percent of total SA, or approximately 4,550 cm^2 (EPA, 1992b). The adult resident was assumed to be exposed to soil 350 days per year for 24 years (EPA, 1991, 1999).

The resident child was assumed to be a 1- through 6 year-old with an average BW of 15 kg, a soil/sediment ingestion rate of 200 mg/day, and an inhalation rate of 10 m^3/day (0.42 m^3/hour) (EPA, 1999). Approximately 30 percent of total body SA or 2,100 cm^2 was assumed to be exposed to surface water while wading (EPA, 1992b). Body SA exposed to soil or sediment was assumed to be 25 percent of total SA, or approximately 1,750 cm^2 (EPA, 1992b). The child receptor was assumed to be exposed to soil for 350 days per year for 6 years.

EPA (1989a) permits the development of a fraction to reflect the proportion of total daily exposure that a receptor obtains from potentially contaminated medium. In this scenario, the FI was used to apportion the resident's time of exposure between site soil and sediment. It was assumed that the resident spends 16 hours per day awake and potentially exposed to soil or sediment. As previously noted, 350 days per year are available for contact with soil; 52 of those days are also available for

contact with sediment. It was assumed that contact with soil and sediment does not occur simultaneously; i.e., on those days when the resident spends time at the brook, 8 hours would be spent in contact with surface soil and 8 hours would be spent in contact with sediment. The fraction of exposure to soil, therefore, is 16 hours/16 hours = 1 on the 298 days without time spent at the brook, and 8 hours/16 hours = 0.5 on the 52 days with some time spent at the brook. An overall weighted fraction of 0.93 (rounded to 0.9) is estimated for exposure to soil. An overall weighted fraction of 0.07 (rounded to 0.1) is estimated for exposure to sediment.

The inhalation rate of the adult resident, 20 m^3/day, is multiplied by 16.4 hours per 24 hours per day to estimate a daily indoor inhalation rate of 13.7 m^3/day. An indoor inhalation rate of 6.8 m^3/day is estimated in the same manner for the child resident.

An average soil and sediment AF of 0.2 mg/cm^2 (EPA, 1992b) was used in this evaluation.

5.3.1.3.4 Indoor Worker

This receptor scenario is created to evaluate exposure to indoor airborne VOCs entrapped in a building. VOCs released from subsurface soil or shallow groundwater 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. Dermal exposure, although plausible, is expected to be far less significant than incidental ingestion and is not quantified separately. In the future, the indoor worker may be exposed to groundwater developed as a source of potable water. Scenarios and pathways for exposure to groundwater will be developed in the sitewide HHRA when groundwater data become available.

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

5.3.1.3.5 Other Receptors Not Considered

Other plausible site workers include office workers and delivery personnel. These workers, however, would be less intensively exposed to soil than the groundskeeper; therefore, their exposures are not evaluated. The Red Water Ponds Areas could become part of the area used for National Guard training activities. National Guard trainees, however, would be less exposed to any of the potentially

contaminated media than the previously described receptors; their exposures are not evaluated. Parts of PBOW are used for fishing and hunting. The Red Water Ponds, however, are not used for fishing, and the Red Water Ponds Areas are too small to provide a significant amount of browse for deer or food for other game animals that would make a significant contribution to the diet. Furthermore, experience has shown that the game ingestion pathway generally is insignificant for contaminants other than the polychlorinated dibenzo-p-dioxins/dibenzofurans (PCDD/PCDF), and the previously described receptors would represent the upper-bound for exposure to soil, surface water, and sediment. For these reasons, a hunting scenario is not evaluated. Much of the land around PBOW is used for agriculture, and it is possible that areas of PBOW could be farmed in the future. The areas around the Red Water Ponds, however, are not suited for agriculture. Also, experience has shown that ingestion of home-grown grains, fruits, meat, poultry, eggs, or milk is generally insignificant compared with direct exposure pathways, except for PCDDs/PCDFs; therefore, indirect food-chain exposures are not evaluated.

The last receptor considered is a trespasser or site visitor who would use the site for recreational purposes. This scenario, however, is not plausible under the current site-use scenario, because the facility is fenced and patrolled. The site visitor scenario is plausible under the future site-use scenario (the fence and patrols may be removed in the future), but the resident would represent the upper-bound on exposure, and evaluation of a site visitor is not necessary.

5.3.2 Quantification of Exposure-Point Concentrations

The exposure-point concentrations of COPC for direct exposure pathways for soil, surface water, and sediment were the source-term concentrations estimated as described in Section 2.2.

Chemical-specific physical property values used in the transport models described below are presented in Table 5-18 and documented in the toxicity profiles compiled in Appendix H.3.

5.3.2.1 Exposure-Point Concentrations in Air

No VOCs were identified as COPC in soil. Therefore, calculations of COPC concentrations in outdoor air were confined to estimating airborne dust concentrations. As previously noted, there is concern for inhalation exposure to VOCs that volatilize from subsurface soil and become entrapped in a building. This is a plausible exposure scenario for the indoor worker and the on-site resident.

5.3.2.1.1 COPC Concentrations from Dust

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

$$C_a = (D)(C_{so})(CF2) \qquad \text{Eq. 5.5}$$

where:

C_a = contaminant concentration in air (mg/m^3, calculated)
D = dust loading factor (grams of soil/m^3 of air)
C_{so} = contaminant concentration in soil (mg/kg)
CF2 = conversion factor (1E-3 kg/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 was used for the groundskeeper. It was assumed that construction activities requiring intimate contact with soil, for which D = 6E-4 g/m^3 is appropriate, would 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 was estimated for the construction worker.

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

$$PEF = Q/C \cdot \frac{3600}{0.036 \cdot (1 - V) \cdot (U_m/U_t)^3 \cdot F(x)} \qquad \text{Eq. 5.6}$$

where:

PEF = particulate emission factor (m^3/kg, calculated)

Q/C = inverse of the mean concentration at center of square source (43.08 g/m^2-second per kg/m^3, site-specific value from Table 3 in EPA, 1996a [Zone 7, Cleveland, 30-acre site])
3600 = seconds/hour
V = fraction of surface covered with vegetation (0.8, unitless, assumed)
U_m = mean annual wind speed (default, 4.69 m/second)
U_t = equivalent threshold value of wind speed at 7 m (default, 11.32 m/second)
F(x) = function dependent on U_m/U_t (default, 0.194).

The WARWP and PRRWP are each approximately 22 to 23 acres in size; the Q/C value based on approximately 30 acres (EPA, 1996a) is selected as most appropriate for these sites.

The concentration of COPC in air is calculated as follows:

$$C_a = \frac{C_{so}}{PEF} \qquad \text{Eq. 5.7}$$

where:

C_a = contaminant concentration in air (mg/m^3)
C_{so} = contaminant concentration in soil (mg/kg)
PEF = particulate emission factor (m^3/kg).

5.3.2.1.2 COPC Concentrations in Indoor Air

The RBSCs applied to subsurface soil for COPC selection do not address this pathway; therefore, an EPA (1997b) modification of the Johnson and Ettinger model is used to estimate airborne concentrations in indoor air.

Estimating indoor airborne concentrations from subsurface soil can be considered to consist of three separate steps:

- Estimating VOC concentration in soil gas at source of contamination (C_{source})
- Estimating an attenuation coefficient that captures the decline in VOC concentration between soil gas at the source and indoor air (")

- Combining C_{source} and " to estimate VOC concentration in indoor air in the building ($C_{building}$).

An "infinite source" assumption is selected to maintain consistency with the EPA (1996a) methodology for particulate emission factor, and to impart a conservative bias to the evaluation. It is assumed that both the source of VOC contamination in subsurface soil and the foundation of the building are located above the groundwater saturation zone. It is also assumed that VOC contamination in soil does not exist in a nonaqueous phase. Because of the strongly conservative bias imparted by the infinite source assumption, average values are selected for model variables, when possible, if site-specific data are not available. Default values are taken preferentially from 1996 EPA guidance (1996a) to maintain consistency with the other models described in Section 5.3.2, then from 1997 EPA guidelines (1997b).

The first step in estimating indoor VOC concentrations in air is to relate the concentration of VOC in soil gas at the source of contamination to the concentration of VOC in soil, as follows:

$$C_{source} = \frac{(H')(C_s)(D_b)(CF_1)}{(D_w) + (K_d)(D_b) + (H')(D_a)} \qquad \text{Eq. 5.8}$$

where:

C_{source}	=	VOC concentration in soil gas at source of contamination (g/cm^3)
H'	=	dimensionless Henry's law constant (chemical-specific, may be estimated as H @ 41 [EPA, 1996a])
H	=	Henry's law constant (atmosphere-m^3/mole, chemical-specific)
C_s	=	contaminant concentration in soil (mg/kg)
D_b	=	dry soil bulk density (1.5 g/cm^3, default [EPA, 1996a], or site-specific)
CF_1	=	conversion factor (10^{-6} kg/mg)
2_w	=	water-filled soil porosity (0.15 L_{water}/L_{soil}, default [EPA, 1996a], or site-specific)
K_d	=	soil-water partition coefficient (cm^3/g, chemical-specific, may be estimated as K_{oc} @ f_{oc})
K_{oc}	=	soil organic carbon-water partition coefficient (cm^3/g, chemical-specific)
f_{oc}	=	organic carbon content of soil (0.006 g/g, default [EPA, 1996a], or site-specific)
2_a	=	air-filled soil porosity (0.28 unitless, default [EPA, 1996a], or site-specific estimated as n-2_w)

n	=	total soil porosity (0.43 unitless, default [EPA, 1996a], or site-specific estimated as 1-[D_b/D_s]).

The next step in estimating indoor VOC concentrations in air is the estimation of an attenuation coefficient that reflects the phenomena that reduce concentration in air between the source and the interior of the building. Because of the many phenomena involved, it is helpful to break this step into several smaller segments.

Diffusion is probably the most important phenomenon involved in the transport of VOC vapors from source to building. The EPA (1997b) modification of the Johnson and Ettinger model provides for multiple layers, i.e., different soil types, each of which would have its own physical properties that affect diffusion, between the contaminant source and the foundation of the building. For the purposes of this evaluation, it is simplistically assumed that only one soil type – the predominant soil type in the area – intervenes between source and building foundation. The equation for effective diffusivity through the soil between the source and the building foundation is given as:

$$D^{eff} = D_a(\theta_a^{3.33} / n^2) + (D_w / H')(\theta_w^{3.33} / n^2) \qquad \text{Eq. 5.9}$$

where:

D^{eff}	=	effective diffusion coefficient across soil (cm^2/second, calculated)
D_a	=	diffusivity in air (cm^2/second, chemical specific)
2_a	=	air-filled soil porosity (0.28 unitless, default [EPA, 1996a], or site-specific estimated as n-2_w)
n	=	total soil porosity (0.43 unitless, default [EPA, 1996a], or site-specific estimated as 1-[D_b/D_s])
D_w	=	diffusivity in water (cm^2/second, chemical specific)
H'	=	dimensionless Henry's law constant (chemical-specific, may be estimated as H @ 41 [EPA, 1996a])
2_w	=	water-filled soil porosity (0.15 L_{water}/L_{soil}, default [EPA, 1996a], or site-specific).

The equation for the attenuation coefficient is given as:

$$\alpha = \frac{\left(\left(\frac{D^{eff} A_B}{Q_{building} L_T}\right) \times \exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right)\right)}{\left(\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) + \left(\frac{D^{eff} A_B}{Q_{building} L_T}\right) + \left(\frac{D^{eff} A_B}{Q_{soil} L_T}\right)\left(\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) - 1\right)\right)} \qquad \text{Eq. 5.10}$$

where:

"	=	attenuation coefficient (unitless, calculated)
D^{eff}	=	effective diffusion coefficient across soil (cm^2/second)
A_B	=	area of enclosed space below grade (1.51E+6 cm^2, see following)
$Q_{building}$	=	building ventilation rate (4.61E+4 cm^3/second, see following)
L_T	=	distance from source to building (150 cm, approximately 5 feet [the midpoint of the depth of the soil column of interest])
Q_{soil}	=	flow rate of soil gas into enclosed space (cm^2/second, see following)
L_{crack}	=	foundation or slab thickness (15 cm, default [EPA, 1997b])
D^{crack}	=	effective diffusion coefficient through cracks (cm^2/second, assumed to be equivalent to D^{eff} [EPA, 1997b])
A_{crack}	=	area of total cracks (492 cm^2, see following).

No buildings are currently present on site from which to estimate several of the parameters required for Equation 5-10. However, some of the building characteristics can be estimated from data provided for the potable-water-to-air volatilization model. EPA (1997a) reviewed several studies of the volumes of houses and recommends 369 m^3 as a central estimate of the volume of a house. Assuming the house has 8-foot (2.44 meters) ceilings and exists on one level, an area of 151.3 square meters, equivalent to 1.51E+6 cm^2, can be estimated as an upper-bound on the area below grade.

An average building ventilation rate of 3,984 m^3/day was estimated for a home (EPA, 1997b), which is equivalent to 4.61E+4 cm^3/second.

EPA (1997b) assumes that the only crack available for the entry of soil gas is a 0.1-centimeters-wide gap at the interface of the floor and foundation. As previously noted, it is assumed that the area of the basement floor is 151.3 square meters. Assuming that the house is square, the length of one side would be 12.3 meters, and the total length of the wall would be 49.2 meters (4,920 centimeters). Therefore, the area of the crack would be 492 square meters.

The equation for the flow rate of soil gas into enclosed space is:

$$Q_{soil} = \frac{2 \pi \Delta P k_v X_{crack}}{\mu \ln(2 Z_{crack} / r_{crack})} \qquad \text{Eq. 5.11}$$

where:

Q_{soil}	=	flow rate of soil gas into enclosed space (cm^2/second, calculated)
) P	=	pressure differential between soil surface and enclosed space (20 g/cm-second^2)
k_v	=	soil vapor permeability (cm^2, see following)
X_{crack}	=	floor-wall seam perimeter (4,920 cm, see previous text)
:	=	viscosity of air (1.83E+5 g/cm-second [EPA, 1992e])
Z_{crack}	=	crack depth below grade (108 cm, see following)
r_{crack}	=	equivalent crack radius (0.1 cm, see following).

Data were not located from which to estimate the crack depth below grade. Presumably, however, houses or other buildings may be built on slabs or on full foundations. EPA (1997b) provides default depths of 15 centimeters for buildings on slabs and 200 centimeters for buildings on foundations. The average, 108 centimeters, is chosen for this evaluation.

Equation 5-11 assumes that vapor transport occurs solely by pressure-driven air flow to an idealized cylinder buried some distance (Z_{crack}) below grade. The length of the cylinder is assumed to be equal to X_{crack}. Therefore, the equivalent crack radius can be estimated as follows:

$$r_{crack} = \eta \left(\frac{A_B}{X_{crack}} \right) \qquad \text{Eq. 5.12}$$

where:

r_{crack}	=	equivalent crack radius (cm, calculated)
0	=	A_{crack}/A_B
A_{crack}	=	area of total cracks (492 cm^2, see previous text)
A_B	=	area of enclosed space below grade (1.51E+6 cm^2, see previous text)
X_{crack}	=	floor-wall seam perimeter (4,920 cm, see previous text).

From the foregoing, a value of 0.1 centimeter is estimated for r_{crack}.

Soil vapor permeability is a very sensitive parameter associated with convective transport of vapors within the zone of influence of a building (EPA, 1997b). It can be estimated as the product of soil intrinsic permeability and the relative air permeability at the estimated water-filled soil porosity (2_w). Soil intrinsic permeability is estimated as follows:

$$k_i = \frac{K_s \mu_w}{\rho_w g} \qquad \text{Eq. 5.13}$$

where:

k_i	=	soil intrinsic permeability (cm^2, calculated)
K_s	=	soil saturation hydraulic conductivity (4.05E-3 cm/second, see below)
$:_w$	=	dynamic viscosity of water (0.01307 g/cm-second [EPA, 1997b])
D_w	=	density of water (0.999 g/cm^2, [EPA, 1997b])
g	=	acceleration due to gravity (980.665 $cm/second^2$ [EPA, 1997b]).

Soil saturation hydraulic conductivity is related to soil texture. Section 6.2.1.1 states that the soils in the Red Water Ponds Areas consists predominately of loamy fine sand and fine sand, or sandy loam, underlain by silt or clay. Table 4 of EPA (1997b) provides approximate values for K_s ranging from 0.20 to 0.25 centimeters per hour (cm/hr) for silt or clay, to 4.42 cm/hr for sandy loam, to 14.59 cm/hr for loamy sand, to 29.70 cm/hr for sand. The value of 14.59 cm/hr for loamy sand, equivalent to 4.05E-3 centimeters per second, is chosen for this evaluation.

Relative air permeability is estimated as follows:

$$k_{rg} = \left(1 - S_{te}\right)^{0.5}\left(1 - S_{te}^{1/M}\right)^{2M} \qquad \text{Eq. 5.14}$$

where:

k_{rg}	=	relative air permeability (positive unitless value, calculated)

S_{te}	=	effective total fluid saturation (unitless, see below)
M	=	van Genuchten shape parameter (0.561 unitless, see following).

Section 6.2.1.1 states that the soils in the Red Water Ponds Areas consists predominately of loamy fine sand and fine sand, or sandy loam, underlain by silt or clay. Table 2 of EPA (1997b) provides an approximate values for M ranging from 0.083 to 0.270 for silty clay or silt, to 0.471 for sandy loam, to 0.561 for loamy sand, to 0.627 for sand. The value of 0.561 for loamy sand is chosen for this evaluation. S_{te} is calculated as follows:

$$S_{te} = \frac{\theta_w - \theta_r}{n - \theta_r} \qquad \text{Eq. 5.15}$$

where:

S_{te}	=	effective total fluid saturation (unitless, calculated)
2_w	=	water-filled soil porosity (0.15 L_{water}/L_{soil}, default [EPA, 1996a], or site-specific)
2_r	=	soil water content (0.057 cm^3/cm^3, see following taken from Table 2 of EPA [1997b])
n	=	total soil porosity (0.43 unitless, default [EPA, 1996a], or site-specific estimated as 1-[D_b/D_s]).

The soil water content (2_r) of 0.057 cm^3/cm^3 was the valued provided by EPA (1997b) for loamy sand.

Soil vapor permeability is estimated as follows:

$$k_v = (k_i)(k_{rg}) \qquad \text{Eq. 5.16}$$

where:

k_v	=	soil vapor permeability (cm^2, calculated)
k_i	=	soil intrinsic permeability (cm^2)
k_{rg}	=	relative air permeability (unitless).

The foregoing permit calculation of the attenuation coefficient, which, in turn permits calculation of the concentration of the VOC in indoor air in the building, as follows:

$$C_{building} = \alpha \, CF_2 \, C_{source} \qquad \text{Eq. 5.17}$$

where:

$C_{building}$	=	VOC concentration in indoor air in the building (mg/m^3, calculated)
"	=	attenuation coefficient (unitless)
CF_2	=	conversion factor (1E+9 mg-cm^3/g-m^3)
C_{source}	=	VOC concentration in soil gas at source of contamination (g/cm^3).

5.3.3 Quantification of Chemical Intake

This section describes the models used to quantify doses or intakes of the COPC by the identified exposure pathways. Models were taken or modified from EPA (1989a) unless otherwise indicated.

5.3.3.1 Inhalation of COPC in Air

The following equation was used to estimate the inhaled dose of COPC in air. The equation was applied to exposures of the groundskeeper, construction worker, and residents by inhalation of dust dust from soil.

$$I_a = \frac{(C_a)(FI_a)(IR_a)(EF)(ED)}{(BW)(AT)} \qquad \text{Eq. 5.18}$$

where:

I_a	=	inhaled dose of COPC (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).

5.3.3.2 Incidental Ingestion of COPC in Soil

The ingested dose of COPC in soil (groundskeeper, construction worker, resident adult and child) is estimated from the equation:

$$I_{so} = \frac{(C_{so})(FI_{so})(IR_{so})(EF)(ED)(CF4)}{(BW)(AT)} \qquad \text{Eq. 5.19}$$

where:

I_{so} = ingested dose of COPC in soil (mg/kg-day, calculated)
C_{so} = concentration of COPC in soil (mg/kg)
FI_{so} = fraction of exposure attributed to site soil (unitless)
IR_{so} = ingestion rate of soil (mg/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
CF4 = conversion factor (1E-6 kg/mg)
BW = body weight (kg)
AT = averaging time (days).

5.3.3.3 Incidental Ingestion of COPC in Sediment

The ingested dose of COPC in sediment (construction worker, adult and child resident) is estimated from the equation:

$$I_{sd} = \frac{(C_{sd})(FI_{sd})(IR_{sd})(EF)(ED)(CF4)}{(BW)(AT)} \qquad \text{Eq. 5.20}$$

where:

I_{sd} = ingested dose of COPC in sediment (mg/kg-day, calculated)
C_{sd} = concentration of COPC in sediment (mg/kg)
FI_{sd} = fraction of exposure attributed to site sediment (unitless)
IR_{sd} = ingestion rate of sediment (mg/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
CF4 = conversion factor (1E-6 kg/mg)
BW = body weight (kg)
AT = averaging time (days).

5.3.3.4 Dermal Contact with COPC in Soil, Sediment, or Water

Unlike the methodologies for estimating inhaled or ingested dose of 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 COPC is estimated from the equation (EPA, 1992b):

$$DAD = \frac{(DA)(SA)(EF)(ED)}{(BW)(AT)} \qquad \text{Eq. 5.21}$$

where:

DAD = average dermally absorbed dose of COPC (mg/kg-day, calculated)
DA = dose absorbed per unit body surface area per day (mg/cm^2-day)
SA = SA_{so} for soil, SA_{sd} for sediment, SA_{sw} for surface water, SA_{gw} for ground-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 (DA) is calculated differently for dermal uptake from soil or sediment and from water. Dermal uptake of COPC from soil (groundskeeper, construction worker, resident) or sediment (construction worker, resident) assumes that absorption is a function of the fraction of a dermally applied dose that is absorbed. It is calculated from the equation (EPA, 1992b):

$$DA = (C)(FI)(CF4)(AF)(ABS) \qquad \text{Eq. 5.22}$$

where:

DA = dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C = C_{so} for soil, C_{sd} for sediment, = concentration of COPC in medium (mg/kg)
FI = FI_{so} for soil, FI_{sd} for sediment, = fraction of exposure attributed to site medium (unitless)
CF4 = conversion factor (1E-6 kg/mg)
AF = AF_{so} 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 have been empirically determined for very few chemicals. EPA (1992b) discussed the available empirical data, as well as several predictive approaches for estimating ABS, but refrains from recommending any single approach. OEPA (1998) offers ABS default values of 10 percent (0.1) for organic chemicals and 1 percent (0.01) for inorganic chemicals, consistent with EPA (1999). These default values are used when empirical data are not available. The ABS values for soil are used also for sediment. ABS values are presented in Table 5-18.

Quantification of dermal uptake of COPC from surface water (construction worker, resident) and groundwater (groundskeeper, construction worker, resident) depends on a PC, which describes the rate of movement of a constituent from water across the dermal barrier to the systemic circulation (EPA, 1992b). The equation for dermal uptake of chemicals from water is the same as the equation for dermal uptake of chemicals from soil. DA for dermal uptake from water is calculated from the following equation:

$$DA = (C)(FI)(PC)(ET)(CF5) \qquad \text{Eq. 5.23}$$

where:

DA = dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C = C_{sw} for surface water, C_{gw} for groundwater, = concentration of COPC in water (mg/L)
FI = FI_{sw} for surface water, FI_{gw} for groundwater, = fraction of exposure attributed to site medium (unitless)
PC = permeability coefficient (cm/hr)
ET = ET_{sw} for surface water, ET_{gw} for groundwater, = time of exposure (hours/day)
CF5 = conversion factor (1E-3 L/cm^3).

PC has been determined for very few inorganic compounds. For those inorganic compounds for which empirical data are not available, EPA (1992b) recommends a default of 1E-3 cm/hr.

PC for organic chemicals varies by several orders of magnitude. PC for organic chemicals is highly dependent on lipophilicity, expressed as a function of the octanol/water partition coefficient (K_{ow}).

Documentation for PC values is provided in the toxicity profiles compiled in Appendix H.3. The values are summarized in Table 5-18.

The end of the exposure assessment is an estimation of lifetime average COPC intake or contact rates for quantifying cancer risk and chronic COPC intake or contact rates for quantifying noncancer hazard. These estimations, performed as part of the chain of computations that calculate risk and hazard, are presented in the risk characterization table (Section 5.5.).

5.4 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).
- Estimate 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.

5.4.1 Cancer Evaluation

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, 1986b). The qualitative aspect is a weight-of-evidence evaluation of the likelihood that a chemical might induce cancer in humans. The EPA recognizes six weight-of-evidence group classifications for carcinogenicity:

- Group A - Human Carcinogen: human data are sufficient to identify the chemical as a human carcinogen.
- Group B1 - Probable Human Carcinogen: human data indicate that a causal association is credible, but alternative explanations cannot be dismissed.
- Group B2 - Probable Human Carcinogen: human data are insufficient to support a causal association, but testing data in animals support a causal association.

- Group C - Possible Human Carcinogen: human data are inadequate or lacking, but animal data suggest a causal association, although the studies have deficiencies that limit interpretation.

- Group D - Not Classifiable as to Human Carcinogenicity: human and animal data are lacking or inadequate.

- Group E - Evidence of Noncarcinogenicity to Humans: human data are negative or lacking, and adequate animal data indicate no association with cancer.

Weight-of-evidence group classifications for the site COPC are provided on Table 5-19.

The toxicity value for carcinogenicity, called a cancer slope factor (SF), is an estimate of potency. Potency estimates are developed only for chemicals in Groups A, B1, B2 and C, and only if the data are sufficient. The potency estimates 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 confounding or quantify its effect 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 done 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 by the expression:

$$(p_{(d)} - p_{(0)}) / (1 - p_{(0)})$$

where:

$p_{(d)}$ = the probability of cancer associated with dose = 1 mg/kg-day
$p_{(0)}$ = the background probability of developing cancer at dose = 0 mg/kg-day.

The SF is expressed as risk per mg/kg per day (mg/kg-day). In order 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 (1986b) assumes that there are no thresholds for carcinogenic expression; therefore, any exposure represents some quantifiable risk.

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 BW data.

The EPA (2000) Integrated Risk Information System (IRIS) expresses inhalation cancer potency as a unit risk factor (URF) based on concentration, or risk per microgram (: g) of chemical/m^3 of ambient

air. Because cancer risk characterization requires a potency expressed as risk per mg/kg-day, the URF must be converted to the mathematical equivalent of an inhalation cancer SF, or risk per unit dose. Since 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 ：g/m^3) by 70 kg and by 1,000 ：g/mg, and dividing the result by 20 m^3/day. Oral and inhalation cancer SFs for the site COPC are presented in Table 5-19.

5.4.2 Evaluation of Noncancer Effects

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

- Qualitative identification of the adverse effect(s) associated with the chemical; these may differ depending on the duration (e.g., acute or chronic) or route (e.g., 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; 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 data base, in regard to developing a reference dose (RfD) for human exposure

- Identification of the target organ 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 uncertainty factor.

IRIS (EPA, 2000) and the Health Effects Assessment Summary Tables (HEAST) (EPA, 1997c) express the inhalation noncancer reference value as a reference concentration (RfC) in units of mg/m^3. Because noncancer risk characterization requires a reference value expressed as mg/kg-day, the RfC must be converted to an inhalation RfD. Since the inhalation RfC is based on continuous exposure of an adult human (assumed to inhale 20 m^3 of air/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. Oral and inhalation RfDs for the site COPC are presented in Table 5-19.

5.4.3 Target Organ Toxicity

As a matter of science policy, EPA (1989a) assumes dose- and effect-additivity for cancer effects. This assumption provides the justification for adding the hazard quotients (HQ) or HIs in the risk characterization for noncancer effects resulting from exposure to multiple chemicals, pathways or media. EPA, however, 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.

Mechanism 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, unless the data clearly indicate otherwise. That is, the target organ serves as a surrogate for mechanism of toxicity. When total HI for all media for a receptor exceeds 1.0 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.

As a practical matter, since 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 at the threshold, the more severely affected is chosen. 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. Target organs for the site COPC that have noncancer endpoints are presented in Table 5-19.

5.4.4 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 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 SFs are expressed as reciprocal doses.

5.4.5 Sources of Toxicity Information Used in the Human Health Risk Assessment

Toxicity values are chosen using the following hierarchy:

- EPA's on-line IRIS database (EPA, 2000) containing toxicity values that have undergone the most rigorous Agency review
- The latest version of the annual HEAST, including all supplements (EPA, 1997c)
- Other EPA documents, memoranda, former Environmental Criteria and Assessment Office, or National Center for Environmental Assessment (NCEA) derivations for the Superfund Technical Support Center.

All toxicity values, regardless of their source, have been evaluated for appropriateness for use in this HHRA. Documentation for the toxicity values is presented in the toxicity profiles in Appendix H.3.

GAFs (used to derive dermal RfDs and SFs from the corresponding oral toxicity values) presented in Table 5-19 are documented in the toxicity profiles in Appendix H.3.

GAFs obtained from reviews were compared to empirical (especially more recent) data, when possible, and were evaluated for suitability for use for deriving dermal toxicity values from oral toxicity values. The suitability of the GAF increases when the following similarities are present in the oral toxicokinetic 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 was 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.

The most defensible GAF for each chemical is used in the HHRA.

When quantitative data were insufficient, a default GAF was used.

5.5 Risk Characterization

Risk characterization is the combination of the results of the exposure assessment and toxicity assessment to yield a quantitative expression of cancer risk or noncancer hazard for the exposed receptors. This quantitative expression is the probability of developing cancer, or a non-probabilistic comparison of estimated dose with a RfD for noncancer effects. Quantitative estimates are developed for individual chemicals, exposure pathways, and exposure media for each receptor. The risk characterization is used to guide risk management decisions.

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, are generally overly conservative, because risk characterization involves multiplication of the conservatisms built into the estimation of source-term and exposure-point concentrations, the exposure (intake) estimates and the toxicity dose-response assessments.

Risk characterization is limited to those chemicals selected as COPC, i.e., present at concentrations that exceed RBSCs (Section 5.2.1.4). OEPA requires characterizing risk for all chemicals whose concentrations exceed their RBSCs, regardless of whether their concentrations are comparable to background. This approach, although consistent with EPA (1989a), obscures the risk associated with background chemicals, and may leave the misimpression that the entire risk estimate is due to site-related activity. This potential misimpression is avoided by providing three separate risk estimates: total site risk, which includes all COPC identified; background risk, which includes the inorganic and organic COPC identified as natural or anthropogenic background; and site-related risk, which is limited to COPC not identified as background and presumed to be present as a result of former PBOW

activity. Segregating risk estimates in this manner provides maximum useful information for site management.

5.5.1 Carcinogenic Effects of Chemicals

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

$$ILCR = (CDI)(SF) \qquad \text{Eq. 5.24}$$

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 (per mg/kg-day).

The chronic daily intake (CDI) term in Equation 5.24 is equivalent to the "I" or "DAD" terms (intake or dose) in Equations 5.18 through 5.23, when these equations are evaluated for cancer intakes.

The use of Equation 5.24 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 one-hit model:

$$ILCR = 1 - e^{[(CDI)(SF)]} \qquad \text{Eq. 5.25}$$

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 5.24.

As a matter of policy, EPA (1986b) considers the carcinogenic potency of simultaneous exposure to low doses of carcinogenic chemicals to be additive, regardless of the chemical's mechanisms of toxicity or sites (organs of the body) of action. Cancer risk arising from simultaneous exposure by a given pathway to multiple chemicals is estimated from the following equation:

$$Risk_p = ILCR_{(chem1)} + ILCR_{(chem2)} + \ldots ILCR_{(chemi)} \qquad \text{Eq. 5.26}$$

where:

$Risk_p$ = total pathway risk of cancer incidence, calculated
$ILCR(chem_i)$ = individual chemical cancer risk.

Cancer risk for a given receptor across pathways and across media is summed in the same manner.

5.5.2 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 (EPA, 1989a):

$$HQ = I/RfD \qquad \text{Eq. 5.27}$$

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 5.27 is equivalent to the "I" or "DAD" terms (intake or dose) in Equations 5.18 through 5.23, 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 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 several chemicals, an HI is calculated as the sum of the HQs by:

$$HI = I_1/RfD_1 + I_2/RfD_2 + \ldots I_i/RfD_i \qquad \text{Eq. 5.28}$$

where:

HI	=	hazard index (unitless, calculated)
I_i	=	intake for the ith toxicant
RfD_i	=	reference dose for the ith toxicant.

If HI for a given pathway exceeds 1, individual HI values may be calculated for each target organ.

5.5.3 Risk Characterization Results and Discussion

ILCR, HQ, and HI estimates are surrounded by considerable uncertainty; therefore, EPA (1989a) recommends that they be rounded to one significant figure for presentation in a risk assessment. However, in order to facilitate review and to more accurately estimate the contribution of individual chemicals and exposure pathways to the totals, these estimates are presented in the risk tables in scientific notation rounded to two places to the right of the decimal.

For this discussion, a significant contribution to cancer risk is defined for an individual chemical as an ILCR summed across all exposure pathways for a given source medium exceeding 1E-6; a significant contribution to hazard is defined as an HI across all pathways for a source medium exceeding 0.1. The COC were selected because of their cancer risk (cancer COC) or noncancer hazard (noncancer COC). The results and discussion of the risk characterization for soil, surface water, and sediment are described in the following subsections.

5.5.3.1 West Area Red Water Ponds

5.5.3.1.1 Groundskeeper

ILCR and HI values for potential exposures of the groundskeeper to surface soil at the WARWP are shown in Table 5-20. The ILCR summed across all exposure pathways falls within the 1E-6 to 1E-4 risk management range requiring further evaluation. The greatest contributor to cancer risk is chromium, which is carcinogenic only by the inhalation route. The ILCR for chromium, therefore, arises solely from inhalation of dust. Chromium is considered to be a site-related COPC because its concentration slightly exceeds background levels in surface soil. Benzo(a)pyrene is the only other site-related COPC that contributes significantly to cancer risk

The total HI from all exposure pathways, when rounded to one significant figure, does not exceed the threshold value of 1 (Table 5-20). Comparison of total HI values calculated for total risk, background risk and site-related risk indicates that background is the predominant contributor to the total HI and that aluminum and manganese are significant contributors. No site-related chemicals contribute significantly to noncancer hazard.

5.5.3.1.2 Indoor Worker

ILCR and HI values for potential exposures of the indoor worker to surface soil via incidental ingestion are shown in Table 5-21. The ILCR summed across all exposure pathways falls below the 1E-6 to 1E-4 risk management range requiring further evaluation. The total HI from all exposure pathways is well under the threshold value of 1 (Table 5-21).

5.5.3.1.3 Construction Worker

ILCR and HI values for potential construction worker exposures to total soil are shown in Table 5-22. The total ILCR from all exposure pathways is below the 1E-6 to 1E-4 risk management range requiring further evaluation. The total HI from all exposure pathways exceeds the threshold value of 1. The major contributor is manganese. A significant contribution is also provided by aluminum. The site-related HI summed across chemicals and exposure pathways is below the threshold value of 1. No site-related COPC in total soil at the WARWP contribute significantly to cancer risk or noncancer hazard to the construction worker.

ILCR and HI values for potential exposures of the construction worker to surface water are shown in Table 5-23. All ILCR values are below the 1E-6 to 1E-4 risk management range, and all HI values are below the threshold of 1. No site-related COPC in surface water at the WARWP contribute significantly to cancer risk or noncancer hazard to the construction worker.

ILCR and HI values for potential exposures of the construction worker to sediment are shown in Table 5-24. All ILCR values are below the 1E-6 to 1E-4 risk management range, and all HI values are below the threshold of 1. No site-related COPC in sediment at the WARWP contribute significantly to cancer risk or noncancer hazard to the construction worker.

5.5.3.1.4 On-Site Resident

ILCR and HI values for potential exposures of future on-site residents to total soil are shown in Tables 5-25 and 5-26. The total ILCR for potential exposures of a future on-site resident to total surface and subsurface soil from all exposure pathways falls within the 1E-6 to 1E-4 risk management range (Table 5-25). Comparison of total ILCR values calculated for total risk, background risk, and site-related risk shows that the predominant calculated risk is associated with arsenic present at background levels. 2,4-DNT, 2,6-DNT, and benzo(a)pyrene are significant contributors to site-related risk in total soil.

Ingestion and dermal contact rates for children are greater than adults; therefore, noncancer hazards to future residents were calculated only for potential exposures to children. The resulting HI calculations are expected to overestimate the HI for exposures to adults, and thus are conservative. The total HI calculated for potential exposures of children from all exposure pathways exceeds the threshold value of 1 (Table 5-26). However, neither the background risk nor the site-related total HI exceeds the threshold value. Significant contributors to background HI include the metals aluminum, antimony, arsenic and manganese. The site-related COPC that contribute significantly to site-related noncancer hazard include 2-amino-4,6-DNT, 4-amino, 2-6-DNT, and 1,3-dinitrobenzene.

ILCR and HI values for potential exposures of future on-site residents to surface water are shown in Tables 5-27 and 5-28, respectively. All ILCR values calculated for potential exposures of adults and children are below the risk management range. All HI values calculated for potential exposures of children are below the threshold of 1.

ILCR and HI values calculated for residential exposures to sediment are shown in Tables 5-29 and 5-30, respectively. All ILCR values calculated for potential exposures of adults and children are below the risk management range. All HI values calculated for potential exposures of children are below the threshold HI value of 1.

5.5.3.1.5 Summary for West Area Red Water Ponds

Site-related ILCR and HI values calculated for potential exposures of groundskeepers, indoor workers, construction workers, and future residents to COPC in soil, surface water and sediment at the West Area Red Water Ponds are summarized in Table 5-31. All site-related ILCR values summed across COPC and media are within or below the risk management range of 1E-6 to 1E-4. All site-related HI values are below the threshold value of 1.

As mentioned in Section 5.2.2.1, the exposure unit concept may be used to develop data sets and source-term concentrations for site-related COPC in total soil, because it could be inappropriate to use data from an entire site for some receptors, such as the construction worker and on-site resident that may be exposed to relatively small areas. Generally, data from the entire site are used in the first iteration of the HHRA, the results of which were previously presented. Alternative assessments are performed only if necessary. Necessity is defined in this context as the occurrence of MDCs significantly higher than source-term concentrations, so that the first iteration estimates fail to capture the risk associated with exposure to areas smaller than the entire site on which the data set was based.

Table 5-7 identifies the site-related COPC selected for total soil, and provides source-term concentrations and MDCs in surface and/or subsurface soil. The MDC of chromium in surface soil exceeds the source-term concentration by a factor of approximately 2, indicating the potential for higher risk estimates than those previously presented. However, chromium's contribution to cancer risk for the construction worker (Table 5-22) and the on-site resident (Table 5-25) is insignificant. Chromium's contribution to noncancer hazard for the construction worker (Table 5-22 and on-site resident (Table 5-26) is also insignificant. Substituting the MDC for chromium for the source-term concentration would not elevate cancer risk or noncancer hazard estimates significantly. Therefore, it is concluded that it is not necessary to identify exposure units based on the spatial distribution of chromium.

A similar analysis can be performed for the PAHs. The source-term concentrations of the PAHs are equal to their MDCs in surface soil, and exceed their MDCs in subsurface soil (Table 5-7). Therefore, the risk estimates previously summarized capture the maximum risk associated with the PAHs. Of the PAHs, only benzo(a)pyrene contributes significantly to cancer risk for the on-site resident (Table 5-25). It should be noted, however, that PAHs were detected only at sample location DP13 (Appendix E). Therefore, inclusion of the PAHs may slightly overestimate risks for the construction worker or on-site resident located someplace other than at DP13. (Please see Figure 4-1 for the location of DP13).

The MDCs of several nitroaromatic compounds in surface or subsurface soil (1,3-dinitrobenzene, 2,4-DNT, 4-amino-2,6-DNT) exceed their source-term concentrations by factors of approximately 2 or less (Table 5-7), suggesting that slightly higher risk estimates could be calculated for smaller exposure units. Figure 5-2 ranks the detected concentrations of these compounds from highest to lowest, and identifies the concentrations and the corresponding sample locations that exceed the source-term concentrations. For example, 2-4-DNT, with a source-term concentration of 3.09 mg/kg, was identified at 6.3 mg/kg in subsurface soil at sample location DP13. DP13 is located approximately 80 feet northwest of monitoring well MW-02 in the north central part of the site (Figure 4-1). Other sample locations of interest include S6, S10, and S17. These locations come from previous investigations and are presented in Figure 5-3. The four sample locations of interest are scattered over the site and do not appear to reflect a pattern of contamination.

Each of the four sample locations of interest is evaluated as a separate exposure unit. Source-term concentrations of site-related COPC in soil are developed separately for each sample location. The source-term concentration is the highest detected value in surface or subsurface soil. One-half the reporting limit is used as a surrogate concentration for COPC that were not detected at the particular sample location.

Source-term concentrations for site-related COPC at sample location DP13 are presented in Table 5-32. It is noted that the source-term concentration of chromium is below the BSC of 29 mg/kg (Table 5-1); therefore, chromium could be considered a background COPC and deleted from the analysis of DP13. Cancer risk estimates for the construction worker (Table 5-33) are below the 1E-6 to 1E-4 risk management range, as was observed for the WARWP as a whole (Table 5-22). Noncancer HI estimates for the construction worker are below the threshold of 1 (Table 5-33), as was observed for the WARWP as a whole (Table 5-22). No COPC are selected as contributing significantly to cancer risk or noncancer hazard.

Cancer risk estimates for the on-site resident at DP13 (Table 5-34) are within the 1E-6 to 1E-5 risk management range and are similar to those observed for the WARWP as a whole (Table 5-25). 2,4-DNT and benzo(a)pyrene contribute significantly to cancer risk. Noncancer HI estimates for the on-site resident are below the threshold of 1 (Table 5-35), as was observed for the WARWP as a whole (Table 5-26). 4-Amino-2,6-DNT contributes significantly to noncancer hazard.

Similar evaluations were performed for sample locations S6 (Tables 5-36 through 5-39), S10 (Tables 5-40 through 5-43), and S17 (Tables 5-44 through 5-47). The spatial distribution of the nitroaromatic compounds and benzo(a)pyrene results in risk and hazard estimates for both the construction worker and on-site resident being very similar to those noted for the WARWP as a whole. It is concluded that the exposure unit analysis had no effect on the summary observations previously presented, and it is deemed unnecessary to re-summarize the total hazard and risk estimates presented in Table 5-31.

5.5.3.2 Pentolite Road Red Water Ponds

5.5.3.2.1 Groundskeeper

ILCR and HI values for potential exposures of the groundskeeper to surface soil are shown in Table 5-48. The total risk and background ILCR summed across all exposure pathways falls within the 1E-6 to 1E-4 risk management range requiring further evaluation. The greatest contributor to cancer risk is arsenic, which is present at concentrations comparable to background. No other COPC contribute significantly to cancer risk. The site-related ILCR summed across all exposure pathways falls below the risk management range. No site-related COPC contribute significantly to cancer risk.

The total HI from all exposure pathways falls below the threshold value of 1 (Table 5-48). The only significant contribution to HI is provided by aluminum and manganese, both of which are present at concentrations comparable to background.

5.5.3.2.2 Indoor Worker

ILCR and HI values for potential exposures of the indoor worker to surface soil by incidental ingestion are shown in Table 5-49. The total risk and background ILCR summed across all exposure pathways falls within the 1E-6 to 1E-4 risk management range requiring further evaluation. The greatest contributor to cancer risk is arsenic, which is present at concentrations comparable to background. No other COPC contribute significantly to cancer risk. The site-related ILCR summed across all exposure pathways falls below the risk management range.

The total HI from incidental ingestion is under the threshold value of 1 (Table 5-49). No COPC contribute significantly to noncancer HI.

5.5.3.2.3 Construction Worker

ILCR and HI values for potential construction worker exposures to total soil are shown in Table 5-50. The total site and site-related ILCR from all exposure pathways is within the 1E-6 to 1E-4 risk management range requiring further evaluation. The total ILCR for background metals is below the risk management range. The total HI from all exposure pathways exceeds the threshold value of 1, due almost entirely to TNT, which is a site-related chemical (Table 5-50). 4-Amino-2,6-DNT also provides a slight but significant contribution to noncancer hazard. The total HI for background metals also exceeds the threshold of 1 due primarily to manganese, with a slight but significant contribution from aluminum.

ILCR and HI values for potential exposures of the construction worker to surface water are not estimated because no chemicals were selected as COPC in surface water.

ILCR and HI values for potential exposures of the construction worker to sediment are shown in Table 5-51. All ILCR values are below the 1E-6 to 1E-4 risk management range, and all HI values are below the threshold of 1. Arsenic, the only COPC identified in sediment, is present at concentrations comparable to background.

5.5.3.2.4 On-Site Resident

ILCR and HI values for potential exposures of future on-site residents to total soil are shown in Tables 5-52 and 5-53. The total ILCR for potential exposures of a future on-site resident to total surface and subsurface soil from all exposure pathways exceeds the 1E-6 to 1E-4 risk management range (Table 5-52), due almost entirely to TNT, which is a site-related chemical. Significant contributions to site-related risk are also made by 2,4- and 2,6-DNT. The total ILCR associated with background metals falls within the risk management range, due almost entirely to arsenic.

Ingestion and dermal contact rates for children are greater than adults; therefore, noncancer hazards to future residents were calculated only for potential exposures to children. The resulting HI calculations are expected to overestimate the HI for exposures to adults, and thus are conservative. The total HI calculated for potential exposures of children from all exposure pathways exceeds the threshold value of 1 (Table 5-53) due almost entirely to TNT, with slight but significant contributions from 4-amino-2,6-DNT and 1,3-dinitrobenzene. The total HI for background metals does not exceed the threshold of 1, but significant contributions are provided by aluminum, antimony, arsenic, and manganese.

ILCR and HI values for potential exposures of future on-site residents to surface water are not calculated because no chemicals were selected as COPC in surface water.

ILCR and HI values calculated for residential exposures to sediment are shown in Tables 5-54 and 5-55, respectively. All site-related ILCR values calculated for potential exposures of adults and children are below the 1E-6 to 1E-4 risk management range. All HI values calculated for potential exposures of children are well below the threshold HI value of 1.

5.5.3.2.5 Summary for Pentolite Road Red Water Ponds

Site-related ILCR and HI values calculated for potential exposures of groundskeepers, indoor workers, construction workers, and on-site residents to COPC in soil, surface water, and sediment at the PRRWP are summarized in Table 5-56. Site-related ILCR values summed across COPC and source media are within or below the risk management range of 1E-6 to 1E-4 for all receptors except the on-site resident. The ILCR for the on-site resident is substantially above the risk management range. Site-related HI values for the groundskeeper and indoor worker are below the threshold value of 1. Site-related HI values for the construction worker and on-site resident are substantially above the threshold value of 1.

TNT in total soil accounts for almost all of the site-related cancer risk and noncancer hazard estimates for the construction worker and on-site resident, although other nitroaromatics contribute slightly to cancer risk (2,4- and 2,6-DNT) and noncancer HI (4-amino-2,6-DNT, 1,3-dinitrobenzene). Examination of Table 5-13 reveals that the MDCs exceed the source-term concentrations for these site-related COPC, except for TNT, for which the MDC was adopted as the source-term concentration. Figure 5-4 ranks the detected concentrations of these compounds from highest to lowest and identifies the concentrations and the corresponding sample locations that exceed the source-term concentrations. Sample locations of interest include DP03, DP10, and DP11 from the present investigation (Figure 4-4), and S4, S6, S10, S13, S14, S15, and S16 from previous investigations (Figure 5-5). Figure 5-4 identifies sample location S14 as a potential hot spot for TNT. Therefore, the evaluation that follows is called an exposure unit/hot spot analysis.

Examination of Tables 5-50, 5-52 and 5-53 reveals that higher ILCR and HI estimates are computed for the on-site resident than for the construction worker. Therefore, the PRRWP exposure unit/hot spot analysis will be performed only for the on-site resident.

Three tables are prepared for each of the ten sample locations of interest; Table 5-57 presents the source-term concentrations, Table 5-58 presents the on-site resident ILCR estimates, and Table 5-59 presents the on-site resident HI estimates for DP-03. Tables 5-60 through 5-86 present these estimates for the other nine sample locations of interest previously identified.

ILCR estimates for the on-site resident fall within the 1E-6 to 1E-4 risk management range at all sample locations of interest except for S14, where the ILCR rounded to one figure is 9E-4. The risk is due almost entirely to TNT, which was identified at high levels at two different sampling depths at S14. Other significant contributors to risk, at this and the other sampling locations, include 2,4-DNT and, at some sampling locations, 2,6-DNT as well.

HI estimates for the on-site resident fall below the threshold value of 1 for all sample locations of interest except for DP03, DP10, DP11, S14, and S15. 1,3-Dinitrobenzene is the greatest contributor to HI at all of these sample locations except S14. The greatest contributor to HI at S14 is TNT. A substantial contribution to HI at S14 is provided by 4-amino-2,6-DNT; lesser but significant contributions are provided by 1,3-dinitrobenzene and 2,4-DNT.

In summary, the exposure unit/hot spot evaluation identifies DP03, DP10, DP11, S14, and S15 as sample locations with HI estimates above the threshold value of 1. A casual examination of the data (Figure 5-4) would have easily reveal sample location S14 as a hot spot associated with unusually high levels of TNT. However, the significance of 1,3-dinitrobenzene as a contributor to HI at the other four sample locations would not have been as easily seen.

5.5.4 Risk-Based Remediation Criteria Development

RBRC development performed as part of the HHRA provides key risk information to risk managers. RBRC are site-specific risk-based concentrations that reflect the exposure and toxicity assumptions applied in the BHHRA. Consequently, the RBRC are source medium-, receptor-, and chemical-specific.

The first step in RBRC development is selection of COC. Either of two conditions result in designation of a COPC as a COC:

- The concentration of the COPC exceeds its medium-specific ARAR.

- The COPC contributes significantly to cancer risk or hazard, as described in the following text.

COC based on cancer are selected for any medium for which the total ILCR (summed across chemicals and exposure pathways) exceeds 1E-6. An individual COPC in that medium must have an ILCR (summed across exposure pathways) exceeding 1E-6 to be selected as a cancer-based COC. Generally, COC based on noncancer are selected for any receptor whose HI summed across all source media exceeds 1, then for any medium for which the total HI (summed across chemicals and exposure pathways) exceeds 0.1. An individual COPC in that medium must have an HI (summed across exposure pathways) exceeding 0.1 to be selected as a noncancer-based COC.

As previously noted, exposure to shallow or deep groundwater is plausible for all receptors evaluated herein. Groundwater data, however, are not yet available. Risk for exposure to groundwater will be estimated when the data become available, and the risk estimates from this evaluation (soil, surface water, sediment) will be combined with those for groundwater to yield total risk for each receptor summed across all relevant media. Since total receptor HI estimates across media are not available at this time, it is assumed for the purpose of noncancer COC selection that the total HI exceeds the threshold of 1. Therefore, all COPC in a given medium that yield an HI (summed across all exposure pathways) greater than 0.1 are selected as noncancer-based COC.

There are no ARARs for soil, surface water, or sediment; therefore, only the risk-based conditions are evaluated in COC selection.

RBRC are risk-or hazard-specific concentrations of chemicals developed only for the COC in media selected by the criteria described above. In this HHRA, COC were selected for exposure to surface soil (groundskeeper) and total soil (construction worker and on-site resident).

RBRC for cancer COC are estimated for soil from the following equation:

$$RBRC_{coc} = \frac{ST_{coc}\,TR}{ILCR_{COC}} \qquad \text{Eq. 5.29}$$

where:

$RBRC_{coc}$	=	remedial goal option for a given COC, receptor and source medium (calculated)
ST_{coc}	=	source-term concentration of the COC in the given medium
TR	=	target risk level (1E-6, 1E-5)
$ILCR_{coc}$	=	total incremental lifetime cancer risk for a given COC, receptor and source medium.

RBRC for noncancer COC are estimated as follows:

$$RBRC_{coc} = \frac{ST_{coc}\ THI}{HI_{COC}} \qquad \text{Eq. 5.30}$$

where:

$RBRC_{coc}$	=	remedial goal option for a given COC, receptor, and source medium (calculated)
ST_{coc}	=	source-term concentration of the COC in the given medium
THI	=	target hazard index (0.1, 1)
HI_{coc}	=	total hazard index for a given COC, receptor, and source medium.

Concentration units are not provided in Equations 5.29 or 5.30; the RBRC units are the same as the concentration units of the source-term concentration (e.g., mg/kg for soil).

5.5.5 Conclusions

COC were identified and RBSCs were developed for groundskeeper exposure to surface soil (Table 5-87), construction worker exposure to total soil (Table 5-88) and on-site resident exposure to total soil (Table 5-89).

5.6 Uncertainty Analysis

This section explores the uncertainties inherent in the HHRA process. Uncertainty is a factor in each step of the data evaluation and exposure and toxicity assessments presented in the preceding sections. Uncertainties associated with earlier stages of the HHRA become magnified when they are concatenated with other uncertainties in the latter stages. It is not possible to eliminate all uncertainty; however, a recognition of the uncertainties is fundamental to the understanding and reasonable use of the HHRA results.

Generally, BHHRAs carry two types of uncertainty. Measurement uncertainty refers to the usual variance that accompanies scientific measurements, e.g., instrument uncertainty (accuracy and precision) associated with contaminant concentrations. The results of the HHRA reflect the accumulated variances of the individual measured values. A different kind of uncertainty stems from data gaps, i.e., additional information needed to complete the database for the assessment (EPA, 1992c). Often, the data gap is significant, such as imprecision regarding the number of days that a construction worker might work at the Red Water Ponds Areas, or the absence of information on the effects of human exposure to the aminodinitrotoluenes.

EPA (1992c) guidance urges risk assessors to address or provide descriptions of individual risk to include the "high end" portions and "central tendency" (CT) of the risk distribution. One way of fulfilling this request, if either cancer or noncancer risk exceed generally acceptable limits (cancer risk greater than 1E-5 or target organ-specific HI greater than 1), is to re-compute the ILCRs or HIs using CT values for as many intake model variables as possible. In contrast to the RME evaluation, which prevails in HHRA and uses upper-end values for intake or contact rates, EF, and ED, the CT evaluation chooses average or mid-range values for these variables (EPA, 1991, 1993b). The intent is to present a quantified risk/hazard estimate more typical for the receptor of interest.

The CT exposure evaluation, however, falls short of its stated intent for several reasons. First, the same source-term concentration is usually used for the CT evaluation as is used for the RME evaluation. EPA (1993b) considers that the UCL or MDC selected as a conservative estimate of average for the RME is appropriate for the CT estimates. Second, there is little information available as to what constitutes a reliable CT estimate for most exposure variables, with the possible exception of a simple on-site residential scenario. For these reasons, RME values are still used. In addition, no CT toxicity values are available, so the uncertainty about the toxicity assessment is not included. A CT evaluation, therefore, usually provides little relief compared with the RME, particularly for exposure scenarios such as a groundskeeper or construction worker, for which no reliable estimation of most exposure variable values can be made. It should be stated that management decisions are generally based on RME rather than CT evaluations. The CT evaluation, within the described limitations, simply adds limited perspective regarding the magnitude of uncertainty about the RME estimates.

Another method of quantifying uncertainty, called Monte Carlo simulation, provides a more graphic illustration of the uncertainty about a risk/hazard estimate, because it presents the risk as a range with

probability densities. To be meaningful, however, Monte Carlo simulation requires that the nature of the distributions of the variables that drive the HHRA should be well characterized. However, well characterized distributions are available for few exposure or toxicological variables, in which case the Monte Carlo simulation provides an incomplete illustration of the magnitude or the distribution of the uncertainty.

5.7 Summary and Conclusions

The WARWP and PRRWP areas were individually evaluated in a HHRA. Potentially contaminated media include surface soil, subsurface soil, surface water, sediment, shallow groundwater and deep groundwater. Analytical data were available for soil, surface water, and sediment. Data for shallow and deep groundwater will be evaluated at a later date. Hence, it is acknowledged that this HHRA, which evaluates a set of plausible receptors for exposure to soil, surface water, and sediment, is incomplete because total cancer risk and noncancer hazard estimates across all media, including groundwater, are not evaluated.

Chemicals in a given source medium were chosen as COPC largely on the basis of their potential to contribute significantly to risk. The COPC were designated as background if they are metals present at concentrations comparable to those observed in uncontaminated areas, or as site-related if their concentrations exceed background or if they were organic chemicals likely to have been released as a result of former DOD activities. This approach permitted estimation of total site risk, background risk, and site-related risk. Only site-related risk is considered in this summary.

The receptors chosen include a groundskeeper, an indoor worker, a construction worker, and an on-site resident. The groundskeeper represents the upper-bound for long-term exposure to soil under a nonresidential site-use assumption. The indoor worker represents the upper-bound for exposure to vapors from subsurface soil trapped in indoor air in a nonresidential setting. The construction worker represents the upper-bound for short-term exposure to soil, surface water, and sediment for nonresidential site use. The on-site receptor represents the upper-bound for exposure to soil, indoor vapors from subsurface soil, surface water, and sediment for residential use. Generally, residential site use represents more intense exposure to all media than nonresidential site use and is considered the most conservative evaluation.

It is plausible that a groundskeeper would be exposed randomly over the entire site; therefore, the surface soil data from the entire site was used to create a single data set for use in the HHRA. The construction worker and on-site resident, on the other hand, are more likely to be exposed to a much smaller area, e.g., the site of a construction project, or a resident's own back yard. The first iteration of the HHRA used data from the entire site to develop a single total soil data set. Smaller exposure units were also evaluated to assess the possibility that higher chemical concentrations could yield higher risk estimates.

Site-related COPC selected for soil at the WARWP area include one metal, one PAH, and several nitroaromatic compounds. The groundskeeper evaluation revealed that contaminant concentrations in surface soil yield cancer risk estimates near the middle of the 1E-6 to 1E-4 risk management range. It is unlikely, however, that adverse noncancer effects would be experienced from exposure to surface soil in a nonresidential setting. The construction worker and on-site resident scenarios evaluated exposure to total soil. The construction worker evaluation suggests that short-term exposure to soil in a nonresidential setting is unlikely to be associated with unacceptable cancer risks. The on-site resident evaluations yielded cancer risk estimates near the middle of the risk management range. Both receptor evaluations, however, showed that adverse noncancer effects are unlikely from exposure to soil in a short-term or long-term setting. The construction worker and on-site resident evaluations were carried further to demonstrate that significantly higher risk estimates would not be calculated for smaller exposure units.

The construction worker and resident exposure evaluations demonstrated that contaminant concentrations in surface water and sediment at the WARWP area are unlikely to pose unacceptable risk under any plausible exposure scenario.

Site-related COPC selected for soil at the PRRWP area are limited to several nitroaromatic compounds. The groundskeeper evaluation revealed that contaminant concentrations in surface soil are unlikely to pose unacceptable cancer risk or induce noncancer effects for long-term nonresidential exposure. The construction worker and on-site resident scenarios evaluated exposure to total soil. The construction worker evaluation revealed that contaminant concentrations in total soil yield cancer risk estimates near the middle of the 1E-6 to 1E-4 risk management range. The noncancer HI exceeded the threshold of 1, raising concern for the occurrence of adverse noncancer effects for short-term exposure to soil in a nonresidential setting. The on-site resident evaluations yielded cancer risk

estimates substantially above the 1E-6 to 1E-4 risk management range. The HI for on-site resident exposure to soil exceeded the threshold of 1 by more than two orders of magnitude, raising concern for the occurrence of adverse noncancer effects. TNT contributed nearly all the cancer risk and the large majority of the noncancer hazard.

Exposure unit/hot spot analysis of the PRRWP revealed that TNT levels at sampling location S14 were responsible for the high cancer risk. Cancer risk at other sampling locations within the PRRWP area fall within the risk management range. Exposure unit/hot spot analysis revealed concern for adverse noncancer effects at sampling locations DP03, DP10, DP11, S14, and S15. Noncancer HI estimates were below the threshold of 1 at the other sampling locations. The sampling locations occur in no discernable array that would suggest a pattern of contamination.

The construction worker and resident exposure evaluations at the PRRWP area demonstrated that contaminant concentrations in surface water and sediment are unlikely to pose unacceptable risk under any plausible exposure scenario.

In summary, soils at the WARWP and PRRWP areas are clearly contaminated with TNT and other nitroaromatic compounds as a result of former DOD activities. The foregoing evaluation demonstrates that contaminant levels in soil raise concern regarding cancer risk (WARWP and PRRWP) and adverse noncancer effects (PRRWP). Although certain sampling locations in the PRRWP are more heavily contaminated than others, no pattern of contamination is discernable. Surface water and sediment are unlikely to pose unacceptable risk.

6.0 Ecological Risk Assessment

6.1 Introduction

A baseline ecological risk assessment (BERA) has been performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases within the Red Water Ponds Areas. Ecological risks have been assessed separately for logically distinct source areas within the facility. The results of the BERA contribute to the overall characterization of the sites and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives, as needed. The BERA has been performed following the general guidelines of the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel, et al., 1996), with secondary guidance from EPA (1997d) and EPA (1996b).

The primary objective of the BERA is to determine whether unacceptable adverse risks are posed to ecological receptors as a result of potential hazardous substance releases from the Red Water Ponds Areas. This objective is accomplished through:

- Characterizing the ecological communities in the vicinity of the subsites
- Determining the particular hazardous substances being released from the subsites
- Identifying pathways for receptor exposure
- Estimating the magnitude and likelihood of potential risk to identified receptors. The BERA addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (including both fish and aquatic macro-invertebrates), endangered and threatened species, and wetlands or other sensitive habitats associated with the subsites.

Concentrations of chemicals have been measured in relevant environmental media, including soil, surface water, and sediment. It is anticipated that potential impacts from groundwater will be completed in a sitewide groundwater evaluation in the future. Using available concentration data, the BERA consists of:

- Problem formulation section (6.2)
- An exposure characterization section (6.3)

- An ecological effects characterization section (6.4)
- A risk characterization section (6.5)
- A risk summary and identification of preliminary remedial action objectives section (6.6)
- A conclusions and recommendations section (6.7).

IT has evaluated the chemicals of potential ecological concern (COPEC), the ecosystems and receptors at risk, the ecotoxicity of the contaminants (known or suspected), and observed or anticipated ecological effects. This evaluation has been conducted in two steps: (1) a screening assessment step, and (2) a predictive assessment step. Ecological endpoints to be addressed in both steps have been identified. The results and conclusions of the screening assessment determine whether a predictive assessment is required. The criteria by which a predictive assessment is needed have been formalized as null hypotheses. If the null hypotheses are accepted, then a predictive assessment is not needed. If they are rejected, then a predictive assessment is needed.

6.2 Problem Formulation

The screening assessment null hypotheses are:

- The 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.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential ecological receptors**.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential exposure pathways**.
- The no potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential chemical stressors**.

All four null hypotheses must be rejected for a predictive assessment to be triggered. The first three null hypotheses are tested against the results of the ecological site description (Section 6.2.1). The fourth null hypothesis is tested against the results of the COPEC selection (Sections 6.2.2 and 6.2.3).

If a predictive assessment is triggered, terrestrial and aquatic ecological conceptual site models are developed, as appropriate, and the additional problem formulation tasks described in Sections 6.2.4 to 6.2.6 will be performed.

6.2.1 Ecological Site Description

This ecological site description section includes a general discussion of site background and areas of concern (AOC), surface water resources, wetlands, vegetative communities, a species inventory, and a discussion on threatened and endangered species.

6.2.1.1 General Site Background

PBS, approximately 6,453 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 PBS, the land slopes gently to the north-northeast towards Lake Erie. Elevations range from 675 feet above msl at the southwest edge of the site to 625 feet msl 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 prior owner, Trojan Powder Company, acquired the site in the early 1940s and removed the land from agricultural production, undeveloped portions of the station have become second generation forest and open fields. This has resulted in PBS becoming an island of forest and open fields within a sea of agricultural land in north central Ohio.

Site soils associated with the Red Water Ponds include the Arkport-Galen soil association (USCS, 1971). Arkport soils are characterized as deep, nearly level to moderately sloping, well-drained to moderately-well-drained, and having a subsoil of loamy fine sand and fine sand. Galen soils are mostly

level and moderately well-drained, with find sand or sandy loam surface layers, and a subsurface of fine sand, which is underlain by silt or clay. The thickness of soils at PBS ranges from approximately 5 feet or less for most of the site to approximately 20 feet for the extreme northern portion of the site (Erie Planning Commission Report on Land Capability, 1967 in D&M [1997b]). The Arkport-Galen association is comprised of approximately 40 percent Arkport soils, 30 percent Galen soils, and 30 percent minor soils. Permeability of Arkport and Galen soils is estimated to be 12 and 6 to 12 inches per hour, respectively. Bedrock at PBS includes Ohio (Huron) shale, Prout limestone, Plum Brook shale, and Delaware limestone (Erie Planning Commission Report on Land Capability, 1967 in D&M [1997b]) The Red Water Ponds are underlain primarily by Plum Brook shale, and to a lesser extent by Delaware limestone.

AOC at the site include the WARWP, PRRWP, other surface water bodies such as an Pipe Creek and Plum Brook, and area wetlands. These AOC are discussed in more detail in Sections 6.2.1.2 through 6.2.1.5 in the following subsections. Based on a site reconnaissance performed by IT on June 15 and 16, 1998, a photographic record of the site was prepared and is presented in Figures 6-1 through 6-8. The site reconnaissance was performed by two IT ecologists. Prior to arrival at the site, IT personnel obtained relevant information on the site, including topographic maps; 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 sites. Additionally, the *Biological Inventory of Plum Brook Station, 1994* (NASA, 1995), which identifies and shows the locations of threatened and endangered species at PBOW, was reviewed. IT personnel completed a checklist similar to EPA's "Checklist for Ecological Assessment/Sampling" (EPA, 1997d); and information from this checklist was used to complete Section 6.2 herein. The locations were identified of known or potential contaminant sources affecting the sites and the probable gradient of the pathway by which contaminants may be released from the site to the surrounding environment. IT personnel used the reconnaissance to evaluate the sites for more subtle clues of potential effects from contaminant release.

6.2.1.2 West Area Red Water Ponds

The WARWP area being investigated as part of the current study is approximately 23 acres in size. Present at the site are the "east" and "west" ponds, with the west pond normally being full of water. The two ponds are not hydraulically connected. NASA drained the east pond in the late 1970s and it is usually dry, except for small areas of standing water that accumulate during periods of wet weather.

During the site reconnaissance, approximately 50 percent of the west pond surface was covered with duckweed, and a white-tailed deer was observed drinking out of the red-orange-tinted surface water. Fish were also observed in the west pond, along with great blue heron, American robin, and quail in the surrounding area. Aquatic macrophytes were observed growing within the shallow borders of the west pond. The area surrounding the ponds was primarily wooded, except for the northeast side of the west pond, which was open field. Trees adjacent to the ponds were approximately 30 to 40 feet in height, with diameters at breast height of 6 to 8 inches. A variety of grasses were observed growing within the interior area of the east pond that was not inundated with rain water, and the surface water that did exist was almost entirely covered with duckweed. Pipe Creek flows along the eastern and southern boundaries of the east pond; deer tracks and bull frogs were observed along the creek during site reconnaissance.

6.2.1.3 Pentolite Road Red Water Ponds

The PRRWP area being investigated as part of the current study is approximately 22 acres in size. Ponded water is seasonally present and the area of open water, when it is present, is quite small, estimated to be less than approximately 0.5 acres. Historically, two ponds were present, totaling approximately 2.5 acres in size (D&M, 1997b). According to information provided by D&M (1997b), the water table in this area rises seasonally to a depth of 3 to 5 feet bgs. Ponded water generally occurs in bare areas of the site. An approximately 10-foot-deep southwest-northeast ditch traverses the eastern edge of the site. Based on a site reconnaissance performed by IT ecologists on June 15 to 16, 1998, the seasonally ponded areas of the site exhibited thick stands of reed canary grass and cattails, while common plant species in this and other areas included red maple, dogbane, fox sedge, Canada thistle, grass-leaved goldenrod, tall fescue, and fescue (see Section 6.2.1.7 for a more complete species list).

6.2.1.4 Surface Water

All surface waters present at the sites that are likely to support forage fish throughout the year (the WARWP and Pipe Creek) are most properly designated “warm water habitat.” For the WARWP area, the water depths in the center of west pond range from 1.0 to 1.5 feet, a maximum depth of 2.4 feet occurs in the southwest corner of the water body, and the pond has an average depth of 0.8 feet (D&M, 1997b). The volume of water within the west pond has been estimated to be approximately 114,000 cubic feet, with a surface area of 3.3 acres and an average sediment thickness of approximately 1 foot (November 1994 field study; D&M, 1997b). Sediments of the west pond are

soft to very soft dark gray to black organic silty clay with decayed organic material and fine to medium sand. Below the sediments, natural soils consist of gray to brown silty clay with varying amounts of fine sand and organic material (D&M, 1997b). The smaller east pond is estimated to be between 0.5 and 1.0 acre in size. According to D&M (1997b), the water in both ponds is perched and not directly connected to the underlying groundwater.

Pipe Creek is located south and east of both West Area ponds and is part of the Pickerel Creek-Pipe Creek drainage basin. Pipe Creek flows north to northeasterly into Sandusky Bay approximately 4.5 miles away. According to information from an August 1990 NASA Environmental Resources Document cited in D&M (1997b), the drainage area of Pipe Creek as it passes the WARWP is approximately 12,000 acres. Pipe Creek was observed to be approximately 12 feet wide and 1 foot deep during the site reconnaissance, shaded by overhanging bank vegetation, and with a silt/clay substrate. Water flow in the creek was estimated to be approximately 0.8 feet per second. The water was turbid and the banks of the creek had well-established vegetation and relatively little erosion. A northwest-southeast trending ditch is located to the northeast of the east pond; this ditch flows in a southeasterly direction and discharges into Pipe Creek. The ditch does not drain either of the ponds.

The PRRWP area contains seasonal ponded water. The area of open water, when it is present, is quite small, estimated to be less than half an acre. As mentioned previously, an approximately 10-foot-deep southwest-northeast ditch traverses the eastern edge of the site, and located approximately 1/3-mile further to the east is Plum Brook. According to information from an August 1990 NASA Environmental Resources Document cited in D&M (1997b), the drainage area of Plum Brook as it passes the PRRWP is approximately 500 acres. It is unlikely that any runoff from the site drains to Plum Brook due to the presence of the ditch along the eastern edge of the site. The ditch carries water to the northeast into another ditch that flows parallel to Pentolite Road. According to information in D&M (1997b), an underground clay pipe ("drainage tile") drains the Red Water Ponds and discharges into the ditch that parallels Pentolite Road; however, the outfall of this clay pipe could not be located during the site reconnaissance. During the site visit the 10-foot-deep ditch was observed to have flowing water, with the creek at the bottom approximately 3 feet wide, covered with algae, and 3 to 4 inches deep. Vegetation in and along the flowage included cattails and other emergent macrophytes, and dragon flies, water striders, and crayfish were also observed. The 10-foot banks of the ditch were steep, vegetated with grasses, shaded by overhanging bushes, and were observed to have little erosion.

6.2.1.5 Wetlands

According to the National Wetland Inventory (NWI) Maps for the area (U.S. Fish and Wildlife Service [USFWS], 1977), the open water within the PRRWP area is classified as a palustrine wetland, with both broad-leaved deciduous shrub/scrub and emergent wetland species present. Within the WARWP there are two different wetland classification types: a palustrine open water wetland category for the west pond and a riverine open water category for Pipe Creek. It should be noted that the accuracy of NWI maps are limited, especially in relatively flat landscapes (such as PBS) because minor depressions often contain isolated wetlands not easily identified through air photo interpretation (the process used by the USFWS in preparing NWI maps). As discussed in the following section, additional small seasonal wetlands exist in both study areas.

6.2.1.6 Vegetative Communities

Vegetative communities at the site were classified during site reconnaissance using the 15 potential community types (presented in Table 6-1). The three largest community types observed at the WARWP were moderate forest (FRM), late forest (FRL), and palustrine open water (POW), as shown in Figure 6-9. The three largest community types observed at PRRWP were early old field (OFE), FRM, and palustrine scrub/scrub and emergent wetlands, as shown in Figure 6-10. These general habitat figures presents the type and extent of biological communities present within the immediate vicinity of each AOC. Each of these habitat types can be expected to support different wildlife species assemblages; however, given the close proximity of the habitats to each other, many of the species (discussed in the following text) would be expected to spend some amount of time within each community type for foraging, resting, and loafing activities, depending on the season.

During site reconnaissance, the study areas were examined for vegetative stress, including the identification of plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. Possible vegetative stress was observed at the PRRWP, and to a lesser extent at the WARWP, as evidenced by large areas devoid of vegetation (bare areas; Figure 6-1 [Photo No. 1]; Figure 6-2 [Photo No. 4]; Figure 6-5 [Photo No. 9]). Some of these bare areas have red-tinted ponded water, suggesting chemical inhibition of plant growth. Potential adverse impacts of chemical stressors on plant growth are discussed further in Section 6.5.1.

6.2.1.7 Species Inventory

Based on information from ODNR (1995) and information collected during the site reconnaissance, species lists were prepared for plants, mammals, birds, reptiles, amphibians, and fish (Tables 6-2 through 6-7). Of the plant 365 species documented at the 6,453 acre station by the ODNR (Appendix I, Table I-1), 56 of the common and frequently observed species at the two sites are listed in Table 6-2. As shown at the bottom of Table 6-2, the PRRWP area had slightly more plant species than the WARWP area (85 versus 72 species). In addition, the PRRWP area had more common and/or frequent occurring plant species than the WARWP (46 versus 31, respectively; Table 6-2).

Of the 43 species of mammals that may be found in the region based on species range maps, 4 species were observed on site during site reconnaissance (Table 6-3), including woodchuck, short-tailed shrew, masked shrew, and white-tailed deer. Numerous deer tracks were observed during the site reconnaissance, especially within the bare soil areas of the PRRWP, and the ground cover and understory of the forested areas of both sites showed significant overbrowsing by area wildlife, most likely deer.

Of the 129 species of birds that may be found in the region based on species range maps, 105 species (81 percent) have been recorded at the station by the ODNR during their multiyear studies (Table 6-4). Thirteen bird species were documented at the sites currently under study during the site reconnaissance performed June 15 to 16, 1998 by IT. Of the species recorded by the ODNR, 49 were neotropical migrants and would not be expected to nest at the station. ODNR (1995) notes that of the top 50 bird species recorded at the station, only 6 were ground nesters and 3 others occasionally nest on the ground, suggesting that ground nesters are having problems at the station. Burning practices used by NASA at the station, as well as the large deer population that feeds on much of the ground cover, limits the ground cover available for nesting birds, and results in increased predation for these species (ODNR, 1995). It should be noted that NASA has recently altered its burning practices, burning approximately one-third of the station lands every year, rather than one-half of the lands as was performed in the past (Peecook, 1998). The 15 most abundant bird species recorded at the station by the ODNR included American robin; red-winged blackbird; European starling; song sparrow; common grackle; field sparrow; American goldfinch; indigo bunting; blue jay; common yellow throat; brown-headed cowbird; house wren; gray catbird; northern cardinal; and cedar waxwing.

Of the 14 species of reptile that may be found in the region based on species range maps, 10 species (71 percent) have been observed on site, including turtles and snakes (ODNR, 1995; Table 6-5). During the site reconnaissance snapping and painted turtles were observed.

Of the ten species of amphibians that may be found in the region based on species range maps, nine species (90 percent) have been observed at the site (ODNR, 1995; Table 6-6), including salamanders, toads, and frogs. During the site reconnaissance, American toad, spring peeper, bullfrog, and green frog were observed.

Fourteen species of fish have been observed at Plum Brook, including suckers, sunfish, minnows, sticklebacks, and bullheads (Table 6-7).

6.2.1.8 Threatened and Endangered Species Information

According to an Ohio Division of Natural Areas & Preserves (DNAP) review of their Natural Heritage maps and files (ODNR, 1998), there are records of legal status threatened and endangered (T&E) species within a 1-mile radius of the WARWP and the PRRWP. These species include the following:

- Sedge wren (*Cistothorus platensis*) - endangered
- Dwarf bulrush (*Lipocarpha micrantha*) - threatened
- Twisted yellow-eye-grass (*Xyris torta*) - threatened
- Field sedge (*Carex conoidea*) - threatened
- Least St. John's-wort (*Hypericum gymnanthum*) - endangered
- Flat-leaved rush (*Juncus platyphyllus*) - endangered
- Bushy aster (*Aster dumosus*) - threatened.

In addition, based on information contained in ODNR (1995), there are several species of threatened or endangered plants, potentially threatened plants, and threatened or endangered birds that have been recorded at PBS, as follows:

- Grove sandwort (*Arenaria lateriflora*) - threatened
- Thin-leaved sedge (*C. cephaloidea*) - endangered
- Ashy sunflower (*Helianthus mollis*) - 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
- Winter wren (*Trogoldytes troglodytes*) - endangered
- Cattle egret (*Bublucus ibis*) - endangered
- Black-crowned night heron (*Nycticorax nycticorax*) - threatened
- Trumpeter swan (*Cygnus buccinator*) - endangered
- Upland sandpiper (plover) (*Bartramia longicauda*) - threatened
- Indiana bat (*Mytolis sodalis*) - endangered

In addition, wild white lettuce was recently found on site outside the study area. This species is considered extinct in Ohio, but common in prairie states (Peecook, 1998). A detailed listing of these T&E species is included in Appendix I, Table I-2, along with the estimated distance, if known, from the location of the sighting of each of the species to the two sites under study. Also included in the table is a general description of the habitat type preferred by the species and data on general identification characteristics that were used during the site reconnaissance in an attempt to document sightings of T&E species at the two Red Water Ponds Areas. Based on the results of the site reconnaissance, no threatened or endangered species of plants, birds, or mammals were found. The site reconnaissance also included detailed searches performed by a highly qualified botanist subcontractor during both the June 1998 site visit and a subsequent September 1998 site visit. The botanist collected numerous specimens from the genus *Carex* (sedges) for definitive identification by Dr. Stanley Stine of Kent, Ohio, a local authority on this difficult group of plants. After a careful evaluation, IT's subcontractor botanist and Dr. Stine determined that none of the sedge specimens collected were threatened or endangered species (Appendix I.3). It should be noted that the September site visit was performed specifically to search for threatened and endangered plant species that flower in the late summer (e.g., the bushy aster).

None of the threatened or endangered bird species, with the possible exception of the sedge wren (also called the short-billed marsh wren) and the black-crowned night heron, would typically be expected to be found at either of the sites. The winter wren, cattle egret, trumpeter swan, and upland sandpiper are all considered rare visitors or migrants at the station (ODNR, 1995), and have not been documented nesting within a 1-mile radius of either site (ODNR, 1998).

Six sedge wren nesting sites were documented in the ODNR DNAP's database for an area near the PRRWP area in old grassy field habitat during 1994, with the closest nesting site being approximately one-third of a mile to the southwest of the site (ODNR, 1998). In the June 1994 sighting, eight sedge

wrens were observed near the PRRWP and two were observed near the WARWP, with 24 territorial birds and several fledglings identified at the PBS (ODNR, 1995). Sedge wrens, an Ohio endangered species, have a preferred breeding habitat that consists of wet meadows, grassy marshes, and old grassy fields (Peterson, 1947) and moist grasses and sedge marshes or wet meadows with scattered low bushes (Bent, 1948). These habitat types are found at the PRRWP, and to a more limited extent, at the WARWP. A possible sedge wren nest (a globular nest hidden at the base of tall grassy vegetation) was found at the PRRWP site during reconnaissance (Figure 6-4; Photo No. 7), however, a definitive identification was not possible because the nest was abandoned and no sedge wrens were observed in the area. Sedge wrens are very sporadic nesters, and birds may not arrive at a breeding colony until July or August and nesting continues into September (Trautman and Trautman, 1968). Draining of marshes has eliminated considerable breeding habitat in Ohio and many recent colonies have been located in wet meadows and hayfields and have disappeared after these fields have been mowed (ODNR DNAP information) (ODNR, 1998).

The black-crowned night heron, an Ohio threatened species, is a regular visitor at ponds, streams, and ditches within the station, however, it does not nest at the station (ODNR, 1995, 1998). 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 8½ 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 in the area based on the fact that its preferred habitat (e.g., caves along streams or trees with exfoliated bark) is not present at either of the two sites. Trees with exfoliated bark, such as shagbark or shellbark hickory, are rare or only occasionally present at the sites, thereby providing little bat roosting habitat (Appendix I, Table I-1).

With the exception of the Erie Sand Barrens State Nature Preserve (ESBSNP), there are no existing or proposed state nature preserves or scenic rivers within 1 mile of the study area, 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 1-mile radius of the site (ODNR, 1998). The ESBSNP is located approximately 1 mile south of the WARWP and 2 miles southwest of the PRRWP. The 32-acre preserve is a remnant sand beach of Lake Warren, the fifth ancestral Lake Erie, that supports many species of T&E 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 wind-swept conditions such as those found on the sand barrens. The DNAP actively manages the preserve to ensure that the open wind-swept areas remain and do not become overgrown with woody vegetation.

6.2.2 Selection of Preliminary Chemicals of Potential Ecological Concern

IT has identified a subset of chemicals detected at the site that have good quality data and are not naturally occurring, or the result of nonsite sources. These chemicals are also present in sufficient frequency, concentration, and location to pose a potential risk to ecological receptors. Examples of screening criteria that have been used include the following: analytical detection limit; frequency of detection less than 5 percent; comparability with background (Table 6-8); and role as an ecologically essential nutrient at site concentrations. This selection process is described in more detail in the following subsections.

6.2.2.1 Data Organization

The data for each chemical have been sorted by medium. For ecological impacts, soil from 0 to 6 feet have been considered. Chemicals not detected at least once in a medium have not been included in the risk assessment. Available background data have been determined for each medium. Sources of background information include data from previous and current investigations.

The analytical data may have qualifiers from the analytical laboratory QC 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 (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 - QC 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 five-times, ten-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 Section 6.2.2.2.

6.2.2.2 Descriptive Statistical Calculations

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the 95 percent UCL of the mean have been usually estimated for each chemical in each medium of interest (Tables 6-9 through 6-16) . In general, “outliers” are included in the calculation of the UCL because high values in environmental data are seldom true statistical outliers. Inclusion of outliers increases the overall conservatism of the risk estimate, and the likelihood of rejecting the null hypothesis (i.e., there are no chemical stressors at the site).

Data sets have been tested for normality and lognormality based on the Shapiro-Wilks test (EPA, 1992a). Statistical analysis has been performed on all detected chemicals. If statistical tests support the assumption that the data set is normally distributed, the UCL for a normal distribution is calculated. If the statistical analysis shows the data to be lognormally distributed, the UCL is calculated for a lognormal distribution.

The UCL is calculated for a normal distribution as follows (EPA, 1992b):

$$UCL = \bar{x} + t_{1-\alpha, n-1} \times (s/\sqrt{n}) \qquad \text{Eq. 6.1}$$

where:

- $\bar{x}$ = sample arithmetic mean
- t_1 = critical value for student's plus distribution
- α = 0.05 (95 percent confidence limit for a one-tailed test)
- n = number of samples in the set
- s = sample standard deviation.

The UCL is calculated for a lognormal distribution as follows (Gilbert, 1987):

$$UCL = e^{\left(\bar{y} + (0.5 \cdot s_y^2) + \left[H_{0.95} \cdot \frac{s_y}{(n-1)^{0.5}}\right]\right)} \qquad \text{Eq. 6.2}$$

where:

$\bar{y}$ = $\Sigma y/n$=sample arithmetic mean of the log-transformed data, y = ln x
s_y = sample standard deviation of the log-transformed data
n = number of samples in the data set
$H_{0.95}$ = value for computing the one-sided 95 percent UCL on a lognormal mean from standard statistical tables (Land, 1975).

A nonparametric confidence limit is used when the data set fits neither a normal or a lognormal distribution. The nonparametric UCL is estimated as the 95 percent UCL rank order on the arithmetic mean of the data set. It is estimated by ranking the data observations from smallest to largest. The arithmetic mean is converted to a percentile by interpolation. The rank order of the observation selected as the UCL is estimated from the following equation (Gilbert, 1987):

$$u = p(n + 1) + Z_{1-\alpha}\sqrt{np(1 - p)} \qquad \text{Eq. 6.3}$$

where:

u = upper confidence limit
p = percentile corresponding to the arithmetic mean (0.5)
n = number of samples in the set
α = confidence limit; 95 percent
$Z_{1-\alpha}$ = normal deviate variable.

Analytical results are presented as "nondetects" ("U" qualifier) whenever chemical concentrations in samples do not exceed the detection or quantitation limits for the analytical procedures for those samples. Generally, the detection limit is the lowest concentration of a chemical that can be "seen" above the normal, random noise of an analytical instrument or analytical method. To apply the previously mentioned statistical procedures to a data set with nondetects, a concentration value must be assigned to nondetects. Nondetects are assumed to be present at one-half the SQL, although judgement is used in those cases where matrix interference or other phenomena drive the SQL unusually high. The UCL or MDC, whichever is smaller, is selected as the source-term concentration, and is understood to represent a conservative estimate of average for use in the risk assessment or in various transport models used to estimate exposure-point concentrations.

6.2.2.3 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 have not been included 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. For the current assessment, nitroaromatics have not been dropped as COPEC as this group of constituents is site-related. Chemicals detected infrequently at high concentrations 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.

6.2.2.4 Natural Site Constituents (Background and Essential Nutrients)

Chemical concentrations have been compared to background concentrations 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, besides PAHs, are not. Statistical techniques are used as tools to aid the exercise of professional judgement in resolving site-related issues for metals, since metals are naturally present in most environmental media. The statistical techniques generally involve comparing the site data with background data.

The first statistical technique is the development of an UTL for background, and comparing the MDC with the UTL. Chemicals with MDCs less than the background UTL are eliminated from further consideration. If the MDC exceeds the UTL, the chemical is retained as a COPEC, or a more rigorous statistical analysis may be performed. The statistical analysis consists of comparing the site and background data sets to determine if both are drawn from the same population. The Wilcoxon Rank Sum test is used for this purpose. For the current BERA, the more rigorous statistical analysis was not performed.

The UTL was calculated as follows:

$$UTL = \bar{X} + k(\alpha) \qquad \text{Eq. 6.4}$$

where:

UTL = upper tolerance limit (confidence factor of 0.95 and coverage of 95 percent)

$\bar{x}$ = arithmetic mean
a = standard deviation
k = tolerance factor (Table 5, OEPA [1991], *Final How Clean is Clean Policy*, 26 July.

For background data that were determined to have a nonparametric distribution, based on use of the Shapiro-Wilk Test (EPA, 1992d), and for data sets with greater than 15 percent nondetects, the 95th percentile (rather than the UTL) was used, as discussed for soil in IT (1998b). Results are presented in Table 6-8. Background surface water and sediment results were obtained from upstream samples collected at both Red Water Pond sites, and are presented in Tables 6-13 through 6-16.

It must be understood that statistical analysis is only a tool to aid the exercise of professional judgement. Site data from uncontaminated areas with concentrations at the high end of background may "fail" statistical testing because of the limitations of sample size, i.e., the full range of actual background and site variation was not captured. Statistical testing is based on absolute values, but the approximately 20 metals generally analyzed together constitute only approximately 4 to 5 percent of a given sample. Apparently high values of one or more metals may arise from a diminished amount of other constituents in soil, e.g., silica or organic matter, that may be more abundant in background areas. Therefore, it may be necessary to normalize the metal concentrations in site and background data before performing comparisons. However, for the current BERA, this additional analysis was not performed.

Essential nutrients such as calcium, chloride, iodine, magnesium, phosphorus, potassium and sodium may be eliminated as COPEC, provided that their presence in a particular medium is judged to be unlikely to cause adverse effects on wildlife. However, since there are no screening criteria that are readily available for nutrients, they have been retained as COPEC unless shown to be below the background UTL or 95th percentile.

6.2.2.5 Summary of Preliminary COPEC Selection

Tables 6-9 through 6-16 have been prepared for each medium, by site, with the following information:

- Chemical name
- Frequency of detection
- Arithmetic mean of site concentrations
- Range of detected concentrations
- Range of detection limits

- Statistical distribution
- UCL on the arithmetic mean
- Background screening criterion, if available
- Exclusion rationale for selection as COPEC
- COPEC selection conclusion: YES or NO
- Source-term exposure concentration that may be used in the BERA.

Footnotes in the tables provide the rationale for selecting or rejecting a chemical as a preliminary COPEC. An evaluation of all of the constituents that were eliminated for further consideration was performed to determine whether any should be reinstated as COPEC due to other considerations. Examples of these exceptions include: potential breakdown products and chemicals known to have been used on site historically. Based on this evaluation, no additional preliminary COPEC are recommended. Chemicals not eliminated using the screening procedures previously presented are considered preliminary COPEC and have been further evaluated in Section 6.2.3.

6.2.3 Comparison to Risk-Based Screening Ecotoxicity Values

A final comparison has been made between MDCs of chemicals in sampled media, excluding groundwater, and risk-based screening ecotoxicity values (RBSEV) for ecological endpoints following recommendations in EPA Region 5 Biological Technical Assistance Group (BTAG) Bulletin No. 1 (EPA, 1996b). This comparison used the subset of preliminary COPEC identified in Section 6.2.2.5. Chemicals that exceed the RBSEVs have been retained as final COPEC. The following RBSEV have been used for the final ecological screening assessment:

- ***Soil.*** Soil screening values from EPA Region 3 BTAG screening levels (EPA, 1995), and other available guidance documents, as appropriate, have been used.

- ***Groundwater.*** If groundwater is known to impact surface water at the site, EPA Ecotox Threshold screening values for freshwater (EPA, 1996c) and OEPA Water Quality Criteria will be used when the groundwater evaluation is completed at a future date.

- ***Surface Water.*** EPA Ecotox Threshold screening values for freshwater (EPA, 1996c) and OEPA Water Quality Criteria have been used.

- ***Sediment.*** EPA Ecotox Threshold values for freshwater sediment and sediment criteria from the Ontario Ministry of the Environment and Energy (OME) (OME, 1993) have been used, as recommended in EPA Region 5 guidance (EPA, 1996b).

The results of the final screening of the selected COPEC with RBSEV for ecological endpoints of concern are presented in Table 6-17. COPEC are only selected for further consideration in the BERA if the MDC exceeded the available RBSEV. If no RBSEV was available, the constituent was carried forward for consideration in the BERA. Based on this final screening, 20 COPEC have been selected for surface soil, 22 have been selected for subsurface soil, 14 have been chosen for surface water, and 23 have been chosen for sediment. Based on this selection of potential chemical stressors, and on the finding that viable habitat, potential receptors, and potential exposure pathways exist at both of the Red Water Pond sites, a predictive assessment is triggered, as discussed at the beginning of Section 6.2.

An evaluation of all of the constituents that were eliminated for further consideration was performed to determine whether any should be reinstated as COPEC due to other considerations. Examples of these exceptions include: chemicals with detection limits greater than the RBSEV and chemicals with high bioconcentration and/or bioaccumulation factors. Based on this evaluation, no additional COPEC are recommended. Chemicals not eliminated using the screening procedures previously presented are considered final COPEC and have been quantitatively evaluated in the predictive BERA. The relevant and important physical, chemical, and toxicological properties of the identified COPEC risk drivers (Section 6.5) have been reviewed from the scientific literature and are presented as COPEC profiles in Appendix J.

6.2.4 Selection of Assessment Receptors

IT has selected assessment receptors for evaluation during the predictive BERA. In order to focus the exposure characterization portion of the BERA on species or components that are the most likely to be affected and on those that, if affected, are most likely to produce greater effects in the on-site ecosystem, IT has focused the selection process on species, groups of species, or functional groups, rather than higher organization levels such as communities or ecosystems. Site biota are 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 at the sites was determined during a literature review and during the site reconnaissance (Section 6.2.1.7 and 6.2.1.8) prior to identification of target receptor species.

Primary criteria for selecting appropriate assessment receptors included, but were not limited to, the following.

- The assessment receptor will have a relatively high likelihood of contacting chemicals via direct or indirect exposure.
- The assessment receptor will exhibit marked sensitivity to chemicals.
- The assessment receptor will be a key component of ecosystem structure or function (e.g., importance in the food web, ecological relevance).
- The assessment receptor's position in the food chain make it vulnerable to a particular class of chemicals (e.g., top predators vulnerable to COPEC that bioaccumulate readily).
- The assessment receptor may be listed as rare, threatened, or endangered (RTE) by a governmental organization; or the receptor will consist of critical habitat for RTE species. Based on the availability of species-specific data, a RTE surrogate species may be selected (Section 6.2.4.1).

Additional criteria for selection of assessment receptors was 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 COPEC; (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 they will be present at the sites or that habitats present at the sites could support the species.

It is important that sufficient toxicological information is available in the literature on the receptor species, or that a closely related species may be selected. While the ecological communities at the individual sites have species with many desirable characteristics for use as receptor species, not all of these species have been used extensively for toxicological testing.

6.2.4.1 Terrestrial

Seven representative receptor species that are expected or possible in the area of the Red Water Ponds (Section 6.2.1.7) were selected as indicator species for the potential effects of COPEC. These

indicator species represent two classes of vertebrate wildlife (mammals and birds) and a range of both body size and food habits, including herbivory, omnivory, and carnivory. (Potential impacts to terrestrial plants are considered in Section 6.5.1.) 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 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). The marsh wren was selected as a surrogate for the sedge wren, an Ohio endangered species that has been documented within one-half mile of both Red Water Pond Areas and a species that would be expected on site given the availability of preferred nesting habitat.

The deer mouse, shrew, Eastern cottontail, and wren represent the prey base for the larger predators of the area (represented by the red-tailed hawk). A terrestrial food web is presented in Figure 6-11. Many of these species have limited home ranges, particularly the deer mouse, cottontail, shrew, and marsh wren, which makes them particularly vulnerable to exposure to site contaminants. All of the selected terrestrial receptor species have a potential high abundance and wide distribution at the site and sufficient toxicological information (with the exception of some bird species) is available in the literature for comparative and interpretive purposes. In addition, all of the selected species are likely to occur after site remediation (if risk management decisions require it), and all are 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, 1993c).

Larger mammal species were generally not selected as sensitive receptors due to their large home ranges; however, the far-ranging 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 sites. 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. Foraging factors were conservatively set to 100 percent for the mouse, shrew, rabbit, wren, and raccoon, due to their relatively small home ranges (Section 6.3.1). However, for the deer and hawk, the foraging factor was set at 0.01 (or one percent), based on these two

species' relatively large home ranges (518 and 842 hectares, or 1,280 and 2,081 acres, respectively), compared with the size of the two sites (23 and 22 acres, Sections 6.2.1.2 and 6.2.1.3).

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions called assessment receptor profiles (ARP). Additionally, the biologically relevant criteria used to select the seven terrestrial assessment receptors are discussed and summarized in the ARP (Appendix K).

6.2.4.2 Aquatic

The major aquatic habitats at or adjacent to the sites include the west pond and Pipe Creek (and its associated riverine wetland) at the WARWP area, and the palustrine shrub/scrub emergent wetland and 10-foot-deep ditch at the PRRWP area (Section 6.2.1; Figure 6-4 [Photo No. 8]; Figure 6-5 [Photo No. 10]; Figure 6-6 [Photo No. 11]; Figure 6-7 [Photo No. 13]; Figure 6-8 [Photo No. 16]). Exposure to aquatic organisms within the water bodies is assumed to occur via direct exposure to contaminants in the water column and via ingestion of benthic invertebrates and littoral and pelagic prey exposed to contaminants in surface water and sediment. Potential effects to fish, macroinvertebrates, and phytoplankton (algae) have been assessed using available surface water and sediment quality criteria for the protection of aquatic life (Section 6.5.2). Potential uptake through the food chain is evaluated for two representative receptors, including the raccoon (also considered as a terrestrial receptor) and the great blue heron (*Ardea herodias*) (large-sized aquatic piscivore). It should be noted that the great blue heron is a surrogate for the black-crowned night heron, as this threatened species is a common visitor to ponds and streams within PBS. A great blue heron rookery is located within 8 miles of the site.

Fish and other aquatic organisms represent the prey base for aquatic predators (represented by the great blue heron and raccoon). An aquatic food web is presented in Figure 6-12. The selected receptor species have relatively small home ranges, which makes them particularly vulnerable to exposure to site contaminants. Foraging factors were conservatively set to 100 percent for both of the aquatic receptors evaluated in this BERA. Both of the selected aquatic receptor species have been documented on site (Section 6.2.1), have a potential high abundance and wide distribution at the site, and sufficient toxicological information (with the exception of the heron bird species) is available in the literature for comparative and interpretive purposes. In addition, both of the selected species are likely to occur after site remediation (if risk management decisions require it), and both are important to the

stability of the local ecological food chain and biotic community. Finally, the selected species have readily available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (EPA, 1993c).

Other water fowl were not included as representative receptors because they are migratory, although it should be noted that the great blue heron is a migratory species, but has been assumed to be nonmigratory for the BERA. The potential risk to migratory avian species will be included within the predicted risks to the selected aquatic indicator receptors.

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions (ARP). The biological relevant criteria used to select the aquatic assessment receptors are discussed and summarized in the ARPs (Appendix K).

6.2.5 Ecological Endpoint (Assessment and Measurement) Identification

The protection of ecological resources, such as habitats and species of plants and animals, is a principal motivation for conducting the BERA. 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., Comprehensive Environmental Response, Compensation, and Liability Act, National Environmental Policy Act). Other legislation includes the Endangered Species Act 16 U.S.C. 1531-1544 (1993, as amended) and the Migratory Bird Treaty Act 16 U.S.C. 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 BERA focuses on populations or groups of interbreeding nonhuman, nondomesticated receptors. In the BERA process, the risks to individuals are assessed only if they are protected under the Endangered Species Act, are species that are candidates for protection, or are species that are considered rare.

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 ERA are: (1) ecological relevance, (2) susceptibility to the contaminant(s), (3) accessibility to prediction and/or measurement, and (4) definable in clear, operational terms (Suter, 1993). Selected assessment endpoints should 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. Information gained during the site reconnaissance was used to assist in the selection of assessment and measurement endpoints. These endpoints, formal expressions of the environmental values to be protected (Suter, 1993), have been used to focus the goals of the BERA (Table 6-18).

Measurement endpoints for this BERA 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. COPEC 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 (Section 6.2.3). 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 sites.

6.2.5.1 Assessment Endpoints

The assessment endpoints for the Red Water Ponds 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, aquatic vertebrates (fin fish), omnivorous aquatic mammals, and piscivorous aquatic birds.” The corresponding null hypothesis (H_o) 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, aquatic vertebrates (fin fish), omnivorous aquatic mammals, and piscivorous aquatic birds."

Assessment receptor species were selected based on the likelihood of finding the species at the Red Water Ponds. Historical information, the site reconnaissance (performed June 15 to 16, 1998 and September 2, 1998), and the availability of toxicological data were used to select terrestrial and aquatic receptor species. These receptors species are depicted in food web models (Figures 6-11 and 6-12). 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 detailed species selection at the base of the food web (i.e., specific terrestrial/benthic invertebrates or aquatic vertebrates). Thus, generic terrestrial invertebrates, benthic invertebrates, and aquatic vertebrates 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 (Section 6.3). These tissue concentrations were then used as input values for exposure to higher trophic level receptors through the dietary ingestion route. Brief life-history descriptions for the selected area receptor species are provided in Appendix K.

All trophic levels may be exposed to COPEC, either by direct exposure to contaminated abiotic media or through ingestion of lower trophic level food items. Primary producers (plants) absorb COPEC (as well as nutrients) from soil and/or water. Through abiotic processes, COPEC 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 COPEC to benthic communities. Various species of fin fish fulfill the role of aquatic herbivorous (feeding on aquatic plants and suspended detritus) and predatory vertebrates (feeding on benthic invertebrate species). The combination of COPEC bioconcentration from water, ingestion of contaminated prey, and generally restricted ranges for aquatic organisms provides ideal conditions for significant bioconcentration of COPEC. For this reason the great blue heron was included in the aquatic food web as a top trophic-level piscivore capable of bioaccumulating

COPEC. In terrestrial species bioconcentration occurs in plants and invertebrates, and higher food chain receptors bioaccumulate COPEC through the ingestion of food items.

6.2.5.2 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 in toxicity tests; individual abundance; species diversity; and the presence or absence of indicator data in field surveys of existing impacts (EPA, 1994).

For assessments, measurable responses to stressors may include lowest-observed-adverse-effect levels (LOAEL), no-observed-adverse-effect levels (NOAEL), LC_{50}s (lethal concentration to 50 percent of the test population), LD_{50}s (lethal dose to 50 percent of the test population), or EC_{20}s (effective concentration for 20 percent of the test population), collectively termed "toxicity endpoint values." In addition, critical effect values for surface water, sediment, and soil were selected as measurement endpoints (Table 6-18). The most appropriate measurement endpoint(s) were chosen based on exposure pathways as well as ecotoxicity of the contaminant.

6.2.6 Ecological Site Conceptual Model

IT has prepared pictorial representations of potential exposure. These food web pictorials (Figures 6-11 and 6-12) and accompanying text presented in Section 6.3.1 clarify the representations that are 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.

6.3 Exposure Characterization

IT has developed an estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to COPEC that are present at or migrating from the site, considering both current and reasonably plausible future use of the site. Exposure characterization is critical in further evaluating the risk of compounds identified as COPEC during the selection process (Section 6.2.3). 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 areas may contact contaminants.

6.3.1 Exposure Analysis

IT has performed an exposure analysis, which combines the spatial and temporal distribution of the ecological receptors with those of the COPEC to evaluate exposure. The exposure analysis focuses on the chemical amounts that are assumed to be bioavailable, 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.

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.

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. The concepts of bioconcentration, bioaccumulation, and biomagnification are used throughout this document. Definitions describing their application are presented in the Glossary of Terms (Appendix L).

Contamination of biota could result from exposure to one or more COPEC. Bioavailability is an important contaminant characteristic that influences the degree of chemical-receptor interaction. Bioavailable compounds are those that a receptor can take in from the environment. Bioavailability of a chemical is a function of several physical and chemical factors.

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 BERA. If any of these components are not complete,

then contaminants in those media do not constitute an environmental risk at that specific site. As discussed in Section 6.2.3, however, these four components are complete for all sampled site media, except groundwater. The major fate and transport properties associated with typical site contaminants are presented in subsequent sections. These properties directly affect a contaminant's behavior in each of the exposure pathway components.

For terrestrial faunal receptors, calculation of exposure rates relies upon determination of an organism's exposure to COPEC found in surface water, surface soil, and on transfer factors used for food-chain exposure. Exposure rates for terrestrial wildlife receptors are based solely upon ingestion of contaminants from these media and from consumption of other organisms. Given the scarcity of data available for wildlife dermal and/or inhalation exposure pathways, potential risk from these pathways has not been estimated. In addition, dermal and inhalation pathways are generally considered to be incidental for most species, with the possible exception of burrowing animals and dust-bathing birds.

The first step in estimating exposure rates for terrestrial wildlife involves the calculation of feeding and watering rates for site receptors. EPA (1993c) includes a variety of exposure information for a number of avian and mammalian species. Information regarding feeding and watering 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 are incorporated for the receptor species. This information is summarized in Table 6-19.

Algorithms have been evaluated for calculating exposure for terrestrial vertebrates that account for exposure via ingestion of contaminated water, incidental ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and prey items. Singular algorithms have been developed for soil to plant uptake and for animal bioaccumulation (transfer factors).

The basic equation for estimating dose through the dietary pathway is:

$$D_p = \sum_{k=1}^{m} (C_k \cdot F_k \cdot I_k)/W \qquad \text{Eq. 6.5}$$

where:

D_p = the potential average daily dose (mg/kg-day),
C_k = the average COPEC concentration in the kth food type (mg/kg dry weight)
F_k = the fraction of the kth food type that is contaminated
I_k = the ingestion rate of the kth food type (kg dry weight/day)
W = the body weight of the receptor (kg wet weight).

For aquatic faunal receptors, the calculation of exposure rates depends on the determination of the contaminant concentration in water and sediment, and on food-chain multipliers, bioconcentration factors (BCF), and bioaccumulation factors (BAF). If appropriate, an evaluation can be made of the time each organism spends associated with surface water or sediment pore water in order to modify exposure rates; however, this refined approach was not used in the current BERA.

Literature values for animal-specific sediment ingestion have been 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).

For species exposed to organic contaminants found in sediment, calculations have been performed to quantify interstitial (pore) water contaminant concentrations given a known sediment concentration. Suter's (1993) algorithm to calculate pore water concentrations for nonionic organic chemicals was used, as follows:

$$\text{Pore water concentration (milligrams per liter)} = (SC)/[(F_{oc})\,(K_{oc})] \qquad \text{Eq. 6.6}$$

where:

SC = sediment concentration (mg/kg)
F_{oc} = fraction organic carbon in sediment (kg organic carbon/kg sediment)
K_{oc} = chemical-specific organic carbon partition coefficient (L/kg).

For sediment, K_{ow} values (Table 6-20) have been converted to chemical-specific organic carbon/water partition coefficient (K_{oc}) values (EPA, 1996b) as follows:

$$\log K_{oc} = 0.00028 + (0.983 \times \log K_{ow}) \qquad \text{Eq. 6.7}$$

where:

K_{oc} = the partition constant relative to organic carbon.

This equation was chosen because it is the best fit for important site-related compounds, such as semivolatile nonionizing organic compounds.

F_{oc} values for sediment have been set at 0.067 and 0.011, based on sediment samples collected from the WARWP west pond and the RPRWP creek that flows in the 10-foot-deep ravine (Tables 6-15 and 6-16, respectively).

To estimate inorganic partitioning from sediment to pore water, K_d values (Table 6-21; with units of L/kg) were used instead of F_{oc} and K_{oc}. It should be noted that estimates of inorganic COPEC concentrations in sediment pore water were set at the calculated value using the appropriate K_d or were set at the metal's published solubility in water, whichever was lower. This approach was necessary as some of the common nutrients' estimated pore-water concentrations exceeded typical solubility values because inorganic partitioning using K_d values is inaccurate for nutrients with elevated concentrations. Nutrient solubilities were assumed to be best represented by the common environmental compounds MgO, CaO, Al_2O_3, and $FeCO_3$.

Adjustments have been made for potential biomagnification of contaminants through aquatic trophic levels. Food chain multipliers (FCM), derived by EPA (1995), have been used to assess the possibility of contaminant magnification through site receptors. The FCMs are multiplied by chemical-specific BCFs to obtain BAFs. The BERA uses either laboratory-measured BCF values obtained from the scientific literature or fish BCFs calculated for organic compounds using the following equation (EPA, 1995):

$$BCF = K_{oc} \qquad \text{Eq. 6.8}$$

where:

K_{ow} = chemical-specific octanol/water partition coefficient.

When possible, K_{ow} values for appropriate COPEC have been obtained from the literature or from databases, and are presented in Table 6-20.

The BCF is dependent upon a chemical-specific K_{ow} that relates to a chemical's tendency to partition to a polar versus nonpolar solution. EPA has established a relationship between the K_{ow} and the FCM such that as the K_{ow} increases, the FCM increases correspondingly.

Per EPA (1995) guidance, aquatic BAFs have been estimated by one of four methods (in order of preference):

- A measured BAF for an inorganic or organic chemical derived from a field study
- A predicted BAF for an organic chemical derived from a field-measured biota-sediment accumulation factor
- A predicted BAF for an inorganic or organic chemical derived from a laboratory-measured BCF and an FCM
- A predicted BAF for an organic chemical derived from a K_{ow} and an FCM.

The EPA guidance notes, however, that for chemicals for which no K_{ow} is available, and for which no BCF is calculable, a default FCM of 1.0 should be used. Thus, for inorganics not thought to biomagnify and/or which no literature value is available, this value of 1.0 has been used at each trophic level.

In addition to the aquatic food web, FCMs are also related to an organism's trophic status as predator/prey, producer/consumer, etc in the terrestrial food web. Although exposures of terrestrial floral and faunal receptors are significant considerations for many hazardous waste sites, well accepted models for predicting the fate of many contaminants in terrestrial systems are less developed. Trophic level compartments and transfer between compartments based on uptake, storage, and loss processes are not as well defined in terrestrial systems as in aquatic systems. In addition, the relationship between K_{ow} and bioconcentration is less well delineated by trophic level in terrestrial ecosystems. For the

current BERA, soil-to-plant and food-to-muscle BAFs (or transfer factors [TF]) have been estimated for organic constituents using the log K_{ow} relationships developed by Travis and Arms (1988), as presented in the following, with calculated transfer factors presented in Appendix M.

$$\log TF_{soil\text{-}to\text{-}plant} = 1.588 - 0.578(\log K_{ow}) \qquad \text{Eq. 6.9}$$

$$\log TF_{food\text{-}to\text{-}muscle} = -7.735 + 1.033(\log K_{ow}) \qquad \text{Eq. 6.10}$$

Soil-to-insect BAFs are based on log K_{ow} relationships developed by Connell and Markwell (1990). For organic COPEC in soil invertebrates, the transfer factor was derived from the following equation developed by Connell and Markwell (1990) for bioaccumulation in earthworms:

$$BAF = \frac{y_L \cdot K_{ow}^{b-a}}{x \cdot f_{oc}} \qquad \text{Eq. 6.11}$$

where:

BAF	=	the bioaccumulation factor (unitless)
y_L	=	the fractional lipid content of the organism
K_{ow}	=	the octanol/water partition coefficient
(b-a)	=	a nonlinearity constant
x	=	a proportionality constant
f_{oc}	=	the fractional organic carbon content in the soil.

Although derived from earthworm data, the values for the nonlinearity constant (0.05) and proportionality constant (0.66) were applied to modeling uptake in soil invertebrates. Because of differences in integument, it is expected that the uptake by earthworms will generally be greater than that of invertebrates such as insects. Therefore, these factors are expected to yield conservative estimates of invertebrate uptake. The lipid content in insects was estimated at 3.1 percent fresh weight (Taylor, 1975), which is 7.9 percent of dry weight, using a value of 61 percent water content in beetles (EPA, 1993c), calculated as follows:

$$\frac{0.031}{(1-0.61)} = 0.079 \text{ or } 7.9 \text{ percent} \qquad \text{Eq. 6.12}$$

The fraction of organic carbon in the soil was estimated to be 0.01, or 1 percent, as site-specific soil f_{oc} data were not available. This default value was based on information related to fate and transport data for organic constituents, as presented in *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA, 1998). Except where literature-derived values are available, the soil-to-invertebrate transfer factors for inorganics were assumed to be 1. Table 6-21 presents the soil-to-plant and soil-to-invertebrate transfer factors estimated for the inorganic COPEC. The COPEC in this table are limited to those that were not dropped during the screening assessment (Section 6.2.3). Transfer factors for organic COPEC are presented in the risk characterization spreadsheets presented in Appendix M.

Tissue concentrations in vertebrate prey species were estimated from the daily intake of the COPEC through the use of transfer factors for beef. The regression equation developed by Travis and Arms (1988) was used to derive food-to-beef transfer factors for the organic COPEC based on the log K_{ow} value of the chemical of concern. Transfer factors for the inorganic COPEC were taken from International Atomic Energy Agency (1994), National Council on Radiation Protection and Measurements (1989), Ma (1982), and Baes, et al. (1984), as shown in Table 6-21. A weighted total of the concentrations of COPEC intakes (including ingested soil and surface water) was then used in the calculation of tissue concentrations in prey species and the dietary exposure rate in all selected receptor assessment species, as follows:

$$\frac{\text{Total intake of soil, water, plants, and/or invertebrates (in mg COPEC/day)} \times \text{Food-to-Tissue TF}}{0.32 \times \text{Total food and soil intake (in kg mass/day)}} \quad \text{Eq.6.13}$$

A conversion factor of 0.32 was used to convert wet weight tissue concentrations to dry weight values, given that the water content of mammals, passerine birds, and fish is reported to be 68 percent (Table 4-1 in EPA, 1993c).

Media-Specific Exposure Pathways. Exposure to four categories of environmental media are addressed in this BERA, as discussed in the following subsections.

Soil Exposure Pathway. Soil exposure pathways are potentially important for terrestrial plants and animals at the site. For nonburrowing animal exposure, soil samples obtained from a depth of 0 to 3 feet have been considered, as this would be the point of exposure. Note: The agency-approved work plan defined surface soil as 0 to 1 foot; however, due to depth compositing of 0 to 2 feet and 0 to

3 feet in the historic data set, all soils from the 0- to 3-foot-depth interval were considered as surface soil for this BERA. For burrowing animals such as the shrew, soil samples obtained from a depth of 0 to 6 feet have been considered.

For deep-rooted plant exposure, soil samples taken from 0 to 6 feet have been considered because most feeder roots are located within this depth. Thus, the white-tailed deer is assumed to ingest leaves of trees translocating COPEC from subsoils (Figure 6-11).

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 whether they 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. Literature values for soil-to-plant transfer rates for inorganic soil contaminants have been used (Table 6-21).

Sediment Exposure Pathway. Sediment consists of materials precipitated or settled out of suspension in surface water. Potential contaminant sources for sediment include buried or stored waste, 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 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., PCBs and pesticides) decreases with increasing concentrations of TOC 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 COPEC. Potential sources for contaminated surface water include: buried or stored waste, stored or spilled fuel, contaminated soil 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 COPEC. 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. However, contaminant transport along the shallow groundwater pathway would 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. As noted in Section 6.1, a groundwater assessment is not included in this BERA because a sitewide GWI, including samples from the bedrock aquifer, is planned for a future date. In addition, groundwater discharge to surface water within either of the Red Water Pond Areas is not suspected, based on existing data.

6.3.2 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 M. 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 6.5.4). The basis for each uncertainty has been identified, with the degree of uncertainty estimated qualitatively (low, medium, or high) or quantitatively, and the impact of the uncertainty estimated qualitatively (overestimate or underestimate, as appropriate).

6.4 Ecological Effects Characterization

The ecological effects characterization includes the selection of literature benchmark values and the development of reference toxicity values.

6.4.1 Selection of Literature Benchmark Values

IT has consulted appropriate sources for literature benchmark values. The level of effort has been limited to documents that summarize the available ecotoxicological information and does not consist of a

review of the primary toxicological literature (i.e., IT has not reviewed details of toxicity test conditions to determine validity of the tests performed).

6.4.2 Development of Reference Toxicity Values

IT has developed or determined reference toxicity values (RTV) for the site. These RTVs focus on the growth, survival, and reproduction of species and/or populations. Empirical data are available for the specific receptor-endpoint combinations in some instances. However, for some COPEC, data on surrogate species and/or on endpoints other than the NOAEL and LOAEL had to be used. 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 since it would provide the greatest degree of protection to the receptor species. In addition, the LOAEL may be used as a point of comparison for decision-making for risk management purposes. In addition, in instances where data are unavailable for a site-associated COPEC, toxicological information for surrogate chemicals had to be used. Safety factors are used to adjust for these differences and extrapolate risks to the sites' 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 COPEC. 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 ones 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 (e.g., benzo[a]pyrene for other PAHs) have been gathered for use in the BERA.

Using the relevant toxicity information, RTVs have been calculated for each of the COPEC. RTVs represent NOAELs and LOAELs with safety factors incorporated for toxicity information derived from studies other than no-effects or lowest-effects studies. For studies on species other than the receptors selected for this risk assessment, additional uncertainty factors have been used. RTVs have been calculated using safety factors specified in Wentsel, et al. (1996) and shown in Figure 6-13 and Table 6-22. Interclass toxicity extrapolations were not performed because physiological differences between classes are too great to be addressed with the use of simplistic safety factors. Separate factors are used to account for extrapolation to the no-effects or lowest-effects endpoints, for study duration (Table 6-22), and for extrapolation across taxonomic groups (e.g., species, genus, family, order), as

shown in Table 6-23 for the receptors used in this BERA. Although additional safety factors may be employed for endangered species, no endangered species were selected as representative receptors and these additional safety factors were not required. Because NOAELs for the selected wildlife receptor species are based on NOAELs from test species, the latter are converted to NOAELs specific to the selected wildlife receptors using a power function of the ratio of BWs, as described by Sample, et al. (1996) and shown below. A BW scaling factor of 0.25 was used for mammals, whereas a body weight scaling factor of 0 was used for birds.

$$NOAEL_W = NOAEL_T \left(\frac{BW_T}{BW_W} \right)^s \qquad \text{Eq. 6.14}$$

where:

$NOAEL_W$	=	the No Observed Adverse Effect Level for the wildlife indicator species (mg/kg-day)
$NOAEL_T$	=	the No Observed Adverse Effect Level for the test species (mg/kg-day)
BW_T	=	the body weight of the test species (kg)
BW_W	=	the body weight of the wildlife indicator species (kg)
s	=	a body weight scaling factor (s = 1/4 for mammals and s = 0 for birds).

Test species body weights (BW_T) used for COPEC RTVs are contained in the risk characterization spreadsheets presented in Appendix M.

These factors were used together to derive a final adjusted RTV, as shown in the risk characterization spreadsheets (Appendix M). Reference toxicity threshold value uncertainties are discussed in Section 6.5.4. RTVs for essential nutrients are derived as shown in Appendix N.

Exposure rate RTVs provide a reference point for the comparison of toxicological effects upon exposure to a contaminant. To complete this comparison, receptor exposure to site contaminants are calculated, or as in the case of plant receptors, exposure is simply calculated as the soil concentration (Section 6.5.1).

6.5 Risk Characterization

The risk characterization phase integrates information on exposure, exposure-effects relationships, and defined or presumed target populations to arrive at conclusions for the site. The result is a determination of the likelihood, severity, and characteristics of adverse effects to ecological receptors at the 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 COPEC. Potential adverse affects to terrestrial plants have been qualitatively assessed by comparing plant toxicity benchmarks with COPEC concentrations. Potential adverse impacts to aquatic biota were qualitatively assessed by comparing surface water and sediment quality criteria (for the protection of aquatic life) with surface water and sediment COPEC concentrations.

In addition, RTVs and exposure rates were calculated for the semiquantitative predictive assessment and used to generate HQs (Wentsel, et al., 1996). HQs are used to estimate potential for adverse effects to organisms at a contaminated site, and to assess the potential for adverse toxicological effects upon site receptors.

6.5.1 Terrestrial Plant Impact Assessment

To assess the potential impact of COPEC concentrations in surface soil on terrestrial plant species, the source-term concentrations from both Red Water Ponds were compared with available benchmark concentrations developed for the protection of terrestrial plants. As shown in Table 6-24, no benchmarks were exceeded by the COPEC source-term concentrations. It should be noted, however, that only one benchmark, beryllium, was readily available for the COPEC retained for the predictive BERA. Although some bare soil areas were noted during the site reconnaissance (Section 6.2.1.6), these findings cannot be definitively attributed to chemical stressors in surface soils, as the bare soil areas were not linked to COPEC concentrations that were greater than other areas with vegetation. A possible explanation of the bare areas includes heavy deer activity, because many of the bare soil areas were completely covered with deer tracks. Finally, IT's subcontractor, a botanical expert, observed similar conditions (i.e., bare soil) in other areas of Northern Ohio that had not been impacted by chemical stressors.

6.5.2 Aquatic Biota Impact Assessment

To assess the potential impact of COPEC concentrations in surface water and sediment on aquatic biota, the source-term concentrations from both Red Water Ponds were compared with available benchmark concentrations developed for the protection of aquatic life. As shown in Table 6-25,

surface water COPEC concentrations for aluminum, iron, lead, manganese, and vanadium measured in the WARWP exceeded benchmarks for the protection of aquatic life. Because as many as four different benchmarks were used for in the surface water assessment, a weight-of-evidence approach was applied to this analysis. More significant impacts are predicted to occur where more surface water benchmarks are exceeded. Thus, for the WARWP, elevated concentrations of aluminum, iron, and lead are more of a concern than elevated levels of manganese or vanadium. Elevated levels of these metals, particularly iron, may account for the red-orange color noted previously (Section 6.2.1.2). It is important to note that the limited number of surface water samples collected at the WARWP resulted in the maximum measured concentration for each of these five inorganics being used as the source-term concentration (Table 6-13). It is possible that additional sampling would result in different conclusions for the impact assessment.

In addition, surface water COPEC concentrations for aluminum, iron, and manganese measured in the PRRWP exceeded some or all of the available benchmarks. Using a weight-of-evidence approach, elevated concentrations of iron are more of a concern than aluminum or manganese (Table 6-25). As discussed previously, it is important to note that the limited number of surface water samples collected at the PRRWP resulted in the maximum measured concentration for each of these three inorganics being used as the source-term concentration (Table 6-14). It is possible that additional sampling would result in different conclusions for the impact assessment.

As shown in Table 6-26, sediment COPEC concentrations for arsenic, copper, and iron measured in the WARWP exceeded some of the available benchmarks developed for the protection of aquatic biota. It is important to note that source-term concentrations for these three inorganics only exceeded sediment threshold effect levels (TEL) developed by the state of Florida or lowest effect levels developed by OME, and concentrations did not exceed probable effect levels (PEL) or severe effect levels (Table 6-26). These findings suggest COPEC concentrations in the WARWP sediments are not of concern. For the PRRWP, no benchmarks are exceeded. It should be noted that EPA Region 5 (1996b) BTAG recommends that NOAA ER-L and ER-M benchmarks (Table 6-26) only be used when freshwater benchmarks are unavailable, as NOAA benchmarks are primarily for marine environments. Thus, NOAA benchmarks are not applied in the final column in Table 6-26, when other benchmarks are available.

6.5.3 Predictive Risk Estimation for Terrestrial and Aquatic Wildlife

IT has estimated the risk associated with the two Red Water Ponds. The risk estimation has been performed through a series of quantitative HQ calculations that compare receptor-specific exposure values with RTVs. The HQs are compared to HQ guidelines for assessing the risk posed from contaminants. HQs less than or equal to 1 present no probable risk; HQs from 1 up to, but less than 10, present a low potential for environmental effects; HQs from 10 up to, but less than 100, present a significant potential that effects could result from exposure; and HQs greater than 100 present the highest potential for expected effects (Wentsel, et al., 1996).

The simple HQ ratios have been summed to provide conservative HI estimates for all chemicals and exposure pathways for a given receptor. In general, HQ summation is only appropriate and scientifically defensible for a given receptor when chemical HQs have similar modes of toxicological action. While individual contaminants may affect distinct target organs or systems within an organism, classes of chemicals may act in similar ways, thus being additive in effect. The summation of HQs into a HI was performed, in part, to determine whether or not individual COPEC HQs should be segregated based on dissimilar modes of toxicological action. If a risk driver resulted in an HQ greater than approximately 10 to 100, segregation of other COPEC by mode of toxicological action would not be necessary. All individual COPEC HQs are contained in Appendix M.

Conservative HIs (summed HQs) for terrestrial receptors at the WARWP are: 28 for the deer mouse; 9.1 for the cottontail rabbit; 96 for the shrew; 452 for the marsh wren; 38 for the raccoon; 8.3 for the white-tailed deer; and 0.0062 for the red-tailed hawk (Table 6-27). COPEC from soil were the risk drivers for the deer mouse, shrew, and marsh wren. While COPEC from water were the risk drivers for the cottontail and deer receptors, COPEC from water and soil contributed equal shares of estimated risk for the raccoon. Risk drivers, listed in decreasing order of concern, included 4-amino-2,6-dinitrotoluene and PAHs from soil, and aluminum from surface water. Important routes of exposure included invertebrate intake and direct surface water intake (Table 6-27). It should be noted that the elevated hazard predicted for the marsh wren for 4-amino-2,6-dinitrotoluene was based on an adjusted LD_{50} value for an unspecified bird species (Table 6-22) and is of elevated uncertainty. Use of a more realistic NOAEL would likely reduce the hazard. Also, PAH toxicity was assessed using benzo(a) pyrene as a surrogate, and this approach likely resulted in an overestimate of PAH hazards. It should also be noted that the maximum aluminum concentration measured in surface water was used as the source-term concentration due to the limited number of samples (Table 6-13) and an additional sampling effort could potentially reduce the hazard estimate.

Conservative HIs (summed HQs) for aquatic receptors at the WARWP are 724 for the great blue heron and 665 for the raccoon (Table 6-28). It should be noted that both terrestrial and aquatic hazards have been estimated for the raccoon, as it exhibits a combined terrestrial and aquatic lifestyle, and hazards may be summed for this receptor. COPEC from sediment were risk drivers for the raccoon, while COPEC from water were the risk drivers for the heron receptor. Risk drivers, listed in decreasing order of concern, included iron from water, aluminum from sediment, magnesium from water, aluminum from water, calcium from sediment, 2-amino-4,6-dinitrotoluene from sediment, phosphorus from sediment, lead from water, and iron from sediment. Important routes of exposure included fish intake, invertebrate intake, and direct surface water intake (Table 6-28). It should be noted that the maximum concentrations of many of the COPEC measured in surface water and sediment were used as source-term concentrations due to the limited number of samples, and an additional sampling effort could potentially reduce the hazard estimate. It should also be mentioned that there are significant uncertainties associated with estimating concentrations in macroinvertebrates and fish, especially for nutrients such as phosphorus, iron, calcium, and magnesium (Section 6.5.4). Performance of a lab bioassay with earthworms and fish would likely show reduced bioaccumulation from soil and water.

Conservative HIs (summed HQs) for terrestrial receptors at the PRRWP are 4.1 for the deer mouse, 2.7 for the cottontail rabbit, 15 for the shrew, 451 for the marsh wren, 6.1 for the raccoon, 1.8 for the white-tailed deer, and 0.0018 for the red-tailed hawk (Table 6-29). COPEC from soil were risk drivers for the deer mouse, shrew and marsh wren, while COPEC from water were the risk drivers for the cottontail, raccoon, and deer receptors. Risk drivers, listed in decreasing order of concern, included 4-amino-2,6-dinitrotoluene, antimony, and 1,3-dinitrobenzene in soil, and aluminum in surface water. Important routes of exposure included invertebrate intake, soil intake, and direct surface water intake (Table 6-29). It should be noted that the elevated hazard predicted for the marsh wren for 4-amino-2,6-dinitrotoluene was based on an adjusted LD_{50} value for an unspecified bird species (Table 6-22) and is of elevated uncertainty. Use of a more realistic NOAEL would likely reduce the predicted 4-amino-2,6-DNT hazard. It should also be noted that the maximum aluminum concentration measured in surface water was used as the source-term concentration due to the limited number of samples (Table 6-14) and an additional sampling effort could potentially reduce the hazard estimate.

Conservative HIs (summed HQs) for aquatic receptors at the PRRWP are 126 for the great blue heron and 38 for the raccoon (Table 6-30). COPEC from sediment were risk drivers for the raccoon, while

COPEC from water were the risk drivers for the heron receptor. As mentioned previously, both terrestrial and aquatic hazards have been estimated for the raccoon, as it exhibits a combined terrestrial and aquatic lifestyle, and hazards may be summed for this receptor. Risk drivers, listed in decreasing order of concern, included iron from water, aluminum from water, carbazole from sediment, potassium from sediment, and magnesium from sediment. Important routes of exposure included fish intake, invertebrate intake, and direct surface water intake (Table 6-30). It should be noted that the maximum concentrations of many of the COPEC measured in surface water and sediment were used as source-term concentrations due to the limited number of samples, and an additional sampling effort could potentially reduce the hazard estimate. It should also be mentioned that there are significant uncertainties associated with estimating concentrations in macroinvertebrates and fish, especially for nutrients such as potassium, iron, and magnesium (Section 6.5.4). Performance of a lab bioassay with earthworms and fish would likely show reduced bioaccumulation from soil and water.

6.5.4 Uncertainty Analysis

The results of the BERA are influenced to some degree by variability and uncertainty. In theory, investigators might reduce variability by increasing sample size of the media or species sampled. Alternatively, uncertainty within the risk analysis can be reduced by using species-specific and site-specific data (i.e., to better quantify contamination of media, vegetation, and prey through: direct field measurements, toxicity testing of site-specific media, and field studies using site-specific receptor species). Detailed media, prey, and receptor field studies are relatively costly; thus, the preliminary predictive analyses of risk has been conducted to limit the potential use of these resource-intensive techniques to only those COPEC that continue to show a relatively high potential for ecological risk. Since assessment criteria were developed based on conservative assumptions, the results of the screening and predictive assessments err on the side of conservatism. This has the effect of maximizing the likelihood of accepting a false positive (Type I error: the rejection of a true null hypothesis) and simultaneously minimizing the likelihood of accepting a true negative (Type II error: the acceptance of a false null hypothesis).

A number of factors contribute to the overall variability and uncertainty inherent in ERAs. 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 will 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 (but 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 brief site reconnaissance performed on a relatively large site.

The uncertainty analysis is presented in Table 6-31 and lists some of the major assumptions made for the BERA; the direction of bias caused by each assumption (i.e., if the uncertainty results in an overestimate or underestimate of risk); the likely magnitude of impact (quantitative [percent difference], or qualitative [high, medium, low, or unknown]); and, if possible, a description of recommendations for minimizing the identified uncertainties if the BERA progresses to higher level assessment phases (EPA, 1992b). The uncertainty analysis identifies and, if possible, quantifies the uncertainty in the individual preliminary scoping assessment, problem formulation, exposure and effects assessment, and risk characterization phases of this BERA. Based on this uncertainty analysis, the most important biases that may result in an overestimation of risk include the following:

- Assuming that COPEC are 100 percent bioavailable
- Using laboratory-derived or empirically-estimated partitioning and transfer factors to predict COPEC concentrations in plants, invertebrates, fish, prey, and sediment pore water
- Using K_{ow} values without adjustment to estimate fish BCFs for organic COPEC
- Assuming that surface-water-to-fish-tissue BCFs, and sediment-pore-water-to-benthic-invertebrate BCFs, are linear with respect to low level and high level media concentrations, and are appropriate for use with elevated nutrient concentrations (e.g., Fe, Mg) in surface water and sediment. As mentioned in Rand and Petrocelli (1985), greater accumulations of metals usually occurs in soft waters due to complexation and reduced bioavailability. Since site surface waters are not soft, significant accumulation is not expected.

6.5.5 Risk Description

As part of the risk description, IT has completed the following: (1) summarized the ecological risk associated with the site; and (2) interpreted the ecological significance, which describes the magnitude

of the identified risks and the accompanying uncertainty. The effect of additional data or analyses on uncertainty has also been discussed. A weight-of-evidence approach has been used to interpret the ecological significance of the findings.

Based on available data (Section 6.5.1), soil COPEC impacts to terrestrial plants are estimated to be insignificant. Surface water COPEC impacts to aquatic biota are of most concern for aluminum, iron, and lead at the WARWP and for iron at the PRRWP (Section 6.5.2). Considerations of limited sample size suggest these findings should be confirmed based on additional sampling before any remedial actions are considered. Sediment COPEC impacts on aquatic biota are of limited concern, as probable effect levels and/or severe effect levels are not exceeded at either Red Water Ponds (Section 6.5.2). In general, it should be noted that based on the quality of aquatic habitat available at the Red Water Ponds, potential impacts at the WARWP are more of a concern than at PRRWP. Thus, if any aquatic bioassays are performed, they should focus on the WARWP. Terrestrial receptors at the WARWP are predicted to incur elevated hazards from exposure to 4-amino-2,6-dinitrotoluene and PAHs in soil and from exposure to aluminum in surface water (Section 6.5.3). Based on uncertainties of toxicity and sample size, and on the fact that no RTE species have been confirmed at this Red Water Pond, with the possible exception of the black-crowned night heron, remedial actions are not warranted at this time. Aquatic receptors at the WARWP are predicted to have elevated hazards from exposure to iron, magnesium, aluminum, and lead in surface water, and from exposure to aluminum, calcium, 2-amino-4,6-DNT, phosphorus, and iron in sediment (Section 6.5.3). Based on uncertainties associated with toxicity, estimating concentrations in fish and aquatic insects, and limited sample size, a determination regarding remedial actions cannot be made until uncertainties are reduced. Terrestrial receptors at the PRRWP are predicted to have elevated hazards from exposure to 4-amino-2,6-DNT, antimony, and 1,3-DNB in soil and from exposure to aluminum in surface water. Based on uncertainties of toxicity and sample size, and on the fact that no RTE species have been confirmed at the PRRWP, with the possible exception of the black-crowned night heron, remedial actions are not warranted at this time. Aquatic receptors at the PRRWP are predicted to have elevated hazards from potential exposure to iron and aluminum in surface water and from exposure to carbazole, potassium, and magnesium in sediment (Section 6.5.3). Based on uncertainties of toxicity and sample size, and on the fact that no RTE species have been confirmed at the PRRWP, with the possible exception of the black-crowned night heron, remedial actions are not warranted at this time.

6.6 Risk Summary and Identification of Preliminary Remedial Action Objectives

IT has summarized ecological risk associated with releases from the site (Section 6.5.5). This summary is supported by tasks performed during the previous sections. Additionally, IT has made recommendations for further risk investigation in Section 6.7. IT has not developed site-specific remedial action objectives for the site at this time due to previously discussed uncertainties associated with the BERA (Section 6.5.4).

6.7 Conclusions and Recommendations

Only the data, results, and conclusions of the various preliminary scoping and predictive assessment phases are described herein. No recommendations concerning types of remedial actions to be conducted are given other than to present the specific remedial action objectives or additional activities to reduce uncertainty. Conclusions and recommendations are derived from the risk assessment and are based on the responses to the assessment hypotheses. The predictive assessment results have been summarized and presented in Tables 6-24 through 6-30. These tables, along the qualitative estimates of uncertainty bias (Table 6-31), may serve as the foci of discussions among risk managers and regulatory agencies concerning the potential need for additional assessment at PBOW to reduce the uncertainty in the estimate of ecological risk.

Relatively high HQs are predicted for certain receptors (greater than 100 for the marsh wren, great blue heron, and racoon). This is due to potential 4-amino-2,6-DNT uptake by invertebrates from surface soil and sediment, aluminum ingestion by the racoon at the WARWP, and iron uptake by fish from surface water. The following additional investigatory work is recommended to eliminate uncertainty regarding potential adverse ecological impacts from these sites.

- Collection of additional inorganic surface water and sediment data, including background, to supplement the database
- Performance of earthworm bioassay to estimate uptake and bioavailability of organics (particularly 4-amino-2,6-DNT) from surface soil
- Performance of a fish uptake study to estimate bioconcentration and bioavailability of metals (particularly iron, magnesium, and aluminum) from surface water
- Research the literature, including both primary and secondary sources, to obtain a more accurate avian NOAEL for 4-amino-2,6-DNT.

7.0 Conclusions and Recommendations

The purpose of this site investigation was to characterize potential contamination and associated risk to human and ecological receptors from the PBOW Red Water Ponds Sites. The investigation evaluated current and future risk from environmental media including soil, sediment, and surface water. Additional investigatory and risk assessment work may be warranted to characterize and assess potential risk from groundwater at these sites.

The detailed results and conclusions of this study are presented in the human health risk characterization section (5.5) of the HHRA, and the ecological risk characterization section (6.5) of the BERA. The human health risk characterization is organized into three sections: 5.5.1 Carcinogenic Effects of Chemicals; 5.5.2 Noncancer Effects of Chemicals; and 5.5.3 Risk Characterization Results and Discussion. The ecological risk characterization is also organized into three sections of results, plus the uncertainty analysis section. The ecological risk characterization includes: Section 6.5.1 Terrestrial Plant Impact Assessment; Section 6.5.2 Aquatic Biota Impact Assessment; and Section 6.5.3 Predictive Risk Estimation for Terrestrial and Aquatic Wildlife.

7.1 Human Health Risk Assessment Conclusions

Human health risk from potential chemical carcinogens at both the WARWP and the PRRWP are either at or below OEPA acceptable limits, for the residential, groundskeeper, and construction worker exposure scenarios. Similarly, human health risk from potential noncarcinogenic chemical hazards at both these sites are below the OEPA acceptable limit. Because none of the ILCRs or HIs exceeded OEPA limits, no COPC were identified as COC and the development of RBRC was not required.

Site-related cancer risk values for residential exposure to soil, surface water, and sediment at the WARWP are precipitously close to the OEPA acceptance limit. It is probable that cancer risk from groundwater in the Red Water Ponds Areas, when calculated in a future risk assessment previously discussed, will push these values over the edge into the unacceptable range. However, human health risk values metals in surface water at the site have been characterized highly conservatively, because existing data are insufficient to determine whether these metals in surface water are present at background levels or as site-related chemicals. If additional sampling and analysis work demonstrates that risks from metals in groundwater are not site-related, then overall site cancer risk levels could return to the OEPA acceptable range.

7.2 Ecological Risk Assessment Conclusions

To determine potential impacts upon terrestrial plants, source term concentrations calculated for soil at the Red Water Ponds Areas were compared with available benchmark concentrations. None of the benchmark concentration values were exceeded by source term concentrations at either area.

To determine potential impacts upon aquatic biota, surface water and sediment contamination concentrations at the Red Water Ponds Areas were compared with benchmarks designed to protect aquatic life. Concentrations of aluminum, iron, lead, manganese, and vanadium measured in surface water at the WARWP exceeded acceptable benchmarks to protect aquatic biota. Upon further analysis, aluminum, lead, and iron were found to be more significant contaminants of potential concern than manganese and vanadium. The contamination concentration data for sediments at the WARWP exceeded acceptable benchmarks for arsenic, copper, and iron designed to protect aquatic biota. These sediment contaminant concentrations only exceeded the strictest benchmarks for the protection of aquatic biota. They did not exceed less conservative probable or severe effect level benchmarks.

Surface water concentrations of aluminum, iron, and manganese at the PRRWP also exceeded some of the benchmark concentrations applied to the sites. At the latter sites, elevated iron concentrations appeared to be more significant than less elevated aluminum and manganese concentrations. No sediment benchmarks were exceeded at the PRRWP.

Potential risks to terrestrial and aquatic wildlife at the Red Water Pond Sites were evaluated through calculating HQs for all chemicals and exposure pathways for each receptors of concern. The HQ calculated for each receptor was compared with general guidelines. According to the guidelines, the higher the HQ the greater the risk posed by site related contaminants. If the HQ is less than 1, then there is no probable risk. If the HQ is between 1 and 10, then there is a very low potential for ecological effects. If the HQ is between 10 and 100, then significant potential for ecological effects exists. If the HQ is above 100, then very significant potential for ecological effects is present due to site contaminants.

For the WARWP, summed HQs for terrestrial receptors are: 28 for the deer mouse; 9.1 for the cottontail rabbit; 96 for the shrew; 452 for the marsh wren; 38 for the racoon; 8.3 for the white-tailed deer; and 0.0062 for the red-tailed hawk. Summed HQs for aquatic receptors at the WARWP are

724 for the great blue heron and 665 for the racoon. Since the racoon lives a combined terrestrial and aquatic life, HQs (that can be summed) are presented for both environments.

For the PRRWP, summed HQs for terrestrial receptors are: 4.1 for the deer mouse; 2.7 for the cottontail rabbit; 15 for the shrew; 412 for the marsh wren; 6.1 for the racoon; 1.8 for the white-tailed deer; and 0.0018 for the red-tailed hawk. Summed HQs for aquatic receptors at the PRRWP are 126 for the great blue heron and 38 for the racoon.

The presence of receptors with relatively high summed HQs, in the most significant cases greater than 100, was due to the high potential for 4-amino-2,6-DNT uptake by invertebrates, aluminum uptake by racoons in the WARWP, and iron uptake from surface water by fish. More work is needed to better ascertain the nature and extent of ecological risks at the Red Water Ponds, and what types of actions are needed to ameliorate these risks. This additional work should focus on resolving the many uncertainties regarding ecological risk at the Red Water Ponds discussed in Section 6.5.4. Section 6.5.5 presents a more comprehensive summary of ecological risks at the sites, and Section 6.7 of the BERA presents four distinct tasks that could be performed to reduce ecological risk assessment uncertainty associated with these sites.

7.3 Recommendations

The following recommendations are made as a result of the findings of both the HHRA and ERA:

- Background concentrations for metals should be established for site-specific surface water and sediment.
- Following completion of bedrock water quality characterization at the two Red Water Ponds Areas, human health risk from the bedrock groundwater should be evaluated at the two sites.
- Conduct earthworm bioassay to estimate uptake and bioavailability of organics from surface soil.
- Conduct fish uptake study to estimate bioconcentration and bioavailability of metals from surface water.
- Conduct literature search to obtain more accurate avian NOAEL for 4-amino-2,6-DNT.

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TABLES

Table 2-1

Summary of Primary Soil and Groundwater Samples Collected
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 4)

Area	Soil Sample Designation	Direct-Push Boring Designation	Sample Matrix	Sampling Depth Interval (feet, bgs)
West Area Red Water Ponds	PBOW-98-SO-WARP-DP01-8100-(0002)	DP01	Soil	0 - 2
	PBOW-98-SO-WARP-DP01-8110-(0406)			4 - 6
	PBOW-98-SO-WARP-DP01-8120-(0810)			8 - 10
	PBOW-98-GW-WARP-DP01-8130		Groundwater	NA
	PBOW-98-SO-WARP-DP02-8140-(0002)	DP02	Soil	0 - 2
	PBOW-98-SO-WARP-DP02-8150-(0406)			4 - 6
	PBOW-98-SO-WARP-DP02-8160--(0810)			8 - 10
	PBOW-98-GW-WARP-DP02-8170		Groundwater	NA
	PBOW-98-SO-WARP-DP03-8180-(0002)	DP03	Soil	0 - 2
	PBOW-98-SO-WARP-DP03-8190-(0406)			4 - 6
	PBOW-98-SO-WARP-DP03-8200-(0810)			8 - 10
	PBOW-98-GW-WARP-DP03-8210		Groundwater	NS
	PBOW-98-SO-WARP-DP04-8220-(0002)	DP04	Soil	0 - 2
	PBOW-98-SO-WARP-DP04-8230-(0406)			4 - 6
	PBOW-98-SO-WARP-DP04-8240-(0810)			8 - 10
	PBOW-98-GW-WARP-DP04-8250		Groundwater	NA
	PBOW-98-SO-WARP-DP05-8260-(0002)	DP05	Soil	0 - 2
	PBOW-98-SO-WARP-DP05-8270-(0406)			4 - 6
	PBOW-98-SO-WARP-DP05-8280-(0810)			8 - 10
	PBOW-98-GW-WARP-DP05-8290		Groundwater	NS
	PBOW-98-SO-WARP-DP06-8300-(0002)	DP06	Soil	0 - 2
	PBOW-98-SO-WARP-DP06-8310-(0406)			4 - 6
	PBOW-98-SO-WARP-DP06-8320-(0810)			8 - 10
	PBOW-98-GW-WARP-DP06-8330		Groundwater	NA
	PBOW-98-SO-WARP-DP07-8340-(0002)	DP07	Soil	0 - 2
	PBOW-98-SO-WARP-DP07-8350-(0406)			4 - 6
	PBOW-98-SO-WARP-DP07-8360-(0810)			8 - 10
	PBOW-98-GW-WARP-DP07-8370		Groundwater	NA
	PBOW-98-SO-WARP-DP08-8380-(0002)	DP08	Soil	0 - 2
	PBOW-98-SO-WARP-DP07-8390-(0406)			4 - 6
	PBOW-98-SO-WARP-DP07-8400-(0810)			8 - 10
	PBOW-98-GW-WARP-DP08-8410		Groundwater	NA
	PBOW-98-SO-WARP-DP09-8420-(0002)	DP09	Soil	0 - 2
	PBOW-98-SO-WARP-DP09-8430-(0406)			4 - 6
	PBOW-98-SO-WARP-DP09-8440-(0810)			8 - 10
	PBOW-98-GW-WARP-DP09-8450		Groundwater	NA
	PBOW-98-SO-WARP-DP10-8460-(0002)	DP10	Soil	0 - 2
	PBOW-98-SO-WARP-DP10-8470-(0406)			4 - 6
	PBOW-98-SO-WARP-DP10-8480-(0810)			NS
	PBOW-98-GW-WARP-DP10-8490		Groundwater	NS

Table 2-1

Summary of Primary Soil and Groundwater Samples Collected Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 4)

Area	Soil Sample Designation	Direct-Push Boring Designation	Sample Matrix	Sampling Depth Interval (feet, bgs)
West Area Red Water Ponds (Cont.)	PBOW-98-SO-WARP-DP11-8500-(0002)	DP11	Soil	0 - 2
	PBOW-98-SO-WARP-DP11-8510-(0406)			4 - 6
	PBOW-98-SO-WARP-DP11-8520-(0810)			8 - 10
	PBOW-98-GW-WARP-DP11-8530		Groundwater	NA
	PBOW-98-SO-WARP-DP12-8540-(0002)	DP12	Soil	0 - 2
	PBOW-98-SO-WARP-DP12-8550-(0406)			4 - 6
	PBOW-98-SO-WARP-DP12-8560-(0810)			8 - 10
	PBOW-98-GW-WARP-DP12-8570		Groundwater	NA
	PBOW-98-SO-WARP-DP13-8580-(0002)	DP13	Soil	0 - 2
	PBOW-98-SO-WARP-DP13-8590-(0406)			4 - 6
	PBOW-98-SO-WARP-DP13-8600-(0810)			8 - 10
	PBOW-98-GW-WARP-DP13-8610		Groundwater	NA
	PBOW-98-SO-WARP-DP14-8620-(0002)	DP14	Soil	NS
	PBOW-98-SO-WARP-DP14-8630-(0406)			NS
	PBOW-98-SO-WARP-DP14-8640-(0810)			NS
	PBOW-98-GW-WARP-DP14-8650		Groundwater	NS
	PBOW-98-SO-WARP-DP15-8660-(0002)	DP15	Soil	0 - 2
	PBOW-98-SO-WARP-DP15-8670-(0406)			4 - 6
	PBOW-98-SO-WARP-DP15-8680-(0810)			8 - 10
	PBOW-98-GW-WARP-DP15-8690		Groundwater	NA
	PBOW-98-SO-WARP-DP16-8700-(0002)	DP16	Soil	0 - 2
	PBOW-98-SO-WARP-DP16-8710-(0406)			4 - 6
	PBOW-98-SO-WARP-DP16-8720-(0810)			8 - 10
	PBOW-98-GW-WARP-DP16-8730		Groundwater	NA
	PBOW-98-SO-WARP-DP17-8740-(0002)	DP17	Soil	0 - 2
	PBOW-98-SO-WARP-DP17-8750-(0406)			4 - 6
	PBOW-98-SO-WARP-DP17-8760-(0810)			8 - 10
	PBOW-98-GW-WARP-DP17-8770		Groundwater	NA
	PBOW-98-SO-WARP-DP18-8780-(0002)	DP18	Soil	0 - 2
	PBOW-98-SO-WARP-DP18-8790-(0406)			4 - 6
	PBOW-98-SO-WARP-DP18-8800-(0810)			8 - 10
	PBOW-98-GW-WARP-DP18-8810		Groundwater	NS
	PBOW-98-SO-WARP-DP19-8820-(0002)	DP19	Soil	0 - 2
	PBOW-98-SO-WARP-DP19-8830-(0406)			4 - 6
	PBOW-98-SO-WARP-DP19-8840-(0810)			8 - 10
	PBOW-98-GW-WARP-DP19-8850		Groundwater	NA
	PBOW-98-SO-WARP-DP20-8860-(0002)	DP20	Soil	0 - 2
	PBOW-98-SO-WARP-DP20-8870-(0406)			4 - 6
	PBOW-98-SO-WARP-DP20-8880-(0810)			8 - 10
	PBOW-98-GW-WARP-DP20-8890		Groundwater	NS

Table 2-1

Summary of Primary Soil and Groundwater Samples Collected Red Water Ponds, PBOW, Sandusky, Ohio

(Page 3 of 4)

Area	Soil Sample Designation	Direct-Push Boring Designation	Sample Matrix	Sampling Depth Interval (feet, bgs)
Pentolite Road Red Water Ponds	PBOW-98-SO-PRRP-DP01-7200-(0002)	DP01	Soil	0 - 2
	PBOW-98-SO-PRRP-DP01-7210-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP01-7220-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP01-7230		Groundwater	NA
	PBOW-98-SO-PRRP-DP02-7240-(0002)	DP02	Soil	0 - 2
	PBOW-98-SO-PRRP-DP02-7250-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP02-7260--(0810)			8 - 10
	PBOW-98-GW-PRRP-DP02-7270		Groundwater	NA
	PBOW-98-SO-PRRP-DP03-7280-(0002)	DP03	Soil	0 - 2
	PBOW-98-SO-PRRP-DP03-7290-(0406)			4 - 5
	PBOW-98-SO-PRRP-DP03-7300-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP03-7310		Groundwater	NA
	PBOW-98-SO-PRRP-DP04-7320-(0002)	DP04	Soil	0 - 2
	PBOW-98-SO-PRRP-DP04-7330-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP04-7340-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP04-7350		Groundwater	NA
	PBOW-98-SO-PRRP-DP05-7360-(0002)	DP05	Soil	0 - 2
	PBOW-98-SO-PRRP-DP05-7370-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP05-7380-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP05-7390		Groundwater	NA
	PBOW-98-SO-PRRP-DP06-7400-(0002)	DP06	Soil	0 - 2
	PBOW-98-SO-PRRP-DP06-7410-(0406)			4 - 5
	PBOW-98-SO-PRRP-DP06-7420-(0810)			9 - 10
	PBOW-98-GW-PRRP-DP06-7430		Groundwater	NA
	PBOW-98-SO-PRRP-DP07-7440-(0002)	DP07	Soil	0 - 2
	PBOW-98-SO-PRRP-DP07-7450-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP07-7460-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP07-7470		Groundwater	NA
	PBOW-98-SO-PRRP-DP08-7480-(0002)	DP08	Soil	0 - 2
	PBOW-98-SO-PRRP-DP08-7490-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP08-7500-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP08-7510		Groundwater	NA
	PBOW-98-SO-PRRP-DP09-7520-(0002)	DP09	Soil	0 - 2
	PBOW-98-SO-PRRP-DP09-7530-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP09-7540-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP09-7550		Groundwater	NA
	PBOW-98-SO-PRRP-DP10-7560-(0002)	DP10	Soil	0 - 1
	PBOW-98-SO-PRRP-DP10-7570-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP10-7580-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP10-7590		Groundwater	NA

Table 2-1

Summary of Primary Soil and Groundwater Samples Collected
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 4 of 4)

Area	Soil Sample Designation	Direct-Push Boring Designation	Sample Matrix	Sampling Depth Interval (feet, bgs)
Pentolite Road Red Water Ponds (Cont.)	PBOW-98-SO-PRRP-DP11-7600-(0002)	DP11	Soil	0 - 2
	PBOW-98-SO-PRRP-DP11-7610-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP11-7620-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP11-7630		Groundwater	NA
	PBOW-98-SO-PRRP-DP12-7640-(0002)	DP12	Soil	0 - 2
	PBOW-98-SO-PRRP-DP12-7650-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP12-7660-(0810)			9 - 10
	PBOW-98-GW-PRRP-DP12-7670		Groundwater	NA
	PBOW-98-SO-PRRP-DP13-7680-(0002)	DP13	Soil	0 - 2
	PBOW-98-SO-PRRP-DP13-7690-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP13-7700-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP13-7710		Groundwater	NA
	PBOW-98-SO-PRRP-DP14-7720-(0002)	DP14	Soil	0 - 2
	PBOW-98-SO-PRRP-DP14-7730-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP14-7740-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP14-7750		Groundwater	NA
	PBOW-98-SO-PRRP-DP15-7760-(0002)	DP15	Soil	0 - 2
	PBOW-98-SO-PRRP-DP15-7770-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP15-7780-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP15-7790		Groundwater	NA
	PBOW-98-SO-PRRP-DP16-7800-(0002)	DP16	Soil	0 - 2
	PBOW-98-SO-PRRP-DP16-7810-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP16-7820-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP16-7830		Groundwater	NA
	PBOW-98-SO-PRRP-DP17-7840-(0002)	DP17	Soil	0 - 2
	PBOW-98-SO-PRRP-DP17-7850-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP17-7860-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP17-7870		Groundwater	NA
	PBOW-98-SO-PRRP-DP18-7880-(0002)	DP18	Soil	0 - 2
	PBOW-98-SO-PRRP-DP18-7890-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP18-7900-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP18-7910		Groundwater	NA
	PBOW-98-SO-PRRP-DP19-7920-(0002)	DP19	Soil	0 - 2
	PBOW-98-SO-PRRP-DP19-7930-(0406)			4 - 6
	PBOW-98-SO-PRRP-DP19-7940-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP19-7950		Groundwater	NA
	PBOW-98-SO-PRRP-DP20-7960-(0002)	DP20	Soil	0 - 2
	PBOW-98-SO-PRRP-DP20-7970-(0406)			4 - 5
	PBOW-98-SO-PRRP-DP20-7980-(0810)			8 - 10
	PBOW-98-GW-PRRP-DP20-7990		Groundwater	NA

NA - Groundwater not available.
NS - Not sampled.

Table 2-2

Summary of Primary Surface Water and Sediment Samples
Red Water Ponds, PBOW, Sandusky, Ohio

Area	Sample Designation	Sample Location	Sample Matrix
West Area Red Water Ponds	PBOW-98-SW-WARP-SW01-12100	SW-01	Surface Water
	PBOW-98-SD-WARP-SD01-11100	SD-01	Sediment
	PBOW-98-SW-WARP-SW02-12110	SW-02	Surface Water
	PBOW-98-SD-WARP-SD02-11110	SD-02	Sediment
	PBOW-98-SW-WARP-SW03-12120	SW-03	Surface Water
	PBOW-98-SD-WARP-SD03-11120	SD-03	Sediment
	PBOW-98-SW-WARP-SW04-12130	SW-04	Surface Water
	PBOW-98-SD-WARP-SD04-11130	SD-04	Sediment
	PBOW-98-SW-WARP-SW05-12140	SW-05	Surface Water
	PBOW-98-SD-WARP-SD05-11140	SD-05	Sediment
	PBOW-98-SW-WARP-SW06-12150	SW-06	Surface Water
	PBOW-98-SD-WARP-SD06-11150	SD-06	Sediment
Pentolite Road Red Water Ponds	PBOW-98-SW-PRRP-SW01-12160	SW-01	Surface Water
	PBOW-98-SD-PRRP-SD01-11160	SD-01	Sediment
	PBOW-98-SW-PRRP-SW02-12170	SW-02	Surface Water
	PBOW-98-SD-PRRP-SD02-11170	SD-02	Sediment
	PBOW-98-SW-PRRP-SW03-12180	SW-03	Surface Water
	PBOW-98-SD-PRRP-SD03-11180	SD-03	Sediment
	PBOW-98-SW-PRRP-SW04-12190	SW-04	Surface Water
	PBOW-98-SD-PRRP-SD04-11190	SD-04	Sediment

Table 2-3

Summary of Variances Documented During the Direct-Push Investigation
Red Water Ponds, PBOW, Sandusky, Ohio

Variance Number	Date Recorded	Area Affected	Location Affected	Variance and Justification
1	6/9/98	Pentolite Road Red Water Ponds	PRRP-DP06	Low yield, limited quantity sample collected for explosives only
2	6/10/98		PRRP-DP07	Low yield, sample collected for explosives, metals, VOCs, SVOCs only
3	6/10/98		PRRP-DP08	Low yield, sample collected for explosives, metals, VOCs, SVOCs only
4	6/10/98		PRRP-DP10	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
5	6/11/98		PRRP-DP17	Field duplicate (7871)/field split (7872) samples were collected from this location
6	6/11/98		PRRP-DP12	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
7	6/12/98		PRRP-DP01	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
8	6/12/98		PRRP-DP18	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
9	6/12/98		PRRP-DP15	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
10	6/12/98		PRRP-DP13	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
11	6/13/98		PRRP-DP16	Low yield, sample collected for explosives, metals, VOCs, SVOCs only
12	6/13/98		PRRP-DP19	Low yield, sample collected for explosives, metals, VOCs, SVOCs only
13	6/14/98		PRRP-DP20	Matrix spike/matrix spike duplicate samples were collected from this location
14	6/14/98		PRRP-DP05	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
15	6/15/98	West Area Red Water Ponds	WARP-DP12	Low yield, sample collected for explosives and VOCs only
16	6/16/98		WARP-DP08	Low yield, sample collected for explosives and VOCs only
17	6/16/98		WARP-DP05	Completely dry, no sample collected
18	6/23/98		WARP-DP03	Completely dry, no sample collected
19	6/23/98		WARP-DP06	Low yield, sample collected for explosives and VOCs only
20	6/24/98		WARP-DP02	Low yield, sample collected for explosives, metals, and VOCs only
21	6/24/98		WARP-DP20	Completely dry, no sample collected
22	6/24/98		WARP-DP04	Low yield, sample collected for explosives, metals, VOCs, SVOCs only
23	6/24/98		WARP-DP18	Completely dry, no sample collected
24	6/25/98		WARP-DP16	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
25	6/25/98		WARP-DP01	Low yield, sample collected for explosives and VOCs only
26	6/25/98		WARP-DP17	Low yield, sample collected for explosives, metals, VOCs, SVOCs, PCBs only
27	6/26/98		WARP-DP15	Low yield, sample collected for explosives and VOCs only
28	6/26/98		WARP-DP19	Low yield, sample collected for explosives and VOCs only
29	6/26/98		WARP-DP14	Drill rig failure, no soil or groundwater samples collected
30	6/26/98		WARP-DP11	Low yield, sample collected for explosives, metals, VOCs, SVOCs only
31	6/26/98		WARP-DP07	Low yield, sample collected for explosives, metals, VOCs, SVOCs only
32	6/26/98		WARP-DP10	Drill rig failure, no soil sample collected from 8'-10'; no water samples collected

Note: variance logs were completed in the field by either the site coordinator or the sample coordinator. Variances were approved by the project manager in consultation with USACE representative. Variance logs were archived in the project file.

Table 3-1

Summary of Analytical Methods for Groundwater, Surface Water, Sediment, and Soil Samples
Red Water Ponds, PBOW, Sandusky, Ohio

Parameter Name	Surface/Subsurface Soil and Sediment Method Number	Surface Water and Groundwater Method Number
TCL Volatile Organic Compounds	8260A	8260A
TCL Semivolatile Organic Compounds	3540B/8270B	3520B/8270B
Nitroaromatics	8330	Modified 8330
Total TAL Metals	3050A/6010A 7471A	3005A/6010A/ 7470
Dissolved TAL Metals	NA	3005A/6010A 7470
Polychlorinated Biphenyls	3540B/8081	3520B/8081
Hardness	NA	EPA 130.2
Alkalinity	NA	EPA 310.1
Total Organic Carbons	NA	SW-846 9060
Total Dissolved Solids	NA	EPA 160.1
Total Suspended Solids	NA	EPA 160.2
Chloride	NA	EPA 325.3
Cyanide (Total)	NA	9010A
Nitrate	NA	EPA 352.2
Sulfate	NA	EPA 375.4

The analytical methods above are found in the following references:
Test Method for Evaluating Solid Waste, Physical/Chemical Methods, 3rd Edition, update II September 1994.
Test Method for Evaluating Solid Waste, Physical/Chemical Methods, 3rd Edition, update I July 1992.
Test Method for Evaluating Solid Waste, Physical/Chemical Methods, 3rd Edition, Revision I December 1990.

PCB - Polychlorinated biphenyls.
TCL - Target compound list.
TAL - Target Analyte List. Metals include Ag, Al, Ba, Ca, Cd, Co, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Tl, V, As, Hg, and Se.

Table 4-1

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Soils
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		WARWP-DP01		WARWP-DP02		WARP-DP04		WARWP-DP06		WARWP-DP08		WARWP-DP09			
Sample No:		8110		8140		8240		8300		8380		8430		8440	
Sample Date:		23-Jun-98		23-Jun-98		23-Jun-98		23-Jun-98		15-Jun-98		16-Jun-98		16-Jun-98	
Depth (ft):		4-6		0-2		8-10		0-2		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds															
Acetone	mg/kg									0.035					
Methylene chloride	mg/kg									0.002	J				
Toluene	mg/kg	0.0022	J	0.0018	J	0.0025	J	0.0023	J						
Semivolatile Organic Compounds															
2,4-Dinitrotoluene	mg/kg														
Acenaphthylene	mg/kg														
Anthracene	mg/kg														
Benzo(a)anthracene	mg/kg														
Benzo(a)pyrene	mg/kg														
Benzo(b)fluoranthene	mg/kg														
Benzo(ghi)perylene	mg/kg														
Benzo(k)fluoranthene	mg/kg														
Chrysene	mg/kg														
Fluoranthene	mg/kg											0.058	J		
Indeno(1,2,3-cd)pyrene	mg/kg														
Phenanthrene	mg/kg														
Pyrene	mg/kg											0.043	J		
Nitroaromatic Compounds															
1,3,5-Trinitrobenzene	mg/kg													0.31	
2,4,6-Trinitrotoluene	mg/kg														
2,4-Dinitrotoluene	mg/kg													0.49	
2,6-Dinitrotoluene	mg/kg														

Table 4-1

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Soils
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		WARWP-DP10		WARWP-DP11				WARWP-DP12		WARWP-DP13		WARWP-DP15		WARWP-DP17	
Sample No:		8470		8500		8520		8550		8580		8670		8750	
Sample Date:		26-Jun-98		25-Jun-98		25-Jun-98		15-Jun-98		15-Jun-98		24-Jun-98		25-Jun-98	
Depth (ft):		4-6		0-2		8-10		4-6		0-2		4-6		4-6	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds															
Acetone	mg/kg														
Methylene chloride	mg/kg							0.002	J	0.0023	J				
Toluene	mg/kg			0.0032	J							0.0021	J	0.0022	J
Semivolatile Organic Compounds															
2,4-Dinitrotoluene	mg/kg			0.043	J										
Acenaphthylene	mg/kg									0.041	J				
Anthracene	mg/kg									0.23	J				
Benzo(a)anthracene	mg/kg									0.4					
Benzo(a)pyrene	mg/kg									0.39					
Benzo(b)fluoranthene	mg/kg									0.3	J				
Benzo(ghi)perylene	mg/kg									0.22	J				
Benzo(k)fluoranthene	mg/kg									0.35	J				
Chrysene	mg/kg									0.42					
Fluoranthene	mg/kg									0.76					
Indeno(1,2,3-cd)pyrene	mg/kg									0.23	J				
Phenanthrene	mg/kg									0.36	J				
Pyrene	mg/kg									0.55					
Nitroaromatic Compounds															
1,3,5-Trinitrobenzene	mg/kg	4.4				0.74									
2,4,6-Trinitrotoluene	mg/kg	0.38													
2,4-Dinitrotoluene	mg/kg	1.4													
2,6-Dinitrotoluene	mg/kg	1.5													

Table 4-1

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Soils
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

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	Sample Location:	WARWP-DP18		WARWP-DP20	
	Sample No:	8800		8870	
	Sample Date:	25-Jun-98		24-Jun-98	
	Depth (ft):	8-10		4-6	
Parameter	Units	Result	VQ	Result	VQ
Volatile Organic Compounds					
Acetone	mg/kg				
Methylene chloride	mg/kg				
Toluene	mg/kg			0.0015	J
Semivolatile Organic Compounds					
2,4-Dinitrotoluene	mg/kg				
Acenaphthylene	mg/kg			0.04	J
Anthracene	mg/kg			0.12	J
Benzo(a)anthracene	mg/kg			0.17	J
Benzo(a)pyrene	mg/kg			0.14	J
Benzo(b)fluoranthene	mg/kg			0.14	J
Benzo(ghi)perylene	mg/kg			0.076	J
Benzo(k)fluoranthene	mg/kg			0.11	J
Chrysene	mg/kg			0.17	J
Fluoranthene	mg/kg			0.38	
Indeno(1,2,3-cd)pyrene	mg/kg			0.076	J
Phenanthrene	mg/kg			0.25	J
Pyrene	mg/kg			0.28	J
Nitroaromatic Compounds					
1,3,5-Trinitrobenzene	mg/kg	0.98			
2,4,6-Trinitrotoluene	mg/kg				
2,4-Dinitrotoluene	mg/kg				
2,6-Dinitrotoluene	mg/kg				

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP01						WARWP-DP02					
Sample No:		8100		8110		8120		8140		8150		8160	
Sample Date:		23-Jun-98		23-Jun-98		23-Jun-98		23-Jun-98		23-Jun-98		23-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	6880		9190		6010		17900		7540		14500	
Antimony	mg/kg												
Arsenic	mg/kg	2.8		8.6		4.5		7.2		2.5		11.7	
Barium	mg/kg			40.3		27.9		124		32.1		75.3	
Beryllium	mg/kg							1				0.7	
Cadmium	mg/kg												
Calcium	mg/kg	1490		35700		67600		5930		3010		56600	
Chromium	mg/kg	9.9	J	16.1	J	10.9	J	20.8	J	12.1	J	22.2	J
Cobalt	mg/kg			8.5		6.2		16.2				10	
Copper	mg/kg	4		20.1		17.1		20		7		25.6	
Iron	mg/kg	10300		19600		15000		26800		11500		26400	
Lead	mg/kg	3.6	J	8.1	J	7.1	J	13.5	J	4.8	J	10.8	J
Magnesium	mg/kg	1090		14500		20700		4020		2110		15100	
Manganese	mg/kg	89.6		282		329		1190		92.5		423	
Mercury	mg/kg							0.061					
Nickel	mg/kg	7.6		19.4		14		29.1		13		27.8	
Potassium	mg/kg			2010	J	1480	J	2490	J	1210	J	3370	J
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	18.9		28		20.5		37.7		17.8		34.6	
Zinc	mg/kg	21.7		51.2		40		87.4		33.9		68.1	
Moisture Content													
% moisture	%	12.1		20.4		19.5		16.6		16.9		21.1	

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP03						WARP-DP04					
Sample No:		8180		8190		8200		8220		8230		8240	
Sample Date:		23-Jun-98		23-Jun-98		23-Jun-98		23-Jun-98		23-Jun-98		23-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	16500		7040		9400		17000		8640		13400	
Antimony	mg/kg												
Arsenic	mg/kg	8.1		6.8		5.8		6.1		4.5		11.2	
Barium	mg/kg	112		87.2		58		85.4		45.7		35.3	
Beryllium	mg/kg	0.76	J					0.78	J				
Cadmium	mg/kg	0.59											
Calcium	mg/kg	2710		2200		40200		1900		1860		40300	
Chromium	mg/kg	19.9	J	11.4	J	14.8	J	19.2	J	11.9	J	20	J
Cobalt	mg/kg	17.9		21		8.5		14.7		9.2		11.6	
Copper	mg/kg	21.4				20.3		21.9				34.7	
Iron	mg/kg	30200		19600		20100		23900		14500		27800	
Lead	mg/kg	11.7		9.4		7.6		10.3		6.2		12.3	
Magnesium	mg/kg	3760		2020		10800		3220		1990		11000	
Manganese	mg/kg	1340		495		372		915		267		363	
Mercury	mg/kg												
Nickel	mg/kg	44.3		24		23		29.7		20.9		36	
Potassium	mg/kg	2970	J	941	J	2460	J	2510	J	1370	J	3570	J
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	32.5	J	19.6	J	23.3	J	32.9	J	18.2	J	24.7	J
Zinc	mg/kg	111		64.1		54.7		88.1		53.8		80	
Moisture Content													
% moisture	%	15.1		15.2		20.1		14.5		11		21.3	

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP05						WARWP-DP06					
Sample No:		8260		8270		8280		8300		8310		8320	
Sample Date:		16-Jun-98		16-Jun-98		16-Jun-98		23-Jun-98		23-Jun-98		23-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	8120		8840		9510		5600		8610		12100	
Antimony	mg/kg												
Arsenic	mg/kg	4.8		4.6		6.7		2.3		6.8		6.6	
Barium	mg/kg	51.2		62.4		54.3				31.3		82.3	
Beryllium	mg/kg												
Cadmium	mg/kg												
Calcium	mg/kg	2390		54500		50400		1620		2530		55700	
Chromium	mg/kg	13.1		15.3		17.4		8.9	J	15.5	J	17.9	J
Cobalt	mg/kg	8.5		9.6		9.2				7.9		12.8	
Copper	mg/kg	11.7		19.3		19		4.5		12.4		23.5	
Iron	mg/kg	17600		17000		18200		10200		17000		21500	
Lead	mg/kg	6.1		10.5		8.4		2.8	J	7.1	J	11.6	J
Magnesium	mg/kg	2150		23400		14800		1060		1860		17700	
Manganese	mg/kg	468		527		362		143		413		768	
Mercury	mg/kg												
Nickel	mg/kg	17		23.2		21.7		7.1		14.8		31.4	
Potassium	mg/kg	813		1740		1730				924	J	2860	J
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	24.1	J	27.1	J	25.9	J	17.9		25.4		30.8	
Zinc	mg/kg	40.4		53.6		53.4		21.1		39.3		62.2	
Moisture Content													
% moisture	%	10.9		18.2		17.7		10.7		14.5		20.3	

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP07						WARWP-DP08					
Sample No:		8340		8350		8360		8380		8390		8400	
Sample Date:		25-Jun-98		25-Jun-98		25-Jun-98		15-Jun-98		15-Jun-98		15-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	11500		9160		10900		4880		8740		5570	
Antimony	mg/kg												
Arsenic	mg/kg	3.7		3.1		7.4		2.2		6.9		4	
Barium	mg/kg	69.7		43.3		55.4				43.8			
Beryllium	mg/kg	0.7				0.65							
Cadmium	mg/kg												
Calcium	mg/kg	2700		2410		25000		1480		1810		1460	
Chromium	mg/kg	15.8	J	14.1	J	17.1	J	6.8		17.4		7.5	
Cobalt	mg/kg	9		7.3		13.8				7.4			
Copper	mg/kg	15.9		12.5		21.4		2.9		10.4		6.9	
Iron	mg/kg	16800		13900		20700		8460		22000		10000	
Lead	mg/kg	10.1	J	6.9	J	11.6	J	2.2		5.4		4.4	
Magnesium	mg/kg	2720		2340		5620				1810		832	
Manganese	mg/kg	186		123		472		107		231		215	
Mercury	mg/kg												
Nickel	mg/kg	22.3		18.3		29.7		7.5		17		10.8	
Potassium	mg/kg	1650	J	1650	J	2390	J			643			
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	21.1		20.4		24.2		15.8		30		17.8	
Zinc	mg/kg	70.5		57.5		75.6		15.9		37.8		26.5	
Moisture Content													
% moisture	%	16.4		14.4		18.1		13.7		15.9		13.5	

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP09						WARWP-DP10					
Sample No:		8420		8430		8440		8460		8470		Not Sampled	
Sample Date:		16-Jun-98		16-Jun-98		16-Jun-98		26-Jun-98		26-Jun-98			
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	7610		6470		11100		12300		12000			
Antimony	mg/kg					7.7							
Arsenic	mg/kg	6.8		2.2		14		5.2		7.9			
Barium	mg/kg	53.9		41.3		78.2		77.4		80.3			
Beryllium	mg/kg					0.65		0.73		0.86			
Cadmium	mg/kg												
Calcium	mg/kg	58600		1220		7860		3260		2130			
Chromium	mg/kg	22.2		8.2		20.9		15.7	J	17.9	J		
Cobalt	mg/kg					11.9		15.7		11.2			
Copper	mg/kg	18.5		4.9		24.2		16.5		20.4			
Iron	mg/kg	14200		8490		29000		20000		27000			
Lead	mg/kg	11.7		5.8		10.6		11	J	11.5	J		
Magnesium	mg/kg	4510		2010		4980		2930		2850			
Manganese	mg/kg	213		83.4		405		681		243			
Mercury	mg/kg	0.1						0.045					
Nickel	mg/kg	10.6		7.4		36.6		29		33.5			
Potassium	mg/kg					1160		1600	J	1340	J		
Selenium	mg/kg												
Sodium	mg/kg									1270			
Vanadium	mg/kg	21.1	J	14.2	J	27.5	J	22.4		24.6			
Zinc	mg/kg	36.9		30.6		72.5		74.6		94.6			
Moisture Content													
% moisture	%	27.8		16.4		21.7		14.2		16.7			

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP11						WARWP-DP12					
Sample No:		8500		8510		8520		8540		8550		8560	
Sample Date:		25-Jun-98		25-Jun-98		25-Jun-98		15-Jun-98		15-Jun-98		15-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	11300		5980		11400		4720		5080		9320	
Antimony	mg/kg												
Arsenic	mg/kg	3.7		6.5		7.9		2		23.6		8.3	
Barium	mg/kg	72.9		35.5		51.5		24.8		39.3		54.5	
Beryllium	mg/kg	0.64				0.59							
Cadmium	mg/kg												
Calcium	mg/kg	2600		1570		51000		757		18800		57200	
Chromium	mg/kg	15.8	J	9.4	J	16.8	J	5.4		10.6		16.2	
Cobalt	mg/kg	11.5		6.9		10.1				8.2		8.9	
Copper	mg/kg	12.3		10.4		24.3		3.5		19.3		22.6	
Iron	mg/kg	18700		16800		22500		7190		23200		19500	
Lead	mg/kg	9.1	J	6.2	J	8.2	J	2.9		6.4		9.8	
Magnesium	mg/kg	3030		1580		11300		684		6810		17400	
Manganese	mg/kg	375		114		392		172		551		433	
Mercury	mg/kg												
Nickel	mg/kg	22.6		16.6		30.2		8.6		24.9		23.9	
Potassium	mg/kg	1660	J	903	J	3140	J			803		1860	
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	21.1		13.9		24.2		10.1		22.3		25.9	
Zinc	mg/kg	75.4		42.4		58.9		22.9		55		60.6	
Moisture Content													
% moisture	%	16.2		14.4		13.9		10.6		19.7		19.8	

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP13						WARWP-DP15					
Sample No:		8580		8590		8600		8660		8670		8680	
Sample Date:		15-Jun-98		15-Jun-98		15-Jun-98		24-Jun-98		24-Jun-98		24-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	11900		5910		13700		14300		11100		13800	
Antimony	mg/kg												
Arsenic	mg/kg	11.5		3.1		15.3		9.3		3.7		7.6	
Barium	mg/kg	82		27.9		76.3		91.4		53.8		165	
Beryllium	mg/kg	0.67				0.83		0.63	J			0.64	J
Cadmium	mg/kg					0.68							
Calcium	mg/kg	16600		4680		3580		31400		2480		3480	
Chromium	mg/kg	20.3		10.3		22.2		19.7	J	13	J	12.9	J
Cobalt	mg/kg	11.1		6		18.4		13		6.2		16.2	
Copper	mg/kg	26.8		14		29.1		22.7				18	
Iron	mg/kg	27400		10900		34000		24700		13400		24500	
Lead	mg/kg	11.3		4.9		14		10.7		5.9		13.2	
Magnesium	mg/kg	8890		2050		4310		12200		2010		4220	
Manganese	mg/kg	391		231		780		781		269		1900	
Mercury	mg/kg												
Nickel	mg/kg	29.1		10.3		45		32.1		13.6		40.8	
Potassium	mg/kg	1830				1630		2640	J	1370	J	2070	J
Selenium	mg/kg												
Sodium	mg/kg					1030							
Vanadium	mg/kg	31		17		36.7		36.3	J	23.2	J	27.7	J
Zinc	mg/kg	69.9		27.2		82.9		63.4		45.3		75.7	
Moisture Content													
% moisture	%	12.1		13.7		19.1		17		15.4		14.7	

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP16						WARWP-DP17					
Sample No:		8700		8710		8720		8740		8750		8760	
Sample Date:		24-Jun-98		24-Jun-98		24-Jun-98		25-Jun-98		25-Jun-98		25-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	20600		12400		18400		11200		9420		12500	
Antimony	mg/kg	7.4	J										
Arsenic	mg/kg	11.4		11		9.5		5.1		11.6		10	
Barium	mg/kg	130		117		118		61.9		67.7		74.8	
Beryllium	mg/kg	1.2	J			0.82	J					0.74	
Cadmium	mg/kg												
Calcium	mg/kg	3760		31700		13300		1460		2240		2460	
Chromium	mg/kg	25.4	J	15.8	J	22.7	J	14.8	J	15.5	J	19.6	J
Cobalt	mg/kg	17.1		13		15		11.5		15.5		13.8	
Copper	mg/kg	30.9		26.2		26.4		15.4		19.2		21.7	
Iron	mg/kg	36000		29200		31100		19800		26100		26600	
Lead	mg/kg	11.4		9.1		10.1		10.6		9		8.7	
Magnesium	mg/kg	4870		10100		6970		2500	J	2530	J	2920	J
Manganese	mg/kg	982		1280		1170		207		326		362	
Mercury	mg/kg	0.04											
Nickel	mg/kg	46.9		33.9		39.3		20.5		31.6		31.1	
Potassium	mg/kg	2590	J	1830	J	3240	J	898	J	1030	J	1580	J
Selenium	mg/kg							0.65					
Sodium	mg/kg	681				726				858		952	
Vanadium	mg/kg	40.5	J	31	J	40.3	J	19.2		22.1		27.5	
Zinc	mg/kg	103		70.9		81.2		65.4		66.1		74.3	
Moisture Content													
% moisture	%	16.6		18.5		21.6		14.6		17.8		16.3	

Table 4-2

Summary of Detected Inorganic Compounds and Soil Moisture Content
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		WARWP-DP18						WARWP-DP19					
Sample No:		8780		8790		8800		8820		8830		8840	
Sample Date:		25-Jun-98		25-Jun-98		25-Jun-98		24-Jun-98		24-Jun-98		24-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	10700		8670		21000		6680		18000		17000	
Antimony	mg/kg												
Arsenic	mg/kg	5.3		4.1		4.9		2.1		9.4		9.8	
Barium	mg/kg	61.9		58.8		92.7		26.4		70		83.3	
Beryllium	mg/kg	0.59				1				0.83	J	0.75	J
Cadmium	mg/kg												
Calcium	mg/kg	7330		4890		39100		1620		2600		34600	
Chromium	mg/kg	15.3	J	13	J	28.6	J	9.1	J	23.3	J	25.1	J
Cobalt	mg/kg	11.1		8.1		11.5				19		14.5	
Copper	mg/kg	17.3		14		25.2				30.6		30.9	
Iron	mg/kg	18400		15400		26000		10600		32000		30000	
Lead	mg/kg	9.6		7.6		11		3.4		13.2		11.2	
Magnesium	mg/kg	4680	J	2860	J	10300	J	1290		4480		14700	
Manganese	mg/kg	453		261		374		184		898		568	
Mercury	mg/kg												
Nickel	mg/kg	23.5		20.4		35.9		9.8		42.3		37.9	
Potassium	mg/kg	1270	J	1080	J	5630	J	742	J	2430	J	3960	J
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	23		17.8		37.2		19.8	J	38.9	J	37.3	J
Zinc	mg/kg	60.3		55.2		64.9		28.7		85.1		81.6	
Moisture Content													
% moisture	%	11.8		12.1		26.3		10.7		18		21.9	

Table 4-2

mary of Detected Inorganic Compounds and Soil Moisture Co
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 10 of 10)

Sample Location:		WARWP-DP20					
Sample No:		8860		8870		8880	
Sample Date:		24-Jun-98		24-Jun-98		24-Jun-98	
Depth (ft):		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ
Metals							
Aluminum	mg/kg	13000		10900		12000	
Antimony	mg/kg						
Arsenic	mg/kg	8.5		7		4.6	
Barium	mg/kg	66		56.1		80.3	
Beryllium	mg/kg						
Cadmium	mg/kg						
Calcium	mg/kg	35600		23500		5120	
Chromium	mg/kg	16.7	J	16.1	J	16.9	J
Cobalt	mg/kg	11.9		7.8		10.1	
Copper	mg/kg						
Iron	mg/kg	20900		19100		18800	
Lead	mg/kg	9.4		7.4		7.4	
Magnesium	mg/kg	9970		8670		3690	
Manganese	mg/kg	551		320		484	
Mercury	mg/kg						
Nickel	mg/kg	19.3		18.6		28.7	
Potassium	mg/kg	2040	J	1350	J	1710	J
Selenium	mg/kg						
Sodium	mg/kg					619	
Vanadium	mg/kg	35	J	29.1	J	24.1	J
Zinc	mg/kg	49.8		48.2		77.5	
Moisture Content							
% moisture	%	11.7		13		14.1	

Table 4-3

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Groundwater
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 3)

Sample Location:		WARWP-DP02		WARWP-DP04		WARWP-DP06		WARWP-DP08	
Sample No:		8170		8250		8330		8410	
Sample Date:		24-Jun-98		24-Jun-98		23-Jun-98		16-Jun-98	
Depth (ft):		0-0		0-0		0-0		0-0	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds									
2-Butanone	µg/L								
Benzene	µg/L	0.15	J						
Carbon disulfide	µg/L							0.15	J
Ethylbenzene	µg/L								
Tetrachloroethene	µg/L							0.2	J
Semivolatile Organic Compounds									
2,4-Dinitrotoluene	µg/L								
2,6-Dinitrotoluene	µg/L								
3-Nitroaniline	µg/L			3.2	J				
4,6-Dinitro-2-methylphenol	µg/L								
4-Nitrophenol	µg/L								
Nitroaromatic Compounds									
1,3,5-Trinitrobenzene	µg/L								
1,3-Dinitrobenzene	µg/L					0.2		0.74	
2,4,6-Trinitrotoluene	µg/L								
2,4-Dinitrotoluene	µg/L							2.3	
2,6-Dinitrotoluene	µg/L							0.28	

Table 4-3

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Groundwater
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 3)

Sample Location:		WARWP-DP09		WARWP-DP11		WARWP-DP12		WARWP-DP13	
Sample No:		8450		8530		8570		8610	
Sample Date:		16-Jun-98		26-Jun-98		15-Jun-98		15-Jun-98	
Depth (ft):		0-0		0-0		0-0		0-0	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds									
2-Butanone	µg/L								
Benzene	µg/L			0.13	J				
Carbon disulfide	µg/L								
Ethylbenzene	µg/L							0.19	J
Tetrachloroethene	µg/L	0.15	J						
Semivolatile Organic Compounds									
2,4-Dinitrotoluene	µg/L	60		1.8	J			660	
2,6-Dinitrotoluene	µg/L	6.3	J					56	J
3-Nitroaniline	µg/L	5.1	J	2.1	J			15	J
4,6-Dinitro-2-methylphenol	µg/L	24	J						
4-Nitrophenol	µg/L	2.4	J						
Nitroaromatic Compounds									
1,3,5-Trinitrobenzene	µg/L	9.4		7.2				680	
1,3-Dinitrobenzene	µg/L	8.6				0.69		270	
2,4,6-Trinitrotoluene	µg/L			7.1					
2,4-Dinitrotoluene	µg/L	28				2		950	
2,6-Dinitrotoluene	µg/L	2.7				0.25			

Table 4-3

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Groundwater
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 3 of 3)

Sample Location:		WARWP-DP15		WARWP-DP16		WARWP-DP17		WARWP-DP19	
Sample No:		8690		8730		8770		8850	
Sample Date:		26-Jun-98		25-Jun-98		25-Jun-98		26-Jun-98	
Depth (ft):		0-0		0-0		0-0		0-0	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds									
2-Butanone	µg/L	1.2	J					1.8	J
Benzene	µg/L								
Carbon disulfide	µg/L							0.18	J
Ethylbenzene	µg/L								
Tetrachloroethene	µg/L								
Semivolatile Organic Compounds									
2,4-Dinitrotoluene	µg/L			60	J	52	J		
2,6-Dinitrotoluene	µg/L			15	J	18	J		
3-Nitroaniline	µg/L			43	J	49	J		
4,6-Dinitro-2-methylphenol	µg/L								
4-Nitrophenol	µg/L								
Nitroaromatic Compounds									
1,3,5-Trinitrobenzene	µg/L			40		32			
1,3-Dinitrobenzene	µg/L							0.24	
2,4,6-Trinitrotoluene	µg/L								
2,4-Dinitrotoluene	µg/L	1.1				22			
2,6-Dinitrotoluene	µg/L								

Table 4-4

Summary of Detected Inorganic Constituents in Groundwater
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 4)

Sample Location:		WARWP-DP02		WARWP-DP04		WARWP-DP07		WARWP-DP09	
Sample No:		8170		8250		8370		8450	
Sample Date:		24-Jun-98		24-Jun-98		26-Jun-98		16-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Total Metals (Unfiltered)									
Aluminum	µg/L	13100		1240		51100		11100	
Antimony	µg/L								
Arsenic	µg/L	21.4						15.2	
Barium	µg/L					248			
Beryllium	µg/L								
Calcium	µg/L	336000		569000		644000		230000	
Chromium	µg/L	28.8				91.6			
Cobalt	µg/L					68.4			
Copper	µg/L	90.2				126			
Iron	µg/L	39900		2650		123000		28500	
Lead	µg/L	14.4						11.8	
Magnesium	µg/L	95100	J	234000	J	105000	J	219000	
Manganese	µg/L	750		1410		3310		8610	
Mercury	µg/L								
Nickel	µg/L	61.5				220			
Potassium	µg/L	6880		17400		17100			
Selenium	µg/L								
Sodium	µg/L	408000		81800		182000		44300	
Thallium	µg/L								
Vanadium	µg/L	62				125			
Zinc	µg/L	123		22.1		411			

Table 4-4

Summary of Detected Inorganic Constituents in Groundwater
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 4)

Sample Location:		WARWP-DP02		WARWP-DP04		WARWP-DP07		WARWP-DP09	
Sample No:		8170		8250		8370		8450	
Sample Date:		24-Jun-98		24-Jun-98		26-Jun-98		16-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Dissolved Metals (Filtered)									
Aluminum	µg/L								
Cadmium	µg/L								
Calcium	µg/L	211000		549000		364000		237000	
Chromium	µg/L								
Cobalt	µg/L								
Copper	µg/L	42.1							
Iron	µg/L							120	
Lead	µg/L							4.4	
Magnesium	µg/L	62800	J	242000	J	71400	J	227000	
Manganese	µg/L	84.5		1450		480		8480	
Nickel	µg/L								
Potassium	µg/L			18200		6170			
Sodium	µg/L	443000		114000		185000		44800	
Zinc	µg/L								
Water Quality Parameters									
Alkalinity	µg/L							1E+06	
Hardness	µg/L							1E+06	
Total suspended	µg/L							85000	
Total dissolved so	µg/L							2E+06	
Total organic carb	µg/L							32000	
Nitrate	µg/L								
Sulfate	µg/L							305000	

Table 4-4

Summary of Detected Inorganic Constituents in Groundwater
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 3 of 4)

Sample Location:		WARWP-DP11		WARWP-DP13		WARWP-DP16		WARWP-DP17	
Sample No:		8530		8610		8730		8770	
Sample Date:		26-Jun-98		15-Jun-98		25-Jun-98		25-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Total Metals (Unfiltered)									
Aluminum	µg/L	59700		77200		206000		38500	
Antimony	µg/L					106			
Arsenic	µg/L	56.2		1780		111			
Barium	µg/L	386				773		217	
Beryllium	µg/L					9.5			
Calcium	µg/L	982000		315000		2680000		555000	
Chromium	µg/L	96.8		127		296		58.7	
Cobalt	µg/L	85.2				264		173	
Copper	µg/L	214				654		153	
Iron	µg/L	137000		153000		339000		73000	
Lead	µg/L	68.3		459		157		28.9	
Magnesium	µg/L	242000	J	86200		651000	J	178000	J
Manganese	µg/L	4840		12600		9280		2470	
Mercury	µg/L	0.24		0.65		0.47		0.25	
Nickel	µg/L	249				515		134	
Potassium	µg/L	20500				33100		7640	
Selenium	µg/L			1790					
Sodium	µg/L	503000		187000		907000		1060000	
Thallium	µg/L			1770					
Vanadium	µg/L	161				381		113	
Zinc	µg/L	467		397		1260		265	

Table 4-4

Summary of Detected Inorganic Constituents in Groundwater
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 4 of 4)

Sample Location:		WARWP-DP11		WARWP-DP13		WARWP-DP16		WARWP-DP17	
Sample No:		8530		8610		8730		8770	
Sample Date:		26-Jun-98		15-Jun-98		25-Jun-98		25-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Dissolved Metals (Filtered)									
Aluminum	µg/L					203		1350	
Cadmium	µg/L					46			
Calcium	µg/L	395000		156000		735000		301000	
Chromium	µg/L							32.9	
Cobalt	µg/L					162		142	
Copper	µg/L	67				117		94.6	
Iron	µg/L	121				373		2600	
Lead	µg/L								
Magnesium	µg/L	80100	J			193000	J	145000	J
Manganese	µg/L	1070		7870		635		891	
Nickel	µg/L	62				46.3			
Potassium	µg/L	10200							
Sodium	µg/L	614000		192000		1040000		993000	
Zinc	µg/L					28.2			
Water Quality Parameters									
Alkalinity	µg/L			643000					
Hardness	µg/L			960000					
Total suspended	µg/L			15000					
Total dissolved so	µg/L			1E+06					
Total organic carb	µg/L			36600					
Nitrate	µg/L			1600					
Sulfate	µg/L			278000					

Table 4-5

Summary of Detected Constituents in Surface Water and Sediment Samples
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

		Surface Water Samples											
		WARP-SW01 12100 5-Nov-98		WARP-SW02 12110 5-Nov-98		WARP-SW03 12120 5-Nov-98		WARP-SW04 12130 5-Nov-98		WARP-SW05 12140 5-Nov-98		WARP-SW06 12150 5-Nov-98	
Parameter	Units	Result	V.Q.	Result	V.Q.	Result	V.Q.	Result	V.Q.	Result	V.Q.	Result	V.Q.
Organic Compounds													
Bromomethane	µg/L	0.22	J			0.16	J	0.21	J	0.21	J	0.16	J
di-n-Octyl phthalate	µg/L									7.8	J		
Total Metals													
Aluminum	µg/L	631	J			300	J			13800	J	12400	J
Arsenic	µg/L									20.2		21.8	
Calcium	µg/L	107000		106000		106000		105000		31100		115000	
Chromium	µg/L									17.4		23.3	J
Iron	µg/L	1300		126		747		646		21100		19000	
Lead	µg/L									25		32.9	
Magnesium	µg/L	26000		26500		26200		25800		46500		50700	
Manganese	µg/L	890		30.6		261		126		1150		1550	
Potassium	µg/L	9400		9730		9750		9910		5590		5180	
Sodium	µg/L	38200		39300		38300		39000		104000		107000	
Vanadium	µg/L											52.2	
Zinc	µg/L	27								84.8		92.5	
Dissolved Metals													
Aluminum	µg/L					233				6340		11400	
Arsenic	µg/L									10.9		17.2	
Calcium	µg/L	104000		106000		104000		103000		27600		71500	
Chromium	µg/L											21.2	J
Iron	µg/L	153				484		589		8630		15500	
Lead	µg/L									7.2		20.4	J
Magnesium	µg/L	25600		26500		25700		25400		44300		49100	
Manganese	µg/L	218				97.2		107		669		907	
Potassium	µg/L	8870		9340		9080		9370				5900	
Sodium	µg/L	37400		38800		37200		37900		103000		112000	
Zinc	µg/L									42.3		68	
Hardness													
Hardness	µg/L	380000		408000		400000		420000		372000		592000	

Table 4-5

Summary of Detected Constituents in Surface Water and Sediment Samples
West Area
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

		Sediment Samples											
		WARP-SD01		WARP-SD02		WARP-SD03		WARP-SD04		WARP-SD05		WARP-SD06	
		11100		11110		11120		11130		11140		11150	
		5-Nov-98		5-Nov-98		5-Nov-98		5-Nov-98		5-Nov-98		5-Nov-98	
		0 - 0.5 ft		0 - 0.5 ft		0 - 0.5 ft		0 - 0.5 ft		0 - 0.5 ft		0 - 0.5 ft	
Parameter	Units	Result	V.Q.	Result	V.Q.	Result	V.Q.	Result	V.Q.	Result	V.Q.	Result	V.Q.
Organic Compounds													
2-Butanone	mg/kg					0.029	J			0.021	J		
Acetone	mg/kg									0.11	J	0.071	J
Benzo(a)anthracene	mg/kg	0.051	J										
Benzo(a)pyrene	mg/kg	0.053	J										
Benzo(k)fluoranthene	mg/kg	0.052	J										
Chrysene	mg/kg	0.06	J										
Fluoranthene	mg/kg	0.11	J					0.047	J				
Phenanthrene	mg/kg	0.055	J										
Pyrene	mg/kg	0.079	J										
Metals													
Aluminum	mg/kg	3170		2450		4260		3230		6880		9600	
Arsenic	mg/kg	5.4		3.5		7.3		8.6		4.6		8.7	
Barium	mg/kg	26.6				36		34.8		65			
Calcium	mg/kg	10800		13900		12300		16000		6710		74700	
Chromium	mg/kg	6.7		5.3		8.1		7.4		12.6		28.7	
Cobalt	mg/kg	10.9		6.4		10.6		10.8					
Copper	mg/kg	13.7		8.8		15		9.8		15.2		24.5	
Iron	mg/kg	14900		9900		16500		24300		16000		18000	
Lead	mg/kg	9.7		6.5		9.4		8.1		22.6		32.1	
Magnesium	mg/kg	2110		2720		2520		2950		3130		6770	
Manganese	mg/kg	305		231		290		255		338		726	
Nickel	mg/kg	23		13.7		24.4		18.3		15.2		24.5	
Vanadium	mg/kg											25	
Potassium	mg/kg					821		45.3		54.4		77	
Zinc	mg/kg	48		35.1		58.4							
Total Organic Carbon													
Total organic carbon	mg/kg	5430		3960		9650		5520		40200		93400	

Table 4-6

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Soils
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 3)

Sample Location:		PRRWP-DP01				PRRWP-DP02		PRRWP-DP03			
Sample No:		7210		7220		7260		7280		7290	
Sample Date:		11-Jun-98		11-Jun-98		14-Jun-98		8-Jun-98		8-Jun-98	
Depth (ft):		4-6		8-10		8-10		0-2		4-5	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds											
Acetone	mg/kg										
Methylene chloride	mg/kg										
Toluene	mg/kg										
Semivolatile Organic Compounds											
2,4-Dinitrotoluene	mg/kg					0.081	J			8.8	
2,6-Dinitrotoluene	mg/kg									0.58	J
3-Nitroaniline	mg/kg										
Nitroaromatic Compounds											
1,3,5-Trinitrobenzene	mg/kg	0.56		2.7						43	
1,3-Dinitrobenzene	mg/kg									9.3	
2,4,6-Trinitrotoluene	mg/kg					0.38					
2,4-Dinitrotoluene	mg/kg	0.96		0.29		0.28		1.2		25	
2,6-Dinitrotoluene	mg/kg	0.35									
4-Amino-2,6-dinitrotoluene	mg/kg										

Table 4-6

Volatile Organcis, Semivolatile Organics, and Nitroaromatic Analytical Results in Soils
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 3)

Sample Location:		PRRWP-DP06		PRRWP-DP07		PRRWP-DP09				PRRWP-DP10	
Sample No:		7420		7450		7530R		7540R		7580	
Sample Date:		8-Jun-98		9-Jun-98		25-Jun-98		25-Jun-98		10-Jun-98	
Depth (ft):		9-10		4-6		4-6		8-10		9-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds											
Acetone	mg/kg			0.0082	J						
Methylene chloride	mg/kg										
Toluene	mg/kg					0.0017	J				
Semivolatile Organic Compounds											
2,4-Dinitrotoluene	mg/kg					0.056	J				
2,6-Dinitrotoluene	mg/kg										
3-Nitroaniline	mg/kg										
Nitroaromatic Compounds											
1,3,5-Trinitrobenzene	mg/kg	1.8						1.3		18	
1,3-Dinitrobenzene	mg/kg									5.2	
2,4,6-Trinitrotoluene	mg/kg										
2,4-Dinitrotoluene	mg/kg	1.1								15	
2,6-Dinitrotoluene	mg/kg									1.7	
4-Amino-2,6-dinitrotoluene	mg/kg										

Table 4-6

Volatile Organic, Semivolatile Organics, and Nitroaromatic Analytical Results in Soils
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 3 of 3)

Sample Location:		PRRWP-DP11						PRRWP-DP15		PRRWP-DP16		PRRWP-DP19	
Sample No:		7600		7610		7620		7780		7820		7920	
Sample Date:		13-Jun-98		13-Jun-98		13-Jun-98		12-Jun-98		12-Jun-98		12-Jun-98	
Depth (ft):		0-2		4-6		8-10		8-10		8-10		0-2	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds													
Acetone	mg/kg												
Methylene chloride	mg/kg									0.0021	J	0.0018	J
Toluene	mg/kg												
Semivolatile Organic Compounds													
2,4-Dinitrotoluene	mg/kg	0.16	J					0.19	J	0.0004	J		
2,6-Dinitrotoluene	mg/kg	0.05	J							0.049	J		
3-Nitroaniline	mg/kg							0.053	J				
Nitroaromatic Compounds													
1,3,5-Trinitrobenzene	mg/kg			0.43		7				1.9			
1,3-Dinitrobenzene	mg/kg			0.43		5.8				0.25			
2,4,6-Trinitrotoluene	mg/kg	0.27											
2,4-Dinitrotoluene	mg/kg	0.32		1.6		1.2				0.5			
2,6-Dinitrotoluene	mg/kg			0.29		0.3				0.5			
4-Amino-2,6-dinitrotoluene	mg/kg	2.7											

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		PRRWP-DP01						PRRWP-DP02					
Sample No:		7200		7210		7220		7240R		7250		7260	
Sample Date:		11-Jun-98		11-Jun-98		11-Jun-98		22-Jun-98		14-Jun-98		14-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	9370		11500		10100		9210		11200		11500	
Antimony	mg/kg			7.9	J								
Arsenic	mg/kg	4.5	J	27.9	J	9.1	J	5		6.1		12.5	
Barium	mg/kg	84.3		239		88.5		45.1		61.5		91.9	
Beryllium	mg/kg	0.69		0.71						0.68			
Cadmium	mg/kg												
Calcium	mg/kg	5740		35300		35600		10300		3670		7720	
Chromium	mg/kg	14.7		9		17.7		13.3	J	20.4		20.8	
Cobalt	mg/kg	11.1		21.2		11.6		6.6		11.2		13.6	
Copper	mg/kg	22.6		34.5		23.3		12.6		14.5		25.8	
Iron	mg/kg	18000		34500		22500		14300		21900		23800	
Lead	mg/kg	8.6		13.2		10.4		12.3	J	7.8		12.2	
Magnesium	mg/kg	2480		12500		13900		5150		2590		5650	
Manganese	mg/kg	321		2230		706		234		315		521	
Mercury	mg/kg							0.04		0.045			
Nickel	mg/kg	27.2		57.2		32.5		14.6		25.6		32.2	
Potassium	mg/kg	777		2330		1790		1460	J	916		1630	
Selenium	mg/kg	0.84								0.69		0.82	
Sodium	mg/kg	1240		1080		1050							
Vanadium	mg/kg	19.1		30		26.6		23.1		27.3	J	26.2	J
Zinc	mg/kg	78.5		83.1		65.9		45.5		64.6		70.3	
Moisture Content													
% moisture	%	19		19.7		20.8		13.2		19.3		25	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		PRRWP-DP03						PRRP-DP04					
Sample No:		7280		7290				7320		7330		7340	
Sample Date:		8-Jun-98		8-Jun-98				9-Jun-98		9-Jun-98		9-Jun-98	
Depth (ft):		0-2		4-5		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	6330		9580				7030		6990		8040	
Antimony	mg/kg												
Arsenic	mg/kg	5.4		9.7				6.6		5.4		5.2	
Barium	mg/kg	65.7		67.9				37.2		39.4		50.5	
Beryllium	mg/kg												
Cadmium	mg/kg												
Calcium	mg/kg	2560		2600				2680		19800		61200	
Chromium	mg/kg	8.7		15.7				15.5		12.4		14.1	
Cobalt	mg/kg			6.3						7.4		9.8	
Copper	mg/kg	8.4		18.7				7		13.3		23.6	
Iron	mg/kg	14100		23700				16700		13900		18200	
Lead	mg/kg	9.3	J	11.6	J			4.3	J	9.8	J	10.3	J
Magnesium	mg/kg	1160		2810				1290		10700		19500	
Manganese	mg/kg	320		338				144		292		327	
Mercury	mg/kg												
Nickel	mg/kg	9.3		22.9				12.2		16.6		25.9	
Potassium	mg/kg			968						864		1580	
Selenium	mg/kg	0.59								0.64		1.1	
Sodium	mg/kg			3760									
Vanadium	mg/kg	17.3	J	23.9	J			28.5	J	19.7	J	23.7	J
Zinc	mg/kg	34.2		61.3				30.6		43.7		56.9	
Moisture Content													
% moisture	%	8.7		20.8				17.1		20.7		20.6	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		PRRWP-DP05						PRRWP-DP06					
Sample No:		7360R		7370		7380R		7400		7410		7420	
Sample Date:		25-Jun-98		14-Jun-98		25-Jun-98		8-Jun-98		8-Jun-98		8-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-5		9-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	6820		11300		9040		6110		8710		7260	
Antimony	mg/kg			9.3									
Arsenic	mg/kg	2.9		42.8		17.6		3.6		9.1		5.3	
Barium	mg/kg	27.6		128		115				57.3		44.9	
Beryllium	mg/kg			0.67									
Cadmium	mg/kg												
Calcium	mg/kg	1490		58500		57800		945		62300		43700	
Chromium	mg/kg	9.3		18.4		14.4		10.9		15.9		14.4	
Cobalt	mg/kg			19		10.2							
Copper	mg/kg	4.9		24.6		19.7		5.9		26.2		15.2	
Iron	mg/kg	9170		43700		22700		13700		24200		15300	
Lead	mg/kg	5.5		10.6		8		3.5	J	11.3	J	7.6	J
Magnesium	mg/kg	1010		17400		17100		885		16000		12600	
Manganese	mg/kg	127	J	797		731	J	166		430		321	
Mercury	mg/kg												
Nickel	mg/kg	7.4		40.1		23.8		9.4		22.9		17.6	
Potassium	mg/kg			2250		2190				1380		1190	
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	16.3	J	38.4	J	25.4	J	23.1	J	27.1	J	21.8	J
Zinc	mg/kg	24.9		104		52.1		22.6		68.9		45.5	
Moisture Content													
% moisture	%	11.6		20.8		20.4		15.8		18.4		20.3	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		PRRWP-DP07						PRRWP-DP08					
Sample No:		7440		7450		7460		7480		7490		7500	
Sample Date:		9-Jun-98		9-Jun-98		9-Jun-98		10-Jun-98		10-Jun-98		10-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	4120		8560		7960		4450		8700		7140	
Antimony	mg/kg												
Arsenic	mg/kg	2.5		6.3		6.5		4.2		12.9		4.2	
Barium	mg/kg			55.3		54.5				42.5		47.4	
Beryllium	mg/kg												
Cadmium	mg/kg												
Calcium	mg/kg	1420		62800		62000		1820		57000		52200	
Chromium	mg/kg	6.1		14.3		13		10.6		14.6		12.6	
Cobalt	mg/kg			13.1		9.8		6		9.8		7.9	
Copper	mg/kg	4.3		20.3		23.9		6.5		21.7		16.5	
Iron	mg/kg	8330		17500		20000		13400		19400		16000	
Lead	mg/kg	3.2	J	10.3	J	10.9	J	3.1	J	9.2	J	7.6	J
Magnesium	mg/kg	830		19100		19200		894		16800		15700	
Manganese	mg/kg	116		536		520		207		283		393	
Mercury	mg/kg												
Nickel	mg/kg	7		29.7		26.1		7.9		25.7		19.6	
Potassium	mg/kg			1720		1660				1820		1580	
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	12.9	J	24.4	J	22.9	J	24.4	J	24.1	J	21.3	J
Zinc	mg/kg	17.9		54.7		61.9		21.7		64.8		46.6	
Moisture Content													
% moisture	%	6.1		18.6		18.9		13.6		18.5		18	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		PRRWP-DP09						PRRWP-DP10					
Sample No:		7520R		7530R		7540R		7560		7570		7580	
Sample Date:		25-Jun-98		25-Jun-98		25-Jun-98		10-Jun-98		10-Jun-98		10-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-1		4-5		9-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	7220		4410		4630		4620		9510		11600	
Antimony	mg/kg												
Arsenic	mg/kg	2.4		2.6		6.3		3.4		5.6		14.9	
Barium	mg/kg	24.3				26.5				81.5		90.9	
Beryllium	mg/kg									0.83		0.77	
Cadmium	mg/kg												
Calcium	mg/kg	1750		63200		58500		2440		4620		4510	
Chromium	mg/kg	8.8		9.2		8.7		10.9		12.6		20.1	
Cobalt	mg/kg											10.2	
Copper	mg/kg	4.9		11.2		15.1		5.9		17.5		22.1	
Iron	mg/kg	8430		9480		10600		13700		16100		28700	
Lead	mg/kg	5.1		4.9		6.3		3.2	J	11.3	J	14.3	J
Magnesium	mg/kg	1110		16800		16900		920		2090		3970	
Manganese	mg/kg	102	J	184	J	273	J	273		230		484	
Mercury	mg/kg												
Nickel	mg/kg	6.3		8.4		15.5		9.6		11.4		30	
Potassium	mg/kg			1050		1200						1080	
Selenium	mg/kg					0.87				0.71			
Sodium	mg/kg									4130		4280	
Vanadium	mg/kg	15.8	J	20.9	J	17.5	J	23.6	J	22.1	J	31.6	J
Zinc	mg/kg	22.5		24.8		35.5		24.4		49.7		72.7	
Moisture Content													
% moisture	%	11.2		19.6		23		10.5		22.4		20.4	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		PRRWP-DP11						PRRWP-DP12					
Sample No:		7600		7610		7620		7640		7650		7660	
Sample Date:		13-Jun-98		13-Jun-98		13-Jun-98		11-Jun-98		11-Jun-98		11-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	6200		8950		11200		9560		12000		12300	
Antimony	mg/kg											7.8	J
Arsenic	mg/kg	7		25.3		5.3		7.3	J	5.7	J	7.4	J
Barium	mg/kg	39.4		209		51.5		71.5		60.3		69.5	
Beryllium	mg/kg			0.66				0.68					
Cadmium	mg/kg												
Calcium	mg/kg	17300		3380		61600		4310		37100		55600	
Chromium	mg/kg	11.2		11		19		14		19.7		20	
Cobalt	mg/kg	7.4		30.3		10.8		6.4		10.8		12	
Copper	mg/kg	10.1		13.1		23.3		10.4		26.7		25.4	
Iron	mg/kg	14700		36200		20800		16000		22300		23200	
Lead	mg/kg	7.9		9.8		9.9		9.6		10.7		10.6	
Magnesium	mg/kg	6390		2500		20500		1900		16600		19100	
Manganese	mg/kg	365		1640		457		337		306		521	
Mercury	mg/kg												
Nickel	mg/kg	14.4		26.8		30.1		12.1		31.6		30.9	
Potassium	mg/kg	849		1060		2580		684		2430		2730	
Selenium	mg/kg												
Sodium	mg/kg	741		1200		1520							
Vanadium	mg/kg	20.1	J	34.2	J	31	J	23.7		26.8		29.9	
Zinc	mg/kg	39.1		68.5		62.2		38.5		71.9		65.3	
Moisture Content													
% moisture	%	13.5		17.1		20.4		12.4		19.9		19.6	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:		PRRWP-DP13						PRRWP-DP14					
Sample No:		7680		7690		7700		7720		7730		7740	
Sample Date:		12-Jun-98		12-Jun-98		12-Jun-98		11-Jun-98		11-Jun-98		11-Jun-98	
Depth (ft):		0-2		4-6		8-10				4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	7760		6380		5930		12700		9640		8710	
Antimony	mg/kg												
Arsenic	mg/kg	3.4		5.3		4.1		7.4		8.2		8.1	
Barium	mg/kg			29.2		42.4		49.6		39		64.8	
Beryllium	mg/kg							0.69					
Cadmium	mg/kg												
Calcium	mg/kg			2100		67100		3010		4340		53400	
Chromium	mg/kg	9.4		11.3		10.7		20.2		17.4		15.9	
Cobalt	mg/kg			7		7.2		8.3		8.4		10.3	
Copper	mg/kg	6.5		13.7		16.2		14.7		14.3		21.1	
Iron	mg/kg	11200		15400		13000		22900		20100		18700	
Lead	mg/kg	4.1		5.1		7.7		6.8		6.5		9.6	
Magnesium	mg/kg	938		1560		25300		2310		2940		21100	
Manganese	mg/kg	74.5		313		472		173		275		506	
Mercury	mg/kg							0.043					
Nickel	mg/kg	8.4		20.2		19.4		20.5		19.4		26.5	
Potassium	mg/kg					1330		771		713		1850	
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	19.8		19.1		21		35.2		27		25.2	
Zinc	mg/kg	23.1		40.6		43.7		46.1		41.2		57.3	
Moisture Content													
% moisture	%	10		17		17.2		19.3		17.3		17.8	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

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Sample Location:						PRRWP-DP16					
Sample No:		7770		7780		7800		7810		7820	
Sample Date:		12-Jun-98		12-Jun-98		12-Jun-98		12-Jun-98		12-Jun-98	
Depth (ft):		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals											
Aluminum	mg/kg	8870		6010		7300		9850		9430	
Antimony	mg/kg										
Arsenic	mg/kg	15.9		6.9		5.4		9.7		4.8	
Barium	mg/kg	176		41.5		30.4		59.5		47.5	
Beryllium	mg/kg							0.55			
Cadmium	mg/kg										
Calcium	mg/kg	53300		67400		7980		3080		57600	
Chromium	mg/kg	5.2		11.6		11		17.5		16.8	
Cobalt	mg/kg	26.7		9				14.4		9.1	
Copper	mg/kg	24.6		19.3		11.2		21.7		24.3	
Iron	mg/kg	20500		18300		13300		22000		19300	
Lead	mg/kg	13.4		8.1		7.7	J	10.7	J	10.5	J
Magnesium	mg/kg	17200		20300		3100		4020		18100	
Manganese	mg/kg	2270		467		147		437		303	
Mercury	mg/kg										
Nickel	mg/kg	56.1		22.2		12		31.1		27	
Potassium	mg/kg	1380		1370				1210		1750	
Selenium	mg/kg										
Sodium	mg/kg			1030				1160		1090	
Vanadium	mg/kg	26.7		19.3		21.4	J	23.3	J	26.1	J
Zinc	mg/kg	59.7		52		37.4		67.2		64.2	
Moisture Content											
% moisture	%	19.4		17.9		18.8		9.4		20.2	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Sample Location:		PRRWP-DP17						PRRWP-DP18					
Sample No:		7840		7850		7860		7880		7890		7900	
Sample Date:		10-Jun-98		10-Jun-98		10-Jun-98		11-Jun-98		11-Jun-98		11-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	7140		5570		3320		10700		7340		9140	
Antimony	mg/kg												
Arsenic	mg/kg	2.3	J	3.1	J	4.5	J	4	J	27.3	J	5.8	J
Barium	mg/kg							32.3		41.8		66.2	
Beryllium	mg/kg												
Cadmium	mg/kg											0.63	
Calcium	mg/kg	817		1850		61500		1040		38400		61600	
Chromium	mg/kg	10.8		15.5		7.3		14.6		13.6		15.7	
Cobalt	mg/kg			7.3				6.2		8.7		10.6	
Copper	mg/kg	3.8		5.3		10.6		7.5		19		24.3	
Iron	mg/kg	13100		16400		8940		17800		20000		20600	
Lead	mg/kg	3.3		2.9		4.3		5.6		7.6		9.6	
Magnesium	mg/kg	791		917		16200		1120		12800		19200	
Manganese	mg/kg	104		323		252		158		300		534	
Mercury	mg/kg												
Nickel	mg/kg	6.4		8.1		11		9.8		21.5		29	
Potassium	mg/kg					726				1310		1990	
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	23.4		29.3		15		30.3		25.7		24.6	
Zinc	mg/kg	21.3		22.7		31.6		27.9		56.2		64.5	
Moisture Content													
% moisture	%	9.7		16.3		18.1		12.9		21.7		19.9	

Table 4-7

Summary of Detected Inorganic Compounds and Soil Moisture Content
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 10 of 10)

Sample Location:		PRRWP-DP19						PRRWP-DP20					
Sample No:		7920		7930		7940		7960		7970		7980	
Sample Date:		12-Jun-98		12-Jun-98		12-Jun-98		13-Jun-98		13-Jun-98		13-Jun-98	
Depth (ft):		0-2		4-6		8-10		0-2		4-6		8-10	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Metals													
Aluminum	mg/kg	2370		7060		9590		5360		7580		10800	
Antimony	mg/kg											7.7	
Arsenic	mg/kg	14.1		4.7		4.9		3.6		4.7		5.5	
Barium	mg/kg	33.6		51.2		61				58.2		69.3	
Beryllium	mg/kg												
Cadmium	mg/kg												
Calcium	mg/kg	54000		56900		68000		2160		61900		70400	
Chromium	mg/kg	4.2		12.5		15.7		11.4		13.1		17	
Cobalt	mg/kg			8.7		9.4		5.8		9.3		11.3	
Copper	mg/kg	10.6		19.1		22.4		7.2		18.3		20.1	
Iron	mg/kg	15900		16200		19900		16000		18000		22500	
Lead	mg/kg	3.2		8.5		9.4		3.2		9		9.7	
Magnesium	mg/kg	11500		22500		21300		999		24600		20200	
Manganese	mg/kg	658		495		512		262		527		513	
Mercury	mg/kg												
Nickel	mg/kg	11.6		22.8		26.1		9.3		24		29.6	
Potassium	mg/kg			1490		2330				1610		2640	
Selenium	mg/kg												
Sodium	mg/kg												
Vanadium	mg/kg	13.2		21.4		26.2		27.6	J	23.8	J	28.6	J
Zinc	mg/kg	26.8		52.8		60.5		26		50.6		69.5	
Moisture Content													
% moisture	%	8.9		17.1		17.6		13.5		18.1		18.7	

Table 4-8

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 4)

Sample Location:		PRRWP-DP01		PRRWP-DP03		PRRWP-DP04		PRRWP-DP05	
Sample No:		7230		7310		7350		7390	
Sample Date:		12-Jun-98		8-Jun-98		9-Jun-98		14-Jun-98	
Depth (ft):		0-0		0-0		12-Aug		0-0	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds									
2-Butanone	µg/L			24	J				
2-Hexanone	µg/L			1.8	J				
Acetone	µg/L			20	J				
Benzene	µg/L			0.14	J				
Carbon disulfide	µg/L					0.26	J		
Ethylbenzene	µg/L			0.19	J				
Tetrachloroethene	µg/L			0.22	J			0.26	J
Total xylenes	µg/L			0.88	J				
Trichloroethene	µg/L								
Semivolatile Organic Compounds									
2,4-Dinitrophenol	µg/L	8.3	J	5800	D				
2,4-Dinitrotoluene	µg/L	20		9200	D				
2,6-Dinitrotoluene	µg/L	3.3	J	550					
2-Nitroaniline	µg/L	3.2	J						
2-Nitrophenol	µg/L								
3-Nitroaniline	µg/L	88							
4,6-Dinitro-2-methylphenol	µg/L			2300					
4-Nitrophenol	µg/L			290	J				
Naphthalene	µg/L							1.9	J
bis(2-Ethylhexyl)phthalate	µg/L								
Nitroaromatic Compounds									
1,3,5-Trinitrobenzene	µg/L								
1,3-Dinitrobenzene	µg/L			4800		0.28			
2,4-Dinitrotoluene	µg/L	10		6800		0.47			
2,6-Dinitrotoluene	µg/L								
Tetryl	µg/L								

Table 4-8

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 4)

		Sample Location:	PRRWP-DP06		PRRWP-DP07		PRRWP-DP08		PRRWP-DP10	
		Sample No:	7430		7470		7510		7590	
		Sample Date:	9-Jun-98		10-Jun-98		10-Jun-98		10-Jun-98	
		Depth (ft):	0-0		0-0		0-0		0-0	
Parameter	Units	RBC	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds										
2-Butanone	µg/L	190								
2-Hexanone	µg/L	150								
Acetone	µg/L	370								
Benzene	µg/L	0.36								
Carbon disulfide	µg/L	100					0.16	J		
Ethylbenzene	µg/L	130								
Tetrachloroethene	µg/L	1.1			0.17	J				
Total xylenes	µg/L	1200								
Trichloroethene	µg/L	1.6			0.43	J	0.16	J		
Semivolatile Organic Compounds										
2,4-Dinitrophenol	µg/L	7.3							5900	D
2,4-Dinitrotoluene	µg/L	7.3					2.8	J	4100	D
2,6-Dinitrotoluene	µg/L	3.7							390	
2-Nitroaniline	µg/L	NE								
2-Nitrophenol	µg/L	NE								
3-Nitroaniline	µg/L	NE								
4,6-Dinitro-2-methylphenol	µg/L	0.37							1700	
4-Nitrophenol	µg/L	29							210	J
Naphthalene	µg/L	150								
bis(2-Ethylhexyl)phthalate	µg/L	4.8								
Nitroaromatic Compounds										
1,3,5-Trinitrobenzene	µg/L	110								
1,3-Dinitrobenzene	µg/L	0.37	10		0.42		1.2		2100	
2,4-Dinitrotoluene	µg/L	7.3	31		0.82		1.4		2200	
2,6-Dinitrotoluene	µg/L	3.7	5.1				0.28		400	
Tetryl	µg/L	37								

Table 4-8

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 3 of 4)

		Sample Location:	PRRWP-DP11		PRRWP-DP12		PRRWP-DP13		PRRWP-DP14		PRRWP-DP15	
		Sample No:	7630		7670		7710		7750		7790	
		Sample Date:	14-Jun-98		11-Jun-98		12-Jun-98		12-Jun-98		12-Jun-98	
		Depth (ft):	0-0		0-0		0-0		0-0		0-0	
Parameter	Units	RBC	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds												
2-Butanone	µg/L	190										
2-Hexanone	µg/L	150										
Acetone	µg/L	370										
Benzene	µg/L	0.36										
Carbon disulfide	µg/L	100			0.16	J						
Ethylbenzene	µg/L	130										
Tetrachloroethene	µg/L	1.1										
Total xylenes	µg/L	1200										
Trichloroethene	µg/L	1.6										
Semivolatile Organic Compounds												
2,4-Dinitrophenol	µg/L	7.3										
2,4-Dinitrotoluene	µg/L	7.3	380	J					2.5	J	80	J
2,6-Dinitrotoluene	µg/L	3.7										
2-Nitroaniline	µg/L	NE										
2-Nitrophenol	µg/L	NE										
3-Nitroaniline	µg/L	NE										
4,6-Dinitro-2-methylphenol	µg/L	0.37									830	J
4-Nitrophenol	µg/L	29										
Naphthalene	µg/L	150										
bis(2-Ethylhexyl)phthalate	µg/L	4.8			**10**				3.2	J		
Nitroaromatic Compounds												
1,3,5-Trinitrobenzene	µg/L	110	600									
1,3-Dinitrobenzene	µg/L	0.37	840		1.3		1.6					
2,4-Dinitrotoluene	µg/L	7.3	150		2.3		2.4					
2,6-Dinitrotoluene	µg/L	3.7			0.35		0.36					
Tetryl	µg/L	37					0.2					

Table 4-8

Volatile Organic, Semivolatile Organic, and Nitroaromatic Analytical Results in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 4 of 4)

		Sample Location:	PRRWP-DP16		PRRWP-DP17		PRRWP-DP18		PRRWP-DP19	
		Sample No:	7830		7870		7910		7950	
		Sample Date:	13-Jun-98		11-Jun-98		12-Jun-98		13-Jun-98	
		Depth (ft):	0-0		0-0		0-0		0-0	
Parameter	Units	RBC	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Volatile Organic Compounds										
2-Butanone	µg/L	190								
2-Hexanone	µg/L	150								
Acetone	µg/L	370								
Benzene	µg/L	0.36								
Carbon disulfide	µg/L	100								
Ethylbenzene	µg/L	130								
Tetrachloroethene	µg/L	1.1							0.13	J
Total xylenes	µg/L	1200								
Trichloroethene	µg/L	1.6								
Semivolatile Organic Compounds										
2,4-Dinitrophenol	µg/L	7.3	22	J						
2,4-Dinitrotoluene	µg/L	7.3	35		1.5	J			2.3	J
2,6-Dinitrotoluene	µg/L	3.7	6.2	J						
2-Nitroaniline	µg/L	NE	1.3	J						
2-Nitrophenol	µg/L	NE	2.1	J						
3-Nitroaniline	µg/L	NE								
4,6-Dinitro-2-methylphenol	µg/L	0.37								
4-Nitrophenol	µg/L	29	5	J						
Naphthalene	µg/L	150								
bis(2-Ethylhexyl)phthalate	µg/L	4.8								
Nitroaromatic Compounds										
1,3,5-Trinitrobenzene	µg/L	110								
1,3-Dinitrobenzene	µg/L	0.37			6.4		1.1			
2,4-Dinitrotoluene	µg/L	7.3			8.9		2.4			
2,6-Dinitrotoluene	µg/L	3.7			1.7		0.36			
Tetryl	µg/L	37								

Table 4-9

Summary of Detected Inorganic Constituents in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky Ohio

(Page 1 of 8)

Sample Location:		PRRWP-DP01		PRRWP-DP02		PRRWP-DP03		PRRWP-DP04		PRRWP-DP05	
Sample No:		7230		7270		7310		7350		7390	
Sample Date:		12-Jun-98		14-Jun-98		8-Jun-98		9-Jun-98		14-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Total Metals (Unfiltered)											
Aluminum	µg/L	52900		52200		88400		3E+05		32700	
Antimony	µg/L										
Arsenic	µg/L			63.3				305	J	53.9	
Barium	µg/L							1680			
Beryllium	µg/L										
Cadmium	µg/L										
Calcium	µg/L	4E+05		221000		683000		2E+06		6E+05	
Chromium	µg/L	112		113		208		561		82.6	
Cobalt	µg/L					2610					
Copper	µg/L	277				1410		669			
Iron	µg/L	1E+05		100000		200000		7E+05		98200	
Lead	µg/L	58.3	J	42.6		96.7	J	292	J	48.4	
Magnesium	µg/L	1E+05		66300		172000		6E+05		2E+05	
Manganese	µg/L	4040		1120		39600		12400		3240	
Mercury	µg/L			0.23				0.55			
Nickel	µg/L					2380		740			
Potassium	µg/L							31500			
Sodium	µg/L	8E+05		266000		5930000				1E+05	
Vanadium	µg/L							821			
Zinc	µg/L	374		299		597		2010		279	

Table 4-9

Summary of Detected Inorganic Constituents in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky Ohio

(Page 2 of 8)

Sample Location:		PRRWP-DP01		PRRWP-DP02		PRRWP-DP03		PRRWP-DP04		PRRWP-DP05	
Sample No:		7230		7270		7310		7350		7390	
Sample Date:		12-Jun-98		14-Jun-98		8-Jun-98		9-Jun-98		14-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Dissolved Metals (Filtered)											
Arsenic	µg/L							13.4			
Barium	µg/L										
Calcium	µg/L	2E+05		193000		542000		90900		3E+05	
Chromium	µg/L										
Cobalt	µg/L					3090					
Copper	µg/L					1600					
Iron	µg/L			150		7480		166			
Lead	µg/L										
Magnesium	µg/L	52800		44400		139000		25300		96100	
Manganese	µg/L	1680		257		42700		39.3		818	
Nickel	µg/L					2760					
Sodium	µg/L	1E+06		288000		7260000				1E+05	
Zinc	µg/L							21.6			
Cyanide											
Cyanide, total	µg/L					780					
Water Quality Parameters											
Alkalinity	µg/L			450000		1500000		3E+05			
Hardness	µg/L			780000		3400000		9E+05			
Total suspended	µg/L					110000					
Total dissolved so	µg/L			1E+06		1.5E+07		4E+05			
Total organic carb	µg/L			19300		6600000					
Chloride	µg/L			9800				2300			
Nitrate	µg/L					465000					
Sulfate	µg/L			574000		1E+07		22700			

Table 4-9

Summary of Detected Inorganic Constituents in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky Ohio

(Page 3 of 8)

Sample Location:		PRRWP-DP07		PRRWP-DP08		PRRWP-DP09		PRRWP-DP10		PRRWP-DP11	
Sample No:		7470		7510		7550		7590		7630	
Sample Date:		10-Jun-98		10-Jun-98		14-Jun-98		10-Jun-98		14-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Total Metals (Unfiltered)											
Aluminum	µg/L	69000		178000		56800		78300		4820	
Antimony	µg/L			118	J						
Arsenic	µg/L			259	J						
Barium	µg/L	556		1210							
Beryllium	µg/L			8.8							
Cadmium	µg/L			6.5							
Calcium	µg/L	7E+05		863000		9E+05		662000		8E+05	
Chromium	µg/L	114		273		141		223			
Cobalt	µg/L	77.6		208				5610		3360	
Copper	µg/L	194		472		438		2800		1530	
Iron	µg/L	2E+05		468000		1E+05		202000		15500	
Lead	µg/L	86.2	J	323	J	67.1					
Magnesium	µg/L	2E+05		253000		2E+05		326000		2E+05	
Manganese	µg/L	4310		11800		4050		55100		35300	
Mercury	µg/L			0.2		0.29					
Nickel	µg/L	191		521		407		5040		1950	
Potassium	µg/L	12300		22700							
Sodium	µg/L	7060				7E+05		9410000		4E+06	
Vanadium	µg/L	212		438							
Zinc	µg/L	525		1550		441		736			

Table 4-9

Summary of Detected Inorganic Constituents in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky Ohio

(Page 4 of 8)

Sample Location:		PRRWP-DP07		PRRWP-DP08		PRRWP-DP09		PRRWP-DP10		PRRWP-DP11	
Sample No:		7470		7510		7550		7590		7630	
Sample Date:		10-Jun-98		10-Jun-98		14-Jun-98		10-Jun-98		14-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Dissolved Metals (Filtered)											
Arsenic	µg/L	11									
Barium	µg/L										
Calcium	µg/L	66500		58000		3E+05		681000		7E+05	
Chromium	µg/L									495	
Cobalt	µg/L							6660		3030	
Copper	µg/L					311		3260		2000	
Iron	µg/L	190		116				15300		5870	
Lead	µg/L					31.5					
Magnesium	µg/L	15800		12900		73600		348000		2E+05	
Manganese	µg/L	71.4				1120		62400		31300	
Nickel	µg/L							5820		1970	
Sodium	µg/L	5490				8E+05		1.3E+07		3E+06	
Zinc	µg/L	77.7		26.5				225		1100	
Cyanide											
Cyanide, total	µg/L					23				400	
Water Quality Parameters											
Alkalinity	µg/L					5E+05				9E+05	
Hardness	µg/L					2E+06				2E+06	
Total suspended	µg/L					12000				34000	
Total dissolved so	µg/L					4E+06				2E+07	
Total organic carb	µg/L					7E+05				3E+06	
Chloride	µg/L										
Nitrate	µg/L					16900				4E+05	J
Sulfate	µg/L					1E+06				4E+06	

Table 4-9

Summary of Detected Inorganic Constituents in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky Ohio

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Sample Location:		PRRWP-DP12		PRRWP-DP13		PRRWP-DP14		PRRWP-DP15		PRRWP-DP16	
Sample No:		7670		7710		7750		7790		7830	
Sample Date:		11-Jun-98		12-Jun-98		12-Jun-98		12-Jun-98		13-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Total Metals (Unfiltered)											
Aluminum	µg/L	2E+05		7220		7970				15500	
Antimony	µg/L	105	J								
Arsenic	µg/L	238	J	11.1	J						
Barium	µg/L	896									
Beryllium	µg/L	8.5									
Cadmium	µg/L										
Calcium	µg/L	9E+05		249000		281000				3E+05	
Chromium	µg/L	277		16		105					
Cobalt	µg/L	172								668	
Copper	µg/L	515		27.7						510	
Iron	µg/L	4E+05		18800		27500				40200	
Lead	µg/L	202	J	9.5	J	38.1	J	33	J		
Magnesium	µg/L	3E+05		71900		83800				88000	
Manganese	µg/L	6460		496		927				2080	
Mercury	µg/L	0.32									
Nickel	µg/L	490								468	
Potassium	µg/L	21600									
Sodium	µg/L	5960		29700		79400				1E+06	
Vanadium	µg/L	391		52.3		877		1000			
Zinc	µg/L	1350		76							

Table 4-9

Summary of Detected Inorganic Constituents in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky Ohio

(Page 6 of 8)

Sample Location:		PRRWP-DP12		PRRWP-DP13		PRRWP-DP14		PRRWP-DP15		PRRWP-DP16	
Sample No:		7670		7710		7750		7790		7830	
Sample Date:		11-Jun-98		12-Jun-98		12-Jun-98		12-Jun-98		13-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Dissolved Metals (Filtered)											
Arsenic	µg/L										
Barium	µg/L										
Calcium	µg/L	98800		189000		405000		8E+05		2E+05	
Chromium	µg/L										
Cobalt	µg/L							1290		784	
Copper	µg/L							531		568	
Iron	µg/L	125		237		2400		3240		1950	
Lead	µg/L										
Magnesium	µg/L	25100		53800		143000		3E+05		67700	
Manganese	µg/L	150		108		454		1460		1700	
Nickel	µg/L							2370		441	
Sodium	µg/L			33500		256000		3E+06		1E+06	
Zinc	µg/L										
Cyanide											
Cyanide, total	µg/L										
Water Quality Parameters											
Alkalinity	µg/L										
Hardness	µg/L										
Total suspended	µg/L										
Total dissolved so	µg/L										
Total organic carb	µg/L										
Chloride	µg/L										
Nitrate	µg/L										
Sulfate	µg/L										

Table 4-9

Summary of Detected Inorganic Constituents in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky Ohio

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Sample Location:		PRRWP-DP17		PRRWP-DP18		PRRWP-DP19		PRRWP-DP20	
Sample No:		7870		7910		7950		7990	
Sample Date:		11-Jun-98		12-Jun-98		13-Jun-98		14-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Total Metals (Unfiltered)									
Aluminum	µg/L	38600				118000		13400	
Antimony	µg/L					77.8	J		
Arsenic	µg/L			584	J	122	J	31.3	
Barium	µg/L	218				1020			
Beryllium	µg/L					5.5			
Cadmium	µg/L								
Calcium	µg/L	1E+06				787000		300000	
Chromium	µg/L	65.8				176		26.9	
Cobalt	µg/L					140			
Copper	µg/L	106				334		33.2	
Iron	µg/L	87000				266000		31500	
Lead	µg/L			320	J	142	J	21.6	
Magnesium	µg/L	3E+05				240000		75900	
Manganese	µg/L	3280				5940		1220	
Mercury	µg/L			0.25					
Nickel	µg/L	113				338			
Potassium	µg/L	6430				20800			
Sodium	µg/L	6010				14500		6480	
Vanadium	µg/L	163		101		288		76.5	
Zinc	µg/L	341				799		151	

Table 4-9

Summary of Detected Inorganic Constituents in Groundwater
Pentolite Road
Red Water Ponds, PBOW, Sandusky Ohio

(Page 8 of 8)

Sample Location:		PRRWP-DP17		PRRWP-DP18		PRRWP-DP19		PRRWP-DP20	
Sample No:		7870		7910		7950		7990	
Sample Date:		11-Jun-98		12-Jun-98		13-Jun-98		14-Jun-98	
Parameter	Units	Result	VQ	Result	VQ	Result	VQ	Result	VQ
Dissolved Metals (Filtered)									
Arsenic	µg/L					22.9		16.9	
Barium	µg/L					237			
Calcium	µg/L	55000		244000		63400		58800	
Chromium	µg/L								
Cobalt	µg/L								
Copper	µg/L								
Iron	µg/L			1260		119		456	
Lead	µg/L								
Magnesium	µg/L	13200		80300		16400		14300	
Manganese	µg/L	22.4		252		28.4		78.4	
Nickel	µg/L								
Sodium	µg/L			140000		11500		6810	
Zinc	µg/L	28.7							
Cyanide									
Cyanide, total	µg/L								
Water Quality Parameters									
Alkalinity	µg/L							155000	
Hardness	µg/L							670000	
Total suspended	µg/L							6000	
Total dissolved so	µg/L							276000	
Total organic carb	µg/L							1800	
Chloride	µg/L							2300	
Nitrate	µg/L								
Sulfate	µg/L							24700	

µg/L = Micrograms per liter.
VQ = Validation qualifier.

Table 4-10

Summary of Detected Constituents in Surface Water and Sediment Samples
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Surface Water Samples									
		PRRP-SW01		PRRP-SW02		PRRP-SW03		PRRP-SW04	
		12160		12170		12180		12190	
		5-Nov-98		5-Nov-98		5-Nov-98		5-Nov-98	
Parameter	Units	Result	V.Q.	Result	V.Q.	Result	V.Q.	Result	V.Q.
Organic Compounds									
Acetone	µg/L	2.5	B	1.7	B	2.5	B	1.2	B
bis(2-Ethylhexyl)phthalate	µg/L			2.1	B				
Bromodichloromethane	µg/L	0.72	J						
Bromomethane	µg/L	0.17	J	0.11	J				
Chloroform	µg/L	3.5	B	0.55	B				
Dibromochloromethane	µg/L	0.21	J						
Phenol	µg/L	2.2	B	1.9	B	2.3	B		
Total Metals									
Aluminum	µg/L	778	J	530	J	3040	J		
Calcium	µg/L	74200		71700		118000		97900	
Iron	µg/L	1420		972		5790		948	
Magnesium	µg/L	16000		15800		37300		36800	
Manganese	µg/L	245		261		404		67.1	
Sodium	µg/L	24900		24700		13700		14800	
Zinc	µg/L					58		20.2	
Dissolved Metals									
Aluminum	µg/L	463		874		10200			
Barium	µg/L					215			
Calcium	µg/L	74000		71400		179000		98100	
Chromium	µg/L					17.2			
Iron	µg/L	809		1260		16800		550	
Lead	µg/L					8.7			
Magnesium	µg/L	15700		15800		46700		36900	
Manganese	µg/L	144		249		649		34.4	
Potassium	µg/L					7130			
Sodium	µg/L	25700		24500		15000		15300	
Vanadium	µg/L					53.9			
Zinc	µg/L					145			
Hardness									
Hardness	µg/L	328000		284000		488000		432000	

Table 4-10

Summary of Detected Constituents in Surface Water and Sediment Samples
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

		Sediment Samples							
		PRRP-SD01 11160 5-Nov-98 0 - 0.5 ft		PRRP-SD02 11170 5-Nov-98 0 - 0.5 ft		PRRP-SD03 11180 5-Nov-98 0 - 0.5 ft		PRRP-SD04 11190 5-Nov-98 0 - 0.5 ft	
Parameter	Units	Result	V.Q.	Result	V.Q.	Result	V.Q.	Result	V.Q.
Organic Compounds									
2-Butanone	mg/kg	0.011	J			0.01	J		
Acenaphthene	mg/kg			0.11	J				
Acetone	mg/kg	0.051	J			0.049	J		
Anthracene	mg/kg			0.077	J			0.029	J
Benzo(a)anthracene	mg/kg							0.084	J
Benzo(a)pyrene	mg/kg							0.096	J
Benzo(b)fluoranthene	mg/kg							0.1	J
Benzo(ghi)perylene	mg/kg							0.053	J
Benzo(k)fluoranthene	mg/kg							0.084	J
Carbazole	mg/kg			0.18	J				
Chrysene	mg/kg							0.11	J
Dibenzofuran	mg/kg			0.06	J				
Fluoranthene	mg/kg			0.14	J			0.23	J
Fluorene	mg/kg			0.11	J				
Indeno(1,2,3-cd)pyrene	mg/kg							0.054	J
Phenanthrene	mg/kg			0.32	J			0.12	J
Pyrene	mg/kg			0.11	J			0.16	J
Metals									
Aluminum	mg/kg	6020		2830		5130		3400	
Arsenic	mg/kg	4.5		5.1		4.3		4.4	
Barium	mg/kg	53.4				48.1		30.9	
Calcium	mg/kg	96000		46300		62000		8110	
Chromium	mg/kg	11.5		6.3		10.4		6.8	
Copper	mg/kg	17.9		7.6		14.5		7.4	
Iron	mg/kg	16200		9620		13700		9330	
Lead	mg/kg	12.8		4.8		7.8		5.6	
Magnesium	mg/kg	10700		19300		13500		2710	
Manganese	mg/kg	865		421		404		104	
Nickel	mg/kg	18.6		9.5		17.9		10.4	
Potassium	mg/kg					1040			
Vanadium	mg/kg	17.4		12.9		14.2		7.9	
Zinc	mg/kg	73.3		23.2		58.4		42.1	
Total Organic Carbon									
Total organic carbon	mg/kg	33000		5450		17000		12000	J

Table 5-1

Background Concentrations of Metals in Soil
Red Water Ponds, PBOW, 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	2.69E+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	7.10E+01
Barium	9 / 12	35.6 - 826	23.2 - 24.7	L	1.16E+02	1.30E+03	1.30E+03
Beryllium	6 / 25	0.57 - 1	0.57 - 1.2	L	5.65E-01	1.17E+00	1.17E+00
Cadmium	0 / 25	NA	0.57 - 1.2	NP	4.49E-01	NA	NA
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	2.48E+02
Copper	23 / 26	2.3 - 56.2	2.2 - 2.9	L	1.70E+01	1.47E+02	1.47E+02
Iron	12 / 12	5880 - 234000	NA	L	4.01E+04	3.58E+05	3.58E+05
Lead	26 / 26	1.9 - 48.6	NA	L	1.28E+01	5.13E+01	5.13E+01
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	5.60E-01
Nickel	26 / 26	5.4 - 55.1	NA	L	2.28E+01	7.79E+01	7.79E+01
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
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	8.31E+01
Zinc	26 / 26	6.6 - 655	NA	L	7.30E+01	3.22E+02	3.22E+02

NA = Not applicable; not available.

[a] 95% UTL = 95% upper tolerance limit calculated as described in Section 2.1.3 and rounded to 3 significant figures.

[b] The maximum detected concentration is used as the background screening criterion for nonparametric data sets.

Note: Reporting limits from sample 6990 were deleted when calculating the mean and UTL for antimony, beryllium, cadmium, selenium and thallium, because the reporting limits were elevated by dilution factors.

Table 5-2

Background Concentrations of Metals in Surface Water
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (μg/L)	Frequency of Detection	Range of Detected Concentration	Range of Reporting Limits	Statistical Distribution [a]	Arithmetic Mean	Background Screening Criterion [b]
Inorganics (unfiltered)						
Aluminum	3 / 4	530 - 3040	200 - 200	NA	1.08E+03	3.04E+03
Calcium	4 / 4	71700 - 118000	5000 - 5000	NA	1.01E+05	Nutrient
Iron	4 / 4	126 - 5790	100 - 100	NA	2.05E+03	Nutrient
Magnesium	4 / 4	15800 - 37300	5000 - 5000	NA	2.64E+04	Nutrient
Manganese	4 / 4	30.6 - 890	15 - 15	NA	3.96E+02	8.90E+02
Potassium	2 / 4	9400 - 9730	5000 - 5000	NA	7.28E+03	Nutrient
Sodium	4 / 4	13700 - 39300	5000 - 5000	NA	2.90E+04	Nutrient
Zinc	2 / 4	27 - 58	20 - 20	NA	2.88E+01	5.80E+01

[a] Insufficient number of samples (less than 5), to determine statistical distribution or calculate an upper tolerance limit.
[b] The maximum detected concentration is used as the background screening criterion.

Table 5-3

Background Concentrations of Metals in Sediment
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentration	Range of Reporting Limits	Statistical Distribution [a]	Arithmetic Mean	Background Screening Criterion [b]
Inorganics						
Aluminum	4 / 4	2450 - 6020	24.1 - 52.4	NA	3.76E+03	6.02E+03
Arsenic	4 / 4	3.5 - 5.4	1.2 - 2.6	NA	4.45E+00	5.40E+00
Barium	3 / 4	26.6 - 53.4	24.1 - 52.4	NA	3.07E+01	5.34E+01
Calcium	4 / 4	8110 - 96000	603 - 1310	NA	3.22E+04	Nutrient
Chromium	4 / 4	5.3 - 11.5	1.2 - 2.6	NA	7.58E+00	1.15E+01
Cobalt	2 / 4	6.4 - 10.9	6 - 13.1	NA	9.25E+00	1.09E+01
Copper	4 / 4	7.4 - 17.9	3 - 6.5	NA	1.20E+01	1.79E+01
Iron	4 / 4	9330 - 16200	12.1 - 26.2	NA	1.26E+04	Nutrient
Lead	4 / 4	5.6 - 12.8	0.36 - 0.79	NA	8.65E+00	1.28E+01
Magnesium	4 / 4	2110 - 10700	603 - 1310	NA	4.56E+03	Nutrient
Manganese	4 / 4	104 - 865	1.8 - 3.9	NA	3.76E+02	8.65E+02
Nickel	4 / 4	10.4 - 23	4.8 - 10.5	NA	1.64E+01	2.30E+01
Vanadium	2 / 4	7.9 - 17.4	6 - 13.1	NA	7.85E+00	1.74E+01
Zinc	4 / 4	35.1 - 73.3	2.4 - 5.2	NA	4.96E+01	7.33E+01

[a] Insufficient number of samples (less than 5), to determine statistical distribution or calculate an upper tolerance limit.
[b] The maximum detected concentration is used as the background screening criterion.

Table 5-4

Statistical Summary and COPC Selection of Surface Soil[a] Sample Analyses, West Area Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration
Inorganics										
ALUMINUM	19 / 19	4720 - 20600	22.4 - 27.7	N	1.12E+04	1.30E+04	2.69E+04	7.60E+03	Y (b)	1.30E+04
ANTIMONY	2 / 40	7.4 - 7.4	5.4 - 8.3	NP	3.44E+00		9.30E+00	3.10E+01	N (a)	--
ARSENIC	36 / 40	2 - 11.5	1.1 - 4.3	NP	5.21E+00	6.08E+00	7.10E+01	3.90E-02	Y (b)	6.08E+00
BARIUM	16 / 19	24.8 - 130	22.4 - 27.7	N	6.45E+01		1.30E+03	5.40E+02	N (a)	--
BERYLLIUM	10 / 40	0.59 - 1.2	0.56 - 1.4	NP	5.72E-01		1.17E+00	1.50E+01	N (a)	--
CADMIUM	1 / 40	0.59 - 0.59	0.56 - 1.4	NP	4.60E-01			3.70E+00	N (a)	--
CALCIUM	19 / 19	757 - 58600	559 - 693	NP	9.64E+03			Nutrient	N (b)	--
CHROMIUM	40 / 40	5.4 - 35	1.1 - 1.4	L	1.67E+01	1.87E+01	2.90E+01	2.10E+01 g	Y (a)	1.87E+01
COBALT	13 / 19	8.5 - 17.9	5.6 - 6.9	NP	9.83E+00		2.48E+02	4.70E+02	N (a)	--
COPPER	36 / 40	2.4 - 30.9	2.2 - 3.5	L	9.62E+00		1.47E+02	2.90E+02	N (a)	--
IRON	19 / 19	7190 - 36000	11.2 - 13.9	N	1.91E+04			Nutrient	N (b)	--
LEAD	40 / 40	2.2 - 23	0.34 - 3.6	N	1.20E+01		5.13E+01	4.00E+02	N (a)	--
MAGNESIUM	18 / 19	684 - 12200	559 - 693	L	3.89E+03			Nutrient	N (b)	--
MANGANESE	40 / 40	89.6 - 1340	1.7 - 5.8	L	4.69E+02	6.02E+02	3.51E+03	1.80E+02	Y (b)	6.02E+02
MERCURY	4 / 40	0.04 - 0.1	0.037 - 0.36	NP	9.18E-02		5.60E-01	2.30E+00	N (a)	--
NICKEL	40 / 40	7.1 - 46.9	2.2 - 5.5	L	2.14E+01		7.79E+01	1.60E+02	N (a)	--
POTASSIUM	14 / 19	742 - 2970	559 - 693	N	1.43E+03			Nutrient	N (b)	--
SELENIUM	1 / 40	0.65 - 0.65	0.56 - 5.8	NP	1.41E+00		2.00E+00	3.90E+01	N (a)	--
SODIUM	1 / 19	681 - 681	559 - 693	NP	3.13E+02			Nutrient	N (b)	--
VANADIUM	19 / 19	10.1 - 40.5	5.6 - 6.9	L	2.53E+01		8.31E+01	5.50E+01	N (a)	--
ZINC	39 / 40	15.9 - 111	2.2 - 2.9	N	5.87E+01		3.22E+02	2.30E+03	N (a)	--
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1 / 40	0.3 - 0.3	0.25 - 0.25	NP	1.29E-01			3.70E-01 h	N (a)	--
2,4-DINITROTOLUENE	4 / 40	0.3 - 0.4	0.25 - 0.25	NP	1.43E-01	4.00E-01		7.20E-02 i	Y (a)	4.00E-01
1,3,5-TRINITROBENZENE	3 / 40	0.3 - 0.7	0.25 - 0.25	NP	1.56E-01			1.80E+02	N (a)	--
2,4,6-TRINITROTOLUENE	1 / 40	0.3 - 0.3	0.25 - 0.25	NP	1.29E-01			1.60E+00	N (a)	--
Semivolatile Organics										
2,4-Dinitrotoluene-svoc	10	0.043 0.043	0.37 0.4	NP	1.76E-01			7.20E-02 k	N (a)	--
ACENAPHTHYLENE	1 / 10	0.041 - 0.041	0.37 - 0.4	NP	1.77E-01			3.70E+02 h	N (a)	--
ANTHRACENE	1 / 10	0.23 - 0.23	0.37 - 0.4	NP	1.96E-01			2.20E+03	N (a)	--
BENZO(A)ANTHRACENE	1 / 10	0.4 - 0.4	0.37 - 0.4	NP	2.13E-01	4.00E-01		6.20E-02	Y (a)	4.00E-01
BENZO(A)PYRENE	1 / 10	0.39 - 0.39	0.37 - 0.4	NP	2.12E-01	3.90E-01		6.20E-03	Y (a)	3.90E-01
BENZO(B)FLUORANTHENE	1 / 10	0.3 - 0.3	0.37 - 0.4	NP	2.03E-01	3.00E-01		6.20E-02	Y (a)	3.00E-01
BENZO(GHI)PERYLENE	1 / 10	0.22 - 0.22	0.37 - 0.4	NP	1.95E-01			2.30E+02 h	N (a)	--
BENZO(K)FLUORANTHENE	1 / 10	0.35 - 0.35	0.37 - 0.4	NP	2.08E-01			6.20E-01	N (a)	--

Table 5-4

Statistical Summary and COPC Selection of Surface Soil[a] Sample Analyses, West Area Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration
CHRYSENE	1 / 10	0.42 - 0.42	0.37 - 0.4	NP	2.15E-01			6.20E+00	N (a)	--
FLUORANTHENE	1 / 10	0.76 - 0.76	0.37 - 0.4	NP	2.49E-01			2.30E+02	N (a)	--
INDENO(1,2,3-CD)PYRENE	1 / 10	0.23 - 0.23	0.37 - 0.4	NP	1.96E-01	2.30E-01		6.20E-02	Y (a)	2.30E-01
PHENANTHRENE	1 / 10	0.36 - 0.36	0.37 - 0.4	NP	2.09E-01			2.30E+02 h	N (a)	--
PYRENE	1 / 10	0.55 - 0.55	0.37 - 0.4	NP	2.28E-01			2.30E+02	N (a)	--
Volatile Organics										
ACETONE	1 / 10	0.035 - 0.035	0.022 - 0.024	NP	1.40E-02			1.60E+02	N (a)	--
METHYLENE CHLORIDE	3 / 10	0.00185 - 0.0023	0.0056 0.006	L	1.50E-03			8.90E-01	N (a)	--
TOLUENE	3 / 10	0.0018 - 0.0032	0.0056 - 0.006	NP	2.76E-03			5.20E+01	N (a)	--

COPC - Chemical of potential concern; UCL - Upper confidence limit.
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparmametric; data are found to be neither normally nor lognormally distributed.
mg/kg - Milligrams per kilogram.

[a] Surface soil is defined as the interval from 0 to 3 feet below the ground surface. Soil samples were classified on the basis of the beginning depth of the sample.
[b] Method of estimation based on statistical distribution (please see Section 5.2.2).
[c] Please see Table 5-1.
[d] Residential Soil PRGs from EPA, 1999, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, adjusted to reflect a cancer risk of 1E-7 and a hazard index of 0.1.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the risk-based screening concentration (RBSC).
(b) = essential nutrient.
[f] Y = Chemical is chosen as COPC:
(a) = maximum detection is greater than RBSC.
(b) = included in background risk calculation.
[g] Based on PRG for total chromium.
[h] Calculated; reference Appendix H.1.
[i] Based on PRG for mixed dinitrotoluene.

Table 5-5

Statistical Summary and COPC Selection of Subsurface Soil[a] Sample Analyses, West Area Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration
Inorganics										
ALUMINUM	37 / 37	5080 - 21000	22.5 - 27.1	L	1.07E+04	1.19E+04	2.69E+04	7.60E+03	Y (b)	1.19E+04
ANTIMONY	1 / 56	7.7 - 7.7	5.3 - 8.1	L*	3.49E+00	3.51E+00	9.30E+00	3.10E+00	Y (b)	3.51E+00
ARSENIC	52 / 56	2.2 - 23.6	1.1 - 4	L	6.89E+00	8.03E+00	7.10E+01	3.90E-02	Y (b)	8.03E+00
BARIUM	36 / 37	27.9 - 165	22.5 - 27.1	L	6.24E+01		1.30E+03	5.40E+02	N (a)	--
BERYLLIUM	12 / 56	0.59 - 1	0.56 - 1.3	N	4.97E-01		1.17E+00	1.50E+01	N (a)	--
CADMIUM	2 / 56	0.68 - 1.4	0.56 - 1.3	L	4.24E-01			3.70E+00	N (a)	--
CALCIUM	37 / 37	1220 - 67600	562 - 678	NP	2.04E+04			Nutrient	N (b)	--
CHROMIUM	56 / 56	7.5 - 29	1.1 - 1.4	L	1.65E+01	1.78E+01	2.90E+01	2.10E+01 g	Y (b)	1.78E+01
COBALT	34 / 37	6 - 21	5.6 - 6.8	N	1.04E+01		2.48E+02	4.70E+02	N (a)	--
COPPER	52 / 56	2.4 - 34.7	2.1 - 3.4	N	1.46E+01		1.47E+02	2.90E+02	N (a)	--
IRON	37 / 37	8490 - 34000	11.2 - 13.6	N	2.10E+04	2.29E+04		Nutrient	N (b)	--
LEAD	56 / 56	4.4 - 20	0.34 - 3.3	L	9.99E+00		5.13E+01	4.00E+02	N (a)	--
MAGNESIUM	37 / 37	832 - 23400	562 - 678	NP	7.39E+03			Nutrient	N (b)	--
MANGANESE	56 / 56	83.4 - 1900	1.7 - 5.3	L	4.34E+02	5.06E+02	3.51E+03	1.80E+02	Y (b)	5.06E+02
NICKEL	56 / 56	7.4 - 45	2.1 - 5.4	N	2.45E+01		7.79E+01	1.60E+02	N (a)	--
POTASSIUM	34 / 37	643 - 5630	562 - 678	L	1.82E+03			Nutrient	N (b)	--
SODIUM	6 / 37	619 - 1270	562 - 678	NP	4.01E+02			Nutrient	N (b)	--
VANADIUM	37 / 37	13.9 - 40.3	5.6 - 6.8	L	2.57E+01		8.31E+01	5.50E+01	N (a)	--
ZINC	56 / 56	26.5 - 94.6	2.1 - 2.7	N	5.77E+01		3.22E+02	2.30E+03	N (a)	--
Nitroaromatics										
2-AMINO-4,6-DINITROTOLUENE	1 / 19	0.5 - 0.5	0.25 - 0.25	NP	1.45E-01	5.00E-01		3.70E-01 h	Y (a)	5.00E-01
4-AMINO-2,6-DINITROTOLUENE	5 / 56	0.3 - 0.7	0.25 - 1.2	L*	1.63E-01	6.00E-01		3.70E-01 h	Y (a)	6.00E-01
1,3-DINITROBENZENE	6 / 56	0.3 - 2.4	0.25 - 1.2	L*	2.65E-01	2.12E+00		6.10E-01	Y (a)	2.12E+00
2,4-DINITROTOLUENE	11 / 56	0.3 - 6.3	0.25 - 1.2	L*	5.07E-01	3.09E+00		7.20E-02 i	Y (a)	3.09E+00
2,6-DINITROTOLUENE	3 / 56	0.3 - 1.5	0.25 - 1.2	L*	1.66E-01	1.50E+00		7.20E-02 i	Y (a)	1.50E+00
3,4-DINITROTOLUENE	2 / 19	0.3 - 0.5	0.25 - 0.25	NP	1.54E-01	5.00E-01		7.20E-02 i	Y (a)	5.00E-01
1,3,5-TRINITROBENZENE	19 / 56	0.28 - 5.5	0.25 - 1.2	L	7.06E-01			1.80E+02	N (a)	--
2,4,6-TRINITROTOLUENE	5 / 56	0.3 - 2.1	0.25 - 1.2	L	1.84E-01			1.60E+01	N (a)	--
Semivolatile Organics										
ACENAPHTHYLENE	1 / 9	0.04 - 0.04	0.38 - 0.42	NP	1.83E-01			3.70E+02 h	N (a)	--
ANTHRACENE	1 / 9	0.12 - 0.12	0.38 - 0.42	NP	1.92E-01			2.20E+03	N (a)	--
BENZO(A)ANTHRACENE	1 / 9	0.17 - 0.17	0.38 - 0.42	NP	1.97E-01	2.05E-01		6.20E-02	Y (a)	1.70E-01
BENZO(A)PYRENE	1 / 9	0.14 - 0.14	0.38 - 0.42	NP	1.94E-01	1.96E-01		6.20E-03	Y (a)	1.40E-01
BENZO(B)FLUORANTHENE	1 / 9	0.14 - 0.14	0.38 - 0.42	NP	1.94E-01	1.96E-01		6.20E-02	Y (a)	1.40E-01
BENZO(GHI)PERYLENE	1 / 9	0.076 - 0.076	0.38 - 0.42	NP	1.87E-01			2.30E+02 h	N (a)	--
BENZO(K)FLUORANTHENE	1 / 9	0.11 - 0.11	0.38 - 0.42	NP	1.91E-01			6.20E-01	N (a)	--

Table 5-5

Statistical Summary and COPC Selection of Subsurface Soil[a] Sample Analyses, West Area Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration
CHRYSENE	1 / 9	0.17 - 0.17	0.38 - 0.42	NP	1.97E-01			6.20E+00	N (a)	--
FLUORANTHENE	2 / 9	0.058 - 0.38	0.38 - 0.42	NP	2.05E-01			2.30E+02	N (a)	--
INDENO(1,2,3-CD)PYRENE	1 / 9	0.076 - 0.076	0.38 - 0.42	NP	1.87E-01	1.96E-01		6.20E-02	Y (a)	7.60E-02
PHENANTHRENE	1 / 9	0.25 - 0.25	0.38 - 0.42	NP	2.06E-01			2.30E+02 h	N (a)	--
PYRENE	2 / 9	0.043 - 0.28	0.38 - 0.42	NP	1.93E-01			2.30E+02	N (a)	--
Volatile Organics										
METHYLENE CHLORIDE	1 / 9	0.002 - 0.002	0.0057 - 0.0064	NP	2.91E-03			8.90E-01	N (a)	--
TOLUENE	5 / 9	0.0015 - 0.0025	0.0057 - 0.0064	N	2.51E-03			5.20E+01	N (a)	--

COPC - Chemical of potential concern; UCL - Upper confidence limit.
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparmametric; data are found to be neither normally nor lognormally distributed.
mg/kg - Milligrams per killogram.

[a] Subsurface soil is defined as the interval from 2 to 10 feet below the ground surface.
[b] Method of estimation based on statistical distribution (please see Section 5.2.2).
[c] Please see Table 5-1.
[d] Residential Soil PRGs from EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, adjusted to reflect a cancer risk of 1E-7 and a hazard index of 0.1.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the risk-based screening concentration (RBSC).
(b) = essential nutrient.
[f] Y = Chemical is chosen as COPC:
(a) = maximum detection is greater than RBSC.
(b) = included in background risk calculation.
[g] Based on PRG for total chromium.
[h] Calculated; reference Appendix H.1.
[i] Based on PRG for mixed dinitrotoluene.

Table 5-6

Screening of VOCs from Subsurface Soil in Indoor Air, West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Chemical Concentration In Soil (mg/kg)	VOC Concentration In Soil Gas C_{source} (g/cm^3)	Effective Diffusion Coefficient D^{eff} (cm^2)	Attenuation Coefficient α (unitless)	VOC Concentration in Indoor Air In the Building (mg/m^3)	Risk-Based Screening Criterion [a] (mg/m^3)	COPC?
Volatile Organics							
ACENAPHTHYLENE	4.00E-02	9.08E-09	5.16E-03	3.66E-06	3.32E-05	2.20E-02	No
METHYLENE CHLORIDE	2.00E-03	9.59E-10	7.88E-03	5.59E-06	5.36E-06	4.10E-04	No
TOLUENE	2.50E-03	5.47E-10	6.79E-03	4.81E-06	2.63E-06	4.00E-02	No

COPC = Chemical of potential concern.

[a] Ambient Air PRGs from EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3,1999, adjusted to reflect a cancer risk of 1E-7 and a hazard index of 0.1.

Table 5-7

COPC Selection for Total Soil[a], West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	COPC? [b]	Source Term Concentration	MDC Surface Soil [c]	MDC Subsurface Soil [d]
Inorganics				
ALUMINUM	Y (b)	1.30E+04	--	--
ANTIMONY	Y (b)	3.51E+00	--	--
ARSENIC	Y (b)	8.03E+00	--	--
CHROMIUM	Y (a)	1.87E+01	3.50E+01	2.90E+01
MANGANESE	Y (b)	6.02E+02	--	--
Nitroaromatics				
2-AMINO-4,6-DINITROTOLUENE	Y (a)	5.00E-01	--	5.00E-01
4-AMINO-2,6-DINITROTOLUENE	Y (a)	6.00E-01	--	7.00E-01
1,3-DINITROBENZENE	Y (a)	2.12E+00	--	2.40E+00
2,4-DINITROTOLUENE	Y (a)	3.09E+00	4.00E-01	6.30E+00
2,6-DINITROTOLUENE	Y (a)	1.50E+00	--	1.50E+00
3,4-DINITROTOLUENE	Y (a)	5.00E-01	--	5.00E-01
Semivolatile Organics				
BENZO(A)ANTHRACENE	Y (a)	4.00E-01	4.00E-01	1.70E-01
BENZO(A)PYRENE	Y (a)	3.90E-01	3.90E-01	1.40E-01
BENZO(B)FLUORANTHENE	Y (a)	3.00E-01	3.00E-01	1.40E-01
INDENO(1,2,3-CD)PYRENE	Y (a)	2.30E-01	2.30E-01	7.60E-02

COPC - Chemical of potential concern.
MDC - Maximum detected concentration.
mg/kg - Milligrams per kilogram.

[a] Total soil is defined in Section 5.2.1.1 of the text.
[b] Y = Chemical is chosen as COPC:
(a) = maximum detection is greater than risk-based screening concentration.
(b) = included in background risk calculation
[c] See Table 5-4.
[d] See Table 5-5.

Table 5-8

Statistical Summary and COPC Selection of Surface Water Sample Analyses, West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (µg/L)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution [a]	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]		COPC? [e,f]	Source Term Concentration
Inorganics											
ALUMINUM	3 / 4	300 - 13800	200 - 200	NA	6.65E+03		3.04E+03	3.60E+04		N (a)	--
ARSENIC	2 / 9	20.2 - 21.8	10 - 30	NP	1.41E+01	1.50E+01		4.50E-02		Y (a)	1.50E+01
CALCIUM	4 / 4	31100 - 115000	5000 - 5000	NA	8.93E+04			Nutrient		N (b)	--
CHROMIUM	3 / 9	10 - 23.3	10 - 10	NP	8.97E+00			1.10E+02	g	N (a)	--
IRON	4 / 4	646 - 21100	100 - 100	NA	1.04E+04			Nutrient		N (b)	--
LEAD	3 / 9	25 - 77	3 - 25	NP	2.09E+01	7.70E+01		1.50E+01	h	Y (a)	7.70E+01
MAGNESIUM	4 / 4	25800 - 50700	5000 - 5000	NA	3.73E+04			Nutrient		N (b)	--
MANGANESE	9 / 9	126 - 1600	15 - 40	NP	6.25E+02	1.60E+03	8.90E+02	8.80E+02		Y (a)	1.60E+03
NICKEL	1 / 9	20 - 20	20 - 40	NP	1.56E+01			7.30E+02		N (a)	--
POTASSIUM	4 / 4	5180 - 9910	5000 - 5000	NA	7.61E+03			Nutrient		N (b)	--
SODIUM	4 / 4	38300 - 107000	5000 - 5000	NA	7.21E+04			Nutrient		N (b)	--
VANADIUM	1 / 4	52.2 - 52.2	50 - 50	NA	3.18E+01			2.60E+02		N (a)	--
ZINC	7 / 9	20 - 92.5	20 - 20	NP	4.44E+01		5.80E+01	1.10E+04		N (a)	--
Nitroaromatics											
4-AMINO-2-NITROTOLUENE	1 / 5	0.6 - 0.6	0.55 - 0.55	NP	3.40E-01			2.00E+00		N (a)	--
1,3-DINITROBENZENE	1 / 9	0.3 - 0.3	0.15 - 0.2	NP	1.11E-01			3.60E+00		N (a)	--
2,4-DINITROTOLUENE	1 / 9	0.5 - 0.5	0.1 - 0.2	NP	1.22E-01	5.00E-01		9.90E-02	i	Y (a)	5.00E-01
2,6-DINITROTOLUENE	1 / 9	0.8 - 0.8	0.1 - 0.2	NP	1.56E-01	8.00E-01		9.90E-02	i	Y (a)	8.00E-01
3,4-DINITROTOLUENE	4 / 5	0.5 - 0.6	0.21 - 0.21	NP	4.81E-01	6.00E-01		9.90E-02	i	Y (a)	6.00E-01
3-NITROTOLUENE	4 / 9	2.3 - 54	0.2 - 1.4	L	6.92E+00			6.10E+01		N (a)	--
Semivolatile Organics											
DI-n-OCYLPHTHALATE	1 / 4	7.8 - 7.8	10 - 10	NA	5.70E+00			7.30E+02		N (a)	--
Volatile Organics											
BROMOMETHANE	4 / 4	0.16 - 0.21	2 - 2	NA	1.85E-01			8.70E+00		N (a)	--

UCL - Upper confidence limit.
COPC - Chemical of potential concern.
NA - Not applicable.
µg/L - Micrograms per liter.
[a] Statistical Distribution: L = Lognormal distribution; NP = Nonparametric distribution; NA = sample size is less than 5 and distribution is not characterized.
[b] Method of estimation based on statistical distribution (please see Section 5.2.2).
[c] Please see Table 5-2.
[d] EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, S. J. Smucker, Ph.D., unadjusted tap water PRGs.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the risk-based screening concentration (RBSC).
(b) = essential nutrient.
[f] Y = Chemical is chosen as COPC.
(a) = maximum detection is greater than RBSC.
(b) = included in background risk calculation.
[g] RBSC based on the PRG for chromium VI.
[h] EPA, 1996, *Drinking Water Regulations and Health Advisories,* Office of Water, Washington, DC, October.
[i] Based on PRG for mixed dinitrotoluene.

Table 5-9

Statistical Summary and COPC Selection of Sediment Sample Analyses, West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentration	Range of Reporting Limits	Statistical Distribution [a]	Arithmetic Mean	95% UCL[b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration
Inorganics										
ALUMINUM	4 / 4	3230 - 9600	24.2 - 98.5	NA	5.99E+03		6.02E+03	7.60E+04	N (a)	--
ARSENIC	9 / 17	4 - 11.3	1.2 - 4.9	NP	4.58E+00	8.38E+00	5.40E+00	3.90E-01	Y (a)	8.38E+00
BARIUM	3 / 4	34.8 - 65	24.2 - 98.5	NA	4.63E+01		5.34E+01	5.40E+03	N (a)	--
CALCIUM	4 / 4	6710 - 74700	606 - 2460	NA	2.74E+04			Nutrient	N (b)	--
CHROMIUM	17 / 17	7.4 - 28.7	1.2 - 4.9	L	1.51E+01		1.15E+01	2.10E+02 g	N (a)	--
COBALT	2 / 4	10.6 - 10.8	6.1 - 24.6	NA	1.01E+01		1.09E+01	4.70E+03	N (a)	--
COPPER	7 / 17	3.2 - 24.5	2.4 - 12.3	NP	5.24E+00		1.79E+01	2.90E+03	N (a)	--
IRON	4 / 4	16000 - 24300	12.1 - 49.3	NA	1.87E+04			Nutrient	N (b)	--
LEAD	17 / 17	8.1 - 32.1	0.36 - 4	L	1.60E+01		1.28E+01	4.00E+02	N (a)	--
MAGNESIUM	4 / 4	2520 - 6770	606 - 2460	NA	3.84E+03			Nutrient	N (b)	--
MANGANESE	17 / 17	149 - 726	1.8 - 7.4	NP	2.49E+02		8.65E+02	1.80E+03	N (a)	--
NICKEL	17 / 17	8.8 - 24.5	2.4 - 19.7	N	1.77E+01		2.30E+01	1.60E+03	N (a)	--
POTASSIUM	2 / 5	821 - 1500	27 - 2460	N	9.04E+02			Nutrient	N (b)	--
VANADIUM	1 / 4	25 - 25	6.1 - 24.6	NA	9.54E+00		1.74E+01	5.50E+02	N (a)	--
ZINC	17 / 17	36 - 94	2.4 - 9.9	L	6.09E+01		7.33E+01	2.30E+04	N (a)	--
Nitroaromatics										
2-AMINO-4,6-DINITROTOLUENE	1 / 17	0.3 - 0.3	0.25 - 0.25	NP	1.35E-01			3.70E+00 h	N (a)	--
1,3-DINITROBENZENE	4 / 17	0.3 - 0.7	0.25 - 0.25	NP	2.37E-01			6.10E+00	N (a)	--
2,4-DINITROTOLUENE	6 / 17	0.3 - 0.7	0.25 - 0.25	NP	2.57E-01			7.20E-01 i	N (a)	--
2,6-DINITROTOLUENE	1 / 17	0.4 - 0.4	0.25 - 0.26	NP	1.45E-01			7.20E-01 i	N (a)	--
1,3,5-TRINITROBENZENE	3 / 17	0.6 - 0.8	0.25 - 0.25	NP	2.21E-01			1.80E+03	N (a)	--
Semivolatile Organics										
FLUORANTHENE	1 / 4	0.047 - 0.047	0.4 - 1.6	NA	3.79E-01			2.30E+03	N (a)	--
Volatile Organics										
2-BUTANONE	2 / 4	0.021 - 0.029	0.024 - 0.099	NA	2.79E-02			7.30E+03	N (a)	--
ACETONE	2 / 2	0.071 - 0.11	0.053 - 0.099	NA	9.05E-02			1.60E+03	N (a)	--

COPC - Chemical of potential concern.
UCL - Upper confidence limit.
mg/kg - Milligrams per kilogram.
[a] Statistical Distribution: L = Lognormal distribution; NP = Nonparametric distribution; NA = sample size is less than 5 and distribution is not characterized.
[b] Method of estimation based on statistical distribution (please see Section 5.2.2).
[c] Please see Table 5-3.
[c] EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, S. J. Smucker, Ph.D., unadjusted residential soil PRG.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the risk-based screening concentration (RBSC).
(b) = essential nutrient.
[f] Y = Chemical is chosen as COPC.
(a) = maximum detection is greater than RBSC.
(b) = included in background risk calculation.
[g] RBSC based on the PRG for total chromium.
[h] Calculated; reference Appendix H.1.
[i] Based on PRG for mixed dinitrotoluene.

Table 5-10

Statistical Summary and COPC Selection of Surface Soil[a] Sample Analyses, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC?[e,f]	Source Term Concentration
Inorganics										
ALUMINUM	20 / 20	2370 - 12700	21.3 - 24.8	N	7.05E+03	7.99E+03	2.69E+04	7.60E+03	Y (b)	7.99E+03
ARSENIC	36 / 50	2.3 - 22	1.1 - 3.8	NP	4.59E+00	5.80E+00	7.10E+01	3.90E-02	Y (b)	5.80E+00
BARIUM	13 / 20	24.3 - 84.3	21.3 - 24.8	NP	3.27E+01		1.30E+03	5.40E+02	N (a)	--
BERYLLIUM	3 / 50	0.68 - 0.69	0.53 - 1.3	NP	4.77E-01		1.17E+00	1.50E+01	N (a)	--
CALCIUM	19 / 20	817 - 54000	532 - 620	L	6.25E+03			Nutrient	N (b)	--
CHROMIUM	50 / 50	4.2 - 21	1 - 1.3	L	1.07E+01	1.15E+01	2.90E+01	2.10E+01 g	N (a)	--
COBALT	9 / 20	5.8 - 11.1	5.3 - 6.2	NP	4.74E+00		2.48E+02	4.70E+02	N (a)	--
COPPER	29 / 50	2.5 - 22.6	2.1 - 3.1	NP	4.77E+00		1.47E+02	2.90E+02	N (a)	--
IRON	20 / 20	8330 - 22900	10.6 - 12.4	N	1.43E+04			Nutrient	N (b)	--
LEAD	50 / 50	3.1 - 19	0.32 - 3.2	L	7.68E+00		5.13E+01	4.00E+02	N (a)	--
MAGNESIUM	20 / 20	791 - 11500	532 - 620	NP	2.32E+03			Nutrient	N (b)	--
MANGANESE	50 / 50	74.5 - 820	1.6 - 5.1	L	2.38E+02	2.74E+02	3.51E+03	1.80E+02	Y (b)	2.74E+02
MERCURY	2 / 50	0.04 - 0.043	0.035 - 0.31	NP	9.29E-02		5.60E-01	2.30E+00	N (a)	--
NICKEL	50 / 50	4.7 - 27.2	2.1 - 5	NP	9.62E+00		7.79E+01	1.60E+02	N (a)	--
POTASSIUM	5 / 20	684 - 1460	532 - 620	NP	4.41E+02			Nutrient	N (b)	--
SELENIUM	2 / 50	0.59 - 0.84	0.53 - 5	NP	1.48E+00		2.00E+00	3.90E+01	N (a)	--
SODIUM	2 / 20	741 - 1240	532 - 620	NP	3.57E+02			Nutrient	N (b)	--
VANADIUM	20 / 20	12.9 - 35.2	5.3 - 6.2	N	2.21E+01		8.31E+01	5.50E+01	N (a)	--
ZINC	50 / 50	17 - 78.5	2.1 - 2.5	NP	3.00E+01		3.22E+02	2.30E+03	N (a)	--
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1 / 50	2.7 - 2.7	0.25 - 0.25	NP	1.77E-01	2.70E+00		3.70E-01 h	Y (a)	2.70E+00
1,3-DINITROBENZENE	6 / 50	0.3 - 1.6	0.25 - 0.25	NP	1.98E-01	8.97E-01		6.10E-01	Y (a)	8.97E-01
2,4-DINITROTOLUENE	12 / 50	0.3 - 2.4	0.25 - 0.25	NP	3.31E-01	1.57E+00		7.20E-02 i	Y (a)	1.57E+00
2,6-DINITROTOLUENE	2 / 50	0.4 - 0.8	0.25 - 0.26	NP	1.47E-01	8.00E-01		7.20E-02 i	Y (a)	8.00E-01
3,4-DINITROTOLUENE	1 / 30	0.3 - 0.3	0.25 - 0.25	NP	1.31E-01	3.00E-01		7.20E-02 i	Y (a)	3.00E-01
1,3,5-TRINITROBENZENE	5 / 50	0.4 - 1.7	0.25 - 0.25	NP	2.01E-01			1.80E+02	N (a)	--
2,4,6-TRINITROTOLUENE	1 / 50	0.27 - 0.27	0.25 - 0.25	NP	1.28E-01			1.60E+00	N (a)	--

Table 5-10

Statistical Summary and COPC Selection of Surface Soil[a] Sample Analyses, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC?[e,f]	Source Term Concentration
Volatile Organics										
METHYLENE CHLORIDE	1 / 10	0.0018 - 0.0018	0.0055 - 0.0062	NP	2.82E-03			8.90E-01	N (a)	--

COPC - Chemical of potential concern; UCL - Upper confidence limit.
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparmametric; data are found to be neither normally nor lognormally distributed.
mg/kg - Milligrams per kilogram.

[a] Surface soil is defined as the interval from 0 to 3 feet below the ground surface. Soil samples were classified on the basis of the beginning depth of the sample.

[b] Method of estimation based on statistical distribution (please see Section 5.2.2).

[c] Please see Table 5-1.

[d] Residential Soil PRGs from EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, adjusted to reflect a cancer risk of 1E-7 and a hazard index of 0.1.

[e] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the risk-based screening concentration (RBSC).
(b) = essential nutrient.

[f] Y = Chemical is chosen as COPC:
(a) = maximum detection is greater than RBSC.
(b) = included in background risk calculation

[g] Based on PRG for total chromium.

[h] Calculated; reference Appendix H.1.

[i] Based on PRG for mixed dinitrotoluene.

Table 5-11

Statistical Summary and COPC Selection of Subsurface[a] Soil Sample Analyses, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration
Inorganics										
ALUMINUM	39 / 39	3320 - 12300	22.1 - 26.7	N	8.65E+03	9.25E+03	2.69E+04	7.60E+03	Y (b)	9.25E+03
ANTIMONY	12 / 73	5.6 - 9.3	5.2 - 8	L*	4.00E+00	6.80E+00	9.30E+00	3.10E+00	Y (b)	6.80E+00
ARSENIC	69 / 73	2.6 - 42.8	1.1 - 3.8	L	8.80E+00	1.01E+01	7.10E+01	3.90E-02	Y (b)	1.01E+01
BARIUM	36 / 39	26.5 - 239	22.1 - 26.7	NP	6.81E+01		1.30E+03	5.40E+02	N (a)	--
BERYLLIUM	7 / 73	0.55 - 0.83	0.55 - 1.3	N	4.76E-01		1.17E+00	1.50E+01	N (a)	--
CADMIUM	1 / 73	0.63 - 0.63	0.55 - 1.3	N	4.43E-01			3.70E+00	N (a)	--
CALCIUM	39 / 39	1850 - 70400	552 - 667	NP	4.20E+04			Nutrient	N (b)	--
CHROMIUM	73 / 73	5.2 - 27	1 - 1.3	N	1.51E+01	1.58E+01	2.90E+01	2.10E+01 g	Y (b)	1.58E+01
COBALT	33 / 39	6.3 - 30.3	5.5 - 6.7	NP	1.03E+01		2.48E+02	4.70E+02	N (a)	--
COPPER	68 / 73	3 - 34.5	2.1 - 3.3	N	1.40E+01		1.47E+02	2.90E+02	N (a)	--
IRON	39 / 39	8940 - 43700	11 - 13.3	L	2.04E+04			Nutrient	N (b)	--
LEAD	73 / 73	2.9 - 18	0.33 - 3.2	N	9.89E+00		5.13E+01	4.00E+02	N (a)	--
MAGNESIUM	39 / 39	917 - 25300	552 - 667	NP	1.41E+04			Nutrient	N (b)	--
MANGANESE	73 / 73	140 - 2270	1.7 - 5.1	L	5.15E+02	5.63E+02	3.51E+03	1.80E+02	Y (b)	5.63E+02
MERCURY	1 / 73	0.045 - 0.045	0.036 - 0.32	N	8.08E-02		5.60E-01	2.30E+00	N (a)	--
NICKEL	73 / 73	6.4 - 57.2	2.1 - 5.3	L	2.24E+01		7.79E+01	1.60E+02	N (a)	--
POTASSIUM	37 / 40	713 - 2730	27 - 667	N	1.50E+03			Nutrient	N (b)	--
SELENIUM	6 / 73	0.64 - 1.1	0.55 - 5.1	L	1.33E+00		2.00E+00	3.90E+01	N (a)	--
SODIUM	10 / 39	1030 - 4280	552 - 667	NP	7.51E+02			Nutrient	N (b)	--
VANADIUM	39 / 39	15 - 38.4	5.5 - 6.7	L	2.51E+01		8.31E+01	5.50E+01	N (a)	--
ZINC	73 / 73	22.7 - 104	2.1 - 2.7	N	5.32E+01		3.22E+02	2.30E+03	N (a)	--
Nitroaromatics										
4-AMINO-2-NITROTOLUENE	2 / 34	0.6 - 0.9	0.25 - 2.5	NP	1.95E-01			1.50E+00	N (a)	--
4-AMINO-2,6-DINITROTOLUENE	6 / 73	0.3 - 9.5	0.25 - 2.5	L*	3.35E-01	1.88E+00		3.70E-01 h	Y (a)	1.88E+00
1,3-DINITROBENZENE	24 / 73	0.25 - 9.3	0.25 - 5	L*	1.12E+00	2.20E+00		6.10E-01	Y (a)	2.20E+00
2,4-DINITROTOLUENE	29 / 73	0.28 - 25	0.25 - 2.5	L*	1.97E+00	5.34E+00		7.20E-02 i	Y (a)	5.34E+00
2,6-DINITROTOLUENE	15 / 73	0.29 - 3.6	0.25 - 2.6	L*	3.42E-01	9.51E-01		7.20E-02 i	Y (a)	9.51E-01
3,4-DINITROTOLUENE	5 / 34	0.5 - 4.5	0.25 - 2.5	NP	3.60E-01	3.68E+00		7.20E-02 i	Y (a)	3.68E+00
NITROBENZENE	1 / 73	1.1 - 1.1	0.25 - 2.6	L	1.80E-01			2.00E+00	N (a)	--
2-NITROTOLUENE	1 / 73	0.9 - 0.9	0.25 - 2.5	L	1.75E-01			3.70E+01	N (a)	--
1,3,5-TRINITROBENZENE	31 / 73	0.4 - 58	0.25 - 5	L	4.01E+00			1.80E+02	N (a)	--
2,4,6-TRINITROTOLUENE	5 / 73	0.3 - 12000	0.25 - 2.5	L*	1.69E+02	1.20E+04		1.60E+00	Y (a)	1.20E+04
Semivolatile Organics										
3-NITROANILINE	1 / 9	0.053 - 0.053	1.9 - 20	NP	1.89E+00			1.80E+00	N (a)	--

Table 5-11

Statistical Summary and COPC Selection of Subsurface[a] Soil Sample Analyses, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration
Volatile Organics										
ACETONE	1 / 8	0.0082 - 0.0082	0.024 - 0.027	NP	1.20E-02			1.60E+02	N (a)	--
METHYLENE CHLORIDE	1 / 9	0.0021 - 0.0021	0.006 - 0.0067	NP	3.00E-03			8.90E-01	N (a)	--
TOLUENE	1 / 9	0.0017 - 0.0017	0.006 - 0.0067	NP	2.96E-03			5.90E+01	N (a)	--

COPC - Chemical of potential concern; UCL - Upper confidence limit.
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparmametric; data are found to be neither normally nor lognormally distributed.
mg/kg - Milligrams per kilogram.

* Please see section 5.2.2.1.

[a] Subsurface soil is defined as the interval from 2 to 10 feet below the ground surface.

[b] Method of estimation based on statistical distribution (please see Section 5.2.2).

[c] Please see Table 5-1.

[d] Residential Soil PRGs from EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, adjusted to reflect a cancer risk of 1E-7 and a hazard index of 0.1.

[e] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the risk-based screening concentration (RBSC).
(b) = essential nutrient.

[f] Y = Chemical is chosen as COPC:
(a) = maximum detection is greater than RBSC.
(b) = included in background risk calculation

[g] Based on PRG for total chromium.

[h] Calculated; reference Appendix H.1.

[i] Based on PRG for mixed dinitrotoluene.

Table 5-12

Screening of VOCs from Subsurface Soil in Indoor Air, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Chemical Concentration In Soil (mg/kg)	VOC Concentration In Soil Gas C_{source} (g/cm^3)	Effective Diffusion Coefficient D^{eff} (cm^2/s)	Attenuation Coefficient α (unitless)	VOC Concentration in Indoor Air In the Building (mg/m^3)	Risk-Based Screening Criterion [a] (mg/m^3)	COPC?
Volatile Organics							
Acetone	8.20E-03	1.26E-10	9.74E-03	6.91E-06	8.69E-07	3.70E-02	No
Methylene chloride	2.10E-03	1.01E-09	7.88E-03	5.59E-06	5.63E-06	4.10E-04	No
Toluene	1.70E-03	3.72E-10	6.79E-03	4.81E-06	1.79E-06	4.00E-02	No

COPC = Chemical of potential concern.
mg/kg - Milligrams per kilogram.
g/cm^3 - Grams per cubic centimeter.
cm^2/s - Square centimeters per second.
mg/m^3 - Milligrams per cubic meter.

[a] Ambient Air PRGs from EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3,1999, adjusted to reflect a cancer risk of 1E-7 and a hazard index of 0.1.

Table 5-13

COPC Selection for Total Soil[a], Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	COPC? [b]	Source Term Concentration	MDC Surface Soil [c]	MDC Subsurface Soil [d]
Inorganics				
ALUMINUM	Y (b)	9.25E+03	--	--
ANTIMONY	Y (b)	6.80E+00	--	--
ARSENIC	Y (b)	1.01E+01	--	--
CHROMIUM	Y (b)	1.58E+01	--	--
MANGANESE	Y (b)	5.63E+02	--	--
Nitroaromatics				
4-AMINO-2,6-DINITROTOLUENE	Y (a)	2.70E+00	2.70E+00	9.50E+00
1,3-DINITROBENZENE	Y (a)	2.20E+00	1.60E+00	9.30E+00
2,4-DINITROTOLUENE	Y (a)	5.34E+00	2.40E+00	2.50E+01
2,6-DINITROTOLUENE	Y (a)	9.51E-01	8.00E-01	3.60E+00
3,4-DINITROTOLUENE	Y (a)	3.68E+00	3.00E-01	4.50E+00
2,4,6-TRINITROTOLUENE	Y (a)	1.20E+04	--	1.20E+04

COPC - Chemical of potential concern.
MDC - Maximum detected concentration.
mg/kg - Milligrams per kilogram.

[a] Total soil is defined in Section 5.2.1.1 of the text.
[b] Y = Chemical is chosen as COPC:
(a) = maximum detection is greater than RBSC.
(b) = included in background risk calculation
[c] Please see Table 5-10.
[d] Please see Table 5-11.

Table 5-14

Statistical Summary and COPC Selection of Surface Water Samples, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (µg/L)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution [a]	Arithmetic Mean	95% UCL [a]	Background Screening Criterion [b]	Risk-Based Screening Criterion [c]	COPC?[d]
Inorganics (unfiltered)									
Aluminum	2 / 2	530 - 3040	200 - 200	NA	1.79E+03	NA	3.04E+03	3.60E+04	N (a)
Calcium	2 / 2	71700 - 118000	5000 - 5000	NA	9.49E+04	NA		Nutrient	N (b)
Iron	2 / 2	972 - 5790	100 - 100	NA	3.38E+03	NA		Nutrient	N (b)
Magnesium	2 / 2	15800 - 37300	5000 - 5000	NA	2.66E+04	NA		Nutrient	N (b)
Manganese	2 / 2	261 - 404	15 - 15	NA	3.33E+02	NA	8.90E+02	8.80E+02	N (a)
Sodium	2 / 2	13700 - 24700	5000 - 5000	NA	1.92E+04	NA		Nutrient	N (b)
Zinc	1 / 2	58 - 58	20 - 20	NA	3.90E+01	NA	5.80E+01	1.10E+04	N (a)
Volatile Organics									
Bromomethane	1 / 2	0.11 - 0.11	2 - 2	NA	1.06E+00	NA		8.70E+00	N (a)

UCL - Upper confidence limit.
COPC - Chemical of potential concern.
NA - Not available or not applicable.
µg/L - Micrograms per liter.

[a] Insufficient number of samples (less than five) to determine statistical distribution or calculate a UCL.
[b] Please see Table 5-2.
[c] EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, S. J. Smucker, Ph.D., unadjusted tap water PRGs.
[d] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the risk-based screening concentration (RBSC).
(b) = essential nutrient.

Table 5-15

Statistical Summary and COPC Selection in Sediment Sample Analyses, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentration	Range of Reporting Limits	Statistical Distribution [a]	Arithmetic Mean	95% UCL mg/kg [a]	Background Screening Criterion [b]	Risk-Based Screening Criterion [c]	COPC? [d,e]	Source Term Concentration
Inorganics										
ALUMINUM	2 / 2	2830 - 5130	25.3 - 34.6	NA	3.98E+03	NA	6.02E+03	7.60E+04	N (a)	--
ARSENIC	2 / 2	4.3 - 5.1	1.3 - 1.7	NA	4.70E+00	NA	5.40E+00	3.90E-01	Y (b)	5.1
BARIUM	1 / 2	48.1 - 48.1	25.3 - 34.6	NA	3.67E+01	NA	5.34E+01	5.40E+03	N (a)	--
CALCIUM	2 / 2	46300 - 62000	631 - 865	NA	5.42E+04	NA		Nutrient	N (b)	--
CHROMIUM	2 / 2	6.3 - 10.4	1.3 - 1.7	NA	8.35E+00	NA	1.15E+01	2.10E+02 f	N (a)	--
COPPER	2 / 2	7.6 - 14.5	3.2 - 4.3	NA	1.11E+01	NA	1.79E+01	2.90E+03	N (a)	--
IRON	2 / 2	9620 - 13700	12.6 - 17.3	NA	1.17E+04	NA		Nutrient	N (b)	--
LEAD	2 / 2	4.8 - 7.8	0.38 - 0.52	NA	6.30E+00	NA	1.28E+01	4.00E+02	N (a)	--
MAGNESIUM	2 / 2	13500 - 19300	631 - 865	NA	1.64E+04	NA		Nutrient	N (b)	--
MANGANESE	2 / 2	404 - 421	1.9 - 2.6	NA	4.13E+02	NA	8.65E+02	1.80E+03	N (a)	--
NICKEL	2 / 2	9.5 - 17.9	5.1 - 6.9	NA	1.37E+01	NA	2.30E+01	1.60E+03	N (a)	--
POTASSIUM	1 / 2	1040 - 1040	631 - 865	NA	8.36E+02	NA		Nutrient	N (b)	--
VANADIUM	2 / 2	12.9 - 14.2	6.3 - 8.7	NA	1.36E+01	NA	1.74E+01	5.50E+02	N (a)	--
ZINC	2 / 2	23.2 - 58.4	2.5 - 3.5	NA	4.08E+01	NA	7.33E+01	2.30E+04	N (a)	--
Semivolatile Organics										
ACENAPHTHENE	1 / 2	0.11 - 0.11	0.42 - 0.57	NA	3.40E-01	NA		3.70E+03	N (a)	--
ANTHRACENE	1 / 2	0.077 - 0.077	0.42 - 0.57	NA	3.24E-01	NA		2.20E+04	N (a)	--
CARBAZOLE	1 / 2	0.18 - 0.18	0.42 - 0.57	NA	3.75E-01	NA		2.40E+01	N (a)	--
DIBENZOFURAN	1 / 2	0.06 - 0.06	0.42 - 0.57	NA	3.15E-01	NA		2.90E+02	N (a)	--
FLUORANTHENE	1 / 2	0.14 - 0.14	0.42 - 0.57	NA	3.55E-01	NA		2.30E+03	N (a)	--
FLUORENE	1 / 2	0.11 - 0.11	0.42 - 0.57	NA	3.40E-01	NA		2.60E+03	N (a)	--
PHENANTHRENE	1 / 2	0.32 - 0.32	0.42 - 0.57	NA	4.45E-01	NA		2.30E+03 g	N (a)	--
PYRENE	1 / 2	0.11 - 0.11	0.42 - 0.57	NA	3.40E-01	NA		2.30E+03	N (a)	--
Volatile Organics										
ACETONE	1 / 1	0.049 - 0.049	0.035 - 0.035	NA	4.90E-02	NA		1.60E+03	N (a)	--
2-BUTANONE	1 / 2	0.01 - 0.01	0.025 - 0.035	NA	1.75E-02	NA		7.30E+03	N (a)	--

COPC - Chemical of potential concern.
NA - Not available or not applicable.
UCL - Upper confidence limit.
mg/kg - Milligrams per kilogram.
[a] Insufficient number of samples (less than five), to determine statistical distribution or calculate a UCL..
[b] Please see Table 5-3.
[c] EPA, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, S. J. Smucker, Ph.D., unadjusted residential soil PRG.
[d] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the risk-based screening concentration (RBSC).
(b) = essential nutrient.
[e] Y = Chemical is chosen as a COPC:
(a) = maximum detection is greater than RBSC.
(b) = included in background risk calculation.
[f] PRG based on total chromium.
[g] Calculated; reference Appendix H.1.

Table 5-16

Receptor/Exposure Scenarios
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 3)

Source Medium	Model	Exposure Medium	Exposure Pathway
Groundskeeper			
Surface soil	None	Soil	Incidental ingestion
			Dermal contact
	Volatilization from soil	Air	Inhalation
	Dust emissions based on activity	Air	Inhalation
Total soil	Not quantified[a]		
Surface water	Not quantified[b]		
Sediment	Not quantified[b]		
Groundwater	Not evaluated at this time[c]		
Indoor Worker			
Surface soil	None	Soil	Incidental ingestion
Subsurface soil	Volatilization from soil	Indoor air	Inhalation
Total soil	Not quantified[a]		
Surface water	Not quantified[a]		
Sediment	Not quantified[a]		
Groundwater	Not evaluated at this time[c]		

Table 5-16

Receptor/Exposure Scenarios
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 3)

Source Medium	Model	Exposure Medium	Exposure Pathway
Construction Worker			
Total soil	None	Soil	Incidental ingestion
			Dermal contact
	Volatilization from soil	Air	Inhalation
	Dust emissions based on activity	Air	Inhalation
Surface water	None	Surface water	Dermal contact
	Volatilization from water	Air	Inhalation[d]
Sediment	None	Sediment	Incidental ingestion
			Dermal contact
Groundwater	Not evaluated at this time[c]		

Table 5-16

Receptor/Exposure Scenarios
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 3 of 3)

Source Medium	Model	Exposure Medium	Exposure Pathway
Future On-Site Resident			
Total soil	None	Soil	Incidental ingestion
			Dermal contact
	Volatilization from soil	Air	Inhalation
	Dust emissions based on wind erosion	Air	Inhalation[e]
Subsurface soil	Volatilization from soil	Indoor air	Inhalation
Groundwater	Not evaluated at this time[c]		
Surface water	None	Surface water	Dermal contact
	Volatilization from water	Air	Inhalation[d]
Sediment	None	Sediment	Incidental ingestion
			Dermal contact

[a] There is no plausible pathway for exposure to this medium.
[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] No groundwater data are available at this writing. Future groundwater exposures will be assessed when data become available.
[d] Although theoretically complete, this pathway is not quantified as explained in text.
[e] It is assumed that residential soil is 80 percent covered with pavement or vegetation for evaluating inhalation exposure via dust emissions.

Table 5-17

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 4)

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker
General Variables Used in All Intake Models				
Exposure duration (ED), years	25[a]	0.5[b]	Child: 6[c] Adult: 24[c]	25[a]
Body weight (BW), kg	70[a]	70[a]	Child: 15[c] Adult: 70[a]	70[a]
Averaging time, noncancer (AT), days[d]	9125	183	Child: 2190 Adult: 8760	9125
Averaging time, cancer (AT), days[e]	25550	25550	25550	25550
Inhalation of VOCs and Resuspended Dust from Soil				
Fraction exposed to contaminated medium (FI_a), unitless	1[b]	1[b]	1[b]	NA
Inhalation rate (IR_a), m^3/day	20[a]	20[a]	Child: 10[c] Adult: 20[a]	NA
Exposure frequency (EF), days/year	250[a]	250[a]	350[a]	NA
Inhalation of VOCs, Entrapped in Building				
Fraction exposed to contaminated medium (FI_a), unitless	NA	NA	1[b]	1[b]
Inhalation rate (IR_a), m^3/day	NA	NA	Child: 6.8[b] Adult: 13.7[b]	20[a]
Exposure frequency (EF), days/year	NA	NA	350[a]	250[a]

Table 5-17

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 4)

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker
Incidental Ingestion of Soil				
Fraction exposed to contaminated medium (FI_{so}), unitless	1[b]	0.5[b]	0.9[b]	1[b]
Soil incidental ingestion rate (IR_{so}), mg/day	100[a]	290[b]	Child: 200[c] Adult: 100[a]	50[a]
Exposure frequency (EF), days/year	250[a]	250[a]	350[a]	250[a]
Incidental Ingestion of Sediment				
Fraction exposed to contaminated medium (FI_{sd}), unitless	NA	0.5[b]	0.1[b]	NA
Sediment incidental ingestion rate (IR_{sd}), mg/day	NA	480[b]	Child: 200[c] Adult: 100[a]	NA
Exposure frequency (EF), days/year	NA	250[a]	52[b]	NA
Dermal Contact with Soil				
Fraction exposed to contaminated medium ($_{FIso}$), unitless	1[b]	0.5[b]	0.9[b]	NA
Body surface area exposed to soil (SA_{so}), cm^2	11,300[f]	11,300[f]	Child: 1750[g] Adult: 4550[g]	NA
Soil-to-skin adherence factor (AF_{so}), mg/cm^2	0.009[f]	0.08[f]	0.2[g]	NA
Dermal absorption factor (ABS), unitless	csv	csv	csv	NA
Exposure frequency (EF), days/year	250[a]	250[a]	350[a]	NA

Table 5-17

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors Red Water Ponds, PBOW, Sandusky, Ohio

(Page 3 of 4)

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker
Dermal Contact with Sediment				
Fraction exposed to contaminated medium (FI_{sd}), unitless	NA	0.5[b]	0.1[b]	NA
Body surface area exposed to sediment (SA_{sd}), cm^2	NA	3100[f]	Child: 1750[g] Adult: 4550[g]	NA
Sediment-to-skin adherence factor (AF_{sd}), mg/cm^2	NA	0.24[f]	0.2[g]	NA
Dermal absorption factor (ABS), unitless	NA	csv	csv	NA
Exposure frequency (EF), days/year	NA	250[a]	52[b]	NA
Dermal Contact with Surface Water				
Body surface area exposed to surface water, (SA_{sw}), cm^2	NA	3100[f]	Child: 2100[g] Adult: 5450[g]	NA
Permeability coefficient (PC), cm/hour	NA	csv	csv	NA
Exposure time (ET_{sw}), hour/day	NA	4[b]	3[b]	NA
Exposure frequency (EF), days/year	NA	250[a]	52[b]	NA

Table 5-17

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors Red Water Ponds, PBOW, Sandusky, Ohio

(Page 4 of 4)

[a] 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.

[b] Assumed; see text.

[c] U.S. Environmental Protection Agency (EPA), 1999, *Region IX Preliminary Remediation Goals* (PRG), December 3, 1999, on-line.

[d] Calculated as the product of ED (years) x 365 days/year.

[e] Calculated as the product of 70 years (assumed human lifetime) x 365 days/year.

[f] U.S. Environmental Protection Agency (EPA), 1997, *Exposure Factors Handbook*, Final, National Center for Environmental Assessment, Washington, DC, EPA/600/P-95/002Fa, August.

[g] EPA, 1992, *Dermal Exposure Assessment: Principles and Applications*, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, including Supplemental Guidance dated August 18, 1992.

NA = Not applicable to this receptor; csv = chemical-specific value (see Table 4-1).

Table 5-18

Chemical-Specific Physical Property Values Used in Exposure Assessment[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	ABS (unitless)	PC (cm/hr)	Henry's Law Constant	Koc unitless	Kd cm^3/g	Da cm^2/s	Dw cm^2/s
Inorganics							
Aluminum	0.01	NA	NA	NA	NA	NA	NA
Antimony	0.01	NA	NA	NA	NA	NA	NA
Arsenic	0.01	1.00E-03	NA	NA	NA	NA	NA
Chromium	0.01	NA	NA	NA	NA	NA	NA
Lead	0.01	4.00E-06	NA	NA	NA	NA	NA
Manganese	0.01	1.00E-03	NA	NA	NA	NA	NA
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	0.1	NA	NA	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	0.1	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	0.1	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	0.1	3.80E-03	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	0.1	2.50E-03	NA	NA	NA	NA	NA
3,4-Dinitrotoluene	0.1	3.88E-03	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	0.1	NA	NA	NA	NA	NA	NA
Semivolatile Organics							
Acenapthylene	0.1	NA	1.45E-03	2.51E+01	1.51E-01	6.61E-02	6.60E-06
Benzo(a)anthracene	0.1	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	0.1	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	0.1	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	0.1	NA	NA	NA	NA	NA	NA
Volatile Organics							
Acetone	NA	NA	3.88E-05	5.75E-01	3.45E-03	1.24E-01	1.14E-05
Methylene Chloride	NA	NA	2.19E-03	1.17E+01	7.05E-02	1.01E-01	1.17E-05
Toluene	NA	NA	6.63E-03	1.82E+02	1.09E+00	8.70E-02	8.60E-06

NA = Not applicable.
[a] Please see toxicity profiles in Appendix H.3 for documentation of the values.
cm/hr - Centimeters per hour.
cm^3/g - Cubic centimeters per gram.
cm^2/s - Square centimeters per second.

Table 5-19

COPC-Specific Toxicity Values[a] Used in Risk Assessment
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	GAF	Oral RfD (mg/kg-day)	Target Organs (Oral)	Dermal RfD (mg/kg-day)	Inhalation RfD (mg/kg-day)	Target Organs (Inhalation)	Cancer Weight-of-Evidence Group	Oral SF (mg/kg-day)	Dermal SF (mg/kg-day)	Inhalation SF (mg/kg-day)
Inorganics										
Aluminum	0.27	1.00E+00	N	2.70E-01	1.40E-03	N	ND	ND	ND	ND
Antimony	0.1	4.00E-04	H	4.00E-05	ND	NA	D	ND	ND	ND
Arsenic	0.95	3.00E-04	S, CV	2.85E-04	ND	NA	A	1.50E+00	1.58E+00	1.50E+01
Chromium	0.01	1.50E+00	ND	1.50E-02	2.90E-05	Lung	A	ND	ND	4.20E+01
Lead	0.1	ND	NA	NA	ND	NA	B2	ND	ND	ND
Manganese	0.05	4.70E-02	N	2.35E-03	1.40E-05	N	D	ND	ND	ND
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	0.6	6.00E-05	L, E	3.60E-05	ND	NA	D	ND	ND	ND
4-Amino-2,6-dinitrotoluene	0.6	6.00E-05	L, E	3.60E-05	ND	NA	D	ND	ND	ND
1,3-Dinitrobenzene	0.8	1.00E-04	E, T	8.00E-05	ND	NA	D	ND	ND	ND
2,4-Dinitrotoluene	1	2.00E-03	N, E, L	2.00E-03	ND	NA	B2	6.80E-01	6.80E-01	ND
2,6-Dinitrotoluene	1	1.00E-03	N, E, L, K	1.00E-03	ND	NA	B2	6.80E-01	6.80E-01	ND
3,4-Dinitrotoluene	1	2.00E-03	N, E, L	2.00E-03	ND	NA	ND	ND	ND	ND
2,4,6-Trinitrotoluene	0.6	5.00E-04	L, E	3.00E-04	ND	NA	C	3.00E-02	5.00E-02	ND
Semivolatile Organics										
Acenapthylene	0.5	6.00E-02	L	3.00E-02	ND	NA	D	ND	ND	ND
Benzo(a)anthracene	0.5	ND	NA	NA	ND	NA	B2	7.30E-01	1.46E+00	3.10E-01
Benzo(a)pyrene	0.5	ND	NA	NA	ND	NA	B2	7.30E+00	1.46E+01	3.10E+00
Benzo(b)fluoranthene	0.5	ND	NA	NA	ND	NA	B2	7.30E-01	1.46E+00	3.10E-01
Indeno(1,2,3-cd)pyrene	0.5	ND	NA	NA	ND	NA	B2	7.30E-01	1.46E+00	3.10E-01

ND = No data; NA = Not applicable.
mg/kg-day - Milligrams per kilogram per day.
[a] Please see toxicity profiles in Appendix H.3 for documentation of the values.

Target Organs:
N = nervous system, H = heart, S = skin, CV = cardiovascular, L = liver, K = kidney, E = erythrocyte, T = testis.

Weight of Evidence Group:
A - Human carcinogen; B1 - Probable human carcinogen (human data); B2 - Probable human carcinogen (animal data);
C - Possible human carcinogen; D - Not classifiable as to carcinogenicity to humans.

Table 5-20

Cancer Risk and Noncancer Hazard Index: Groundskeeper Exposure to Surface Soil, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
TOTAL RISK																	
Inorganics																	
Aluminum	1.30E+04	1.28E-02	4.55E-03	1.28E-02	NA	1.17E-06	1.30E-04	4.63E-05	4.80E-04	NA	1.30E-03	2.55E-04	9.11E-05	1.82E-01	NA	1.95E-01	NA
Arsenic	6.08E+00	5.95E-06	2.13E-06	1.98E-02	3.19E-06	5.47E-10	6.05E-08	2.16E-08	2.12E-04	3.41E-08	6.08E-07	1.19E-07	4.25E-08	NA	6.38E-07	2.00E-02	3.86E-06
Chromium	1.87E+01	1.83E-05	6.54E-06	1.22E-05	NA	1.68E-09	1.86E-07	6.65E-08	1.24E-05	NA	1.87E-06	3.66E-07	1.31E-07	1.26E-02	5.49E-06	1.26E-02	5.49E-06
Manganese	6.02E+02	5.89E-04	2.10E-04	1.25E-02	NA	5.42E-08	5.99E-06	2.14E-06	2.55E-03	NA	6.02E-05	1.18E-05	4.21E-06	8.41E-01	NA	8.56E-01	NA
Nitroaromatics																	
2,4-Dinitrotoluene	4.00E-01	3.91E-07	1.40E-07	1.96E-04	9.51E-08	3.60E-10	3.98E-08	1.42E-08	1.99E-05	9.67E-09	4.00E-08	7.83E-09	2.80E-09	NA	NA	2.16E-04	1.05E-07
Semivolatile Organics																	
Benzo(a)anthracene	4.00E-01	3.91E-07	1.40E-07	NA	1.02E-07	3.60E-10	3.98E-08	1.42E-08	NA	2.08E-08	4.00E-08	7.83E-09	2.80E-09	NA	8.67E-10	NA	1.24E-07
Benzo(a)pyrene	3.90E-01	3.82E-07	1.36E-07	NA	9.95E-07	3.51E-10	3.88E-08	1.39E-08	NA	2.02E-07	3.90E-08	7.63E-09	2.73E-09	NA	8.45E-09	NA	1.21E-06
Benzo(b)fluoranthene	3.00E-01	2.94E-07	1.05E-07	NA	7.65E-08	2.70E-10	2.99E-08	1.07E-08	NA	1.56E-08	3.00E-08	5.87E-09	2.10E-09	NA	6.50E-10	NA	9.27E-08
Indeno(1,2,3-cd)pyrene	2.30E-01	2.25E-07	8.04E-08	NA	5.87E-08	2.07E-10	2.29E-08	8.17E-09	NA	1.19E-08	2.30E-08	4.50E-09	1.61E-09	NA	4.98E-10	NA	7.11E-08
Total HI				**4.63E-02**					**3.27E-03**					**1.04E+00**		**1.08E+00**	
Total ILCR					**4.51E-06**					**2.94E-07**					**6.14E-06**		**1.09E-05**
BACKGROUND RISK																	
Inorganics																	
Aluminum	1.30E+04	1.28E-02	4.55E-03	1.28E-02	NA	1.17E-06	1.30E-04	4.63E-05	4.80E-04	NA	1.30E-03	2.55E-04	9.11E-05	1.82E-01	NA	1.95E-01	NA
Arsenic	6.08E+00	5.95E-06	2.13E-06	1.98E-02	3.19E-06	5.47E-10	6.05E-08	2.16E-08	2.12E-04	3.41E-08	6.08E-07	1.19E-07	4.25E-08	NA	6.38E-07	2.00E-02	3.86E-06
Manganese	6.02E+02	5.89E-04	2.10E-04	1.25E-02	NA	5.42E-08	5.99E-06	2.14E-06	2.55E-03	NA	6.02E-05	1.18E-05	4.21E-06	8.41E-01	NA	8.56E-01	NA
Total HI				**4.51E-02**					**3.24E-03**					**1.02E+00**		**1.07E+00**	
Total ILCR					**3.19E-06**					**3.41E-08**					**6.38E-07**		**3.86E-06**
SITE-RELATED RISK																	
Inorganics																	
Chromium	1.87E+01	1.83E-05	6.54E-06	1.22E-05	NA	1.68E-09	1.86E-07	6.65E-08	1.24E-05	NA	1.87E-06	3.66E-07	1.31E-07	1.26E-02	5.49E-06	1.26E-02	5.49E-06
Nitroaromatics																	
2,4-Dinitrotoluene	4.00E-01	3.91E-07	1.40E-07	1.96E-04	9.51E-08	3.60E-10	3.98E-08	1.42E-08	1.99E-05	9.67E-09	4.00E-08	7.83E-09	2.80E-09	NA	NA	2.16E-04	1.05E-07
Semivolatile Organics																	
Benzo(a)anthracene	4.00E-01	3.91E-07	1.40E-07	NA	1.02E-07	3.60E-10	3.98E-08	1.42E-08	NA	2.08E-08	4.00E-08	7.83E-09	2.80E-09	NA	8.67E-10	NA	1.24E-07
Benzo(a)pyrene	3.90E-01	3.82E-07	1.36E-07	NA	9.95E-07	3.51E-10	3.88E-08	1.39E-08	NA	2.02E-07	3.90E-08	7.63E-09	2.73E-09	NA	8.45E-09	NA	1.21E-06
Benzo(b)fluoranthene	3.00E-01	2.94E-07	1.05E-07	NA	7.65E-08	2.70E-10	2.99E-08	1.07E-08	NA	1.56E-08	3.00E-08	5.87E-09	2.10E-09	NA	6.50E-10	NA	9.27E-08
Indeno(1,2,3-cd)pyrene	2.30E-01	2.25E-07	8.04E-08	NA	5.87E-08	2.07E-10	2.29E-08	8.17E-09	NA	1.19E-08	2.30E-08	4.50E-09	1.61E-09	NA	4.98E-10	NA	7.11E-08
Total HI				**2.08E-04**					**3.23E-05**					**1.26E-02**		**1.29E-02**	
Total ILCR					**1.33E-06**					**2.60E-07**					**6.50E-06**		**7.09E-06**

HQ - Hazard quotient; HI - Hazard index; ILCR - Incremental lifetime cancer risk.
DA - Dose absorbed (per unit body surface area per day).
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2 - Milligrams per square centimeter.
mg/m^3 - Milligrams per cubic meter.

Table 5-21

Cancer Risk and Noncancer Hazard Index: Indoor Worker Exposure to Surface Soil, West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR
TOTAL RISK					
Inorganics					
Aluminum	1.30E+04	1.84E-02	1.32E-04	1.84E-02	NA
Arsenic	6.08E+00	8.60E-06	6.16E-08	2.87E-02	9.24E-08
Chromium	1.87E+01	2.65E-05	1.90E-07	1.76E-05	NA
Manganese	6.02E+02	8.51E-04	6.10E-06	1.81E-02	NA
Nitroaromatics					
2,4-Dinitrotoluene	4.00E-01	5.66E-07	4.05E-09	2.83E-04	2.76E-09
Semivolatile Organics					
Benzo(a)anthracene	4.00E-01	5.66E-07	4.05E-09	NA	2.96E-09
Benzo(a)pyrene	3.90E-01	5.52E-07	3.95E-09	NA	2.89E-08
Benzo(b)fluoranthene	3.00E-01	4.24E-07	3.04E-09	NA	2.22E-09
Indeno(1,2,3-cd)pyrene	2.30E-01	3.25E-07	2.33E-09	NA	1.70E-09
Total HI				**6.55E-02**	
Total ILCR					**1.31E-07**
BACKGROUND RISK					
Inorganics					
Aluminum	1.30E+04	1.84E-02	1.32E-04	1.84E-02	NA
Arsenic	6.08E+00	8.60E-06	6.16E-08	2.87E-02	9.24E-08
Manganese	6.02E+02	8.51E-04	6.10E-06	1.81E-02	NA
Total HI				**6.52E-02**	
Total ILCR					**9.24E-08**
SITE-RELATED RISK					
Inorganics					
Chromium	1.87E+01	2.65E-05	1.90E-07	1.76E-05	NA
Nitroaromatics					
2,4-Dinitrotoluene	4.00E-01	5.66E-07	4.05E-09	2.83E-04	2.76E-09
Semivolatile Organics					
Benzo(a)anthracene	4.00E-01	5.66E-07	4.05E-09	NA	2.96E-09
Benzo(a)pyrene	3.90E-01	5.52E-07	3.95E-09	NA	2.89E-08
Benzo(b)fluoranthene	3.00E-01	4.24E-07	3.04E-09	NA	2.22E-09
Indeno(1,2,3-cd)pyrene	2.30E-01	3.25E-07	2.33E-09	NA	1.70E-09
Total HI				**2.83E-04**	
Total ILCR					**3.85E-08**

HQ - Hazard quotient; HI - Hazard index; ILCR - Incremental lifetime cancer risk.
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.

Table 5-22

Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Total Soil, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm²-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration In Air (mg/m³)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
TOTAL RISK																	
Inorganics																	
Aluminum	1.30E+04	3.69E-02	2.64E-04	3.69E-02	NA	1.04E-05	1.15E-03	8.23E-06	4.26E-03	NA	4.56E-03	8.90E-04	6.38E-06	6.36E-01	NA	6.77E-01	NA
Antimony	3.51E+00	9.94E-06	7.12E-08	2.48E-02	NA	2.81E-09	3.10E-07	2.22E-09	7.74E-03	NA	1.23E-06	2.40E-07	1.72E-09	NA	NA	3.26E-02	NA
Arsenic	8.03E+00	2.27E-05	1.63E-07	7.57E-02	2.44E-07	6.42E-09	7.08E-07	5.07E-09	2.48E-03	8.01E-09	2.81E-06	5.48E-07	3.93E-09	NA	5.89E-08	7.82E-02	3.11E-07
Chromium	1.87E+01	5.29E-05	3.79E-07	3.53E-05	NA	1.50E-08	1.65E-06	1.18E-08	1.10E-04	NA	6.55E-06	1.28E-06	9.15E-09	4.40E-02	3.84E-07	4.42E-02	3.84E-07
Manganese	6.02E+02	1.70E-03	1.22E-05	3.62E-02	NA	4.81E-07	5.31E-05	3.80E-07	2.26E-02	NA	2.11E-04	4.11E-05	2.94E-07	2.94E+00	NA	2.99E+00	NA
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	5.00E-01	1.41E-06	1.01E-08	2.36E-02	NA	4.00E-09	4.41E-07	3.16E-09	1.23E-02	NA	1.75E-07	3.42E-08	2.45E-10	NA	NA	3.58E-02	NA
4-Amino-2,6-dinitrotoluene	6.00E-01	1.70E-06	1.22E-08	2.83E-02	NA	4.80E-09	5.29E-07	3.79E-09	1.47E-02	NA	2.10E-07	4.10E-08	2.94E-10	NA	NA	4.30E-02	NA
1,3-Dinitrobenzene	2.12E+00	6.00E-06	4.30E-08	6.00E-02	NA	1.70E-08	1.87E-06	1.34E-08	2.34E-02	NA	7.42E-07	1.45E-07	1.04E-09	NA	NA	8.34E-02	NA
2,4-Dinitrotoluene	3.09E+00	8.74E-06	6.26E-08	4.37E-03	4.25E-08	2.47E-08	2.72E-06	1.95E-08	1.36E-03	1.33E-08	1.08E-06	2.11E-07	1.51E-09	NA	NA	5.73E-03	5.58E-08
2,6-Dinitrotoluene	1.50E+00	4.24E-06	3.04E-08	4.24E-03	2.07E-08	1.20E-08	1.32E-06	9.48E-09	1.32E-03	6.44E-09	5.25E-07	1.02E-07	7.34E-10	NA	NA	5.57E-03	2.71E-08
3,4-Dinitrotoluene	5.00E-01	1.41E-06	1.01E-08	7.07E-04	NA	4.00E-09	4.41E-07	3.16E-09	2.21E-04	NA	1.75E-07	3.42E-08	2.45E-10	NA	NA	9.28E-04	NA
Semivolatile Organics																	
Benzo(a)anthracene	4.00E-01	1.13E-06	8.11E-09	NA	5.92E-09	3.20E-09	3.53E-07	2.53E-09	NA	3.69E-09	1.40E-07	2.73E-08	1.96E-10	NA	6.07E-11	NA	9.67E-09
Benzo(a)pyrene	3.90E-01	1.10E-06	7.90E-09	NA	5.77E-08	3.12E-09	3.44E-07	2.46E-09	NA	3.60E-08	1.37E-07	2.66E-08	1.91E-10	NA	5.91E-10	NA	9.43E-08
Benzo(b)fluoranthene	3.00E-01	8.49E-07	6.08E-09	NA	4.44E-09	2.40E-09	2.65E-07	1.90E-09	NA	2.77E-09	1.05E-07	2.05E-08	1.47E-10	NA	4.55E-11	NA	7.25E-09
Indeno(1,2,3-cd)pyrene	2.30E-01	6.51E-07	4.66E-09	NA	3.40E-09	1.84E-09	2.03E-07	1.45E-09	NA	2.12E-09	8.05E-08	1.57E-08	1.13E-10	NA	3.49E-11	NA	5.56E-09
Total HI				**2.95E-01**					**9.04E-02**					**3.62E+00**		**4.00E+00**	
Total ILCR					**3.79E-07**					**7.23E-08**					**4.44E-07**		**8.95E-07**
BACKGROUND RISK																	
Inorganics																	
Aluminum	1.30E+04	3.69E-02	2.64E-04	3.69E-02	NA	1.04E-05	1.15E-03	8.23E-06	4.26E-03	NA	4.56E-03	8.90E-04	6.38E-06	6.36E-01	NA	6.77E-01	NA
Antimony	3.51E+00	9.94E-06	7.12E-08	2.48E-02	NA	2.81E-09	3.10E-07	2.22E-09	7.74E-03	NA	1.23E-06	2.40E-07	1.72E-09	NA	NA	3.26E-02	NA
Arsenic	8.03E+00	2.27E-05	1.63E-07	7.57E-02	2.44E-07	6.42E-09	7.08E-07	5.07E-09	2.48E-03	8.01E-09	2.81E-06	5.48E-07	3.93E-09	NA	5.89E-08	7.82E-02	3.11E-07
Manganese	6.02E+02	1.70E-03	1.22E-05	3.62E-02	NA	4.81E-07	5.31E-05	3.80E-07	2.26E-02	NA	2.11E-04	4.11E-05	2.94E-07	2.94E+00	NA	2.99E+00	NA
Total HI				**1.74E-01**					**3.71E-02**					**3.57E+00**		**3.78E+00**	
Total ILCR					**2.44E-07**					**8.01E-09**					**5.89E-08**		**3.11E-07**
SITE-RELATED RISK																	
Inorganics																	
Chromium	1.87E+01	5.29E-05	3.79E-07	3.53E-05	NA	1.50E-08	1.65E-06	1.18E-08	1.10E-04	NA	6.55E-06	1.28E-06	9.15E-09	4.40E-02	3.84E-07	4.42E-02	3.84E-07
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	5.00E-01	1.41E-06	1.01E-08	2.36E-02	NA	4.00E-09	4.41E-07	3.16E-09	1.23E-02	NA	1.75E-07	3.42E-08	2.45E-10	NA	NA	3.58E-02	NA
4-Amino-2,6-dinitrotoluene	6.00E-01	1.70E-06	1.22E-08	2.83E-02	NA	4.80E-09	5.29E-07	3.79E-09	1.47E-02	NA	2.10E-07	4.10E-08	2.94E-10	NA	NA	4.30E-02	NA
1,3-Dinitrobenzene	2.12E+00	6.00E-06	4.30E-08	6.00E-02	NA	1.70E-08	1.87E-06	1.34E-08	2.34E-02	NA	7.42E-07	1.45E-07	1.04E-09	NA	NA	8.34E-02	NA
2,4-Dinitrotoluene	3.09E+00	8.74E-06	6.26E-08	4.37E-03	4.25E-08	2.47E-08	2.72E-06	1.95E-08	1.36E-03	1.33E-08	1.08E-06	2.11E-07	1.51E-09	NA	NA	5.73E-03	5.58E-08
2,6-Dinitrotoluene	1.50E+00	4.24E-06	3.04E-08	4.24E-03	2.07E-08	1.20E-08	1.32E-06	9.48E-09	1.32E-03	6.44E-09	5.25E-07	1.02E-07	7.34E-10	NA	NA	5.57E-03	2.71E-08
3,4-Dinitrotoluene	5.00E-01	1.41E-06	1.01E-08	7.07E-04	NA	4.00E-09	4.41E-07	3.16E-09	2.21E-04	NA	1.75E-07	3.42E-08	2.45E-10	NA	NA	9.28E-04	NA
Semivolatile Organics																	
Benzo(a)anthracene	4.00E-01	1.13E-06	8.11E-09	NA	5.92E-09	3.20E-09	3.53E-07	2.53E-09	NA	3.69E-09	1.40E-07	2.73E-08	1.96E-10	NA	6.07E-11	NA	9.67E-09
Benzo(a)pyrene	3.90E-01	1.10E-06	7.90E-09	NA	5.77E-08	3.12E-09	3.44E-07	2.46E-09	NA	3.60E-08	1.37E-07	2.66E-08	1.91E-10	NA	5.91E-10	NA	9.43E-08
Benzo(b)fluoranthene	3.00E-01	8.49E-07	6.08E-09	NA	4.44E-09	2.40E-09	2.65E-07	1.90E-09	NA	2.77E-09	1.05E-07	2.05E-08	1.47E-10	NA	4.55E-11	NA	7.25E-09
Indeno(1,2,3-cd)pyrene	2.30E-01	6.51E-07	4.66E-09	NA	3.40E-09	1.84E-09	2.03E-07	1.45E-09	NA	2.12E-09	8.05E-08	1.57E-08	1.13E-10	NA	3.49E-11	NA	5.56E-09
Total HI				**1.21E-01**					**5.33E-02**					**4.40E-02**		**2.19E-01**	
Total ILCR					**1.35E-07**					**6.43E-08**					**3.85E-07**		**5.84E-07**

HQ = Hazard quotient; HI = Hazard Index; ILCR = Incremental lifetime cancer risk.
DA = dose absorbed (per unit body surface area per day).
NA = not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm²-day - Milligrams per square centimeter per day.
mg/m³ - Milligrams per cubic meter.

Table 5-23

Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Surface Water, West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Dermal Absorption: Noncancer Dose (mg/kg-day)	Dermal Absorption: Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
TOTAL RISK						
Inorganics						
Arsenic	1.50E-02	6.00E-08	1.81E-06	1.30E-08	6.37E-03	2.05E-08
Lead	7.70E-02	1.23E-09	3.73E-08	2.67E-10	NA	NA
Manganese	1.60E+00	6.40E-06	1.94E-04	1.39E-06	8.24E-02	NA
Nitroaromatics						
2,4-Dinitrotoluene	5.00E-04	7.60E-09	2.30E-07	1.65E-09	1.15E-04	1.12E-09
2,6-Dinitrotoluene	8.00E-04	8.00E-09	2.42E-07	1.73E-09	2.42E-04	1.18E-09
3,4-Dinitrotoluene	6.00E-04	9.31E-09	2.82E-07	2.02E-09	1.41E-04	NA
Total HI					**8.92E-02**	
Total ILCR						**2.28E-08**
BACKGROUND RISK						
NA	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
SITE-RELATED RISK						
Inorganics						
Arsenic	1.50E-02	6.00E-08	1.81E-06	1.30E-08	6.37E-03	2.05E-08
Lead	7.70E-02	1.23E-09	3.73E-08	2.67E-10	NA	NA
Manganese	1.60E+00	6.40E-06	1.94E-04	1.39E-06	8.24E-02	NA
Nitroaromatics						
2,4-Dinitrotoluene	5.00E-04	7.60E-09	2.30E-07	1.65E-09	1.15E-04	1.12E-09
2,6-Dinitrotoluene	8.00E-04	8.00E-09	2.42E-07	1.73E-09	2.42E-04	1.18E-09
3,4-Dinitrotoluene	6.00E-04	9.31E-09	2.82E-07	2.02E-09	1.41E-04	NA
Total HI					**8.92E-02**	
Total ILCR						**2.28E-08**

DA -Dose absorbed (per unit body surface area per day).
ILCR - Incremental lifetime cancer risk; HQ - Hazard quotient; HI - Hazard index.
NA - Not applicable.
mg/L - Milligrams per liter.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/kg-day - Milligrams per kilogram per day.

Table 5-24

Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Sediment, West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Noncancer Dose (mg/kg-day)	Dermal Absorption Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Total HI All Pathways	Total ILCR All Pathways
TOTAL RISK												
Inorganics												
Arsenic	8.38E+00	1.96E-05	1.41E-07	6.54E-02	2.11E-07	1.01E-08	3.04E-07	2.18E-09	1.07E-03	3.44E-09	6.65E-02	2.14E-07
Total HI				**6.54E-02**					**1.07E-03**		**6.65E-02**	
Total ILCR					**2.11E-07**					**3.44E-09**		**2.14E-07**
BACKGROUND RISK	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
SITE-RELATED RISK												
Inorganics												
Arsenic	8.38E+00	1.96E-05	1.41E-07	6.54E-02	2.11E-07	1.01E-08	3.04E-07	2.18E-09	1.07E-03	3.44E-09	6.65E-02	2.14E-07
Total HI				**6.54E-02**					**1.07E-03**		**6.65E-02**	
Total ILCR					**2.11E-07**					**3.44E-09**		**2.14E-07**

ILCR - Incremental lifetime cancer risk.
HQ - Hazard quotient; HI - Hazard index.
DA -Dose absorbed (per unit body surface area per day).
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.

Table 5-25

Cancer Risk: On-Site Resident Exposure to Total Soil, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion: Adult Cancer Dose (mg/kg-day)	Incidental Ingestion: Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption: Adult Cancer Dose (mg/kg-day)	Dermal Absorption: Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
TOTAL RISK													
Inorganics													
Aluminum	1.30E+04	5.51E-03	1.29E-02	NA	2.35E-05	5.01E-04	2.25E-04	NA	8.35E-06	7.84E-07	4.57E-07	NA	NA
Antimony	3.51E+00	1.48E-06	3.46E-06	NA	6.32E-09	1.35E-07	6.06E-08	NA	2.25E-09	2.11E-10	1.23E-10	NA	NA
Arsenic	8.03E+00	3.39E-06	7.92E-06	1.70E-05	1.45E-08	3.09E-07	1.39E-07	7.06E-07	5.14E-09	4.83E-10	2.82E-10	1.15E-08	1.77E-05
Chromium	1.87E+01	7.91E-06	1.84E-05	NA	3.37E-08	7.19E-07	3.23E-07	NA	1.20E-08	1.13E-09	6.56E-10	7.48E-08	7.48E-08
Manganese	6.02E+02	2.54E-04	5.93E-04	NA	1.08E-06	2.31E-05	1.04E-05	NA	3.85E-07	3.62E-08	2.11E-08	NA	NA
Nitroaromatics													
2-Amino-4,6-dinitrotoluene	5.00E-01	2.11E-07	4.93E-07	NA	9.00E-09	1.92E-07	8.63E-08	NA	3.20E-10	3.01E-11	1.75E-11	NA	NA
4-Amino-2,6-dinitrotoluene	6.00E-01	2.54E-07	5.92E-07	NA	1.08E-08	2.31E-07	1.04E-07	NA	3.84E-10	3.61E-11	2.11E-11	NA	NA
1,3-Dinitrobenzene	2.12E+00	8.96E-07	2.09E-06	NA	3.82E-08	8.15E-07	3.66E-07	NA	1.36E-09	1.28E-10	7.44E-11	NA	NA
2,4-Dinitrotoluene	3.09E+00	1.30E-06	3.04E-06	2.96E-06	5.56E-08	1.19E-06	5.33E-07	1.17E-06	1.98E-09	1.86E-10	1.08E-10	NA	4.13E-06
2,6-Dinitrotoluene	1.50E+00	6.34E-07	1.48E-06	1.44E-06	2.70E-08	5.77E-07	2.59E-07	5.68E-07	9.61E-10	9.02E-11	5.26E-11	NA	2.01E-06
3,4-Dinitrotoluene	5.00E-01	2.11E-07	4.93E-07	NA	9.00E-09	1.92E-07	8.63E-08	NA	3.20E-10	3.01E-11	1.75E-11	NA	NA
Semivolatile Organics													
Benzo(a)anthracene	4.00E-01	1.69E-07	3.95E-07	4.11E-07	7.20E-09	1.54E-07	6.90E-08	3.25E-07	2.56E-10	2.41E-11	1.40E-11	1.18E-11	7.37E-07
Benzo(a)pyrene	3.90E-01	1.65E-07	3.85E-07	4.01E-06	7.02E-09	1.50E-07	6.73E-08	3.17E-06	2.50E-10	2.35E-11	1.37E-11	1.15E-10	7.18E-06
Benzo(b)fluoranthene	3.00E-01	1.27E-07	2.96E-07	3.09E-07	5.40E-09	1.15E-07	5.18E-08	2.44E-07	1.92E-10	1.80E-11	1.05E-11	8.86E-12	5.53E-07
Indeno(1,2,3-cd)pyrene	2.30E-01	9.72E-08	2.27E-07	2.37E-07	4.14E-09	8.85E-08	3.97E-08	1.87E-07	1.47E-10	1.38E-11	8.07E-12	6.79E-12	4.24E-07
Total ILCR				**2.63E-05**				**6.37E-06**				**8.64E-08**	**3.28E-05**
BACKGROUND RISK													
Inorganics													
Aluminum	1.30E+04	5.51E-03	1.29E-02	NA	2.35E-05	5.01E-04	2.25E-04	NA	8.35E-06	7.84E-07	4.57E-07	NA	NA
Antimony	3.51E+00	1.48E-06	3.46E-06	NA	6.32E-09	1.35E-07	6.06E-08	NA	2.25E-09	2.11E-10	1.23E-10	NA	NA
Arsenic	8.03E+00	3.39E-06	7.92E-06	1.70E-05	1.45E-08	3.09E-07	1.39E-07	7.06E-07	5.14E-09	4.83E-10	2.82E-10	1.15E-08	1.77E-05
Manganese	6.02E+02	2.54E-04	5.93E-04	NA	1.08E-06	2.31E-05	1.04E-05	NA	3.85E-07	3.62E-08	2.11E-08	NA	NA
Total ILCR				**1.70E-05**				**7.06E-07**				**1.15E-08**	**1.77E-05**
SITE-RELATED RISK													
Inorganics													
Chromium	1.87E+01	7.91E-06	1.84E-05	NA	3.37E-08	7.19E-07	3.23E-07	NA	1.20E-08	1.13E-09	6.56E-10	7.48E-08	7.48E-08
Nitroaromatics													
2-Amino-4,6-dinitrotoluene	5.00E-01	2.11E-07	4.93E-07	NA	9.00E-09	1.92E-07	8.63E-08	NA	3.20E-10	3.01E-11	1.75E-11	NA	NA
4-Amino-2,6-dinitrotoluene	6.00E-01	2.54E-07	5.92E-07	NA	1.08E-08	2.31E-07	1.04E-07	NA	3.84E-10	3.61E-11	2.11E-11	NA	NA
1,3-Dinitrobenzene	2.12E+00	8.96E-07	2.09E-06	NA	3.82E-08	8.15E-07	3.66E-07	NA	1.36E-09	1.28E-10	7.44E-11	NA	NA
2,4-Dinitrotoluene	3.09E+00	1.30E-06	3.04E-06	2.96E-06	5.56E-08	1.19E-06	5.33E-07	1.17E-06	1.98E-09	1.86E-10	1.08E-10	NA	4.13E-06
2,6-Dinitrotoluene	1.50E+00	6.34E-07	1.48E-06	1.44E-06	2.70E-08	5.77E-07	2.59E-07	5.68E-07	9.61E-10	9.02E-11	5.26E-11	NA	2.01E-06
3,4-Dinitrotoluene	5.00E-01	2.11E-07	4.93E-07	NA	9.00E-09	1.92E-07	8.63E-08	NA	3.20E-10	3.01E-11	1.75E-11	NA	NA
Semivolatile Organics													
Benzo(a)anthracene	4.00E-01	1.69E-07	3.95E-07	4.11E-07	7.20E-09	1.54E-07	6.90E-08	3.25E-07	2.56E-10	2.41E-11	1.40E-11	1.18E-11	7.37E-07
Benzo(a)pyrene	3.90E-01	1.65E-07	3.85E-07	4.01E-06	7.02E-09	1.50E-07	6.73E-08	3.17E-06	2.50E-10	2.35E-11	1.37E-11	1.15E-10	7.18E-06
Benzo(b)fluoranthene	3.00E-01	1.27E-07	2.96E-07	3.09E-07	5.40E-09	1.15E-07	5.18E-08	2.44E-07	1.92E-10	1.80E-11	1.05E-11	8.86E-12	5.53E-07
Indeno(1,2,3-cd)pyrene	2.30E-01	9.72E-08	2.27E-07	2.37E-07	4.14E-09	8.85E-08	3.97E-08	1.87E-07	1.47E-10	1.38E-11	8.07E-12	6.79E-12	4.24E-07
Total ILCR				**9.36E-06**				**5.67E-06**				**7.50E-08**	**1.51E-05**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-26

Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
TOTAL RISK										
Inorganics										
Aluminum	1.30E+04	1.50E-01	1.50E-01	2.35E-05	2.62E-03	9.72E-03	8.35E-06	5.34E-06	3.81E-03	1.64E-01
Antimony	3.51E+00	4.04E-05	1.01E-01	6.32E-09	7.07E-07	1.77E-02	2.25E-09	1.44E-09	NA	1.19E-01
Arsenic	8.03E+00	9.24E-05	3.08E-01	1.45E-08	1.62E-06	5.67E-03	5.14E-09	3.29E-09	NA	3.14E-01
Chromium	1.87E+01	2.15E-04	1.43E-04	3.37E-08	3.77E-06	2.51E-04	1.20E-08	7.66E-09	2.64E-04	6.59E-04
Manganese	6.02E+02	6.92E-03	1.47E-01	1.08E-06	1.21E-04	5.16E-02	3.85E-07	2.46E-07	1.76E-02	2.16E-01
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	5.00E-01	5.75E-06	9.59E-02	9.00E-09	1.01E-06	2.80E-02	3.20E-10	2.05E-10	NA	1.24E-01
4-Amino-2,6-dinitrotoluene	6.00E-01	6.90E-06	1.15E-01	1.08E-08	1.21E-06	3.36E-02	3.84E-10	2.46E-10	NA	1.49E-01
1,3-Dinitrobenzene	2.12E+00	2.44E-05	2.44E-01	3.82E-08	4.27E-06	5.34E-02	1.36E-09	8.68E-10	NA	2.97E-01
2,4-Dinitrotoluene	3.09E+00	3.55E-05	1.78E-02	5.56E-08	6.22E-06	3.11E-03	1.98E-09	1.26E-09	NA	2.09E-02
2,6-Dinitrotoluene	1.50E+00	1.73E-05	1.73E-02	2.70E-08	3.02E-06	3.02E-03	9.61E-10	6.14E-10	NA	2.03E-02
3,4-Dinitrotoluene	5.00E-01	5.75E-06	2.88E-03	9.00E-09	1.01E-06	5.03E-04	3.20E-10	2.05E-10	NA	3.38E-03
Semivolatile Organics										
Benzo(a)anthracene	4.00E-01	4.60E-06	NA	7.20E-09	8.05E-07	NA	2.56E-10	1.64E-10	NA	NA
Benzo(a)pyrene	3.90E-01	4.49E-06	NA	7.02E-09	7.85E-07	NA	2.50E-10	1.60E-10	NA	NA
Benzo(b)fluoranthene	3.00E-01	3.45E-06	NA	5.40E-09	6.04E-07	NA	1.92E-10	1.23E-10	NA	NA
Indeno(1,2,3-cd)pyrene	2.30E-01	2.65E-06	NA	4.14E-09	4.63E-07	NA	1.47E-10	9.42E-11	NA	NA
Total HI			**1.20E+00**			**2.06E-01**			**2.17E-02**	**1.43E+00**
BACKGROUND RISK										
Inorganics										
Aluminum	1.30E+04	1.50E-01	1.50E-01	2.35E-05	2.62E-03	9.72E-03	8.35E-06	5.34E-06	3.81E-03	1.64E-01
Antimony	3.51E+00	4.04E-05	1.01E-01	6.32E-09	7.07E-07	1.77E-02	2.25E-09	1.44E-09	NA	1.19E-01
Arsenic	8.03E+00	9.24E-05	3.08E-01	1.45E-08	1.62E-06	5.67E-03	5.14E-09	3.29E-09	NA	3.14E-01
Manganese	6.02E+02	6.92E-03	1.47E-01	1.08E-06	1.21E-04	5.16E-02	3.85E-07	2.46E-07	1.76E-02	2.16E-01
Total HI			**7.06E-01**			**8.46E-02**			**2.14E-02**	**8.12E-01**
SITE-RELATED RISK										
Inorganics										
Chromium	1.87E+01	2.15E-04	1.43E-04	3.37E-08	3.77E-06	2.51E-04	1.20E-08	7.66E-09	2.64E-04	6.59E-04
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	5.00E-01	5.75E-06	9.59E-02	9.00E-09	1.01E-06	2.80E-02	3.20E-10	2.05E-10	NA	1.24E-01
4-Amino-2,6-dinitrotoluene	6.00E-01	6.90E-06	1.15E-01	1.08E-08	1.21E-06	3.36E-02	3.84E-10	2.46E-10	NA	1.49E-01
1,3-Dinitrobenzene	2.12E+00	2.44E-05	2.44E-01	3.82E-08	4.27E-06	5.34E-02	1.36E-09	8.68E-10	NA	2.97E-01
2,4-Dinitrotoluene	3.09E+00	3.55E-05	1.78E-02	5.56E-08	6.22E-06	3.11E-03	1.98E-09	1.26E-09	NA	2.09E-02
2,6-Dinitrotoluene	1.50E+00	1.73E-05	1.73E-02	2.70E-08	3.02E-06	3.02E-03	9.61E-10	6.14E-10	NA	2.03E-02
3,4-Dinitrotoluene	5.00E-01	5.75E-06	2.88E-03	9.00E-09	1.01E-06	5.03E-04	3.20E-10	2.05E-10	NA	3.38E-03
Semivolatile Organics										
Benzo(a)anthracene	4.00E-01	4.60E-06	NA	7.20E-09	8.05E-07	NA	2.56E-10	1.64E-10	NA	NA
Benzo(a)pyrene	3.90E-01	4.49E-06	NA	7.02E-09	7.85E-07	NA	2.50E-10	1.60E-10	NA	NA
Benzo(b)fluoranthene	3.00E-01	3.45E-06	NA	5.40E-09	6.04E-07	NA	1.92E-10	1.23E-10	NA	NA
Indeno(1,2,3-cd)pyrene	2.30E-01	2.65E-06	NA	4.14E-09	4.63E-07	NA	1.47E-10	9.42E-11	NA	NA
Total HI			**4.93E-01**			**1.22E-01**			**2.64E-04**	**6.15E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-27

Cancer Risk: On-Site Resident Exposure to Surface Water, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Adult Resident: Dermally Absorbed Dose (mg/kg-day)	Adult Resident: Dermal ILCR	Child Resident: Dermally Absorbed Dose (mg/kg-day)	Child Resident: Dermal ILCR	On-Site Resident Total ILCR
TOTAL RISK							
Inorganics							
Arsenic	1.50E-02	4.50E-08	1.71E-07	2.70E-07	7.69E-08	1.21E-07	3.92E-07
Lead	7.70E-02	9.24E-10	3.51E-09	NA	1.58E-09	NA	NA
Manganese	1.60E+00	4.80E-06	1.83E-05	NA	8.21E-06	NA	NA
Nitroaromatics							
2,4-Dinitrotoluene	5.00E-04	5.70E-09	2.17E-08	1.47E-08	9.74E-09	6.63E-09	2.14E-08
2,6-Dinitrotoluene	8.00E-04	6.00E-09	2.28E-08	1.55E-08	1.03E-08	6.98E-09	2.25E-08
3,4-Dinitrotoluene	6.00E-04	6.98E-09	2.66E-08	NA	1.19E-08	NA	NA
Total ILCR				**3.00E-07**		**1.35E-07**	**4.36E-07**
BACKGROUND RISK							
NA	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	
SITE-RELATED RISK							
Inorganics							
Arsenic	1.50E-02	4.50E-08	1.71E-07	2.70E-07	7.69E-08	1.21E-07	3.92E-07
Lead	7.70E-02	9.24E-10	3.51E-09	NA	1.58E-09	NA	NA
Manganese	1.60E+00	4.80E-06	1.83E-05	NA	8.21E-06	NA	NA
Nitroaromatics							
2,4-Dinitrotoluene	5.00E-04	5.70E-09	2.17E-08	1.47E-08	9.74E-09	6.63E-09	2.14E-08
2,6-Dinitrotoluene	8.00E-04	6.00E-09	2.28E-08	1.55E-08	1.03E-08	6.98E-09	2.25E-08
3,4-Dinitrotoluene	6.00E-04	6.98E-09	2.66E-08	NA	1.19E-08	NA	NA
Total ILCR				**3.00E-07**		**1.35E-07**	**4.36E-07**

DA - Dose absorbed (per unit body surface area per day).
ILCR - Incremental lifetime cancer risk.
NA - Not applicable.

Table 5-28

Noncancer Hazard Index: On-Site Resident Child Exposure to Surface Water, West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Dermally Absorbed Dose (mg/kg-day)	Dermal HQ
TOTAL RISK				
Inorganics				
Arsenic	1.50E-02	4.50E-08	8.98E-07	3.15E-03
Lead	7.70E-02	9.24E-10	1.84E-08	NA
Manganese	1.60E+00	4.80E-06	9.57E-05	4.07E-02
Nitroaromatics				
2,4-Dinitrotoluene	5.00E-04	5.70E-09	1.14E-07	5.68E-05
2,6-Dinitrotoluene	8.00E-04	6.00E-09	1.20E-07	1.20E-04
3,4-Dinitrotoluene	6.00E-04	6.98E-09	1.39E-07	6.96E-05
Total HI				**4.41E-02**
BACKGROUND RISK				
NA	**NA**	**NA**	**NA**	**NA**
SITE-RELATED RISK				
Inorganics				
Arsenic	1.50E-02	4.50E-08	8.98E-07	3.15E-03
Lead	7.70E-02	9.24E-10	1.84E-08	NA
Manganese	1.60E+00	4.80E-06	9.57E-05	4.07E-02
Nitroaromatics				
2,4-Dinitrotoluene	5.00E-04	5.70E-09	1.14E-07	5.68E-05
2,6-Dinitrotoluene	8.00E-04	6.00E-09	1.20E-07	1.20E-04
3,4-Dinitrotoluene	6.00E-04	6.98E-09	1.39E-07	6.96E-05
Total HI				**4.41E-02**

DA - Dose absorbed (per unit body surface area per day).
HQ - Hazard quotient; HI - Hazard index.
NA - Not applicable.
mg/L - Milligrams per liter.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/kg-day - Milligrams per kilogram per day.

Table 5-29

Cancer Risk: On-Site Resident Exposure to Sediment, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Adult Ingested Dose (mg/kg-day)	Child Ingested Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Dermally Absorbed Dose (mg/kg-day)	Child Dermally Absorbed Dose (mg/kg-day)	On-Site Resident Dermal ILCR	On-Site Resident Total All Pathways ILCR
TOTAL RISK									
Inorganics									
Arsenic	8.38E+00	5.85E-08	1.36E-07	2.92E-07	1.68E-09	5.32E-09	2.39E-09	1.22E-08	3.05E-07
Total ILCR				**2.92E-07**				**1.22E-08**	**3.05E-07**
BACKGROUND RISK	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
SITE-RELATED RISK									
Inorganics									
Arsenic	8.38E+00	5.85E-08	1.36E-07	2.92E-07	1.68E-09	5.32E-09	2.39E-09	1.22E-08	3.05E-07
Total ILCR				**2.92E-07**				**1.22E-08**	**3.05E-07**

ILCR - Incremental lifetime cancer risk.
DA -Dose absorbed (per unit body surface area per day).
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.

Table 5-30
Noncancer Hazard Index: On-Site Resident Child Exposure to Sediment, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Child Ingested Dose (mg/kg-day)	Child Resident Oral HQ	DA (mg/cm^2-day)	Child Dermally Absorbed Dose (mg/kg-day)	Child Resident Dermal HQ	Child Resident Total All Pathways HI
TOTAL RISK							
Inorganics							
Arsenic	8.38E+00	1.59E-06	5.31E-03	1.68E-09	2.79E-08	9.78E-05	5.41E-03
Total HI			**5.31E-03**			**9.78E-05**	**5.41E-03**
BACKGROUND RISK	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
SITE-RELATED RISK							
Inorganics							
Arsenic	8.38E+00	1.59E-06	5.31E-03	1.68E-09	2.79E-08	9.78E-05	5.41E-03
Total HI			**5.31E-03**			**9.78E-05**	**5.41E-03**

ILCR - Incremental lifetime cancer risk.
HQ - Hazard quotient; HI - Hazard index.
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.

Table 5-31

Summary of Total Hazard Index and Total Cancer Risk from Site-Related Chemicals of Potential Concern, West Area Red Water Ponds, PBOW, Sandusky, Ohio

	Groundskeeper		Indoor Worker		Construction Worker		On-Site Resident	
Contaminant Source	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR
Surface Soil	1.29E-02	7.09E-06	2.83E-04	3.85E-08	NA	NA	NA	NA
Total Soil	NA	NA	NA	NA	2.19E-01	5.84E-07	6.15E-01	1.51E-05
Surface Water	NA	NA	NA	NA	8.92E-02	2.28E-08	4.41E-02	4.36E-07
Sediment	NA	NA	NA	NA	6.65E-02	2.14E-07	5.41E-03	3.05E-07
Total across all media	**1.29E-02**	**7.09E-06**	**2.83E-04**	**3.85E-08**	**3.74E-01**	**8.21E-07**	**6.65E-01**	**1.58E-05**

HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable.

Table 5-32

Exposure Unit Values[a] for Sample Location DP13, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 2 ft bgs Surface Soil		4 - 6 ft bgs Subsurface Soil		8 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Inorganics							
CHROMIUM	2.03E+01		1.03E+01		2.22E+01		2.22E+01
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	6.00E-01	c	6.00E-01
1,3-DINITROBENZENE	1.25E-01	c	1.25E-01	c	6.00E-01	c	6.00E-01
2,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	6.30E+00		6.30E+00
2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	6.00E-01	c	6.00E-01
Semivolatile Organics							
BENZO(A)ANTHRACENE	4.00E-01		NA		NA		4.00E-01
BENZO(A)PYRENE	3.90E-01		NA		NA		3.90E-01
BENZO(B)FLUORANTHENE	3.00E-01		NA		NA		3.00E-01
INDENO(1,2,3-CD)PYRENE	2.30E-01		NA		NA		2.30E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.
NA - Not analyzed.
[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-33

Site-Related Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Total Soil
Sample Location DP13, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration In Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
Inorganics																	
Chromium	2.22E+01	6.28E-05	4.50E-07	4.19E-05	NA	1.78E-08	1.96E-06	1.40E-08	1.31E-04	NA	7.77E-06	1.52E-06	1.09E-08	5.23E-02	4.56E-07	5.25E-02	4.56E-07
Nitroaromatics																	
4-Amino-2,6-dinitrotoluene	6.00E-01	1.70E-06	1.22E-08	2.83E-02	NA	4.80E-09	5.29E-07	3.79E-09	1.47E-02	NA	2.10E-07	4.10E-08	2.94E-10	NA	NA	4.30E-02	NA
1,3-Dinitrobenzene	6.00E-01	1.70E-06	1.22E-08	1.70E-02	NA	4.80E-09	5.29E-07	3.79E-09	6.62E-03	NA	2.10E-07	4.10E-08	2.94E-10	NA	NA	2.36E-02	NA
2,4-Dinitrotoluene	6.30E+00	1.78E-05	1.28E-07	8.91E-03	8.68E-08	5.04E-08	5.56E-06	3.98E-08	2.78E-03	2.71E-08	2.21E-06	4.30E-07	3.08E-09	NA	NA	1.17E-02	1.14E-07
2,6-Dinitrotoluene	6.00E-01	1.70E-06	1.22E-08	1.70E-03	8.27E-09	4.80E-09	5.29E-07	3.79E-09	5.29E-04	2.58E-09	2.10E-07	4.10E-08	2.94E-10	NA	NA	2.23E-03	1.08E-08
Semivolatile Organics																	
Benzo(a)anthracene	4.00E-01	1.13E-06	8.11E-09	NA	5.92E-09	3.20E-09	3.53E-07	2.53E-09	NA	3.69E-09	1.40E-07	2.73E-08	1.96E-10	NA	6.07E-11	NA	9.67E-09
Benzo(a)pyrene	3.90E-01	1.10E-06	7.90E-09	NA	5.77E-08	3.12E-09	3.44E-07	2.46E-09	NA	3.60E-08	1.37E-07	2.66E-08	1.91E-10	NA	5.91E-10	NA	9.43E-08
Benzo(b)fluoranthene	3.00E-01	8.49E-07	6.08E-09	NA	4.44E-09	2.40E-09	2.65E-07	1.90E-09	NA	2.77E-09	1.05E-07	2.05E-08	1.47E-10	NA	4.55E-11	NA	7.25E-09
Indeno(1,2,3-cd)pyrene	2.30E-01	6.51E-07	4.66E-09	NA	3.40E-09	1.84E-09	2.03E-07	1.45E-09	NA	2.12E-09	8.05E-08	1.57E-08	1.13E-10	NA	3.49E-11	NA	5.56E-09
Total HI				**5.59E-02**					**2.48E-02**					**5.23E-02**		**1.33E-01**	
Total ILCR					**1.67E-07**					**7.42E-08**					**4.57E-07**		**6.98E-07**

HQ = Hazard quotient; HI = Hazard index; ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-34

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location DP13, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Inorganics													
Chromium	2.22E+01	9.38E-06	2.19E-05	NA	4.00E-08	8.54E-07	3.83E-07	NA	1.42E-08	1.34E-09	7.79E-10	8.88E-08	8.88E-08
Nitroaromatics													
4-Amino-2,6-dinitrotoluene	6.00E-01	2.54E-07	5.92E-07	NA	1.08E-08	2.31E-07	1.04E-07	NA	3.84E-10	3.61E-11	2.11E-11	NA	NA
1,3-Dinitrobenzene	6.00E-01	2.54E-07	5.92E-07	NA	1.08E-08	2.31E-07	1.04E-07	NA	3.84E-10	3.61E-11	2.11E-11	NA	NA
2,4-Dinitrotoluene	6.30E+00	2.66E-06	6.21E-06	6.04E-06	1.13E-07	2.42E-06	1.09E-06	2.39E-06	4.04E-09	3.79E-10	2.21E-10	NA	8.42E-06
2,6-Dinitrotoluene	6.00E-01	2.54E-07	5.92E-07	5.75E-07	1.08E-08	2.31E-07	1.04E-07	2.27E-07	3.84E-10	3.61E-11	2.11E-11	NA	8.02E-07
Semivolatile Organics													
Benzo(a)anthracene	4.00E-01	1.69E-07	3.95E-07	4.11E-07	7.20E-09	1.54E-07	6.90E-08	3.25E-07	2.56E-10	2.41E-11	1.40E-11	1.18E-11	7.37E-07
Benzo(a)pyrene	3.90E-01	1.65E-07	3.85E-07	4.01E-06	7.02E-09	1.50E-07	6.73E-08	3.17E-06	2.50E-10	2.35E-11	1.37E-11	1.15E-10	7.18E-06
Benzo(b)fluoranthene	3.00E-01	1.27E-07	2.96E-07	3.09E-07	5.40E-09	1.15E-07	5.18E-08	2.44E-07	1.92E-10	1.80E-11	1.05E-11	8.86E-12	5.53E-07
Indeno(1,2,3-cd)pyrene	2.30E-01	9.72E-08	2.27E-07	2.37E-07	4.14E-09	8.85E-08	3.97E-08	1.87E-07	1.47E-10	1.38E-11	8.07E-12	6.79E-12	4.24E-07
Total ILCR				**1.16E-05**				**6.54E-06**				**8.90E-08**	**1.82E-05**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-35

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location DP13, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Inorganics										
Chromium	2.22E+01	2.55E-04	1.70E-04	4.00E-08	4.47E-06	2.98E-04	1.42E-08	9.09E-09	3.13E-04	7.82E-04
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	6.00E-01	6.90E-06	1.15E-01	1.08E-08	1.21E-06	3.36E-02	3.84E-10	2.46E-10	NA	1.49E-01
1,3-Dinitrobenzene	6.00E-01	6.90E-06	6.90E-02	1.08E-08	1.21E-06	1.51E-02	3.84E-10	2.46E-10	NA	8.41E-02
2,4-Dinitrotoluene	6.30E+00	7.25E-05	3.62E-02	1.13E-07	1.27E-05	6.34E-03	4.04E-09	2.58E-09	NA	4.26E-02
2,6-Dinitrotoluene	6.00E-01	6.90E-06	6.90E-03	1.08E-08	1.21E-06	1.21E-03	3.84E-10	2.46E-10	NA	8.11E-03
Semivolatile Organics										
Benzo(a)anthracene	4.00E-01	4.60E-06	NA	7.20E-09	8.05E-07	NA	2.56E-10	1.64E-10	NA	NA
Benzo(a)pyrene	3.90E-01	4.49E-06	NA	7.02E-09	7.85E-07	NA	2.50E-10	1.60E-10	NA	NA
Benzo(b)fluoranthene	3.00E-01	3.45E-06	NA	5.40E-09	6.04E-07	NA	1.92E-10	1.23E-10	NA	NA
Indeno(1,2,3-cd)pyrene	2.30E-01	2.65E-06	NA	4.14E-09	4.63E-07	NA	1.47E-10	9.42E-11	NA	NA
Total HI			**2.27E-01**			**5.65E-02**			**3.13E-04**	**2.84E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-36

Exposure Unit Values for Sample Location PB-RWP-DS-S6, West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	Surface Soil [a]	Subsurface Soil [b]	Source Term Concentration
Inorganics			
CHROMIUM	1.60E+01	1.27E+01	1.60E+01
Nitroaromatics			
2-AMINO-4,6-DINITROTOLUENE	1.25E-01	1.25E-01	1.25E-01
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	6.00E-01	6.00E-01
1,3-DINITROBENZENE	1.25E-01	2.40E+00	2.40E+00
2,4-DINITROTOLUENE	1.25E-01	3.00E+00	3.00E+00
2,6-DINITROTOLUENE	1.30E-01	1.30E-01	1.30E-01
3,4-DINITROTOLUENE	1.25E-01	1.25E-01	1.25E-01

mg/kg - Milligrams per kilogram.

[a] This sample is from location PB-RWP-DS-S6 depth 0 - 2 feet below ground surface.
[b] This sample is from location PB-RWP-DS-S6 depth 2 - 5 feet below ground surface.

Table 5-37

Site-Related Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Soil, DS-S6 at West Area Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration In Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
Inorganics																	
Chromium	1.60E+01	4.53E-05	3.24E-07	3.02E-05	NA	1.28E-08	1.41E-06	1.01E-08	9.41E-05	NA	5.60E-06	1.09E-06	7.83E-09	3.77E-02	3.29E-07	3.78E-02	3.29E-07
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	1.25E-01	3.54E-07	2.53E-09	5.90E-03	NA	1.00E-09	1.10E-07	7.90E-10	3.06E-03	NA	4.38E-08	8.54E-09	6.12E-11	NA	NA	8.96E-03	NA
4-Amino-2,6-dinitrotoluene	6.00E-01	1.70E-06	1.22E-08	2.83E-02	NA	4.80E-09	5.29E-07	3.79E-09	1.47E-02	NA	2.10E-07	4.10E-08	2.94E-10	NA	NA	4.30E-02	NA
1,3-Dinitrobenzene	2.40E+00	6.79E-06	4.86E-08	6.79E-02	NA	1.92E-08	2.12E-06	1.52E-08	2.65E-02	NA	8.40E-07	1.64E-07	1.17E-09	NA	NA	9.44E-02	NA
2,4-Dinitrotoluene	3.00E+00	8.49E-06	6.08E-08	4.24E-03	4.13E-08	2.40E-08	2.65E-06	1.90E-08	1.32E-03	1.29E-08	1.05E-06	2.05E-07	1.47E-09	NA	NA	5.57E-03	5.42E-08
2,6-Dinitrotoluene	1.30E-01	3.68E-07	2.63E-09	3.68E-04	1.79E-09	1.04E-09	1.15E-07	8.21E-10	1.15E-04	5.59E-10	4.55E-08	8.88E-09	6.36E-11	NA	NA	4.83E-04	2.35E-09
3,4-Dinitrotoluene	1.25E-01	3.54E-07	2.53E-09	1.77E-04	NA	1.00E-09	1.10E-07	7.90E-10	5.51E-05	NA	4.38E-08	8.54E-09	6.12E-11	NA	NA	2.32E-04	NA
Total HI				**1.07E-01**					**4.58E-02**					**3.77E-02**		**1.90E-01**	
Total ILCR					**4.31E-08**					**1.34E-08**					**3.29E-07**		**3.85E-07**

HQ = Hazard quotient; HI = Hazard index; ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m3 - Milligrams per cubic meter.

Table 5-38

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil, DS-S6 at West Area
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Inorganics													
Chromium	1.60E+01	6.76E-06	1.58E-05	NA	2.88E-08	6.15E-07	2.76E-07	NA	1.02E-08	9.63E-10	5.62E-10	6.40E-08	6.40E-08
Nitroaromatics													
2-Amino-4,6-dinitrotoluene	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
4-Amino-2,6-dinitrotoluene	6.00E-01	2.54E-07	5.92E-07	NA	1.08E-08	2.31E-07	1.04E-07	NA	3.84E-10	3.61E-11	2.11E-11	NA	NA
1,3-Dinitrobenzene	2.40E+00	1.01E-06	2.37E-06	NA	4.32E-08	9.23E-07	4.14E-07	NA	1.54E-09	1.44E-10	8.42E-11	NA	NA
2,4-Dinitrotoluene	3.00E+00	1.27E-06	2.96E-06	2.87E-06	5.40E-08	1.15E-06	5.18E-07	1.14E-06	1.92E-09	1.80E-10	1.05E-10	NA	4.01E-06
2,6-Dinitrotoluene	1.30E-01	5.50E-08	1.28E-07	1.25E-07	2.34E-09	5.00E-08	2.24E-08	4.93E-08	8.33E-11	7.82E-12	4.56E-12	NA	1.74E-07
3,4-Dinitrotoluene	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
Total ILCR				**3.00E-06**				**1.19E-06**				**6.40E-08**	**4.25E-06**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.
NA = Not applicable.

Table 5-39

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil, DS-S6 at West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Inorganics										
Chromium	1.60E+01	1.84E-04	1.23E-04	2.88E-08	3.22E-06	2.15E-04	1.02E-08	6.55E-09	2.26E-04	5.63E-04
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.25E-01	1.44E-06	2.40E-02	2.25E-09	2.52E-07	6.99E-03	8.01E-11	5.12E-11	NA	3.10E-02
4-Amino-2,6-dinitrotoluene	6.00E-01	6.90E-06	1.15E-01	1.08E-08	1.21E-06	3.36E-02	3.84E-10	2.46E-10	NA	1.49E-01
1,3-Dinitrobenzene	2.40E+00	2.76E-05	2.76E-01	4.32E-08	4.83E-06	6.04E-02	1.54E-09	9.83E-10	NA	3.37E-01
2,4-Dinitrotoluene	3.00E+00	3.45E-05	1.73E-02	5.40E-08	6.04E-06	3.02E-03	1.92E-09	1.23E-09	NA	2.03E-02
2,6-Dinitrotoluene	1.30E-01	1.50E-06	1.50E-03	2.34E-09	2.62E-07	2.62E-04	8.33E-11	5.32E-11	NA	1.76E-03
3,4-Dinitrotoluene	1.25E-01	1.44E-06	7.19E-04	2.25E-09	2.52E-07	1.26E-04	8.01E-11	5.12E-11	NA	8.45E-04
Total HI			**4.35E-01**			**1.05E-01**			**2.26E-04**	**5.40E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-40

Exposure Unit Values[a] for Sample Location S10, West Area Red Water Ponds, PBOW, Sandusky, Ohio'

Chemical Name (mg/kg)	3 - 5 ft bgs Subsurface Soil		5 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Inorganics					
CHROMIUM	2.60E+01		2.50E+01		2.60E+01
Nitroaromatics					
2-AMINO-4,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01
4-AMINO-2,6-DINITROTOLUENE	7.00E-01		1.25E-01	c	7.00E-01
1,3-DINITROBENZENE	2.30E+00		5.00E-01		2.30E+00
2,4-DINITROTOLUENE	5.10E+00		1.25E-01	c	5.10E+00
2,6-DINITROTOLUENE	3.00E-01		1.30E-01	c	3.00E-01
3,4-DINITROTOLUENE	1.25E-01	c	3.00E-01		3.00E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One half reporting limit used as surrogate value for nondetects.

Table 5-41

Site-Related Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Total Soil
Sample Location S10, West Area
Red Water Ponds, PBOW, Sandusky Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
Inorganics																	
Chromium	2.60E+01	7.36E-05	5.27E-07	4.91E-05	NA	2.08E-08	2.29E-06	1.64E-08	1.53E-04	NA	9.10E-06	1.78E-06	1.27E-08	6.12E-02	5.34E-07	6.14E-02	5.34E-07
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	1.25E-01	3.54E-07	2.53E-09	5.90E-03	NA	1.00E-09	1.10E-07	7.90E-10	3.06E-03	NA	4.38E-08	8.54E-09	6.12E-11	NA	NA	8.96E-03	NA
4-Amino-2,6-dinitrotoluene	7.00E-01	1.98E-06	1.42E-08	3.30E-02	NA	5.60E-09	6.17E-07	4.42E-09	1.72E-02	NA	2.45E-07	4.78E-08	3.42E-10	NA	NA	5.02E-02	NA
1,3-Dinitrobenzene	2.30E+00	6.51E-06	4.66E-08	6.51E-02	NA	1.84E-08	2.03E-06	1.45E-08	2.54E-02	NA	8.05E-07	1.57E-07	1.13E-09	NA	NA	9.04E-02	NA
2,4-Dinitrotoluene	5.10E+00	1.44E-05	1.03E-07	7.22E-03	7.03E-08	4.08E-08	4.50E-06	3.22E-08	2.25E-03	2.19E-08	1.79E-06	3.48E-07	2.50E-09	NA	NA	9.47E-03	9.22E-08
2,6-Dinitrotoluene	3.00E-01	8.49E-07	6.08E-09	8.49E-04	4.13E-09	2.40E-09	2.65E-07	1.90E-09	2.65E-04	1.29E-09	1.05E-07	2.05E-08	1.47E-10	NA	NA	1.11E-03	5.42E-09
3,4-Dinitrotoluene	3.00E-01	8.49E-07	6.08E-09	4.24E-04	NA	2.40E-09	2.65E-07	1.90E-09	1.32E-04	NA	1.05E-07	2.05E-08	1.47E-10	NA	NA	5.57E-04	NA
Total HI				**1.13E-01**					**4.84E-02**					**6.12E-02**		**2.22E-01**	
Total ILCR					**7.44E-08**					**2.32E-08**					**5.34E-07**		**6.32E-07**

HQ = Hazard quotient; HI = Hazard index; ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-42

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location S10, West Area
Red Water Ponds, PBOW, Sandusky Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Inorganics													
Chromium	2.60E+01	1.10E-05	2.56E-05	NA	4.68E-08	1.00E-06	4.49E-07	NA	1.67E-08	1.56E-09	9.13E-10	1.04E-07	1.04E-07
Nitroaromatics													
2-Amino-4,6-dinitrotoluene	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
4-Amino-2,6-dinitrotoluene	7.00E-01	2.96E-07	6.90E-07	NA	1.26E-08	2.69E-07	1.21E-07	NA	4.48E-10	4.21E-11	2.46E-11	NA	NA
1,3-Dinitrobenzene	2.30E+00	9.72E-07	2.27E-06	NA	4.14E-08	8.85E-07	3.97E-07	NA	1.47E-09	1.38E-10	8.07E-11	NA	NA
2,4-Dinitrotoluene	5.10E+00	2.16E-06	5.03E-06	4.89E-06	9.18E-08	1.96E-06	8.80E-07	1.93E-06	3.27E-09	3.07E-10	1.79E-10	NA	6.82E-06
2,6-Dinitrotoluene	3.00E-01	1.27E-07	2.96E-07	2.87E-07	5.40E-09	1.15E-07	5.18E-08	1.14E-07	1.92E-10	1.80E-11	1.05E-11	NA	4.01E-07
3,4-Dinitrotoluene	3.00E-01	1.27E-07	2.96E-07	NA	5.40E-09	1.15E-07	5.18E-08	NA	1.92E-10	1.80E-11	1.05E-11	NA	NA
Total ILCR				**5.17E-06**				**2.05E-06**				**1.04E-07**	**7.32E-06**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-43

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location S10, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
TOTAL RISK										
Inorganics										
Chromium	2.60E+01	2.99E-04	1.99E-04	4.68E-08	5.24E-06	3.49E-04	1.67E-08	1.06E-08	3.67E-04	9.16E-04
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.25E-01	1.44E-06	2.40E-02	2.25E-09	2.52E-07	6.99E-03	8.01E-11	5.12E-11	NA	3.10E-02
4-Amino-2,6-dinitrotoluene	7.00E-01	8.05E-06	1.34E-01	1.26E-08	1.41E-06	3.92E-02	4.48E-10	2.87E-10	NA	1.73E-01
1,3-Dinitrobenzene	2.30E+00	2.65E-05	2.65E-01	4.14E-08	4.63E-06	5.79E-02	1.47E-09	9.42E-10	NA	3.23E-01
2,4-Dinitrotoluene	5.10E+00	5.87E-05	2.93E-02	9.18E-08	1.03E-05	5.13E-03	3.27E-09	2.09E-09	NA	3.45E-02
2,6-Dinitrotoluene	3.00E-01	3.45E-06	3.45E-03	5.40E-09	6.04E-07	6.04E-04	1.92E-10	1.23E-10	NA	4.06E-03
3,4-Dinitrotoluene	3.00E-01	3.45E-06	1.73E-03	5.40E-09	6.04E-07	3.02E-04	1.92E-10	1.23E-10	NA	2.03E-03
Total HI			**4.58E-01**			**1.10E-01**			**3.67E-04**	**5.68E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-44

Exposure Unit Values for Sample Location DS-S17, West Area
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 0.5 ft bgs Surface Soil	0 - 3 ft bgs Surface Soil	3 - 5 ft bgs Subsurface Soil	5 - 10 ft bgs Subsurface Soil	Source Term Concentration
Inorganics					
CHROMIUM	1.90E+01	1.70E+01	1.60E+01	1.12E+01	1.90E+01
Nitroaromatics					
2-AMINO-4,6-DINITROTOLUENE	1.25E-01	1.25E-01	1.25E-01	5.00E-01	5.00E-01
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	3.00E-01	1.25E-01	1.25E-01	3.00E-01
1,3-DINITROBENZENE	1.25E-01	1.25E-01	1.25E-01	1.90E+00	1.90E+00
2,4-DINITROTOLUENE	1.25E-01	1.25E-01	1.25E-01	3.30E+00	3.30E+00
2,6-DINITROTOLUENE	1.30E-01	1.30E-01	1.30E-01	3.00E-01	3.00E-01
3,4-DINITROTOLUENE	1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.25E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

Table 5-45

Site-Related Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Total Soil, DS-S17 at West Area Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration In Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
Inorganics																	
Chromium	1.90E+01	5.38E-05	3.85E-07	3.58E-05	NA	1.52E-08	1.68E-06	1.20E-08	1.12E-04	NA	6.65E-06	1.30E-06	9.30E-09	4.48E-02	3.90E-07	4.49E-02	3.90E-07
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	5.00E-01	1.41E-06	1.01E-08	2.36E-02	NA	4.00E-09	4.41E-07	3.16E-09	1.23E-02	NA	1.75E-07	3.42E-08	2.45E-10	NA	NA	3.58E-02	NA
4-Amino-2,6-dinitrotoluene	3.00E-01	8.49E-07	6.08E-09	1.41E-02	NA	2.40E-09	2.65E-07	1.90E-09	7.35E-03	NA	1.05E-07	2.05E-08	1.47E-10	NA	NA	2.15E-02	NA
1,3-Dinitrobenzene	1.90E+00	5.38E-06	3.85E-08	5.38E-02	NA	1.52E-08	1.68E-06	1.20E-08	2.10E-02	NA	6.65E-07	1.30E-07	9.30E-10	NA	NA	7.47E-02	NA
2,4-Dinitrotoluene	3.30E+00	9.34E-06	6.69E-08	4.67E-03	4.55E-08	2.64E-08	2.91E-06	2.08E-08	1.46E-03	1.42E-08	1.16E-06	2.25E-07	1.61E-09	NA	NA	6.12E-03	5.97E-08
2,6-Dinitrotoluene	3.00E-01	8.49E-07	6.08E-09	8.49E-04	4.13E-09	2.40E-09	2.65E-07	1.90E-09	2.65E-04	1.29E-09	1.05E-07	2.05E-08	1.47E-10	NA	NA	1.11E-03	5.42E-09
3,4-Dinitrotoluene	1.25E-01	3.54E-07	2.53E-09	1.77E-04	NA	1.00E-09	1.10E-07	7.90E-10	5.51E-05	NA	4.38E-08	8.54E-09	6.12E-11	NA	NA	2.32E-04	NA
Total HI				**9.72E-02**					**4.24E-02**					**4.48E-02**		**1.84E-01**	
Total ILCR					**4.96E-08**					**1.55E-08**					**3.90E-07**		**4.55E-07**

HQ = Hazard quotient; HI = Hazard index; ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-46

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil, DS-S17 at West Area
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Inorganics													
Chromium	1.90E+01	8.03E-06	1.87E-05	NA	3.42E-08	7.31E-07	3.28E-07	NA	1.22E-08	1.14E-09	6.67E-10	7.60E-08	7.60E-08
Nitroaromatics													
2-Amino-4,6-dinitrotoluene	5.00E-01	2.11E-07	4.93E-07	NA	9.00E-09	1.92E-07	8.63E-08	NA	3.20E-10	3.01E-11	1.75E-11	NA	NA
4-Amino-2,6-dinitrotoluene	3.00E-01	1.27E-07	2.96E-07	NA	5.40E-09	1.15E-07	5.18E-08	NA	1.92E-10	1.80E-11	1.05E-11	NA	NA
1,3-Dinitrobenzene	1.90E+00	8.03E-07	1.87E-06	NA	3.42E-08	7.31E-07	3.28E-07	NA	1.22E-09	1.14E-10	6.67E-11	NA	NA
2,4-Dinitrotoluene	3.30E+00	1.39E-06	3.25E-06	3.16E-06	5.94E-08	1.27E-06	5.70E-07	1.25E-06	2.11E-09	1.99E-10	1.16E-10	NA	4.41E-06
2,6-Dinitrotoluene	3.00E-01	1.27E-07	2.96E-07	2.87E-07	5.40E-09	1.15E-07	5.18E-08	1.14E-07	1.92E-10	1.80E-11	1.05E-11	NA	4.01E-07
3,4-Dinitrotoluene	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
Total ILCR				**3.45E-06**				**1.36E-06**				**7.60E-08**	**4.89E-06**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-47

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil, DS-S17 at West Area Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
TOTAL RISK										
Inorganics										
Chromium	1.90E+01	2.19E-04	1.46E-04	3.42E-08	3.83E-06	2.55E-04	1.22E-08	7.78E-09	2.68E-04	6.69E-04
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	5.00E-01	5.75E-06	9.59E-02	9.00E-09	1.01E-06	2.80E-02	3.20E-10	2.05E-10	NA	1.24E-01
4-Amino-2,6-dinitrotoluene	3.00E-01	3.45E-06	5.75E-02	5.40E-09	6.04E-07	1.68E-02	1.92E-10	1.23E-10	NA	7.43E-02
1,3-Dinitrobenzene	1.90E+00	2.19E-05	2.19E-01	3.42E-08	3.83E-06	4.78E-02	1.22E-09	7.78E-10	NA	2.66E-01
2,4-Dinitrotoluene	3.30E+00	3.80E-05	1.90E-02	5.94E-08	6.65E-06	3.32E-03	2.11E-09	1.35E-09	NA	2.23E-02
2,6-Dinitrotoluene	3.00E-01	3.45E-06	3.45E-03	5.40E-09	6.04E-07	6.04E-04	1.92E-10	1.23E-10	NA	4.06E-03
3,4-Dinitrotoluene	1.25E-01	1.44E-06	7.19E-04	2.25E-09	2.52E-07	1.26E-04	8.01E-11	5.12E-11	NA	8.45E-04
Total HI			**3.95E-01**			**9.69E-02**			**2.68E-04**	**4.93E-01**

HQ = Hazard quotient; HI = Hazard index
DA = Dose absorbed per unit body surface area per day
NA = Not applicable
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-48

Cancer Risk and Noncancer Hazard Index: Groundskeeper Exposure to Surface Soil, Pentolite Road Area
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
TOTAL RISK																	
Inorganics																	
Aluminum	7.99E+03	7.81E-03	2.79E-03	7.81E-03	NA	7.19E-07	7.95E-05	2.84E-05	2.94E-04	NA	7.99E-04	1.56E-04	5.58E-05	1.12E-01	NA	1.20E-01	NA
Arsenic	5.80E+00	5.68E-06	2.03E-06	1.89E-02	3.04E-06	5.22E-10	5.77E-08	2.06E-08	2.03E-04	3.25E-08	5.80E-07	1.14E-07	4.05E-08	NA	6.08E-07	1.91E-02	3.68E-06
Manganese	2.74E+02	2.68E-04	9.58E-05	5.71E-03	NA	2.47E-08	2.73E-06	9.74E-07	1.16E-03	NA	2.74E-05	5.36E-06	1.92E-06	3.83E-01	NA	3.90E-01	NA
Nitroaromatics																	
4-Amino-2,6-dinitrotoluene	2.70E+00	2.64E-06	9.44E-07	4.40E-02	NA	2.43E-09	2.69E-07	9.60E-08	7.46E-03	NA	2.70E-07	5.28E-08	1.89E-08	NA	NA	5.15E-02	NA
1,3-Dinitrobenzene	8.97E-01	8.78E-07	3.13E-07	8.78E-03	NA	8.07E-10	8.93E-08	3.19E-08	1.12E-03	NA	8.97E-08	1.76E-08	6.27E-09	NA	NA	9.89E-03	NA
2,4-Dinitrotoluene	1.57E+00	1.54E-06	5.50E-07	7.70E-04	3.74E-07	1.42E-09	1.57E-07	5.59E-08	7.83E-05	3.80E-08	1.57E-07	3.08E-08	1.10E-08	NA	NA	8.48E-04	4.12E-07
2,6-Dinitrotoluene	8.00E-01	7.83E-07	2.80E-07	7.83E-04	1.90E-07	7.20E-10	7.96E-08	2.84E-08	7.96E-05	1.93E-08	8.00E-08	1.57E-08	5.59E-09	NA	NA	8.62E-04	2.09E-07
3,4-Dinitrotoluene	3.00E-01	2.94E-07	1.05E-07	1.47E-04	NA	2.70E-10	2.99E-08	1.07E-08	1.49E-05	NA	3.00E-08	5.87E-09	2.10E-09	NA	NA	1.62E-04	NA
Total HI				**8.69E-02**					**1.04E-02**					**4.95E-01**		**5.92E-01**	
Total ILCR					**3.60E-06**					**8.99E-08**					**6.08E-07**		**4.30E-06**
BACKGROUND RISK																	
Inorganics																	
Aluminum	7.99E+03	7.81E-03	2.79E-03	7.81E-03	NA	7.19E-07	7.95E-05	2.84E-05	2.94E-04	NA	7.99E-04	1.56E-04	5.58E-05	1.12E-01	NA	1.20E-01	NA
Arsenic	5.80E+00	5.68E-06	2.03E-06	1.89E-02	3.04E-06	5.22E-10	5.77E-08	2.06E-08	2.03E-04	3.25E-08	5.80E-07	1.14E-07	4.05E-08	NA	6.08E-07	1.91E-02	3.68E-06
Manganese	2.74E+02	2.68E-04	9.58E-05	5.71E-03	NA	2.47E-08	2.73E-06	9.74E-07	1.16E-03	NA	2.74E-05	5.36E-06	1.92E-06	3.83E-01	NA	3.90E-01	NA
Total HI				**3.24E-02**					**1.66E-03**					**4.95E-01**		**5.29E-01**	
Total ILCR					**3.04E-06**					**3.25E-08**					**6.08E-07**		**3.68E-06**
SITE-RELATED RISK																	
Nitroaromatics																	
4-Amino-2,6-dinitrotoluene	2.70E+00	2.64E-06	9.44E-07	4.40E-02	NA	2.43E-09	2.69E-07	9.60E-08	7.46E-03	NA	2.70E-07	5.28E-08	1.89E-08	NA	NA	5.15E-02	NA
1,3-Dinitrobenzene	8.97E-01	8.78E-07	3.13E-07	8.78E-03	NA	8.07E-10	8.93E-08	3.19E-08	1.12E-03	NA	8.97E-08	1.76E-08	6.27E-09	NA	NA	9.89E-03	NA
2,4-Dinitrotoluene	1.57E+00	1.54E-06	5.50E-07	7.70E-04	3.74E-07	1.42E-09	1.57E-07	5.59E-08	7.83E-05	3.80E-08	1.57E-07	3.08E-08	1.10E-08	NA	NA	8.48E-04	4.12E-07
2,6-Dinitrotoluene	8.00E-01	7.83E-07	2.80E-07	7.83E-04	1.90E-07	7.20E-10	7.96E-08	2.84E-08	7.96E-05	1.93E-08	8.00E-08	1.57E-08	5.59E-09	NA	NA	8.62E-04	2.09E-07
3,4-Dinitrotoluene	3.00E-01	2.94E-07	1.05E-07	1.47E-04	NA	2.70E-10	2.99E-08	1.07E-08	1.49E-05	NA	3.00E-08	5.87E-09	2.10E-09	NA	NA	1.62E-04	NA
Total HI				**5.45E-02**					**8.75E-03**					**NA**		**6.33E-02**	
Total ILCR					**5.64E-07**					**5.73E-08**					**NA**		**6.21E-07**

DA = Dose absorbed (per unit body surface area per day).
HQ - Hazard quotient; HI - Hazard index; ILCR - Incremental lifetime cancer risk.
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-49

Cancer Risk and Noncancer Hazard Index: Indoor Worker Exposure to Surface Soil, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR
TOTAL RISK					
Inorganics					
Aluminum	7.99E+03	3.91E-03	1.40E-03	3.91E-03	NA
Arsenic	5.80E+00	2.84E-06	1.01E-06	9.46E-03	1.52E-06
Manganese	2.74E+02	1.34E-04	4.79E-05	2.85E-03	NA
Nitroaromatics					
4-Amino-2,6-dinitrotoluene	2.70E+00	1.32E-06	4.72E-07	2.20E-02	NA
1,3-Dinitrobenzene	8.97E-01	4.39E-07	1.57E-07	4.39E-03	NA
2,4-Dinitrotoluene	1.57E+00	7.70E-07	2.75E-07	3.85E-04	1.87E-07
2,6-Dinitrotoluene	8.00E-01	3.91E-07	1.40E-07	3.91E-04	9.51E-08
3,4-Dinitrotoluene	3.00E-01	1.47E-07	5.24E-08	7.34E-05	NA
Total HI				**4.35E-02**	
Total ILCR					**1.80E-06**
BACKGROUND RISK					
Inorganics					
Aluminum	7.99E+03	3.91E-03	1.40E-03	3.91E-03	NA
Arsenic	5.80E+00	2.84E-06	1.01E-06	9.46E-03	1.52E-06
Manganese	2.74E+02	1.34E-04	4.79E-05	2.85E-03	NA
Total HI				**1.62E-02**	
Total ILCR					**1.52E-06**
SITE-RELATED RISK					
Nitroaromatics					
4-Amino-2,6-dinitrotoluene	2.70E+00	1.32E-06	4.72E-07	2.20E-02	NA
1,3-Dinitrobenzene	8.97E-01	4.39E-07	1.57E-07	4.39E-03	NA
2,4-Dinitrotoluene	1.57E+00	7.70E-07	2.75E-07	3.85E-04	1.87E-07
2,6-Dinitrotoluene	8.00E-01	3.91E-07	1.40E-07	3.91E-04	9.51E-08
3,4-Dinitrotoluene	3.00E-01	1.47E-07	5.24E-08	7.34E-05	NA
Total HI				**2.73E-02**	
Total ILCR					**2.82E-07**

HQ - Hazard quotient; HI - Hazard index; ILCR - Incremental lifetime cancer risk.
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.

Table 5-50

Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Total Soil, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
TOTAL RISK																	
Inorganics																	
ALUMINUM	9.25E+03	2.62E-02	1.87E-04	2.62E-02	NA	7.40E-06	8.16E-04	5.84E-06	3.02E-03	NA	3.24E-03	6.32E-04	4.53E-06	4.51E-01	NA	4.81E-01	NA
ANTIMONY	6.80E+00	1.92E-05	1.38E-07	4.81E-02	NA	5.44E-09	6.00E-07	4.30E-09	1.50E-02	NA	2.38E-06	4.64E-07	3.33E-09	NA	NA	6.31E-02	NA
ARSENIC	1.01E+01	2.86E-05	2.05E-07	9.53E-02	3.07E-07	8.08E-09	8.91E-07	6.38E-09	3.13E-03	1.01E-08	3.54E-06	6.90E-07	4.94E-09	NA	7.41E-08	9.84E-02	3.91E-07
CHROMIUM	1.58E+01	4.48E-05	3.21E-07	2.99E-05	NA	1.27E-08	1.40E-06	1.00E-08	9.31E-05	NA	5.54E-06	1.08E-06	7.75E-09	3.73E-02	3.25E-07	3.74E-02	3.25E-07
MANGANESE	5.63E+02	1.59E-03	1.14E-05	3.39E-02	NA	4.51E-07	4.97E-05	3.56E-07	2.11E-02	NA	1.97E-04	3.85E-05	2.76E-07	2.75E+00	NA	2.80E+00	NA
Nitroaromatics																	
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	7.64E-06	5.47E-08	1.27E-01	NA	2.16E-08	2.38E-06	1.71E-08	6.62E-02	NA	9.45E-07	1.84E-07	1.32E-09	NA	NA	1.94E-01	NA
1,3-DINITROBENZENE	2.20E+00	6.21E-06	4.45E-08	6.21E-02	NA	1.76E-08	1.94E-06	1.39E-08	2.42E-02	NA	7.69E-07	1.50E-07	1.07E-09	NA	NA	8.64E-02	NA
2,4-DINITROTOLUENE	5.34E+00	1.51E-05	1.08E-07	7.55E-03	7.36E-08	4.27E-08	4.71E-06	3.37E-08	2.35E-03	2.29E-08	1.87E-06	3.65E-07	2.61E-09	NA	NA	9.91E-03	9.65E-08
2,6-DINITROTOLUENE	9.51E-01	2.69E-06	1.93E-08	2.69E-03	1.31E-08	7.61E-09	8.39E-07	6.01E-09	8.39E-04	4.09E-09	3.33E-07	6.50E-08	4.65E-10	NA	NA	3.53E-03	1.72E-08
3,4-DINITROTOLUENE	3.68E+00	1.04E-05	7.47E-08	5.21E-03	NA	2.95E-08	3.25E-06	2.33E-08	1.62E-03	NA	1.29E-06	2.52E-07	1.80E-09	NA	NA	6.84E-03	NA
2,4,6-TRINITROTOLUENE	1.20E+04	3.40E-02	2.43E-04	6.79E+01	7.30E-06	9.60E-05	1.06E-02	7.58E-05	3.53E+01	3.79E-06	4.20E-03	8.20E-04	5.87E-06	NA	NA	1.03E+02	1.11E-05
Total HI				**6.83E+01**					**3.54E+01**					**3.24E+00**		**1.07E+02**	
Total ILCR					**7.69E-06**					**3.83E-06**					**4.00E-07**		**1.19E-05**
BACKGROUND RISK																	
Inorganics																	
ALUMINUM	9.25E+03	2.62E-02	1.87E-04	2.62E-02	NA	7.40E-06	8.16E-04	5.84E-06	3.02E-03	NA	3.24E-03	6.32E-04	4.53E-06	4.51E-01	NA	4.81E-01	NA
ANTIMONY	6.80E+00	1.92E-05	1.38E-07	4.81E-02	NA	5.44E-09	6.00E-07	4.30E-09	1.50E-02	NA	2.38E-06	4.64E-07	3.33E-09	NA	NA	6.31E-02	NA
ARSENIC	1.01E+01	2.86E-05	2.05E-07	9.53E-02	3.07E-07	8.08E-09	8.91E-07	6.38E-09	3.13E-03	1.01E-08	3.54E-06	6.90E-07	4.94E-09	NA	7.41E-08	9.84E-02	3.91E-07
CHROMIUM	1.58E+01	4.48E-05	3.21E-07	2.99E-05	NA	1.27E-08	1.40E-06	1.00E-08	9.31E-05	NA	5.54E-06	1.08E-06	7.75E-09	3.73E-02	3.25E-07	3.74E-02	3.25E-07
MANGANESE	5.63E+02	1.59E-03	1.14E-05	3.39E-02	NA	4.51E-07	4.97E-05	3.56E-07	2.11E-02	NA	1.97E-04	3.85E-05	2.76E-07	2.75E+00	NA	2.80E+00	NA
Total HI				**2.04E-01**					**4.24E-02**					**3.24E+00**		**3.48E+00**	
Total ILCR					**3.07E-07**					**1.01E-08**					**4.00E-07**		**7.17E-07**
SITE-RELATED RISK																	
Nitroaromatics																	
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	7.64E-06	5.47E-08	1.27E-01	NA	2.16E-08	2.38E-06	1.71E-08	6.62E-02	NA	9.45E-07	1.84E-07	1.32E-09	NA	NA	1.94E-01	NA
1,3-DINITROBENZENE	2.20E+00	6.21E-06	4.45E-08	6.21E-02	NA	1.76E-08	1.94E-06	1.39E-08	2.42E-02	NA	7.69E-07	1.50E-07	1.07E-09	NA	NA	8.64E-02	NA
2,4-DINITROTOLUENE	5.34E+00	1.51E-05	1.08E-07	7.55E-03	7.36E-08	4.27E-08	4.71E-06	3.37E-08	2.35E-03	2.29E-08	1.87E-06	3.65E-07	2.61E-09	NA	NA	9.91E-03	9.65E-08
2,6-DINITROTOLUENE	9.51E-01	2.69E-06	1.93E-08	2.69E-03	1.31E-08	7.61E-09	8.39E-07	6.01E-09	8.39E-04	4.09E-09	3.33E-07	6.50E-08	4.65E-10	NA	NA	3.53E-03	1.72E-08
3,4-DINITROTOLUENE	3.68E+00	1.04E-05	7.47E-08	5.21E-03	NA	2.95E-08	3.25E-06	2.33E-08	1.62E-03	NA	1.29E-06	2.52E-07	1.80E-09	NA	NA	6.84E-03	NA
2,4,6-TRINITROTOLUENE	1.20E+04	3.40E-02	2.43E-04	6.79E+01	7.30E-06	9.60E-05	1.06E-02	7.58E-05	3.53E+01	3.79E-06	4.20E-03	8.20E-04	5.87E-06	NA	NA	1.03E+02	1.11E-05
Total HI				**6.81E+01**					**3.54E+01**					**NA**		**1.04E+02**	
Total ILCR					**7.38E-06**					**3.82E-06**					**NA**		**1.12E-05**

HQ = Hazard quotient; HI = Hazard index; ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-51

Cancer Risk and Noncancer Hazard Index: Construction Worker Exposure to Sediment, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Noncancer Dose (mg/kg-day)	Dermal Absorption Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Total HI All Pathways	Total ILCR All Pathways
TOTAL RISK												
Inorganics												
Arsenic	5.10E+00	1.19E-05	8.55E-08	3.98E-02	1.28E-07	6.12E-09	1.85E-07	1.33E-09	6.50E-04	2.09E-09	4.05E-02	1.30E-07
Total HI				**3.98E-02**					**6.50E-04**		**4.05E-02**	
Total ILCR					**1.28E-07**					**2.09E-09**		**1.30E-07**
BACKGROUND RISK												
Inorganics												
Arsenic	5.10E+00	1.19E-05	8.55E-08	3.98E-02	1.28E-07	6.12E-09	1.85E-07	1.33E-09	6.50E-04	2.09E-09	4.05E-02	1.30E-07
Total HI				**3.98E-02**					**6.50E-04**		**4.05E-02**	
Total ILCR					**1.28E-07**					**2.09E-09**		**1.30E-07**
SITE-RELATED RISK	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ILCR - Incremental lifetime cancer risk
HQ - Hazard quotient; HI - Hazard index
DA -Dose absorbed (per unit body surface area per day).
NA - Not applicable
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/cm^3 - Milligrams per cubic meter.

Table 5-52

Cancer Risk: On-Site Resident Exposure to Total Soil, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion: Adult Cancer Dose (mg/kg-day)	Incidental Ingestion: Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption: Adult Cancer Dose (mg/kg-day)	Dermal Absorption: Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
TOTAL RISK													
Inorganics													
ALUMINUM	9.25E+03	3.91E-03	9.12E-03	NA	1.67E-05	3.56E-04	1.60E-04	NA	5.93E-06	5.57E-07	3.25E-07	NA	NA
ANTIMONY	6.80E+00	2.87E-06	6.71E-06	NA	1.22E-08	2.62E-07	1.17E-07	NA	4.36E-09	4.09E-10	2.39E-10	NA	NA
ARSENIC	1.01E+01	4.27E-06	9.96E-06	2.14E-05	1.82E-08	3.89E-07	1.74E-07	8.89E-07	6.47E-09	6.08E-10	3.55E-10	1.44E-08	2.23E-05
CHROMIUM	1.58E+01	6.70E-06	1.56E-05	NA	2.85E-08	6.09E-07	2.73E-07	NA	1.01E-08	9.53E-10	5.56E-10	6.34E-08	6.34E-08
MANGANESE	5.63E+02	2.38E-04	5.55E-04	NA	1.01E-06	2.17E-05	9.72E-06	NA	3.61E-07	3.39E-08	1.98E-08	NA	NA
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	1.14E-06	2.66E-06	NA	4.86E-08	1.04E-06	4.66E-07	NA	1.73E-09	1.62E-10	9.48E-11	NA	NA
1,3-DINITROBENZENE	2.20E+00	9.28E-07	2.17E-06	NA	3.95E-08	8.45E-07	3.79E-07	NA	1.41E-09	1.32E-10	7.71E-11	NA	NA
2,4-DINITROTOLUENE	5.34E+00	2.26E-06	5.26E-06	5.11E-06	9.61E-08	2.05E-06	9.21E-07	2.02E-06	3.42E-09	3.21E-10	1.87E-10	NA	7.14E-06
2,6-DINITROTOLUENE	9.51E-01	4.02E-07	9.38E-07	9.11E-07	1.71E-08	3.66E-07	1.64E-07	3.60E-07	6.09E-10	5.72E-11	3.34E-11	NA	1.27E-06
3,4-DINITROTOLUENE	3.68E+00	1.56E-06	3.63E-06	NA	6.63E-08	1.42E-06	6.36E-07	NA	2.36E-09	2.22E-10	1.29E-10	NA	NA
2,4,6-TRINITROTOLUENE	1.20E+04	5.07E-03	1.18E-02	5.07E-04	2.16E-04	4.62E-03	2.07E-03	3.34E-04	7.69E-06	7.22E-07	4.21E-07	NA	8.42E-04
Total ILCR				**5.35E-04**				**3.38E-04**				**7.78E-08**	**8.72E-04**
BACKGROUND RISK													
Inorganics													
ALUMINUM	9.25E+03	3.91E-03	9.12E-03	NA	1.67E-05	3.56E-04	1.60E-04	NA	5.93E-06	5.57E-07	3.25E-07	NA	NA
ANTIMONY	6.80E+00	2.87E-06	6.71E-06	NA	1.22E-08	2.62E-07	1.17E-07	NA	4.36E-09	4.09E-10	2.39E-10	NA	NA
ARSENIC	1.01E+01	4.27E-06	9.96E-06	2.14E-05	1.82E-08	3.89E-07	1.74E-07	8.89E-07	6.47E-09	6.08E-10	3.55E-10	1.44E-08	2.23E-05
CHROMIUM	1.58E+01	6.70E-06	1.56E-05	NA	2.85E-08	6.09E-07	2.73E-07	NA	1.01E-08	9.53E-10	5.56E-10	6.34E-08	6.34E-08
MANGANESE	5.63E+02	2.38E-04	5.55E-04	NA	1.01E-06	2.17E-05	9.72E-06	NA	3.61E-07	3.39E-08	1.98E-08	NA	NA
Total ILCR				**2.14E-05**				**8.89E-07**				**7.78E-08**	**2.23E-05**
SITE-RELATED RISK													
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	1.14E-06	2.66E-06	NA	4.86E-08	1.04E-06	4.66E-07	NA	1.73E-09	1.62E-10	9.48E-11	NA	NA
1,3-DINITROBENZENE	2.20E+00	9.28E-07	2.17E-06	NA	3.95E-08	8.45E-07	3.79E-07	NA	1.41E-09	1.32E-10	7.71E-11	NA	NA
2,4-DINITROTOLUENE	5.34E+00	2.26E-06	5.26E-06	5.11E-06	9.61E-08	2.05E-06	9.21E-07	2.02E-06	3.42E-09	3.21E-10	1.87E-10	NA	7.14E-06
2,6-DINITROTOLUENE	9.51E-01	4.02E-07	9.38E-07	9.11E-07	1.71E-08	3.66E-07	1.64E-07	3.60E-07	6.09E-10	5.72E-11	3.34E-11	NA	1.27E-06
3,4-DINITROTOLUENE	3.68E+00	1.56E-06	3.63E-06	NA	6.63E-08	1.42E-06	6.36E-07	NA	2.36E-09	2.22E-10	1.29E-10	NA	NA
2,4,6-TRINITROTOLUENE	1.20E+04	5.07E-03	1.18E-02	5.07E-04	2.16E-04	4.62E-03	2.07E-03	3.34E-04	7.69E-06	7.22E-07	4.21E-07	NA	8.42E-04
Total ILCR				**5.13E-04**				**3.37E-04**				**NA**	**8.50E-04**

ILCR - Incremental lifetime cancer risk.
DA -Dose absorbed (per unit body surface area per day).
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/cm^3 - Milligrams per cubic meter.

Table 5-53

Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
TOTAL RISK										
Inorganics										
ALUMINUM	9.25E+03	1.06E-01	1.06E-01	1.67E-05	1.86E-03	6.90E-03	5.93E-06	3.79E-06	2.71E-03	1.16E-01
ANTIMONY	6.80E+00	7.82E-05	1.96E-01	1.22E-08	1.37E-06	3.42E-02	4.36E-09	2.78E-09	NA	2.30E-01
ARSENIC	1.01E+01	1.16E-04	3.87E-01	1.82E-08	2.03E-06	7.14E-03	6.47E-09	4.14E-09	NA	3.95E-01
CHROMIUM	1.58E+01	1.82E-04	1.22E-04	2.85E-08	3.19E-06	2.13E-04	1.01E-08	6.49E-09	2.24E-04	5.58E-04
MANGANESE	5.63E+02	6.48E-03	1.38E-01	1.01E-06	1.13E-04	4.83E-02	3.61E-07	2.31E-07	1.65E-02	2.03E-01
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	3.11E-05	5.18E-01	4.86E-08	5.44E-06	1.51E-01	1.73E-09	1.11E-09	NA	6.69E-01
1,3-DINITROBENZENE	2.20E+00	2.53E-05	2.53E-01	3.95E-08	4.42E-06	5.53E-02	1.41E-09	8.99E-10	NA	3.08E-01
2,4-DINITROTOLUENE	5.34E+00	6.14E-05	3.07E-02	9.61E-08	1.07E-05	5.37E-03	3.42E-09	2.19E-09	NA	3.61E-02
2,6-DINITROTOLUENE	9.51E-01	1.09E-05	1.09E-02	1.71E-08	1.91E-06	1.91E-03	6.09E-10	3.89E-10	NA	1.29E-02
3,4-DINITROTOLUENE	3.68E+00	4.24E-05	2.12E-02	6.63E-08	7.42E-06	3.71E-03	2.36E-09	1.51E-09	NA	2.49E-02
2,4,6-TRINITROTOLUENE	1.20E+04	1.38E-01	2.76E+02	2.16E-04	2.42E-02	8.05E+01	7.69E-06	4.91E-06	NA	3.57E+02
Total HI			**2.78E+02**			**8.09E+01**			**1.94E-02**	**3.59E+02**
BACKGROUND RISK										
Inorganics										
ALUMINUM	9.25E+03	1.06E-01	1.06E-01	1.67E-05	1.86E-03	6.90E-03	5.93E-06	3.79E-06	2.71E-03	1.16E-01
ANTIMONY	6.80E+00	7.82E-05	1.96E-01	1.22E-08	1.37E-06	3.42E-02	4.36E-09	2.78E-09	NA	2.30E-01
ARSENIC	1.01E+01	1.16E-04	3.87E-01	1.82E-08	2.03E-06	7.14E-03	6.47E-09	4.14E-09	NA	3.95E-01
CHROMIUM	1.58E+01	1.82E-04	1.22E-04	2.85E-08	3.19E-06	2.13E-04	1.01E-08	6.49E-09	2.24E-04	5.58E-04
MANGANESE	5.63E+02	6.48E-03	1.38E-01	1.01E-06	1.13E-04	4.83E-02	3.61E-07	2.31E-07	1.65E-02	2.03E-01
Total HI			**8.28E-01**			**9.67E-02**			**1.94E-02**	**9.44E-01**
SITE-RELATED RISK										
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	3.11E-05	5.18E-01	4.86E-08	5.44E-06	1.51E-01	1.73E-09	1.11E-09	NA	6.69E-01
1,3-DINITROBENZENE	2.20E+00	2.53E-05	2.53E-01	3.95E-08	4.42E-06	5.53E-02	1.41E-09	8.99E-10	NA	3.08E-01
2,4-DINITROTOLUENE	5.34E+00	6.14E-05	3.07E-02	9.61E-08	1.07E-05	5.37E-03	3.42E-09	2.19E-09	NA	3.61E-02
2,6-DINITROTOLUENE	9.51E-01	1.09E-05	1.09E-02	1.71E-08	1.91E-06	1.91E-03	6.09E-10	3.89E-10	NA	1.29E-02
3,4-DINITROTOLUENE	3.68E+00	4.24E-05	2.12E-02	6.63E-08	7.42E-06	3.71E-03	2.36E-09	1.51E-09	NA	2.49E-02
2,4,6-TRINITROTOLUENE	1.20E+04	1.38E-01	2.76E+02	2.16E-04	2.42E-02	8.05E+01	7.69E-06	4.91E-06	NA	3.57E+02
Total HI			**2.77E+02**			**8.08E+01**			**NA**	**3.58E+02**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/cm^3 - Milligrams per cubic meter.

Table 5-54

Cancer Risk: On-Site Resident Exposure to Sediment, Pentolite Road Red Water Ponds Area, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Adult Ingested Dose (mg/kg-day)	Child Ingested Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Dermally Absorbed Dose (mg/kg-day)	Child Dermally Absorbed Dose (mg/kg-day)	On-Site Resident Dermal ILCR	On-Site Resident Total All Pathways ILCR
TOTAL RISK									
Inorganics									
Arsenic	5.10E+00	3.56E-08	8.30E-08	1.78E-07	1.02E-09	3.24E-09	1.45E-09	7.41E-09	1.85E-07
Total ILCR				**1.78E-07**				**7.41E-09**	**1.85E-07**
BACKGROUND RISK									
Inorganics									
Arsenic	5.10E+00	3.56E-08	8.30E-08	1.78E-07	1.02E-09	3.24E-09	1.45E-09	7.41E-09	1.85E-07
Total ILCR				**1.78E-07**				**7.41E-09**	**1.85E-07**
SITE-RELATED RISK	NA	NA	NA	NA	NA	NA	NA	NA	NA

ILCR - Incremental lifetime cancer risk.
DA -Dose absorbed (per unit body surface area per day).
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/cm^3 - Milligrams per cubic meter.

Table 5-55

Noncancer Hazard Index: Resident Child Exposure to Sediment, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Child Ingested Dose (mg/kg-day)	Child Resident Oral HQ	DA (mg/cm^2-day)	Child Dermally Absorbed Dose (mg/kg-day)	Child Resident Dermal HQ	Child Resident Total All Pathways HI
TOTAL RISK							
Inorganics							
Arsenic	5.10E+00	9.69E-07	3.23E-03	1.02E-09	1.70E-08	5.95E-05	3.29E-03
Total HI			**3.23E-03**			**5.95E-05**	**3.29E-03**
BACKGROUND RISK							
Inorganics							
Arsenic	5.10E+00	9.69E-07	3.23E-03	1.02E-09	1.70E-08	5.95E-05	3.29E-03
Total HI			**3.23E-03**			**5.95E-05**	**3.29E-03**
SITE-RELATED RISK	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

HI - Hazard index; HQ - Hazard quotient.
DA -Dose absorbed (per unit body surface area per day).
NA - Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.

Table 5-56

Summary of Total Hazard Index and Total Cancer Risk from Site-Related Chemicals of Potential Concern
Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

	Groundskeeper		Indoor Worker		Construction Worker		On-Site Resident	
Contaminant Source	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR
Surface Soil	6.33E-02	6.21E-07	2.73E-02	2.82E-07	NA	NA	NA	NA
Total Soil	NA	NA	NA	NA	1.04E+02	1.12E-05	3.58E+02	8.50E-04
Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	NA	NA	NA	NA	NA	NA	NA	NA
Total across all media	**6.33E-02**	**6.21E-07**	**2.73E-02**	**2.82E-07**	**1.04E+02**	**1.12E-05**	**3.58E+02**	**8.50E-04**

HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable.

Table 5-57

Exposure Unit Values[a] for Sample Location DP03, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 2 ft bgs Surface Soil		4 - 5 ft bgs Subsurface Soil		Source Term Concentration[b]
Nitroaromatics					
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E+00	c	1.25E+00
1,3-DINITROBENZENE	1.25E-01	c	9.30E+00		9.30E+00
2,4-DINITROTOLUENE	1.20E+00		2.50E+01		2.50E+01
2,6-DINITROTOLUENE	1.25E-01	c	1.25E+00	c	1.25E+00
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E+00	c	1.25E+00

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-58

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location DP03, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion: Adult Cancer Dose (mg/kg-day)	Incidental Ingestion: Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption: Adult Cancer Dose (mg/kg-day)	Dermal Absorption: Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	1.25E+00	5.28E-07	1.23E-06	NA	2.25E-08	4.81E-07	2.16E-07	NA	8.01E-10	7.52E-11	4.39E-11	NA	NA
1,3-DINITROBENZENE	9.30E+00	3.93E-06	9.17E-06	NA	1.67E-07	3.58E-06	1.61E-06	NA	5.96E-09	5.60E-10	3.26E-10	NA	NA
2,4-DINITROTOLUENE	2.50E+01	1.06E-05	2.47E-05	2.40E-05	4.50E-07	9.62E-06	4.32E-06	9.47E-06	1.60E-08	1.50E-09	8.77E-10	NA	3.34E-05
2,6-DINITROTOLUENE	1.25E+00	5.28E-07	1.23E-06	1.20E-06	2.25E-08	4.81E-07	2.16E-07	4.74E-07	8.01E-10	7.52E-11	4.39E-11	NA	1.67E-06
2,4,6-TRINITROTOLUENE	1.25E+00	5.28E-07	1.23E-06	5.28E-08	2.25E-08	4.81E-07	2.16E-07	3.48E-08	8.01E-10	7.52E-11	4.39E-11	NA	8.77E-08
Total ILCR				**2.52E-05**				**9.98E-06**				**NA**	**3.52E-05**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-59

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location DP03, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1.25E+00	1.44E-05	2.40E-01	2.25E-08	2.52E-06	6.99E-02	8.01E-10	5.12E-10	NA	3.10E-01
1,3-DINITROBENZENE	9.30E+00	1.07E-04	1.07E+00	1.67E-07	1.87E-05	2.34E-01	5.96E-09	3.81E-09	NA	1.30E+00
2,4-DINITROTOLUENE	2.50E+01	2.88E-04	1.44E-01	4.50E-07	5.03E-05	2.52E-02	1.60E-08	1.02E-08	NA	1.69E-01
2,6-DINITROTOLUENE	1.25E+00	1.44E-05	1.44E-02	2.25E-08	2.52E-06	2.52E-03	8.01E-10	5.12E-10	NA	1.69E-02
2,4,6-TRINITROTOLUENE	1.25E+00	1.44E-05	2.88E-02	2.25E-08	2.52E-06	8.39E-03	8.01E-10	5.12E-10	NA	3.72E-02
Total HI			**1.50E+00**			**3.40E-01**			**NA**	**1.84E+00**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-60

Exposure Unit Values[a] for Sample Location DP10, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 1 ft bgs Surface Soil		4 - 5 ft bgs Subsurface Soil		9 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.10E+00	c	1.10E+00
1,3-DINITROBENZENE	1.25E-01	c	1.25E-01	c	5.20E+00		5.20E+00
2,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.50E+01		1.50E+01
2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.70E+00		1.70E+00
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E-01	c	6.00E-01	c	6.00E-01

mg/kg - Milligrams per killogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-61

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location DP10, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	1.10E+00	4.65E-07	1.08E-06	NA	1.98E-08	4.23E-07	1.90E-07	NA	7.05E-10	6.62E-11	3.86E-11	NA	NA
1,3-DINITROBENZENE	5.20E+00	2.20E-06	5.13E-06	NA	9.36E-08	2.00E-06	8.98E-07	NA	3.33E-09	3.13E-10	1.83E-10	NA	NA
2,4-DINITROTOLUENE	1.50E+01	6.34E-06	1.48E-05	1.44E-05	2.70E-07	5.77E-06	2.59E-06	5.68E-06	9.61E-09	9.02E-10	5.26E-10	NA	2.01E-05
2,6-DINITROTOLUENE	1.70E+00	7.19E-07	1.68E-06	1.63E-06	3.06E-08	6.54E-07	2.93E-07	6.44E-07	1.09E-09	1.02E-10	5.97E-11	NA	2.27E-06
2,4,6-TRINITROTOLUENE	6.00E-01	2.54E-07	5.92E-07	2.54E-08	1.08E-08	2.31E-07	1.04E-07	1.67E-08	3.84E-10	3.61E-11	2.11E-11	NA	4.21E-08
Total ILCR				**1.60E-05**				**6.34E-06**				**NA**	**2.24E-05**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.

Table 5-62

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location DP10, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1.10E+00	1.27E-05	2.11E-01	1.98E-08	2.22E-06	6.15E-02	7.05E-10	4.50E-10	NA	2.72E-01
1,3-DINITROBENZENE	5.20E+00	5.98E-05	5.98E-01	9.36E-08	1.05E-05	1.31E-01	3.33E-09	2.13E-09	NA	7.29E-01
2,4-DINITROTOLUENE	1.50E+01	1.73E-04	8.63E-02	2.70E-07	3.02E-05	1.51E-02	9.61E-09	6.14E-09	NA	1.01E-01
2,6-DINITROTOLUENE	1.70E+00	1.96E-05	1.96E-02	3.06E-08	3.42E-06	3.42E-03	1.09E-09	6.96E-10	NA	2.30E-02
2,4,6-TRINITROTOLUENE	6.00E-01	6.90E-06	1.38E-02	1.08E-08	1.21E-06	4.03E-03	3.84E-10	2.46E-10	NA	1.78E-02
Total HI			**9.29E-01**			**2.15E-01**			**NA**	**1.14E+00**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-63

Exposure Unit Values[a] for Sample Location DP11, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 2 ft bgs Surface Soil		4 - 6 ft bgs Subsurface Soil		8 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	2.70E+00		1.25E-01	c	1.25E-01	c	2.70E+00
1,3-DINITROBENZENE	1.25E-01	c	4.30E-01		5.80E+00		5.80E+00
2,4-DINITROTOLUENE	3.20E-01		1.60E+00		1.20E+00		1.60E+00
2,6-DINITROTOLUENE	1.25E-01	c	2.90E-01		3.00E-01		3.00E-01
2,4,6-TRINITROTOLUENE	2.70E-01		1.25E-01	c	1.25E-01	c	2.70E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-64

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location DP11, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	1.14E-06	2.66E-06	NA	4.86E-08	1.04E-06	4.66E-07	NA	1.73E-09	1.62E-10	9.48E-11	NA	NA
1,3-DINITROBENZENE	5.80E+00	2.45E-06	5.72E-06	NA	1.04E-07	2.23E-06	1.00E-06	NA	3.72E-09	3.49E-10	2.04E-10	NA	NA
2,4-DINITROTOLUENE	1.60E+00	6.76E-07	1.58E-06	1.53E-06	2.88E-08	6.15E-07	2.76E-07	6.06E-07	1.02E-09	9.63E-11	5.62E-11	NA	2.14E-06
2,6-DINITROTOLUENE	3.00E-01	1.27E-07	2.96E-07	2.87E-07	5.40E-09	1.15E-07	5.18E-08	1.14E-07	1.92E-10	1.80E-11	1.05E-11	NA	4.01E-07
2,4,6-TRINITROTOLUENE	2.70E-01	1.14E-07	2.66E-07	1.14E-08	4.86E-09	1.04E-07	4.66E-08	7.52E-09	1.73E-10	1.62E-11	9.48E-12	NA	1.89E-08
Total ILCR				**1.83E-06**				**7.28E-07**				**NA**	**2.56E-06**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-65

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location DP11, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	3.11E-05	5.18E-01	4.86E-08	5.44E-06	1.51E-01	1.73E-09	1.11E-09	NA	6.69E-01
1,3-DINITROBENZENE	5.80E+00	6.67E-05	6.67E-01	1.04E-07	1.17E-05	1.46E-01	3.72E-09	2.37E-09	NA	8.13E-01
2,4-DINITROTOLUENE	1.60E+00	1.84E-05	9.21E-03	2.88E-08	3.22E-06	1.61E-03	1.02E-09	6.55E-10	NA	1.08E-02
2,6-DINITROTOLUENE	3.00E-01	3.45E-06	3.45E-03	5.40E-09	6.04E-07	6.04E-04	1.92E-10	1.23E-10	NA	4.06E-03
2,4,6-TRINITROTOLUENE	2.70E-01	3.11E-06	6.21E-03	4.86E-09	5.44E-07	1.81E-03	1.73E-10	1.11E-10	NA	8.03E-03
Total HI			**1.20E+00**			**3.01E-01**			**NA**	**1.51E+00**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-66

Exposure Unit Values[a] for Sample Location S4, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 3 ft bgs Surface Soil		3 - 5 ft bgs Subsurface Soil		5 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01
1,3-DINITROBENZENE	8.00E-01		3.20E+00		2.10E+00		3.20E+00
2,4-DINITROTOLUENE	1.10E+00		5.70E+00		2.80E+00		5.70E+00
2,6-DINITROTOLUENE	1.30E-01	c	5.00E-01		1.30E-01	c	5.00E-01
3,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-67

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location S4, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathway
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
1,3-DINITROBENZENE	3.20E+00	1.35E-06	3.16E-06	NA	5.76E-08	1.23E-06	5.52E-07	NA	2.05E-09	1.93E-10	1.12E-10	NA	NA
2,4-DINITROTOLUENE	5.70E+00	2.41E-06	5.62E-06	5.46E-06	1.03E-07	2.19E-06	9.84E-07	2.16E-06	3.65E-09	3.43E-10	2.00E-10	NA	#####
2,6-DINITROTOLUENE	5.00E-01	2.11E-07	4.93E-07	4.79E-07	9.00E-09	1.92E-07	8.63E-08	1.89E-07	3.20E-10	3.01E-11	1.75E-11	NA	#####
3,4-DINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
2,4,6-TRINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	5.28E-09	2.25E-09	4.81E-08	2.16E-08	3.48E-09	8.01E-11	7.52E-12	4.39E-12	NA	#####
Total ILCR				**5.95E-06**				**2.35E-06**				**NA**	#####

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed per unit body surface area per day.
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-68

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location S4, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	1.44E-06	2.40E-02	2.25E-09	2.52E-07	6.99E-03	8.01E-11	5.12E-11	NA	3.10E-02
1,3-DINITROBENZENE	3.20E+00	3.68E-05	3.68E-01	5.76E-08	6.44E-06	8.05E-02	2.05E-09	1.31E-09	NA	4.49E-01
2,4-DINITROTOLUENE	5.70E+00	6.56E-05	3.28E-02	1.03E-07	1.15E-05	5.74E-03	3.65E-09	2.33E-09	NA	3.85E-02
2,6-DINITROTOLUENE	5.00E-01	5.75E-06	5.75E-03	9.00E-09	1.01E-06	1.01E-03	3.20E-10	2.05E-10	NA	6.76E-03
3,4-DINITROTOLUENE	1.25E-01	1.44E-06	7.19E-04	2.25E-09	2.52E-07	1.26E-04	8.01E-11	5.12E-11	NA	8.45E-04
2,4,6-TRINITROTOLUENE	1.25E-01	1.44E-06	2.88E-03	2.25E-09	2.52E-07	8.39E-04	8.01E-11	5.12E-11	NA	3.72E-03
Total HI			**4.34E-01**			**9.53E-02**			**NA**	**5.30E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-69

Exposure Unit Values[a] for Sample Location S6, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 3 ft bgs Surface Soil		3 - 5 ft bgs Subsurface Soil		5 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	3.00E-01		1.00E+00		1.00E+00
1,3-DINITROBENZENE	9.00E-01		3.40E+00		3.80E+00		3.80E+00
2,4-DINITROTOLUENE	2.10E+00		8.70E+00		7.60E+00		8.70E+00
2,6-DINITROTOLUENE	4.00E-01		3.60E+00		5.00E-01		3.60E+00
3,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-70

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location S6, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	1.00E+00	4.23E-07	9.86E-07	NA	1.80E-08	3.85E-07	1.73E-07	NA	6.41E-10	6.02E-11	3.51E-11	NA	NA
1,3-DINITROBENZENE	3.80E+00	1.61E-06	3.75E-06	NA	6.84E-08	1.46E-06	6.56E-07	NA	2.43E-09	2.29E-10	1.33E-10	NA	NA
2,4-DINITROTOLUENE	8.70E+00	3.68E-06	8.58E-06	8.34E-06	1.57E-07	3.35E-06	1.50E-06	3.30E-06	5.57E-09	5.23E-10	3.05E-10	NA	1.16E-05
2,6-DINITROTOLUENE	3.60E+00	1.52E-06	3.55E-06	3.45E-06	6.48E-08	1.38E-06	6.21E-07	1.36E-06	2.31E-09	2.17E-10	1.26E-10	NA	4.81E-06
3,4-DINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
2,4,6-TRINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	5.28E-09	2.25E-09	4.81E-08	2.16E-08	3.48E-09	8.01E-11	7.52E-12	4.39E-12	NA	8.77E-09
Total ILCR				**1.18E-05**				**4.66E-06**				**NA**	**1.65E-05**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-71

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location S6, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1.00E+00	1.15E-05	1.92E-01	1.80E-08	2.01E-06	5.59E-02	6.41E-10	4.09E-10	NA	2.48E-01
1,3-DINITROBENZENE	3.80E+00	4.37E-05	4.37E-01	6.84E-08	7.65E-06	9.57E-02	2.43E-09	1.56E-09	NA	5.33E-01
2,4-DINITROTOLUENE	8.70E+00	1.00E-04	5.01E-02	1.57E-07	1.75E-05	8.76E-03	5.57E-09	3.56E-09	NA	5.88E-02
2,6-DINITROTOLUENE	3.60E+00	4.14E-05	4.14E-02	6.48E-08	7.25E-06	7.25E-03	2.31E-09	1.47E-09	NA	4.87E-02
3,4-DINITROTOLUENE	1.25E-01	1.44E-06	7.19E-04	2.25E-09	2.52E-07	1.26E-04	8.01E-11	5.12E-11	NA	8.45E-04
2,4,6-TRINITROTOLUENE	1.25E-01	1.44E-06	2.88E-03	2.25E-09	2.52E-07	8.39E-04	8.01E-11	5.12E-11	NA	3.72E-03
Total HI			**7.24E-01**			**1.69E-01**			**NA**	**8.93E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-72

Exposure Unit Values[a] for Sample Location S10, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 3 ft bgs Surface Soil		3 - 5 ft bgs Subsurface Soil		5 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01
1,3-DINITROBENZENE	1.25E-01	c	1.60E+00		2.50E+00		2.50E+00
2,4-DINITROTOLUENE	1.25E-01	c	2.60E+00		2.20E+00		2.60E+00
2,6-DINITROTOLUENE	1.30E-01	c	1.30E-01	c	1.30E-01	c	1.30E-01
3,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-73

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location S10, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
1,3-DINITROBENZENE	2.50E+00	1.06E-06	2.47E-06	NA	4.50E-08	9.62E-07	4.32E-07	NA	1.60E-09	1.50E-10	8.77E-11	NA	NA
2,4-DINITROTOLUENE	2.60E+00	1.10E-06	2.56E-06	2.49E-06	4.68E-08	1.00E-06	4.49E-07	9.85E-07	1.67E-09	1.56E-10	9.13E-11	NA	3.48E-06
2,6-DINITROTOLUENE	1.30E-01	5.50E-08	1.28E-07	1.25E-07	2.34E-09	5.00E-08	2.24E-08	4.93E-08	8.33E-11	7.82E-12	4.56E-12	NA	1.74E-07
3,4-DINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
2,4,6-TRINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	5.28E-09	2.25E-09	4.81E-08	2.16E-08	3.48E-09	8.01E-11	7.52E-12	4.39E-12	NA	8.77E-09
Total ILCR				**2.62E-06**				**1.04E-06**				**NA**	**3.66E-06**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-74

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location S10, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	1.44E-06	2.40E-02	2.25E-09	2.52E-07	6.99E-03	8.01E-11	5.12E-11	NA	3.10E-02
1,3-DINITROBENZENE	2.50E+00	2.88E-05	2.88E-01	4.50E-08	5.03E-06	6.29E-02	1.60E-09	1.02E-09	NA	3.51E-01
2,4-DINITROTOLUENE	2.60E+00	2.99E-05	1.50E-02	4.68E-08	5.24E-06	2.62E-03	1.67E-09	1.06E-09	NA	1.76E-02
2,6-DINITROTOLUENE	1.30E-01	1.50E-06	1.50E-03	2.34E-09	2.62E-07	2.62E-04	8.33E-11	5.32E-11	NA	1.76E-03
3,4-DINITROTOLUENE	1.25E-01	1.44E-06	7.19E-04	2.25E-09	2.52E-07	1.26E-04	8.01E-11	5.12E-11	NA	8.45E-04
2,4,6-TRINITROTOLUENE	1.25E-01	1.44E-06	2.88E-03	2.25E-09	2.52E-07	8.39E-04	8.01E-11	5.12E-11	NA	3.72E-03
Total HI			**3.32E-01**			**7.38E-02**			**NA**	**4.05E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-75

Exposure Unit Values[a] for Sample Location S13, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 0.5 ft bgs Surface Soil		0 - 3 ft bgs Surface Soil		3 - 5 ft bgs Subsurface Soil		3 - 10 ft bgs Subsurface Soil	Source Term Concentration[b]
Nitroaromatics								
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	7.00E-01	7.00E-01
1,3-DINITROBENZENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	3.20E+00	3.20E+00
2,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	4.00E-01		5.20E+00	5.20E+00
2,6-DINITROTOLUENE	1.30E-01	c	1.30E-01	c	1.30E-01	c	5.00E-01	5.00E-01
3,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	5.00E-01	5.00E-01
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	5.00E-01	5.00E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-76

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location S13, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	7.00E-01	2.96E-07	6.90E-07	NA	1.26E-08	2.69E-07	1.21E-07	NA	4.48E-10	4.21E-11	2.46E-11	NA	NA
1,3-DINITROBENZENE	3.20E+00	1.35E-06	3.16E-06	NA	5.76E-08	1.23E-06	5.52E-07	NA	2.05E-09	1.93E-10	1.12E-10	NA	NA
2,4-DINITROTOLUENE	5.20E+00	2.20E-06	5.13E-06	4.98E-06	9.36E-08	2.00E-06	8.98E-07	1.97E-06	3.33E-09	3.13E-10	1.83E-10	NA	6.95E-06
2,6-DINITROTOLUENE	5.00E-01	2.11E-07	4.93E-07	4.79E-07	9.00E-09	1.92E-07	8.63E-08	1.89E-07	3.20E-10	3.01E-11	1.75E-11	NA	6.69E-07
3,4-DINITROTOLUENE	5.00E-01	2.11E-07	4.93E-07	NA	9.00E-09	1.92E-07	8.63E-08	NA	3.20E-10	3.01E-11	1.75E-11	NA	NA
2,4,6-TRINITROTOLUENE	5.00E-01	2.11E-07	4.93E-07	2.11E-08	9.00E-09	1.92E-07	8.63E-08	1.39E-08	3.20E-10	3.01E-11	1.75E-11	NA	3.51E-08
Total ILCR				**5.48E-06**				**2.17E-06**				**NA**	**7.66E-06**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-77

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location S13, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	7.00E-01	8.05E-06	1.34E-01	1.26E-08	1.41E-06	3.92E-02	4.48E-10	2.87E-10	NA	1.73E-01
1,3-DINITROBENZENE	3.20E+00	3.68E-05	3.68E-01	5.76E-08	6.44E-06	8.05E-02	2.05E-09	1.31E-09	NA	4.49E-01
2,4-DINITROTOLUENE	5.20E+00	5.98E-05	2.99E-02	9.36E-08	1.05E-05	5.24E-03	3.33E-09	2.13E-09	NA	3.52E-02
2,6-DINITROTOLUENE	5.00E-01	5.75E-06	5.75E-03	9.00E-09	1.01E-06	1.01E-03	3.20E-10	2.05E-10	NA	6.76E-03
3,4-DINITROTOLUENE	5.00E-01	5.75E-06	2.88E-03	9.00E-09	1.01E-06	5.03E-04	3.20E-10	2.05E-10	NA	3.38E-03
2,4,6-TRINITROTOLUENE	5.00E-01	5.75E-06	1.15E-02	9.00E-09	1.01E-06	3.36E-03	3.20E-10	2.05E-10	NA	1.49E-02
Total HI			**5.53E-01**			**1.30E-01**			**NA**	**6.82E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-78

Exposure Unit Values[a] for Sample Location S14, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 0.5 ft bgs Surface Soil		0 - 3 ft bgs Surface Soil		3 - 5 ft bgs Subsurface Soil		5 - 10 ft bgs Subsurface Soil	Source Term Concentration[b]
Nitroaromatics								
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	9.50E+00		2.00E+00	9.50E+00
1,3-DINITROBENZENE	1.25E-01	c	1.25E-01	c	6.40E+00		6.70E+00	6.70E+00
2,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E+00	c	1.90E+01	1.90E+01
2,6-DINITROTOLUENE	1.30E-01	c	1.30E-01	c	1.30E+00	c	2.90E+00	2.90E+00
3,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	4.50E+00		1.70E+00	4.50E+00
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.20E+04		3.40E+02	1.20E+04

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-79

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location S14, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion: Adult Cancer Dose (mg/kg-day)	Incidental Ingestion: Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption: Adult Cancer Dose (mg/kg-day)	Dermal Absorption: Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	9.50E+00	4.02E-06	9.37E-06	NA	1.71E-07	3.65E-06	1.64E-06	NA	6.08E-09	5.72E-10	3.33E-10	NA	NA
1,3-DINITROBENZENE	6.70E+00	2.83E-06	6.61E-06	NA	1.21E-07	2.58E-06	1.16E-06	NA	4.29E-09	4.03E-10	2.35E-10	NA	NA
2,4-DINITROTOLUENE	1.90E+01	8.03E-06	1.87E-05	1.82E-05	3.42E-07	7.31E-06	3.28E-06	7.20E-06	1.22E-08	1.14E-09	6.67E-10	NA	2.54E-05
2,6-DINITROTOLUENE	2.90E+00	1.23E-06	2.86E-06	2.78E-06	5.22E-08	1.12E-06	5.01E-07	1.10E-06	1.86E-09	1.74E-10	1.02E-10	NA	3.88E-06
3,4-DINITROTOLUENE	4.50E+00	1.90E-06	4.44E-06	NA	8.10E-08	1.73E-06	7.77E-07	NA	2.88E-09	2.71E-10	1.58E-10	NA	NA
2,4,6-TRINITROTOLUENE	1.20E+04	5.07E-03	1.18E-02	5.07E-04	2.16E-04	4.62E-03	2.07E-03	3.34E-04	7.69E-06	7.22E-07	4.21E-07	NA	8.42E-04
Total ILCR				**5.28E-04**				**3.43E-04**				**NA**	**8.71E-04**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-80

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location S14, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	9.50E+00	1.09E-04	1.82E+00	1.71E-07	1.91E-05	5.31E-01	6.08E-09	3.89E-09	NA	2.35E+00
1,3-DINITROBENZENE	6.70E+00	7.71E-05	7.71E-01	1.21E-07	1.35E-05	1.69E-01	4.29E-09	2.74E-09	NA	9.40E-01
2,4-DINITROTOLUENE	1.90E+01	2.19E-04	1.09E-01	3.42E-07	3.83E-05	1.91E-02	1.22E-08	7.78E-09	NA	1.28E-01
2,6-DINITROTOLUENE	2.90E+00	3.34E-05	3.34E-02	5.22E-08	5.84E-06	5.84E-03	1.86E-09	1.19E-09	NA	3.92E-02
3,4-DINITROTOLUENE	4.50E+00	5.18E-05	2.59E-02	8.10E-08	9.06E-06	4.53E-03	2.88E-09	1.84E-09	NA	3.04E-02
2,4,6-TRINITROTOLUENE	1.20E+04	1.38E-01	2.76E+02	2.16E-04	2.42E-02	8.05E+01	7.69E-06	4.91E-06	NA	3.57E+02
Total HI			**2.79E+02**			**8.13E+01**			**NA**	**3.60E+02**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-81

Exposure Unit Values[a] for Sample Location S15, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 3 ft bgs Surface Soil		3 - 5 ft bgs Subsurface Soil		5 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01
1,3-DINITROBENZENE	1.25E-01	c	1.25E-01	c	6.60E+00		6.60E+00
2,4-DINITROTOLUENE	6.00E-01		3.00E-01		1.40E+01		1.40E+01
2,6-DINITROTOLUENE	1.30E-01	c	1.30E-01	c	2.00E+00		2.00E+00
3,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.10E+00		1.10E+00
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-82

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location S15, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion: Adult Cancer Dose (mg/kg-day)	Incidental Ingestion: Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption: Adult Cancer Dose (mg/kg-day)	Dermal Absorption: Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
1,3-DINITROBENZENE	6.60E+00	2.79E-06	6.51E-06	NA	1.19E-07	2.54E-06	1.14E-06	NA	4.23E-09	3.97E-10	2.32E-10	NA	NA
2,4-DINITROTOLUENE	1.40E+01	5.92E-06	1.38E-05	1.34E-05	2.52E-07	5.39E-06	2.42E-06	5.31E-06	8.97E-09	8.42E-10	4.91E-10	NA	1.87E-05
2,6-DINITROTOLUENE	2.00E+00	8.45E-07	1.97E-06	1.92E-06	3.60E-08	7.69E-07	3.45E-07	7.58E-07	1.28E-09	1.20E-10	7.02E-11	NA	2.67E-06
3,4-DINITROTOLUENE	1.10E+00	4.65E-07	1.08E-06	NA	1.98E-08	4.23E-07	1.90E-07	NA	7.05E-10	6.62E-11	3.86E-11	NA	NA
2,4,6-TRINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	5.28E-09	2.25E-09	4.81E-08	2.16E-08	3.48E-09	8.01E-11	7.52E-12	4.39E-12	NA	8.77E-09
Total ILCR				**1.53E-05**				**6.07E-06**				**NA**	**2.14E-05**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-83

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location S15, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	1.44E-06	2.40E-02	2.25E-09	2.52E-07	6.99E-03	8.01E-11	5.12E-11	NA	3.10E-02
1,3-DINITROBENZENE	6.60E+00	7.59E-05	7.59E-01	1.19E-07	1.33E-05	1.66E-01	4.23E-09	2.70E-09	NA	9.26E-01
2,4-DINITROTOLUENE	1.40E+01	1.61E-04	8.05E-02	2.52E-07	2.82E-05	1.41E-02	8.97E-09	5.73E-09	NA	9.46E-02
2,6-DINITROTOLUENE	2.00E+00	2.30E-05	2.30E-02	3.60E-08	4.03E-06	4.03E-03	1.28E-09	8.19E-10	NA	2.70E-02
3,4-DINITROTOLUENE	1.10E+00	1.27E-05	6.33E-03	1.98E-08	2.22E-06	1.11E-03	7.05E-10	4.50E-10	NA	7.44E-03
2,4,6-TRINITROTOLUENE	1.25E-01	1.44E-06	2.88E-03	2.25E-09	2.52E-07	8.39E-04	8.01E-11	5.12E-11	NA	3.72E-03
Total HI			**8.96E-01**			**1.93E-01**			**NA**	**1.09E+00**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-84

Exposure Unit Values[a] for Sample Location S16, Pentolite Road Red Water Ponds, PBOW, Sandusky, Ohio

Chemical Name (mg/kg)	0 - 3 ft bgs Surface Soil		3 - 5 ft bgs Subsurface Soil		5 - 10 ft bgs Subsurface Soil		Source Term Concentration[b]
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01
1,3-DINITROBENZENE	1.25E-01	c	1.25E-01	c	4.30E+00		4.30E+00
2,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	8.90E+00		8.90E+00
2,6-DINITROTOLUENE	1.30E-01	c	1.30E-01	c	1.00E+00		1.00E+00
3,4-DINITROTOLUENE	1.25E-01	c	1.25E-01	c	8.00E-01		8.00E-01
2,4,6-TRINITROTOLUENE	1.25E-01	c	1.25E-01	c	1.25E-01	c	1.25E-01

mg/kg - Milligrams per kilogram.
ft bgs - Feet below ground surface.

[a] Analytical concentrations unless otherwise specified.
[b] Maximum value from previous columns.
[c] One-half reporting limit used as surrogate value for nondetects.

Table 5-85

Site-Related Cancer Risk: On-Site Resident Exposure to Total Soil
Sample Location S16, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

		Incidental Ingestion				Dermal Absorption				Inhalation of Dust			
Chemical	Source Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Dermal ILCR	Concentration In Air (mg/m^3)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	On-Site Resident Inhalation ILCR	Total ILCR All Pathways
Nitroaromatics													
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	NA	2.25E-09	4.81E-08	2.16E-08	NA	8.01E-11	7.52E-12	4.39E-12	NA	NA
1,3-DINITROBENZENE	4.30E+00	1.82E-06	4.24E-06	NA	7.74E-08	1.65E-06	7.42E-07	NA	2.75E-09	2.59E-10	1.51E-10	NA	NA
2,4-DINITROTOLUENE	8.90E+00	3.76E-06	8.78E-06	8.53E-06	1.60E-07	3.42E-06	1.54E-06	3.37E-06	5.70E-09	5.35E-10	3.12E-10	NA	1.19E-05
2,6-DINITROTOLUENE	1.00E+00	4.23E-07	9.86E-07	9.58E-07	1.80E-08	3.85E-07	1.73E-07	3.79E-07	6.41E-10	6.02E-11	3.51E-11	NA	1.34E-06
3,4-DINITROTOLUENE	8.00E-01	3.38E-07	7.89E-07	NA	1.44E-08	3.08E-07	1.38E-07	NA	5.12E-10	4.81E-11	2.81E-11	NA	NA
2,4,6-TRINITROTOLUENE	1.25E-01	5.28E-08	1.23E-07	5.28E-09	2.25E-09	4.81E-08	2.16E-08	3.48E-09	8.01E-11	7.52E-12	4.39E-12	NA	8.77E-09
Total ILCR				**9.49E-06**				**3.75E-06**				**NA**	**1.32E-05**

ILCR = Incremental lifetime cancer risk.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-86

Site-Related Noncancer Hazard Index: On-Site Resident Child Exposure to Total Soil
Sample Location S16, Pentolite Road
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Nitroaromatics										
4-AMINO-2,6-DINITROTOLUENE	1.25E-01	1.44E-06	2.40E-02	2.25E-09	2.52E-07	6.99E-03	8.01E-11	5.12E-11	NA	3.10E-02
1,3-DINITROBENZENE	4.30E+00	4.95E-05	4.95E-01	7.74E-08	8.66E-06	1.08E-01	2.75E-09	1.76E-09	NA	6.03E-01
2,4-DINITROTOLUENE	8.90E+00	1.02E-04	5.12E-02	1.60E-07	1.79E-05	8.96E-03	5.70E-09	3.64E-09	NA	6.02E-02
2,6-DINITROTOLUENE	1.00E+00	1.15E-05	1.15E-02	1.80E-08	2.01E-06	2.01E-03	6.41E-10	4.09E-10	NA	1.35E-02
3,4-DINITROTOLUENE	8.00E-01	9.21E-06	4.60E-03	1.44E-08	1.61E-06	8.05E-04	5.12E-10	3.28E-10	NA	5.41E-03
2,4,6-TRINITROTOLUENE	1.25E-01	1.44E-06	2.88E-03	2.25E-09	2.52E-07	8.39E-04	8.01E-11	5.12E-11	NA	3.72E-03
Total HI			**5.89E-01**			**1.28E-01**			**NA**	**7.17E-01**

HQ = Hazard quotient; HI = Hazard index.
DA = Dose absorbed (per unit body surface area per day).
NA = Not applicable.
mg/kg - Milligrams per kilogram.
mg/kg-day - mg/kg per day.
mg/cm^2-day - Milligrams per square centimeter per day.
mg/m^3 - Milligrams per cubic meter.

Table 5-87

Risk-Based Remedial Criteria for Chemicals of Concern
Groundskeeper Exposure to Surface Soil
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	RBRC (mg/kg) for On-Site Child Resident Target Hazard Index: 1.0	RBRC (mg/kg) for On-Site Child Resident Target Hazard Index: 0.1	Total ILCR All Pathways	RBRC (mg/kg) for On-Site Resident Target Risk Level: 1.00E-06	RBRC (mg/kg) for On-Site Resident Target Risk Level: 1.00E-05
Inorganics							
Chromium	1.87E+01	NA	NA	NA	5.49E-06	3.41E+00	3.41E+01
Semivolatile Organics							
Benzo(a)pyrene	3.90E-01	NA	NA	NA	1.21E-06	3.23E-01	3.23E+00

RBRC = Risk-based remedial criterion.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable.
mg/kg - Milligrams per kilogram.

Table 5-88

Risk-Based Remedial Criteria for Chemicals of Concern
Construction Worker Exposure to Total Soil
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	RBRC (mg/kg) for On-Site Child Resident Target Hazard Index: 1.0	RBRC (mg/kg) for On-Site Child Resident Target Hazard Index: 0.1	Total ILCR All Pathways	RBRC (mg/kg) for On-Site Resident Target Risk Level: 1.00E-06	RBRC (mg/kg) for On-Site Resident Target Risk Level: 1.00E-05
Nitroaromatics							
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	1.94E-01	1.40E+01	1.40E+00	NA	NA	NA
2,4,6-TRINITROTOLUENE	1.20E+04	1.03E+02	1.16E+02	1.16E+01	1.11E-05	1.08E+03	1.08E+04

RBRC = Risk-based remedial criterion.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable.
mg/kg - Milligrams per kilogram.

Table 5-89

Risk-Based Remedial Criteria for Chemicals of Concern
On-Site Resident Exposure to Total Soil
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	RBRC (mg/kg) for On-Site Child Resident Target Hazard Index: 1.0	0.1	Total ILCR All Pathways	RBRC (mg/kg) for On-Site Resident Target Risk Level: 1.00E-06	1.00E-05
Semivolatile Organics							
BENZO(A)PYRENE	3.90E-01	NA	NA	NA	7.18E-06	5.43E-02	5.43E-01
Nitroaromatics							
2-AMINO-4,6-DINITROTOLUENE	5.00E-01	1.24E-01	4.04E+00	4.04E-01	NA	NA	NA
4-AMINO-2,6-DINITROTOLUENE	2.70E+00	6.69E-01	4.04E+00	4.04E-01	NA	NA	NA
1,3-DINITROBENZENE	2.20E+00	3.08E-01	7.13E+00	7.13E-01	NA	NA	NA
2,4-DINITROTOLUENE	5.34E+00	3.61E-02	1.48E+02	1.48E+01	7.14E-06	7.48E-01	7.48E+00
2,6-DINITROTOLUENE	9.51E-01	NA	NA	NA	1.27E-06	7.48E-01	7.48E+00
2,4,6-TRINITROTOLUENE	1.20E+04	3.57E+02	3.36E+01	3.36E+00	8.42E-04	1.43E+01	1.43E+02

RBRC = Risk-based remedial criterion.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable.
mg/kg - Milligrams per kilogram.

Table 6-1

Vegetative Communities
PBOW, Sandusky, Ohio

Community Type	Definition
AGRI	Agricultural areas including crop fields, pastures, and fallow fields
DEV	Developed and disturbed areas including residential, commercial, industrial
OFE	Early old field (herbaceous vegetation only)
OFM	Moderate old filed (some shrubs/saplings)
OFL	Late old field (up to 50 percent shrub/sapling cover)
ESU	Early successional/shrub thicket (mostly shrubs, few saplings)
MSU	Moderate successional/shrub thicket (shrubs and saplings dominant)
LSU	Late successional/shrub thicket (saplings most abundant with some trees)
FRE	Early forest (young trees with early successional species, red maple, ashes, elms, etc., most dominant)
FRM	Moderate forest (larger trees regardless of species or younger trees with late successional species)
FRL	Late forest (mature forest with climax species such as sugar maple, beech, oaks, etc., with established subcanopy and understory)
OW	Open water
PEM	Palustrine, emergent wetlands (marshes and wet meadows)
PSS	Palustrine, scrub/shrub wetlands (wetlands dominated by shrubs and saplings)
PFO	Palustrine, forested wetlands (all wooded wetlands)

Table 6-2

Common and/or Frequent Vascular Plant Species Observed at the Red Water Ponds PBOW, Sandusky, Ohio

(Page 1 of 3)

Plant Species	West Red Water Ponds Area	Pentolite Road Red Water Ponds Area
Red maple	common	common
Yarrow	frequent	frequent
southern agrimony	frequent	frequent
Quack grass		frequent
Garlic mustard	common	frequent
Field garlic	frequent	-
Dogbane		common
Common milkweed	frequent	frequent
Sedge (*Carex lanuginosa*)		frequent
Sedge (*C. rosea*)	frequent	
Sedge (*C. scoparia*)		frequent
Sedge (*C. vulpinoidea*)		common
Ox-eye daisy	frequent	frequent
Southern enchanter's nightshade	frequent	frequent
Canada thistle	common	common
Bull thistle		frequent
Horse balm	common	frequent
Rough-leaved dogwood	frequent	frequent
Wild carrot	frequent	
Common teasel		frequent
Wild rye	frequent	frequent
Horsetail		frequent
Fleabane	frequent	frequent
Grass-leaved goldenrod		common
Tall fescue	frequent	common

Table 6-2

Common and/or Frequent Vascular Plant Species Observed at the Red Water Ponds PBOW, Sandusky, Ohio

(Page 2 of 3)

Plant Species	West Red Water Ponds Area	Pentolite Road Red Water Ponds Area
Fescue		common
Wild strawberry	frequent	frequent
Green ash	common	frequent
Ground ivy	frequent	
Dotted St. John's wort		frequent
Common rush		frequent
White grass	frequent	
Moneywort	frequent	
Sensitive fern		frequent
Sorrel		frequent
Hairy panic-grass		frequent
Tall white beard-tongue	frequent	frequent
Reed canary grass	common	common
Timothy		frequent
Reed grass		frequent
English plantain		frequent
Broad-leaved plantain	frequent	
Virginia knotweed	frequent	frequent
Cottonwood	frequent	frequent
Wild black cherry	frequent	frequent
Narrow-leaved mountain-mint		frequent
Pin oak	common	
Dewberry	frequent	frequent
Black willow		common
Dark green bulrush		frequent

Table 6-2

Common and/or Frequent Vascular Plant Species Observed at the Red Water Ponds PBOW, Sandusky, Ohio

(Page 3 of 3)

Plant Species	West Red Water Ponds Area	Pentolite Road Red Water Ponds Area
Common blue-eyed-grass		frequent
Broad-leaved cattail		frequent
Common mullein		frequent
Wingstem	frequent	
Common blue violet	common	
Riverbank grape		frequent
Total Species Documented (common, frequent, occasional, and/or rare)	72	85
Total Common or Frequent Species Documented	31	46

Table 6-3

Mammals Observed On Site and Likely to be Found in Erie County, Ohio PBOW, Sandusky, Ohio

(Page 1 of 2)

Family Name	Scientific Name	Common Name	Observed On Site [a]
Didelphidae	*Didelphis virginiana*	Virginia opossum	
Talpidae	*Condylura cristata*	star-nosed mole	
	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	
Sciuridae	*Glaucomys volans*	Southern flying squirrel	
	Marmota monax	woodchuck	X
	Sciurus carolinensis	gray squirrel	
	S. niger	fox squirrel	
	Spermophilus tridecemlineatus	thirteen-lined ground squirrel	
	Tamias striatus	Eastern chipmunk	
	Tamiasciurus hudsonicus	red squirrel	
	Blarina brevicauda	short-tailed shrew	X
	Cryptotis parva	least shrew	
	Sorex cinereus	masked shrew	X
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	

Table 6-3

Mammals Observed On Site and Likely to be Found in Erie County, Ohio PBOW, Sandusky, Ohio

(Page 2 of 2)

Family Name	Scientific Name	Common Name	Observed On Site [a]
Mustelidae	*Mephitis mephitis*	striped skunk	
	Mustela frenata	long-tailed weasel	
	M. nivalis	least weasel	
	M. vison	mink	
	Taxidea taxus	badger	
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.

E = Ohio Endangered species.
[a] IT Site Reconnaissance, April 15-16, 1998, including discussions with USACE and field crews

Table 6-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio
PBOW, Sandusky, Ohio

(Page 1 of 5)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Ardeidae	*Ardea herodias*	great blue heron	(1) (2) Regular visitor at ponds, streams, and ditches.
	Bublucus ibis	cattle egret (T)	(1) Rare visitor in short grass areas
	Butorides striatus	green-backed 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) (2) 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 (E)	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	(2) 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.
Charadriidae	*Charadrius vociferus*	killdeer	(2) 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) (2) Confirmed breeder, very common.
	Zenaida macroura	mourning dove	(1) Confirmed breeder, very common.

Table 6-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio
PBOW, Sandusky, Ohio

(Page 2 of 5)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Cuculidae	*Coccyzus americanus*	yellow-billed cuckoo	(1) 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) 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.
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) Confirmed breeder, common in mature woods.
	M. erythrocephalus	red-headed woodpecker	(1) Confirmed breeder, uncommon in mature woods.
	Picoides pubescens	downy woodpecker	(1) Confirmed breeder, common in woodlots.
	P. villosus	hairy woodpecker	(1) Confirmed breeder, uncommon in large woodlots.
Tyrannidae	*Contopus virens*	Eastern wood-pewee	(1) Confirmed breeder, very common in large woodlots.
	Empidonax alnorum	alder flycatcher	(1) Possible breeder, rare in shrubby wet areas.
	E. minimus	least flycatcher	(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) 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	(2) 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.
Corvidae	*Corvus brachyrhynchos*	American crow	(1) Confirmed breeder, very common in woodlots.
	Cyanocitta cristata	blue jay	(1) Confirmed breeder, abundant in woods.

Table 6-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio
PBOW, Sandusky, Ohio

(Page 3 of 5)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Paridae	*Parus atricapillus*	black-capped chickadee	(1) Confirmed breeder, common in woodlots.
	P. bicolor	tufted titmouse	(1) 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 **(E)**	(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) Confirmed breeder, abundant in shrubby areas.
	T. troglodytes	winter wren **(E)**	(1) Rare migrant.
Mimidae	*Dumetella carolinensis*	gray catbird	(1) 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) 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) 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) (2) Confirmed breeder, abundant everywhere.
Vireonidae	*Vireo bellii*	Bell's vireo	Confirmed and/or probable breeder in county.
	V. flavifrons	yellow-throated vireo	(1) 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) 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.

Table 6-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio
PBOW, Sandusky, Ohio

(Page 4 of 5)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Parulidae (continued)	*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.
Icteridae	*Agelaius phoeniceus*	red-winged blackbird	(1) (2) 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) 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	rufous-sided towhee	(1) Confirmed breeder, very common in woodlots, edges.

Table 6-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio
PBOW, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Fringillidae (continued)	*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) (2) 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) IT site reconnaisance, April 15-16, 1998.

Table 6-5

Reptiles Observed On Site and Likely to be Found[a] in Erie County, Ohio PBOW, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On-site
Chelydridae	*Chelydra serpentina*	snapping turtle	(1) (2)
Kinosternidae	*Sternotherus odoratus*	musk turtle	
Emydidae	*Chrysemys picta*	painted turtle	(1) (2)
	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)

[a] Pfingsten, R.A. (*Biological Inventory of Plum Brook Station*, Ohio Department of Natural Resources, 1995).

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America*, Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

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).
(2) IT Site Reconnaissance, April 15-16, 1998.

Table 6-6

Amphibians Observed On Site and Likely to be Found[a] in Erie County, Ohio PBOW, 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) (2)
Hylidae	*Acris gryllus*	cricket frog	
	Hyla versicolor	gray treefrog	(1)
	Pseudacris crucifer	spring peeper	(1) (2)
	P. triseriata	chorus frog	(1)
Ranidae	*Rana catesbeiana*	bullfrog	(1) (2)
	R. clamitans	green frog	(1) (2)
	R. pipiens	Northern leopard frog	(1)

[a]Pfingsten, R.A. (*Biological Inventory of Plum Brook Station*, Ohio Department of Natural Resources, 1995).

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).
(2) IT Site Reconnaissance, April 15-16, 1998.

Table 6-7

Fish Observed On Site at Plum Brook Ordnance Works PBOW, 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, 1995).

Table 6-8

Background Distributions of Metals in Soil[a] (Values in mg/kg)
PBOW, Sandusky, Ohio

Metal	Number of Samples	Percent Nondetect	Distribution Type	Minimum	Maximum	Mean	Standard Deviation	Median	95th Percentile	95% UTL[b]
Aluminum	12	0	Lognormal	3,520	15,500	8,430	3,687	7,990	NA	26,879
Antimony	25	64.0	Nonparametric	<5.4	9.3	4.68	2.10	<7.4	7.88	NA
Arsenic	26	11.5	Lognormal	<1.2	36.5	10.8	8.62	8.55	NA	70.8
Barium	12	25.0	Nonparametric	<23.2	826	116	226	48	431	NA
Beryllium	25	76.0	Nonparametric	<0.57	<1.2	0.56	0.18	<1.1	0.96	NA
Cadmium	25	100	Nonparametric	<0.57	<1.2	0.45	0.13	<1.1	<1.2	NA
Calcium	12	0	Lognormal	735	52,300	11,330	16,999	3,070	218,208	NA
Chromium	26	3.8	Lognormal	4.4	29	13.4	6.33	13	NA	36.0
Cobalt	12	25.0	Nonparametric	<5.8	116	22.6	30.5	17.5	66.1	NA
Copper	26	11.5	Lognormal	<2.2	56.2	17.0	15.0	14.2	NA	147
Iron	12	0	Lognormal	5,880	23,4000	40,124	62,173	28,100	NA	358,040
Lead	26	0	Lognormal	1.9	48.6	12.8	9.7	11	NA	51.2
Manganese	26	0	Lognormal	21	13,300	729	2,571	153	NA	3,494
Magnesium	12	0	Lognormal	629	10,400	3,260	3,195	1,890	NA	30,765
Mercury	26	92.3	Nonparametric	<0.037	<0.3	0.09	0.059	<0.27	0.149	NA
Nickel	25	0	Lognormal	5.4	55.1	23.4	12.8	22.8	NA	78.205
Potassium	12	8.0	Lognormal	<308.5	3,390	1,238	853	1,054	NA	6,078
Selenium	25	80.0	Nonparametric	<0.57	<4.9	1.55	0.90	<4.3	2.39	NA
Silver	26	96.2	Nonparametric	<1.1	11.1	1.00	2.1	<1.2	<1.97	NA
Sodium	12	100	Nonparametric	<283	<331.5	303	12.9	305	319	NA
Thallium	25	96.0	Nonparametric	<1.1	<6.1	1.91	1.1	<5.4	<6.0	NA
Vanadium	12	8.3	Lognormal	9	<61.7	24.8	10.7	23.15	NA	83.1
Zinc	26	0	Lognormal	6.6	655	73.0	124	45.4	NA	321

[a] From *Site Investigation of Acid Areas* (IT, 1998)
[b] UTL - Upper tolerance limit.

Table 6-9

Selection of Constituents of Potential Ecological Concern at West Area - Surface Soil[a]
Red Water Ponds, PBOW, Sandusky, Ohio

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Chemical	Frequency of Detection	Arithmetic Mean, mg/kg	Range of values, mg/kg Detected	Range of values, mg/kg Nondetected	Statistical Distribution [b]	95% UCL mg/kg [c]	Background mg/kg [d]	Exclusion Rationale [e]	COPEC? [f]	Source-Term Concentration, mg/kg [g]
INORGANICS										
ALUMINUM	19/19 (100)	11,194	4,720 - 20,600	NA	N	13,033	26,879	A	N	-
ANTIMONY	2/40 (5.0)	3.4	7.4	5.4 - 8.3	U	< 6.8	7.88	A, B	N	-
ARSENIC	36/40 (90)	5.2	2 - 11.5	3.4 - 3.7	N	5.9	70.80	A	N	-
BARIUM	16/19 (84)	64.5	24.8 - 130	22.4 - 23.2	N	79	431.00	A	N	-
BERYLLIUM	10/40 (25)	0.57	0.59 - 1.2	0.56 - 1.4	U	< 1.2	0.96	-	Y	0.6
CADMIUM	1/40 (2.5)	0.46	0.59	0.56 - 1.4	U	< 1.2	1.2	A, B	N	-
CALCIUM	19/19 (100)	9,642	757 - 58,600	NA	L	20,541	218,208	A	N	-
CHROMIUM	40/40 (100)	16.7	5.4 - 35	NA	L	18.7	36.00	A	N	-
COBALT	13/19 (68)	9.8	8.5 - 17.9	5.6 - 6.9	N	12	66.10	A	N	-
COPPER	36/40 (90)	9.6	2.4 - 30.9	2.3 - 2.5	L	14.4	147.00	A	N	-
IRON	19/19 (100)	19,061	7,190 - 36,000	NA	N	22,187	358,040	A	N	-
LEAD	40/40 (100)	12.0	2.2 -23	NA	N	13.3	51.20	A	N	-
MAGNESIUM	18/19 (95)	3,888	684 - 12,200	579	L	7,419	30,765	A	N	-
MANGANESE	40/40 (100)	469	89.6 - 1,340	NA	L	602	3,494	A	N	-
MERCURY	4/40 (10)	0.092	0.04 - 0.1	0.037 - 0.36	U	< 0.3	0.15	A	N	-
NICKEL	40/40 (100)	21.4	7.1 - 46.9	NA	L	25.1	78.21	A	N	-
POTASSIUM	14/19 (74)	1,431	742 - 2,970	559 - 693	N	1,803	6,078	A	N	-
SELENIUM	1/40 (2.5)	1.4	0.65	0.56 - 5.8	U	< 4.7	2.39	A	N	-
SODIUM	1/19 (5.3)	313	681	559 - 693	U	< 597	319	-	Y	298.5
VANADIUM	19/19 (100)	25.3	10.1 - 40.5	NA	L	29.8	83.10	A	N	-
ZINC	39/40 (98)	58.7	15.9 - 111	2.5	N	65.4	321.00	A	N	-
VOLATILE ORGANIC COMPOUNDS										
ACETONE	1/10 (10)	0.014	0.035	0.022 - 0.024	U	< 0.024	NA	-	Y	0.012
METHYLENE CHLORIDE	10/10 (100)	0.0015	0.0009 - 0.0023	NA	L	0.0019	NA	-	Y	0.0019
TOLUENE	3/10 (30)	0.0028	0.0018 - 0.0032	0.0056 - 0.006	U	0.0023	NA	-	Y	0.0023
SEMIVOLATILE ORGANIC COMPOUNDS AND NITROAROMATICS										
1,3-DINITROBENZENE	1/40 (2.5)	0.13	0.3	0.25	U	< 0.25	NA	-	Y	0.125
1,3,5-TRINITROBENZENE	3/40 (7.5)	0.16	0.3 - 0.7	0.25	U	< 0.25	NA	-	Y	0.125
2,4-DINITROTOLUENE	4/50 (8.0)	0.15	0.043 - 0.4	0.25 - 0.4	U	< 0.25	NA	-	Y	0.125
2,4,6-TRINITROTOLUENE	1/42 (2.4)	0.13	0.3	0.25	U	< 0.25	NA	-	Y	0.125
4-AMINO-2,6-DITROTOLUENE	1/40 (2.5)	0.13	0.3	0.25	U	< 0.25	NA	-	Y	0.125
ACENAPHTHYLENE	1/10 (10)	0.18	0.041	0.37 - 0.4	U	< 0.4	0.005	-	Y	0.041
ANTHRACENE	1/10 (10)	0.20	0.23	0.37 - 0.4	U	< 0.4	0.011 - 0.013	-	Y	0.2

Table 6-9

Selection of Constituents of Potential Ecological Concern At West Area - Surface Soil[a]
Red Water Ponds, PBOW, Sandusky Ohio

(Page 2 of 2)

Chemical	Frequency of Detection	Arithmetic Mean, mg/kg	Range of values, mg/kg Detected	Range of values, mg/kg Nondetected	Statistical Distribution [b]	95% UCL mg/kg [c]	Background mg/kg [d]	Exclusion Rationale [e]	COPEC? [f]	Source-Term Concentration, mg/kg [g]
SEMIVOLATILE ORGANIC COMPOUNDS AND NITROAROMATICS (Continued)										
BENZO(A)ANTHRACENE	1/10 (10)	0.21	0.40	0.37 - 0.4	U	< 0.4	0.056 - 0.11	-	Y	0.2
BENZO(A)PYRENE	1/10 (10)	0.21	0.39	0.37 - 0.4	U	< 0.4	0.0046 - 0.9	-	N	-
BENZO(B)FLUORANTHENE	1/10 (10)	0.20	0.3	0.37 - 0.4	U	< 0.4	0.058 - 0.22	-	Y	0.2
BENZO(GHI)PERYLENE	1/10 (10)	0.19	0.22	0.37 - 0.4	U	< 0.4	0.066	-	Y	0.2
BENZO(K)FLUORANTHENE	1/10 (10)	0.21	0.35	0.37 - 0.4	U	< 0.4	0.058 - 0.25	-	Y	0.2
CHRYSENE	1/10 (10)	0.21	0.42	0.37 - 0.4	U	< 0.4	0.078 - 0.12	-	Y	0.2
FLUORANTHENE	1/10 (10)	0.25	0.76	0.37 - 0.4	U	< 0.4	0.12 - 0.21	-	Y	0.2
INDENO(1,2,3-CD)PYRENE	1/10 (10)	0.20	0.23	0.37 - 0.4	U	< 0.4	0.063 - 0.1	-	Y	0.2
PHENANTHRENE	1/10 (10)	0.21	0.36	0.37 - 0.4	U	< 0.4	0.048 - 0.14	-	Y	0.2
PYRENE	1/10 (10)	0.23	0.55	0.37 - 0.4	U	< 0.4	0.099 - 0.15	-	Y	0.2

[a] Surface soil is defined as the interval from 0 to 3 feet below the ground surface. Soil samples were classified on the basis of the end depth of the sample.
[b] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution.
NA = Distribution not determined if sample size is less than 5.
[c] 95% Upper confidence limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.
[d] Background UTL concentration for inorganic constituents are based on site data. PAHs from ATSDR (agricultural soil).
[e] Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):
A = within background concentration.
B = detection frequency less than 5%.
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-10

Selection of Constituents of Potential Ecological Concern at Pentolite Road Area - Surface Soil[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Frequency of Detection	Arithmetic Mean (mg/kg)	Range of values, mg/kg Detected	Range of values, mg/kg Nondetected	Statistical Distribution[b]	95% UCL mg/kg[c]	Background mg/kg[d]	Exclusion Rationale[e]	COPEC?[f]	Source-Term Concentration mg/kg[g]
INORGANICS										
ALUMINUM	20/20 (100)	7,053	2,370 - 12,700	NA	N	7,985	26,879	A	N	-
ARSENIC	36/50 (72)	4.6	2.3 - 22	3.1 - 3.6	L	5.4	71	A	N	-
BARIUM	13/20 (65)	33	24.3 - 84.3	21.3 - 23.8	L	48	431	A	N	-
BERYLLIUM	3/50 (6.0)	0.48	0.68 - 0.69	0.53 - 1.3	U	< 1.1	0.96	A	N	-
CALCIUM	19/20 (95)	6,246	817 - 54,000	556	L	11,864	218,208	A	N	-
CHROMIUM	50/50 (100)	11	4.2 - 21	NA	L	11.5	36	A	N	-
COBALT	9/20 (45)	4.7	5.8 - 11.1	5.3 - 6.2	U	6.2	66.1	A	N	-
COPPER	29/50 (58)	4.8	2.5 - 22.6	2.1 - 2.5	U	4.9	147	A	N	-
IRON	20/20 (100)	14,272	8,330 - 22,900	NA	N	15,600	358,040	A	N	-
LEAD	50/50 (100)	7.7	3.1 - 19	NA	L	8.7	51.2	A	N	-
MAGNESIUM	20/20 (100)	2,322	791 - 11,500	NA	U	2,310	30,765	A	N	-
MANGANESE	50/50 (100)	238	74.5 - 820	NA	L	274	3,494	A	N	-
MERCURY	2/50 (4.0)	0.093	0.04 - 0.043	0.035 - 0.31	U	< 0.28	0.149	A, B	N	-
NICKEL	50/50 (100)	9.6	4.7 - 27.2	NA	L	10.5	78	A	N	-
POTASSIUM	5/20 (25)	441	684 - 1,460	532 - 616	U	< 616	6,078	A	N	-
SELENIUM	2/50 (4.0)	1.5	0.59 - 0.84	0.53 - 5.0	U	< 4.4	2.39	A, B	N	-
SODIUM	2/20 (10)	357	741 - 1,240	532 - 620	U	< 594	319	-	Y	297
VANADIUM	20/20 (100)	22	12.9 - 35.2	NA	L	23.7	83	A	N	-
ZINC	50/50 (100)	30	17 - 78.5	NA	L	32	321	A	N	-
VOLATILE ORGANIC COMPOUNDS										
METHYLENE CHLORIDE	1/10 (10)	0.0028	0.0018	0.0055 - 0.0062	U	< 0.0062	NA	-	Y	0.0018
SEMIVOLATILE ORGANIC COMPOUNDS										
1,3-DINITROBENZENE	6/50 (12)	0.20	0.3 - 1.6	0.25	U	< 0.25	NA	-	Y	0.125
1,3,5-TRINITROBENZENE	5/50 (10)	0.20	0.4 - 1.7	0.25	U	< 0.25	NA	-	Y	0.125
2,4-DINITROTOLUENE	13/60 (22)	0.34	0.16 - 2.4	0.25 - 4.1	U	< 0.25	NA	-	Y	0.125
2,6-DINITROTOLUENE	3/60 (5.0)	0.18	0.05 - 0.8	0.25 - 4.1	U	< 0.26	NA	-	Y	0.13
2,4,6-TRINITROTOLUENE	1/50 (2.0)	0.13	0.27	0.25	U	< 0.25	NA	-	Y	0.125
3,4-DINITROTOLUENE	1/30 (3.3)	0.13	0.3	0.25	U	< 0.25	NA	-	Y	0.125
4-AMINO-2,6-DINITROTOLUENE	1/50 (2.0)	0.18	2.7	0.25	U	< 0.25	NA	-	Y	0.125

[a] Surface soil is defined as the interval from 0 to 3 feet below the ground surface. Soil samples were classified on the basis of the end depth of the sample.
[b] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution. NA = distribution not determined if sample size is less than 5.
[c] 95% Upper confidence limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.
[d] Background UTL concentrations for inorganic constituents are based on site data.
[e] Rationale for exclusion of chemical as a constituent of potential ecological concern (COPEC):
A = within background concentration.
B = detection frequency less than 5%.
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-11

Selection of Constituents of Potential Ecological Concern at West Area - Total Soil[a]
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical	Frequency of Detection	Arithmetic Mean, mg/kg	Range of values, mg/kg Detected	Range of values, mg/kg Nondetected	Statistical Distribution [b]	95% UCL mg/kg [c]	Background mg/kg [d]	Exclusion Rationale [e]	COPEC? [f]	Source-Term Concentration, mg/kg [g]
INORGANICS										
ALUMINUM	38/38 (100)	10,168	4,720 - 20,600	NA	L	11,423	26,879	A	N	-
ANTIMONY	2/74 (2.7)	3.4	7.4 - 7.4	5.3 - 8.3	U	< 6.9	7.88	A,B	N	-
ARSENIC	68/74 (92)	5.7	2.0 - 23.6	3.4 - 3.7	L	6.4	70.8	A	N	-
BARIUM	35/38 (92)	59.4	24.8 - 130	22.4 - 23.2	N	67.7	431	A	N	-
BERYLLIUM	12/74 (16)	0.52	0.59 - 1.2	0.56 - 1.4	U	< 1.2	0.96	-	Y	0.6
CADMIUM	2/74 (2.7)	0.46	0.59 - 1.4	0.56 - 1.4	U	< 1.1	1.2	-	Y	0.55
CALCIUM	38/38 (100)	10,080	757 - 58,600	NA	U	3,760	218,208	A	N	-
CHROMIUM	74/74 (100)	16	5.4 - 35.0	NA	L	17.2	36.0	A	N	-
COBALT	30/38 (79)	9.6	6.0 - 21.0	5.6 - 6.9	N	11.0	66.1	A	N	-
COPPER	68/74 (92)	10.4	2.4 - 30.9	2.3 - 2.9	L	13.7	147	A	N	-
IRON	38/38 (100)	18,917	7,190 - 36,000	NA	N	20,859	358,040	A	N	-
LEAD	74/74 (100)	10.9	2.2 - 23.0	NA	N	11.8	51.2	A	N	-
MAGNESIUM	37/38 (97)	4,470	684 - 23,400	579	L	6,171	30,765	A	N	-
MANGANESE	74/74 (100)	425	83.4 - 1,340	NA	L	498	3,494	A	N	-
MERCURY	4/74 (5.4)	0.084	0.04 - 0.1	0.037 - 0.36	U	< 0.29	0.15	A	N	-
NICKEL	74/74 (100)	21.4	7.1 - 46.9	NA	L	23.7	78.21	A	N	-
POTASSIUM	31/38 (82)	1,326	643 - 2,970	559 - 693	N	1,536	6,078	A	N	-
SELENIUM	1/74 (1.4)	1.3	0.65	0.56 - 5.8	U	< 4.5	2.39	A,B	N	-
SODIUM	3/38 (7.9)	345	681 - 1,270	559 - 693	U	< 598	319	-	Y	299
VANADIUM	38/38 (100)	24.2	10.1 - 40.5	NA	L	26.6	83.1	A	N	-
ZINC	73/74 (99)	56.1	15.9 - 111	2.5	N	60.2	321	A	N	-
VOLATILE ORGANIC COMPOUNDS										
ACETONE	1/18 (5.6)	0.013	0.035	0.022 - 0.025	U	< 0.024	NA	-	Y	0.012
METHYLENE CHLORIDE	11/18 (61)	0.0021	0.0009 - 0.0023	0.0057 - 0.0063	N	0.0024	NA	-	Y	0.0024
TOLUENE	7/18 (39)	0.0026	0.0015 - 0.0032	0.0056 - 0.0062	U	0.0018	NA	-	Y	0.0018

Table 6-11

Selection of Constituents of Potential Ecological Concern At West Area -Total Soil[a]
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

Chemical	Frequency of Detection	Arithmetic Mean, mg/kg	Range of values, mg/kg Detected	Range of values, mg/kg Nondetected	Statistical Distribution [b]	95% UCL mg/kg [c]	Background mg/kg [d]	Exclusion Rationale [e]	COPEC? [f]	Source-Term Concentration, mg/kg [g]
SEMIVOLATILE ORGANIC COMPOUNDS AND NITROAROMATICS										
1,3-DINITROBENZENE	5/74 (6.8)	0.20	0.3 - 2.4	0.25	U	< 0.25	NA	-	Y	0.125
1,3,5-TRINITROBENZENE	13/74 (18)	0.42	0.3 - 5.5	0.25	U	< 0.25	NA	-	Y	0.125
2,4-DINITROTOLUENE	11/92 (12)	0.27	0.043 - 5.1	0.25 - 0.41	U	< 0.25	NA	-	Y	0.125
2,6-DINITROTOLUENE	2/92 (2.2)	0.16	0.3 - 1.5	0.25 - 0.41	U	< 0.26	NA	-	Y	0.13
2,4,6-TRINITROTOLUENE	5/74 (6.8)	0.14	0.3 - 0.4	0.25	U	< 0.25	NA	-	Y	0.125
3,4-DINITROTOLUENE	1/36 (2.8)	0.14	0.5	0.25	U	< 0.25	NA	-	Y	0.125
4-AMINO-2,6-DITROTOLUENE	6/74 (8.1)	0.15	0.3 - 0.7	0.25	U	< 0.25	NA	-	Y	0.125
ACENAPHTHYLENE	2/18 (11)	0.18	0.04 - 0.041	0.37 - 0.41	U	< 0.4	0.005	-	Y	0.2
ANTHRACENE	2/18 (11)	0.19	0.12 - 0.23	0.37 - 0.41	U	< 0.4	0.011 - 0.013	-	Y	0.2
BENZO(A)ANTHRACENE	2/18 (11)	0.21	0.17 - 0.4	0.37 - 0.41	U	< 0.4	0.056 - 0.11	-	Y	0.2
BENZO(A)PYRENE	2/18 (11)	0.20	0.14 - 0.39	0.37 - 0.41	U	< 0.4	0.0046 - 0.9	A	N	-
BENZO(B)FLUORANTHENE	2/18 (11)	0.20	0.14 - 0.3	0.37 - 0.41	U	< 0.4	0.058 - 0.22	-	Y	0.2
BENZO(GHI)PERYLENE	2/18 (11)	0.19	0.076 - 0.22	0.37 - 0.41	U	< 0.4	0.066	-	Y	0.2
BENZO(K)FLUORANTHENE	2/18 (11)	0.20	0.11 - 0.35	0.37 - 0.41	U	< 0.4	0.058 - 0.25	-	Y	0.2
CHRYSENE	2/18 (11)	0.21	0.17 - 0.42	0.37 - 0.41	U	< 0.4	0.078 - 0.12	-	Y	0.2
FLUORANTHENE	3/18 (17)	0.23	0.058 - 0.76	0.37 - 0.41	U	< 0.4	0.12 - 0.21	-	Y	0.2
INDENO(1,2,3-CD)PYRENE	2/18 (11)	0.19	0.076 - 0.23	0.37 - 0.41	U	< 0.4	0.063 - 0.1	-	Y	0.2
PHENANTHRENE	2/18 (11)	0.21	0.25 - 0.36	0.37 - 0.41	U	< 0.4	0.048 - 0.14	-	Y	0.2
PYRENE	3/18 (17)	0.21	0.043 - 0.55	0.37 - 0.41	U	< 0.4	0.099 - 0.15	-	Y	0.2

[a] Total soil is defined as the interval from 0 to 6 feet below the ground surface. Soil samples were classified on the basis of the end depth of the sample.
[b] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution.
NA = Distribution not determined if sample size is less than 5.
[c] 95% Upper confidence limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.
[d] Background UTL concentration for inorganic constituents are based on site data. Background PAHs from ATSDR (agricultural soil).
[e] Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):
A = within background concentration.
B = detection frequency less than 5%.
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-12

Selection of Constituents of Potential Ecological Concern At Pentolite Road Area - Total Soil[a]
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical	Frequency of Detection	Arithmetic Mean (mg/kg)	Range of values, mg/kg Detected	Range of values, mg/kg Nondetected	Statistical Distribution[b]	95% UCL mg/kg[c]	Background mg/kg[d]	Exclusion Rationale[e]	COPEC?[f]	Source-Term Concentration mg/kg[g]
INORGANICS										
ALUMINUM	40/40 (100)	7,869	2,370 - 12,700	NA	N	8,494	26,879	A	N	-
ANTIMONY	11/90 (12)	3.5	3.6 - 9.3	5.2 - 7.7	U	< 6.8	7.8	-	Y	3.4
ARSENIC	74/90 (82)	6.9	2.3 - 42.8	3.1 - 3.6	L	8.0	71	A	N	-
BARIUM	31/40 (78)	54.4	24.3 - 239	21.3 - 24.9	L	73.5	431	A	N	-
BERYLLIUM	9/90 (10)	0.49	0.55 - 0.83	0.53 - 1.3	U	< 1.1	0.96	A	N	-
CALCIUM	39/40 (98)	18,927	817 - 63,200	566	U	10,300	218,208	A	N	-
CHROMIUM	90/90 (100)	12.3	4.2 - 21	NA	N	12.9	36	A	N	-
COBALT	26/40 (65)	8.1	5.8 - 30.3	5.3 - 6.4	L	10.1	66.1	A	N	-
COPPER	64/90 (71)	8.3	2.5 - 34.5	2.1 - 2.5	U	7.5	147	A	N	-
IRON	40/40 (100)	17,923	8,330 - 43,700	NA	L	19,837	358,040	A	N	-
LEAD	90/90 (100)	8.6	2.9 - 19	NA	N	9.2	51.2	A	N	-
MAGNESIUM	40/40 (100)	6,722	791 - 24,600	NA	U	5,150	30,765	A	N	-
MANGANESE	90/90 (100)	374	74.5 - 2,270	NA	L	414	3,494	A	N	-
MERCURY	3/90 (3.3)	0.089	0.04 - 0.045	0.035 - 0.31	U	< 0.28	0.149	A,B	N	-
NICKEL	90/90 (100)	14.9	4.7 - 57.2	NA	L	16.5	78	A	N	-
POTASSIUM	22/40 (55)	856	684 - 2,430	532 - 644	U	968	6,078	A	N	-
SELENIUM	5/90 (5.6)	1.4	0.59 - 0.84	0.53 - 5	U	< 4.5	2.39	A	N	-
SILVER	4/90 (4.4)	0.58	0.6 - 0.65	1.0 - 1.3	U	< 1.2	1.97	A	N	-
SODIUM	7/40 (18)	577	741 - 4,130	532 - 639	U	< 620	319	-	Y	310
THALLIUM	4/90 (4.4)	1.9	0.6 - 1.25	1.1 - 6.3	U	< 5.6	6.0	A	N	-
VANADIUM	40/40 (100)	23.9	12.9 - 38.4	NA	N	25.4	83	A	N	-
ZINC	90/90 (100)	39.2	17.0 - 104	NA	L	42.2	321	A	N	-
VOLATILE ORGANIC COMPOUNDS										
1,1,2,2-TETRACHLOROETHANE	1/14 (7.1)	0.0030	0.0031	0.0055 - 0.0063	U	< 0.0062	NA	-	Y	0.0031
ACETONE	1/10 (10)	0.011	0.0082	0.022 - 0.025	U	< 0.025	NA	-	Y	0.0125
METHYLENE CHLORIDE	1/14 (7.1)	0.0029	0.0018	0.0055 - 0.0063	U	< 0.0062	NA	-	Y	0.0031
TOLUENE	1/14 (7.1)	0.0029	0.0017	0.0055 - 0.0063	U	< 0.0062	NA	-	Y	0.0031
SEMIVOLATILE ORGANIC COMPOUNDS AND NITROAROMATICS										
1,3-DINITROBENZENE	15/90 (17)	0.48	0.3 - 9.3	0.25	U	< 0.25	NA	-	Y	0.125
1,3,5-TRINITROBENZENE	17/90 (19)	1.8	0.4 - 58	0.25	U	< 0.25	NA	-	Y	0.125
2,4-DINITROTOLUENE	27/104 (26)	0.85	0.056 - 25	0.25 - 4.1	U	< 0.25	NA	-	Y	0.125
2,6-DINITROTOLUENE	10/104 (9.6)	0.23	0.05 - 3.6	0.25 - 4.1	U	< 0.26	NA	-	Y	0.13
2,4,6-TRINITROTOLUENE	3/90 (3.3)	133	0.27 - 12,000	0.25 - 2.5	U	< 0.25	NA	-	Y	0.125
3,4-DINITROTOLUENE	2/50 (4.0)	0.22	0.3 - 4.5	0.25	U	< 0.25	NA	-	Y	0.125
4-AMINO-2,6-DINITROTOLUENE	4/90 (4.4)	0.28	0.3 - 9.5	0.25 - 2.5	U	< 0.25	NA	-	Y	0.125
NITROBENZENE	1/104 (0.96)	0.20	1.1	0.25 - 4.2	U	< 0.26	NA	-	Y	0.13
MISCELLANEOUS										
TOTAL ORGANIC CARBON							NA			

Table 6-12

Selection of Constituents of Potential Ecological Concern At Pentolite Road Area - Total Soil[a]
Red Water Ponds, PBOW, Sandusky, Ohio

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[a] Total soil is defined as the interval from 0 to 6 feet below the ground surface. Soil samples were classified on the basis of the end depth of the sample.
[b] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution.
NA = distribution not determined if sample size is less than 5.
[c] 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.
[d] Background UTL concentrations for inorganic constituents are based on site-specific data. Background PAH values from ATSDR (Agricultural).
[e] Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):
A = within background concentration.
B = detection frequency less than 5%.
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-13

Selection of Constituents of Potential Ecological Concern at West Area - Surface Water[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Frequency of Detection	Arithmetic Mean, mg/L	Range of values, mg/L Detected	Range of values, mg/L Nondetected	Statistical Distribution[b]	95% UCL mg/L[c]	Background mg/L[d]	Exclusion Rationale[e]	COPEC?[f]	Source-Term Concentration mg/L[g]
INORGANICS										
ALUMINUM	3/4 (75)	6.6	0.3 - 13.8	0.20	L	1.4E+12	<0.20 - 0.631	-	Y	13.8
ARSENIC	2/9 (22)	0.014	0.0202 - 0.0218	0.010 - 0.030	N	0.0177	<0.010	-	Y	0.0177
CALCIUM	4/4 (100)	89	31.1 - 115	NA	N	135	106 - 107	A	N	-
CHROMIUM	3/9 (33)	0.009	0.010 - 0.0233	0.01	U	0.0233	<0.010	-	Y	0.0233
IRON	4/4 (100)	10.4	0.646 - 21.1	NA	N	23.6	0.126 - 1.3	-	Y	21.1
LEAD	3/9 (33)	0.021	0.025 - 0.077	0.003 - 0.025	L	0.168	<0.003	-	Y	0.077
MAGNESIUM	4/4 (100)	37	25.8 - 50.7	NA	N	52.8	26 - 26.5	-	Y	50.7
MANGANESE	9/9 (100)	0.63	0.126 - 1.60	NA	L	1.95	0.0306 - 0.89	-	Y	1.6
NICKEL	1/9 (11)	0.016	0.02	0.020 - 0.040	U	0.02	<0.040	A	N	-
POTASSIUM	4/4 (100)	7.6	5.18 - 9.91	NA	L	14.1	9.4 - 9.73	A	N	-
SODIUM	4/4 (100)	72	38.3 - 107	NA	N	117.5	38.2 - 39.3	-	Y	107
VANADIUM	1/4 (25)	0.032	0.0522	0.05	U	0.0522	<0.050	-	Y	0.0522
ZINC	5/9 (56)	0.042	0.043 - 0.0925	0.02	N	0.0629	<0.020 - 0.027	-	Y	0.0629
VOLATILE ORGANIC COMPOUNDS										
BROMOMETHANE	4/4 (100)	0.00018	0.00016 - 0.00021	NA	L	0.00023	NA	-	Y	0.00021
SEMIVOLATILE ORGANIC COMPOUNDS AND NITROAROMATICS										
1,3-DINITROBENZENE	1/9 (11)	0.00011	0.0003	0.00015 - 0.0002	U	0.0003	NA	-	Y	0.0003
2,4-DINITROTOLUENE	1/9 (11)	0.00012	0.0005	0.0001 - 0.0002	U	0.0005	NA	-	Y	0.0005
2,6-DINITROTOLUENE	1/9 (11)	0.00016	0.0008	0.0001 - 0.0002	U	0.0008	NA	-	Y	0.0008
3,4-DINITROTOLUENE	4/5 (80)	0.00048	0.0005 - 0.0006	0.00021	U	0.0006	NA	-	Y	0.0006
3-NITROTOLUENE	4/9 (44)	0.0069	0.0023 - 0.054	0.0002 - 0.0014	L	1.007	NA	-	Y	0.054
4-AMINO-2-NITROTOLUENE	1/5 (20)	0.00034	0.0006	0.00055	U	0.0006	NA	-	Y	0.0006
DI-n-OCTYLPHTHALATE	1/4 (25)	0.0057	0.0078	0.01	U	0.0078	NA	-	Y	0.0078
MISCELLANEOUS										
HARDNESS	4/4 (100)	446	372 - 592	NA	NA	NA	360 - 408	--	--	--

[a] Surface water results from totals. Only detected constituents presented.
[b] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects.
[c] 95% Upper confidence limit calculated for the indicated distribution.
[d] Background concentrations for inorganic constituents are based on site data.
[e] Rationale for exclusion of chemical as a constituent of potential ecological concern (COPEC):
A = within background concentration.
B = detection frequency less than 5%.
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-14

Selection of Constituents of Potential Ecological Concern at Pentolite Road Area - Surface Water[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Frequency of Detection	Arithmetic Mean, mg/L	Range of values, mg/L Detected	Range of values, mg/L Nondetected	Statistical Distribution [b]	95% UCL mg/L [c]	Background mg/L [d]	Exclusion Rationale [e]	COPEC? [f]	Source-Term Concentration mg/L [g]
INORGANICS										
ALUMINUM	2/2 (100)	1.8	0.53 - 3.04	NA	NA	NA	<0.20 - 0.778	-	Y	3.04
CALCIUM	2/2 (100)	95	71.7 - 118	NA	NA	NA	74.2 - 98.1	A	N	-
IRON	2/2 (100)	3.4	0.972 - 5.79	NA	NA	NA	0.948 - 1.42	-	Y	5.79
LEAD	1/2 (50)	0.0051	0.0087	0.003	NA	NA	<0.003	-	Y	0.0087
MAGNESIUM	2/2 (100)	27	15.8 - 37.3	NA	NA	NA	16.0 - 36.9	A	N	-
MANGANESE	2/2 (100)	0.33	0.261 - 0.404	NA	NA	NA	0.0671 - 0.245	-	Y	0.404
SODIUM	2/2 (100)	19	13.7 - 24.7	NA	NA	NA	14.8 - 25.7	A	N	-
ZINC	1/2 (50)	0.034	0.058	0.02	NA	NA	<0.020 - 0.0202	-	Y	0.058
VOLATILE ORGANIC COMPOUNDS										
BROMOMETHANE	1/2 (50)	0.00056	0.00011	0.002	NA	NA	NA	-	Y	0.00011
MISCELLANEOUS										
HARDNESS	2/2 (100)	386	284 - 488	NA	NA	NA	328 - 432	--	--	--

[a] Surface water results from totals. Only detected constituents presented.
[b] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NA = Not applicable.
[c] 95% Upper confidence limit calculated for the indicated distribution.
[d] Background concentrations for inorganic constituents are based on site data.
[e] Rationale for exclusion of chemical as a constituent of potential ecological concern (COPEC):
A = within background concentration.
B = detection frequency less than 5%.
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-15

Selection of Constituents of Potential Ecological Concern at West Area - Sediment[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Frequency of Detection	Arithmetic Mean, mg/kg	Range of values, mg/kg Detected	Range of values, mg/kg Nondetected	Statistical Distribution [b]	95% UCL mg/kg [c]	Background mg/kg [d]	Exclusion Rationale [e]	COPEC? [f]	Source-Term Concentration mg/kg [g]
INORGANICS										
ALUMINUM	4/4 (100)	5,993	3,230 - 9,600	NA	L	16,929	2,450 - 3,170	-	Y	9,600
ARSENIC	9/17 (53)	4.6	4.0 - 11.3	3.8 - 4.8	L	6.5	3.5 - 5.4	-	Y	6.5
BARIUM	3/4 (75)	46	34.8 - 65	98.5	L	74.6	<24.1 -26.6	-	Y	65
CALCIUM	4/4 (100)	27,428	6,710 - 74,700	NA	L	1,716,875	10,800 - 13,900	-	Y	74,700
CHROMIUM	17/17 (100)	15	7.4 - 28.7	NA	L	18.1	5.3 - 6.7	-	Y	18.1
COBALT	2/4 (50)	10	10.6 - 10.8	13.3 - 24.6	N	12.9	6.4 - 10.9	A	N	-
COPPER	7/17 (41)	5.2	3.2 - 24.5	2.4 - 3.2	U	24.5	8.8 - 13.7	-	Y	24.5
IRON	4/4 (100)	18,700	16,000 - 24,300	NA	L	24,565	9,900 - 14,900	-	Y	24,300
LEAD	17/17 (100)	16	8.1 - 32.1	NA	L	18.8	6.5 - 9.7	-	Y	18.8
MAGNESIUM	4/4 (100)	3,843	2,520 - 6,770	NA	L	9,227	2,110 - 2,720	-	Y	6,770
MANGANESE	17/17 (100)	249	149 - 726	NA	L	299	231 - 305	-	Y	299
NICKEL	17/17 (100)	18	8.8 - 24.5	NA	N	19.8	13.7 - 23	A	N	-
POTASSIUM	2/5 (40)	904	821 - 1,500	606 - 2,460	N	1,353	<603 - <623	-	Y	1,353
VANADIUM	1/4 (25)	9.5	25	6.1 - 13.3	L	372	<6.0 - <6.2	-	Y	25
ZINC	17/17 (100)	61	36 - 94	NA	L	68	35.1 - 48	-	Y	68
VOLATILE ORGANIC COMPOUNDS										
ACETONE	2/4 (50)	0.052	0.071 - 0.11	0.024 - 0.028	N	0.11	NA	-	Y	0.11
2-BUTANONE	2/4 (50)	0.028	0.021 - 0.029	0.024 - 0.099	L	0.12	NA	-	Y	0.029
METHYLENE CHLORIDE	1/4 (25)	0.0083	0.02	0.0061 - 0.013	L	0.16	NA	-	Y	0.02
SEMIVOLATILE ORGANIC COMPOUNDS AND NITROARMOMATICS										
1,3-DINITROBENZENE	4/17 (24)	0.24	0.3 - 0.7	0.25	U	0.7	NA	-	Y	0.7
1,3,5-TRINITROBENZENE	3/17 (18)	0.22	0.6 - 0.8	0.25	U	0.8	NA	-	Y	0.8
2-AMINO-4,6-DINITROTOLUENE	1/13 (8)	0.14	0.3	0.25	U	0.3	NA	-	Y	0.3
2,4-DINITROTOLUENE	6/17 (35)	0.26	0.3 - 0.7	0.25	U	0.7	NA	-	Y	0.7
2,6-DINITROTOLUENE	1/17 (6)	0.14	0.4	0.25 - 0.26	U	0.4	NA	-	Y	0.4
FLUORANTHENE	1/4 (25)	0.40	0.047	0.46 - 1.6	N	0.76	NA	-	Y	0.047
MISCELLANEOUS										
TOTAL ORGANIC CARBON (pond)	2/2 (100)	66,800	40,200 - 93,400	NA	NA	NA	3,960 - 5430	-	-	-
PHOSPHORUS	1/1 (100)	3.1	3.1	NA	NA	NA	NA	-	Y	3.1

[a] Only detected constituents presented.
[b] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NA = Not applicable.
[c] 95% Upper confidence limit calculated for the indicated distribution.
[d] Background concentrations for inorganic constituents are based on site data.
[e] Rationale for exclusion of chemical as a constituent of potential ecological concern (COPEC):
A = within background concentration.
B = detection frequency less than 5%.
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-16

Selection of Constituents of Potential Ecological Concern at Pentolite Road Area - Sediment[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Frequency of Detection	Arithmetic Mean, mg/kg	Range of values, mg/kg Detected	Range of values, mg/kg Nondetected	Statistical Distribution[b]	95% UCL mg/kg[c]	Background mg/kg[d]	Exclusion Rationale[e]	COPEC?[f]	Source-Term Concentration mg/kg[g]
INORGANICS										
ALUMINUM	2/2 (100)	3,980	2,830 - 5,130	NA	NA	NA	3,400 - 6,020	A	N	-
ARSENIC	2/2 (100)	4.7	4.3 - 5.1	NA	NA	NA	4.4 - 4.6	A	N	-
BARIUM	1/2 (50)	30.4	48.1	25.3	NA	NA	28.5 - 53.4	A	N	-
CALCIUM	2/2 (100)	54,150	46,300 - 62,000	NA	NA	NA	8,110 - 96,000	A	N	-
CHROMIUM	2/2 (100)	8.4	6.3 - 10.4	NA	NA	NA	6.8 - 11.5	A	N	-
COPPER	2/2 (100)	11.1	7.6 - 14.5	NA	NA	NA	7.4 - 17.9	A	N	-
IRON	2/2 (100)	11,660	9,620 - 13,700	NA	NA	NA	9,330 - 16,200	A	N	-
LEAD	2/2 (100)	6.3	4.8 - 7.8	NA	NA	NA	5.6 - 12.8	A	N	-
MAGNESIUM	2/2 (100)	16,400	13,500 - 19,300	NA	NA	NA	2,710 - 10,700	-	Y	19,300
MANGANESE	2/2 (100)	413	404 - 421	NA	NA	NA	104 - 865	A	N	-
NICKEL	2/2 (100)	13.7	9.5 - 17.9	NA	NA	NA	10.4 - 18.6	A	N	-
POTASSIUM	1/2 (50)	678	1,040	631	NA	NA	<663 - <1,310	-	Y	1,040
VANADIUM	2/2 (100)	13.6	12.9 - 14.2	NA	NA	NA	7.9 - 17.4	A	N	-
ZINC	2/2 (100)	40.8	23.2 - 58.4	NA	NA	NA	36.1 - 73.3	A	N	-
VOLATILE ORGANIC COMPOUNDS										
ACETONE	1/2 (50)	0.041	0.069	0.025	NA	NA	NA	-	Y	0.069
2-BUTANONE	1/2 (50)	0.014	0.015	0.025	NA	NA	NA	-	Y	0.015
SEMIVOLATILE ORGANIC COMPOUNDS AND NITROAROMATICS										
ACENAPHTHENE	1/2 (50)	0.20	0.11	0.57	NA	NA	NA	-	Y	0.11
ANTHRACENE	1/2 (50)	0.18	0.077	0.57	NA	NA	NA	-	Y	0.077
CARBAZOLE	1/2 (50)	0.23	0.18	0.57	NA	NA	NA	-	Y	0.18
DIBENZOFURAN	1/2 (50)	0.17	0.06	0.57	NA	NA	NA	-	Y	0.06
FLUORANTHENE	1/2 (50)	0.21	0.14	0.57	NA	NA	NA	-	Y	0.14
FLUORENE	1/2 (50)	0.20	0.11	0.57	NA	NA	NA	-	Y	0.11
PHENANTHRENE	1/2 (50)	0.30	0.32	0.57	NA	NA	NA	-	Y	0.32
PYRENE	1/2 (50)	0.20	0.11	0.57	NA	NA	NA	-	Y	0.11
MISCELLANEOUS										
TOTAL ORGANIC CARBON	2/2 (100)	11,225	5,450 - 17,000	NA	NA	NA	12,000 - 33,000	--	--	--

[a] Only detected constituents presented.
[b] Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NA = Not applicable.
[c] 95% Upper confidence limit calculated for the indicated distribution.
[d] Background concentrations for inorganic constituents are based on site data.
[e] Rationale for exclusion of chemical as a constituent of potential ecological concern (COPEC):
A = within background concentration.
B = detection frequency less than 5%.
[f] N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.
[g] Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-17

Ecological Risk Assessment COPEC[a] Final Screening Assessment
Red Water Ponds
PBOW, Sandusky, Ohio

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Constituent/Media	Maximum Detected Concentration[b]		Screening Concentration[c]	COPEC ?	
	West Area RWPs	Pentolite Rd. RWPs		West Area RWPs	Pentolite Rd. RWPs
Surface Soil[d] - Organics (mg/kg)					
1,3-Dinitrobenzene	0.3	1.6	DNA	Y	Y
1,3,5-Trinitrobenzene	0.7	1.7	DNA	Y	Y
2,4-Dinitrotoluene	0.4	2.4	DNA	Y	Y
2,6-Dinitrotoluene	-[e]	0.8	DNA	N	Y
2,4,6-Trinitrotoluene	0.3	0.27	DNA	Y	Y
3,4-Dinitrotoluene	-	0.3	DNA	-	Y
4-Amino-2,6-Dinitrotoluene	0.3	2.7	DNA	Y	Y
Acenaphthylene	0.041	-	0.10	N	-
Acetone	0.035	-	DNA	Y	-
Anthracene	0.23	-	0.10	Y	-
Benzo(a)anthracene	0.40	-	0.10	Y	-
Benzo(b)fluoranthene	0.30	-	0.10	Y	-
Benzo(g,h,i)perylene	0.22	-	0.10	Y	-
Benzo(k)fluoranthene	0.35	-	0.10	Y	-
Chrysene	0.42	-	0.10	Y	-
Fluoranthene	0.76	-	0.10	Y	-
Indeno(1,2,3-cd)Pyrene	0.23	-	0.10	Y	-
Methylene chloride	0.0023	0.0018	0.30	N	N
Phenanthrene	0.36	-	0.10	Y	-
Pyrene	0.55	-	0.10	Y	-
Toluene	0.0032	-	0.10	N	-

Table 6-17

Ecological Risk Assessment COPEC[a] Final Screening Assessment
Red Water Ponds
PBOW, Sandusky, Ohio

(Page 2 of 6)

Constituent/Media	Maximum Detected Concentration[b]		Screening Concentration[c]	COPEC ?	
	West Area RWPs	Pentolite Rd. RWPs		West Area RWPs	Pentolite Rd. RWPs
Surface Soil[d] - Inorganics (mg/kg)					
Beryllium	1.2	-	0.020	Y	-
Sodium	681	1,240	DNA	Y	Y
Subsurface Soil[d] - Organics (mg/kg)					
1,3-Dinitrobenzene	2.4	9.3	DNA	Y	Y
1,3,5-Trinitrobenzene	5.5	58	DNA	Y	Y
2,4-Dinitrotoluene	5.1	25	DNA	Y	Y
2,6-Dinitrotoluene	1.5	3.6	DNA	Y	Y
2,4,6-Trinitrotoluene	0.4	12,000	DNA	Y	Y
3,4-Dinitrotoluene	0.5	4.5	DNA	Y	Y
4-Amino-2,6-Dinitrotoluene	0.7	9.5	DNA	Y	Y
Acenaphthylene	0.041	-	0.10	N	-
Acetone	0.035	0.0082	DNA	Y	Y
Anthracene	0.23	-	0.10	Y	-
Benzo(a)anthracene	0.4	-	0.10	Y	-
Benzo(b)fluroanthene	0.3	-	0.10	Y	-
Benzo(g,h,i)perylene	0.22	-	0.10	Y	-
Benzo(k)fluroanthene	0.35	-	0.10	Y	-
Chrysene	0.42	-	0.10	Y	-
Fluoranthene	0.76	-	0.10	Y	-
Indeno(1,2,3-cd)pyrene	0.23	-	0.10	Y	-
Methylene chloride	0.0023	0.0018	0.30	N	N
Nitrobenzene	-	1.1	DNA	-	Y

Table 6-17

Ecological Risk Assessment COPEC[a] Final Screening Assessment
Red Water Ponds
PBOW, Sandusky, Ohio

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Constituent/Media	Maximum Detected Concentration[b]		Screening Concentration[c]	COPEC ?	
	West Area RWPs	Pentolite Rd. RWPs		West Area RWPs	Pentolite Rd. RWPs
Subsurface Soil[d] - Organics (mg/kg) (continued)					
Phenanthrene	0.36	-	0.10	Y	-
Pyrene	0.55	-	0.10	Y	-
Toluene	0.0032	0.0017	0.10	N	N
Subsurface Soil[d] - Inorganics (mg/kg)					
Antimony	-	9.3	0.48	-	Y
Beryllium	1.2	-	0.020	Y	-
Cadmium	1.4	-	2.5	N	-
Sodium	1,270	4,130	DNA	Y	Y
Surface Water[f] - Organics (mg/L)					
1,3-Dinitrobenzene	0.0003	-	DNA	Y	-
2,4-Dinitrotoluene	0.0005	-	0.23	N	-
2,6-Dinitrotoluene	0.0008	-	DNA	Y	-
3,4-Dinitrotoluene	0.0006	-	DNA	Y	-
3-Nitrotoluene	0.054	-	DNA	Y	-
4-Amino-2-Nitrotoluene	0.0006	-	DNA	Y	-
Bromomethane	0.00021	0.00011	DNA	Y	Y
Di-n-Octylphthalate	0.0078	-	0.003	Y	-
Surface Water[f] - Inorganics (mg/L)					
Aluminum	13.8	3.04	0.2	Y	Y
Arsenic	0.0218	-	0.15	N	-
Chromium	0.0233	-	0.086	N	-
Iron	21.1	5.79	1.0	Y	Y

Table 6-17

Ecological Risk Assessment COPEC[a] Final Screening Assessment
Red Water Ponds
PBOW, Sandusky, Ohio

(Page 4 of 6)

Constituent/Media	Maximum Detected Concentration[b]		Screening Concentration[c]	COPEC ?	
	West Area RWPs	Pentolite Rd. RWPs		West Area RWPs	Pentolite Rd. RWPs
Surface Water[f] - Inorganics (mg/L) (continued)					
Lead	0.077	0.0087	0.0064	Y	Y
Magnesium	50.7	-	DNA	Y	-
Manganese	1.6	0.404	0.080	Y	Y
Sodium	107	-	DNA	Y	-
Vanadium	0.0522	-	0.019	Y	-
Zinc	0.0925	0.058	0.12	N	N
Sediment - Organics (mg/kg)					
1,3-Dinitrobenzene	0.7	-	DNA	Y	-
1,3,5-Trinitrobenzene	0.8	-	DNA	Y	-
2-Amino-4,6-Dinitrotoluene	0.3	-	DNA	Y	-
2-Butanone	0.029	0.015	DNA	Y	Y
2,4-Dinitrotoluene	0.7	-	DNA	Y	-
2,6-Dinitrotoluene	0.4	-	DNA	Y	-
Acenaphthene	-	0.11	See PAH_{Total}	See PAH_{Total}	
Acetone	0.11	0.069	DNA	Y	Y
Anthracene	-	0.077	See PAH_{Total}	See PAH_{Total}	
Carbazole	-	0.18	DNA	-	Y
Dibenzofuran	-	0.06	DNA	-	Y
Fluoranthene	0.047	0.14	2.9	N	N
Fluorene	-	0.11	See PAH_{Total}	See PAH_{Total}	
Methylene Chloride	0.02	-	DNA	Y	-
Phenanthrene	-	0.32	0.85	-	N

Table 6-17

Ecological Risk Assessment COPEC[a] Final Screening Assessment
Red Water Ponds
PBOW, Sandusky, Ohio

(Page 5 of 6)

Constituent/Media	Maximum Detected Concentration[b]		Screening Concentration[c]	COPEC ?	
	West Area RWPs	Pentolite Rd. RWPs		West Area RWPs	Pentolite Rd. RWPs
Sediment - Organics (mg/kg) (continued)					
Pyrene	-	0.11	See PAH_{Total}	See PAH_{Total}	
PAH_{Total}	0.047	0.87	2.0	N	N
Sediment - Inorganics (mg/kg)					
Aluminum	9,600	-	DNA	Y	-
Arsenic	11.3	-	6	Y	-
Barium	65	-	DNA	Y	-
Calcium	74,700	-	DNA	Y	-
Chromium	28.7	-	26	Y	-
Copper	24.5	-	16	Y	-
Iron	24,300	-	20,000	Y	-
Lead	32.1	-	31	Y	-
Magnesium	6,770	19,330	DNA	Y	Y
Manganese	726	-	460	Y	-
Phosphorus	3.1	-	DNA	Y	-
Potassium	1,500	1,040	DNA	Y	Y
Vanadium	25	-	DNA	Y	-
Zinc	94	-	120	N	-

DNA = Data not available.

[a]COPEC = Constituent of potential ecological concern
[b]Maximum detected concentration in site media, excluding background-related constituents (see text for discussion of the treatment of background), and constituents with a frequency of detection less than 5 percent.

Table 6-17

Ecological Risk Assessment COPEC[a] Final Screening Assessment
Red Water Ponds
PBOW, Sandusky, Ohio

[c]Screening concentrations as follows:

For Soil: EPA, *Region 3 BTAG Screening Levels for Soil* (1995)

For Surface Water (in order of preference):

(1) Ohio Water Quality Criteria for the Lake Erie Basin (Title 3745-1-33; assuming a hardness of 100 mg/L $CaCO_3$),

(2) EPA *Eco Update - Ecotox Threshold* (ET) values (1996), and

(3) EPA *Region 3 BTAG Screening Levels* for freshwater aquatic flora and fauna (1995).

For Sediment: Ontario Ministry of the Environment (OME) thresholds for sediment (OME, *Guidelines for the Protection and Management of Aquatic Quality in Ontario*, 1993), unless otherwise noted.

[d] Surface soil represented by results from a depth of 0 to 3 feet below ground surface; subsurface soil represented by results from a depth of 0 to 6 feet below the ground surface.

[e] "-" entry means constituent either background related, less than 5 percent frequency of detection, or not detected.

[f] Surface water results for total fraction (unfiltered).

Table 6-18

Assessment and Measurement Endpoints and Exposure Delineation
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 3)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for soil invertebrates.	The presence of site contaminants within surficial soils will have no adverse effect on survival and reproductive capabilities of terrestrial invertebrates.	Terrestrial invertebrates Ingestion of soil and direct exposure to soil	Comparison of soil concentration to soil critical effect values (CEV).
	Protection of long-term survival and reproductive capabilities for herbivorous mammals.	The presence of site contaminants within surface and subsurface soils, surface water, and vegetation will have no adverse effect on survival and reproductive capabilities of herbivorous mammals.	Eastern cottontail (*Sylvilagus floridanus*) white-tailed deer (*Odocoileus virginianus*) ingestion of plants, water, and incidental soil	Comparison of total daily dose to species-specific toxicity endpoint values (TEV).
	Protection of long-term survival and reproductive capabilities for omnivorous mammals.	The presence of site contaminants within surface soils, surface water, terrestrial invertebrates and vegetation will have no adverse effect on survival and reproductive capabilities of omnivorous mammals.	raccoon (*Procyon lotor*) ingestion of terrestrial plants, and invertebrates, small mammals, water and incidental soil	Comparison of total daily dose to species-specific toxicity endpoint values (TEV).
	Protection of long-term survival and reproductive capabilities for omnivorous mammals.	The presence of site contaminants within surficial soils, surface water, terrestrial invertebrates, and vegetation will have no adverse effect on survival and reproductive capabilities of omnivorous mammals.	deer mouse (*Peromyscus maniculatus*) ingestion of terrestrial invertebrates, plants, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.

Table 6-18

Assessment and Measurement Endpoints and Exposure Delineation
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 3)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for carnivorous birds.	The presence of site contaminants within surficial soils, surface water, small mammals, and birds will have no adverse effect on survival and reproductive capabilities of carnivorous birds.	red-tailed hawk (*Buteo jamacencis*) ingestion of small mammals, birds, water, incidental soil	Comparison of total daily dose to species-specific TEVs.
	Protection of long-term survival and reproductive capabilities for small insectivorous mammals.	The presence of site contaminants within surficial soils, surface water, and terrestrial invertebrates will have no adverse effect on survival and reproductive capabilities of insectivorous mammals.	short-tailed shrew (*Blarnia brevicauda*) ingestion of terrestrial invertebrates, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.
	Protection of long-term survival and reproductive capabilities for insectivorous birds.	The presence of site contaminants within surficial soils, surface water, and terrestrial invertebrates will have no adverse effect on survival and reproductive capabilities of insectivorous birds.	march wren (*Cistorthorus palustris*) ingestion of terrestrial invertebrates, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.

Table 6-18

Assessment and Measurement Endpoints and Exposure Delineation
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 3 of 3)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of aquatic ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for benthic invertebrates.	The presence of site contaminants within sediments and surface water will have no adverse effect on survival and reproductive capabilities of benthic invertebrates.	benthic invertebrates ingestion of sediment and direct exposure to surface water	Comparison of sediment concentration to sediment CEVs.
	Protection of long-term survival and reproductive capabilities for aquatic vertebrates (fin fish).	The presence of site contaminants within surface water, benthic invertebrates, and plants will have no adverse effect on survival and reproductive capabilities of aquatic vertebrates.	aquatic vertebrates ingestion of benthic invertebrates, plants, and direct exposure to water	Comparison of surface water concentration to aquatic CEVs.
	Protection of long-term survival and reproductive capabilities for semi-aquatic omnivorous mammals (also considered in the terrestrial assessment).	The presence of site contaminants within surface water, sediments, aquatic invertebrates, and fish have no adverse effect on survival and reproductive capabilities of aquatic mammals.	raccoon (*Procyon lotor*) ingestion of aquatic invertebrates, fish, water and incidental sediment	Comparison of total daily dose to species-specific TEVs.
	Protection of long-term survival and reproductive capabilities for piscivorous birds.	The presence of site contaminants within aquatic vertebrates and benthic invertebrates will have no adverse effect on survival and reproductive capabilities of piscivorous birds.	great blue heron (*Ardea herodias*) ingestion of aquatic vertebrates, benthic invertebrates, water, and incidental sediment	Comparison of total daily dose to species-specific TEVs.

Table 6-19

Data Used to Model Exposure in the Indicator Wildlife Species
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

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	0.000057 (2.0%)	0.0022	Omnivore	Terr. Inverts. : 39 Plants: 61
Eastern cottontail (*Sylvilagus floridanus*)	Mammalia/ Lagomorpha	1.132	3.1	0.096	0.006 (6.3%)	0.11	Herbivore	Plants: 100
Short-tailed shrew (*Blarina brevicauda*)	Mammalia/ Insectivora	0.015	0.39	0.008	0.00083 (10.4%)	0.0023	Insectivore	Terr. Inverts.: 100
White-tailed deer (*Odocoileus virginianus*)	Mammalia/ Artiodactyla	61[c]	518[c]	2.0[d]	0.04 (2.0%)	4.0	Herbivore	Plants: 100
Marsh wren (*Cistothorus palustris*)	Aves/ Passeriformes	0.010	0.054	0.0095	0.00019 (2.0%)	0.0027	Insectivore	Terr. Inverts.: 100
Red-tailed hawk (*Buteo jamaicensis*)	Aves/ Falconiformes	0.957	842	0.1	0.002 (2.0%)	0.057	Carnivore	Rabbits: 25.3 Shrews: 25.3 Mice: 25.3 Birds: 24
Great blue heron (*Ardea herodias*)	Aves/ Ciconiiformes	2.204	4.5	0.4	0.0079 (2.0%)	0.10	Piscivore	Fish: 96 Aq. Inverts.: 4
Raccoon (*Procyon lotor*)	Mammalia/ Carnivora	5.1	156	0.26[c]	0.024 (9.4%)	0.43	Omnivore	Fish: 2.0 Aq. Inverts.: 21 Terr. Inverts.: 30 Mice: 5.0 Plants: 42

Table 6-19

Data Used to Model Exposure in the Indicator Wildlife Species
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

[a] From EPA (*Wildlife Exposure Factors*, 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 $Wt^{0.822}$ (EPA, 1993), where FI = food ingestion (dry weight) and Wt = body weight.

Table 6-20

Octanol-Water Partition Coefficients for Organic Chemicals of Potential Ecological Concern Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical	K_{ow} (unitless) [a]
1,3-Dinitrobenzene	30.9[b]
1,3,5-Trinitrobenzene	15.1[b]
2-Amino-4,6-Dinitrotoluene	100[f]
2,6-Dinitrobenzene	30.9[c]
2,4-Dinitrotoluene	95.0
2,6-Dinitrotoluene	190
2,4,6-Trinitrotoluene	100[b]
2-Butanone	1.9[d]
3,4-Dinitrotoluene	190[e]
3-Nitrotoluene	269[d]
4-Amino-2,6-dinitrotoluene	100[f]
4-Amino-2-nitrotoluene	100[f]
Acetone	0.58[d]
Anthracene	28,000
Benzo(a) anthracene	410,000
Benzo(b) fluoranthene	1,150,000
Benzo(g,h,i) perylene	3,200,000
Benzo(k) fluoranthene	1,150,000
Bromomethane	12.3
Carbazole	1,950[d]
Chrysene	410,000
Di-n-octyl phthalate	166,000[g]
Dibenzofuran	13,200[d]
Fluoranthene	79,000
Indeno(1,2,3-cd) pyrene	3,200,000
Methylene chloride	18.2

Table 6-20

Octanol-Water Partition Coefficients for Organic Chemicals of Potential Ecological Concern Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

Chemical	K_{ow} (unitless) [a]
Nitrobenzene	74.0
Phenanthrene	28,000
Pyrene	80,000

[a] Octanol-water partition coefficients (K_{ow}) values are from EPA-440/4-81-014, 1982, *Aquatic Fate Process Data for Organic Priority Pollutants*, unless otherwise noted.
[b] K_{ow} values are from Rosenblatt, D. H., et. al., 1991, *Organic Explosives and Related Compounds.*
[c] The K_{ow} for 1,3-Dinitrobenzene was used as a surrogate.
[d] K_{ow} values are from Leo, A., Hansch, C., and Elkins, D., 1971, *Partition Coefficients and Their Uses.*
[e] The K_{ow} for 2,6-Dinitrotoluene was used as a surrogate.
[f] The K_{ow} for 2,4,6-Trinitrotoluene was used as a surrogate.
[g] National Library of Medicine (NLM) Hazardous Substance Data Bank (HSDB).

Table 6-21

Fate and Transport Factors for Inorganic Chemicals of Potential Ecological Concern Red Water Ponds, PBOW, Sandusky, Ohio

Chemical	Soil-to-Plant Transfer Factor	Soil-to-Insect Transfer Factor	Food-to-Muscle Transfer Factor	Water-to-Fish/Invertebrate Bio-Concentration Factor	Distribution Coefficient K_d (mL/g)
Aluminum	-	-	-	1.0×10^{2} [a]	1.5×10^{3} [b]
Antimony	5.6×10^{-4} [c]	1.0×10^{0} [a]	4.0×10^{-5} [c]	-	-
Arsenic	2.3×10^{-2} [b]	1.0×10^{0} [a]	4.0×10^{-3} [b]	4.4×10^{1} [d]	2.0×10^{2} [b]
Barium	3.0×10^{-2} [c]	1.0×10^{0} [a]	2.0×10^{-4} [c]	4.0×10^{0} [c]	6.0×10^{1} [b]
Beryllium	5.8×10^{-3} [b]	1.0×10^{0} [a]	1.0×10^{-3} [b]	1.0×10^{2} [c]	6.5×10^{2} [b]
Calcium	1.9×10^{0} [b]	1.0×10^{0} [a]	2.0×10^{-3} [c]	1.0×10^{2} [a]	4.1×10^{0} [b]
Chromium	-	-	-	2.0×10^{2} [c]	8.5×10^{2} [b]
Copper	-	-	-	2.0×10^{2} [c]	3.5×10^{1} [b]
Iron	-	-	-	2.0×10^{2} [c]	5.0×10^{3} [c]
Lead	-	-	-	3.0×10^{2} [c]	4.0×10^{2} [b]
Magnesium	7.8×10^{-1} [b]	1.0×10^{0} [a]	2.0×10^{-2} [c]	1.0×10^{2} [a]	4.6×10^{0} [b]
Manganese	-	-	-	4.0×10^{2} [c]	1.0×10^{3} [c]
Phosphorus	-	-	-	5.0×10^{4} [c]	3.5×10^{0} [b]
Potassium	7.8×10^{-1} [b]	1.0×10^{0} [a]	2.0×10^{-2} [c]	1.0×10^{2} [a]	5.6×10^{0} [b]
Sodium	6.5×10^{-2} [b]	1.0×10^{0} [a]	8.0×10^{-2} [c]	2.0×10^{1} [c]	-
Vanadium	-	-	-	1.0×10^{2} [a]	1.0×10^{3} [b]

[a] Consevative default values: 1.0×10^{0} for soil-to-insect TF, based on data in Stafford et al. (1991, *Collation and Interpretation of Data for Times Beach Confined Disposal Facility*), Ma (1982, "The Influence of Soil Properties and Worm-Related Factors ona the Concentration of Heavy Metals in Earthworms"), and NCRP (1989, *Screening Techniques for Determining Compliance with Environmental Standards: Releases of Radionuclides to the Atmosphere*); 1.0×10^{2} for water-to-fish and water-to- invertebrate BCF, based on 95%
UCL for nonparametric distribution of 54 BCF values presented in IAEA (1994, *Site Management Plan, Plum Brook Ordnance Works*).

[b] From Baes et. al., (1984, *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*); for soil-to-plant transfer factors, average of vegetative and nonvegetative values was used.

[c] From IAEA (1994).

[d] From EPA (1994).

" - " Symbol indicates factor was not required as the inorganic was not selected as a COPEC for the particular pathway of concern.

Table 6-22

Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for COPEC Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 3)

Chemical	Mammals			Birds		
	Toxicity Value[a]	NOAEL (mg/kg-d)	Species	Toxicity Value[a]	NOAEL (mg/kg-d)	Species
Organics						
1,3-Dinitrobenzene	59.5 (LD_{50})	0.595	rat	NA[b]	NA	NA
1,3,5-Trinitrobenzene	275 (LD_{50})	2.75	rat	NA	NA	NA
2,6-Dinitrobenzene	0.4[c]	0.4	rat	NA	NA	NA
2,4-Dinitrotoluene	268 (LD_{50})	2.68	rat	NA	NA	NA
2,6-Dinitrotoluene	177 (LD_{50})	1.77	rat	NA	NA	NA
2,4,6-Trinitrotoluene	795 (LD_{50})	7.95	rat	NA	NA	NA
2-Butanone	1,771	1,771	rat	NA	NA	NA
3,4-Dinitrotoluene	807 (LD_{50})	8.07	rat	NA	NA	NA
3-Nitrotoluene	1,072 (LD_{50})	10.72	rat	NA	NA	NA
2-Amino-4,6-dinitrotoluene	1,394 (LD_{50})	13.94	rat	3.2 (LD_{50})	0.032	Unknown
4-Amino-2,6-dinitrotoluene	959 (LD_{50})	9.59	rat	3.2 (LD_{50})	0.032	Unknown
4-Amino-2-nitrotoluene	6,860 (LD_{50})	68.6	rat	3.2 (LD_{50})	0.032	Unknown
Acetone	10	10	rat	NA	NA	NA
Anthracene	1.0	1.0	mouse	NA	NA	NA
Benzo(a)anthracene	1.0	1.0	mouse	NA	NA	NA
Benzo(b)fluoranthene	1.0	1.0	mouse	NA	NA	NA
Benzo(g,h,i)perylene	1.0	1.0	mouse	NA	NA	NA
Benzo(k)fluoranthene	1.0	1.0	mouse	NA	NA	NA
Bromomethane	214 (LD_{50})	2.14	rat	NA	NA	NA
Carbazole	200 (LD_{50})	2.0	mouse	NA	NA	NA
Chrysene	1.0	1.0	mouse	NA	NA	NA
Di-n-octyl phthalate	47,000 (LD_{50})	470	rat	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Fluoranthene	125	125	mouse	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1.0	1.0	mouse	NA	NA	NA

Table 6-22

Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for COPEC Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 3)

Chemical	Mammals			Birds		
	Toxicity Value[a]	NOAEL (mg/kg-d)	Species	Toxicity Value[a]	NOAEL (mg/kg-d)	Species
Methylene chloride	5.85	5.85	rat	NA	NA	NA
Nitrobenzene	4.6[c]	0.23	mouse	NA	NA	NA
Phenanthrene	1.0	1.0	mouse	NA	NA	NA
Pyrene	75[c]	75	mouse	NA	NA	NA
Inorganics						
Aluminum	1.93	1.93	mouse	110	110	ringed dove
Antimony	0.125	0.125	mouse	NA	NA	NA
Arsenic	0.126	0.126	mouse	2.46	2.46	cowbird
Barium	5.1	5.1	rat	20.8	20.8	chicks
Beryllium	0.66	0.66	rat	NA	NA	NA
Calcium	--	1,053[d]	rabbit	--	2,833[d]	Jap. quail
Chromium	2,737	2,737	rat	1.0	1.0	black duck
Copper	11.7	11.7	mink	47	47	chicks
Iron	--	26[d]	rabbit	--	50[d]	poultry
Lead	8.0	8.0	rat	3.85	3.85	Am. kestrel
Magnesium	--	158[d]	rabbit	--	150[d]	poultry
Manganese	88	88	rat	977	977	Jap. quail
Phosphorus	--	526[d]	rabbit	--	400[d]	poultry
Potassium	--	1,579[d]	rabbit	--	1,000[d]	poultry
Sodium	--	1,579[d]	rabbit	--	1,000[d]	poultry
Vanadium	0.21	0.21	rat	11.4	11.4	mallard

[a]Toxicity values are derived from no-observed-adverse-effects levels (NOAEL) taken from Sample, et. al., 1996, *Toxicological Benchmarks for Wildlife: 1996 Revision*, unless otherwise noted. LD_{50} values were converted to chronic NOAELs by dividing by a factor of 100 and subchronic low-observed-adverse-effects-levels were converted to chronic NOAELs by dividing by a factor of 20, as recommended by Wentsel, et. al., 1996, *Tri-Service Procedural Guidelines for Ecological Risk Assessments.*
[b]NA indicates that the information was not available.
[c]The value is based on data contained in the EPA IRIS database.
[d]NOAELs for selected nutrients are estimated based on mineral dietary requirements or maximum tolerated doses (Appendix N).

Table 6-22

Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for COPEC Red Water Ponds, PBOW, Sandusky, Ohio

Note: LD_{50} values from RTECS (1998), as summarized in the TOMES CPC™ System Data Base (1/1/99).

The following surrogates were used:

The NOAEL for benzo(a)pyrene was used for anthracene, benzo(a)anthracene, benzo(b)fluroanthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and phenanthrene.
The NOAEL for 2,4-DNT was used for 2,6-DNT.
The LD_{50} for 4-Amino-2-Nitrotoluene was used for 2-Amino-4,6-DNT and 4-Amino-2,6-DNT.

Table 6-23

Uncertainty Factors [a] for Ecological RTV [b] Extrapolations [c]
Red Water Ponds, PBOW, Sandusky, Ohio

Laboratory Animals (toxicity database)		Selected Site Receptor Species	
Rat	G: Rattus F: Muridae O: Rodentia	Deer mouse	G: Peromyscus F: Cricetidae O: Rodentia
Mouse	G: Mus F: Muridae O: Rodentia	Eastern cottontail	G: Sylvilagus F: Leporidae O: Lagomorpha
Mink	G: Mustela F: Mustelidae O: Carnivora	Raccoon	G: Procyon F: Procyonidae O: Carnivora
Rabbit: G: Oryctolagus (N. Zealand White)	F: Leporidae O:Lagomorpha	Short-tailed shrew	G: Blarina F: Soricidae O: Insectivora
Ringed dove	G: Streptopelia F: Columbidae O: Columbiformes	White-tailed deer	G: Odocoileus F: Cervidae O: Artiodactyla
Cowbird	G: Molothrus F: Emberizidae O: Passeriformes	Great blue heron	G: Ardea F: Ardeidae O: Ciconiiformes
Chick, Poultry	G: Gallus F: Phasianidae O: Galliformes	March wren	G: Cistothorus F: Troglodytidae O: Passeriformes
Black duck, Mallard	G: Anas F: Anatidae O: Anseriformes	Red-tailed hawk	G: Buteo F: Accipitridae O: Falconiformes
Japanese quail	G: Coturnix F: Phasianidae O: Galliformes		
American kestrel	G: Falco F: Falconidae O: Falconiformes		

[a] From *Tri-Service Procedural Guidelines for Ecological Risk Assessment* (Wentsel, et al. 1996)
[b] RTV = Reference toxicity value.
[c] Interclass extrapolations not performed; only within bird class or within mammal class.

Extrapolation between two different species = uncertainty factor of 2
Extrapolation between two different genera (G) = uncertainty factor of 4
Extrapolation between two different families (F) or orders (O) = uncertainty factor of 8
Thus, for all extrapolations used in the current Eco RA (except for the New Zealand White extrapolated to the cottontail), an uncertainty factor of 8 was used. For the latter, an uncertainty factor of 4 was used.

Table 6-24

Terrestrial Plant Impact Assessment
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Constituent	Source-Term Surface Soil Concentration[a] (mg/kg)		Benchmark Concentration for Plants [b] (mg/kg)	Benchmark Exceeded?	
	West Area RWP	Pentolite Road RWP		West Area RWP	Pentolite Rd RWP
Organics					
1,3-Dinitrobenzene	0.125	0.125	DNA[c]	cnba[e]	cnba
1,3,5-Trinitrobenzene	0.125	0.125	DNA	cnba	cnba
2,4-Dinitrotoluene	0.125	0.125	DNA	cnba	cnba
2,6-Dinitrotoluene	-- [d]	0.13	DNA	--	cnba
2,4,6-Trinitrotoluene	0.125	0.125	DNA	cnba	cnba
3,4-Dinitrotoluene	--	0.125	DNA	--	cnba
4-Amino-2,6-Dinitrotoluene	0.125	0.125	DNA	cnba	cnba
Acetone	0.012	--	DNA	cnba	--
Anthracene	0.2	--	DNA	cnba	--
Benzo(a)anthracene	0.2	--	DNA	cnba	--
Benzo(b)fluoranthene	0.2	--	DNA	cnba	--
Benzo(g,h,i)perylene	0.2	--	DNA	cnba	--
Benzo(k)fluoranthene	0.2	--	DNA	cnba	--

Table 6-24

Terrestrial Plant Impact Assessment
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

Constituent	Source-Term Surface Soil Concentration[a] (mg/kg)		Benchmark Concentration for Plants [b] (mg/kg)	Benchmark Exceeded?	
	West Area RWP	Pentolite Road RWP		West Area RWP	Pentolite Rd RWP
Organics (continued)					
Chrysene	0.2	--	DNA	cnba	--
Fluoranthene	0.2	--	DNA	cnba	--
Indeno(1,2,3-cd)pyrene	0.2	--	DNA	cnba	--
Phenanthrene	0.2	--	DNA	cnba	--
Pyrene	0.2	--	DNA	cnba	--
Inorganics					
Beryllium	0.6	--	10	No	--
Sodium	298.5	--	DNA	cnba	--

[a] 95 percent upper confidence limit concentrations presented for COPEC (Tables 6-17 for COPEC and Tables 6-9 and 6-10 for 95% UCL concentration.
[b] Will and Suter (1995, *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants*).
[c] DNA = data not available.
[d] indicates this constituent not selected as COPEC for the indicated area.
[e]cnba = could not be assessed.

Table 6-25

Aquatic Biota Surface Water Impact Assessment
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Constituent	Source -Term Concentration (µg/L) [a]		AWQC [b] (µg/L)	Tier II [c] (µg/L)	State of Ohio [d] (µg/L)	Other [e] (µg/L)	Benchmark Exceeded?	
	West Area RWPs	Pentolite Road RWPs					West Area	Pentolite Road
Organics								
1,3-Dinitrobenzene	0.3	--	NA	71	NA	NA	No	--
2,6-Dinitrotoluene	0.8	--	230 #	NA	NA	200	No	--
3,4-Dinitrotoluene	0.6	--	230 #	NA	NA	200	No	--
3-Nitrotoluene	54	--	NA	NA	NA	NA	cnba	--
4-Amino-2-Nitrotoluene	0.6	--	NA	NA	NA	NA	cnba	--
Bromomethane	0.21	0.11	NA	NA	NA	NA	cnba	cnba
Di-n-octyl phthalate	7.8	--	NA	NA	NA	3,822 *	No	--
Inorganics								
Aluminum	13,800	3,040	87	NA	NA	3,288 *	Yes (2/2)	Yes (1/2)
Iron	21,100	5,790	1,000	NA	1,000	1,300 *	Yes (3/3)	Yes (3/3)
Lead	77	8.7	18.6	NA	37	18.9 *	Yes (3/3)	No
Magnesium	50,700	--	NA	NA	NA	82,000 *	No	--
Manganese	1,600	404	1,500 #	80	NA	1,770 *	Yes (2/3)	Yes (1/3)
Sodium	107,000	--	15,000,000 #	NA	NA	680,000 *	No	--
Vanadium	52.2	--	NA	19	NA	80 *	Yes (1/2)	--

[a]COPEC from Table 6-17 and 95% UCL concentrations from Tables 6-13 and 6-14.
[b]Ambient water quality criteria for chronic exposure (federal) from 40 CFR 131.36, Quality Criteria for Water (Red Book) (EPA, 1976), and EPA Health and Ecological Criteria Division recommendations (1997). Lowest effect concentration (LEC) values (that are not criteria) are indicated with "#".

Table 6-25

Aquatic Biota Surface Water Impact Assessment
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

[c]Values calculated using Great Lakes Water Quality Initiative Tier II methodology, as summarized in *Eco Update - Ecotex Thresholds* (EPA, 1996).
[d]Ohio Water Quality Criteria for the protection of aquatic life (Lake Erie Basin; Title 3745-1-33, assuming a hardness of 400 mg/L $CaCO_3$).
[e]Other references include the following:

- Water Quality Criteria for 2,4-DNT and 2,6-DNT (Etnier, *Water Quality Criteria for 2,4- and 2,6-Dinitrotolune*, ORNL, 1987)
- Lowest effect concentration (LEC) for fish from the AQUIRE database. Value is chronic LEC, or estimated lowest chronic value for fish (or daphnids for Mg and Na) using LC50 and equation from Suter and Mabrey (1994) -- indicated with "*".

Notes:

1) Water hardness measurements ranged from 372 to 592 mg/L at West Area and from 284 to 488 mg/L at Pentolite Road, Tables 6-13 and 6-14.
2) NA = Not available.
3) Hardness dependent criteria calculated for total water body concentration, not dissolved fraction, using average hardness of approximately 400 mg/L $CaCO_3$.
4) 2,4-Dinitrotoluene used as a surrogate for 2,6-DNT and 4,3-DNT.
5) cnba = Could not be assessed.

Table 6-26

Aquatic Biota Sediment Impact Assessment
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 3)

COPEC	Source-Term Concentration[a] (mg/kg)		NOAA ER-L[b] (mg/kg)	NOAA ER-M[c] (mg/kg)	FDEP TEL[d] (mg/kg)	FDEP PEL[e] (mg/kg)	Ontario MOE Low[f] (mg/kg)	Ontario MOE Severe[g] (mg/kg)	Benchmark Exceeded?	
	West Area RWPs	Pentolite Rd. RWPs							West Area	Pentolite Rd.
Organics										
1,3-Dinitrobenzene	0.7	--	NA[h]	NA	NA	NA	NA	NA	cnba[i]	--
1,3,5-Trinitrobenzene	0.8	--	NA	NA	NA	NA	NA	NA	cnba	--
2-Amino-4,6-Dinitrotoluene	0.3	--	NA	NA	NA	NA	NA	NA	cnba	--
2-Butanone	0.029	--	NA	NA	NA	NA	NA	NA	cnba	--
2,4-Dinitrotoluene	0.7	--	NA	NA	NA	NA	NA	NA	cnba	--
2,6-Dinitrotoluene	0.4	--	NA	NA	NA	NA	NA	NA	cnba	--
Acetone	0.11	--	NA	NA	NA	NA	NA	NA	cnba	--
Carbazole	--	0.18	NA	NA	NA	NA	NA	NA	--	cnba
Dibenzofuran	--	0.06	NA	NA	NA	NA	NA	NA	--	cnba

Table 6-26

Aquatic Biota Sediment Impact Assessment
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 3)

COPEC	Source-Term Concentration[a] (mg/kg)		NOAA ER-L[b] (mg/kg)	NOAA ER-M[c] (mg/kg)	FDEP TEL[d] (mg/kg)	FDEP PEL[e] (mg/kg)	Ontario MOE Low[f] (mg/kg)	Ontario MOE Severe[g] (mg/kg)	Benchmark Exceeded?	
	West Area RWPs	Pentolite Rd. RWPs							West Area	Pentolite Rd.
Inorganics										
Aluminum	9,600	--	NA	NA	NA	NA	NA	NA	cnba	--
Arsenic	6.5	--	8.2	70	7.24	41.6	6	33	Yes (1/4)	--
Barium	65	--	NA	NA	NA	NA	NA	NA	cnba	--
Calcium	74,700	--	NA	NA	NA	NA	NA	NA	cnba	--
Chromium	18.1	--	81	370	52.3	160	26	110	No	--
Copper	24.5	--	34	270	18.7	108	16	110	Yes (2/4)	--
Iron	24,300	--	NA	NA	NA	NA	20,000	40,000	Yes (1/2)	--
Lead	18.8	--	46.7	218	30.2	112	31	250	No	--
Magnesium	6,770	19,330	NA	NA	NA	NA	NA	NA	cnba	cnba
Manganese	299	--	NA	NA	NA	NA	460	1,110	No	--
Phosphorus	3.1	--	NA	NA	NA	NA	NA	NA	cnba	--

Table 6-26

Aquatic Biota Sediment Impact Assessment
Red Water Ponds, PBOW, Sandusky, Ohio

COPEC	Source-Term Concentration[a] (mg/kg)		NOAA ER-L[b] (mg/kg)	NOAA ER-M[c] (mg/kg)	FDEP TEL[d] (mg/kg)	FDEP PEL[e] (mg/kg)	Ontario MOE Low[f] (mg/kg)	Ontario MOE Severe[g] (mg/kg)	Benchmark Exceeded?	
	West Area RWPs	Pentolite Rd. RWPs							West Area	Pentolite Rd.
Organics (continued)										
Potassium	1,353	1,040	NA	NA	NA	NA	NA	NA	cnba	cnba
Vanadium	25	--	NA	NA	NA	NA	NA	NA	cnba	--

[a] COPEC from Table 6-17 and 95% UCL concentrations from Tables 6-15 and 6-16.
[b] Effects Range - Low, developed by NOAA published by Long and Morgan (1990, *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program*), updated by Long (1995, *Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments*), and summarized in Jones, et al. (1996, *Toxicologicala Benchmarks or Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota*). Used only if no freshwater benchmarks available (e.g., FDEP and MOE).
[c] Effects Range - Medium, developed by NOAA published by Long and Morgan (1990), updated by Long (1995), and summarized in Jones, et al. (1996). Used only if no freshwater benchmarks available (e.g., FDEP and MOE).
[d] Florida Dept. of Environmental Protection, threshold effects level, summarized in Jones, et al. (1996).
[e] Florida Dept. of Environmental Protection, probable effects level, summarized in Jones, et al. (1996).
[f] Ontario Ministry of the Environment (MOE), Low = lowest effect level and is the 5th percentile of the screening level concentration.
[g] Ontario Ministry of the Environment (MOE), Severe = severe effect level and is the 95th percentile of the screening level concentration.
[h] Not available.
[i] Could not be assessed.

Table 6-27

Terrestrial Receptors Hazard Index (HI) Summary for West Area[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Media	Terrestrial Receptor						
	Deer Mouse	Cottontail	Shrew	Marsh Wren	Raccoon	Deer	Hawk
Soil [b] HI	21	1.1	91	450	19	0.010	0.0013
Risk Drivers:	92% PAHs (invertebrate intake)	60% 1,3-Dinitrobenzene (plant intake)	92% PAHs (invertebrate intake)	99% 4-Amino-2,6-DNT (invertebrate intake)	92% PAHs (invertebrate intake)	55% 1,3-DNB (plant intake)	93% 4-Amino-2,6-DNT (soil intake)
Surface Water HI	7.7	8.0	5.0	2.2	19	8.3	0.0049
Risk Drivers:	93% Aluminum (water intake)	95% Aluminum (water intake)	93% Aluminum (water intake)	41% Iron (water intake)	93% Aluminum (water intake)	93% Aluminum (water intake)	41% Iron (water intake)
Total Receptor HI	28	9.1	96	452	38	8.3	0.0062

[a] Details presented in eco risk assessment spreadsheets in Appendix M.
[b] All receptors exposed to surface soil, except burrowing shrew exposed to surface and subsurface soil via ingestion of soil and ingestion of terrestrial invertebrates, and deer exposed to surface and subsurface soil via ingestion of plants (e.g., tree leaves) that have translocated COPEC via deep feeder roots.

Table 6-28

Aquatic Receptor Hazard Index (HI) Summary for West Area[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Media	Aquatic Receptor	
	Great Blue Heron	Raccoon
Sediment HI	106	582
Risk Drivers:	33% 2-Amino-4,6-DNT (invertebrate intake)	58% Aluminum (sediment intake)
	24% Phosphorus (invertebrate intake)	11% Aluminum (invertebrate intake)
	13% Iron (sediment intake)	7.9% Calcium (invertebrate intake)
	10% Calcium (invertebrate intake)	5.3% Phosphorus (invertebrate intake)
Surface Water HI	618	83
Risk Drivers:	60% Iron (fish intake)	79% Aluminum (fish intake)
	24% Magnesium (fish intake)	10% Aluminum (water intake)
	8.8% Aluminum (fish intake)	5.4% Iron (water intake)
	4.2% Lead (fish intake)	
Total Receptor HI	724	665

[a]Details presented in eco risk assessment spreadsheets (Appendix M).

Table 6-29

Terrestrial Receptors Hazard Index (HI) Summary for Pentolite Road Area[a]
Red Water Ponds, PBOW, Sandusky, Ohio

Media	Terrestrial Receptor						
	Deer Mouse	Cottontail	Shrew	Marsh Wren	Raccoon	Deer	Hawk
Soil [b] HI	2.5	0.96	14	451	2.1	0.026	0.0011
Risk Drivers:	32% 1,3-DNB (invertebrate intake)	59% 1,3-DNB (plant intake)	45% Antimony (soil intake)	99% 4-Amino-2,6-DNT (invertebrate intake)	33% 1,3-DNB (invertebrate intake)	63% Nitrobenzene (plant intake)	60% 4-Amino-2,6-DNT (soil intake)
	19% 1,3-DNB (plant intake)	19% 1,3,5-TNB (plant intake)	26% 1,3-DNB (invertebrate intake)		18% 1,3-DNB (plant intake)		
Surface Water HI	1.6	1.7	1.1	0.32	4.0	1.8	0.0007
Risk Drivers:	96% Aluminum (water intake)	98% Aluminum (water intake)	96% Aluminum (water intake)	79% Iron (water intake)	96% Aluminum (water intake)	96% Aluminum (water intake)	79% Iron (water intake)
Total Receptor HI	4.1	2.7	15	451	6.1	1.8	0.0018

[a] Details presented in eco risk assessment spreadsheets in Appendix M.
[b] All receptors exposed to surface soil, except burrowing shrew exposed to surface and subsurface soil via ingestion of soil and ingestion of terrestrial invertebrates, and deer exposed to surface and subsurface soil via ingestion of plants (e.g., tree leaves) that have translocated COPEC via deep feeder roots.

Table 6-30

Aquatic Receptor Hazard Index (HI) Summary for Pentolite Road Area[a] Red Water Ponds, PBOW, Sandusky, Ohio

Media	Aquatic Receptor	
	Great Blue Heron	Raccoon
Sediment HI	9.0	20
Risk Drivers:	48% Potassium (invertebrate intake)	57% Carbazole (invertebrate intake)
	41% Magnesium (sediment intake)	21% Potassium (invertebrate intake)
Surface Water HI	117	18
Risk Drivers:	86% Iron (fish intake)	92% Aluminum (fish intake)
	10% Aluminum (fish intake)	11% Aluminum (water intake)
Total Receptor HI	126	38

[a]Details presented in eco risk assessment spreadsheet (Appendix M).

Table 6-31

Uncertainty Analysis
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 1 of 2)

Component	Bias	Magnitude	Ways to Minimize Uncertainty
Use of 95% UCL as source-term concentration	Overestimates Risk	Medium	Use central tendency
Assumption that soil depth interval of 0-3 ft is representative of surface soil	Overestimates Risk	Low to Medium	Resample to obtain additional samples 0-0.5 ft. for surface soil characterization
Assumption that MDC for COPEC in surface water or sediment is representative	Overestimates Risk	Medium	Collect additional surface water or sediment samples for those COPEC with < 5 data points
Use of representative receptor species for site ecological community	Underestimates Risk	Low	Select additional receptor species
Use of average intake values and average body weights	Underestimates Risk	Low	Measure site-specific intake values and species' body weights
Use of conservative foraging factors (i.e., 100%) for all species, except deer and hawk	Overestimates Risk	Medium	Use site-specific foraging factors, i.e., less than 100%
Assumption that all COPEC are 100% bioavailable	Overestimates Risk	Medium to High	Obtain medium- and COPEC-specific bioavailability factors
Discounting of dermal and inhalation exposure routes	Underestimates Risk	Low	Include dermal and inhalation routes of exposure
Use of partitioning and transfer factors to estimate COPEC concentrations in plants, invertebrates, fish, other prey items, and sediment pore water	Overestimates Risk	Medium to High	Measure COPEC concentrations in site plants, invertebrates, fish, other prey species, and sediment pore water
Assumption that estimated pore water inorganic COPEC concentrations do not exceed representative nutrient solubilities	Overestimates or Underestimates Risk	Low	Select alternative nutrient compound solubilities (e.g., different than MgO, CaO, Al_2O_3, and $FeCO_3$)
Assumption that soil F_{oc} = 1%	Overestimates or Underestimates Risk	Un-known	Measure site-specific soil F_{oc}
Use of K_{ow} to estimate fish BCFs for organic COPEC	Overestimates Risk	Medium to High	Use alternative BCF estimation method (e.g., Bintein and Devillers, 1993)

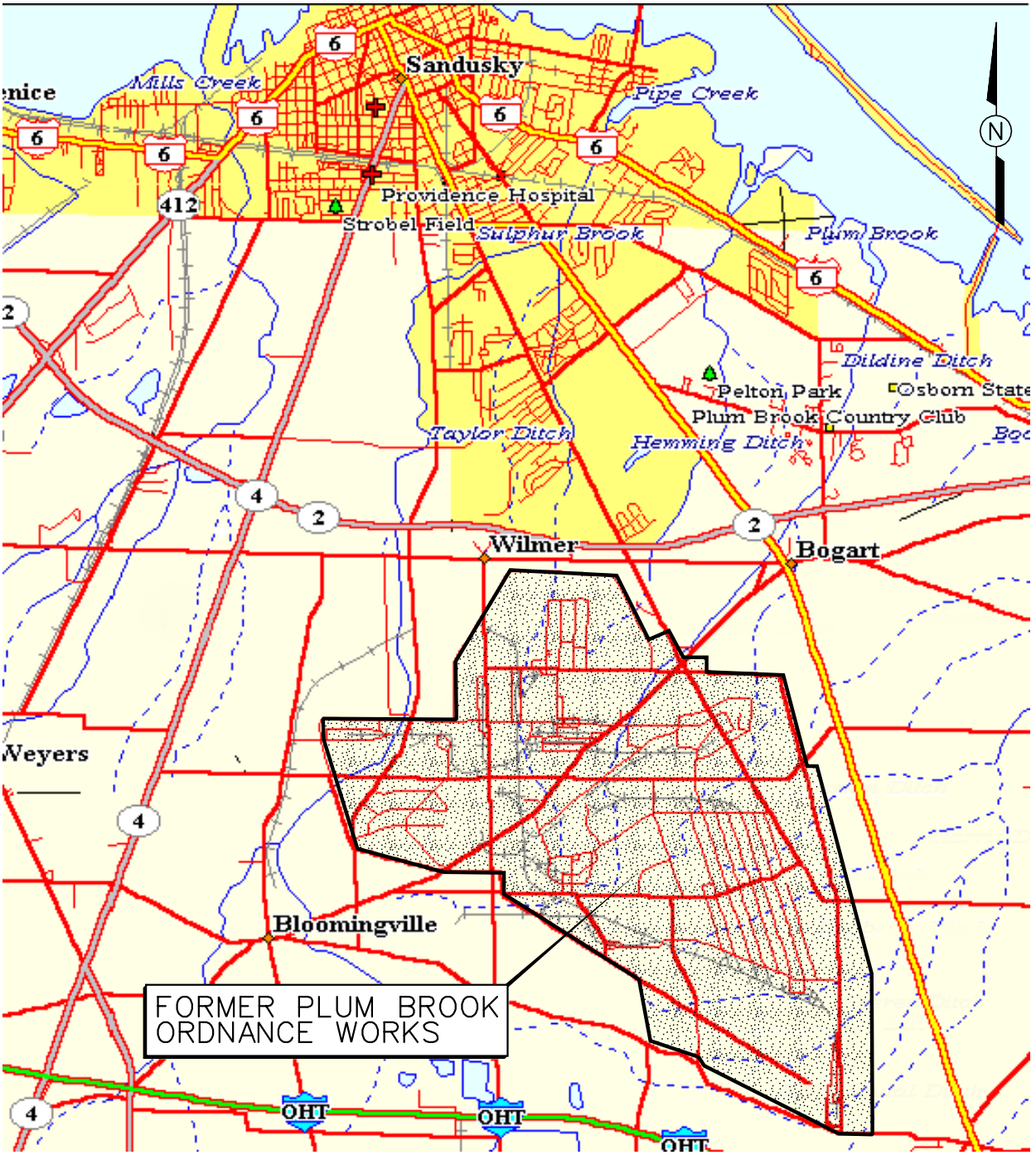
Table 6-31

Uncertainty Analysis
Red Water Ponds, PBOW, Sandusky, Ohio

(Page 2 of 2)

Component	Bias	Magnitude	Ways to Minimize Uncertainty
Assumption that surface-water-to-fish-tissue BCFs, and sediment-pore-water-to-benthic-macroinvertebrate BCFs, are linear	Overestimates Risk	Medium to High; for nutrients	Measure nutrient concentrations (i.e., iron, magnesium) in site fish and benthic macroinvertebrates, or perform literature search for alternative BCF values
Use of fish BCFs to represent sediment-pore-water-to-benthic-macroinvertebrate BCFs	Unknown	Un-known	Measure site-specific-pore-water-to-benthic-macroinvertebrate BCFs
Use of unfiltered surface water data and BCFs to estimate fish tissue concentrations	Overestimates Risk	Medium	Collect additional surface water samples that are representative of filtered surface water data
Use of safety factors to convert LOAEL and LD_{50} toxicity data to NOAELs	Overestimates Risk	Medium	Obtain COPEC-specific NOAEL data
Use of uncertainty factor of 8 to extrapolate RTVs between most species within the same class	Overestimates Risk	Medium	1) Assume RTVs similar for all species in the same genus, family, or order; or 2) obtain species-specific NOAEL data
Assumption that body weight scaling factor = 0 for all bird species' NOAEL toxicity data	Overestimates or Underestimates Risk	Low	Obtain species-specific NOAEL toxicity data
Use of surrogate constituents to estimate toxicity for those COPEC without available toxicity data	Overestimates Risk	Low to Medium	Obtain COPEC-specific toxicity data

FIGURES



NOT TO SCALE

FIGURE 1-1
VICINITY MAP

FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 12/16/97	DATE LAST REV.: 10/30/01	DRAFT. CHCK. BY:	INITIATOR: D. KESSLER	DWG. NO.: \773701ES.001	
DRAWN BY: D. BILLINGSLEY	DRAWN BY: bvanderg	ENGR. CHCK. BY: D. KESSLER	PROJ. MGR.: M.SPANGBERG	PROJ. NO.: 773701	

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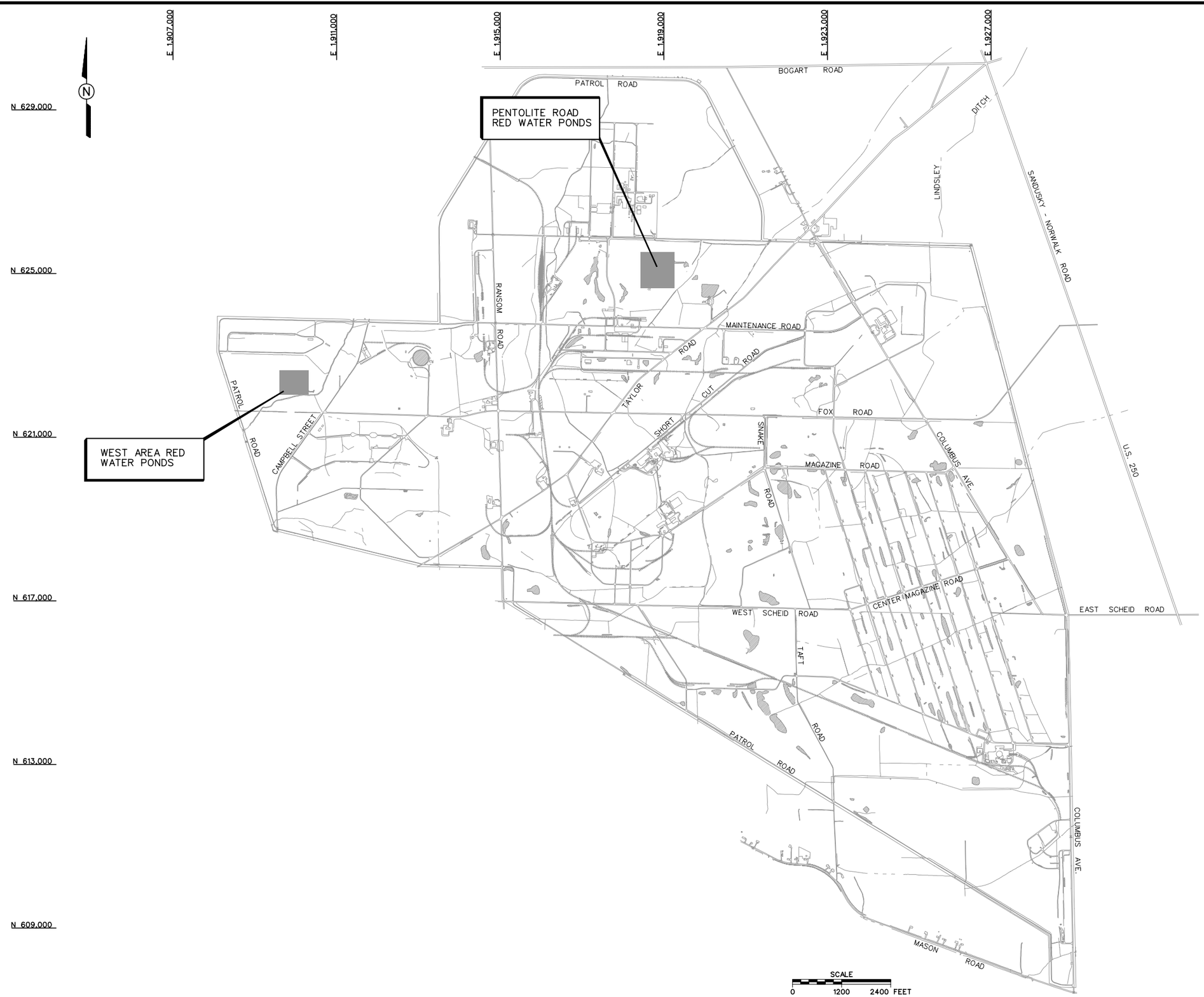

LEGEND:

- AREAS OF CONCERN
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE (PBOW BOUNDARY)

FIGURE 1-2
LOCATIONS OF AREAS OF CONCERN

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

DWG. NO.:..\773701es.010	INITIATOR: G.YU	DRAFT. CHCK. BY: D.HALL	DATE LAST REV.:
PROJ. NO.: 771481	PROJ. MGR.: SPANGBERG	ENGR. CHCK. BY: G.YU	DRAWN BY:
STARTING DATE: 9/3/98	DRAWN BY: D.HALL	11/28/01	02:27:59
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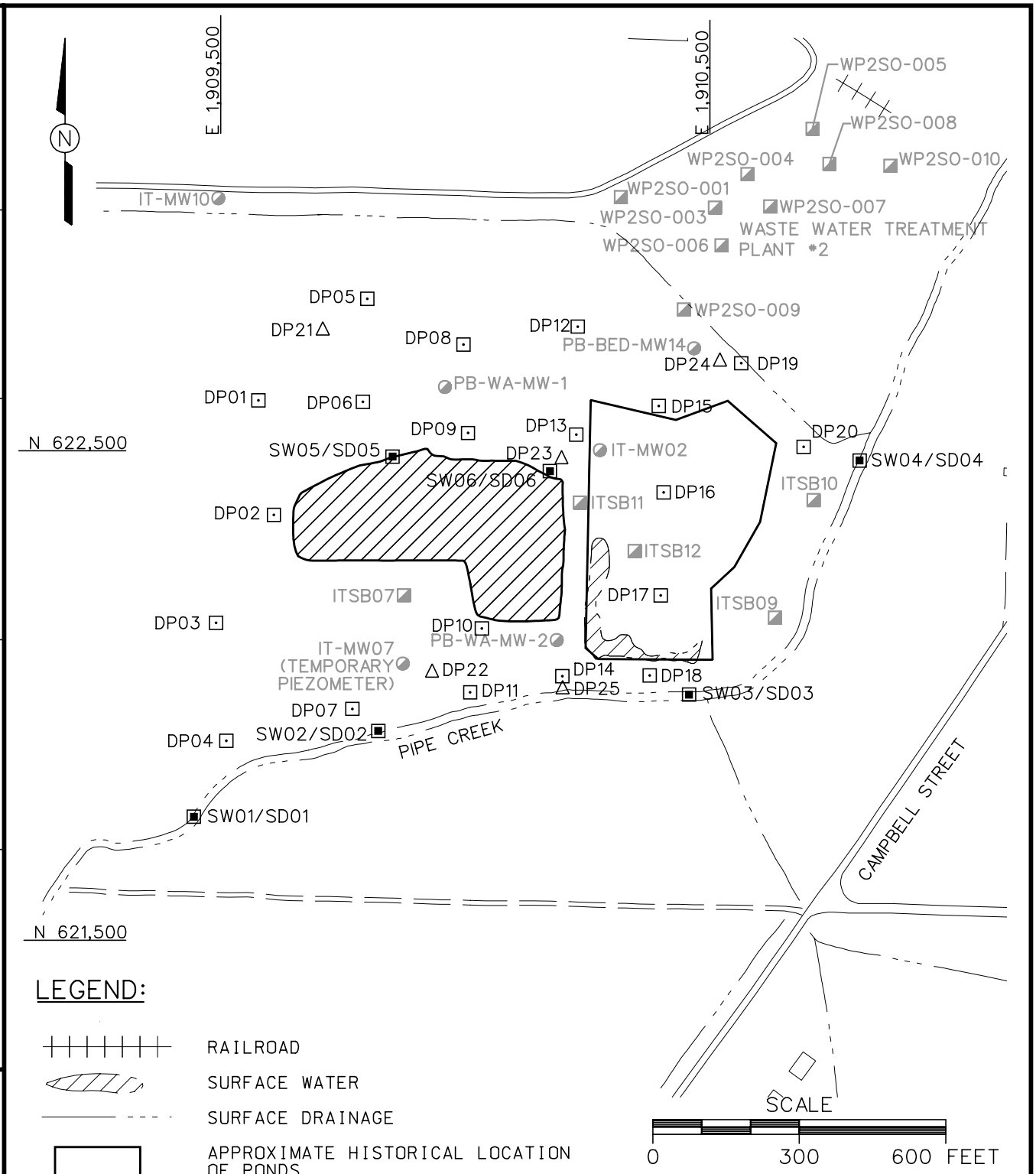

LEGEND:

	RAILROAD
	SURFACE WATER
	SURFACE DRAINAGE
	APPROXIMATE HISTORICAL LOCATION OF PONDS
IT-MW02	EXISTING MONITORING WELL LOCATION
WP2SO-010	EXISTING SOIL BORING LOCATION
DP01	DIRECT PUSH SAMPLE LOCATIONS
DP21	DIRECT PUSH GEOTECHNICAL LOCATIONS
SW01/SD01	SURFACE WATER/SEDIMENT SAMPLES
	UNPAVED ROADS/DRIVES
	PAVED ROADS

FIGURE 2-1
WEST AREA RED WATER PONDS SAMPLE LOCATIONS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 12/16/97	DATE LAST REV.:	DRAFT. CHCK. BY: C. TUMLIN	INITIATOR: D. KESSLER	DWG. NO.: \773701ES.011
DRAWN BY: D. BILLINGSLEY	DRAWN BY:	ENGR. CHCK. BY: R. ELLIS	PROJ. MGR.: SPANGBERG	PROJ. NO.: 773701

01:18:46 04/22/02
BVANDERG
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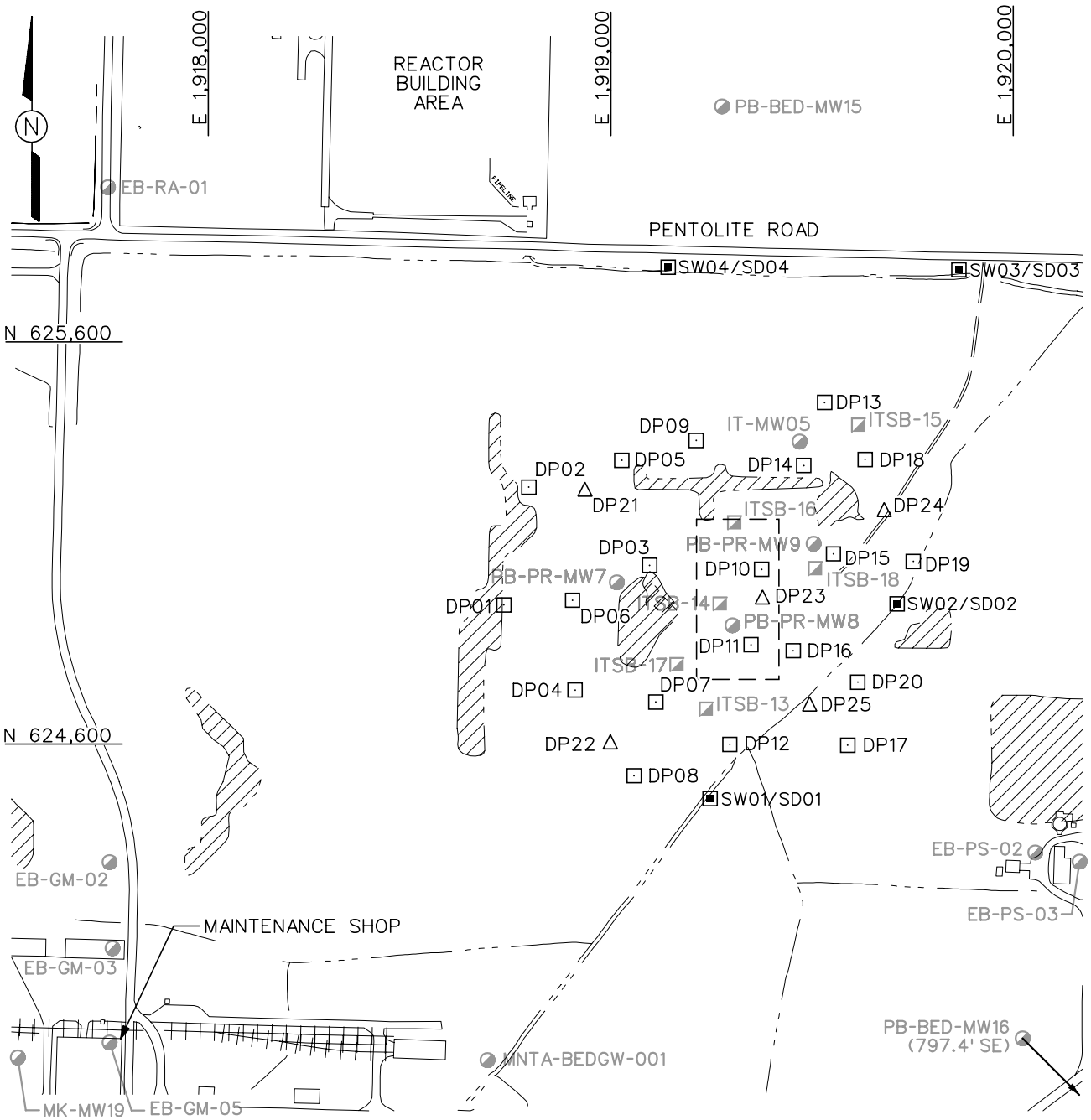

LEGEND:

	BUILDINGS
	RAILROAD
	SURFACE WATER
	SURFACE WATER DRAINAGE
	APPROXIMATE HISTORICAL LOCATION OF PONDS
	FENCE (PBOW BOUNDARY)
IT-MW02	EXISTING MONITORING WELL LOCATION
ITSB-13	EXISTING SOIL BORING LOCAITON
DP01	DIRECT PUSH SAMPLE LOCATIONS
DP21	DIRECT PUSH GEOTECHNICAL LOCATIONS
SW01/SD01	SURFACE WATER/SEDIMENT SAMPLES

SCALE

0 400 800 FEET

FIGURE 2-2
PENTOLITE ROAD RED WATER PONDS SAMPLE LOCATIONS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

DWG. NO.:\773701ES.012
PROJ. NO.: 773701
INITIATOR: D. KESSLER
PROJ. MGR.: SPANGBERG
DRAFT. CHCK. BY: C. TUMLIN
ENGR. CHCK. BY: R. ELLIS
DATE LAST REV.:
DRAWN BY:
STARTING DATE: 12/16/97
DRAWN BY: D. BILLINGSLEY
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04/22/02
BVANDERG
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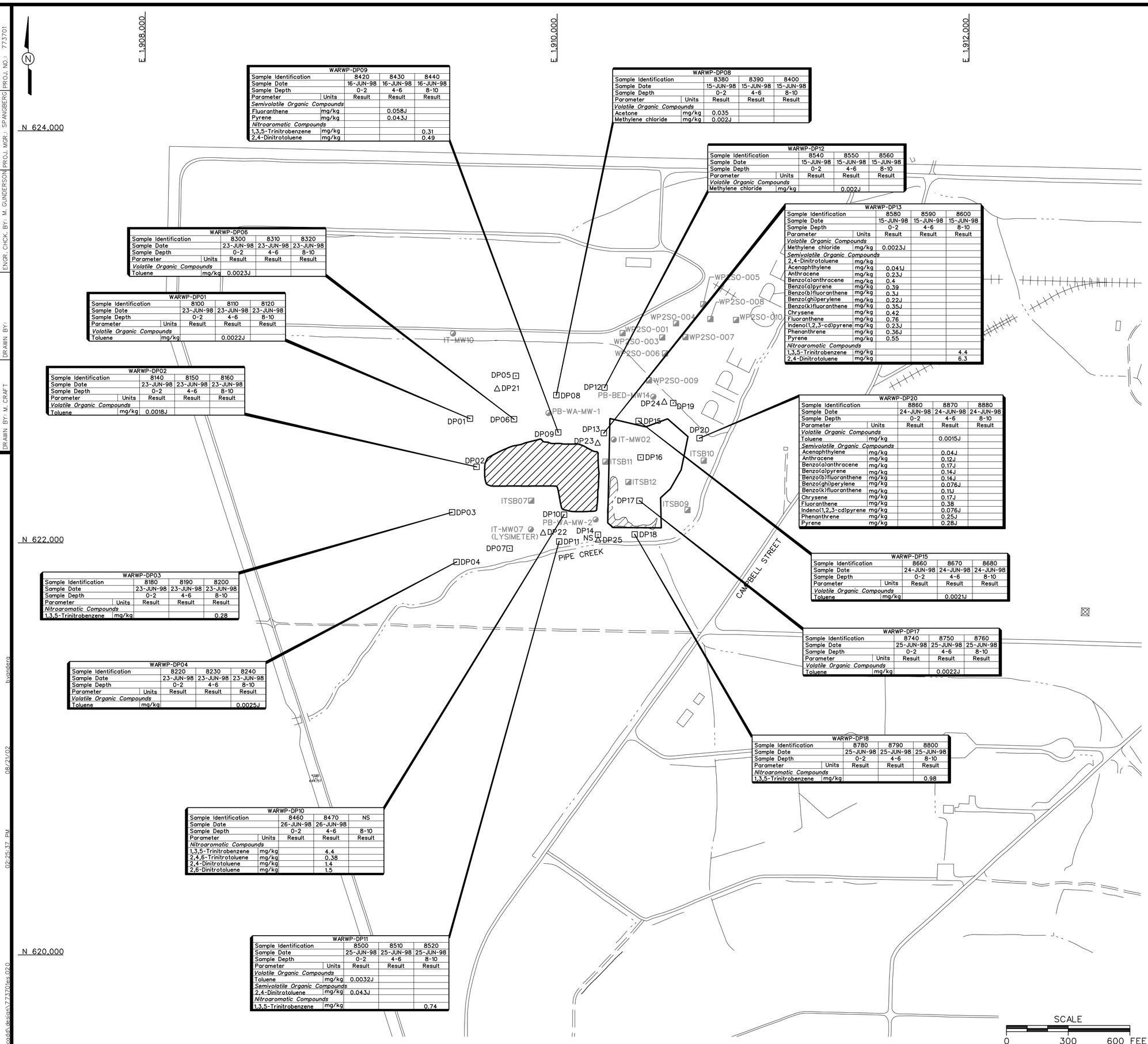

WARWP-DP09				
Sample Identification		8420	8430	8440
Sample Date		16-JUN-98	16-JUN-98	16-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Semivolatile Organic Compounds				
Fluoranthene	mg/kg		0.058J	
Pyrene	mg/kg		0.043J	
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg			0.31
2,4-Dinitrotoluene	mg/kg			0.49

WARWP-DP08				
Sample Identification		8380	8390	8400
Sample Date		15-JUN-98	15-JUN-98	15-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Acetone	mg/kg	0.035		
Methylene chloride	mg/kg	0.002J		

WARWP-DP12				
Sample Identification		8540	8550	8560
Sample Date		15-JUN-98	15-JUN-98	15-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Methylene chloride	mg/kg		0.002J	

WARWP-DP06				
Sample Identification		8300	8310	8320
Sample Date		23-JUN-98	23-JUN-98	23-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg	0.0023J		

WARWP-DP01				
Sample Identification		8100	8110	8120
Sample Date		23-JUN-98	23-JUN-98	23-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg		0.0022J	

WARWP-DP02				
Sample Identification		8140	8150	8160
Sample Date		23-JUN-98	23-JUN-98	23-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg	0.0018J		

WARWP-DP13				
Sample Identification		8580	8590	8600
Sample Date		15-JUN-98	15-JUN-98	15-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Methylene chloride	mg/kg	0.0023J		
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	mg/kg			
Acenaphthylene	mg/kg	0.041J		
Anthracene	mg/kg	0.23J		
Benzo(a)anthracene	mg/kg	0.4		
Benzo(a)pyrene	mg/kg	0.39		
Benzo(b)fluoranthene	mg/kg	0.3J		
Benzo(ghi)perylene	mg/kg	0.22J		
Benzo(k)fluoranthene	mg/kg	0.35J		
Chrysene	mg/kg	0.42		
Fluoranthene	mg/kg	0.76		
Indeno(1,2,3-cd)pyrene	mg/kg	0.23J		
Phenanthrene	mg/kg	0.36J		
Pyrene	mg/kg	0.55		
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg			4.4
2,4-Dinitrotoluene	mg/kg			6.3

WARWP-DP20				
Sample Identification		8860	8870	8880
Sample Date		24-JUN-98	24-JUN-98	24-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg		0.0015J	
Semivolatile Organic Compounds				
Acenaphthylene	mg/kg		0.04J	
Anthracene	mg/kg		0.12J	
Benzo(a)anthracene	mg/kg		0.17J	
Benzo(a)pyrene	mg/kg		0.14J	
Benzo(b)fluoranthene	mg/kg		0.14J	
Benzo(ghi)perylene	mg/kg		0.076J	
Benzo(k)fluoranthene	mg/kg		0.11J	
Chrysene	mg/kg		0.17J	
Fluoranthene	mg/kg		0.38	
Indeno(1,2,3-cd)pyrene	mg/kg		0.076J	
Phenanthrene	mg/kg		0.25J	
Pyrene	mg/kg		0.28J	

WARWP-DP15				
Sample Identification		8660	8670	8680
Sample Date		24-JUN-98	24-JUN-98	24-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg		0.0021J	

WARWP-DP03				
Sample Identification		8180	8190	8200
Sample Date		23-JUN-98	23-JUN-98	23-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg			0.28

WARWP-DP17				
Sample Identification		8740	8750	8760
Sample Date		25-JUN-98	25-JUN-98	25-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg		0.0022J	

WARWP-DP04				
Sample Identification		8220	8230	8240
Sample Date		23-JUN-98	23-JUN-98	23-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg			0.0025J

WARWP-DP18				
Sample Identification		8780	8790	8800
Sample Date		25-JUN-98	25-JUN-98	25-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg			0.98

WARWP-DP10				
Sample Identification		8460	8470	NS
Sample Date		26-JUN-98	26-JUN-98	
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg		4.4	
2,4,6-Trinitrotoluene	mg/kg		0.38	
2,4-Dinitrotoluene	mg/kg		1.4	
2,6-Dinitrotoluene	mg/kg		1.5	

WARWP-DP11				
Sample Identification		8500	8510	8520
Sample Date		25-JUN-98	25-JUN-98	25-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg	0.0032J		
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	mg/kg	0.043J		
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg			0.74

LEGEND:

- BUILDINGS
- RAILROAD
- SURFACE WATER
- SURFACE DRAINAGE
- APPROXIMATE HISTORICAL LOCATION OF PONDS
- IT-MW02 — EXISTING MONITORING WELL LOCATION
- WP2SO-010 — EXISTING SOIL BORING LOCATION
- DP01 — DIRECT PUSH SAMPLE LOCATIONS
- NS — NOT SAMPLED
- DP21 — DIRECT PUSH GEOTECHNICAL LOCATIONS
- UNPAVED ROADS/DRIVES
- PAVED ROADS

SCALE
0 300 600 FEET

FIGURE 4-1
DETECTED ORGANIC CONSTITUENTS IN SOIL, WEST AREA RED WATER PONDS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 3/2/99 | DATE LAST REV.: | DRAFT. CHCK. BY: | INITIATOR: M. GUNDERSON | DWG. NO.: 773701es.020
DRAWN BY: M. CRAFT | DRAWN BY: | ENGR. CHCK. BY: M. GUNDERSON | PROJ. MGR.: SPANGBERG | PROJ. NO.: 773701

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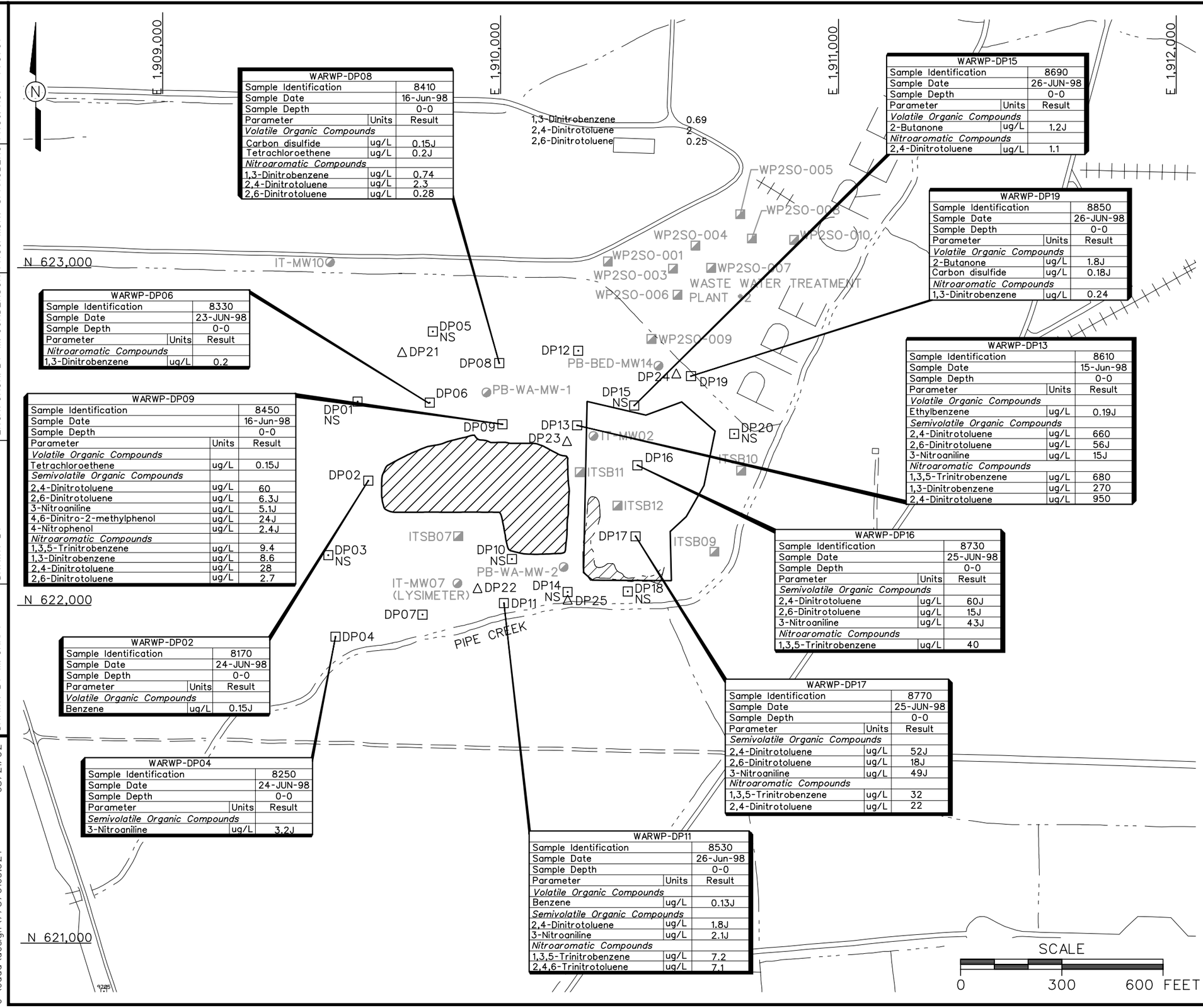

WARWP-DP08		
Sample Identification		8410
Sample Date		16-Jun-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Carbon disulfide	ug/L	0.15J
Tetrachloroethene	ug/L	0.2J
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	0.74
2,4-Dinitrotoluene	ug/L	2.3
2,6-Dinitrotoluene	ug/L	0.28

WARWP-DP15		
Sample Identification		8690
Sample Date		26-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
2-Butanone	ug/L	1.2J
Nitroaromatic Compounds		
2,4-Dinitrotoluene	ug/L	1.1

WARWP-DP19		
Sample Identification		8850
Sample Date		26-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
2-Butanone	ug/L	1.8J
Carbon disulfide	ug/L	0.18J
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	0.24

WARWP-DP06		
Sample Identification		8330
Sample Date		23-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	0.2

WARWP-DP13		
Sample Identification		8610
Sample Date		15-Jun-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Ethylbenzene	ug/L	0.19J
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	660
2,6-Dinitrotoluene	ug/L	56J
3-Nitroaniline	ug/L	15J
Nitroaromatic Compounds		
1,3,5-Trinitrobenzene	ug/L	680
1,3-Dinitrobenzene	ug/L	270
2,4-Dinitrotoluene	ug/L	950

WARWP-DP09		
Sample Identification		8450
Sample Date		16-Jun-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Tetrachloroethene	ug/L	0.15J
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	60
2,6-Dinitrotoluene	ug/L	6.3J
3-Nitroaniline	ug/L	5.1J
4,6-Dinitro-2-methylphenol	ug/L	24J
4-Nitrophenol	ug/L	2.4J
Nitroaromatic Compounds		
1,3,5-Trinitrobenzene	ug/L	9.4
1,3-Dinitrobenzene	ug/L	8.6
2,4-Dinitrotoluene	ug/L	28
2,6-Dinitrotoluene	ug/L	2.7

WARWP-DP16		
Sample Identification		8730
Sample Date		25-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	60J
2,6-Dinitrotoluene	ug/L	15J
3-Nitroaniline	ug/L	43J
Nitroaromatic Compounds		
1,3,5-Trinitrobenzene	ug/L	40

WARWP-DP02		
Sample Identification		8170
Sample Date		24-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Benzene	ug/L	0.15J

WARWP-DP17		
Sample Identification		8770
Sample Date		25-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	52J
2,6-Dinitrotoluene	ug/L	18J
3-Nitroaniline	ug/L	49J
Nitroaromatic Compounds		
1,3,5-Trinitrobenzene	ug/L	32
2,4-Dinitrotoluene	ug/L	22

WARWP-DP04		
Sample Identification		8250
Sample Date		24-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
3-Nitroaniline	ug/L	3.2J

WARWP-DP11		
Sample Identification		8530
Sample Date		26-Jun-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Benzene	ug/L	0.13J
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	1.8J
3-Nitroaniline	ug/L	2.1J
Nitroaromatic Compounds		
1,3,5-Trinitrobenzene	ug/L	7.2
2,4,6-Trinitrotoluene	ug/L	7.1

LEGEND:

- BUILDINGS
- RAILROAD
- SURFACE WATER
- SURFACE DRAINAGE
- APPROXIMATE HISTORICAL LOCATION OF PONDS
- IT-MW02 — EXISTING MONITORING WELL LOCATION
- WP2SO-010 — EXISTING SOIL BORING LOCATION
- DP01 — DIRECT PUSH SAMPLE LOCATIONS
- NS — NOT SAMPLED
- DP21 — DIRECT PUSH GEOTECHNICAL LOCATIONS
- UNPAVED ROADS/DRIVES
- PAVED ROADS

SCALE
0 300 600 FEET

FIGURE 4-2
DETECTED ORGANIC CONSTITUENTS IN GROUNDWATER, WEST AREA RED WATER PONDS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

INTERNATIONAL TECHNOLOGY CORPORATION

DWG. NO.: \773701es.024 | PROJ. NO.: 773701
INITIATOR: M. GUNDERSON | PROJ. MGR.: SPANGBERG
DRAFT. CHCK. BY: | ENGR. CHCK. BY: M. GUNDERSON
DATE LAST REV.: | DRAWN BY:
STARTING DATE: 3/3/99 | DRAWN BY: M. CRAFT
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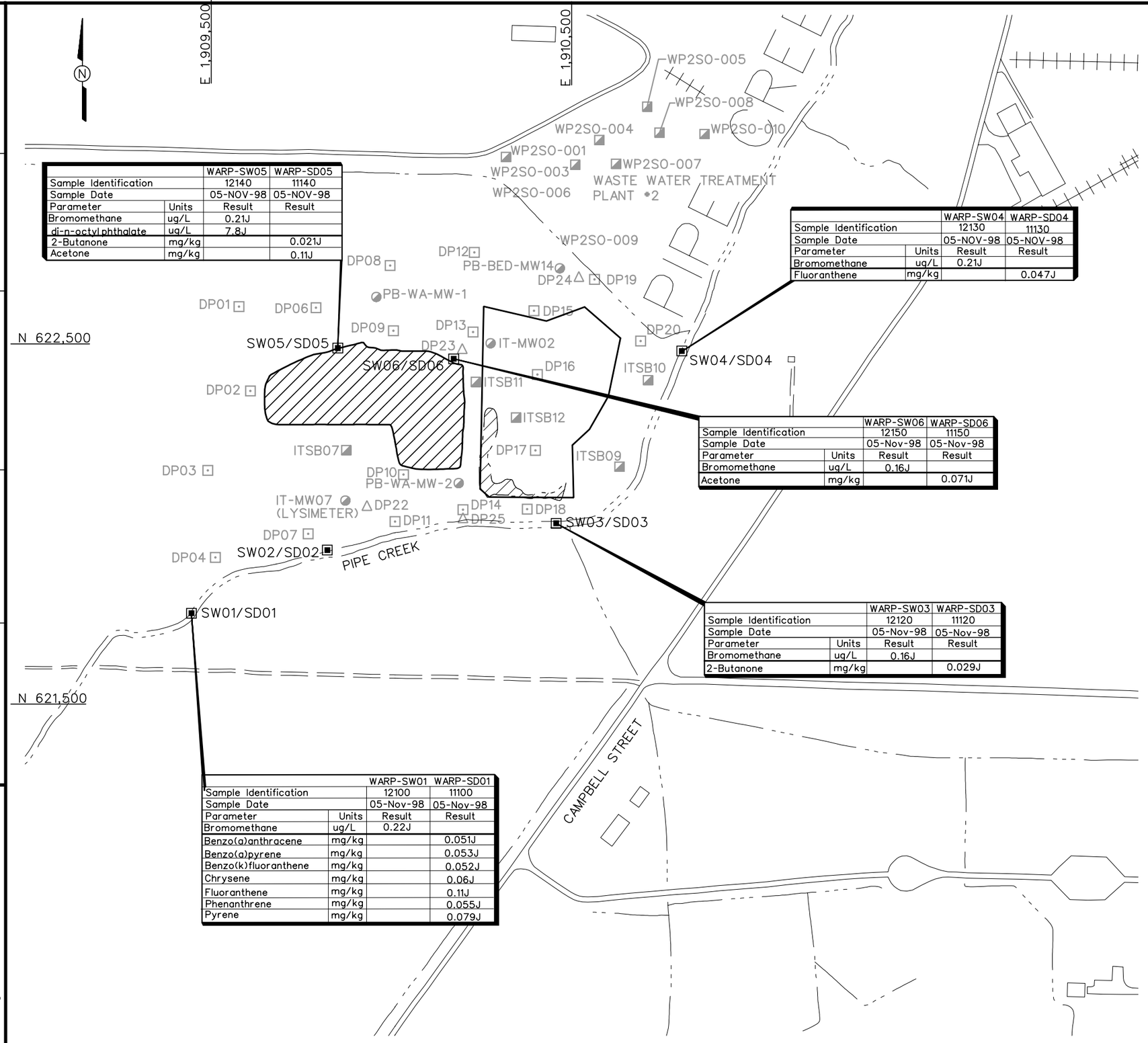

		WARP-SW05	WARP-SD05
Sample Identification		12140	11140
Sample Date		05-NOV-98	05-NOV-98
Parameter	Units	Result	Result
Bromomethane	ug/L	0.21J	
di-n-octylphthalate	ug/L	7.8J	
2-Butanone	mg/kg		0.021J
Acetone	mg/kg		0.11J

		WARP-SW04	WARP-SD04
Sample Identification		12130	11130
Sample Date		05-NOV-98	05-NOV-98
Parameter	Units	Result	Result
Bromomethane	ug/L	0.21J	
Fluoranthene	mg/kg		0.047J

		WARP-SW06	WARP-SD06
Sample Identification		12150	11150
Sample Date		05-Nov-98	05-Nov-98
Parameter	Units	Result	Result
Bromomethane	ug/L	0.16J	
Acetone	mg/kg		0.071J

		WARP-SW03	WARP-SD03
Sample Identification		12120	11120
Sample Date		05-Nov-98	05-Nov-98
Parameter	Units	Result	Result
Bromomethane	ug/L	0.16J	
2-Butanone	mg/kg		0.029J

		WARP-SW01	WARP-SD01
Sample Identification		12100	11100
Sample Date		05-Nov-98	05-Nov-98
Parameter	Units	Result	Result
Bromomethane	ug/L	0.22J	
Benzo(a)anthracene	mg/kg		0.051J
Benzo(a)pyrene	mg/kg		0.053J
Benzo(k)fluoranthene	mg/kg		0.052J
Chrysene	mg/kg		0.06J
Fluoranthene	mg/kg		0.11J
Phenanthrene	mg/kg		0.055J
Pyrene	mg/kg		0.079J

LEGEND:

- RAILROAD
- SURFACE WATER
- SURFACE DRAINAGE
- APPROXIMATE HISTORICAL LOCATION OF PONDS
- IT-MW02 — EXISTING MONITORING WELL LOCATION
- WP2SO-010 — EXISTING SOIL BORING LOCATION
- DP01 — DIRECT PUSH SAMPLE LOCATIONS
- DP21 — DIRECT PUSH GEOTECHNICAL LOCATIONS
- SW01/SD01 — SURFACE WATER/SEDIMENT SAMPLES
- UNPAVED ROADS/DRIVES
- PAVED ROADS

SCALE

0 300 600 FEET

FIGURE 4-3
DETECTED ORGANIC CONSTITUENTS IN SW/SD SAMPLES WEST AREA RED WATER PONDS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

INTERNATIONAL TECHNOLOGY CORPORATION

DRAFT. CHCK. BY: C. TUMLIN	INITIATOR: D. KESSLER	DWG. NO.: \773701es.025	
ENGR. CHCK. BY: R. ELLIS	PROJ. MGR.: SPANGBERG	PROJ. NO.: 773701	
DATE LAST REV.:	STARTING DATE: 3/5/99		
DRAWN BY:	DRAWN BY: P. COLEMAN		

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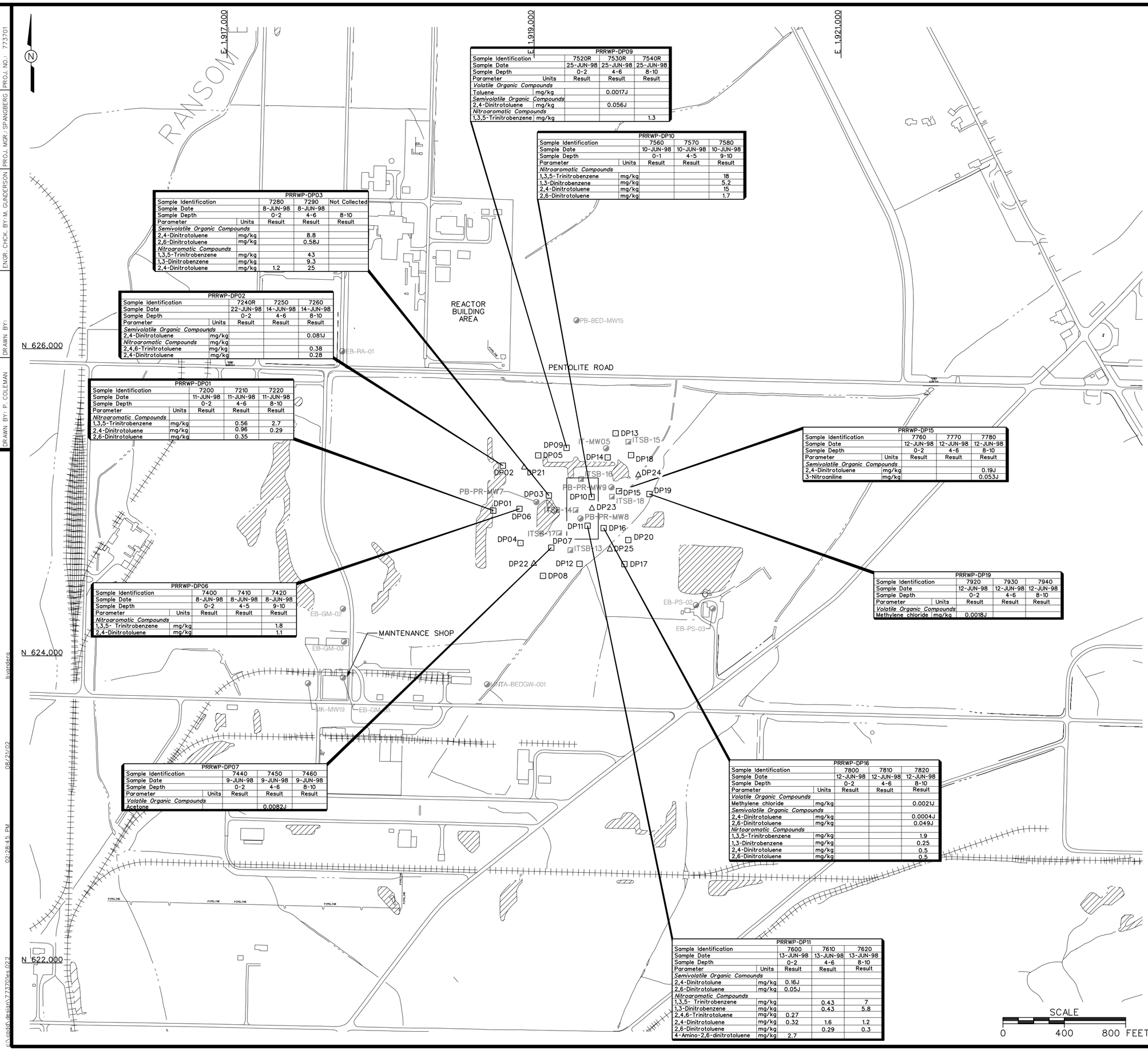

PRRWP-DP09				
Sample Identification		7520R	7530R	7540R
Sample Date		25-JUN-98	25-JUN-98	25-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Toluene	mg/kg		0.0017J	
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	mg/kg		0.056J	
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg			1.3

PRRWP-DP10				
Sample Identification		7560	7570	7580
Sample Date		10-JUN-98	10-JUN-98	10-JUN-98
Sample Depth		0-1	4-5	9-10
Parameter	Units	Result	Result	Result
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg			18
1,3-Dinitrobenzene	mg/kg			5.2
2,4-Dinitrotoluene	mg/kg			15
2,6-Dinitrotoluene	mg/kg			1.7

PRRWP-DP03				
Sample Identification		7280	7290	Not Collected
Sample Date		8-JUN-98	8-JUN-98	
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	mg/kg		8.8	
2,6-Dinitrotoluene	mg/kg		0.58J	
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg		43	
1,3-Dinitrobenzene	mg/kg		9.3	
2,4-Dinitrotoluene	mg/kg	1.2	25	

PRRWP-DP02				
Sample Identification		7240R	7250	7260
Sample Date		22-JUN-98	14-JUN-98	14-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	mg/kg			0.081J
Nitroaromatic Compounds	mg/kg			
2,4,6-Trinitrotoluene	mg/kg			0.38
2,4-Dinitrotoluene	mg/kg			0.28

PRRWP-DP01				
Sample Identification		7200	7210	7220
Sample Date		11-JUN-98	11-JUN-98	11-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Nitroaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg		0.56	2.7
2,4-Dinitrotoluene	mg/kg		0.96	0.29
2,6-Dinitrotoluene	mg/kg		0.35	

PRRWP-DP15				
Sample Identification		7760	7770	7780
Sample Date		12-JUN-98	12-JUN-98	12-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	mg/kg			0.19J
3-Nitroaniline	mg/kg			0.053J

PRRWP-DP19				
Sample Identification		7920	7930	7940
Sample Date		12-JUN-98	12-JUN-98	12-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Methylene chloride	mg/kg	0.0018J		

PRRWP-DP06				
Sample Identification		7400	7410	7420
Sample Date		8-JUN-98	8-JUN-98	8-JUN-98
Sample Depth		0-2	4-5	9-10
Parameter	Units	Result	Result	Result
Nitroaromatic Compounds				
1,3,5- Trinitrobenzene	mg/kg			1.8
2,4-Dinitrotoluene	mg/kg			1.1

PRRWP-DP07				
Sample Identification		7440	7450	7460
Sample Date		9-JUN-98	9-JUN-98	9-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Acetone			0.0082J	

PRRWP-DP16				
Sample Identification		7800	7810	7820
Sample Date		12-JUN-98	12-JUN-98	12-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Volatile Organic Compounds				
Methylene chloride	mg/kg			0.0021J
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	mg/kg			0.0004J
2,6-Dinitrotoluene	mg/kg			0.049J
Nirtoaromatic Compounds				
1,3,5-Trinitrobenzene	mg/kg			1.9
1,3-Dinitrobenzene	mg/kg			0.25
2,4-Dinitrotoluene	mg/kg			0.5
2,6-Dinitrotoluene	mg/kg			0.5

PRRWP-DP11				
Sample Identification		7600	7610	7620
Sample Date		13-JUN-98	13-JUN-98	13-JUN-98
Sample Depth		0-2	4-6	8-10
Parameter	Units	Result	Result	Result
Semivolatile Organic Comounds				
2,4-Dinitrotolune	mg/kg	0.16J		
2,6-Dinitrotoluene	mg/kg	0.05J		
Nitroaromatic Compounds				
1,3,5- Trinitrobenzene	mg/kg		0.43	7
1,3-Dinitrobenzene	mg/kg		0.43	5.8
2,4,6-Trinitrotoluene	mg/kg	0.27		
2,4-Dinitrotoluene	mg/kg	0.32	1.6	1.2
2,6-Dinitrotoluene	mg/kg		0.29	0.3
4-Amino-2,6-dinitrotoluene	mg/kg	2.7		

FIGURE 4-4
DETECTED ORGANIC CONSTITUENTS IN SOIL, PENTOLITE ROAD RED WATER PONDS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 3/3/99	DATE LAST REV.:	DRAFT. CHCK. BY:	INITIATOR:M. GUNDERSON
DRAWN BY: P. COLEMAN	DRAWN BY:	ENGR. CHCK. BY:M. GUNDERSON	PROJ.: MGR.:SPANGBERG
			DWG. NO.: 773701es.022
			PROJ. NO.: 773701

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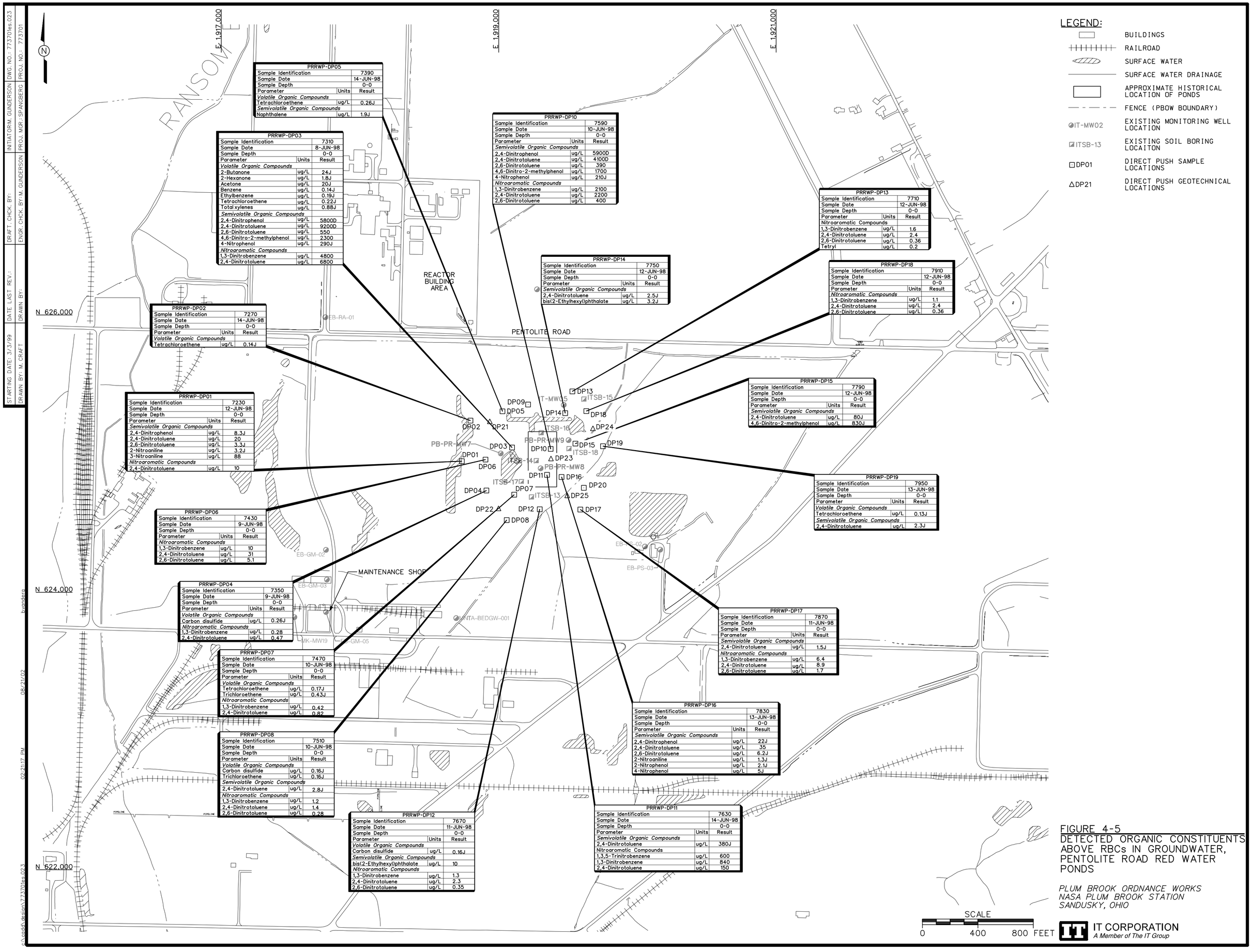

PRRWP-DP05		
Sample Identification		7390
Sample Date		14-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Tetrachloroethene	ug/L	0.26J
Semivolatile Organic Compounds		
Naphthalene	ug/L	1.9J

PRRWP-DP03		
Sample Identification		7310
Sample Date		8-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
2-Butanone	ug/L	24J
2-Hexanone	ug/L	1.8J
Acetone	ug/L	20J
Benzene	ug/L	0.14J
Ethylbenzene	ug/L	0.19J
Tetrachloroethene	ug/L	0.22J
Total xylenes	ug/L	0.88J
Semivolatile Organic Compounds		
2,4-Dinitrophenol	ug/L	5800D
2,4-Dinitrotoluene	ug/L	9200D
2,6-Dinitrotoluene	ug/L	550
4,6-Dinitro-2-methylphenol	ug/L	230D
4-Nitrophenol	ug/L	290J
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	4800
2,4-Dinitrotoluene	ug/L	6800

PRRWP-DP02		
Sample Identification		7270
Sample Date		14-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Tetrachloroethene	ug/L	0.14J

PRRWP-DP01		
Sample Identification		7230
Sample Date		12-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrophenol	ug/L	8.3J
2,4-Dinitrotoluene	ug/L	20
2,6-Dinitrotoluene	ug/L	3.3J
2-Nitroaniline	ug/L	3.2J
3-Nitroaniline	ug/L	88
Nitroaromatic Compounds		
2,4-Dinitrotoluene	ug/L	10

PRRWP-DP06		
Sample Identification		7430
Sample Date		9-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	10
2,4-Dinitrotoluene	ug/L	31
2,6-Dinitrotoluene	ug/L	5.1

PRRWP-DP04		
Sample Identification		7350
Sample Date		9-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Carbon disulfide	ug/L	0.26J
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	0.28
2,4-Dinitrotoluene	ug/L	0.47

PRRWP-DP07		
Sample Identification		7470
Sample Date		10-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Tetrachloroethene	ug/L	0.17J
Trichloroethene	ug/L	0.43J
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	0.42
2,4-Dinitrotoluene	ug/L	0.82

PRRWP-DP08		
Sample Identification		7510
Sample Date		10-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Carbon disulfide	ug/L	0.16J
Trichloroethene	ug/L	0.16J
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	2.8J
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	1.2
2,4-Dinitrotoluene	ug/L	1.4
2,6-Dinitrotoluene	ug/L	0.28

PRRWP-DP12		
Sample Identification		7670
Sample Date		11-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Carbon disulfide	ug/L	0.16J
Semivolatile Organic Compounds		
bis(2-Ethylhexyl)phthalate	ug/L	10
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	1.3
2,4-Dinitrotoluene	ug/L	2.3
2,6-Dinitrotoluene	ug/L	0.35

PRRWP-DP10		
Sample Identification		7590
Sample Date		10-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrophenol	ug/L	5900D
2,4-Dinitrotoluene	ug/L	4100D
2,6-Dinitrotoluene	ug/L	390
4,6-Dinitro-2-methylphenol	ug/L	1700
4-Nitrophenol	ug/L	210J
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	2100
2,4-Dinitrotoluene	ug/L	2200
2,6-Dinitrotoluene	ug/L	400

PRRWP-DP14		
Sample Identification		7750
Sample Date		12-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	2.5J
bis(2-Ethylhexyl)phthalate	ug/L	3.2J

PRRWP-DP13		
Sample Identification		7710
Sample Date		12-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	1.6
2,4-Dinitrotoluene	ug/L	2.4
2,6-Dinitrotoluene	ug/L	0.36
Tetryl	ug/L	0.2

PRRWP-DP18		
Sample Identification		7910
Sample Date		12-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	1.1
2,4-Dinitrotoluene	ug/L	2.4
2,6-Dinitrotoluene	ug/L	0.36

PRRWP-DP15		
Sample Identification		7790
Sample Date		12-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	80J
4,6-Dinitro-2-methylphenol	ug/L	830J

PRRWP-DP19		
Sample Identification		7950
Sample Date		13-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Volatile Organic Compounds		
Tetrachloroethene	ug/L	0.13J
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	2.3J

PRRWP-DP17		
Sample Identification		7870
Sample Date		11-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	1.5J
Nitroaromatic Compounds		
1,3-Dinitrobenzene	ug/L	6.4
2,4-Dinitrotoluene	ug/L	8.9
2,6-Dinitrotoluene	ug/L	1.7

PRRWP-DP16		
Sample Identification		7830
Sample Date		13-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrophenol	ug/L	22J
2,4-Dinitrotoluene	ug/L	35
2,6-Dinitrotoluene	ug/L	6.2J
2-Nitroaniline	ug/L	1.3J
2-Nitrophenol	ug/L	2.1J
4-Nitrophenol	ug/L	5J

PRRWP-DP11		
Sample Identification		7630
Sample Date		14-JUN-98
Sample Depth		0-0
Parameter	Units	Result
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	ug/L	380J
Nitroaromatic Compounds		
1,3,5-Trinitrobenzene	ug/L	600
1,3-Dinitrobenzene	ug/L	840
2,4-Dinitrotoluene	ug/L	150

FIGURE 4-5
DETECTED ORGANIC CONSTITUENTS ABOVE RBCs IN GROUNDWATER, PENTOLITE ROAD RED WATER PONDS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

STARTING DATE: 3/3/99 | DATE LAST REV.: | DRAFT. CHCK. BY: | INITIATOR:M. GUNDERSON | DWG. NO.: 773701es.023
DRAWN BY: M. CRAFT | DRAWN BY: | ENGR. CHCK. BY:M. GUNDERSON | PROJ. MGR.:SPANGBERG | PROJ. NO.: 773701

08/21/02 02:21:17 PM bvandberg
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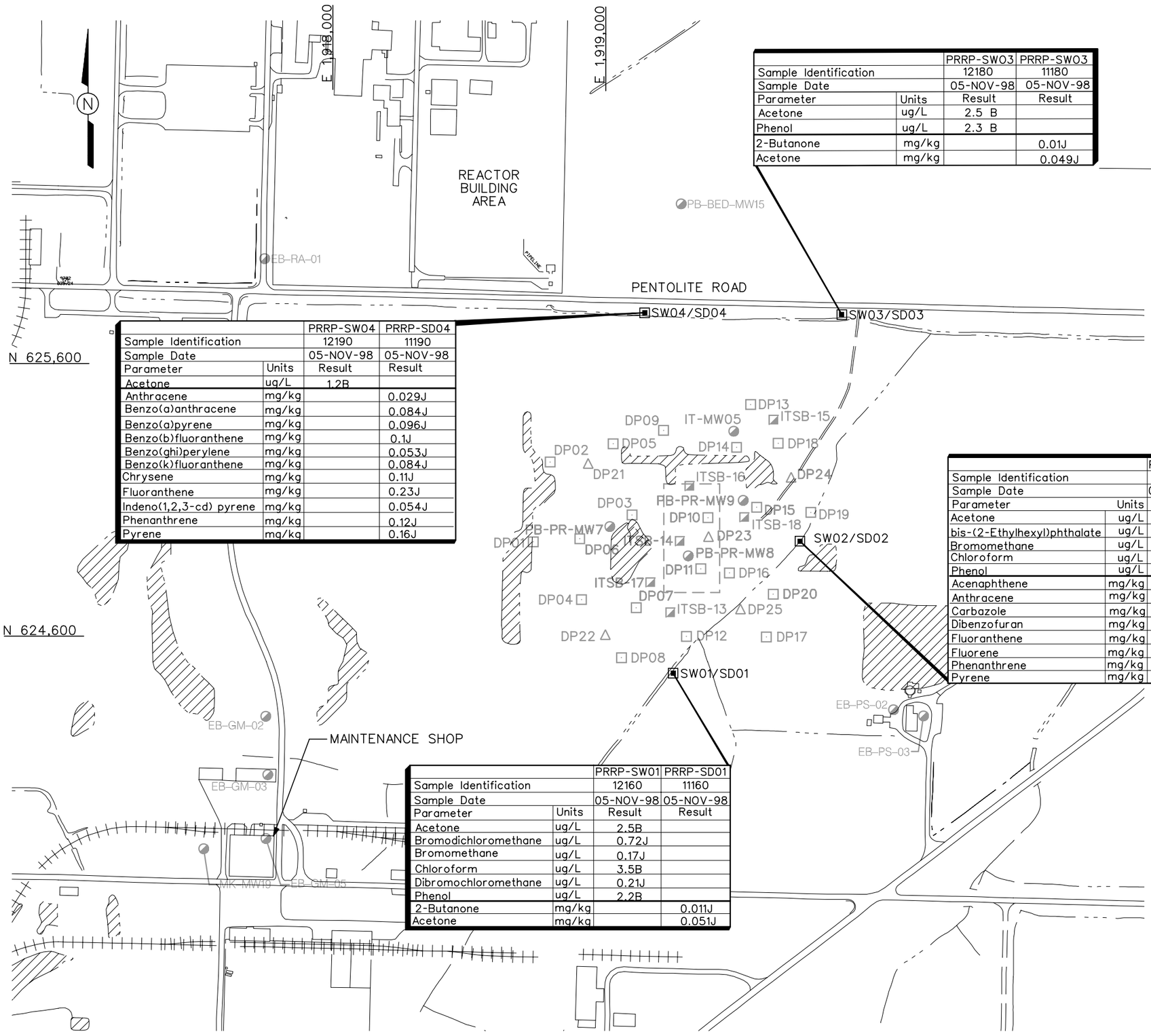


		PRRP-SW03	PRRP-SW03
Sample Identification		12180	11180
Sample Date		05-NOV-98	05-NOV-98
Parameter	Units	Result	Result
Acetone	ug/L	2.5 B	
Phenol	ug/L	2.3 B	
2-Butanone	mg/kg		0.01J
Acetone	mg/kg		0.049J

		PRRP-SW04	PRRP-SD04
Sample Identification		12190	11190
Sample Date		05-NOV-98	05-NOV-98
Parameter	Units	Result	Result
Acetone	ug/L	1.2B	
Anthracene	mg/kg		0.029J
Benzo(a)anthracene	mg/kg		0.084J
Benzo(a)pyrene	mg/kg		0.096J
Benzo(b)fluoranthene	mg/kg		0.1J
Benzo(ghi)perylene	mg/kg		0.053J
Benzo(k)fluoranthene	mg/kg		0.084J
Chrysene	mg/kg		0.11J
Fluoranthene	mg/kg		0.23J
Indeno(1,2,3-cd) pyrene	mg/kg		0.054J
Phenanthrene	mg/kg		0.12J
Pyrene	mg/kg		0.16J

		PRRP-SW02	PRRP-SW02
Sample Identification		12170	11170
Sample Date		05-NOV-98	05-NOV-98
Parameter	Units	Result	Result
Acetone	ug/L	1.7B	
bis-(2-Ethylhexyl)phthalate	ug/L	2.1B	
Bromomethane	ug/L	0.11J	
Chloroform	ug/L	0.55B	
Phenol	ug/L	1.9B	
Acenaphthene	mg/kg		0.11J
Anthracene	mg/kg		0.077J
Carbazole	mg/kg		0.18J
Dibenzofuran	mg/kg		0.06J
Fluoranthene	mg/kg		0.14J
Fluorene	mg/kg		0.11J
Phenanthrene	mg/kg		0.32J
Pyrene	mg/kg		0.11J

		PRRP-SW01	PRRP-SD01
Sample Identification		12160	11160
Sample Date		05-NOV-98	05-NOV-98
Parameter	Units	Result	Result
Acetone	ug/L	2.5B	
Bromodichloromethane	ug/L	0.72J	
Bromomethane	ug/L	0.17J	
Chloroform	ug/L	3.5B	
Dibromochloromethane	ug/L	0.21J	
Phenol	ug/L	2.2B	
2-Butanone	mg/kg		0.011J
Acetone	mg/kg		0.051J

LEGEND:

- BUILDINGS
- RAILROAD
- SURFACE WATER
- SURFACE WATER DRAINAGE
- APPROXIMATE HISTORICAL LOCATION OF PONDS
- FENCE (PBOW BOUNDARY)
- IT-MW02 — EXISTING MONITORING WELL LOCATION
- ITSB-13 — EXISTING SOIL BORING LOCAITON
- DP01 — DIRECT PUSH SAMPLE LOCATIONS
- DP21 — DIRECT PUSH GEOTECHNICAL LOCATIONS
- SW01/SD01 — SURFACE WATER/SEDIMENT SAMPLES

SCALE

0 400 800 FEET

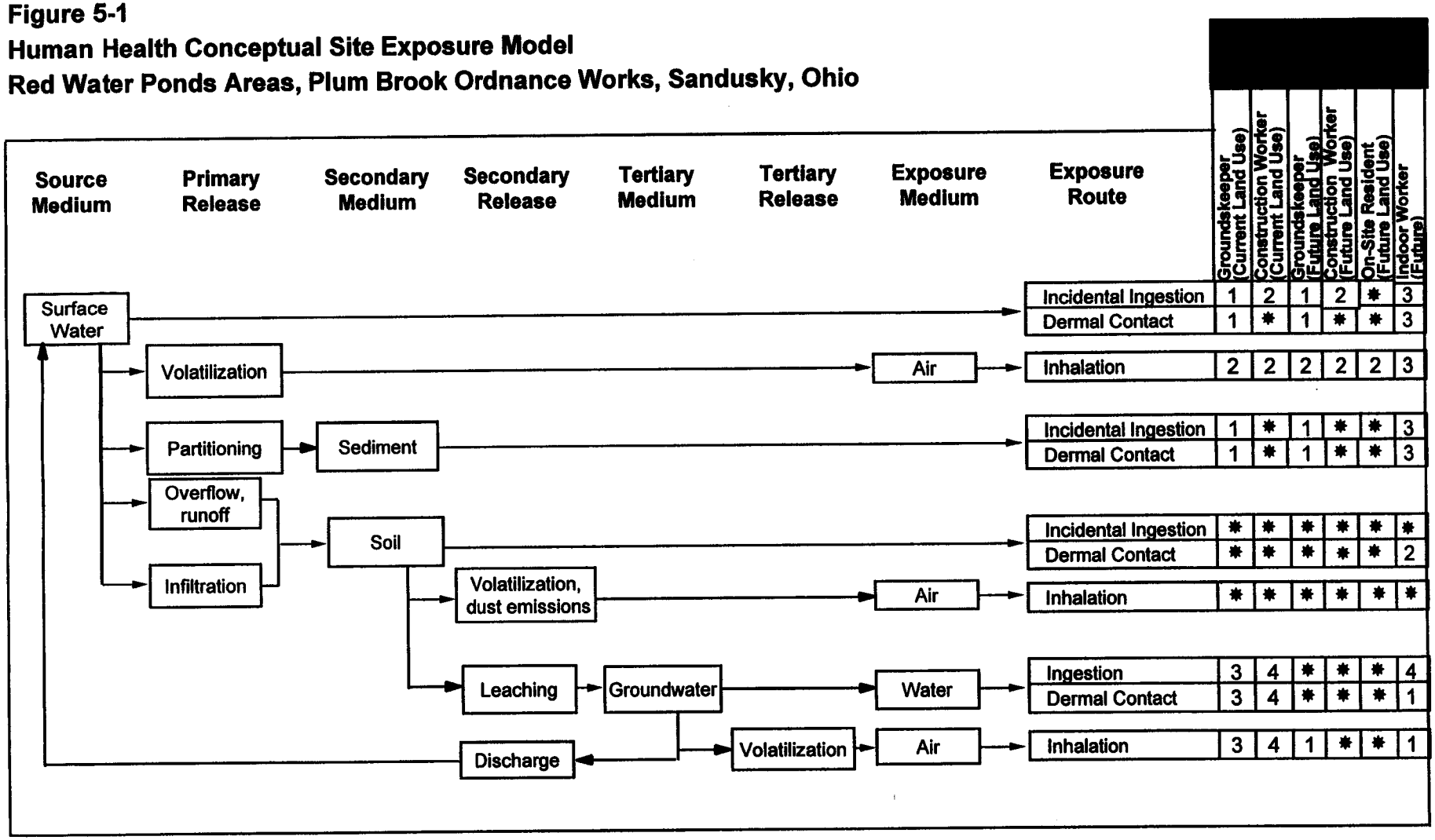
FIGURE 4-6
DETECTED ORGANIC CONSTITUENTS IN SW/SD SAMPLES PENTOLITE ROAD RED WATER PONDS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

INTERNATIONAL TECHNOLOGY CORPORATION

DWG. NO.:\773701es.026 PROJ. NO.:773701
INITIATOR: D. KESSLER PROJ. MGR.:SPANGBERG
DRAFT. CHCK. BY: C. TUMLIN ENGR. CHCK. BY: R. ELLIS
DATE LAST REV.: DRAWN BY:
STARTING DATE: 12/16/97 DRAWN BY: D. BILLINGSLEY
02:22:28 PM 08/21/02
bvanderg c:\cadd\design\773701es.026

Figure 5-1
Human Health Conceptual Site Exposure Model
Red Water Ponds Areas, Plum Brook Ordnance Works, Sandusky, Ohio



* = Complete exposure pathway evaluated in the risk assessment.
1 = Contact with this medium, although possible, is not part of this receptor's normal or expected activities; therefore, contact would be sporadic and is not quantified.
2 = Although theoretically complete, this pathway is not quantified as explained in text.
3 = There is no plausible pathway for exposure to this medium.
4 = Although a complete pathway, groundwater data are not available. Future groundwater exposures will be assessed when data become available.

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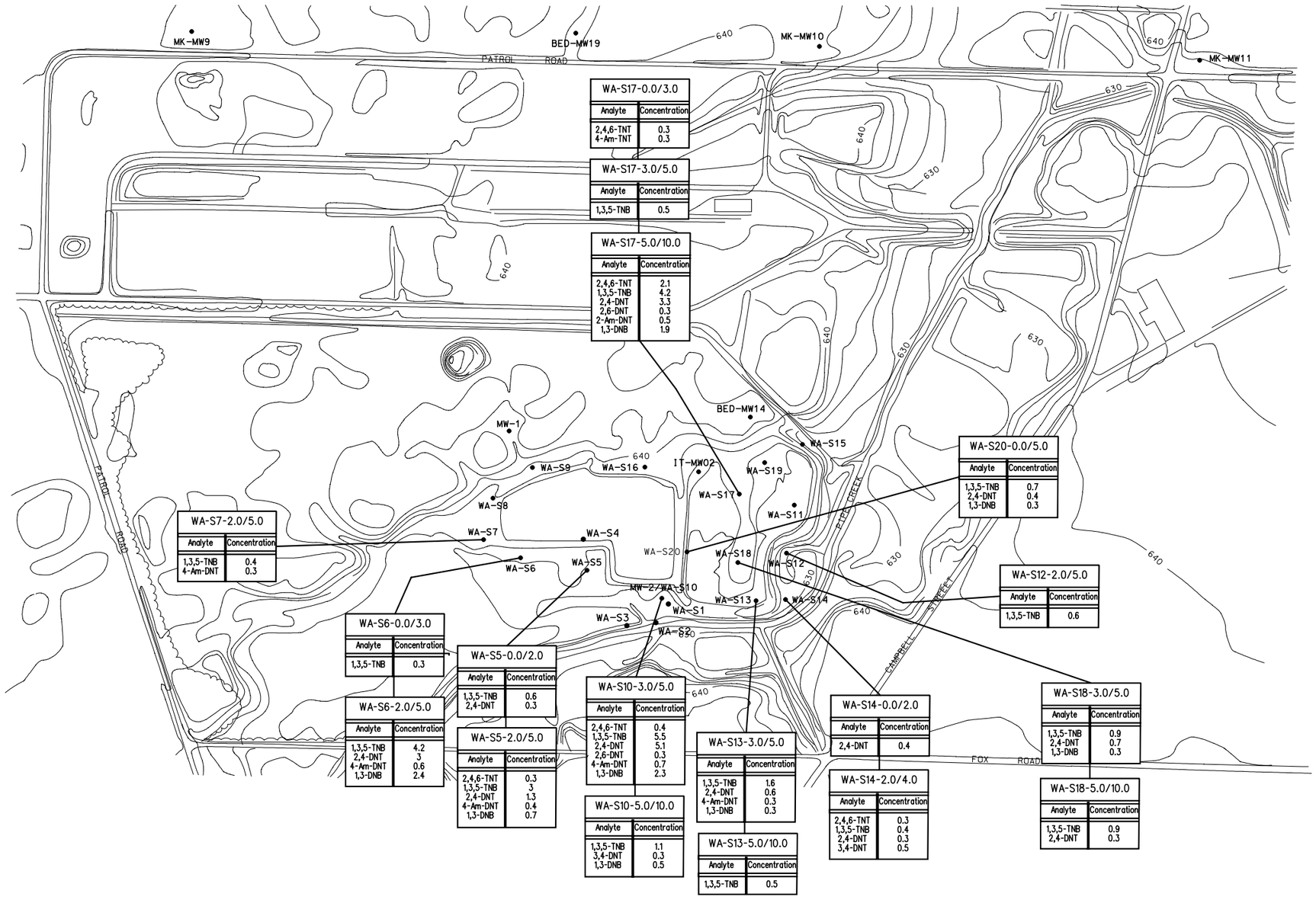
Figure 5-2

Detected Concentrations of Selected COPC in Subsurface Soil Ranked from Highest to Lowest[a]
West Area, Red Water Ponds, Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Result	Units	Sample Location	Sample Number
4-Amino-2,6-dinitrotoluene	**0.7**	mg/kg	PB-RWP-DS-S10	PB-WA-S10-3.0/5.0
4-Amino-2,6-dinitrotoluene	0.6	mg/kg	PB-RWP-DS-S6	PB-WA-S6-2.0/5.0
4-Amino-2,6-dinitrotoluene	0.4	mg/kg	PB-RWP-DS-S5	PB-WA-S5-2.0/5.0
4-Amino-2,6-dinitrotoluene	0.3	mg/kg	PB-RWP-DS-S13	PB-WA-S13-3.0/5.0
4-Amino-2,6-dinitrotoluene	0.3	mg/kg	PB-RWP-DS-S7	PB-WA-S7-2.0/5.0
1,3-Dinitrobenzene	**2.4**	mg/kg	PB-RWP-DS-S6	PB-WA-S6-2.0/5.0
1,3-Dinitrobenzene	**2.3**	mg/kg	PB-RWP-DS-S10	PB-WA-S10-3.0/5.0
1,3-Dinitrobenzene	1.9	mg/kg	PB-RWP-DS-S17	PB-WA-S17-5.0/10.0
1,3-Dinitrobenzene	0.7	mg/kg	PB-RWP-DS-S5	PB-WA-S5-2.0/5.0
1,3-Dinitrobenzene	0.5	mg/kg	PB-RWP-DS-S10	PB-WA-S10-5.0/10.0
1,3-Dinitrobenzene	0.3	mg/kg	PB-RWP-DS-S18	PB-WA-S18-3.0/5.0
2,4-Dinitrotoluene	**6.3**	mg/kg	WARP-DP13	8600
2,4-Dinitrotoluene	**5.1**	mg/kg	PB-RWP-DS-S10	PB-WA-S10-3.0/5.0
2,4-Dinitrotoluene	**3.3**	mg/kg	PB-RWP-DS-S17	PB-WA-S17-5.0/10.0
2,4-Dinitrotoluene	3	mg/kg	PB-RWP-DS-S6	PB-WA-S6-2.0/5.0
2,4-Dinitrotoluene	1.4	mg/kg	WARP-DP10	8470
2,4-Dinitrotoluene	1.3	mg/kg	PB-RWP-DS-S5	PB-WA-S5-2.0/5.0
2,4-Dinitrotoluene	0.7	mg/kg	PB-RWP-DS-S18	PB-WA-S18-3.0/5.0
2,4-Dinitrotoluene	0.6	mg/kg	PB-RWP-DS-S13	PB-WA-S13-3.0/5.0
2,4-Dinitrotoluene	0.49	mg/kg	WARP-DP09	8440
2,4-Dinitrotoluene	0.3	mg/kg	PB-RWP-DS-S14	PB-WA-S14-2.0/5.0
2,4-Dinitrotoluene	0.3	mg/kg	PB-RWP-DS-S18	PB-WA-S18-5.0/10.0
2,6-Dinitrotoluene	1.5	mg/kg	WARP-DP10	8470
2,6-Dinitrotoluene	0.3	mg/kg	PB-RWP-DS-S10	PB-WA-S10-3.0/5.0
2,6-Dinitrotoluene	0.3	mg/kg	PB-RWP-DS-S17	PB-WA-S17-5.0/10.0

mg/kg - Milligrams per kilogram.
[a] Bolded values exceed the source-term concentration.



NOTES:

CONCENTRATIONS ARE IN mg/Kg

SOURCE: DAMES & MOORE 1996

SCALE

0 400 800 FEET

FIGURE 5-3

WEST AREA RED WATER PONDS SOIL BORING LOCATIONS AND EXPLOSIVE RESIDUES CONCENTRATIONS

PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

DWG. NO.:\807053es.001 | INITIATOR:M. GUNDERSON | DRAFT. CHCK. BY: C. TUMLIN | STARTING DATE: 09/22/00 | DRAWN BY: B. VANDERGRIFF | 02:23:23 PM | bvanderg
PROJ. NO.: 807053 | PROJ. MGR.: SPANGBERG | ENGR. CHCK. BY: M. GUNDERSON | DATE LAST REV.: | DRAWN BY: | 08/21/02 | c:\cadd\design\807053es.001

Figure 5-4

Detected Concentrations of Selected COPC in Subsurface Soil Ranked from Highest to Lowest[a]
Pentolite Road Red Water Area, Red Water Ponds, Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Result	Units	Sample Location	Sample Number
4-Amino-2,6-dinitrotoluene	**9.5**	mg/kg	PB-RWP-PR-S14	PB-PR-S14-3.0/5.0
4-Amino-2,6-dinitrotoluene	**2**	mg/kg	PB-RWP-PR-S14	PB-PR-S14-5.0/10.0
4-Amino-2,6-dinitrotoluene	1	mg/kg	PB-RWP-PR-S6	PB-PR-S6-5.0/10.0
4-Amino-2,6-dinitrotoluene	0.7	mg/kg	PB-RWP-PR-S13	PB-PR-S13-5.0/10.0
4-Amino-2,6-dinitrotoluene	0.3	mg/kg	PB-RWP-PR-S6	PB-PR-S6-3.0/5.0
4-Amino-2,6-dinitrotoluene	0.3	mg/kg	PB-RWP-PR-S7	PB-PR-S7-3.0/5.0
1,3-Dinitrobenzene	**9.3**	mg/kg	PRRP-DP03	7290
1,3-Dinitrobenzene	**6.7**	mg/kg	PB-RWP-PR-S14	PB-PR-S14-5.0/10.0
1,3-Dinitrobenzene	**6.6**	mg/kg	PB-RWP-PR-S15	PB-PR-S15-5.0/10.0
1,3-Dinitrobenzene	**6.4**	mg/kg	PB-RWP-PR-S14	PB-PR-S14-3.0/5.0
1,3-Dinitrobenzene	**5.8**	mg/kg	PRRP-DP11	7620
1,3-Dinitrobenzene	**5.2**	mg/kg	PRRP-DP10	7580
1,3-Dinitrobenzene	**4.3**	mg/kg	PB-RWP-PR-S16	PB-PR-S16-5.0/10.0
1,3-Dinitrobenzene	**3.8**	mg/kg	PB-RWP-PR-S6	PB-PR-S6-5.0/10.0
1,3-Dinitrobenzene	**3.4**	mg/kg	PB-RWP-PR-S6	PB-PR-S6-3.0/5.0
1,3-Dinitrobenzene	**3.2**	mg/kg	PB-RWP-PR-S13	PB-PR-S13-5.0/10.0
1,3-Dinitrobenzene	**3.2**	mg/kg	PB-RWP-PR-S4	PB-PR-S4-3.0/5.0
1,3-Dinitrobenzene	**2.5**	mg/kg	PB-RWP-PR-S10	PB-PR-S10-5.0/10.0
1,3-Dinitrobenzene	2.2	mg/kg	PB-RWP-PR-S9	PB-PR-S9-5.0/10.0
1,3-Dinitrobenzene	2.1	mg/kg	PB-RWP-PR-S4	PB-PR-S4-5.0/10.0
1,3-Dinitrobenzene	2.1	mg/kg	PB-RWP-PR-S7	PB-PR-S7-3.0/5.0
1,3-Dinitrobenzene	1.6	mg/kg	PB-RWP-PR-S10	PB-PR-S10-3.0/5.0
1,3-Dinitrobenzene	1.5	mg/kg	PB-RWP-PR-S12	PB-PR-S12-5.0/10.0
1,3-Dinitrobenzene	1.5	mg/kg	PB-RWP-PR-S9	PB-PR-S9-3.0/5.0
1,3-Dinitrobenzene	1.4	mg/kg	PB-RWP-PR-S19	PB-PR-S19-5.0/10.0
1,3-Dinitrobenzene	1.1	mg/kg	PB-RWP-PR-S12	PB-PR-S12-3.0/5.0
1,3-Dinitrobenzene	0.5	mg/kg	PB-RWP-PR-S7	PB-PR-S7-5.0/10.0
1,3-Dinitrobenzene	0.43	mg/kg	PRRP-DP11	7610
1,3-Dinitrobenzene	0.3	mg/kg	PB-RWP-PR-S2	PB-PR-S2-5.0/10.0
1,3-Dinitrobenzene	0.25	mg/kg	PRRP-DP16	7820
2,4-Dinitrotoluene	**25**	mg/kg	PRRP-DP03	7290
2,4-Dinitrotoluene	**19**	mg/kg	PB-RWP-PR-S14	PB-PR-S14-5.0/10.0
2,4-Dinitrotoluene	**15**	mg/kg	PRRP-DP10	7580
2,4-Dinitrotoluene	**14**	mg/kg	PB-RWP-PR-S15	PB-PR-S15-5.0/10.0
2,4-Dinitrotoluene	**8.9**	mg/kg	PB-RWP-PR-S16	PB-PR-S16-5.0/10.0
2,4-Dinitrotoluene	**8.7**	mg/kg	PB-RWP-PR-S6	PB-PR-S6-3.0/5.0
2,4-Dinitrotoluene	**7.6**	mg/kg	PB-RWP-PR-S6	PB-PR-S6-5.0/10.0
2,4-Dinitrotoluene	**5.7**	mg/kg	PB-RWP-PR-S4	PB-PR-S4-3.0/5.0
2,4-Dinitrotoluene	5.2	mg/kg	PB-RWP-PR-S13	PB-PR-S13-5.0/10.0
2,4-Dinitrotoluene	3.8	mg/kg	PB-RWP-PR-S9	PB-PR-S9-3.0/5.0
2,4-Dinitrotoluene	3.4	mg/kg	PB-RWP-PR-S7	PB-PR-S7-3.0/5.0
2,4-Dinitrotoluene	2.8	mg/kg	PB-RWP-PR-S4	PB-PR-S4-5.0/10.0
2,4-Dinitrotoluene	2.6	mg/kg	PB-RWP-PR-S10	PB-PR-S10-3.0/5.0
2,4-Dinitrotoluene	2.2	mg/kg	PB-RWP-PR-S10	PB-PR-S10-5.0/10.0

Figure 5-4

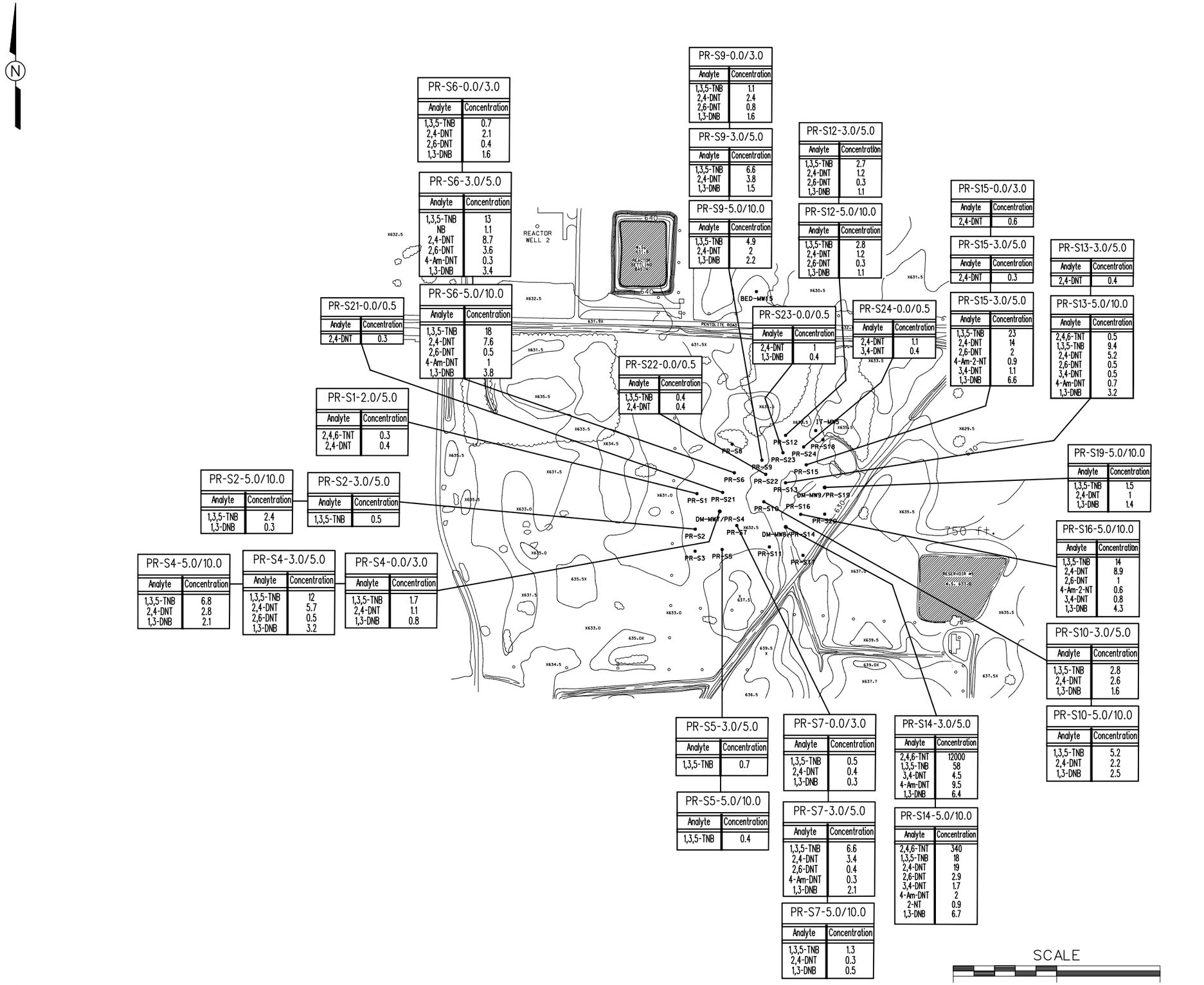
Detected Concentrations of Selected COPC in Subsurface Soil Ranked from Highest to Lowest[a]
Pentolite Road Red Water Area, Red Water Ponds, Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Result		Units	Sample Location	Sample Number
2,4-Dinitrotoluene	2		mg/kg	PB-RWP-PR-S9	PB-PR-S9-5.0/10.0
2,4-Dinitrotoluene	1.6		mg/kg	PRRP-DP11	7610
2,4-Dinitrotoluene	1.6		mg/kg	PB-RWP-PR-S12	PB-PR-S12-5.0/10.0
2,4-Dinitrotoluene	1.2		mg/kg	PRRP-DP11	7620
2,4-Dinitrotoluene	1.2		mg/kg	PB-RWP-PR-S12	PB-PR-S12-3.0/5.0
2,4-Dinitrotoluene	1.1		mg/kg	PRRP-DP06	7420
2,4-Dinitrotoluene	1		mg/kg	PB-RWP-PR-S19	PB-PR-S19-5.0/10.0
2,4-Dinitrotoluene	0.96		mg/kg	PRRP-DP01	7210
2,4-Dinitrotoluene	0.5		mg/kg	PRRP-DP16	7820
2,4-Dinitrotoluene	0.4		mg/kg	PB-RWP-PR-S1	PB-PR-S1-2.0/5.0
2,4-Dinitrotoluene	0.4		mg/kg	PB-RWP-PR-S13	PB-PR-S13-3.0/5.0
2,4-Dinitrotoluene	0.3		mg/kg	PB-RWP-PR-S15	PB-PR-S15-3.0/5.0
2,4-Dinitrotoluene	0.3		mg/kg	PB-RWP-PR-S7	PB-PR-S7-5.0/10.0
2,4-Dinitrotoluene	0.29		mg/kg	PRRP-DP01	7220
2,4-Dinitrotoluene	0.28		mg/kg	PRRP-DP02	7260
2,6-Dinitrotoluene	**3.6**		mg/kg	PB-RWP-PR-S6	PB-PR-S6-3.0/5.0
2,6-Dinitrotoluene	**2.9**		mg/kg	PB-RWP-PR-S14	PB-PR-S14-5.0/10.0
2,6-Dinitrotoluene	**2**		mg/kg	PB-RWP-PR-S15	PB-PR-S15-5.0/10.0
2,6-Dinitrotoluene	**1.7**		mg/kg	PRRP-DP10	7580
2,6-Dinitrotoluene	**1**		mg/kg	PB-RWP-PR-S16	PB-PR-S16-5.0/10.0
2,6-Dinitrotoluene	0.5		mg/kg	PRRP-DP16	7820
2,6-Dinitrotoluene	0.5		mg/kg	PB-RWP-PR-S13	PB-PR-S13-5.0/10.0
2,6-Dinitrotoluene	0.5		mg/kg	PB-RWP-PR-S4	PB-PR-S4-3.0/5.0
2,6-Dinitrotoluene	0.5		mg/kg	PB-RWP-PR-S6	PB-PR-S6-5.0/10.0
2,6-Dinitrotoluene	0.4		mg/kg	PB-RWP-PR-S7	PB-PR-S7-3.0/5.0
2,6-Dinitrotoluene	0.35		mg/kg	PRRP-DP01	7210
2,6-Dinitrotoluene	0.3		mg/kg	PRRP-DP11	7620
2,6-Dinitrotoluene	0.3		mg/kg	PB-RWP-PR-S12	PB-PR-S12-3.0/5.0
2,6-Dinitrotoluene	0.3		mg/kg	PB-RWP-PR-S12	PB-PR-S12-5.0/10.0
2,6-Dinitrotoluene	0.29		mg/kg	PRRP-DP11	7610
2,4,6-Trinitrotoluene	**12000**	b	mg/kg	PB-RWP-PR-S14	PB-PR-S14-3.0/5.0
2,4,6-Trinitrotoluene	**340**	b	mg/kg	PB-RWP-PR-S14	PB-PR-S14-5.0/10.0
2,4,6-Trinitrotoluene	0.5		mg/kg	PB-RWP-PR-S13	PB-PR-S13-5.0/10.0
2,4,6-Trinitrotoluene	0.38		mg/kg	PRRP-DP02	7260
2,4,6-Trinitrotoluene	0.3		mg/kg	PB-RWP-PR-S1	PB-PR-S1-2.0/5.0

mg/kg - Milligrams per kilogram.

[a] Bolded values exceed the source-term concentration, unless otherwise noted.

[b] Although these values do not exceed the source-term concentration, they do exceed the RBSC.



PR-S6-0.0/3.0	
Analyte	Concentration
1,3,5-TNB	0.7
2,4-DNT	2.1
2,6-DNT	0.4
1,3-DNB	1.6

PR-S6-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	13
NB	1.1
2,4-DNT	8.7
2,6-DNT	3.6
4-Am-DNT	0.3
1,3-DNB	3.4

PR-S6-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	18
2,4-DNT	7.6
2,6-DNT	0.5
4-Am-DNT	1
1,3-DNB	3.8

PR-S21-0.0/0.5	
Analyte	Concentration
2,4-DNT	0.3

PR-S1-2.0/5.0	
Analyte	Concentration
2,4,6-TNT	0.3
2,4-DNT	0.4

PR-S2-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	2.4
1,3-DNB	0.3

PR-S2-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	0.5

PR-S4-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	6.8
2,4-DNT	2.8
1,3-DNB	2.1

PR-S4-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	12
2,4-DNT	5.7
2,6-DNT	0.5
1,3-DNB	3.2

PR-S4-0.0/3.0	
Analyte	Concentration
1,3,5-TNB	1.7
2,4-DNT	1.1
1,3-DNB	0.8

PR-S9-0.0/3.0	
Analyte	Concentration
1,3,5-TNB	1.1
2,4-DNT	2.4
2,6-DNT	0.8
1,3-DNB	1.6

PR-S9-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	6.6
2,4-DNT	3.8
1,3-DNB	1.5

PR-S9-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	4.9
2,4-DNT	2
1,3-DNB	2.2

PR-S12-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	2.7
2,4-DNT	1.2
2,6-DNT	0.3
1,3-DNB	1.1

PR-S12-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	2.8
2,4-DNT	1.2
2,6-DNT	0.3
1,3-DNB	1.1

PR-S15-0.0/3.0	
Analyte	Concentration
2,4-DNT	0.6

PR-S15-3.0/5.0	
Analyte	Concentration
2,4-DNT	0.3

PR-S15-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	23
2,4-DNT	14
2,6-DNT	2
4-Am-2-NT	0.9
3,4-DNT	1.1
1,3-DNB	6.6

PR-S13-3.0/5.0	
Analyte	Concentration
2,4-DNT	0.4

PR-S13-5.0/10.0	
Analyte	Concentration
2,4,6-TNT	0.5
1,3,5-TNB	9.4
2,4-DNT	5.2
2,6-DNT	0.5
3,4-DNT	0.5
4-Am-DNT	0.7
1,3-DNB	3.2

PR-S23-0.0/0.5	
Analyte	Concentration
2,4-DNT	1
1,3-DNB	0.4

PR-S24-0.0/0.5	
Analyte	Concentration
2,4-DNT	1.1
3,4-DNT	0.4

PR-S22-0.0/0.5	
Analyte	Concentration
1,3,5-TNB	0.4
2,4-DNT	0.4

PR-S19-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	1.5
2,4-DNT	1
1,3-DNB	1.4

PR-S16-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	14
2,4-DNT	8.9
2,6-DNT	1
4-Am-2-NT	0.6
3,4-DNT	0.8
1,3-DNB	4.3

PR-S10-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	2.8
2,4-DNT	2.6
1,3-DNB	1.6

PR-S10-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	5.2
2,4-DNT	2.2
1,3-DNB	2.5

PR-S5-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	0.7

PR-S5-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	0.4

PR-S7-0.0/3.0	
Analyte	Concentration
1,3,5-TNB	0.5
2,4-DNT	0.4
1,3-DNB	0.3

PR-S7-3.0/5.0	
Analyte	Concentration
1,3,5-TNB	6.6
2,4-DNT	3.4
2,6-DNT	0.4
4-Am-DNT	0.3
1,3-DNB	2.1

PR-S7-5.0/10.0	
Analyte	Concentration
1,3,5-TNB	1.3
2,4-DNT	0.3
1,3-DNB	0.5

PR-S14-3.0/5.0	
Analyte	Concentration
2,4,6-TNT	12000
1,3,5-TNB	58
3,4-DNT	4.5
4-Am-DNT	9.5
1,3-DNB	6.4

PR-S14-5.0/10.0	
Analyte	Concentration
2,4,6-TNT	340
1,3,5-TNB	18
2,4-DNT	19
2,6-DNT	2.9
3,4-DNT	1.7
4-Am-DNT	2
2-NT	0.9
1,3-DNB	6.7

NOTES:
CONCENTRATIONS ARE IN mg/Kg

SOURCE: DAMES & MOORE 1996

FIGURE 5-5
PENTOLITE ROAD RED WATER PONDS SOIL BORING LOCATIONS AND EXPLOSIVE RESIDUES CONCENTRATIONS

PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 09/25/00	INITIATOR:M. GUNDERSON	DWG. NO.:\807053es.002	
DRAWN BY:B. VANDERGRIFF	PROJ. MGR.: SPANGBERG	PROJ. NO.: 807053	
DRAFT. CHCK. BY: C. TUMLIN	DATE LAST REV.:		
ENGR. CHCK. BY: M. GUNDERSON	DRAWN BY:		

02:24:20 PM 08/21/02
bvanderg c:\cadd\design\807053es.002

Figure 6-1

Photo No. 1 - Pentolite Road Red Water Pond (looking northwest, potential stressed area.)

Photo No. 2 - Pentolite Road Red Water Pond (looking south southwest from DP-21 location)

Figure 6-2

Photo No. 3 - Pentolite Road Red Water Pond (old tree with woodpecker hole near DP-21 location)

Photo No. 4 - Pentolite Road Red Water Pond (looking south, wet barren area, potentially stressed)

Figure 6-3

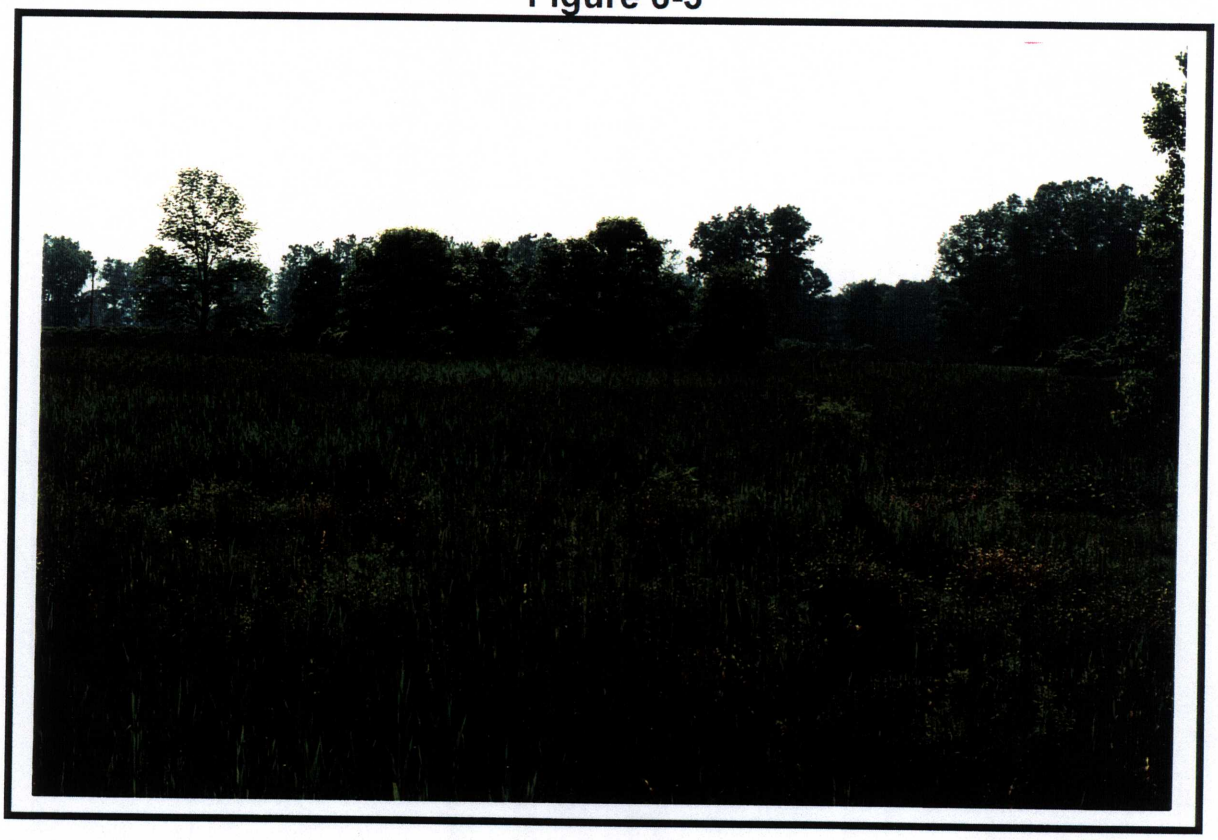


Photo No. 5 - Pentolite Road Red Water Pond (general area looking west from DP-20 location)

Photo No. 6 - Pentolite Road Red Water Pond (general area, looking north from DP-24 location)

Figure 6-4

Photo No. 7 - Pentolite Road Red Water Pond (possible sedge wren nest near DP-14 location)

Photo No. 8 - Pentolite Road Red Water Pond (looking northeast along 10-foot deep ditch)

Figure 6-5

Photo No. 9 - West Area Red Water Pond (bare spot looking south near GP-23 location)

Photo No. 10 - West Area Red Water Pond (west pond area)

Figure 6-6

Photo No. 11 - West Area Red Water Pond (looking southwest, west pond surface, with deer)

Photo No. 12 - West Area Red Water Pond (looking north, near DP-5 location)

Figure 6-7

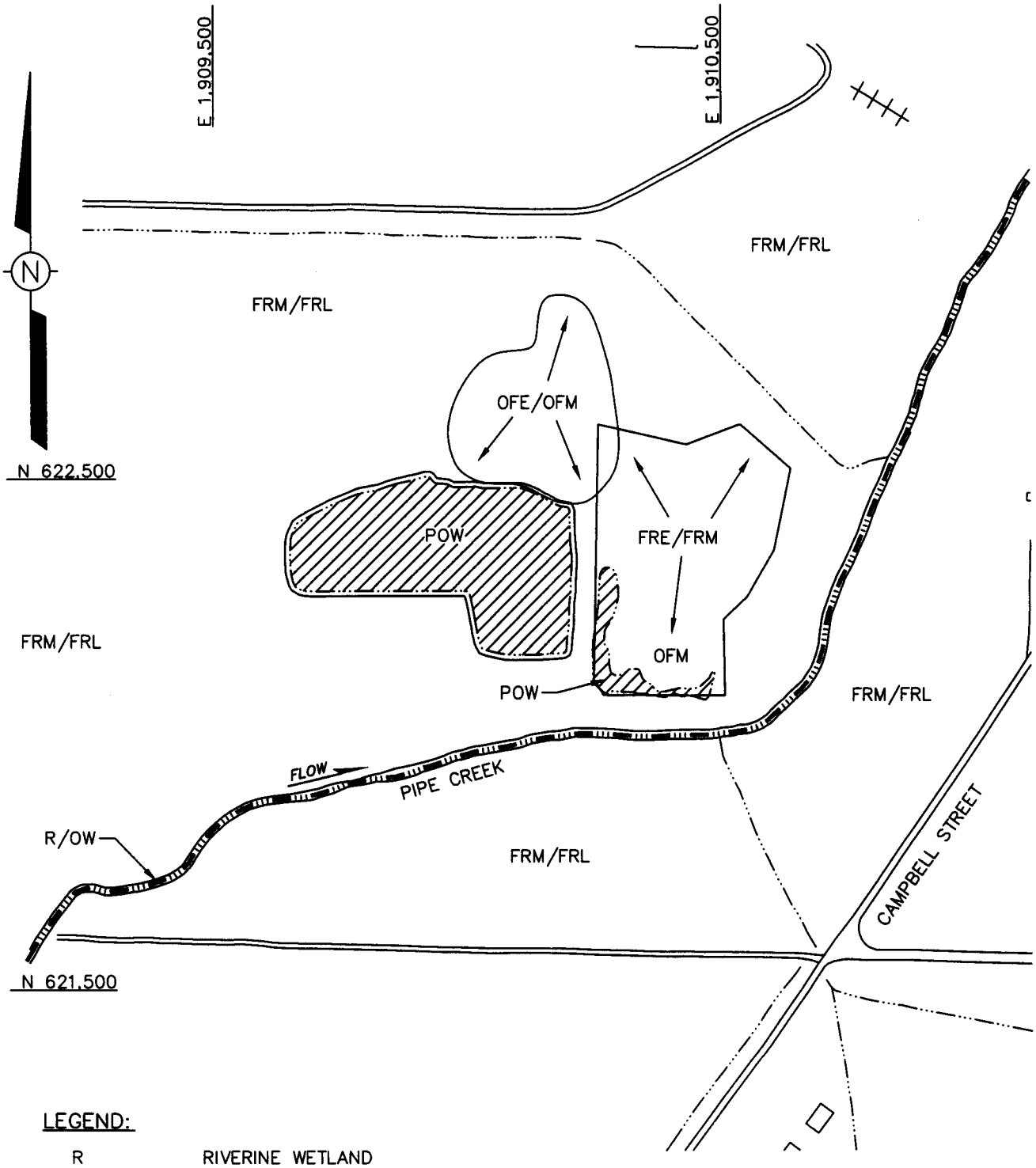
Photo No. 13 - West Area Red Water Pond (looking southeast from SB-11 location, east pond area)

Photo No. 14 - West Area Red Water Pond (looking southwest at low-lying area, former east pond)

Figure 6-8

Photo No. 15 - West Area Red Water Pond (looking west from DP-12, only open area at site)

Photo No. 16 - West Area Red Water Pond (looking northeast [downstream] along Pipe Creek)



LEGEND:

R	RIVERINE WETLAND
POW	PALUSTRINE OPEN WATER
OFE	EARLY OLD FIELD
OFM	MODERATE OLD FIELD
FRE	EARLY FOREST
FRM	MODERATE FOREST
FRL	LATE FOREST
	SURFACE WATER
	SURFACE DRAINAGE
	APPROXIMATE HISTORICAL LOCATION OF PONDS
	UNPAVED AND PAVED ROADS

IT CORPORATION

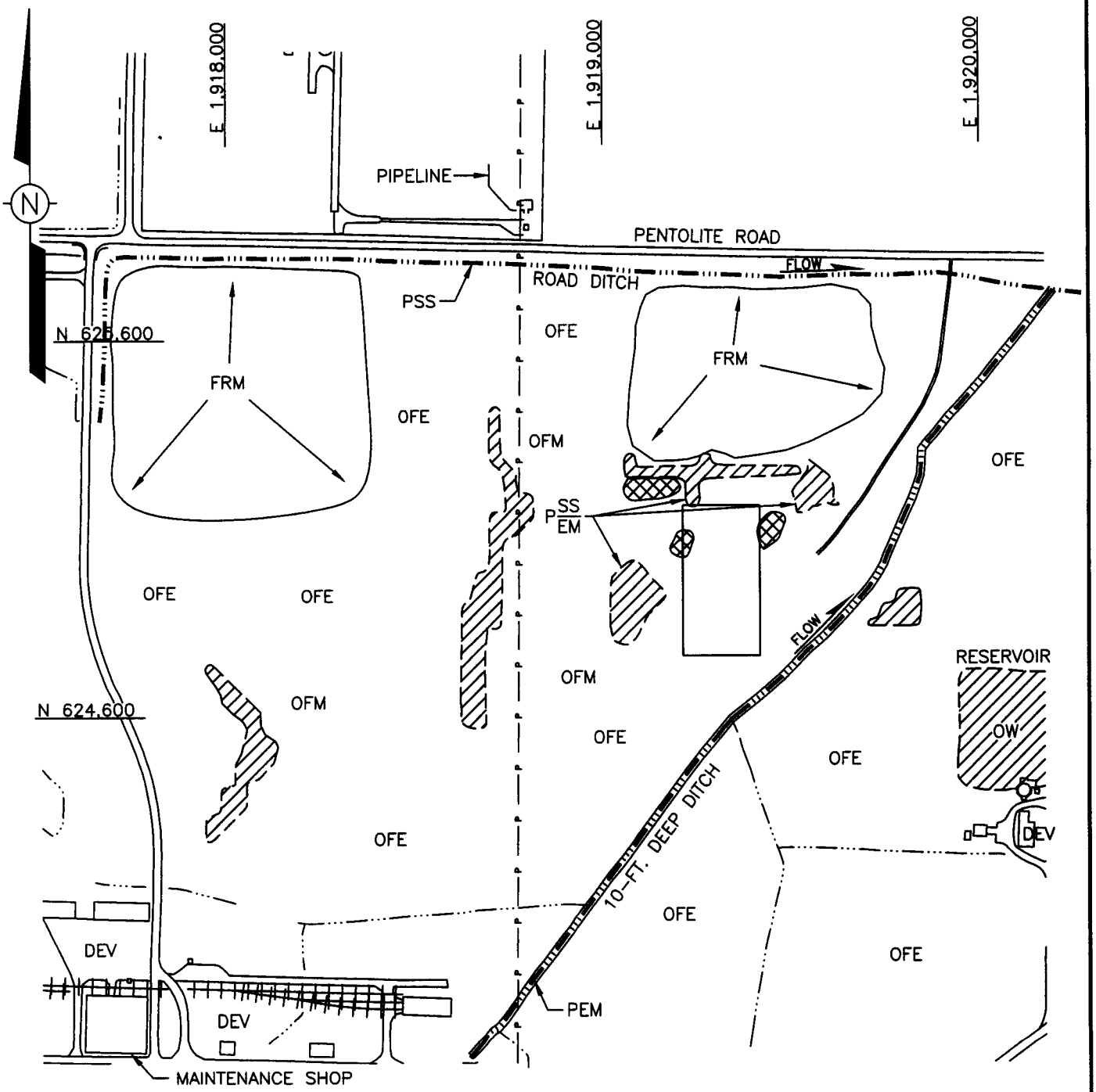
PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 6-9

VEGETATIVE COMMUNITIES
WEST AREA RED WATER PONDS

IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	PGH	R. WEIBLE	21 DEC 98			773701-A1

DATE: 2-19-99
TIME: 1:51 PM
PLOT SCALE: 1 = 300



LEGEND:

FRM	MODERATE FOREST
OW	OPEN WATER
OFE	EARLY OLD FIELD
OFM	MODERATE OLD FIELD
PSS	PALUSTRINE SCRUB/SHRUB WETLAND
PEM	PALUSTRINE EMERGENT WETLAND
DEV	DEVELOPED AND DISTURBED AREAS
	BUILDINGS
	APPROXIMATE HISTORICAL LOCATION OF POND
	SURFACE WATER (AERIAL PHOTO, FALL 1997)
	SURFACE DRAINAGE
	UNPAVED/PAVED ROAD
	BARE SOIL
—P —P—	POWER LINE

SCALE

0 400 800 FEET

IT CORPORATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 6-10

VEGETATIVE COMMUNITIES
PENTOLITE ROAD RED WATER PONDS

DRAWING NUMBER	APPROVED BY	CHECKED BY	DRAWN BY	OFFICE	X-REF	IMAGE
773701-A2			R. WEIBLE 12-21-98	PGH	---	---

DATE: 2-19-99
TIME: 1:52 PM
PLOT SCALE: 1 = 400

Figure 6-11

Simplified Terrestrial Food Web Conceptual Site Model (CSM)
Plum Brook Ordnance Works, Ohio

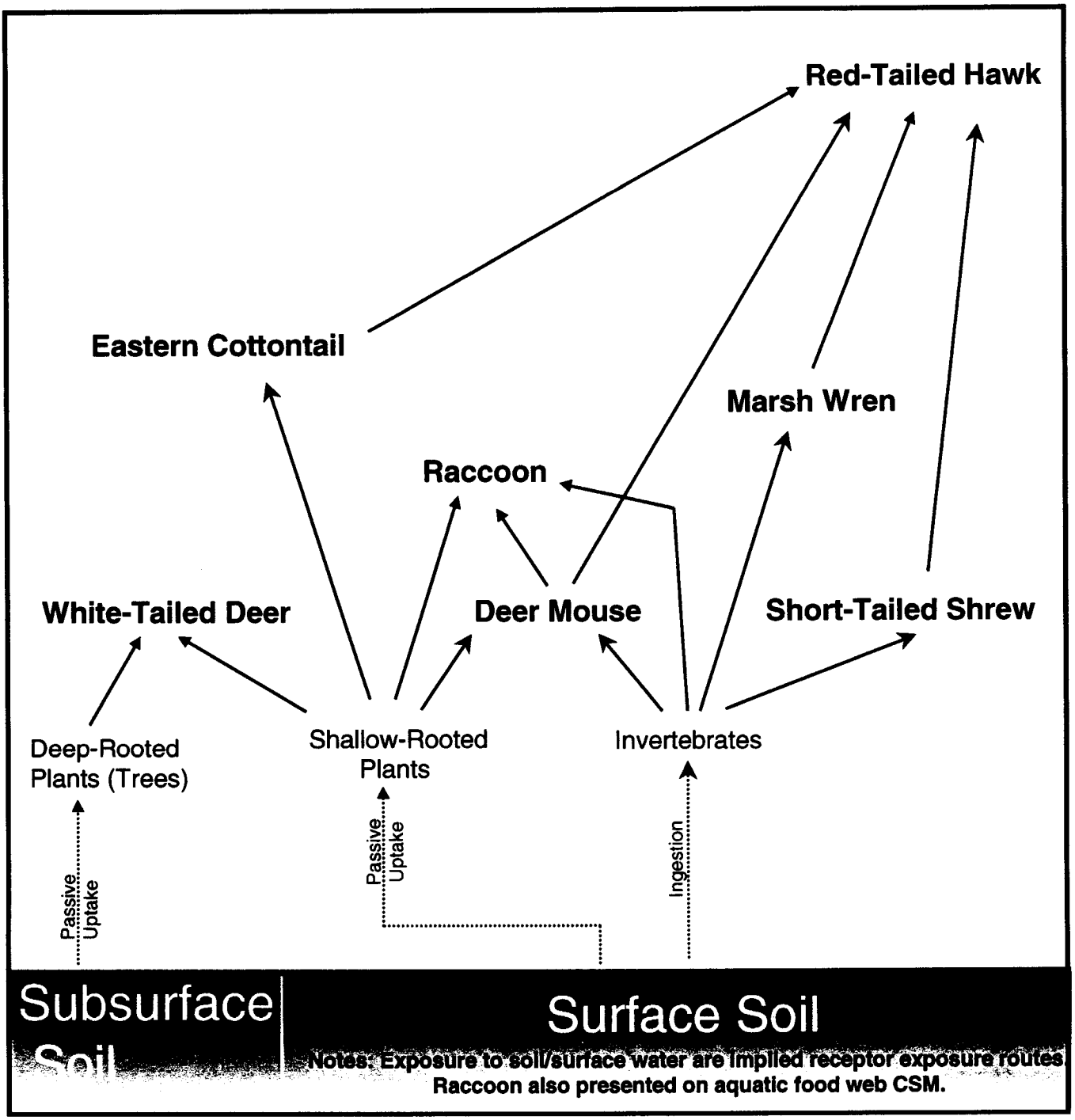
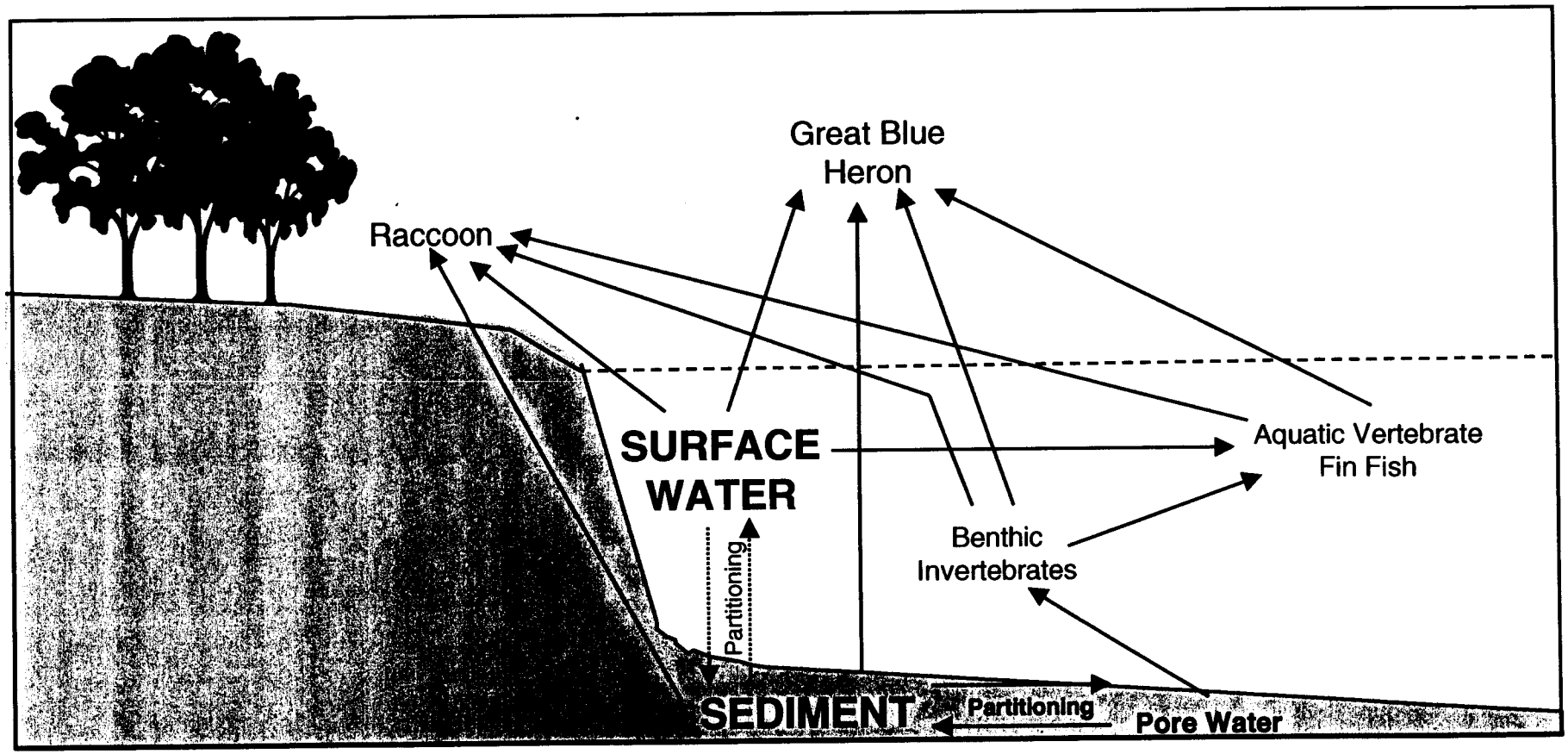


Figure 6-12

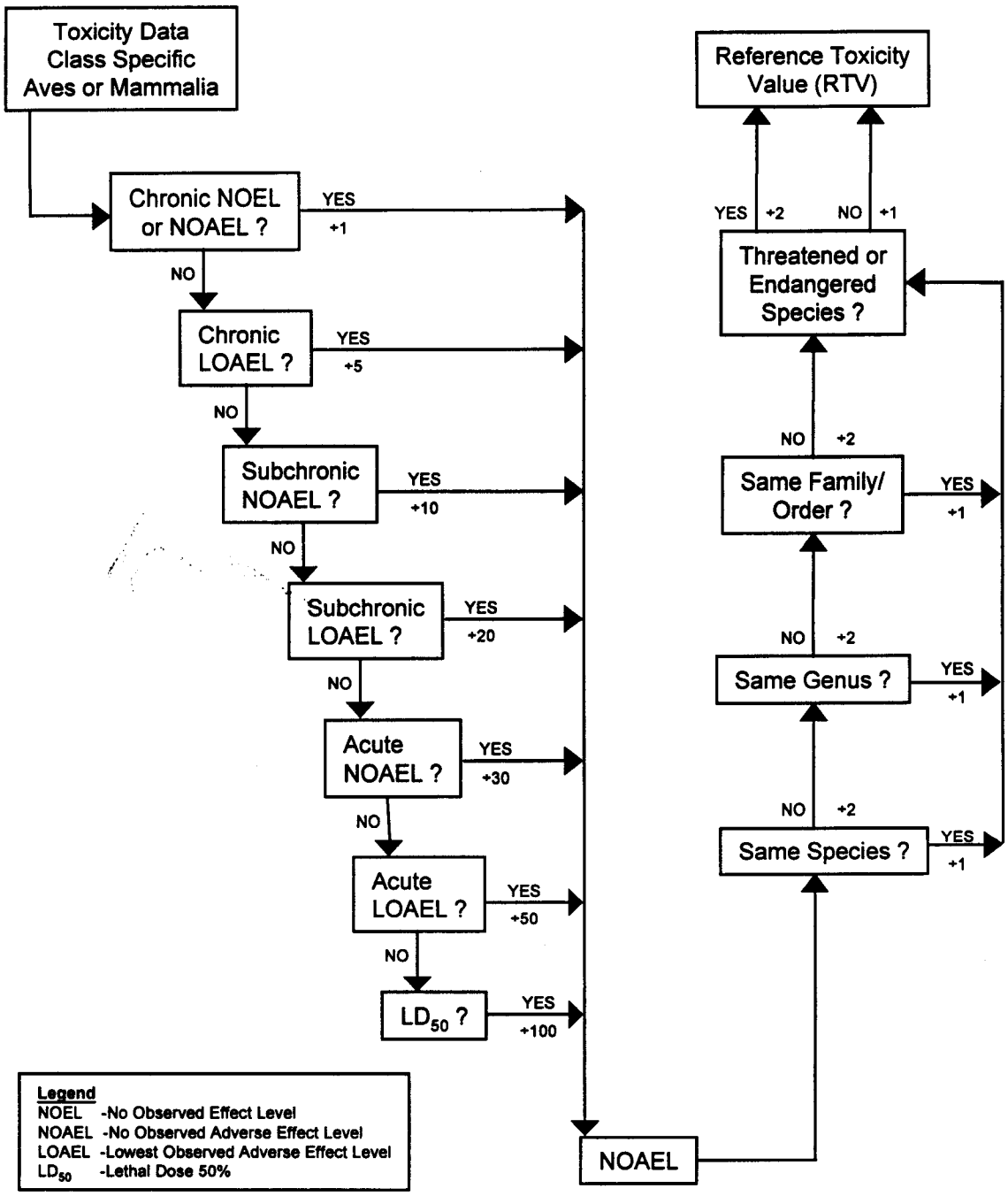
Simplified Aquatic Food Web Conceptual Site Model (CSM)
Plum Brook Ordnance Works, Ohio



Note: Raccoon also presented on terrestrial food web CSM.

Figure 6-13

Procedural Flow Chart for Deriving Reference Toxicity Values (RTVs) from Class-Specific Toxicity Data
Plum Brook Ordnance Works
Sandusky, Ohio



Credit: Adapted from *Tri-Service Procedural Guidelines for Ecological Risk Assessments*, 1996

c:\mweisberg\plumbrk\fig6-13.ppt