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MIAMI-ERIE CANAL AREA

RESIDUAL RISK EVALUATION

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Miamisburg Closure Project

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This document is the Final Report.

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Acronyms

ATSDR	Agency for Toxic Substances Disease Registry
ARARs	Applicable or Relevant and Appropriate Requirements
BVA	Great Miami Buried Valley Aquifer
CDC	Centers of Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPCs	constituents of potential concern
CSF	cancer slope factor
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FFA	Federal Facilities Agreement
HEAST	Health Effects and Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic Model for Lead in Children
IRIS	Integrated Risk Information System
LOAEL	lowest observed adverse effects level
NCEA	National Center for Environmental Assessment

Acronyms
(continued)

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Not detected
NOAEL	no observed adverse effect level
Ohio EPA	Ohio Environmental Protection Agency
OSC	On-Scene Coordinator
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
ppm	parts per million
PRS	Potential Release Site
QAPjP	quality assurance project plan
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RBGV	Risk-Based Guideline Values
RfD	reference dose factor
RfC	reference concentration factor
RME	reasonable maximum exposure
RRE	residual risk evaluation
RREM	residual risk evaluation methodology
SVOCs	semi-volatile organic compounds
TPH	total petroleum hydrocarbon
TIC	tentatively identified compound
UCL	upper confidence limit
UTL	upper tolerance limit
VOCs	volatile organic compounds

EXECUTIVE SUMMARY

This report was prepared using the Mound 2000 Residual Risk Evaluation Methodology (DOE 1997a)(RREM) to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in the Miami-Erie Canal area. A Residual Risk Evaluation (RRE) evaluates human health risks associated with residual levels of contamination remaining within an area to ensure that future users of the land will not be exposed to unacceptable contaminant levels. Residual risks were calculated for total risk, background risk and incremental risk for the most likely and most conservative scenarios for the canal property. These scenarios included current and future recreational user (adult and child), a hypothetical future resident (adult and child) and a hypothetical adult off-site construction worker. These scenarios included potential exposure to surface and subsurface soil and sediment via incidental ingestion, dermal contact, inhalation of dust and volatile organic compounds and external radiation exposure. Groundwater was not included as a media of concern since water at the canal area will be provided by the City of Miamisburg. However, potential risks due to exposure to Buried Valley Aquifer (BVA) groundwater will be assessed as a separate evaluation prior to completion of the final Mound Record of Decision (ROD).

Total, background and incremental non-carcinogenic risks for all receptors in all scenarios were below the target hazard level of one (non-cancer risk is presented in parenthesis in the Executive Summary Table see below). This suggests that non-carcinogenic risks are within acceptable levels. Total, background and incremental carcinogenic risks for the recreational scenario (adult and child), and the adult off-site construction worker are within the acceptable risk range of 10^{-4} to 10^{-6} (see Executive Summary Table). Background carcinogenic risk for the hypothetical child residential scenario was within the acceptable carcinogenic risk range. Total, background and incremental carcinogenic risk for the hypothetical resident adult, and total and incremental carcinogenic risk for the hypothetical resident child exceed the target carcinogenic range of 10^{-4} to 10^{-6}. However, these analyses did not include any information on OU4 background levels of polycyclic aromatic hydrocarbons (PAHs). These results are summarized in the following table.

Executive Summary Table of Miami-Erie Canal Residual Risk			
Receptor	Total Cancer Risk (Total HI)	Background Cancer Risk (Background HI)	Incremental Cancer Risk (Incremental HI)
Recreational Adult	$1.3x10^{-5}$ (0.011)	$8.6x10^{-6}$ (0.0058)	$4.5x10^{-6}$ (0.0053)
Recreational Child	$3.6x10^{-6}$ (0.039)	$2.4x10^{-6}$ (0.02)	$1.2x10^{-6}$ (0.018)
Resident Adult	$3.9x10^{-4}$ (0.18)	$1.4x10^{-4}$ (0.13)	$2.4x10^{-4}$ (0.045)
Resident Child	$1.6x10^{-4}$ (0.77)	$5.1x10^{-5}$ (0.60)	$1.1x^{-4}$ (0.17)
Adult Off-site Construction Worker	$1.0x10^{-5}$ (0.22)	$6.8x10^{-6}$ (0.18)	$3.2x10^{-6}$ (0.045)

HI – Hazard Index, non-carcinogenic risk

Incremental cancer risk for the hypothetical adult resident was $2.4x10^{-4}$: Of this risk, BaP, radium-226, DbA, plutonium-238 and arsenic concentrations resulted in incremental cancer risks of $1.3x10^{-04}$, $6.7x10^{-05}$, $4.4x10^{-05}$, $5.2x10^{-06}$, and $1.5x10^{-06}$, respectively, in descending order of contribution to overall incremental cancer risk. For the resident child, incremental cancer risk was $1.1x10^{-4}$. Of this risk, in descending order of contribution, $6.2x10^{-5}$ was due to BaP; $2.2x10^{-5}$ was due to DbA; $1.7x10^{-5}$ was due to radium-226; $2.6x10^{-6}$ was due to plutonium-238; and $1.9x10^{-6}$ was due to arsenic. No OU4 background concentrations for PAHs were included in the evaluation of incremental carcinogenic risk.

Radium-226 is a naturally occurring radioisotope that is present in background soils. PAHs, like BaP and DbA, are ubiquitous in many environments, particularly along railroad right-of-ways, such as the one running through the canal area (ATSDR 1994; Edwards 1983; Eisler 1987: LaFlamme and Hites 1978; Yang et al. 1991). Since there were no OU4 site-specific background values for PAHs in soil to use in the evaluation of the significance of these data, a study was completed in December 2002 to determine OU4 background levels of BaP and DbA. This information was used to evaluate the level of PAHs found in the Miami-Erie Canal verification samples in comparison to the level of PAHs from anthropogenic sources outside of Mound's influence.

The BaP and DbA results from the December 2002 OU4 PAH study and the Miami-Erie Canal verification sampling are very similar. The range of detected concentrations from the December 2002 OU4 background sampling are 56 to 7700 µg/kg BaP and 27 to 400

µg/kg DbA. The range of detected concentrations from the Miami-Erie Canal verification data set are 21 to 7900 µg/kg BaP and 20 to 1500 µg/kg DbA. Since the concentrations of PAHs detected in the OU4 background study are similar to levels found in the remediated area of the canal, if the background levels of PAHs were accounted for in the risk calculations, incremental risk for the hypothetical residential receptors would fall within the target risk range. This indicates that the existing levels of residual contamination detected in the canal area are protective of current and potential future users and that no further remedial action is warranted.

1.0 INTRODUCTION

The U.S. Department of Energy's (DOE) Mound Plant is located on a 306-acre parcel of land within the City of Miamisburg, Ohio, about 10 miles southwest of Dayton, Ohio. Figure 1 shows the vicinity of the Mound Plant. The plant is located approximately 2,000 feet east of the Great Miami River and partially overlies the Great Miami Buried Valley Aquifer (BVA). Since 1948, Mound has operated as a research, development and production facility in support of DOE's weapons and energy programs. Mound's past weapons program mission included process development, production engineering, manufacturing, and surveillance of detonators, explosives, and nuclear components. Mound's current mission is to support DOE's efforts in environmental management and to transition the site, in cooperation with the City of Miamisburg, from a cold-war production facility to commercial or industrial use. The Miami-Erie Canal area, the subject of this report, will be returned to recreational use as a city park. A map of the Miami-Erie Canal area is included as Figure 2.

This report was developed using the Mound 2000 Residual Risk Evaluation Methodology (RREM) (DOE 1997a) to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in the canal area also known as Operable Unit 4 (OU4). A Residual Risk Evaluation (RRE) evaluates human health risks associated with residual levels of contamination remaining within an area to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks. The RRE results will be used, together with Applicable or Relevant and Appropriate Requirements (ARARs), to determine the need for additional site remediation or to demonstrate that land is ready for public use.

1.1 Purpose of Residual Risk Evaluation

The objective of the Miami-Erie Canal area RRE is to assess risks associated with residual levels of contamination that exist after completion of the removal action. Although the RRE method was developed specifically for use at Mound, the method is consistent with the CERCLA baseline risk assessment method to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks.

1.2 Scope of the Miami-Erie Canal RRE

The RRE for the Miami-Erie Canal area includes an evaluation of human health risk for potential residual contamination in the area following the completion of the removal action documented in the On-Scene Coordinator (OSC) Report (DOE 1999). The canal area RRE was completed using the Mound 2000 RREM (DOE 1997a). Since the canal area is currently used for recreational purposes, residual risks were evaluated for the recreational scenario. Although residential use of the canal area is unlikely, risk to residential receptors was included to evaluate the need for land use restrictions. Since the RREM does not provide exposure assumptions or intake equations for the residential or recreational use scenarios the needed values were drawn from the "Risk Based Guideline Values, Mound Plant, Miamisburg, Ohio, March, 1997, Final Rev 4" (DOE 1997b). The RRE also includes a qualitative analysis of risks due to PAHs. The RRE shows that when risks due to PAHs are excluded, residual risks to all receptors fall within the acceptable risk range. Therefore no land use restrictions are needed for the Miami-Erie Canal area.

The exposure scenarios, receptors, exposure pathways, exposure parameters, and media included in the Canal RRE were discussed and agreed to in a meeting held December 2nd, 1999 with DOE, U.S. EPA, and Ohio EPA. Groundwater was not included as a media of concern since water at the canal area will be provided by the City of Miamisburg. Residual risks due to exposures to soil were calculated for total risk, background risk and incremental risk. Total risk was calculated using the total concentration of the constituents of potential concern (COPCs) detected in the canal area. Background risk was calculated based on background levels of the COPCs and incremental risk was calculated using the difference between total and background levels. Incremental risk can be used to assess the increase in risk above background levels due to Mound Plant operations.

1.3 Organization of Report

The RREM provides a framework for evaluating potential human health risks associated with residual levels of contamination. Although the RREM is similar to a traditional CERCLA baseline risk assessment, it serves a different purpose and, therefore, is not identical. The RREM consists of five elements, including:

- identification of the contaminants to be evaluated,
- exposure assessment,
- toxicity assessment,
- risk characterization, and
- evaluation of potential cumulative risks.

The following sections describe each of these elements in more detail starting with Section 2.0, Data Compilation and Evaluation, which describes the methods used to compile Miami-Erie Canal area data and identify contaminants to be evaluated in the RRE. Section 3.0, Exposure Assessment, summarizes the pathways through which hazardous substances may reach potential receptors and intake assumptions used to quantify exposure. In Section 4.0, Toxicity Assessment, exposure point concentrations, intake equations and toxicological reference values are presented. Information from the exposure assessment is combined with information from the toxicity assessment to characterize human health risks in Section 5.0, Risk Characterization. Section 6.0, Uncertainties, presents some of the sources of uncertainty inherent in risk assessments and in the RRE. Section 7.0, References, contains a list of all documents cited in this report.

2.0 DATA COMPILATION AND EVALUATION

Identification of contaminants to be carried through the RRE calculations is a multi-step process beginning with the identification of all contaminants detected in the area and then eliminating contaminants based upon a set of established screening criteria described in the RREM. The RRE data set was validated and the analytical detection limits checked prior to use in the RRE calculations.

All available sampling data was compiled for use in the Miami-Erie Canal RRE. Newer data was used to supplement, rather than supersede older data except when older data described materials that had subsequently been removed from the area. In this case, the older data no longer represent site conditions and were, therefore, not used in the RRE. Sampling data obtained from the Mound Soil Screening Facility was used except

in the case where a sample was split and analyzed by both the Mound Soil Screening Facility and a commercial analytical laboratory. In such cases, the value from the commercial analytical laboratory was used to take advantage of the greater precision available from the commercial analytical laboratory. Data used to characterize the Miami-Erie Canal area were drawn from the following data sets:

DATA SET DESCRIPTION	REFERENCE
Canal Removal Action Verification Data *Includes samples from South Pond, Runoff Hollow, Overflow Creek, and portions of the Plant Drainage Ditch between the plant boundary and the canal*	On-Scene Coordinator Report, OU4 Miami-Erie Canal Removal Action, Final, June, 1999
Water Park/Tennis Court Sampling Results *Samples obtained in park area as part of previous investigations*	OU9 Regional Soils Investigation Report, August 1995, Final, Revision 2 Mound Laboratory Environmental Plutonium Study 1974 (MLM-02249), September 1975
Twin 60s Sediment Sampling	PRS 416 Data Package, June 24, 2000

The following data sets were excluded because they represent areas remediated by removal actions.

DATA SET DESCRIPTION	REFERENCE
Original Rogers Study	"Mound Laboratory Environmental Plutonium Study" (1974). Samples from the park vicinity were included in the RRE.

Special Canal Sampling, SAIC 1992	
Agency for Toxic Substances Disease Registry (ATSDR)	"Health Consultation, DOE Mound Plant" (1994)

The ATSDR report included samples obtained from the park area; however, insufficient information about the analytical techniques (e.g. minimum detectable activities, sample quantitation limits) was provided to allow for data verification, so the data were not included in the RRE. All data used for the RRE is included on the compact disc found in Appendix A.

2.1 Data Quality Assessment

Samples were collected and analyzed according to the methods outlined in the OU9 Quality Assurance Project Plan (QAPjP) (DOE 1993a) and the OU5 QAPjP (DOE 1993b). All data used in the risk assessment have undergone Quality Assurance/Quality Control (QA/QC) evaluation and data validation in accordance with the requirements described in the OU9 QAPjP (DOE 1993a) and the OU5 QAPjP (DOE 1993b).

2.2 Environmental Media Considered and Data Availability

Field investigations conducted for the canal area are listed above. Samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), dioxins/dibenzofurans, metals, common anions, total petroleum hydrocarbons (TPH), and radionuclides. Environmental media that were evaluated include surface soil (0-2 feet below land surface), subsurface soil (>2 feet below land surface), and sediment. During the canal area removal action, approximately 40,000 yds^3 of soil were removed. Out of 15,214 analyses only 16 were run on soil collected more than two feet below land surface. Following soil removal, clean soil was brought in to backfill excavated areas so samples collected at 0-2 feet below land surface may now have an additional 1-2 feet of clean fill over them.

Although it is possible that contamination in the canal area may leach through soil to reach the BVA, for the canal area RRE it was assumed that residential, recreational and

off-site construction worker receptors would drink municipally supplied water, not water obtained from the BVA. However, potential risks due to exposure to BVA groundwater will be assessed as a separate evaluation of the final Mound Record of Decision.

Canal area drainage ways contain water only during heavy rain events and therefore, are dry most of the time. Due to intermittent flow in the canal area ditches, receptors in the canal area were assumed to come into contact with sediments with the same frequency, as they would surface soils. Therefore, the exposure assumptions for soils and sediments are the same and these media have been merged into one data set for the RRE. Merging the soil and sediment data sets increased the statistical power of the data set by increasing the number of observations. Since the same exposure assumptions were used to estimate exposures to sediment and soil, combining the data sets does not reduce the overall estimate of risk but does simplify the presentation of RRE results.

2.3 Data Analysis

For each constituent detected in Miami-Erie Canal area soils, the 95% upper confidence limit of the mean (UCL) was calculated to estimate the concentration that receptors in the area may be exposed to. This is known as the Exposure Point Concentration or EPC. The 95% UCL was calculated in accordance with Mound 2000, Gilbert's *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987), and the *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA, 1992a). Before calculating the 95% UCL, the distribution of the data set was determined. If the data were found to be normally distributed, the EPC was calculated as the 95% UCL of the arithmetic mean of the data, using the Student's t-statistic (EPA 1992a). If the data were found to be log normally distributed, the EPC was calculated as the 95% UCL using the H-statistic (EPA 1992a).

The 95% UCL on the arithmetic mean for normal data sets was calculated as follows:

$$95\% \text{ UCL} = \text{Mean} + t(s/n^{1/2})$$

Where:

UCL= upper confidence limit,

t = t statistic (Table A2, Gilbert, 1987),

s = standard deviation, and

n = number of observation in the data set

The 95% UCL equation of the arithmetic mean for log-normal data sets was calculated as follows:

$$95\% \text{ UCL} = e^{\text{Mean}+H(s/(n-1)^{1/2})}$$

Where:

UCL = upper confidence limit,

H = H statistic (Table A12, Gilbert, 1987),

s = standard deviation, and

n = number of observations in the data set

e = constant

If the 95% UCL exceeded the maximum value observed in the sampling results, the maximum value was used as the EPC for that constituent (whether the data were normally or log normally distributed). For both chemical and radiological constituents "not detected" (ND) results were treated as one-half the limit of detection and included in the calculations of the mean and UCL values. Blind field duplicates were collected to assess variability in the sampling process. Duplicate samples were used in the data quality assessment but were not included in the calculation of the exposure point concentrations. If a data set had less than twenty observations (n<20) the maximum detected concentration was used as the EPC. For radionuclides, zero or negative results with no detection limits were excluded from the data set. Data qualified as "J", or estimated values at concentrations less than the detection limit, were evaluated as half the detection limit. For "J" data, which was greater than the detection limit or reported without the sample detection limit, the value was used as reported. Samples reported as ND or zero with no detection limit were not utilized in calculating a 95% UCL. Data flagged with an "R", meaning rejected, were also not used in calculating the EPC.

2.4 Data Screening Process

All constituents that were detected one or more times were listed in constituent summary tables and sorted by media and depth where they were detected. The constituent screening methods described below were then used to generate a final list

of constituents of potential concern (COPCs). The constituent summary tables also provide maximum detected concentrations, the frequency of detection, and the decision and rationale to include or exclude a constituent from further consideration in the RRE. The following section describes how COPCs were selected. Tables 1, 2 and 3 list all detected constituents and identify the COPCs for the recreational, residential, and off-site construction worker scenarios, respectively.

2.4.1 Screening Constituents Based on Background

Site-specific background concentrations described as the Upper 95% Tolerance Limit of the background sample results for each constituent have been developed for Mound Plant soils (DOE 1997a) and are presented in the RREM. Constituents with a maximum concentration detected exceeding their level in background were identified as COPCs and carried to the next step of the RRE. Constituents with maximum concentrations less than their background concentration were not carried though the RRE. If no background value was available for a particular constituent (e.g., many organic compounds, including PAHs), the constituent was carried through to the next step of the RRE.

In cases where the 95% UCL of the arithmetic mean fell below the maximum detected value, the 95% UCL was compared to background to determine whether the 95% UCL was below background. If the 95% UCL was below the background value for the constituent, the constituent was not identified as a COPC in the RRE. Including constituents whose 95% UCL is less than background would cause the incremental risk to be a "negative" risk. Eliminating these constituents focuses the RRE on constituents detected above background.

2.4.2 Screening Constituents Based on Guideline Values

Constituents present in soil or sediment at concentrations that exceed background concentrations were compared to Risk-Based Guideline Values (RBGVs) for the Mound Facility (DOE 1997b). RBGVs are media-specific concentrations of constituents that correspond to specific human health risk levels for specified exposure scenarios. RBGVs were developed for recreational, residential and off-site construction worker scenarios (see DOE 1997b for the detailed derivation of Guideline Values). Recreational, residential and off-site construction worker RBGVs, were used to screen COPCs for retention in the quantitative risk assessment.

The RBGVs used to screen COPCs were developed specifically for Mound, and were

approved by the DOE, the U.S. EPA, and Ohio EPA. The RBGVs correspond to the 10^{-6} risk level for carcinogenic constituents and radionuclides, and to a Hazard Quotient of one for each non-carcinogen constituent. A $1x10^{-6}$ risk level represents an incremental increase of one chance in one million of developing cancer as a result of exposure to the RBGV concentration. Since the target risk level for carcinogenic constituents is a range of 10^{-4} to 10^{-6}, as specified in the NCP, screening COPCs against the RBGV is protective. For non-carcinogenic constituents, the Hazard Quotient (HQ), or the ratio of the intake of a single constituent to its reference dose, is used to define acceptable risk. When multiple COPCs occur in the same area, the HQs are summed to derive a Hazard Index (HI). The target threshold for non-carcinogenic constituents is a HI of less than or equal to one. The RBGVs for non-carcinogenic constituents were calculated for a HI of one. To account for the possibility of more than one non-carcinogenic constituent, COPC's were screened using 1/10 the RBGV for non-carcinogenic constituents. Carcinogenic or radioactive constituents that exceed their RBGVs and non-carcinogenic constituents that exceed one-tenth of their RBGV were carried to the next step of the RRE.

2.4.3 Screening Constituents Based on Frequency of Detection

Constituents detected at concentrations above Mound background levels and above applicable RBGVs were next evaluated for their frequency of detection. The Risk Assessment Guidance for Superfund (RAGS) Part A (EPA, 1989) states that infrequently detected compounds may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be site-related. Compounds that were detected infrequently in all media, and not detected at high concentrations in any medium were eliminated from further consideration by the RRE.

Infrequent detection was defined as five percent or less which is equivalent to one detect in 20 samples. If there were an insufficient number of samples (e.g. less than 20) to determine whether the frequency of detection is five percent or less, the contaminant was not eliminated on the basis of frequency of detection. Other relevant factors such as whether the constituent is expected to be present based on historical data or degradation products of known contaminants also was considered in the decision to include or exclude infrequently detected constituents. Historical data and information on degradation products were not used to eliminate any COPCs at the Miami-Erie Canal area.

2.4.4 Screening Constituents Based on Essential Human Nutrients

According to RAGS Part A (EPA 1989): "Chemicals that are (1) essential human nutrients, (2) present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and (3) toxic only at very high doses (i.e., much higher than those that could be associated with contact at the site) need not be considered further in the quantitative risk assessment." Inorganic analytes meeting this description were not carried through the RRE. Calcium, chloride, iron, magnesium, potassium, and sodium are considered essential nutrients to humans. These compounds were detected in the canal area at levels below or slightly elevated above background and are toxic only at very high doses. Concentrations of these compounds in on-site media would not be expected to result in intakes associated with a toxic response. Therefore, these compounds were eliminated as COPCs for the canal area.

2.4.5 Additional Screening Procedures

In accordance with the RREM, additional screening procedures also were used to evaluate Miami-Erie Canal area constituents. For example, in accordance with EPA's Functional Guideline for Organics (EPA 1988) if a blank contains measurable levels of a common laboratory contaminant, then the associated sample results were considered as positive results only if the concentration in the samples exceeded ten times the concentration in the blank. If the concentration of a common laboratory contaminant was less than ten times the blank concentration, the constituent was considered to be an artifact of laboratory handling and was not included in the RRE. Common laboratory contaminants include acetone, 2-butanone, methylene chloride, toluene and phthalate esters.

Given the high degree of uncertainty in both the identity and reported concentrations of tentatively identified compounds (TICs), these constituents were not carried through the RRE. Relatively few TICs were reported in the Miami-Erie Canal database and historical information does not suggest that a particular TIC should be present.

3.0 EXPOSURE ASSESSMENT

The goal of the RRE exposure assessment is to estimate the type and magnitude of contaminant exposures that may occur under current conditions with the area being used for recreational purposes and in the future assuming that the area is developed for residential use. The information gathered in the exposure assessment is integrated with

toxicity information to characterize potential risks associated with exposure to residual contamination in the canal area.

3.1 Characterization of Exposure Setting

The Miami-Erie Canal area is located west of the Mound Plant between the Conrail Railroad right-of-way to the east and Dayton-Cincinnati Road to the west. The area includes: (1) the abandoned Miami-Erie Canal; (2) Overflow Creek which connects the canal to the Great Miami River; (3) a drainage ditch from the site boundary to the canal; (4) Runoff Hollow between the Conrail tracks and the Mound Plant; and (5) South Pond in the Miamisburg City Park. During canal restoration the drainage ditch from the site boundary, consisting of two 60-inch lines (a.k.a. the "twin sixties") were blocked, and a closed pipeline installed on plant property running south to the Overflow Creek, and discharging to the canal at this point. Since the canal restoration was completed, the discharge point of the closed pipeline was moved approximately 300 feet north. Currently, land use in the canal area is a combination of city park, Conservancy District, and railroad right-of-way.

Historic operations and accidental releases from the Mound Plant have resulted in the discharge of contamination into the Miami-Erie Canal area. This contamination consisted primarily of plutonium and tritium (DOE 1999). An underground pipeline rupture at the Mound Plant in 1969 resulted in the release of plutonium-238 in a nitric acid solution. During pipeline remediation, a rainstorm washed contaminated soil to the canal and, to a lesser extent, to Overflow Creek and the Great Miami River. Plutonium –contaminated soils were deposited as sediments in the canal. Tritium contamination of canal area soil is largely due to the pre-1970 disposal of tritiated process liquids. The depth distribution profiles for the tritium contamination were found to resemble those of the plutonium contamination. The highest concentrations of tritium in canal soil samples decreased over time from 7.0×10^5 pCi/g in 1974 and 1.1×10^5 pCi/g in 1976 (Kershner and Rhinehammer 1978) to 180 pCi/g in 1993 (DOE 1993c).

A fraction of the tritiated water that entered the canal percolated into the substrata where it could potentially migrate into the Buried Valley Aquifer (BVA). The results from groundwater samples collected from monitoring wells in the BVA during 1991 and 1992 indicated that the annual average tritium concentrations were below the Safe Drinking Water Act (SDWA) standard (EG&G 1992). Tritium concentrations in sampled drinking water wells were also below the SDWA standards (DOE 1999a).

Several investigations and one removal action have been performed in the Miami-Erie Canal area since the pipeline break in 1969. For a complete chronology of Miami-Erie Canal activities, see the OSC Report (DOE 1999). Restoration activities in the Miami-Erie Canal area have included the excavation and removal of approximately 40,000 cubic yards of soil. The removal action clean-up goal was to remove plutonium-238, with a resulting 95% UCL of the mean concentrations less than 75 pCi/g, and to remove all known spots of contamination greater than 150 pCi/g (DOE 1999). These goals were established by a focus group of stakeholders to be consistent with RBGVs for the recreation use scenario. The OSC report (DOE 1999) demonstrated that the verification sampling results confirm that these goals were achieved. Following completion of the Miami-Erie Canal restoration project, 1-2 feet of clean soil was brought in to replace soil that had been removed. The clean soil was graded, grass was seeded, trees were planted, and a bike path was constructed. The canal property is used as a City of Miamisburg park.

3.2 Identifying Exposure Pathways

Although many exposure pathways are possible, this RRE evaluates the pathways for the most likely receptors the recreational adult and child and other less likely receptors that include the resident adult and child and off-site construction worker. Pathways for the additional scenarios residential and off-site construction worker use were added to evaluate the potential need for additional land use restrictions. When identifying exposure pathways it is important to keep in mind the four elements of an exposure pathway. An exposure pathway consists of: (1) a source of chemical release, (2) a transport media, (3) a point of potential human contact with the contaminated media, and (4) an exposure route (e.g. ingestion). If any of these elements is missing or eliminated, the pathway will be incomplete and exposure will not occur.

A graphical representation of the exposure pathways identified for potential receptors is included in the conceptual site model for the Miami-Erie Canal (Figure 3). The conceptual site model summarizes the pathways that hazardous substances may take to reach potential receptors. Exposure assumptions used to evaluate potential exposure pathways were drawn from the Mound Plant *Risk-Based Guideline Values* (DOE 1997b) and are based on the reasonable maximum exposure (RME) scenario recommended by RAGS Part A (EPA 1989). The RME scenario is a conservative depiction of potential exposure conditions intended to represent the maximum exposure conditions that one might reasonably expect to occur at the site. RME assumptions were used to characterize risk for all potential canal area receptors. Exposure

assumptions used to quantify contaminant exposures are summarized in Table 4.

3.3 Identifying Exposure Scenarios

Residual contamination in the Miami-Erie Canal area was evaluated for three potential use scenarios. Residual contamination in the canal area was evaluated for recreational adults and children, for residential adults and children and for an adult off-site construction worker. Recreational use is the intended use. Residential use of the canal area is unlikely; however it was included to determine whether land use restrictions were needed. The construction worker was also included to determine whether land use restrictions were needed. All three scenarios assume exposure to soil and sediment.

3.3.1 Recreational Adult and Child Scenarios

Since recreational activities are planned within the canal area, recreational adults and children were identified as potential receptors. During recreational activities these receptors could be exposed to residual contamination present in soil 0-2 feet below land surface including sediment. It was assumed that recreational users would use municipally supplied water. The City of Miamisburg obtains its drinking water from five (5) wells completed in the Great Miami Buried Valley aquifer. Municipal supply wells are hydraulically up gradient of the Mound Facility. No indications of impacts from the Mound facility exceeding action levels have been detected in the municipal supply wells. The recreational users were assumed to be on the property four hours per day, 52 days per year over a six year period for children and over a 24 year period for adults. Adults were assumed to weigh 70-kilograms while children were assumed to weigh 15 kilograms.

Current and future exposure scenarios for the recreational scenario are identical. Exposure pathways evaluated for the recreational user for both current and future scenarios, include:

- incidental ingestion of sediment or soil 0-2 feet below land surface;
- external exposure to ionizing radiation from radionuclides in sediment or soil 0-2 feet below land surface;
- dermal contact with contaminants in sediment or soil 0-2 feet below land surface;
- inhalation of airborne contaminated soil particulates; and

- inhalation of volatile emissions from soil.

The parameters used to evaluate these pathways and their references are provided in Table 4.

3.3.2 Residential Adult and Child Scenarios

In order to calculate risk under a residential use scenario, hypothetical residents were assumed to live at the site for 24 years and hypothetical resident children were assumed to live at the site for 6 years. Allowing for a two-week vacation, site residents have an exposure frequency of 350 days/year. During home construction, excavation for basement construction could bring subsurface soil to the land surface. Therefore, potential direct soil exposure pathways were evaluated assuming that site residents could be exposed to residual contamination present in sediment or soil at any depth. It was assumed that canal area residents would use municipally supplied water for potable supply. The City of Miamisburg obtains its drinking water from five (5) wells completed in the Great Miami Buried Valley aquifer. Municipal supply wells are hydraulically up gradient of the Mound Facility. No indications of impacts from the Mound facility exceeding action levels have been detected in the municipal supply wells.

There are currently no site residents, so the site resident scenario was conducted for a hypothetical future use. The exposure pathways evaluated for the future site resident include:

- incidental ingestion of sediment or soil at or below land surface;
- external exposure to ionizing radiation from radionuclides in sediment or soil at or below land surface;
- dermal contact with contaminants in sediment or soil at or below land surface;
- inhalation of airborne contaminated soil particulates; and
- inhalation of volatile emissions from soil.

The parameters used to evaluate these pathways and their references are provided in Table 4.

3.3.3 Off-Site Construction Worker Scenario

Since it is reasonable to assume that construction activities could occur within the canal area, adult construction workers were identified as potential receptors. During construction activities these receptors could be exposed to residual contamination present in soil or sediment at or below land surface. Potential exposure pathways include incidental soil or sediment ingestion, external radiation exposure, and inhalation of airborne dust and vapors. Off-site Construction workers were assumed to be on the property 8 hours per day, 250 days per year over a 1-year period. Since construction workers are assumed to be adults, a body weight of 70-kilogram was used to assess exposure to chemical contaminants. It was assumed that canal area residents would use municipally supplied water for potable supply.

Exposure pathways evaluated for the hypothetical construction worker scenario include:

- incidental ingestion of soil or sediment at or below land surface;
- external exposure to ionizing radiation from radionuclides in soil or sediment at or below land surface;
- inhalation of airborne contaminated dust; and
- inhalation of volatile emissions from soil or sediment.

The parameters used to evaluate these pathways and their references are provided in Table 4.

3.4 Exposure Point Concentrations

Exposure point concentrations (EPC) are the concentrations of contaminants available to human receptors at the point of contact. If the data were found to be normally distributed, the EPC for the RRE was calculated as the 95% UCL of the arithmetic mean of the data, using the student's t-statistic. If the data were found to be log normally distributed, the RME estimate was calculated as the 95% UCL using the H-statistic (EPA 1992a).

Only surface soil data (0-2 feet below land surface) was used to calculate the exposure point concentration for the recreational user. Recreational users are assumed to spend

most of their time riding bikes or hiking and having only limited contact with surface soil or sediment. During home construction subsurface soils could be brought to land surface. Therefore the exposure point concentration for the hypothetical off-site construction worker and future site resident scenario was calculated using sediment and soil samples collected at any depth. Given the low number of subsurface samples collected, the inclusion of subsurface soil had little to no effect on EPC for the residential scenario.

3.5 Human Intake Equations and Assumptions

This section presents the exposure equations and assumptions used to derive contaminant-specific intake estimates for the populations and exposure pathways evaluated in the risk assessment. The use of the intake equations presented in this section is in accordance with methods presented by EPA in RAGS Part A (EPA 1989) and the RREM presented in Mound 2000 (DOE 1997a). Exposure assumptions have been developed to represent high-end RME conditions. Exposure assumptions for each of the potential receptors, and corresponding guidance or rationale used in this assessment are presented in Table 4.

There is a fundamental difference in the measurement of exposures from chemical contaminants as compared to radionuclide contaminants. For chemicals, exposure generally refers to the intake (e.g., inhalation, ingestion, dermal exposure) of the chemical, expressed in units of mg/kg-day. Toxicity values for chemicals are generally expressed in these terms; therefore, the product of the intake estimate with the toxicity value yields a risk value. Radionuclide intake is typically expressed in units of activity (i.e., bequerel [Bq] or curie [Ci]) rather than mass. In addition, dose has a different meaning for radionuclides than for chemicals since adverse effects are related to rate decay rather than amount or mass. For radionuclides, dose is equal to the energy imparted to a unit mass of human tissue. Despite these differences the risk due to chemical and radiological contaminants have been summed in the RRE summary tables (Tables 21-23).

The approach used to estimate intake for chemical contaminants largely applies to radionuclides. However, there are a few key differences in the methods. For example, in addition to the ingestion, inhalation and direct contact pathways considered for chemical contaminants, external exposure to penetrating radiation was also evaluated for radionuclides. Equations for estimating the intake of radionuclides have been modified by omitting the body weight and averaging time from the denominator. This is

done because radiation exposure assessments do not end with the calculation of intake, but use dose conversion factors to estimate dose equivalents to specified organs.

Oral and inhalation intakes are expressed as the amount of chemical at the exchange boundary (e.g., skin, lungs, intestine) that is available for absorption. These intakes are not equivalent to the absorbed dose (the amount of chemical actually absorbed into the blood stream). Dermal doses are expressed as estimates of absorbed dose. The toxicological reference values used to calculate risk have been adjusted to account for this difference; however, this discrepancy is a source of uncertainty when comparing or combining dermal doses with intakes from other exposure routes.

Exposure to soil and sediment through incidental ingestion was evaluated for recreational users under current and future land use scenarios and for future off-site construction workers and residents. Intakes for the chemical contaminants in soil/sediment ingestion pathway were estimated by using the following equation:

$$Intake\ (mg/kg\text{-}day) = \frac{C_{so}\ x\ IR\ x\ FI\ x\ EF\ x\ ED\ x\ CF}{BW\ x\ AT}$$

Where:

C_{SO}	=	Contaminant concentration in soil/sediment (mg/kg)
IR	=	Ingestion rate (mg/day)
FI	=	Fraction ingested from contaminated source (1.0) (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time for cancer and non-cancer effects (days)

Radionuclide intakes for the soil/sediment via incidental ingestion was estimated by using the following equation:

$$Intake\ (pCi) = C_{so} x\ IR x\ FI x\ EF x\ ED x\ CF$$

Where:

C_{SO} = Radiological activity in soil/sediment (pCi/g)

IR = Ingestion rate (mg/day)

FI = Fraction ingested from contaminated source (1.0) (unitless)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

CF = Conversion factor (10^{-3} kg/mg)

Dermal exposure to soil and sediment was assumed to occur simultaneously with incidental ingestion exposure. Exposure to soil and sediment through dermal contact was evaluated for recreational users under current and future land use scenarios, and for future off-site construction workers and residents. Soil/sediment dermal exposures were evaluated for recreational users under current and future land use scenarios. Chemical intakes for the soil/sediment via dermal exposure were estimated using the following equation:

$$Absorbed\ Dose\ (mg/kg\text{-}day) = \frac{C_{so} x\ SA x\ AF x\ ABS x\ EF x\ ED x\ CF}{BW x\ AT}$$

Where:

C_{SO} = Chemical concentration in soil/sediment (mg/kg)

SA = Skin surface area available for contact (cm^2/day)

AF = Soil to skin adherence factor (1) (mg/cm^2)

ABS = Dermal absorption factor (unitless)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

CF = Conversion factor (10^{-6} kg/mg)

BW = Body weight (kg)

AT = Averaging time for cancer and non-cancer effects (days)

Exposure to external radiation from radionuclides in soils/sediments was estimated by using the following equation:

Absorbed Dose (pCi/g) = Cso x ED x Te x (1-Se)

Where:

C_{SO} = Radionuclide activity in soil/sediment (pCi/g)

ED = Exposure duration (years)

Te = Gamma exposure time factor (hrs/hrs)

Se = Shielding factor (unitless)

Unlike inhalation, ingestion, and dermal exposure, the external radiation exposure term is defined as an equivalent radionuclide concentration in soil/sediment that an onsite receptor would be exposed to for a particular exposure duration. This exposure term is adjusted for exposure time and shielding. For the canal area RRE a default shielding factor of 20% was assumed. These assumptions provide for a conservative estimate of external radiation exposure.

Intake of soil/sediment (fugitive dust) via inhalation was evaluated for recreational users under current and future land use scenarios, and for future off-site construction workers and residents. The intake equation for chemical contaminants for this pathway is provided below:

$$Intake\ (mg/kg\text{-}day) = \frac{C_{so} \times IR \times ET \times EF \times ED}{PEF \times BW \times AT}$$

Where:

C_{SO} = Contaminant concentration in soil/sediment (mg/kg)

IR = Inhalation rate (m^3/hr)

ET = Exposure time (hrs/day)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

PEF = Particulate emission factor (1.32×10^9 m^3/kg, EPA default value)

BW = Body weight (kg)

AT = Averaging time for cancer and non-cancer effects (days)

The intake equation for radionuclide contaminants via inhalation of fugitive dust was estimated using the following equation:

$$Intake\ (pCi) = \frac{C_{so}\ x\ IR\ x\ ET\ x\ EF\ x\ ED}{PEF}$$

Where:

C_{SO} = Radiological activity in soil/sediment (pCi/g)

IR = Inhalation rate (m^3/hr)

ET = Exposure time (hrs/day)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

PEF = Particulate emission factor (1.32×10^9 m^3/g, EPA default value)

The PEF relates the concentration of the contaminant in soil/sediment to the concentration of respirable particles in the air from fugitive dust emissions. These emissions result from wind erosion. The default value of 1.32×10^9 m^3/kg was taken from RAGS, Volume I, Part B (EPA 1991b) and represents a surface with unlimited erosion potential.

Volatilization of chemical contaminants from soils/sediments may result in exposures via inhalation for recreational users; however, no volatile COPCs were identified in the

canal area. Therefore, this pathway was not evaluated for chemical constituents.

4.0 TOXICITY ASSESSMENT

The objectives of the toxicity assessment are to identify and select toxicological values for use in estimating the significance of the exposure and to evaluate potential adverse effects associated with exposure to compounds detected in the Miami-Erie Canal area. The RRE for the canal area evaluated chronic exposures. The RRE utilized methods recommended by EPA for evaluating human cancer and non-cancer health effects resulting from exposure to the COPCs. The toxicity criteria used in the RRE were obtained from the most current update of the EPA Integrated Risk Information System (IRIS) or, if the information was not available in IRIS, the EPA Health Effects Assessment Summary Tables (HEAST). IRIS is an electronic database containing the most current descriptive and quantitative EPA regulatory information on chemical and radiological constituents. Constituent files maintained in IRIS contain information related to non-carcinogenic and carcinogenic health effects of constituents. HEAST is a published reference, updated periodically by EPA. It contains toxicity information and values for constituents from health effects documents and profiles. Other sources for toxicity information include the National Center for Environmental Assessment (NCEA) Provisional Values, ATSDR Toxicology Profiles or EPA Criteria Documents and DOE's Risk Assessment Information System (RAIS) website. Table 5 presents a summary of toxicological criteria used along with the chemical-specific characteristics used to estimate dermal absorbed dose and the concentrations present in vapors or dust.

In assessing the potential for non-cancer health effects, EPA assumes that there is a threshold below which no adverse toxic effects are expected. For example, a toxic threshold would exist if a substance had no toxic effect at a certain level of exposure, but did have a toxic effect at a higher level. EPA derives and publishes reference doses (RfDs) and reference concentrations (RfCs) for use in evaluating adverse non-carcinogenic effects. These are estimates (with uncertainty spanning an order of magnitude or greater) of daily human exposures, including sensitive sub-populations, that may go without appreciable harmful effects during a lifetime (EPA 1989). EPA derives RfDs and RfCs for humans based on estimates of the no-observable-adverse-effect-level (NOAEL) or lowest-observable-adverse-effect-level (LOAEL) observed in test organisms.

Carcinogenesis, however, is generally thought to be a phenomenon without a threshold for effect (EPA 1989). The basis for this presumption is that an extremely low level of

exposure to some carcinogens may result in chromosomal or enzyme changes leading to uncontrolled cellular proliferation or cancer. EPA does not therefore estimate an effect threshold for carcinogenic chemicals. EPA uses a two-part evaluation for carcinogens. First the constituent is assigned a weight-of-evidence classification based on both epidemiological evidence of carcinogenic effects and laboratory tests conducted with animals. Then a cancer potency factor, or slope factor (CSF), is calculated. The slope factor is a plausible upper-bound estimate of the slope of the dose-response curve in the low dose range. In risk assessment, the cancer slope factor is used to estimate the excess lifetime probability of a carcinogenic effect occurring in exposed receptors.

4.1 Toxicity Values for Evaluating the Dermal Pathway

Toxicological reference values are available only for the oral and inhalation pathways and the majority of these values are based on intake (i.e., administered dose) rather than an absorbed dose. Because the intake equation for the dermal contact pathway calculates absorbed dose (by incorporating a dermal absorption factor or a permeability coefficient), it is necessary to convert the administered dose toxicity value to an absorbed dose toxicity value in order to calculate risk. For the Miami-Erie Canal RRE oral administered-dose toxicity values were adjusted using compound specific gastrointestinal absorption factors when the gastrointestinal absorption factors were less than 0.5. For non-carcinogens, the administered dose toxicity value (i.e., the RfD) was multiplied by the gastrointestinal absorption factor. For carcinogens, the slope factor was divided by the gastrointestinal absorption factor.

4.2 Toxicity Assessment for Lead

Lead was identified as a COPC in the canal area, however, lead does not have toxicological reference values. A risk-based remediation goal for lead, 400 parts per million (ppm) in soil, was established by EPA based on the "Interim Guidance on Establishing Soil Lead Cleanup Levels at RCRA Facilities" (EPA, 1994a). The allowable concentration of 400 ppm lead in soil is supported by USEPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) (USEPA, 1994b). The IEUBK predicts that 400 ppm lead in soil could cause a 6 year old resident child (averaged across the preceding 84 months) to have a probability of no greater than 5% of a blood lead level of 10 micrograms/deciliter (Φg/dL) assuming exposure to surface soil and subsurface soil brought to the land surface. In children, a blood lead level of between 10 and 15 micrograms per deciliter (Φg/dL) has been associated with a level at

which no adverse effects would be expected (Centers for Disease Control and Prevention [CDC], 1985). Since the residential exposure scenario is more conservative than the recreational scenario, the acceptable level of 400 ppm lead is expected to be protective under both the recreational and residential scenarios.

5.0 RISK CHARACTERIZATION

This section presents the risk characterization for the Miami-Erie Canal area. Information from the exposure assessment (Section 3) is combined with information from a toxicity assessment (Section 4) to characterize human health risks.

5.1 Risk Characterization Methods

Risk characterization integrates the exposure and toxicity assessments by comparing estimates of intake or dose with appropriate toxicity values. This in turn provides an indication of the potential for adverse effects to exposed receptors. The objective of the risk characterization is to determine if exposure to contaminants associated with the site pose risks that exceed EPA target levels for human health effects. The results of the risk assessment may thus support the determination of site release or the need for site remediation.

The RRE reports the incremental risk, total risk, and risk from background for each contaminant evaluated in the Miami-Erie Canal Area. The incremental risk is the risk posed by site-related contamination above the risk posed by background environmental levels. Background risk is the risk resulting from sources other than the Mound-related residual contamination. Site-specific background values are provided in the Mound 2000 RREM (DOE 1997a). The Mound 2000 background values that correspond to the canal COPCs were used as the EPCs to determine background risk. This report does not provide site-specific background levels for PAHs,

To allow for a comparison of the concentration of PAHs detected during the Miami-Erie Canal verification sampling with site-specific anthropogenic background levels a study titled the *Determination of Site-Specific Benzo(a)pyrene and Dibenzo(a,h,)anthracene Background Levels for the Miami-Erie Canal* was released in December 2002 (See Appendix D). This report documents sample collection and results completed to document site-specific levels of PAHs in the Miami-Erie Canal area. A qualitative discussion of the results is included in Sections 5.2 and 6.4, however, these values are not officially designated as background PAH values for Mound so risks due to

background levels of PAHs were not quantified or subtracted from the reported risk levels."

Although the concentration of PAHs at background sample location 2 does appear to be somewhat elevated, these concentrations are not believed to be related to Mound site operations and are, therefore, indicative of anthropogenic background levels.

Total risk is the sum of the background and incremental risk. This risk characterization presents a separate evaluation of non-carcinogenic and carcinogenic effects. The assessment distinguishes cancer from non-cancer effects because organisms typically respond differently following exposure to carcinogenic or non-carcinogenic agents. Quantification methods for cancer and non-cancer effects are discussed separately in the following sections.

5.1.1 Quantification of Carcinogenic Risk

Cancer risks are probabilistic estimates of the excess (incremental) lifetime cancer risk for an individual specifically attributable to long term exposure to site-related chemicals. The procedure for calculating risk associated with exposure to carcinogenic compounds has been established by EPA (EPA 1989). A non-threshold, dose-response model was used to calculate a cancer slope (potency) factor for each COPC. To derive an estimate of risk, the cancer slope factor was multiplied by the estimated chronic daily intake experienced by the exposed individual:

$$\text{Risk} = \text{CDI} \times \text{CSF}$$

Where:

Risk	=	High end estimate of the excess lifetime cancer risk to an individual (unitless probability)
CDI	=	Chronic daily intake averaged over an established period (mg/kg body weight/day)
CSF	=	Cancer slope factor (95% upper-bound estimate of the slope of the dose-response curve) expressed as (mg/kg body weight/day)$^{-1}$.

To evaluate the risk of exposure to more than one carcinogenic COPC, the risk estimates for each COPC were summed to provide an overall estimate of total carcinogenic risk (EPA 1989).

$$\text{Risk}_T = \sum_{i=1}^{n} \text{Risk}_i$$

Where:

Risk_T = The combined excess lifetime cancer risk across chemical carcinogens

Risk_i = The risk estimate for the ith chemical of n chemicals under evaluation.

5.1.2 Quantification of Non-carcinogenic Risk

The traditionally accepted practice of evaluating exposure to non-carcinogenic compounds has been to experimentally determine a NOAEL and to divide this by a safety factor to establish an acceptable human dose, for example, acceptable daily intake or RfD. The RfD is then compared to the daily intake of the exposed population to obtain a measure of concern for adverse non-carcinogenic effects:

$$HQ = \frac{Intake}{RfD}$$

Where:

HQ = Hazard Quotient: potential for adverse non-carcinogenic effects

Intake = Average daily intake for subchronic or chronic exposure (mg/kg body weight/day)

RfD = Acceptable intake for subchronic or chronic exposure (mg/kg body weight/day).

To evaluate exposure to multiple non-carcinogenic COPCs the HQs for all COPCs were summed to obtain the Hazard Index (HI).

$$HI = \Sigma HQ_i$$

Where:

HI = Hazard Index

HQ_i = Hazard Quotient for the ith chemical of n chemicals under evaluation.

EPA has established target risk levels for use in determining the need for site remediation. For non-carcinogenic effects, EPA has set the target HQ at one. If the HQ is >1, there is the potential for adverse health effects at the given exposure/dose level, but the HQ value is not an indication of the severity of the effects. For multiple non-carcinogens, the HQs for all of the chemicals under evaluation are summed resulting in the HI. If the HI is > 1, the potential also exists for adverse health effects resulting from exposure to mixtures of chemicals. In cases where the HQ for individual substances is below 1 yet several HQs sum to greater than 1, EPA recommends segregating the compounds into groups with like or common toxicological effects and re-evaluating the potential for the various adverse health effects. In cases where HQs for individual substances are greater than 1, this step is not necessary or useful.

5.2 Risk Characterization Results

The following sections present the risk characterization results for the Miami-Erie Canal area by potential receptor. All of the tables for Section 5 (Tables 6 through 26) are presented at the end of the Section. Risk estimates for individual COPCs for all scenarios and pathways are presented in Tables 6 through 26. Tables 6 through 11 present risk estimates based on recreational exposure parameters, Tables 12 through 18 present risk estimates based on residential exposure parameters and Tables 19 through 23 present risk estimates based on off-site construction worker exposure parameters. Residual risks were calculated based on total risk, background risk and incremental risk. Total risk was calculated using total concentration of the COPCs detected in the area. Background risk was based on background levels of the COPCs, and incremental risk was calculated using the difference between total and background levels. Incremental risk can be used to assess the increase in risk above background levels due to Mound Plant operations. Tables 24 through 26 present summaries of the results for all scenarios and pathways assessed in the RRE. In the summary tables, risk estimates that are at or above the non-cancer HI of 1 and the cancer target risk range of 10^{-6} are bolded. Risk estimates of zero indicate that toxicity criteria were not

available for the COPC being evaluated.

Recreational Adult

Tables 6 through 8 present total, background and incremental risk for a recreational adult in the Miami-Erie Canal area. The total, background and incremental non-cancer risk is less than 1 indicating that non-cancer risk is at an acceptable level. Total cancer risk for a recreational adult is $1.3x10^{-5}$, which falls within the target risk range of 10^{-4} to 10^{-6}. The only constituent to exceed $1x10^{-6}$ was radium-226. Residual risk due to radium-226 was driven by external exposure to radium-226 in soil. The majority of this risk is due to background levels ($8.6x10^{-6}$). The incremental risk due to radium-226 in the canal area to a recreational adult is $4.5x10^{-6}$, which again falls within the target risk range.

Recreational Child

Tables 9 through 11 present total, background and incremental risk for a recreational child in the Miami-Erie Canal area. The total, background and incremental non-cancer risk is less than 1 indicating that non-cancer risk is at an acceptable level. Total cancer risk for a recreational child is $3.6x10^{-6}$, which falls within the target risk range of 10^{-4} to 10^{-6}. The only constituent to exceed 10^{-6} was radium-226. Residual risk due to radium-226 was driven by external exposure to radium-226 in soil. The majority of this risk is due to background levels ($2.4x10^{-6}$). The incremental risk due to radium-226 in the canal area to a recreational child is $1.2x10^{-6}$, which falls within the target risk range.

Residential Adult

Tables 12 through 14 present total, background and incremental risk for a residential adult in the Miami-Erie Canal area. The total, background, and incremental non-cancer risk, or HI, is less than 1 indicating that non-cancer risk is at an acceptable level. Total chemical and radiological cancer risk of $3.9x10^{-4}$ for the residential adult exceeds the target cancer risk range of $1x10^{-4}$ to $1x10^{-6}$. Of this total risk, constituents that exceed the $1x10^{-6}$ cancer risk level include BaP, DbA, arsenic, plutonium-238 and radium-226 with risk levels of $1.3x10^{-4}$, $4.4x10^{-5}$, $1.6x10^{-5}$, $5.2x10^{-6}$, and $1.9x10^{-4}$, respectively. Background cancer risk to a residential adult is $1.4x10^{-4}$. Constituents with approved background concentrations for Mound that exceed the $1x10^{-6}$ risk level include arsenic and radium-226 with risks of $1.4x10^{-5}$ and $1.3x10^{-4}$, respectively. Incremental residual cancer risk for a residential adult in the canal area is $2.4x10^{-4}$, which exceeds the target risk range. Of the incremental risk the constituents that exceed the target risk level

include BaP ($1.3x10^{-4}$), radium-226 ($6.7x10^{-5}$), DbA ($4.4x10^{-5}$), plutonium-238 ($5.2x10^{-6}$), and arsenic ($1.5x10^{-6}$), in descending order of risk. The background risks for arsenic and radium-226 are similar to total risks for each of these constituents and result in incremental risks lower than background.

The largest contributor to incremental cancer risk for the resident adult is BaP at a level of $1.3x10^{-4}$. The range of detected concentrations of BaP documented in the OU4 background PAH study was 56 µg/kg to 7700 µg/kg. The range of detected concentrations of BaP in the Miami-Erie Canal verification samples was 21 µg/kg to 7900 µg/kg. Since the concentrations of BaP detected in the OU4 background study are similar to levels found in the remediated area of the canal, if the background levels of PAHs were accounted for in the risk calculations overall incremental risk for the resident adult would fall within the target risk range. This indicates that the existing levels of residual contamination detected in the canal area are protective of current and potential future users and that no further remedial action is warranted.

Residential Child

Tables 15 through 17 present total, background and incremental risk for a residential child in the Miami-Erie Canal area. The total, background and incremental non-cancer risk is less than 1 indicating that non-cancer risk is at an acceptable level. Total chemical and radiological cancer risk for a residential child is $1.6x10^{-4}$, which exceeds the target risk range of 10^{-4} to 10^{-6}. Of this total risk, constituents that exceed $1x10^{-6}$ include BaP, DbA, arsenic, plutonium-238 and radium-226 with risk levels of $6.2x10^{-5}$, $2.2x10^{-5}$, $2.0x10^{-5}$, $2.6x10^{-6}$, and $5.1x10^{-5}$, respectively. Background cancer risk to a residential child is $5.1x10^{-5}$. Constituents with approved background concentrations for Mound that exceed the $1x10^{-6}$ risk level include arsenic and radium-226 with risks of $1.8x10^{-5}$ and $3.3x10^{-5}$, respectively. Incremental residual cancer risk for a residential child in the canal area is $1.1x10^{-4}$, which exceeds the target risk range. For incremental risk, the constituents that exceed the target risk level include BaP ($6.2x10^{-5}$), DbA ($2.2x10^{-5}$), radium-226 ($1.7x10^{-5}$), plutonium-238 ($2.6x10^{-6}$), and arsenic ($1.9x10^{-6}$), in descending order of risk. Background risks for arsenic and radium-226 are similar to total risks for these constituents resulting in incremental risks that are lower than background risks.

The largest contributor to incremental cancer risk for the residential child is BaP at a level of $6.2x10^{-5}$. The range of detected concentrations of BaP documented in the OU4

background PAH study was 56 µg/kg to 7700 µg/kg. The range of detected concentrations of BaP in the Miami-Erie Canal verification samples was 21 µg/kg to 7900 µg/kg. Since the concentrations of BaP detected in the OU4 background study are similar to levels found in the remediated area of the canal, if the background levels of PAHs were accounted for in the risk calculations overall incremental risk for the resident child would fall within the target risk range. This indicates that the existing levels of residual contamination detected in the canal area are protective of current and potential future users and that no further remedial action is warranted.

Off-Site Construction Worker

Tables 18 through 20 present total, background and incremental risk for an off-site construction worker in the Miami-Erie Canal area. The total, background and incremental non-cancer risk is less than 1 indicating that non-cancer risk is at an acceptable level. Total chemical and radiological cancer risk for an off-site construction worker is 1.0×10^{-5}, and only constituents that exceed 1×10^{-6} is radium-226 via oral and external exposure. Background and incremental cancer risk to an off-site construction worker are 6.8×10^{-6} and 3.2×10^{-6}, respectively. Both these values fall within the target risk range of 10^{-4} to 10^{-6}.

6.0 UNCERTAINTY IN THE RISK ASSESSMENT

In the following section, an evaluation is presented of the sources of uncertainty in the Miami-Erie Canal area RRE and the relative influence of these sources on the results of the evaluation. Uncertainty is inherent in the selection of input parameters and in every step of the risk assessment process. Risk assessment of contaminated sites must not be viewed as yielding single value, invariant results. Rather, the results of risk assessment are estimates that span a range of possible values, and which must be understood only in light of the assumptions and methods used in the evaluation.

The results of the RRE are presented in terms of the potential for adverse effects based upon a number of conservative assumptions. The tendency to be conservative is an effort to err toward protecting health. Uncertainty can be found at all phases in the risk assessment: in the analytical data, the exposure assessment, the toxicity assessment, and the risk characterization. Where uncertainty does exist, the RRE uses conservative assumptions to ensure that the outcome will be protective.

6.1 Uncertainty in Analytical Data

Uncertainty is introduced to the RRE when sample locations are selected and when samples are collected and analyzed. In the RRE, the long-term exposure concentrations were upper estimates of site concentrations (e.g., maximum detect or 95% UCL); therefore, a conservative bias to overestimate potential exposure has been incorporated into the risk estimates. The uncertainty associated with the statistical analysis of environmental data is low, with little introduction of bias. However, it is possible that contaminated areas of the canal were not sampled. This is unlikely given the extent of sampling conducted.

6.2 Uncertainty in Exposure Assessment

Exposure assessment may introduce considerable uncertainty in the risk assessment process. The RREM presents exposure and intake calculations based on EPA procedures that were used in the Miami-Erie Canal RRE. Exposure assumption values were also used to develop site-specific risk-based guideline values for the Mound Plant which were approved by Ohio EPA and U.S. EPA. Exposure assumptions are based on speculation regarding potential land use, assumptions concerning contaminant fate and transport, and receptor behavior. The uncertainty associated with the exposure assumptions used in the risk assessment is low to moderate, and most likely overestimates the actual risks.

Identification of contaminants to be carried through the Residual Risk Evaluation (RRE) calculations is a multi-step process beginning with the identification of all contaminants detected in the area and then eliminating contaminants based upon a set of established screening criteria described in the Residual Risk Evaluation Methodology (RREM). One of the screening criteria utilized to identify COPCs were regulator-approved background levels presented in Appendix A of the RREM guidance (DOE 1997a). The approved background values listed in the RREM are 95% upper tolerance limit (95%UTL) values while the exposure point concentrations used to quantify total risk are the lower of the 95% upper confidence limit (95%UCL) or the maximum detected concentration from the verification sample data set. The 95%UTLs estimate the high end of the detected range of concentrations while 95%UCLs estimate a bounding concentration based on the central tendency of the distribution. This difference may result in a less conservative screening of COPCs and characterization of background risk. To characterize the magnitude of the difference, a comparison of the 95%UTLs and the 95%UCLs for analytes in the background data set was conducted and is described in Appendix E.

When the background values (95%UTLs) were compared to the 95%UCLs the difference was less than an order of magnitude for all background analytes. Since the difference between the background values (95% UTLs) and the 95%UCLs was less an order of magnitude utilizing the RREM background values to screen COPCs and characterize background risk will have a small impact on outcome of risk calculations

The exposure scenarios, receptors, exposure pathways, exposure parameters, and media included in the Canal RRE were selected to conservatively represent a variety of exposure scenarios that could occur at the Miami-Erie Canal area. Groundwater was not included as a media of concern since water at the canal area will be provided by the City of Miamisburg. Since the city will provide potable water, it is unlikely that a construction worker in the canal area would drink or shower in water drawn from the OU4 area. Incidental ingestion and dermal exposure to groundwater may occur while excavating, however, standing groundwater in an excavation is likely to be a rare occurrence and would probably be pumped out or allowed to dry out before work is resumed in a given area. The permitting of future groundwater or surface water discharges within the canal area is not within the purview of the RRE and may be a source of uncertainty for future users of the canal area.

One source of uncertainty in the Miami-Erie Canal RRE involves external exposure to gamma-emitting radionuclides. External exposure refers to the irradiation of tissues by radiations emitted by radionuclides located outside the body either dispersed in air, on skin surfaces, or deposited on ground surfaces. Gamma and x-rays are the most penetrating of the emitted radiations and comprise the primary contribution to radiation dose from external exposures. The calculation of risk from external radiation exposure assumes that any gamma-emitting radionuclide in soil is uniformly distributed in soil. The calculation of external radiation exposure risk includes a gamma shielding factor (S_e) to account for attenuation of radiation by structures, terrain or engineered barriers. S_e is expressed as a fractional value between 0 and 1, representing the possible risk reduction range from 0% to 100% due to shield. The Miami-Erie Canal RRE used a default value of 0.2 or 20% shielding for both the recreational and residential scenarios. This is a conservative value, which does not account for 1-2 feet of clean fill material that was placed over excavated areas. Calculations done using RESRAD Version 5.621 and verified with Microshield Version 4.21 show that the reduction in dose from a gamma source by applying soil covers of various depths would be on the order of a 99% reduction or 99% shielding with 2 feet of soil cover (SAIC 1997). It is likely that

clean fill in the canal area does provide shielding from gamma radiation resulting in lower risk than what is presented here.

6.3 Uncertainties Related to Toxicity Information

Although EPA approved toxicity values were used for the RRE a significant amount of uncertainty may surround these values. Identification of the sources of this uncertainty enables the risk assessor to establish the degree of confidence associated with the toxicity measures.

Uncertainty is inherent within the toxicity assessment and is primarily due to differences in study design, species, sex, routes of exposure, or dose-response relationships. A major source of uncertainty involves using toxicity values based on experimental studies that substantially differ from typical human exposure scenarios. The derivation of the toxicity values must take into account such differences as 1) using dose-response information from animal studies to predict effects in humans, 2) extrapolating dose-response information from high-dose studies to predict adverse health effects from low doses, 3) using data from short-term studies to predict chronic effects, and 4) extrapolating from uniform animal populations to variable human populations.

The cancer slope factors in particular are based on studies that may differ greatly from realistic situations. Experimental cancer bioassays typically expose animals to very high levels of chemicals (i.e., the maximum tolerated dose) for their entire lifetime. After appropriate studies have been identified, the slope factor is calculated as the upper 95th percent confidence limit of the slope of the dose-response curve. This introduces conservatism into the risk assessment. In addition, carcinogens are assumed to be human carcinogens regardless of EPA's weight-of-evidence classification.

The derivation of reference doses involves the use of animal studies. Uncertainty factors ranging from 1 to 1,000 are incorporated into the reference dose to provide an extra level of health protection. The factors used depend on the type of study from which the value has been derived (e.g., animal or human, chronic or acute, study design). The scientific basis for this practice is somewhat subjective. In general, high uncertainty factors are meant to bias the results conservatively so that exposures at the reference dose level will not result in adverse health effects.

Toxicity values derived from oral administered dose studies have been converted to absorbed dose toxicity values for use in evaluating the dermal contact pathway. This is considered a more accurate approach than using unadjusted oral toxicity values for the

dermal pathway. Uncertainty is introduced in the use of the gastrointestinal absorption factors. Limited information is available on the gastrointestinal absorption of some analytes and many have no information at all. In addition, no adjustments have been made for the medium of exposure (e.g., when the medium of exposure in the site differs from the medium of exposure assumed by the toxicity value). The uncertainty associated with using the absorbed dose toxicity values for the dermal pathway is moderate and the bias unknown.

There are some chemicals for which no toxicity value exists and for which little information is available. Therefore, a quantitative risk estimate cannot be calculated for these chemicals. For example, many chemicals are not evaluated for the inhalation pathway because of limited inhalation-based toxicological information. The lack of toxicity information for some chemicals contributes to the underestimation of risks.

Cancer and non-cancer risks are summed in the risk characterization process (separately for carcinogens and non-carcinogens) to estimate potential risks associated with the simultaneous exposure to multiple chemicals. In the case of carcinogens, this gives carcinogens with a class B or class C weight-of-evidence the same weight as carcinogens with a class A weight-of-evidence. It also equally weights slope factors derived from animal data with those derived from human data. Uncertainties in the combined risks are also compounded because RfDs and cancer slope factors do not have equal accuracy or levels of confidence and are not based on the same severity of effect.

6.4 Uncertainties in Risk Characterization

Uncertainties in any phase of the risk analysis are reflected in the risk estimates. Some uncertainty is associated with the summation of risks and HQs for multiple chemical contaminants. As stated in RAGS (EPA 1989), "The assumption of dose additivity ignores possible synergisms or antagonisms among chemicals, and assumes similarity in mechanisms of action and metabolism." However, summing risks and HQs for multiple substances in this risk assessment provides a conservative estimate.

One of the key uncertainties associate with the Miami-Erie Canal area is the residual risk associated with PAHs in canal area soils. The Residual Risk Evaluation (RRE) for the remediated portion of the Miami-Erie Canal found benzo(a)pyrene (BaP) and dibenzo(a,h)anthracene (DbA) to be leading contributors to the residual risk from soil. PAHs are ubiquitous in many environments, particularly along railroad right-of-ways,

such as the one running through the canal area (ATSDR 1994; Edwards 1983; Eisler 1987: LaFlamme and Hites 1978; Yang et al. 1991).

To verify the ubiquitous distribution of PAHs found near the Miami-Erie Canal and to determine OU4 site-specific background levels of BaP and DbA samples were collected in February 2002 and the PAH study was completed in December 2002. The intent was to obtain unbiased information on the levels of PAHs in soil collected within the banks of the Miami-Erie Canal, but outside of the DOE Mound influence. For this study three discrete samples were collected at each of the four locations for a total of twelve (12) samples.

The BaP results from the December 2002 PAH study (Appendix D) ranged from 56 μg/kg (estimated) to 7700 μg/kg and had an average of 793 μg/kg (with a standard deviation of 2177μg/kg). The BaP results from the Miami-Erie Canal verification data set ranged from 21 μg/kg (estimated) to 7900 μg/kg and had an average of 550 μg/kg (with a standard deviation of 1144 μg/kg). The DbA results from the December 2002 PAH study ranged from 27 μg/kg (estimated) to 430 μg/kg (U qualified) and had an average of 206 μg/kg (with a standard deviation of 73 μg/kg). The DbA results from the Miami-Erie Canal verification data set ranged from 20 μg/kg (estimated) to 1500 μg/kg and had an average of 319 μg/kg (with a standard deviation of 241μg/kg).

The BaP and DbA results from the December 2002 PAH study and the Miami-Erie Canal verification sampling are very similar. This indicates the BaP and DbA levels observed in the Miami-Erie Canal verification are typical of this urban area and not the result of Mound operations. This finding is not surprising since PAHs are organic compounds that are created during the incomplete combustion of hydrocarbons and are produced by many human-initiated activities and natural occurrences. PAHs are widespread in the environment at concentrations similar to those that occur at the Miami-Erie Canal area. Typically, asphalt roads and parking lots, vehicle exhaust, utility poles, and railroad ties are more likely sources of PAHs in urban environments than industrial activities of the kind conducted at the Mound site. For example, soils at the base of treated-wood utility poles have been shown to contain a mean total PAH concentration of 3,076 mg/kg (Wan 1994). Railway ties have been shown to contain 1,600 mg/kg (Wan 1994). The Miami-Erie Canal area is bordered by a railway line and includes numerous treated wood utility poles, which are likely to have contributed to the level of PAHs detected in area soil. The concentration of PAHs detected in the Miami-Erie Canal area soils are significantly lower than those cited above and do not contribute significantly to residual risks. However, it is important for the reader to

understand the possible origins of this material when assessing residual risk for the area.

7.0 SUMMARY AND CONCLUSIONS

This report was prepared to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in the Miami-Erie Canal area. A Residual Risk Evaluation (RRE) evaluates human health risks associated with residual levels of contamination remaining within an area to ensure that future users of the land will not be exposed to unacceptable contaminant levels. Residual risks were calculated for total risk, background risk and incremental risk for the most likely and most conservative scenarios for the canal property.

Total, background and incremental non-carcinogenic risks for all receptors in all scenarios were below the target hazard level of one indicating that non-carcinogenic risks are within acceptable levels. Total, background and incremental carcinogenic risks for the recreational scenario (adult and child), and the adult off-site construction worker are within the acceptable risk range of 10^{-4} to 10^{-6}. Background carcinogenic risk for the hypothetical child residential scenario was within the acceptable carcinogenic risk range. Total, background and incremental carcinogenic risk for the hypothetical resident adult, and total and incremental carcinogenic risk for the hypothetical resident child exceed the target carcinogenic risk range of 10^{-4} to 10^{-6}. However, these analyses did not include any information on OU4 background levels of polycyclic aromatic hydrocarbons (PAHs). PAHs, like BaP and DbA, are ubiquitous in many environments, particularly along railroad right-of-ways, such as the one running through the canal area (ATSDR 1994; Edwards 1983; Eisler 1987: LaFlamme and Hites 1978; Yang et al. 1991). Since there were no OU4 site-specific background values for PAHs in soil to use in the evaluation of the significance of these data, a study was completed in December 2002 to determine background levels of BaP and DbA in OU4. This information was used to evaluate the level of PAHs found in the Miami-Erie Canal verification samples in comparison to the level of PAHs from anthropogenic sources outside of Mound's influence.

The BaP and DbA results from the December 2002 OU4 PAH background study and the Miami-Erie Canal verification sampling are very similar. Since the concentrations of PAHs detected in the OU4 background study are similar to levels found in the remediated area of the canal, if the background levels of PAHs were accounted for in

the risk calculations, incremental risk for the hypothetical residential receptors would fall within the target risk range. This indicates that the existing levels of residual contamination detected in the canal area are protective of current and potential future users and that no further remedial action is warranted.

8.0 REFERENCES

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APPENDIX B

Tables

Table 1: Identification of Constituents of Potential Concern for the Recreational RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Inorganics (mg/kg)									
Aluminum	7429-90-5	3080.00	15300.00	128-128	9890.00	9890.00	19000		NO:2
Antimony	7440-36-0	0.45	81.10	31-128	2.15	2.15		44.0	NO:3
Arsenic	7440-38-2	3.70	27.00	128-128	9.50	9.50	8.6	33.0	NO:3
Barium	7440-39-3	24.00	234.00	128-128	88.40	88.40	180	77000.0	NO:2,3
Beryllium	7440-41-7	0.17	1.10	127-128	0.62	0.62	1.3	6.0	NO:2,3
Bismuth	7440-69-9	1.20	63.9	17-128	3.10	3.10			YES
Cadmium	7440-43-9	0.08	4.20	65-128	0.34	0.34	2.1	1100.0	NO:2,3
Calcium	7440-70-2	4080.00	144000.00	128-128	43200.00	43200.00	310000		NO:2,4
Chromium	7440-47-3	4.50	126.00	128-128	22.40	22.40	20	5500.0	NO:3
Cobalt	7440-48-4	3.40	15.50	128-128	9.21	9.21	19		NO:2
Copper	7440-50-8	9.90	141.00	128-128	34.70	34.70	26		YES
Cyanide	57-12-5	0.36	6.80	6-128	0.30	0.30		22000.0	NO:1
Iron	7439-89-6	7040.00	46800.00	128-128	20500.00	20500.00	35000		NO:2.,4
Lead	7439-92-1	5.50	8190.00	128-128	226.00	226.00	48		YES
Magnesium	7439-95-4	2080.00	83200.00	128-128	16700.00	16700.00	40000		NO:2,4
Manganese	7439-96-5	213.00	1130.00	128-128	551.00	551.00	1400	130000.0	NO:2,3
Mercury	7439-97-6	0.05	1.30	97-128	0.21	0.21		330.0	NO:3
Nickel	7440-02-0	7.50	31.80	128-128	19.30	19.30	32	22000.0	NO:2,3
Potassium	7440-09-7	529.00	2690.00	128-128	1600.00	1600.00	1900		NO:2,4
Selenium	7782-49-2	0.51	2.20	62-128	0.91	0.91			YES
Silver	7440-22-4	0.20	11.20	21-128	0.44	0.44	1.7	5500.0	NO:2,3
Sodium	7440-23-5	72.50	600.00	125-128	180.00	180.00	240		NO:2
Thallium	7440-28-0	0.94	3.20	33-128	0.88	0.88	0.46		YES
Vanadium	7440-62-2	8.40	34.40	128-128	22.00	22.00	25	7700.0	NO:2,3
Zinc	7440-66-6	28.30	481.00	128-128	91.00	91.00	140	330000.0	NO:2,3

Table 1: Identification of Constituents of Potential Concern for the Recreational RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Semi-Volatile Organic Compounds (ug/kg)									
2-Methylnaphthalene	91-57-6	23	150	25-128	229.00	150.00			YES
4-Methylphenol	106-44-5	64	64	1-128	262.00	64.00		5500000.00	NO:1
Acenaphthene	83-32-9	20	750	30-128	195.00	195.00			YES
Acenaphthylene	208-96-8	19	650	41-128	213.00	213.00			YES
Anthracene	120-12-7	23	2300	59-128	254.00	254.00		330000000.00	NO:3
Benzo(a)anthracene	56-55-3	21	7300	117-128	654.00	654.00		35000.00	NO:3
Benzo(a)pyrene	50-32-8	21	7900	111-128	688.00	688.00		3500.00	NO:3
Benzo(b)fluoranthene	205-99-2	23	7100	117-128	681.00	681.00		35000.00	NO:3
Benzo(g,h,i)perylene	191-24-2	22	4700	110-128	477.00	477.00			YES
Benzo(k)fluoranthene	207-08-9	22	7000	113-128	669.00	669.00		350000.00	NO:3
Benzoic Acid	65-85-0	20	220	37-125	1070.00	220.00		4400000000.00	NO:3
Bis(2-ethylhexyl)phthalate	117-81-7	20	44000	68-128	1070.00	1070.00		1800000.00	NO:3
Butyl Benzyl Phthalate	85-68-7	20	380	11-128	257.00	257.00		220000000.00	NO:3
Carbazole	86-74-8	22	930	48-128	191.00	191.00			YES
Chrysene	218-01-9	25	8100	120-128	747.00	747.00		3500000.00	NO:3
Di-n-butyl Phthalate	84-74-2	22	4300	31-128	368.00	368.00		110000000.00	NO:3
Dibenz(a,h)anthracene	53-70-3	20	1500	59-128	240.00	240.00		3500.00	NO:3
Dibenzofuran	132-64-9	20	510	26-128	195.00	195.00			YES
Diethyl Phthalate	84-66-2	44	59	2-128	262.00	59.00			NO:1
Fluoranthene	206-44-0	20	17000	122-128	1440.00	1440.00		44000000.00	NO:3
Fluorene	86-73-7	20	1200	34-128	210.00	210.00			YES
Indeno(1,2,3-cd)pyrene	193-39-5	20	4600	109-128	462.00	462.00		35000.00	NO:3
Naphthalene	91-20-3	19	140	24-128	229.00	140.00			YES
Pentachlorophenol	87-86-5	30	70	2-128	658.00	70.00		210000.00	NO:1
Phenanthrene	85-01-8	21	13000	113-128	773.00	773.00			YES
Phenol	108-95-2	21	270	16-128	248.00	248.00		660000000.00	NO:3
Pyrene	129-00-0	28	17000	121-128	1310.00	1310.00		33000000.00	NO:3
Volatile Organic Compounds (ug/kg)									
1,2-Dichloroethane	107-06-2	1	1	1-3	3.92	1.00		63000.00	NO:3
Methylene Chloride	75-09-2	2	2	1-3	3.34	2.00		100000.00	NO:3
Toluene	108-88-3	1	1	1-3	3.92	1.00		220000000.00	NO:3
Pesticides/PCBS (ug/kg)									
Dieldrin	60-57-1	1.100	1.100	1-3	1.33	1.10		1600.00	NO:3
Endrin Ketone	53494-70-5	0.430	2.000	3-3	2.47	2.00			YES
Gamma Chlordane	5103-74-2	0.300	0.300	1-3	0.34	0.30			YES

Table 1: Identification of Constituents of Potential Concern for the Recreational RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Radionuclides (pCi/g)									
Cesium-137	10045-97-3	0.19	0.19	1-3	0.25	0.19	0.42	0.84	NO:2,3
Plutonium-238	13981-16-3	0.01	715.00	683-702	23.00	23.00	0.13	110.00	NO:3
Plutonium-239/240	PU-239/240	0.00	4.17	412-680	0.10	0.10	0.18	100.00	NO:2,3
Potassium-40	13966-00-2	11.10	14.90	3-3	16.00	14.90	37		NO:2
Radium-226	13982-63-3	1.84	3.04	2-3	4.09	3.04	2	0.26	YES
Strontium-90	10098-97-2	0.52	7.20	3-3	9.22	7.20	0.72	570.00	NO:3
Thorium-228	14274-82-9	0.61	7.67	126-126	1.27	1.27	1.5	1.70	NO:2,3
Thorium-230	14269-63-7	0.87	7.99	126-126	1.57	1.57	1.9	820.00	NO:2,3
Thorium-232	7440-29-1	0.51	2.17	126-126	1.00	1.00	1.4	950.00	NO:2,3
Tritium	10028-17-8	0.05	79.60	106-124	5.96	5.96	1.6	45000.00	NO:3
Uranium-234	13966-29-5	0.62	1.28	126-126	0.95	0.95	1.1	710.00	NO:2,3
Uranium-235	15117-96-1	0.01	0.10	97-126	0.05	0.05	0.11	6.60	NO:3
Uranium-238	7440-61-1	0.64	1.62	126-126	1.03	1.03	1.2	31.00	NO:2,3

CAS - Chemical Abstract Service
COPC - Constituents of Potential Concern
EPC - Exposure Point Concentration
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
pCi/g - picocurie per gram
RBGV - Risk Based Guideline Value
RRE - Residual Risk Evaluation
UCL - Upper Confidence Limit

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Risk-Based Guideline Value
NO:4 - Essential Human Nutrient
1.00E-06 Is equivalent to 1.00 x 10-6

In cases where the 95%UCL of the arithmetic mean falls below the maximum detected value, the 95%UCL is compared to background. If the 95%UCL is below the background value, the contaminant is not carried forward through the rest of the RRE process because this would result in negative incremental risk.

Table 2: Identification of Constituents of Potential Concern for the Residential RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Inorganics (mg/kg)									
Aluminum	7429-90-5	3080.00	15300.00	128-128	9890.00	9890.00	19000		NO:2
Antimony	7440-36-0	0.45	81.10	31-128	2.15	2.15		11.00	NO:3
Arsenic	7440-38-2	3.70	27.00	128-128	9.50	9.50	8.6	8.20	YES
Barium	7440-39-3	24.00	234.00	128-128	88.40	88.40	180	1900.00	NO:2,3
Beryllium	7440-41-7	0.17	1.10	127-128	0.62	0.62	1.3	0.15	NO:2
Bismuth	7440-69-9	1.20	63.9	17-128	3.10	3.10			YES
Cadmium	7440-43-9	0.08	4.20	65-128	0.34	0.34	2.1	27.00	NO:2,3
Calcium	7440-70-2	4080.00	144000.00	128-128	43200.00	43200.00	310000		NO:2,4
Chromium	7440-47-3	4.50	126.00	128-128	22.40	22.40	20	140.00	NO:3
Cobalt	7440-48-4	3.40	15.50	128-128	9.21	9.21	19		NO:2
Copper	7440-50-8	9.90	141.00	128-128	34.70	34.70	26		YES
Cyanide	57-12-5	0.36	6.80	6-128	0.30	0.30		550.00	NO:1
Iron	7439-89-6	7040.00	46800.00	128-128	20500.00	20500.00	35000		NO:2,4
Lead	7439-92-1	5.50	8190.00	128-128	226.00	226.00	48		YES
Magnesium	7439-95-4	2080.00	83200.00	128-128	16700.00	16700.00	40000		NO:2
Manganese	7439-96-5	213.00	1130.00	128-128	551.00	551.00	1400	3800.00	NO:2,3
Mercury	7439-97-6	0.05	1.30	97-128	0.21	0.21		8.20	NO:3
Nickel	7440-02-0	7.50	31.80	128-128	19.30	19.30	32	550.00	NO:2,3
Potassium	7440-09-7	529.00	2690.00	128-128	1600.00	1600.00	1900		NO:2,4
Selenium	7782-49-2	0.51	2.20	62-128	0.91	0.91			YES
Silver	7440-22-4	0.20	11.20	21-128	0.44	0.44	1.7	140.00	NO:2,3
Sodium	7440-23-5	72.50	600.00	125-128	180.00	180.00	240		NO:2,4
Thallium	7440-28-0	0.94	3.20	33-128	0.88	0.88	0.46		YES
Vanadium	7440-62-2	8.40	34.40	128-128	22.00	22.00	25	190.00	NO:2,3
Zinc	7440-66-6	28.30	481.00	128-128	91.00	91.00	140	8200.00	NO:2,3

Table 2: Identification of Constituents of Potential Concern for the Residential RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Semi-Volatile Organic Compounds (ug/kg)									
2-Methylnaphthalene	91-57-6	23	150	25-128	229.00	150.00			YES
4-Methylphenol	106-44-5	64	64	1-128	262.00	64.00		140.00	NO:1
Acenaphthene	83-32-9	20	750	30-128	195.00	195.00			YES
Acenaphthylene	208-96-8	19	650	41-128	213.00	213.00			YES
Anthracene	120-12-7	23	2300	59-128	254.00	254.00		8200000.00	NO:3
Benzo(a)anthracene	56-55-3	21	7300	117-128	654.00	654.00		880.00	NO:3
Benzo(a)pyrene	50-32-8	21	7900	111-128	688.00	688.00		88.00	YES
Benzo(b)fluoranthene	205-99-2	23	7100	117-128	681.00	681.00		880.00	NO:3
Benzo(g,h,i)perylene	191-24-2	22	4700	110-128	477.00	477.00			YES
Benzo(k)fluoranthene	207-08-9	22	7000	113-128	669.00	669.00		8800.00	NO:3
Benzoic Acid	65-85-0	20	220	37-125	1070.00	220.00		110000000.00	NO:3
Bis(2-ethylhexyl)phthalate	117-81-7	20	44000	68-128	1070.00	1070.00		46000.00	NO:3
Butyl Benzyl Phthalate	85-68-7	20	380	11-128	257.00	257.00		5500000.00	NO:3
Carbazole	86-74-8	22	930	48-128	191.00	191.00			YES
Chrysene	218-01-9	25	8100	120-128	747.00	747.00		88000.00	NO:3
Di-n-butyl Phthalate	84-74-2	22	4300	31-128	368.00	368.00		2700000.00	NO:3
Dibenz(a,h)anthracene	53-70-3	20	1500	59-128	240.00	240.00		88.00	YES
Dibenzofuran	132-64-9	20	510	26-128	195.00	195.00			YES
Diethyl Phthalate	84-66-2	44	59	2-128	262.00	59.00			NO:1
Fluoranthene	206-44-0	20	17000	122-128	1440.00	1440.00		1100000.00	NO:3
Fluorene	86-73-7	20	1200	34-128	210.00	210.00			YES
Indeno(1,2,3-cd)pyrene	193-39-5	20	4600	109-128	462.00	462.00		880.00	NO:3
Naphthalene	91-20-3	19	140	24-128	229.00	140.00			YES
Pentachlorophenol	87-86-5	30	70	2-128	658.00	70.00		5300.00	NO:1
Phenanthrene	85-01-8	21	13000	113-128	773.00	773.00			YES
Phenol	108-95-2	21	270	16-128	248.00	248.00		16000000.00	NO:3
Pyrene	129-00-0	28	17000	121-128	1310.00	1310.00		820000.00	NO:3
Volatile Organic Compounds (ug/kg)									
1,2-Dichloroethane	107-06-2	1	1	1-3	3.92	1.00		1600.00	NO:3
Methylene Chloride	75-09-2	2	2	1-3	3.34	2.00		100000.00	NO:3
Toluene	108-88-3	1	1	1-3	3.92	1.00		25000.00	NO:3
Pesticides/PCBS (ug/kg)									
Dieldrin	60-57-1	1.100	1.100	1-3	1.33	1.10		40.00	NO:3
Endrin Ketone	53494-70-5	0.430	2.000	3-3	2.47	2.00			YES
Gamma Chlordane	5103-74-2	0.300	0.300	1-3	0.34	0.30			YES

Table 2: Identification of Constituents of Potential Concern for the Residential RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Radionuclides (pCi/g)									
Cesium-137	10045-97-3	0.19	0.19	1-3	0.25	0.19	0.42	0.05	NO:2
Plutonium-238	13981-16-3	0.01	715.00	689-718	22.50	22.50	0.13	2.70	YES
Plutonium-239/240	PU-239/240	0.00	4.17	412-680	0.10	0.10	0.18	2.50	NO:2,3
Potassium-40	13966-00-2	11.10	14.90	3-3	16.00	14.90	37		NO:2
Radium-226	13982-63-3	1.84	3.04	2-3	4.09	3.04	2	0.02	YES
Strontium-90	10098-97-2	0.52	7.20	3-3	9.22	7.20	0.72	14.00	NO:3
Thorium-228	14274-82-9	0.61	7.67	126-126	1.27	1.27	1.5	0.11	NO:2
Thorium-230	14269-63-7	0.87	7.99	126-126	1.57	1.57	1.9	21.00	NO:2,3
Thorium-232	7440-29-1	0.51	2.17	126-126	1.00	1.00	1.4	24.00	NO:2,3
Tritium	10028-17-8	0.05	79.60	106-124	5.96	5.96	1.6	11000.00	NO:3
Uranium-234	13966-29-5	0.62	1.28	126-126	0.95	0.95	1.1	18.00	NO:2,3
Uranium-235	15117-96-1	0.01	0.10	97-126	0.05	0.05	0.11	0.41	NO:2,3
Uranium-238	7440-61-1	0.64	1.62	126-126	1.03	1.03	1.2	1.80	NO:2,3

CAS - Chemical Abstract Service
COPC - Constituents of Potential Concern
EPC - Exposure Point Concentration
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
pCi/g - picocurie per gram
RBGV - Risk Based Guideline Value
RRE - Residual Risk Evaluation
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NO:1 - <5% Detects
NO:2 - <Background
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NO:4 - Essential Human Nutrient
1.00E-06 Is equivalent to 1.00 x 10-6

In cases where the 95%UCL of the arithmetic mean falls below the maximum detected value, the 95%UCL is compared to background. If the 95%UCL is below the background value, the contaminant is not carried forward through the rest of the RRE process because this would result in negative incremental risk.

Table 3: Identification of Constituents of Potential Concern for the Off-Site Construction Worker RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Inorganics (mg/kg)									
Aluminum	7429-90-5	3080.00	15300.00	128-128	9890.00	9890.00	19000		NO:2
Antimony	7440-36-0	0.45	81.10	31-128	2.15	2.15		8.50	NO:3
Arsenic	7440-38-2	3.70	27.00	128-128	9.50	9.50	8.6	6.40	YES
Barium	7440-39-3	24.00	234.00	128-128	88.40	88.40	180	1500.00	NO:2,3
Beryllium	7440-41-7	0.17	1.10	127-128	0.62	0.62	1.3	3.50	NO:2,3
Bismuth	7440-69-9	1.20	63.9	17-128	3.10	3.10			YES
Cadmium	7440-43-9	0.08	4.20	65-128	0.34	0.34	2.1	21.00	NO:2,3
Calcium	7440-70-2	4080.00	144000.00	128-128	43200.00	43200.00	310000		NO:2,4
Chromium	7440-47-3	4.50	126.00	128-128	22.40	22.40	20	110.00	NO:3
Cobalt	7440-48-4	3.40	15.50	128-128	9.21	9.21	19		NO:2
Copper	7440-50-8	9.90	141.00	128-128	34.70	34.70	26		YES
Cyanide	57-12-5	0.36	6.80	6-128	0.30	0.30		430.00	NO:1
Iron	7439-89-6	7040.00	46800.00	128-128	20500.00	20500.00	35000		NO:2,4
Lead	7439-92-1	5.50	8190.00	128-128	226.00	226.00	48		YES
Magnesium	7439-95-4	2080.00	83200.00	128-128	16700.00	16700.00	40000		NO:2
Manganese	7439-96-5	213.00	1130.00	128-128	551.00	551.00	1400	2700.00	NO:2,3
Mercury	7439-97-6	0.05	1.30	97-128	0.21	0.21		6.40	NO:3
Nickel	7440-02-0	7.50	31.80	128-128	19.30	19.30	32	430.00	NO:2,3
Potassium	7440-09-7	529.00	2690.00	128-128	1600.00	1600.00	1900		NO:2,4
Selenium	7782-49-2	0.51	2.20	62-128	0.91	0.91			YES
Silver	7440-22-4	0.20	11.20	21-128	0.44	0.44	1.7	110.00	NO:2,3
Sodium	7440-23-5	72.50	600.00	125-128	180.00	180.00	240		NO:2,4
Thallium	7440-28-0	0.94	3.20	33-128	0.88	0.88	0.46		YES
Vanadium	7440-62-2	8.40	34.40	128-128	22.00	22.00	25	150.00	NO:2,3
Zinc	7440-66-6	28.30	481.00	128-128	91.00	91.00	140	6400.00	NO:2,3

Table 3: Identification of Constituents of Potential Concern for the Off-Site Construction Worker RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Semi-Volatile Organic Compounds (ug/kg)									
2-Methylnaphthalene	91-57-6	23	150	25-128	229.00	150.00			YES
4-Methylphenol	106-44-5	64	64	1-128	262.00	64.00		110000.00	NO:1
Acenaphthene	83-32-9	20	750	30-128	195.00	195.00			YES
Acenaphthylene	208-96-8	19	650	41-128	213.00	213.00			YES
Anthracene	120-12-7	23	2300	59-128	254.00	254.00		6400000.00	NO:3
Benzo(a)anthracene	56-55-3	21	7300	117-128	654.00	654.00		20000.00	NO:3
Benzo(a)pyrene	50-32-8	21	7900	111-128	688.00	688.00		2000.00	NO:3
Benzo(b)fluoranthene	205-99-2	23	7100	117-128	681.00	681.00		20000.00	NO:3
Benzo(g,h,i)perylene	191-24-2	22	4700	110-128	477.00	477.00			YES
Benzo(k)fluoranthene	207-08-9	22	7000	113-128	669.00	669.00		200000.00	NO:3
Benzoic Acid	65-85-0	20	220	37-125	1070.00	220.00		85000000.00	NO:3
Bis(2-ethylhexyl)phthalat	117-81-7	20	44000	68-128	1070.00	1070.00		430000.00	NO:3
Butyl Benzyl Phthalate	85-68-7	20	380	11-128	257.00	257.00		4300000.00	NO:3
Carbazole	86-74-8	22	930	48-128	191.00	191.00			YES
Chrysene	218-01-9	25	8100	120-128	747.00	747.00		2000000.00	NO:3
Di-n-butyl Phthalate	84-74-2	22	4300	31-128	368.00	368.00		2100000.00	NO:3
Dibenz(a,h)anthracene	53-70-3	20	1500	59-128	240.00	240.00		2000000.00	NO:3
Dibenzofuran	132-64-9	20	510	26-128	195.00	195.00			YES
Diethyl Phthalate	84-66-2	44	59	2-128	262.00	59.00			NO:1
Fluoranthene	206-44-0	20	17000	122-128	1440.00	1440.00		850000.00	NO:3
Fluorene	86-73-7	20	1200	34-128	210.00	210.00			YES
Indeno(1,2,3-cd)pyrene	193-39-5	20	4600	109-128	462.00	462.00		20000.00	NO:3
Naphthalene	91-20-3	19	140	24-128	229.00	140.00			YES
Pentachlorophenol	87-86-5	30	70	2-128	658.00	70.00		120000.00	NO:1
Phenanthrene	85-01-8	21	13000	113-128	773.00	773.00			YES
Phenol	108-95-2	21	270	16-128	248.00	248.00		13000000.00	NO:3
Pyrene	129-00-0	28	17000	121-128	1310.00	1310.00		640000.00	NO:3
Volatile Organic Compounds (ug/kg)									
1,2-Dichloroethane	107-06-2	1	1	1-3	3.92	1.00		55000.00	NO:3
Methylene Chloride	75-09-2	2	2	1-3	3.34	2.00		100000.00	NO:3
Toluene	108-88-3	1	1	1-3	3.92	1.00		25000.00	NO:3

Table 3: Identification of Constituents of Potential Concern for the Off-Site Construction Worker RRE of the Miami-Erie Canal Area

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL	EPC	Background Value	RBGV	COPC?
Pesticides/PCBS (ug/kg)									
Dieldrin	60-57-1	1.100	1.100	1-3	1.33	1.10		930.00	NO:3
Endrin Ketone	53494-70-5	0.430	2.000	3-3	2.47	2.00			YES
Gamma Chlordane	5103-74-2	0.300	0.300	1-3	0.34	0.30			YES
Radionuclides (pCi/g)									
Cesium-137	10045-97-3	0.19	0.19	1-3	0.25	0.19	0.42	2.30	NO:2,3
Plutonium-238	13981-16-3	0.01	715.00	689-718	22.50	22.50	0.13	28.00	NO:3
Plutonium-239/240	PU-239/240	0.00	4.17	412-680	0.10	0.10	0.18	26.00	NO:2,3
Potassium-40	13966-00-2	11.10	14.90	3-3	16.00	14.90	37		NO:2
Radium-226	13982-63-3	1.84	3.04	2-3	4.09	3.04	2	0.70	YES
Strontium-90	10098-97-2	0.52	7.20	3-3	9.22	7.20	0.72	150.00	NO:3
Thorium-228	14274-82-9	0.61	7.67	126-126	1.27	1.27	1.5	4.30	NO:2,3
Thorium-230	14269-63-7	0.87	7.99	126-126	1.57	1.57	1.9	220.00	NO:2,3
Thorium-232	7440-29-1	0.51	2.17	126-126	1.00	1.00	1.4	250.00	NO:2,3
Tritium	10028-17-8	0.05	79.60	106-124	5.96	5.96	1.6	120000.00	NO:3
Uranium-234	13966-29-5	0.62	1.28	126-126	0.95	0.95	1.1	190.00	NO:2,3
Uranium-235	15117-96-1	0.01	0.10	97-126	0.05	0.05	0.11	17.00	NO:2,3
Uranium-238	7440-61-1	0.64	1.62	126-126	1.03	1.03	1.2	55.00	NO:2,3

CAS - Chemical Abstract Service
COPC - Constituents of Potential Concern
EPC - Exposure Point Concentration
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
pCi/g - picocurie per gram
RBGV - Risk Based Guideline Value
RRE - Residual Risk Evaluation
UCL - Upper Confidence Limit

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Risk-Based Guideline Value
NO:4 - Essential Human Nutrient
1.00E-06 Is equivalent to 1.00 x 10-6

In cases where the 95%UCL of the arithmetic mean falls below the maximum detected value, the 95%UCL is compared to background. If the 95%UCL is below th background value, the contaminant is not carried forward through the rest of the RRE process because this would result in negative incremental risk.

Table 4: Exposure Assumptions for Recreational, Residential, Off-Site Construction Worker Scenarios in the Miami-Erie Canal Area

Parameter	Units	Recreational Adult	Recreational Child	Resident Adult	Resident Child	Off Site Construction Worker	Reference
Medium/pathway							
Surface soil (0 - 2 ft.) & Sediment							
Incidental ingestion							
Soil ingestion rate	mg/day	100	200	NA	NA	NA	a
Exposure frequency	days/year	52	52	NA	NA	NA	b
Exposure duration	years	24	6	NA	NA	NA	c
Body weight	kg	70	15	NA	NA	NA	d
Carcinogen averaging time	days	25550	25550	NA	NA	NA	e
Noncarcinogen averaging time	days	8760	2190	NA	NA	NA	e
Conversion Factor	kg/mg	1.00E-06	1.00E-06	NA	NA	NA	
Dermal contact							
Skin surface area available for con	cm^2	5463	2115	NA	NA	NA	f
Adherence factor	mg/cm^2	1	1	NA	NA	NA	g
Exposure frequency	events/year	52	52	NA	NA	NA	b
Exposure duration	years	24	6	NA	NA	NA	c
Body weight	kg	70	15	NA	NA	NA	d
Carcinogen averaging time	days	25550	25550	NA	NA	NA	e
Noncarcinogen averaging time	days	8760	2190	NA	NA	NA	e
Conversion Factor	kg/mg	1.00E-06	1.00E-06	NA	NA	NA	
Inhalation of VOCs and dust							
Inhalation rate	m^3/day	20	8.7	NA	NA	NA	h
Exposure time	hours/day	4	4	NA	NA	NA	i
Exposure frequency	days/year	52	52	NA	NA	NA	b
Exposure duration	years	24	6	NA	NA	NA	c
Body weight	kg	70	15	NA	NA	NA	d
Carcinogen averaging time	days	25550	25550	NA	NA	NA	e
Noncarcinogen averaging time	days	8760	2190	NA	NA	NA	e
Conversion Factor	days/hour	0.042	0.042	NA	NA	NA	

Table 4: Exposure Assumptions for Recreational, Residential, Off-Site Construction Worker Scenarios in the Miami-Erie Canal Area

Parameter	Units	Recreational Adult	Recreational Child	Resident Adult	Resident Child	Off Site Construction Worker	Reference
Surface/Subsurface soil (0 ft - total depth) and Sediment							
Incidental ingestion							
Soil ingestion rate	mg/day	NA	NA	100	200	480	a
Exposure frequency	days/year	NA	NA	350	350	250	b
Exposure duration	years	NA	NA	24	6	1	c
Body weight	kg	NA	NA	70	15	70	d
Carcinogen averaging time	days	NA	NA	25550	25550	25550	e
Noncarcinogen averaging time	days	NA	NA	8760	2190	365	e
Conversion Factor	kg/mg	NA	NA	1.00E-06	1.00E-06	1.00E-06	
Dermal contact							
Skin surface area available for con	cm^2	NA	NA	5463	2115	5000	f
Adherence factor	mg/cm^2	NA	NA	1	1	0.2	g
Exposure frequency	events/year	NA	NA	350	350	250	b
Exposure duration	years	NA	NA	24	6	1	c
Body weight	kg	NA	NA	70	15	70	d
Carcinogen averaging time	days	NA	NA	25550	25550	25550	e
Noncarcinogen averaging time	days	NA	NA	8760	2190	365	e
Conversion Factor	kg/mg	NA	NA	1.00E-06	1.00E-06	1.00E-06	
Inhalation of VOCs and dust							
Inhalation rate	m^3/day	NA	NA	20	8.7	20	h
Exposure frequency	days/year	NA	NA	350	350	250	b
Exposure time	hours/day	1	1	16	16	8	i
Exposure duration	years	NA	NA	24	6	1	c
Body weight	kg	NA	NA	70	15	70	d
Carcinogen averaging time	days	NA	NA	25550	25550	25550	e
Noncarcinogen averaging time	days	NA	NA	8760	2190	365	e
Conversion Factor	days/hour	NA	NA	0.042	0.042	0.042	

Table 5: Toxicity Values and Chemical-Specific Parameters for Constituents of Potential Concern in the Miami-Erie Canal Area

	Non-Cancer					Cancer							Dermal Exposure Parameters		
Chemical	Oral RFDo (mg/kg/day)	Ref	Dermal Adjusted RFDa (mg/kg/day)	Inhalation RFDi (mg/kg/day)	Ref	Oral CSFo $(mg/kg/day)^{-1}$	Ref	Dermal Adjusted CSFa $(mg/kg/day)^{-1}$	Inhalation CSFi $(mg/kg/day)^{-1}$	Ref	External Radiation $(mg/kg/day)^{-1}$	Ref	General GI Factor (Unitless)	Ref	Soil Dermal ABS (Unitless)
INORGANICS															
Arsenic	3.00E-04	i	1.23E-04	NA		1.50E+00	i	3.66E+00	1.50E+01	i	NA		0.41	a	0.01
Bismuth	NA		NA	NA		NA		NA	NA		NA		NA	a	0.01
Copper	3.70E-02	h	1.11E-02	NA	h	NA		NA	NA		NA		0.3	a	0.01
Lead	NA		NA	NA		NA		NA	NA		NA		0.15	a	0.01
Selenium	5.00E-03	i	2.20E-03	NA	i	NA		NA	NA		NA		0.44	c	0.01
Thallium	8.00E-05	i	1.20E-05	NA	i	NA		NA	NA		NA		0.15	a	0.01
SVOCs															
2-Methylnaphthalene	NA		NA	NA		NA		NA	NA		NA		0.8		0.3
Acenaphthene	6.00E-02	i	1.86E-02	NA	i	NA		NA	NA		NA		0.31	a	0.3
Acenaphthylene	NA		NA	NA		NA		NA	NA		NA		0.31	a	0.3
Benzo(a)pyrene	NA		NA	NA		7.30E+00	i	2.35E+01	NA		NA		0.31	a	0.3
Benzo(ghi)perylene	NA		NA	NA		NA		NA	NA		NA		0.31	a	0.3
Carbazole	NA		NA	NA		2.00E-02	h	2.00E-02	NA		NA		0.7	a	0.3
Dibenz(a,h)anthracene	NA		NA	NA		7.30E+00	n	2.35E+01	NA		NA		0.31	a	0.3
Dibenzofuran	NA		NA	NA		NA		NA	NA		NA		0.31	b	0.3
Fluorene	4.00E-02	i	2.00E-02		i	NA		NA	NA		NA		0.5	b	0.3
Naphthalene	2.00E-02	i	1.00E-02	8.60E-04	i	NA		NA	NA		NA		0.5	a	0.3
Phenanthrene	NA		NA	NA		NA		NA	NA		NC		0.65	a	0.3
Pesticides															
Edrin Ketone	NA		NA	NA		NA		NA	NA		NA		0.5	a	0.3
Gamma Chlordane	5.00E-04	i	2.50E-04	2.00E-04	i	3.50E-01	i	7.00E-01	3.50E-01	i	NA		0.5	a	0.3
Radionuclides															
Plutonium-238	NA		NA	NA	NA	2.72E-10	h	NA	3.36E-08	h	7.22E-11	h	NA		NA
Radium-226	NA		NA	NA	NA	3.39E-09	h	NA	2.55E-08	h	8.49E-06	h	NA		NA

i= IRIS; n=NCEA, h=HEAST

a. These gastrointestinal absorption factors have been compiled by the Biomedical and Environmental Information Analysis Section (BEIAS) of the Health and Safety Research Division of Oak Ridge National Laboratory (ORNL) for use at all DOE-OR/ERD sites;

b. Default gastrointestinal absorption factors (0.8 for VOCs, 0.5 for SVOCs, 0.2 for inorganics) were assumed if no other information could be located (EPA Region IV guidance).

c. These gastrointestinal absorption factors are taken from the Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profiles;

Ref = Reference

NA = Not Available

RfD = Reference Dose

CSF = Cancer Slope Factor

GI = Gastrointestinal

ABS = Dermal Absorption Factor

SVOCs = Semi-volatile Organic Compounds

1.00E-06 Is equivalent to 1.00×10^{-6}

Table 6: Total Residual Risk for a Recreational Adult at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Pesticides/PCBS													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	7.3E-12	2.4E-10	1.9E-16	NAP	NAP	2.5E-10	1.2E-07	4.0E-06	7.7E-12	NAP	NAP	4.1E-06
Metals													
Bismuth	3.10	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	34.70	NA	NA	NA	NAP	NAP	NA	1.9E-04	3.5E-04	NA	NAP	NAP	5.4E-04
Lead	226.00	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	3.7E-05	4.6E-05	NA	NAP	NAP	8.3E-05
Thallium	0.88	NA	NA	NA	NAP	NAP	NA	2.2E-03	8.2E-03	NA	NAP	NAP	1.0E-02
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	6.6E-07	3.5E-05	NA	NAP	NAP	3.6E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	2.7E-10	4.4E-09	NA	NAP	NAP	4.6E-09	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	1.1E-06	3.5E-05	NA	NAP	NAP	3.6E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	1.4E-06	4.7E-05	8.4E-10	NAP	NAP	4.8E-05
Phenanthrene	0.773	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Total Chemcial		2.7E-10	4.6E-09	1.9E-16	NAP	NA	4.9E-09	2.5E-03	8.7E-03	8.5E-10	NAP	NAP	1.1E-02
	EPC												
Radionuclides	**pCi/g**												
Radium-226	3.04	**1.3E-06**	NAP	2.4E-10	NAP	**1.2E-05**	**1.3E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclides		**1.3E-06**	NAP	2.4E-10	NAP	**1.2E-05**	**1.3E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Total Overall Risk		**1.3E-06**	4.6E-09	2.4E-10	NAP	**1.2E-05**	**1.3E-05**	2.5E-03	8.7E-03	8.5E-10	NAP	NAP	1.1E-02

EPC Exposure point concentration
mg/kg Milligram per kilogram
NA Not available; insufficient toxicity data
NAP Not applicable pathway

pCi/g Picocuries per gram
VOCs Volatile organic compounds
1.00E-06 Is equivalent to 1.00×10^{-6}

Table 7: Background Residual Risk for a Recreational Adult at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Pesticides/PCBS													
Endrin Ketone		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Bismuth		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	26	NA	NA	NA	NAP	NAP	NA	1.4E-04	2.6E-04	NA	NAP	NAP	4.0E-04
Lead	48	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.46	NA	NA	NA	NAP	NAP	NA	1.2E-03	4.3E-03	NA	NAP	NAP	5.4E-03
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Dibenzofuran		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Naphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Total Chemical		NA	NA	NA	NAP	NAP	NA	1.3E-03	4.5E-03	NA	NAP	NAP	5.8E-03
	EPC												
Radionuclides	**pCi/g**												
Radium-226	2	8.5E-07	NAP	1.6E-10	NAP	**7.7E-06**	**8.6E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclides		8.5E-07	NAP	1.6E-10	NAP	**7.7E-06**	**8.6E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Overall Risk		8.5E-07	NA	1.6E-10	NAP	**7.7E-06**	**8.6E-06**	1.3E-03	4.5E-03	NA	NAP	NAP	5.8E-03

EPC Exposure point concentration
mg/kg Milligram per kilogram
NA Not available; insufficient toxicity data
NAP Not applicable pathway
pCi/g Picocuries per gram
VOCs Volatile organic compounds
1.00E-06 Is equivalent to 1.00×10^{-6}

Table 8: Incremental Residual Risk for a Recreational Adult at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Pesticides/PCBS													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	7.3E-12	2.4E-10	1.9E-16	NAP	NAP	2.5E-10	1.2E-07	4.0E-06	7.7E-12	NAP	NAP	4.1E-06
Metals													
Bismuth	3.10	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	8.70	NA	NA	NA	NAP	NAP	NA	4.8E-05	8.7E-05	NA	NAP	NAP	1.3E-04
Lead	178.00	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	3.7E-05	4.6E-05	NA	NAP	NAP	8.3E-05
Thallium	0.42	NA	NA	NA	NAP	NAP	NA	1.1E-03	3.9E-03	NA	NAP	NAP	5.0E-03
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	6.6E-07	3.5E-05	NA	NAP	NAP	3.6E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	2.7E-10	4.4E-09	NA	NAP	NAP	4.6E-09	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	1.1E-06	3.5E-05	NA	NAP	NAP	3.6E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	1.4E-06	4.7E-05	8.4E-10	NAP	NAP	4.8E-05
Phenanthrene	0.773	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Total Chemical		2.7E-10	4.6E-09	1.9E-16	NAP	0.0E+00	4.9E-09	1.2E-03	4.1E-03	8.5E-10	NAP	NAP	5.3E-03
	EPC												
Radionuclides	**pCi/g**												
Radium-226	1.04	4.4E-07	NAP	8.4E-11	NAP	**4.0E-06**	**4.5E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		4.4E-07	NAP	8.4E-11	NAP	**4.0E-06**	**4.5E-06**	NA	NA	NA	NAP	NAP	NAP
Total Overall Risk		4.4E-07	4.6E-09	8.4E-11	NAP	**4.0E-06**	**4.5E-06**	1.2E-03	4.1E-03	8.5E-10	NAP	NAP	5.3E-03

EPC — Exposure point concentration for incremental risk is total minus background
mg/kg — Milligram per kilogram
NA — Not available; insufficient toxicity data
NAP — Not applicable pathway
pCi/g — Picocuries per gram
VOCs — Volatile organic compounds
1.00E-06 — Is equivalent to 1.00×10^{-6}

Table 9: Total Residual Risk for a Recreational Child at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Pesticides/PCBS													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	1.7E-11	1.1E-10	9.4E-17	NAP	NAP	1.3E-10	1.1E-06	7.2E-06	1.6E-11	NAP	NAP	8.4E-06
Metals													
Bismuth	3.10	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	34.70	NA	NA	NA	NAP	NAP	NA	1.8E-03	6.3E-04	NA	NAP	NAP	2.4E-03
Lead	226.00	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	3.5E-04	8.3E-05	NA	NAP	NAP	4.3E-04
Thallium	0.88	NA	NA	NA	NAP	NAP	NA	2.1E-02	1.5E-02	NA	NAP	NAP	3.6E-02
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	6.2E-06	6.3E-05	NA	NAP	NAP	6.9E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	6.2E-10	2.0E-09	NA	NAP	NAP	2.6E-09	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	1.0E-05	6.3E-05	NA	NAP	NAP	7.3E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	1.3E-05	8.4E-05	1.7E-09	NAP	NAP	9.8E-05
Phenanthrene	0.773	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Total Chemical		6.4E-10	2.1E-09	9.4E-17	NAP	NAP	2.7E-09	2.3E-02	1.6E-02	1.7E-09	NAP	NAP	3.9E-02
	EPC												
Radionuclides	**pCi/g**												
Radium-226	3.04	6.4E-07	NAP	2.7E-11	NAP	**2.9E-06**	**3.6E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclides		6.4E-07	NAP	2.7E-11	NAP	**2.9E-06**	**3.6E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Overall Risk		6.4E-07	2.1E-09	2.7E-11	NAP	**2.9E-06**	**3.6E-06**	2.3E-02	1.6E-02	1.7E-09	NAP	NAP	3.9E-02

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
NA	Not available; insufficient toxicity data
NAP	Not applicable pathway
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 10: Background Residual Risk for a Recreational Child at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Pesticides/PCBS													
Endrin Ketone		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Bismuth		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	26	NA	NA	NA	NAP	NAP	NA	1.3E-03	4.7E-04	NA	NAP	NAP	1.8E-03
Lead	48	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.46	NA	NA	NA	NAP	NAP	NA	1.1E-02	7.7E-03	NA	NAP	NAP	1.9E-02
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Dibenzofuran		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Naphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Total Chemical		NA	NA	NA	NAP	NAP	NA	1.2E-02	8.2E-03	NA	NAP	NAP	2.0E-02
	EPC												
Radionuclides	**pCi/g**												
Radium-226	2	4.2E-07	NAP	1.8E-14	NAP	**1.9E-06**	**2.4E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclides		4.2E-07	NAP	1.8E-14	NAP	**1.9E-06**	**2.4E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Overall Risk		4.2E-07	NA	1.8E-14	NAP	**1.9E-06**	**2.4E-06**	1.2E-02	8.2E-03	NAP	NAP	NAP	2.0E-02

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
NA	Not available; insufficient toxicity data
NAP	Not applicable pathway
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 11: Incremental Residual Risk for a Recreational Child at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Pesticides/PCBS													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	1.7E-11	1.1E-10	9.4E-17	NAP	NAP	1.3E-10	1.1E-06	7.2E-06	1.6E-11	NAP	NAP	8.4E-06
Metals													
Bismuth	3.10	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	8.70	NA	NA	NA	NAP	NAP	NA	4.5E-04	1.6E-04	NA	NAP	NAP	6.0E-04
Lead	178.00	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	3.5E-04	8.3E-05	NA	NAP	NAP	4.3E-04
Thallium	0.42	NA	NA	NA	NAP	NAP	NA	1.0E-02	7.0E-03	NA	NAP	NAP	1.7E-02
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	6.2E-06	6.3E-05	NA	NAP	NAP	6.9E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	6.2E-10	2.0E-09	NA	NAP	NAP	2.6E-09	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	1.0E-05	6.3E-05	NA	NAP	NAP	7.3E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	1.3E-05	8.4E-05	1.7E-09	NAP	NAP	9.8E-05
Phenanthrene	0.773	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Total Chemical		6.4E-10	2.1E-09	9.4E-17	NAP	NAP	2.7E-09	1.1E-02	7.5E-03	1.7E-09	NAP	NAP	1.8E-02
	EPC												
Radionuclides	**pCi/g**												
Radium-226	1.04	2.2E-07	NAP	9.1E-12	NAP	1.0E-06	1.2E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		2.2E-07	NAP	9.1E-12	NAP	1.0E-06	1.2E-06	NA	NA	NA	NAP	NAP	NAP
Total Overall Risk		2.2E-07	2.1E-09	9.1E-12	NAP	1.0E-06	1.2E-06	1.1E-02	7.5E-03	1.7E-09	NAP	NAP	1.8E-02

EPC	Exposure point concentration for incremental risk is total minus background
mg/kg	Milligram per kilogram
NA	Not available; insufficient toxicity data
NAP	Not applicable pathway
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 12: Total Residual Risk for a Residential Adult at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	4.5E-06	2.4E-04	NA	NAP	NAP	2.4E-04
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene	0.688	**2.4E-06**	**1.2E-04**	NA	NAP	NAP	**1.3E-04**	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	1.8E-09	2.9E-08	NA	NAP	NAP	3.1E-08	NA	NA	NA	NAP	NAP	NA
Dibenz(a,h)anthracene	0.24	8.2E-07	**4.4E-05**	NA	NAP	NAP	**4.4E-05**	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	7.2E-06	2.4E-04	NA	NAP	NAP	2.4E-04
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	9.6E-06	3.1E-04	3.4E-08	NAP	NAP	3.2E-04
Phenanthrene	0.773	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	4.9E-11	1.6E-09	7.5E-15	NAP	NAP	1.7E-09	8.2E-07	2.7E-05	3.1E-10	NAP	NAP	2.8E-05
Metals													
Arsenic	9.5	**6.7E-06**	**8.9E-06**	1.0E-08	NAP	NAP	**1.6E-05**	4.3E-02	5.8E-02	NA	NAP	NAP	1.0E-01
Bismuth	3.1	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	34.7	NA	NA	NA	NAP	NAP	NA	1.3E-03	2.3E-03	NA	NAP	NAP	3.6E-03
Lead	226	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	2.5E-04	3.1E-04	NA	NAP	NAP	5.6E-04
Thallium	0.88	NA	NA	NA	NAP	NAP	NA	1.5E-02	5.5E-02	NA	NAP	NAP	7.0E-02
Total Chemical		**9.9E-06**	**1.8E-04**	1.0E-08	NAP	NAP	**1.9E-04**	6.0E-02	1.2E-01	3.4E-08	NAP	NAP	1.8E-01
	EPC												
Radionuclides	**pCi/g**												
Plutonium-238	22.5	**5.1E-06**	NAP	9.6E-08	NAP	1.2E-08	**5.2E-06**	NA	NA	NA	NAP	NAP	NA
Radium-226	3.04	8.7E-06	NAP	9.9E-09	NAP	**1.9E-04**	**1.9E-04**	NA	NA	NA	NAP	NAP	NA
Total Radionuclide		**1.4E-05**	NAP	1.1E-07	NAP	**1.9E-04**	**2.0E-04**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		**2.4E-05**	**1.8E-04**	1.2E-07	NAP	**1.9E-04**	**3.9E-04**	6.0E-02	1.2E-01	3.4E-08	NAP	NAP	1.8E-01

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
NA	Not available; insufficient toxicity data
NAP	Not applicable pathway
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 13: Background Residual Risk for a Residential Adult at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Dibenz(a,h)anthracene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Dibenzofuran		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Naphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Arsenic	8.6	**6.1E-06**	**8.1E-06**	9.2E-09	NAP	NAP	**1.4E-05**	3.9E-02	5.2E-02	NA	NAP	NAP	9.2E-02
Bismuth		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	26	NA	NA	NA	NAP	NAP	NA	9.6E-04	1.8E-03	NA	NAP	NAP	2.7E-03
Lead	48	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.46	NA	NA	NA	NAP	NAP	NA	7.9E-03	2.9E-02	NA	NAP	NAP	3.7E-02
Total Chemical		**6.1E-06**	**8.1E-06**	9.2E-09	NAP	NAP	**1.4E-05**	4.8E-02	8.3E-02	NA	NAP	NAP	1.3E-01
	EPC												
Radionuclides	**pCi/g**												
Plutonium-238	0.13	3.0E-08	NAP	5.6E-10	NAP	6.8E-11	3.0E-08	NAP	NAP	NAP	NAP	NAP	NAP
Radium-226	2	5.7E-06	NAP	6.5E-09	NAP	**1.2E-04**	**1.3E-04**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		5.7E-06	NAP	7.0E-09	NAP	**1.2E-04**	**1.3E-04**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		**1.2E-05**	**8.1E-06**	1.6E-08	NAP	**1.2E-04**	**1.4E-04**	4.8E-02	8.3E-02	NA	NAP	NAP	1.3E-01

EPC — Exposure point concentration
mg/kg — Milligram per kilogram
NA — Not available; insufficient toxicity data
NAP — Not applicable pathway
pCi/g — Picocuries per gram
VOCs — Volatile organic compounds
1.00E-06 — Is equivalent to 1.00×10^{-6}

Table 14: Incremental Residual Risk for a Residential Adult at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	4.5E-06	2.4E-04	NA	NAP	NAP	2.4E-04
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene	0.688	**2.4E-06**	**1.2E-04**	NA	NAP	NAP	**1.3E-04**	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	1.8E-09	2.9E-08	NA	NAP	NAP	3.1E-08	NA	NA	NA	NAP	NAP	NA
Dibenz(a,h)anthracene	0.24	8.2E-07	**4.4E-05**	NA	NAP	NAP	**4.4E-05**	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	7.2E-06	2.4E-04	NA	NAP	NAP	2.4E-04
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	9.6E-06	3.1E-04	3.4E-08	NAP	NAP	3.2E-04
Phenanthrene	0.773	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	4.9E-11	1.6E-09	7.5E-15	NAP	NAP	1.7E-09	8.2E-07	2.7E-05	3.1E-10	NAP	NAP	2.8E-05
Metals													
Arsenic	0.9	6.3E-07	8.4E-07	9.6E-10	NAP	NAP	**1.5E-06**	4.1E-03	5.5E-03	NA	NAP	NAP	9.6E-03
Bismuth	3.1	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	8.7	NA	NA	NA	NAP	NAP	NA	3.2E-04	5.9E-04	NA	NAP	NAP	9.1E-04
Lead	178	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	2.5E-04	3.1E-04	NA	NAP	NAP	5.6E-04
Thallium	0.42	NA	NA	NA	NAP	NAP	NA	7.2E-03	2.6E-02	NA	NAP	NAP	3.3E-02
Total Chemical [a]		**3.8E-06**	**1.7E-04**	9.6E-10	NAP	NAP	**1.7E-04**	1.2E-02	3.3E-02	3.4E-08	0.0E+00	0.0E+00	4.5E-02
	EPC												
Radionuclides	**pCi/g**												
Plutonium-238	22.37	**5.1E-06**	NAP	9.6E-08	NAP	1.2E-08	**5.2E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Radium-226	1.04	3.0E-06	NAP	3.4E-09	NAP	**6.4E-05**	**6.7E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		**8.1E-06**	NAP	9.9E-08	NAP	**6.4E-05**	**7.2E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		**1.2E-05**	**1.7E-04**	1.0E-07	NAP	**6.4E-05**	**2.4E-04**	1.2E-02	3.3E-02	3.4E-08	NAP	NAP	4.5E-02

EPC — Exposure point concentration, incremental value is total minus background
mg/kg — Milligram per kilogram
NA — Not available; insufficient toxicity data
NAP — Not applicable pathway
pCi/g — Picocuries per gram
VOCs — Volatile organic compounds
1.00E-06 — Is equivalent to 1.00×10^{-6}

a - The concentrations of BaP found in the OU4 background PAH study are comparable to levels found in the remediated area of the canal, therefore, the BaP risk contribution is not believed to be due to Mound operations.

Table 15: Total Residual Risk for a Residential Child at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	4.2E-05	4.3E-04	NA	NAP	NAP	4.7E-04
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene	0.688	**5.5E-06**	**5.6E-05**	NA	NAP	NAP	**6.2E-05**	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	4.2E-09	1.3E-08	NA	NAP	NAP	1.7E-08	NA	NA	NA	NAP	NAP	NA
Dibenz(a,h)anthracene	0.24	**1.9E-06**	**2.0E-05**	NA	NAP	NAP	**2.2E-05**	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	6.7E-05	4.3E-04	NA	NAP	NAP	4.9E-04
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	8.9E-05	5.7E-04	6.9E-08	NAP	NAP	6.6E-04
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	1.2E-10	7.3E-10	3.8E-15	NAP	NAP	8.5E-10	7.7E-06	4.9E-05	6.3E-10	NAP	NAP	5.6E-05
Metals													
Arsenic	9.5	**1.6E-05**	**4.0E-06**	5.1E-09	NAP	NAP	**2.0E-05**	4.0E-01	1.0E-01	NA	NAP	NAP	5.1E-01
Bismuth	3.1	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	34.7	NA	NA	NA	NAP	NAP	NA	1.2E-02	4.2E-03	NA	NAP	NAP	1.6E-02
Lead	226	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	2.3E-03	5.6E-04	NA	NAP	NAP	2.9E-03
Thallium	0.88	NA	NA	NA	NAP	NAP	NA	1.4E-01	9.9E-02	NA	NAP	NAP	2.4E-01
Total Chemical		**2.3E-05**	**8.0E-05**	5.1E-09	NAP	NAP	**1.0E-04**	5.6E-01	2.1E-01	6.9E-08	NAP	NAP	7.7E-01
	EPC												
Radionuclides	**pCi/g**												
Plutonium-238	22.5	**2.6E-06**	NAP	1.0E-08	NAP	2.9E-09	**2.6E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Radium-226	3.04	4.3E-06	NAP	1.1E-09	NAP	**4.6E-05**	**5.1E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		**6.9E-06**	NAP	1.2E-08	NAP	**4.6E-05**	**5.3E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		**3.0E-05**	**8.0E-05**	1.7E-08	NAP	**4.6E-05**	**1.6E-04**	5.6E-01	2.1E-01	6.9E-08	NAP	NAP	7.7E-01

EPC Exposure point concentration
mg/kg Milligram per kilogram
NA Not available; insufficient toxicity data
NAP Not applicable pathway
pCi/g Picocuries per gram
VOCs Volatile organic compounds
1.00E-06 Is equivalent to 1.00×10^{-6}

Table 16: Background Residual Risk for a Residential Child at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Dibenz(a,h)anthracene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Dibenzofuran		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Naphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Arsenic	8.6	**1.4E-05**	**3.6E-06**	4.7E-09	NAP	NAP	**1.8E-05**	3.7E-01	9.5E-02	NA	NAP	NAP	4.6E-01
Bismuth		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	26	NA	NA	NA	NAP	NAP	NA	9.0E-03	3.2E-03	NA	NAP	NAP	1.2E-02
Lead	48	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.46	NA	NA	NA	NAP	NAP	NA	7.4E-02	5.2E-02	NA	NAP	NAP	1.3E-01
Total Chemical		**1.4E-05**	**3.6E-06**	4.7E-09	NAP	0.0E+00	**1.8E-05**	4.5E-01	1.5E-01	NA	NAP	NAP	6.0E-01
	EPC												
Radionuclides	**pCi/g**												
Plutonium-238	0.13	1.5E-08	NAP	6.0E-11	NAP	1.7E-11	1.5E-08	NAP	NAP	NAP	NAP	NAP	NAP
Radium-226	2	2.8E-06	NAP	7.1E-10	NAP	**3.1E-05**	**3.3E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		2.9E-06	NAP	7.7E-10	NAP	**3.1E-05**	**3.3E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		**1.7E-05**	**3.6E-06**	5.4E-09	NAP	**3.1E-05**	**5.1E-05**	4.5E-01	1.5E-01	NA	NAP	NAP	6.0E-01

EPC — Exposure point concentration
mg/kg — Milligram per kilogram
NA — Not available; insufficient toxicity data
NAP — Not applicable pathway
pCi/g — Picocuries per gram
VOCs — Volatile organic compounds
1.00E-06 — Is equivalent to 1.00×10^{-6}

Table 17: Incremental Residual Risk for a Residential Child at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total	Route-Specific HQ					Total
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk	Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer Hazard
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	4.2E-05	4.3E-04	NA	NAP	NAP	4.7E-04
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene	0.688	**5.5E-06**	**5.6E-05**	NA	NAP	NAP	**6.2E-05**	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	4.2E-09	1.3E-08	NA	NAP	NAP	1.7E-08	NA	NA	NA	NAP	NAP	NA
Dibenz(a,h)anthracene	0.24	**1.9E-06**	**2.0E-05**	NA	NAP	NAP	**2.2E-05**	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	6.7E-05	4.3E-04	NA	NAP	NAP	4.9E-04
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	8.9E-05	5.7E-04	6.9E-08	NAP	NAP	6.6E-04
Phenanthrene	0.773	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	1.2E-10	7.3E-10	3.8E-15	NAP	NAP	8.5E-10	7.7E-06	4.9E-05	6.3E-10	NAP	NAP	5.6E-05
Metals													
Arsenic	0.9	**1.5E-06**	3.8E-07	4.9E-10	NAP	NAP	**1.9E-06**	3.8E-02	9.9E-03	NA	NAP	NAP	4.8E-02
Bismuth	3.1	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	8.7	NA	NA	NA	NAP	NAP	NA	3.0E-03	1.1E-03	NA	NAP	NAP	4.1E-03
Lead	178	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	2.3E-03	5.6E-04	NA	NAP	NAP	2.9E-03
Thallium	0.42	NA	NA	NA	NAP	NAP	NA	6.7E-02	4.7E-02	NA	NAP	NAP	1.1E-01
Total Chemical [a]		**8.9E-06**	**7.6E-05**	4.9E-10	NAP	NAP	**8.5E-05**	1.1E-01	6.0E-02	6.9E-08	NAP	NAP	1.7E-01
	EPC												
Radionuclides	pCi/g												
Plutonium-238	22.37	**2.6E-06**	NAP	1.0E-08	NAP	2.9E-09	**2.6E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Radium-226	1.04	1.5E-06	NAP	3.7E-10	NAP	**1.6E-05**	**1.7E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		**4.0E-06**	NAP	1.1E-08	NAP	**1.6E-05**	**2.0E-05**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		**1.3E-05**	**7.6E-05**	1.1E-08	NAP	**1.6E-05**	**1.1E-04**	1.1E-01	6.0E-02	6.9E-08	NAP	NAP	1.7E-01

EPC — Exposure point concentration, incremental value is total minus background
mg/kg — Milligram per kilogram
NA — Not available; insufficient toxicity data
NAP — Not applicable pathway
pCi/g — Picocuries per gram
VOCs — Volatile organic compounds
1.00E-06 — Is equivalent to 1.00×10^{-6}

a - The concentrations of BaP found in the OU4 background PAH study are comparable to levels found in the remediated area of the canal, therefore, the BaP risk contribution is not believed to be due to Mound operations.

Table 18: Total Residual Risk for an Off-Site Construction Worker at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	1.5E-05	3.1E-05	NA	NAP	NAP	4.6E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	2.6E-10	1.6E-10	NA	NAP	NAP	4.2E-10	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	2.5E-05	3.1E-05	NA	NAP	NAP	5.5E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	3.3E-05	4.1E-05	2.4E-08	NAP	NAP	7.4E-05
Phenanthrene	0.773	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	7.0E-12	8.8E-12	2.2E-16	NAP	NAP	1.6E-11	2.8E-06	3.5E-06	2.2E-10	NAP	NAP	6.3E-06
Metals													
Arsenic	9.5	9.6E-07	4.9E-08	3.0E-10	NAP	NAP	**1.0E-06**	1.5E-01	7.6E-03	2.8E-06	NAP	NAP	1.6E-01
Bismuth	3.1	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	34.7	NA	NA	NA	NAP	NAP	NA	4.4E-03	3.1E-04	NA	NAP	NAP	4.7E-03
Lead	226	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	8.5E-04	4.0E-05	NA	NAP	NAP	9.0E-04
Thallium	0.88	NA	NA	NA	NAP	NAP	NA	5.2E-02	7.2E-03	NA	NAP	NAP	5.9E-02
Total Chemical		9.6E-07	4.9E-08	3.0E-10	NAP	NAP	**1.0E-06**	2.1E-01	1.5E-02	2.8E-06	NAP	NAP	2.2E-01
	EPC												
Radionuclides	**pCi/g**												
Radium-226	3.04	1.2E-06	NAP	2.9E-10	NAP	**7.7E-06**	**9.0E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		1.2E-06	NAP	2.9E-10	NAP	**7.7E-06**	**9.0E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		**2.2E-06**	4.9E-08	6.0E-10	NAP	**7.7E-06**	**1.0E-05**	2.1E-01	1.5E-02	2.8E-06	NAP	NAP	2.2E-01

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
NA	Not available; insufficient toxicity data
NAP	Not applicable pathway
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 19: Background Residual Risk for an Offsite construction Worker at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Dibenzofuran		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Naphthalene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Arsenic	8.6	8.7E-07	4.4E-08	2.7E-10	NAP	NAP	9.1E-07	1.3E-01	6.8E-03	2.5E-06	NAP	NAP	1.4E-01
Bismuth		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	26	NA	NA	NA	NAP	NAP	NA	3.3E-03	2.3E-04	NA	NAP	NAP	3.5E-03
Lead	48	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.46	NA	NA	NA	NAP	NAP	NA	2.7E-02	3.8E-03	NA	NAP	NAP	3.1E-02
Total Chemical		8.7E-07	4.4E-08	2.7E-10	NAP	NAP	9.1E-07	1.6E-01	1.1E-02	2.5E-06	NAP	NAP	1.8E-01
	EPC												
Radionuclides	**pCi/g**												
Radium-226	2	8.1E-07	NAP	1.9E-10	NAP	**5.1E-06**	**5.9E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		8.1E-07	NAP	1.9E-10	NAP	**5.1E-06**	**5.9E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		1.7E-06	4.4E-08	4.7E-10	NAP	**5.1E-06**	**6.8E-06**	1.6E-01	1.1E-02	2.5E-06	NAP	NAP	1.8E-01

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
NA	Not available; insufficient toxicity data
NAP	Not applicable pathway
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 20: Incremental Residual Risk for an Offsite Construction Worker at the Miami-Erie Canal Area

Analyte	EPC mg/kg	CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Total Cancer Risk	Route-Specific HQ					Total Non-Cancer Hazard
		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External		Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	NA	1.5E-05	3.1E-05	NA	NAP	NAP	4.6E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.191	2.6E-10	1.6E-10	NA	NAP	NAP	4.2E-10	NA	NA	NA	NAP	NAP	NA
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Fluorene	0.21	NA	NA	NA	NAP	NAP	NA	2.5E-05	3.1E-05	NA	NAP	NAP	5.5E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	NA	3.3E-05	4.1E-05	2.4E-08	NAP	NAP	7.4E-05
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Gamma Chlordane	0.0003	7.0E-12	8.8E-12	2.2E-16	NAP	NAP	1.6E-11	2.8E-06	3.5E-06	2.2E-10	NAP	NAP	6.3E-06
Metals													
Arsenic	0.9	9.1E-08	4.6E-09	2.9E-11	NAP	NAP	9.5E-08	1.4E-02	7.2E-04	2.7E-07	NAP	NAP	1.5E-02
Bismuth	3.1	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Copper	8.7	NA	NA	NA	NAP	NAP	NA	1.1E-03	7.7E-05	NA	NAP	NAP	1.2E-03
Lead	178	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Selenium	0.91	NA	NA	NA	NAP	NAP	NA	8.5E-04	4.0E-05	NA	NAP	NAP	9.0E-04
Thallium	0.42	NA	NA	NA	NAP	NAP	NA	2.5E-02	3.4E-03	NA	NAP	NAP	2.8E-02
Total Chemical		9.1E-08	4.8E-09	2.9E-11	NAP	NAP	9.6E-08	4.1E-02	4.4E-03	2.9E-07	NAP	NAP	4.5E-02
	EPC												
Radionuclides	**pCi/g**												
Radium-226	1.04	4.2E-07	NAP	1.0E-10	NAP	**2.7E-06**	**3.1E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		4.2E-07	NAP	1.0E-10	NAP	**2.7E-06**	**3.1E-06**	NAP	NAP	NAP	NAP	NAP	NAP
Overall Total Risk		5.1E-07	4.8E-09	1.3E-10	NAP	**2.7E-06**	**3.2E-06**	4.1E-02	4.4E-03	2.9E-07	NAP	NAP	4.5E-02

EPC — Exposure point concentration, incremental value is total minus background
mg/kg — Milligram per kilogram
NA — Not available; insufficient toxicity data
NAP — Not applicable pathway
pCi/g — Picocuries per gram
VOCs — Volatile organic compounds
1.00E-06 — Is equivalent to 1.00×10^{-6}

Table 21. Total Residual Risk for the Miami-Erie Canal Area Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncarcinogen Risk HI	Total Carcinogenic Risk ELCR
Resident Adult Scenario	Soil (all sample depths)	Chemical	Ingestion	6.0E-02	**9.9E-06**
			Dermal	1.2E-01	**1.5E-04**
			Inhalation of Dust	1.2E-06	3.2E-09
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	1.8E-01	**1.6E-04**
		Radionuclides	Ingestion	NAP	**6.3E-06**
			Inhalation of Dust	NAP	2.5E-08
			External	NAP	**1.5E-04**
			TOTAL	NAP	**1.5E-04**
		Chemical & Radionuclide Total		1.8E-01	**3.1E-04**
Resident Child Scenario	Soil (all sample depths)	Chemical	Ingestion	5.6E-01	**2.3E-05**
			Dermal	2.1E-01	**6.9E-05**
			Inhalation of Dust	2.5E-06	1.6E-09
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	7.7E-01	**9.2E-05**
		Radionuclides	Ingestion	NAP	**3.2E-06**
			Inhalation of Dust	NAP	2.7E-09
			External	NAP	**3.7E-05**
			TOTAL	NAP	**4.0E-05**
		Chemical & Radionuclide Total		7.7E-01	**1.3E-04**
Recreational Adult Scenario	Soil (0-2 ft bls)	Chemical	Ingestion	2.5E-03	2.7E-10
			Dermal	8.6E-03	1.4E-08
			Inhalation of Dust	1.0E-09	2.2E-16
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	1.1E-02	1.5E-08
		Radionuclides	Ingestion	NAP	1.1E-07
			Inhalation of Dust	NAP	3.2E-11
			External	NAP	**9.3E-06**
			TOTAL	NAP	**9.4E-06**
		Chemical & Radionuclide Total		1.1E-02	**9.4E-06**
Recreational Child Scenario	Soil (0-2 ft bls)	Chemical	Ingestion	2.3E-02	6.4E-10
			Dermal	1.6E-02	6.5E-09
			Inhalation of Dust	3.2E-09	1.7E-16
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	3.9E-02	7.1E-09
		Radionuclides	Ingestion	NAP	5.7E-08
			Inhalation of Dust	NAP	5.4E-12
			External	NAP	**2.3E-06**
			TOTAL	NAP	**2.4E-06**
		Chemical & Radionuclide Total		3.9E-02	**2.4E-06**

Table 21. Total Residual Risk for the Miami-Erie Canal Area Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncarcinogen Risk HI	Total Carcinogenic Risk ELCR
Off Site Construction Worker Scenario	Soil (0-10 ft bls)	Chemical	Ingestion	2.1E-01	9.6E-07
			Dermal	1.5E-02	4.9E-08
			Inhalation of Dust	8.8E-07	9.3E-11
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	2.2E-01	1.0E-06
		Radionuclides	Ingestion	NAP	1.1E-07
			Inhalation of Dust	NAP	9.9E-12
			External	NAP	**6.1E-06**
			TOTAL	NAP	**6.2E-06**
		Chemical & Radionuclide Total		2.2E-01	**7.2E-06**

HI values which exceed the target risk level of one and ELCR values which exceed 10^{-6} presented in bold text.

1E-01 is equivalent to 1.00×10^{-1}

Table 22. Background Residual Risk for the Miami-Erie Canal Area Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Background Noncarcinogen Risk HI	Background Carcinogenic Risk ELCR
Resident Adult Scenario	Soil (all sample depths)	Chemical	Ingestion	4.8E-02	**6.1E-06**
			Dermal	8.3E-02	**8.1E-06**
			Inhalation of Dust	1.1E-06	2.8E-09
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	1.3E-01	**1.4E-05**
		Radionuclides	Ingestion	NAP	5.4E-07
			Inhalation of Dust	NAP	3.6E-10
			External	NAP	**9.6E-05**
			TOTAL	NAP	**9.7E-05**
		Chemical & Radionuclide Total		1.3E-01	**1.1E-04**
Resident Child Scenario	Soil (all sample depths)	Chemical	Ingestion	4.5E-01	**1.4E-05**
			Dermal	1.5E-01	**3.6E-06**
			Inhalation of Dust	2.2E-06	1.4E-09
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	6.0E-01	**1.8E-05**
		Radionuclides	Ingestion	NAP	2.7E-07
			Inhalation of Dust	NAP	3.9E-11
			External	NAP	**2.4E-05**
			TOTAL	NAP	**2.4E-05**
		Chemical & Radionuclide Total		6.0E-01	**4.2E-05**
Recreatonal Adult Scenario	Soil (0-2 ft bls)	Chemical	Ingestion	1.3E-03	0.0E+00
			Dermal	4.5E-03	0.0E+00
			Inhalation of Dust	0.0E+00	0.0E+00
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	5.8E-03	0.0E+00
		Radionuclides	Ingestion	NAP	7.5E-08
			Inhalation of Dust	NAP	2.1E-11
			External	NAP	**6.1E-06**
			TOTAL	NAP	**6.2E-06**
		Chemical & Radionuclide Total		5.8E-03	**6.2E-06**
Recreational Child Scenario	Soil (0-2 ft bls)	Chemical	Ingestion	1.3E-03	0.0E+00
			Dermal	4.5E-03	0.0E+00
			Inhalation of Dust	0.0E+00	0.0E+00
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	5.8E-03	0.0E+00
		Radionuclides	Ingestion	NAP	7.5E-08
			Inhalation of Dust	NAP	2.1E-11
			External	NAP	**1.5E-06**
			TOTAL	NAP	**1.6E-06**
		Chemical & Radionuclide Total		5.8E-03	**1.6E-06**

Table 22 Background Residual Risk for the Miami-Erie Canal Area Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Background Noncarcinogen Risk HI	Background Carcinogenic Risk ELCR
Off Site Construction Worker Scenario	Soil (0-10 ft bls)	Chemical	Ingestion	1.6E-01	8.7E-07
			Dermal	1.1E-02	4.4E-08
			Inhalation of Dust	7.9E-07	8.4E-11
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	1.8E-01	9.1E-07
		Radionuclides	Ingestion	NAP	7.2E-08
			Inhalation of Dust	NAP	6.5E-12
			External	NAP	**4.0E-06**
			TOTAL	NAP	**4.1E-06**
		Chemical & Radionuclide Total		1.8E-01	**5.1E-06**

HI values which exceed the target risk level of one and ELCR values which exceed 10^{-6} presented in bold text.

1E-01 is equivalent to 1.00×10^{-1}

Table 23: Incremental Residual Risk for the Miami-Erie Canal Area Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Incremental Noncancer Hazard or HI	Incremental Cancer Risk ELCR
Resident Adult Scenario	Soil (all sample depths)	Chemical	Ingestion	1.2E-02	**3.8E-06**
			Dermal	3.3E-02	**1.7E-04**
			Inhalation of Dust	3.4E-08	9.6E-10
			Inhalation of VOCs	NAP	NAP
			TOTAL	4.5E-02	**1.7E-04** [a]
		Radionuclides	Ingestion	NAP	**8.1E-06**
			Inhalation of Dust	NAP	9.9E-08
			External	NAP	**6.4E-05**
			TOTAL	NAP	**7.2E-05**
		Chemical & Radionuclide Total		4.5E-02	**2.4E-04** [a]
Resident Child Scenario	Soil (all sample depths)	Chemical	Ingestion	1.1E-01	**8.9E-06**
			Dermal	6.0E-02	**7.6E-05**
			Inhalation of Dust	6.9E-08	4.9E-10
			Inhalation of VOCs	NAP	NAP
			TOTAL	1.7E-01	**8.5E-05** [a]
		Radionuclides	Ingestion	NAP	**4.0E-06**
			Inhalation of Dust	NAP	1.1E-08
			External	NAP	**1.6E-05**
			TOTAL	NAP	**2.0E-05**
		Chemical & Radionuclide Total		1.7E-01	**1.1E-04** [a]
Recreational Adult Scenario	Soil (0-2 ft bls)	Chemical	Ingestion	1.2E-03	2.7E-10
			Dermal	4.1E-03	4.6E-09
			Inhalation of Dust	8.5E-10	1.9E-16
			Inhalation of VOCs	NAP	NAP
			TOTAL	5.3E-03	4.9E-09
		Radionuclides	Ingestion	NAP	4.4E-07
			Inhalation of Dust	NAP	8.4E-11
			External	NAP	**4.0E-06**
			TOTAL	NAP	**4.5E-06**
		Chemical & Radionuclide Total		5.3E-03	**4.5E-06**
Recreational Child Scenario	Soil (0-2 ft bls)	Chemical	Ingestion	1.1E-02	6.4E-10
			Dermal	7.5E-03	2.1E-09
			Inhalation of Dust	1.7E-09	9.4E-17
			Inhalation of VOCs	NAP	NAP
			TOTAL	1.8E-02	2.7E-09
		Radionuclides	Ingestion	NAP	2.2E-07
			Inhalation of Dust	NAP	9.1E-12
			External	NAP	**1.0E-06**
			TOTAL	NAP	**1.2E-06**
		Chemical & Radionuclide Total		1.8E-02	**1.2E-06**

Off Site Construction Worker Scenario	Soil (0-10 ft bls)	Chemical	Ingestion	4.1E-02	9.1E-08
			Dermal	4.4E-03	4.8E-09
			Inhalation of Dust	2.9E-07	2.9E-11
			Inhalation of VOCs	NAP	NAP
			TOTAL	4.5E-02	9.6E-08
		Radionuclides	Ingestion	NAP	4.2E-07
			Inhalation of Dust	NAP	1.0E-10
			External	NAP	**2.7E-06**
			TOTAL	NAP	**3.1E-06**
		Chemical & Radionuclide Total		4.5E-02	**3.2E-06**

bls - below land surface
ECLR - Excess Cancer Lifetime Risk
HI - Hazard Index
HI values which exceed the target risk level of one and ELCR values which exceed 10^{-6} *are presented in bold text.*
NAP - Not Applicable pathway
1E-01 is equivalent to 1.00×10^{-1}

a - The concentrations of BaP found in the OU4 background PAH study are comparable to levels found in the remediated area of the canal, therefore, the BaP risk contribution is not believed to be due to Mound operations.

APPENDIX C

Figures

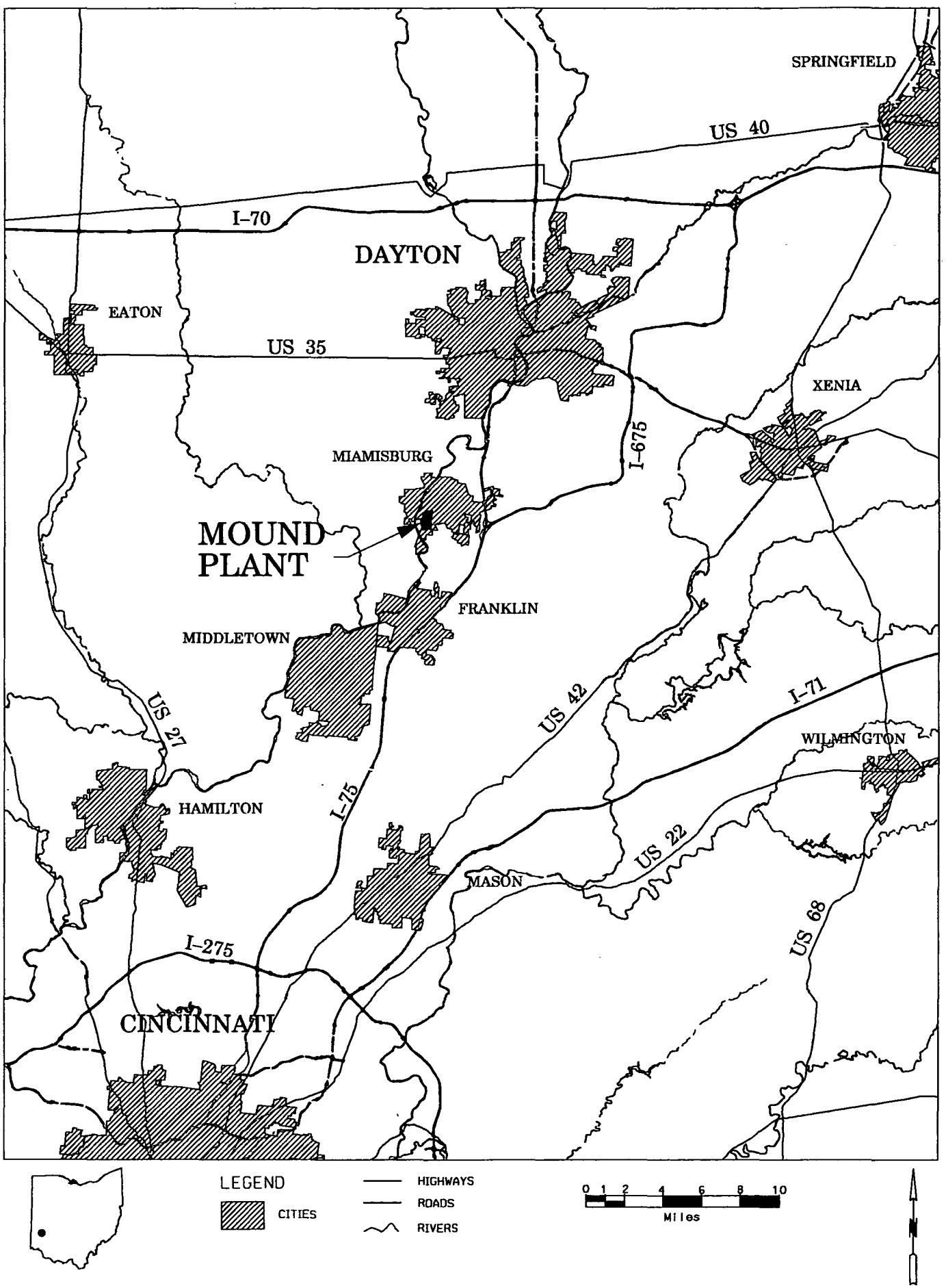


Figure 1. Regional Context of Mound Plant

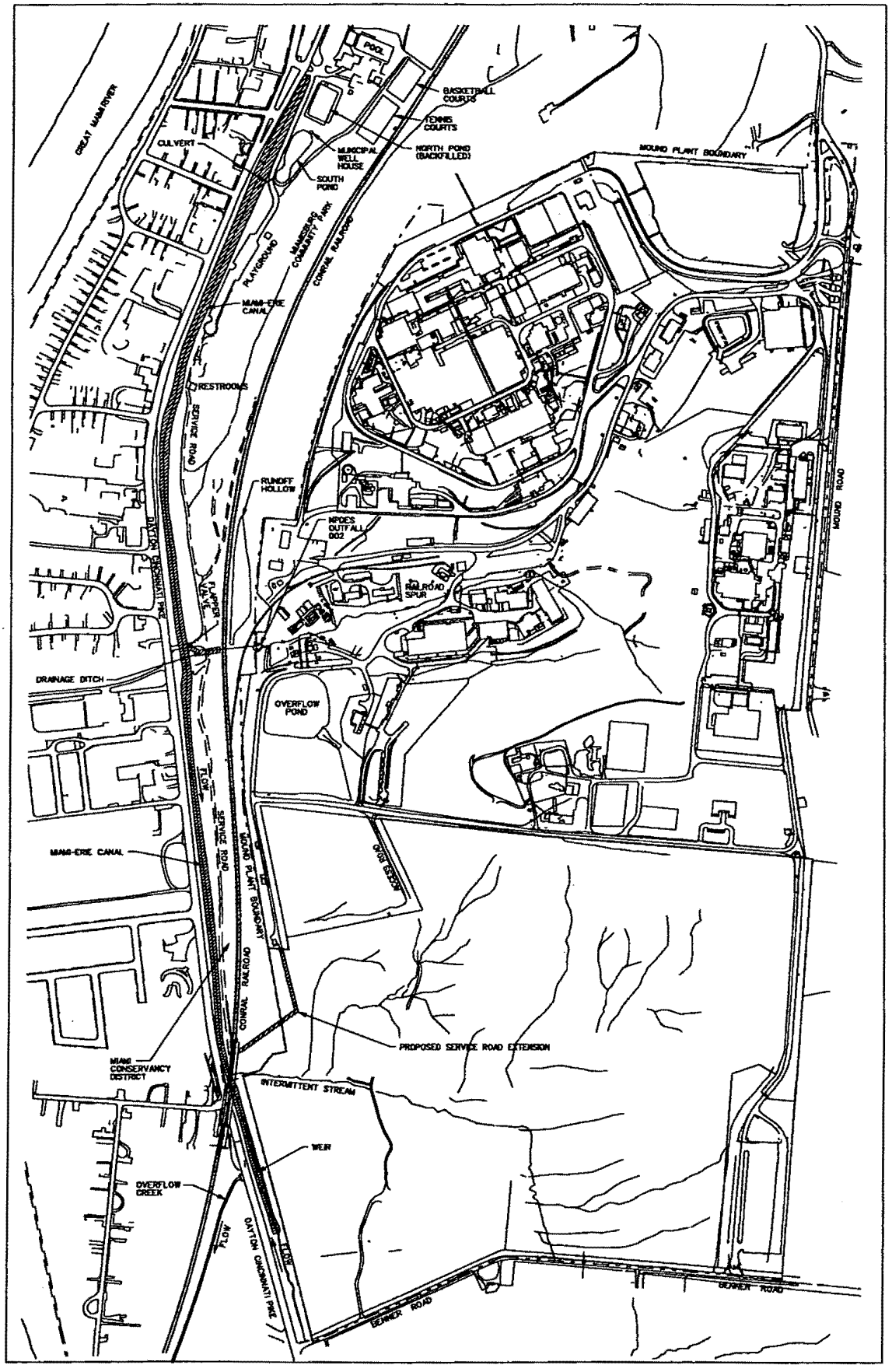
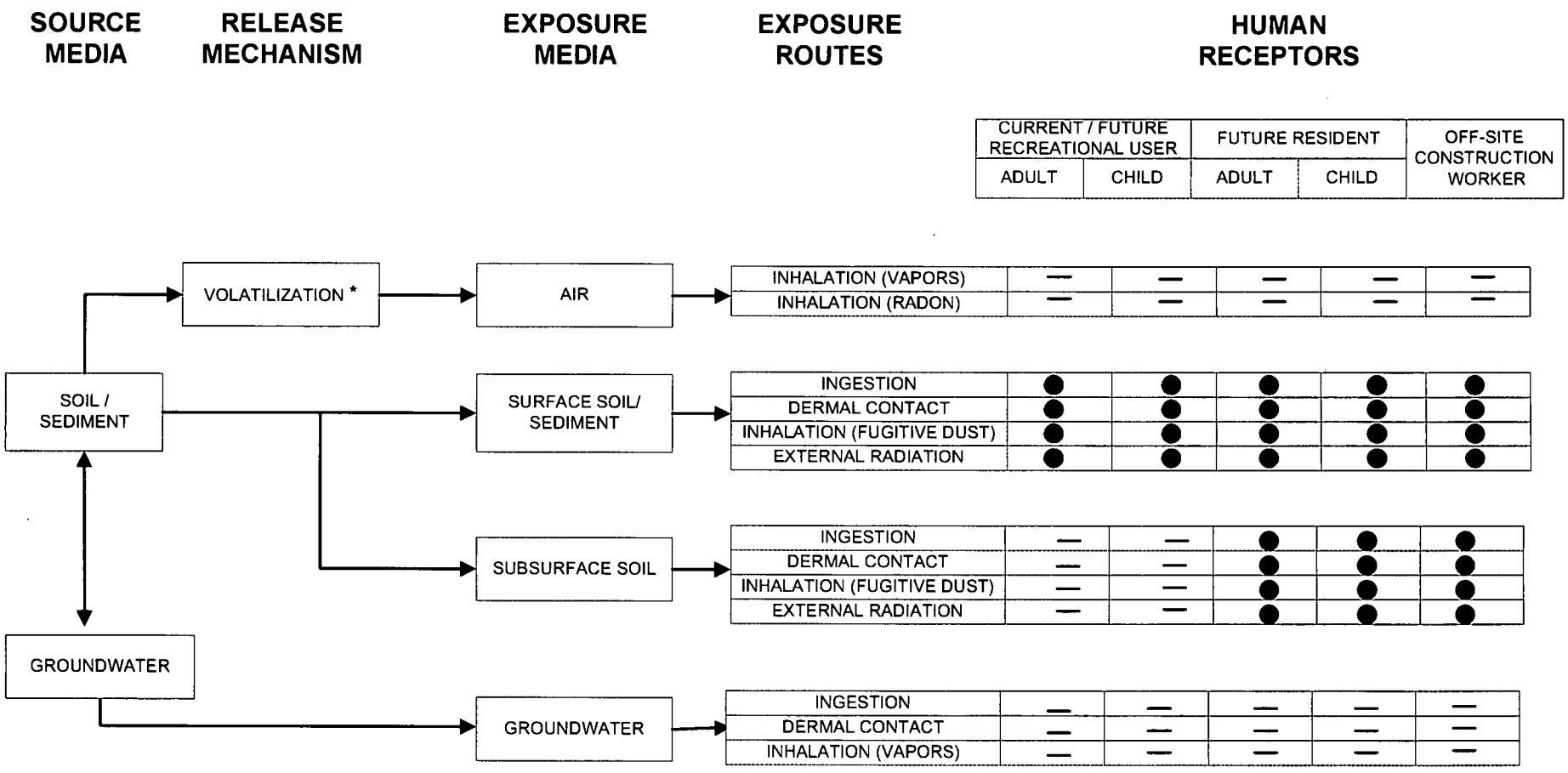


Figure 2 - Miami-Erie Canal Area Map



● COMPLETE PATHWAY EVALUATED QUANTITATIVELY

○ COMPLETE PATHWAY EVALUATED QUALITATIVELY

— INCOMPLETE PATHWAY, NOT EVALUATED

* NO VOLATILE COPCs IN AREA

Figure 3
Conceptual Site Model for the Miami-Erie Canal RRE

T:/GOV/MOUND/CANALRRE/FINAL CANAL/FIG3.1APRIL 14, 2000

APPENDIX D

December 2002 Polycyclic Aromatic Study

Determination of Site-Specific Benzo(a)pyrene and Dibenzo(a,h)anthracene Background Levels for the Miami-Erie Canal

Determination of Site-Specific Benzo(a)pyrene and Dibenzo(a,h)anthracene Background Levels for the Miami-Erie Canal

Final

December 2002

Department of Energy
Miamisburg Closure Project

BWXT of Ohio, Inc.

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Acronyms

BaP	benzo(a)pyrene
COC	contaminant of concern
DbA	dibenzo(a,h)anthracene
DOE/MEMP	Department of Energy/Miamisburg Environmental Management Project
MEIMS	Mound Environmental Information Management System
OEPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
QC	quality control
RRE	Residual Risk Evaluation
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SVOC	semivolatile organic compound
UTL	upper tolerance limit

1.0 PURPOSE

The Residual Risk Evaluation (RRE) for the remediated portion of the Miami-Erie Canal found benzo(a)pyrene (BaP) and dibenzo(a,h)anthracene (DbA) to be leading contributors to the residual risk from soil (Reference 1). BaP was reported in 111 of 128 verification samples, at levels ranging from 21 to 7900 µg/kg. DbA was reported in 59 of 128 verification samples, at levels ranging from 20 to 1500µg/kg. There is no site-specific (Mound) or regional background value for BaP or DbA in soil to use in the evaluation of the significance of these data.

BaP and DbA are polycyclic aromatic hydrocarbons (PAHs) (Reference 6). PAHs are a group of over 100 different chemicals (Reference 5). They are not produced or used commercially but are very commonly found since they are formed by the incomplete burning of coal, oil, and gas, or other organic substances (References 5, 6, 9, 10, 11). PAHs are usually found as a mixture containing two or more of these compounds (Reference 5). The anthropogenic (resulting from man-made sources) sources of PAHs can be categorized as stationary and mobile. Vehicle engines are the major contributors to the mobile emission sources. The stationary sources include a wide variety of combustion processes; residential heating, aluminum production, coke manufacture, incineration, power generation, and asphalt production (Reference 5, 6, 7). Natural sources of PAHs include forest fires and volcanic activity (Reference 7). PAHs have been described as "ubiquitous" in the environment (Reference 6, 7, 9, 10). In non-biological materials, concentrations of PAHs are elevated in the vicinity of urban industrial locales (Reference 7).

Without additional information, it is impossible to determine if the concentrations of PAHs detected during the Mound verification sampling of the canal are the result of Mound-related activities or due to other sources in the surrounding area. The primary objective for this investigation is to determine site-specific background concentrations of PAHs, specifically BaP and DbA. The second objective of this effort is to use this information in the Miami-Erie Canal RRE to evaluate the concentrations of PAHs

detected in the Miami-Erie Canal during verification sampling within the site-specific anthropogenic background concentration as determined from this effort. This information will help risk managers evaluate the contribution of PAHs from the Mound in comparison to the contribution of PAHs from anthropogenic sources outside of Mound's influence. This information will then be used to complete the Miami-Erie Canal RRE.

A Draft Sample and Analysis Plan (SAP) was submitted to the Department of Energy/ Miamisburg Environmental Management Project (DOE/MEMP) in November 2001. On January 31, 2002, the Ohio Environmental Protection Agency (OEPA) received the Draft SAP during a meeting to discuss appropriate sampling site locations. OEPA conducted an informal review and provided comments on the Draft SAP. The sampling proposed in the Draft SAP was conducted on February 14, 2002, prior to finalization of this report. The Core Team agreed the best use of resources was to stop further development of the Draft SAP and document what was done and the results obtained. The purpose of this report is to provide that documentation. As a result of this unusual progression, this report has elements of both the traditional SAP and Data Report.

2.0 SAMPLING

2.1 TYPE

All samples collected were from soil obtained from soil borings.

2.2 LOCATION, FREQUENCY, AND COORDINATES

The attributes of the background sampling locations aimed to mimic the conditions where verification samples were taken within the Miami-Erie Canal. These desired attributes included:

- The location must be within the banks of the canal;
- The location must not be in the drainage pattern of water/runoff coming from the Mound site;

- The location must be close enough to the Mound site such that it would have been exposed to the same anthropogenic contaminants as the remediated portion of the canal;
- The soil must be undisturbed; and
- The location must be randomly selected.

Figure 1 shows an aerial view of the Mound site and the sample locations. These areas are outside of the Mound Plant watershed (as reported in the OU9 RI/FS Site Wide Work Plan, Reference 2). The areas, as described by adjacent roads or other identifiable features, are as follows:

Location 1 is north of the Miamisburg/West Carrollton Corporation line. It is between Kendal Street in West Carrollton and Richard Street in Miamisburg. The location coincides with a railroad service building and personnel causeway, which crosses the historic canal, to provide personnel access to the building from a vehicle pull-off area along West Central Avenue (old State Route 25/Dixie Highway). There was no water present at the time of sampling, however visual evidence and topographical data would indicate a Southward flow of any water/runoff, which is toward the Mound site. The soil at this location appeared to be undisturbed.

Location 2 is within Miamisburg and is located northwest of the intersection of North 4th Street, Louis Street, and Richard Street. It is east of old State Route 25 (Dixie Highway) between Richard Street and Kendal Street in West Carrollton. The water present at the time of sampling was flowing in a southern direction toward the Mound site. The general area can be described as a mixture of residential and industrial. However, residential housing is nearest to the sampling location. The soil at this location appeared to be undisturbed.

Location 3 is located on the eastern side of Dayton-Cincinnati Pike (old State Route 25/Dixie Highway) across the street from the southern entrance to Rice Field. This location is between Benner and Chautauqua Roads. This is a recreational area. There was no water present at the time of sampling. Visual evidence and topographical data

would indicate a southern flow of any water/runoff, which is away from the Mound site and in an area that has not been influenced by the Mound site. The soil at this location appeared to be undisturbed.

Location 4 is just south of Shephard Road on the east side of Dayton-Cincinnati Pike (old State Route 25/Dixie Highway). The next cross road to the south is Crains Run Road. The area is best described as rural in nature with no housing nearby. No water was present at the time of sampling. Visual evidence and topographical data indicate a southern flow of any water/runoff, which is away from the Mound site. The sample location is in an area that has not been influenced by the Mound site. The soil at this location appeared to be undisturbed.

Three discrete samples were collected at each of the four locations for a total of twelve (12) samples. An equilateral triangle with sides approximately equal to 50 feet was established at each location. The three nodes of the triangle served as the discrete sampling points for that location. The intent was to obtain unbiased information. The exact location of each sampling point was not determined prior to the sampling effort. The team accessed the canal from the road at the approved location. The first point was selected at random, but within the banks of the canal. The triangle was then positioned so that the other two points likewise were located within the banks of the canal. A Global Positioning System was used to obtain the coordinates. Table 1 presents the easting, northing, and elevation for each of the samples. Horizontal locations were recorded in the Ohio State Plane Coordinate System. Figures 2 through 5 show the layout of the sample grid at each of the four locations.

Sample locations 1, 2, and 3 are located within the public right-of-way along Dayton-Cincinnati Pike. Therefore, permission for access from property owners was not an issue. The City of Miamisburg was asked to contact the Miami Conservancy District to notify them when and where sampling in the canal would occur. Sample location 4 is within the Dayton Power and Light right-of-way. A phone call was made to provide notification prior to entering the right-of-way to collect the samples.

2.3 ANALYTE JUSTIFICATION

BaP and DbA were the risk drivers observed during the Miami-Erie Canal RRE calculations. Therefore, they are the contaminants of concern (COCs) for this investigation.

2.4 DESIGNATION

Soil and quality control (QC) samples were identified and labeled according to procedures in Method: S-028, Sample Control and Documentation, of the Methods Compendium (Reference 3). Sample identification labels were used for each sample container. Sample containers were sealed immediately after sample collection. Labels were completed, when possible, prior to fieldwork to minimize the handling of the sample containers. Each label included the following information:

-Sample identification
-Time and date of collection
-Parameters to be analyzed
-Sampler's initials

Collected samples were uniquely identified according to the system

BAP-W-BXXX-YY-ZZZZZZ, where:

BAP = Mound Environmental Information Management System (MEIMS) Project Code (BaP characterization samples)

W = QC sample where:
0 = no QC sample
1 = field duplicate
2 = equipment rinsate
3 = trip blank

BXXX = boring location
YY = maximum depth in feet of the sampling interval
ZZZZZZ = a sequential, six digit sample identifier (i.e., 000001, 000002, etc.) to be used on the laboratory chain of custody (Appendix F) for incorporation of the data into MEIMS.

Matrix Spike and Matrix Spike Duplicate Samples were identified on the field tracking sheet (Appendix C), but no unique QC code was used for these samples.

2.5 PROCEDURES

Soil samples were collected from the ground surface to a depth of approximately 12-inches below grade. The samples were collected manually using a hand operated GeoProbe apparatus. A 2-inch diameter rod with an acetate liner was forced into the ground using a sliding hammer.

All rocks larger than ¼-inch diameter and all organic material were removed from the sample medium prior to transfer into laboratory containers.

Field activities followed standard operating procedures (SOPs) presented in the Methods Compendium (Reference 3). Applicable SOPs are summarized in Table 2, along with any additions or deviations.

Field notes were recorded in a logbook. A copy of the Field Logbook is included in Appendix D.

2.6 QC SAMPLES

QC samples were collected as follows:

- field duplicates: 2
- matrix spike: 1
- matrix spike duplicates: 1.

2.7 CONTAINERS, HOLDING TIMES, AND PRESERVATIVES

Table 3 presents the container requirements, preservatives, and holding times for the required offsite analyses.

2.8 OTHER SAMPLING

OEPA repeated this sampling event on March 14, 2002. A participant in the sampling event of February 14, 2002 accompanied the OEPA team. The samples obtained by OEPA were from soil adjacent to the locations sampled on February 14. Locator flags placed on February 14th were still in position. The locations of the OEPA samples were surveyed. OEPA resampled these locations as a quality check on the data collected by

DOE since OEPA was not notified of the sampling in a timely manner to conduct oversight.

3.0 ANALYSES

3.1 RADIOLOGICAL SCREENING

Since all the samples were from outside of the DOE Mound boundaries exposure to radionuclides was not expected, therefore radiological screening was not required.

3.2 OFFSITE CHEMICAL

All analyses were performed at an offsite laboratory in accordance with Compendium Method A-003, CLP Semi-Volatile Analysis (Appendix E). This method is equivalent to that used to analyze the Miami-Erie Canal samples and was expected to result in the most comparable data. Though the entire suite of semivolatile hydrocarbons (SVOCs) included in this analysis will be reported, BaP and DbA are the only analytes of concern.

4.0 EVALUATION AND REPORTING

Validation of ten-percent of the analytical results was performed as well as a general review of all of the data not validated.

Table 4 lists the analytical results for the samples collected as part of this investigation. The table lists all the SVOCs included in the laboratory method. The results for BaP are shown in bold type.

4.1 Data Evaluation

Table 5 shows the results of BaP, excluding QC data, for the twelve sample locations.

Figure 6 shows the locations and BaP concentrations of the samples collected as part of this investigation. Figure 7 shows the locations along the canal where verification samples were collected and their corresponding concentration of BaP.

The BaP results from the February 14, 2002 sampling event ranged from 56 μg/kg (estimated) to 7700 μg/kg. An average concentration of approximately 793 μg/kg for BaP was calculated. Data points that are indicated as non-detect (U) were reported with a concentration equal to the reporting limit (410 μg/kg). In determining the average concentration, one-half of the reporting limit value was used in the calculation. Data from QC samples were not included in calculating the average concentration. The 95% upper tolerance limit (UTL) was calculated (Reference 4) as 6306 μg/kg.

Table 6 shows the results for DbA, excluding QC data, for the twelve sample locations.

Figure 8 shows the locations and DbA concentrations of the samples collected as part of this investigation. Figure 9 shows the locations along the canal where verification samples were collected and their corresponding concentration of DbA.

The DbA results from the February 14, 2002 sampling event ranged from 27 μg/kg (estimated) to 430 μg/kg (U qualified). An average concentration of approximately 206 μg/kg was calculated. Qualified data and QC samples were treated the same way as they were for BaP. The 95% UTL was calculated as 424 μg/kg.

4.2 Discussion

The BaP results from the February 2002 sampling event ranged from 56 μg/kg (estimated) to 7700 μg/kg and had an average of 793 μg/kg (with a standard deviation of 2177μg/kg). The BaP results from the Miami-Erie Canal verification data set ranged from 21 μg/kg (estimated) to 7900 μg/kg and had an average of 550 μg/kg (with a standard deviation of 1144 μg/kg).

The DbA results from the February 2002 sampling event ranged from 27 μg/kg (estimated) to 430 μg/kg (U qualified) and had an average of 206 μg/kg (with a standard deviation of 73 μg/kg). The DbA results from the Miami-Erie Canal verification data set ranged from 20 μg/kg (estimated) to 1500 μg/kg and had an average of 319 μg/kg (with a standard deviation of 241μg/kg).

The BaP and DbA results from the February 2002 sampling and the Miami-Erie Canal verification sampling are very similar. This indicates the BaP and DbA levels observed in the Miami-Erie Canal verification are typical of this urban area and not the result of Mound operations. This information will be used in the discussion of Risk Uncertainty in the Miami-Erie Canal Residual Risk Evaluation.

5.0 REFERENCES

Reference 1 Residual Risk Evaluation, OU-4 Miami-Erie Canal Area, Mound Plant, Miamisburg, Ohio, U.S. DOE, Draft Proposed Final, April 2000

Reference 2 Remedial Investigation/Feasibility Study, Operable Unit 9, Site-Wide Work Plan, Final, Mound Plant, Miamisburg, Ohio, U.S. DOE, April 1992

Reference 3 Technical Manual MD-80045, Issue 2, Methods Compendium, 22 January 2002

Reference 4 Operable Unit 9 Surface Water and Sediment Investigation Report, Revision 2, Mound Plant, Miamisburg, Ohio, U.S. DOE, September 1996

Reference 5 Polycyclic Aromatic Hydrocarbons (PAHs), Agency for Toxic Substances and Disease Registry (ATSDR) ToxFaqs, www.atsdr.cdc.gov/tfacts.69.html

Reference 6 Environmental Toxicology: Impacts of Environmental Toxicants on Living Systems., Ming-Hu Yu, Lewis Publishers, 2001, pp. 145-148

Reference 7 Handbook of Chemical Risk Assessment: Health Hazards to Humans, Plants, and Animals, Ronald Eisler, Lewis Publishers, 2000, pp. 1343-1397

Reference 8 Public Health Statement for Polycyclic Aromatic Hydrocarbons. Agency for Toxic Substances and Disease Registry (ATSDR), www.atsdr.cdc.gov/toxprofiles/phs69.html

Reference 9 Benzo(a)pyrene, Hazardous Substances Data Bank, U.S. National Library of Medicine, National Institutes of Health website, http://toxnet.nlm.nih.gov

Reference 10 Dibenzo(a,h)anthracene, Hazardous Substances Data Bank, U.S. National Library of Medicine, National Institutes of Health website, http://toxnet.nlm.nih.gov

Reference 11 Benzo(a)pyrene, Ohio EPA, Office of Groundwater and Drinking Water website, http://www.epa.gov/OGWDW/dwh/c-soc/benzopyr.html

APPENDIX A

Tables

Table 1: Survey Coordinates for Boring Locations

Boring Location	Easting	Northing	Elevation
1a	1469083.290	609334.282	715.132
1b	1469049.068	609299.157	709.414
1c	1469034.896	609339.661	702.388
2a	1467272.229	607148.342	710.966
2b	1467249.047	607199.415	712.832
2c	1467219.389	607146.815	717.517
3a	1464505.648	593034.834	703.897
3b	1464522.030	592993.356	694.339
3c	1464561.498	593034.069	725.813
4a	1465734.378	590391.465	696.320
4b	1465756.648	590432.381	681.024
4c	1465779.270	590367.154	690.759

Table 2: Summary of Applicable SOPs

SOP No. and Title	Procedure Description	Deviations
S-001: General Instructions for Field Personnel	• Followed procedures outlined in the SOP.	• None.
S-002: Soil Sampling with a Spade and Scoop	• Followed procedures outlined in the SOP.	• Manufacturer's procedures were followed for the hand held GeoProbe apparatus.
S-004: Guide to Management of Collected Investigative-Derived Material	• Followed procedures outlined in the SOP.	• None.
S-020: General Equipment Decontamination	• All sampling equipment was decontaminated between sampling intervals and locations.	• Methanol and hexane rinses for the decontamination of sampling equipment were not required.
S-028: Sample Control and Documentation	• Followed procedures outlined in the SOP.	• None.
S-029: Guide to Handling, Packaging, and Shipping of Samples	• Followed procedures outlined in the SOP.	• None.

Table 3: Containers, Holding Times, and Preservatives

Analysis	Method	Matrix	Bottle Type	Bottle Size	Preservation	Holding Time
SVOCs (PAH)	Compendium A-003; CLP-SOW	Soil	Wide mouth amber glass	8 ounce	Cool to 4°C	14 Days

Table 4: Analytical Results (in ug/Kg)

	Location 1				Location 2		
	a	b	c	c-dup	a	b	c
Naphthalene	61J	430U	410U	430U	410U	390U	2200U
2-Methylnaphthalene	82J	430U	410U	430U	410U	390U	2200U
Acenaphthylene	47J	430U	410U	430U	410U	390U	580J
Acenaphthene	400U	430U	410U	430U	410U	390U	730J
Dibenzofuran	29J	430U	410U	430U	410U	390U	280J
Fluorene	400 U	430U	410U	430U	410U	390U	760J
Phenanthrene	330J	43J	410U	290J	120J	73J	11000
Anthracene	58J	430U	410U	24J	23J	390U	2100J
Fluoranthene	710	110J	74J	890	290J	170J	19000E
Pyrene	620	120J	58J	700	250J	150J	15000
Chrysene	440	66J	44J	410J	160J	98J	8500
Benzo(a)anthracene	380J	56J	410U	120J	130J	74J	7400
Benzo(b)fluoranthene	390J	73J	410U	230J	130J	84J	6300
Benzo(k)fluoranthene	400	57J	410U	210J	140J	83J	7100
Benzo(a)pyrene	**380J**	**56J**	**410U**	**120J**	**140J**	**90J**	**7700**
Indeno(1,2,3-cd)pyrene	290J	38J	410U	110J	97JU	63J	5700
Dibenz(a,h)anthracene	**27J**	**430U**	**410U**	**430U**	**410U**	**390U**	**400J**
Benzo(g,h,I)perylene	280J	40J	410U	100J	100J	66J	6500

	Location 3				Location 4		
	a	b	b-dup	c	a	b	c
Naphthalene	410U	410U	410U	120J	410U	420U	410U
2-Methylnaphthalene	410U	410U	410U	210J	410U	420U	410U
Acenaphthylene	410U	410U	410U	400U	410U	29J	410U
Acenaphthene	410U	410U	410U	400U	410U	420U	410U
Dibenzofuran	410U	410U	410U	54J	410U	420U	410U
Fluorene	410U	410U	410U	400U	410U	420U	410U
Phenanthrene	410U	410U	410U	220J	93J	260J	53J
Anthracene	410U	410U	27U	23J	21J	49J	410U
Fluoranthene	410U	410U	24U	150J	230J	560	130J
Pyrene	410U	410U	410U	140J	200J	490	120J
Chrysene	410U	410U	410U	130J	130J	280J	80J
Benzo(a)anthracene	410U	410U	410U	80J	97J	210J	60J
Benzo(b)fluoranthene	410U	410U	410U	87J	110J	220J	67J
Benzo(k)fluoranthene	410U	410U	410U	74J	120J	260J	73J
Benzo(a)pyrene	**410U**	**410U**	**410U**	**80J**	**120J**	**260J**	**72J**
Indeno(1,2,3-cd)pyrene	410U	410U	410U	56J	83J	180J	51J
Dibenz(a,h)anthracene	**410U**	**410U**	**410U**	**400U**	**410U**	**420U**	**410U**
Benzo(g,h,I)perylene	410U	410U	410U	72J	95J	190J	58J

Qualifiers

U Indicates compound was analyzed for, but not detected. The associated sample quanitation limit will be CRQL, corrected for dilution and for percent moisture.

J Indicates an estimated value, used when: 1) estimating a concentration for tentatively identified compounds assuming a 1:1 response; 2) the qualitative data indicated the presence of a compound that meets the semi-volatile identification criteria, and the result is less than the CRQL but greater than zero.

E Identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis.

Table 5: BaP Results

	Result in ug/kg		
Location 1	380J	56J	410U
Location 2	140J	90J	7700
Location 3	410U	410U	80J
Location 4	120J	260J	72J

J: estimated
U: Not detected at the associated detection limit

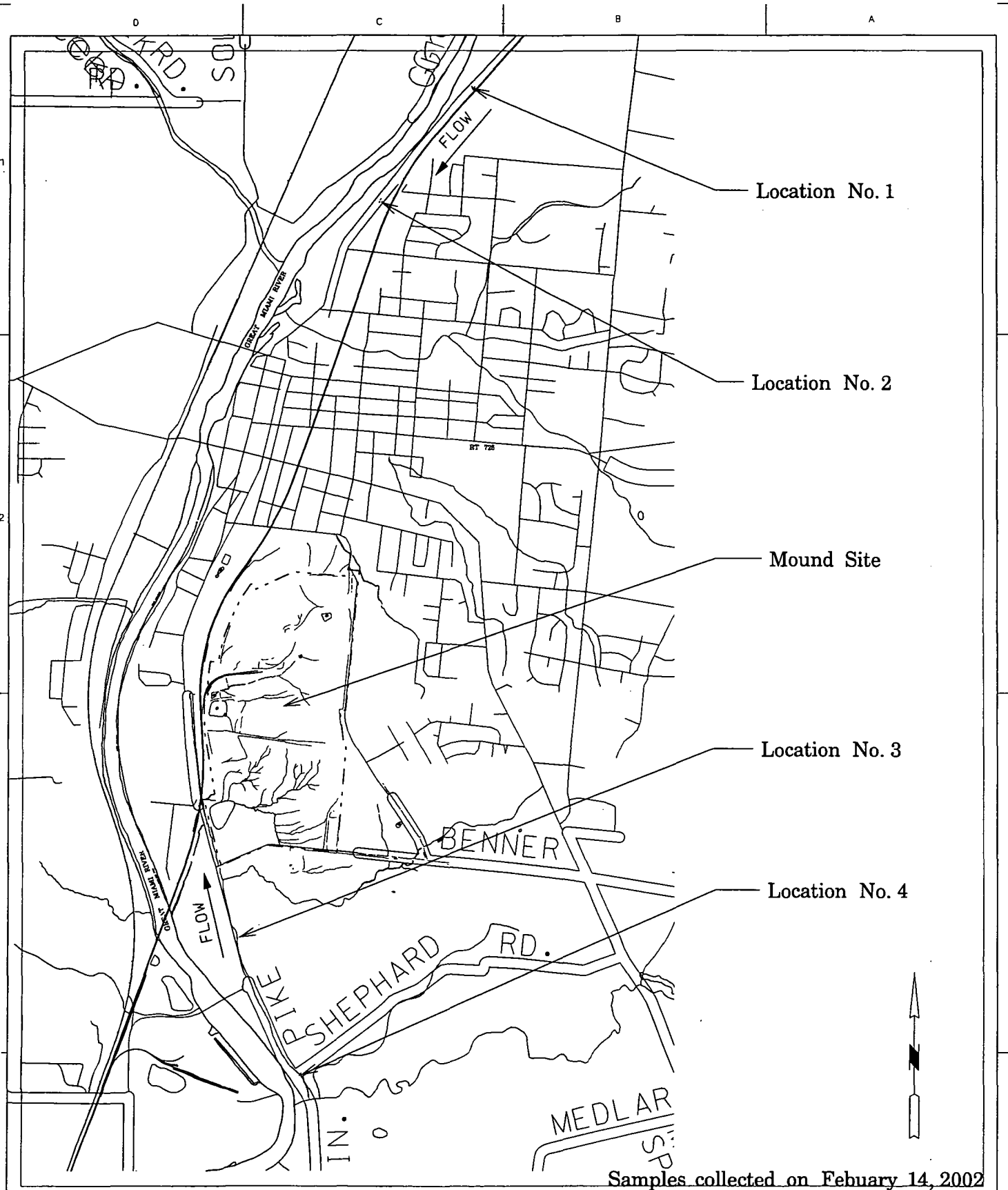
Table 6: DbA Results

	Result in ug/kg		
Location 1	27J	430U	410U
Location 2	410U	390U	400J
Location 3	410U	410U	400U
Location 4	410U	420U	410U

J: estimated
U: Not detected at the associated detection limit

APPENDIX B

Figures



GRAPHIC SCALE

1000 500 0 1000 2000FT 3000 4000FT

ISS	DATE	REVISION	BY	CHKR	ENG	LP&EC	APVD	M
	10/09/02	ISSUE FOR DATA REPORT	SSF					

MOUND

Environmental Restoration Geographic Information System

SHEET	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ISSUE																					

SHEET	1	2	3	4	5	6
ISSUE	A					

PART CLASSIFICATION

FIGURE 1
OFF-SITE
PAH SAMPLE LOCATIONS

DRAWING CLASSIFICATION: UNCLASSIFIED | SIZE | DRAWING NUMBER: offsite_samples.dgn | JOB NUMBER: *

DWG TYPE: STE | PRMG: ER-GIS | CAGEC | SCALE: GRAPHIC | SHEET 1 OF *

STATUS: MD-REL-03/06/02 | ORIGIN: MSTATION / J

0 40
Scale in Ft.

10/09/02	ISSUE FOR DATA REPORT	KRW					
DATE	REVISION	BY	CHKR	ENG	SPEC	APVD	

MOUND
Environmental Restoration Geographic Information System

SHEET 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27	
ISSUE	
SHEET 1 2 3 4 5 6	FIGURE 2 LOCATION NO.1 OFF-SITE PAH SAMPLE LOCATIONS
ISSUE	
PART CLASSIFICATION	
DRAWING CLASSIFICATION: UNCLASSIFIED	SIZE / DRAWING NUMBER: location_1.dgn / JOB NUMBER: *
DWG TYPE: STE	PROJ: ER-GIS / CASE: / SCALE: GRAPHIC / SHEET 1 OF *
STATUS: MD-REL-03/06/02	ORIGIN: MSTATION / J

0 40
Scale in Ft.

DATE	REVISION	BY	CHKR	ENG	LPREC	APVD	#
10/09/02	ISSUE FOR DATA REPORT	SSF					

MOUND

Environmental Restoration Geographic Information System

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ISSUE																					

SHEET	1	2	3	4	5	6
ISSUE						

PART CLASSIFICATION

FIGURE 3
LOCATION NO.2
OFF-SITE
PAH SAMPLE LOCATIONS

DRAWING CLASSIFICATION: UNCLASSIFIED
SIZE
DRAWING NUMBER: location_2.dgn
JOB NUMBER: #
DGN TYPE: STE
PROJ: ER-GIS
CADD:
SCALE: GRAPHIC
SHEET 1 OF #
STATUS: MD-REL-03/06/02
ORIGIN: MSTATION / J

0 40
Scale in Ft.

DATE	REVISION	BY	DWGR	ENG	LPLEC	APVD	U
10/09/02	ISSUE FOR DATA REPORT	SSP					

MOUND
Environmental Restoration Geographic Information System

SHEET	7	8	9	10	11	12	13	14	15	15	17	18	19	20	21	22	23	24	25	26	27
ISSUE																					

SHEET	1	2	3	4	5	6
ISSUE						

PART CLASSIFICATION

FIGURE 4
LOCATION 3
OFF-SITE
PAH SAMPLE LOCATIONS

DRAWING CLASSIFICATION: UNCLASSIFIED
SIZE
DRAWING NUMBER: location_3.dgn
JOB NUMBER: *
DWG TYPE: STE
PROJ: ER-GIS
CAGEC
SCALE: GRAPHIC
SHEET 1 OF *
STATUS: MD-REL-03/06/02
ORIGIN: MSTATION / J

0 40
Scale in Ft.

DATE	REVISION	BY	CHKR	ENG	LPREC	APVD	M
10/09/02	ISSUE FOR DATA REPORT	SSF					

MOUND
Environmental Restoration Geographic Information System

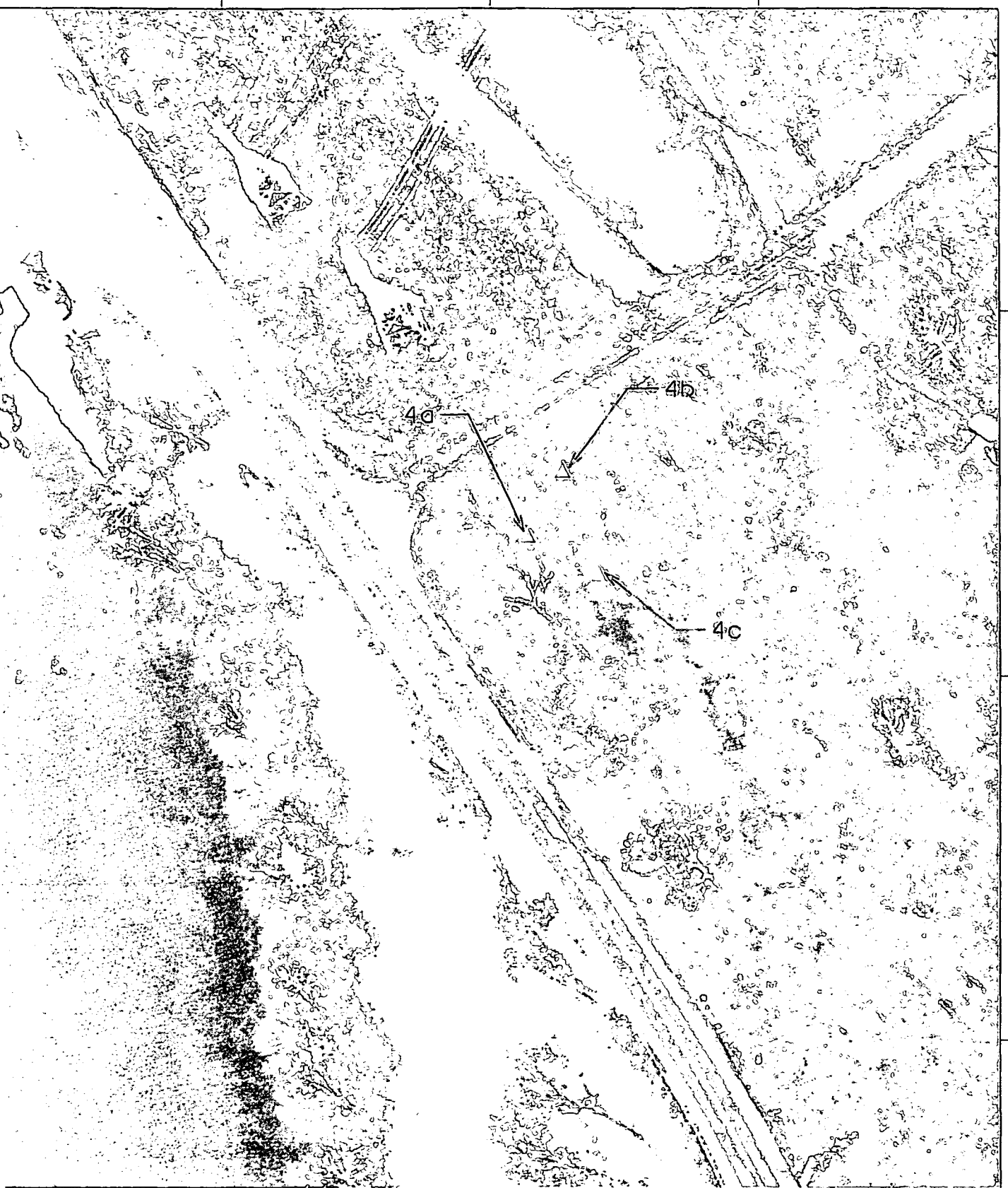
SHEET	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ISSUE																					

SHEET	1	2	3	4	5	6
ISSUE						

PART CLASSIFICATION

FIGURE 3
LOCATION NO.2
OFF-SITE
PAH SAMPLE LOCATIONS

DRAWING CLASSIFICATION: UNCLASSIFIED
SIZE
DRAWING NUMBER: location_2.dgn
JOB NUMBER: #
DWG TYPE: STE
PROJ: ER-GIS
CADEC
SCALE: GRAPHIC
SHEET 1 OF #
STATUS: MD-REL-03/06/02
ORIGIN: MSTATION / J



MOUND
Environmental Restoration Geographic Information System

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ISSUE																					

SHEET	1	2	3	4	5	6
ISSUE						

PART CLASSIFICATION

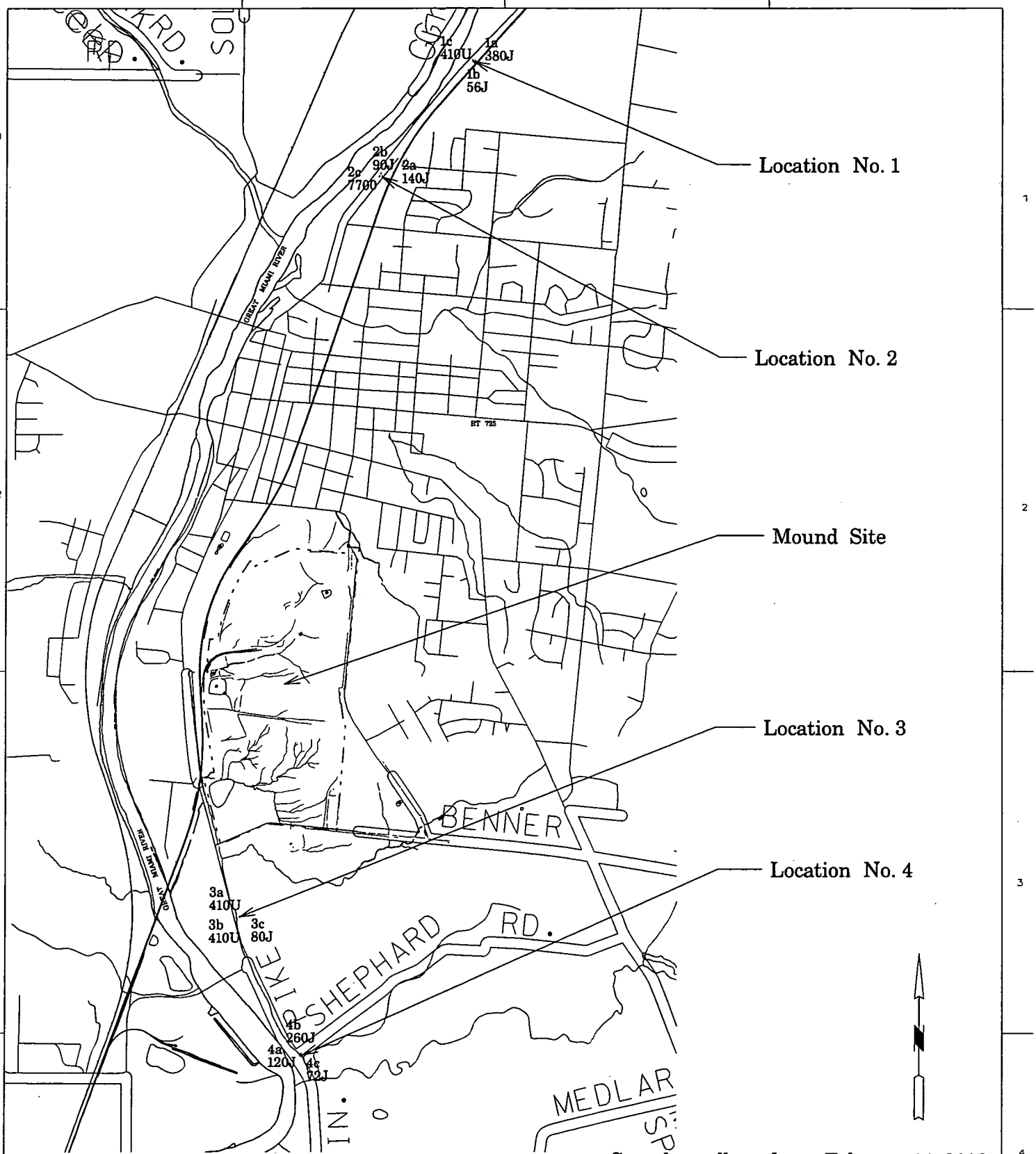
FIGURE 5
LOCATION 4
OFF-SITE
PAH SAMPLE LOCATIONS

DRAWING CLASSIFICATION: UNCLASSIFIED | SIZE | DRAWING NUMBER: location_4.dgn | JOB NUMBER

DWG TYPE: STE | PROJ: ER-GIS | CADD: | SCALE: GRAPHIC | SHEET 1 OF *

STATUS: MD-REL-03/06/02 | ORIGIN: MSTATION / J

DATE	REVISION	BY	DWN	ENG	EPLEC	APVD	W
10/09/02	ISSUE FOR DATA REPORT	SSR					



Samples collected on Febuary 14, 2002

GRAPHIC SCALE

1000 500 0 1000 2000FT 3000 4000FT

ISS	DATE	REVISION	BY	CHKR	ENG	LP&EC	APVD	M
	10/09/02	ISSUE FOR DATA REPORT	SSP					

MOUND

Environmental Restoration Geographic Information System

SHEET	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ISSUE																					

SHEET	1	2	3	4	5	6
ISSUE	A					

PART CLASSIFICATION

FIGURE 6
OFF-SITE
PAH SAMPLE LOCATIONS
AND BAP RESULTS

DRAWING CLASSIFICATION: UNCLASSIFIED

SIZE | DRAWING NUMBER: offsite_samples.dgn | JOB NUMBER: *

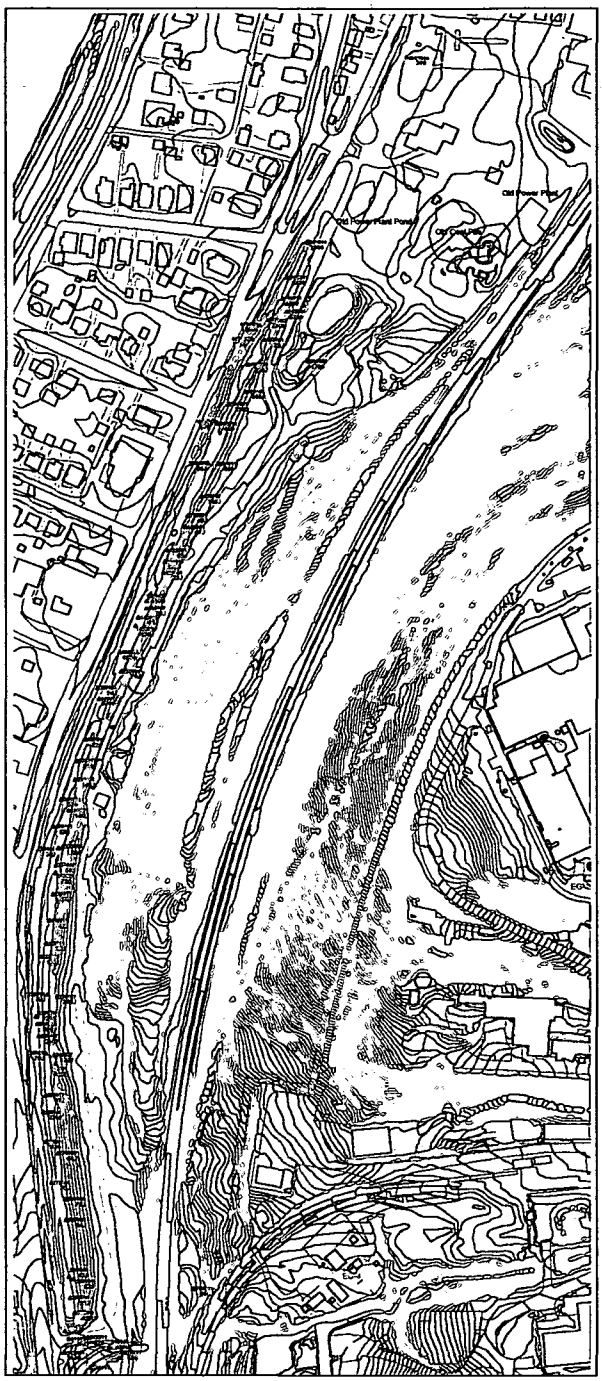
DWG TYPE: STE | PRWG: ER-GIS | CAGEC | SCALE: GRAPHIC | SHEET 1 OF *

STATUS: MD-REL-03/06/02 | ORIGIN: MSTATION / J

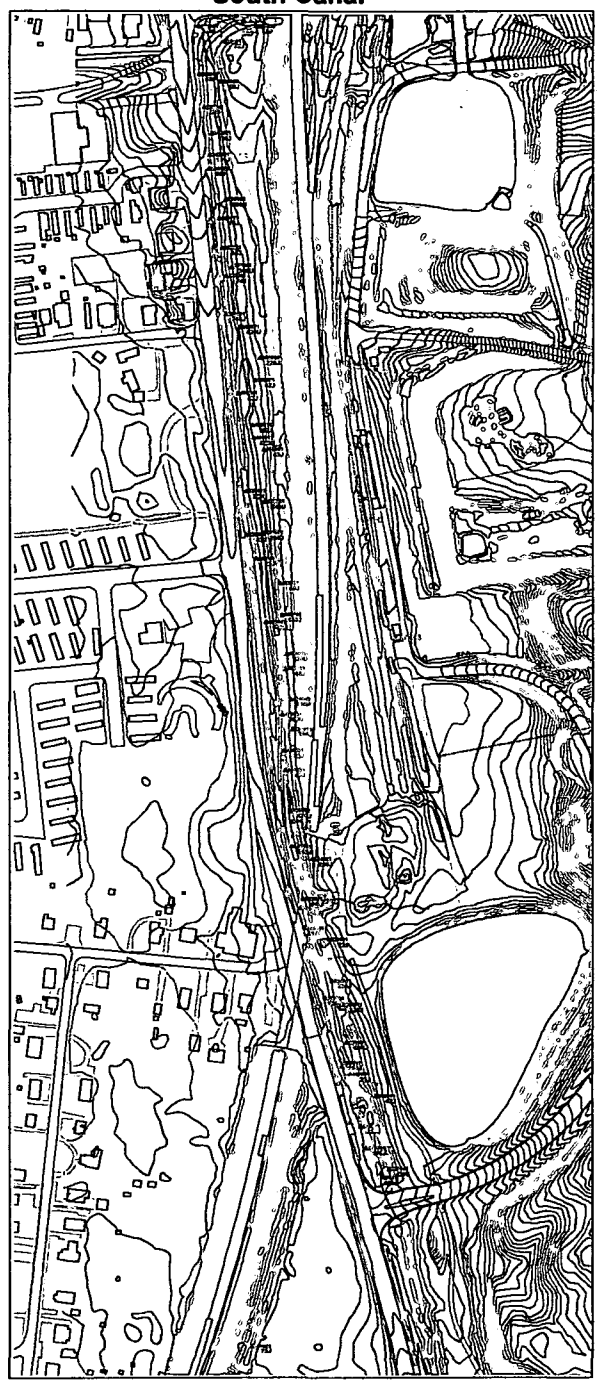
Miami/Erie Canal Verification Project

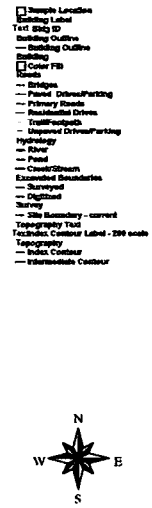
Sample Locations with Benzo(a)pyrene results in ug/kg

North Canal



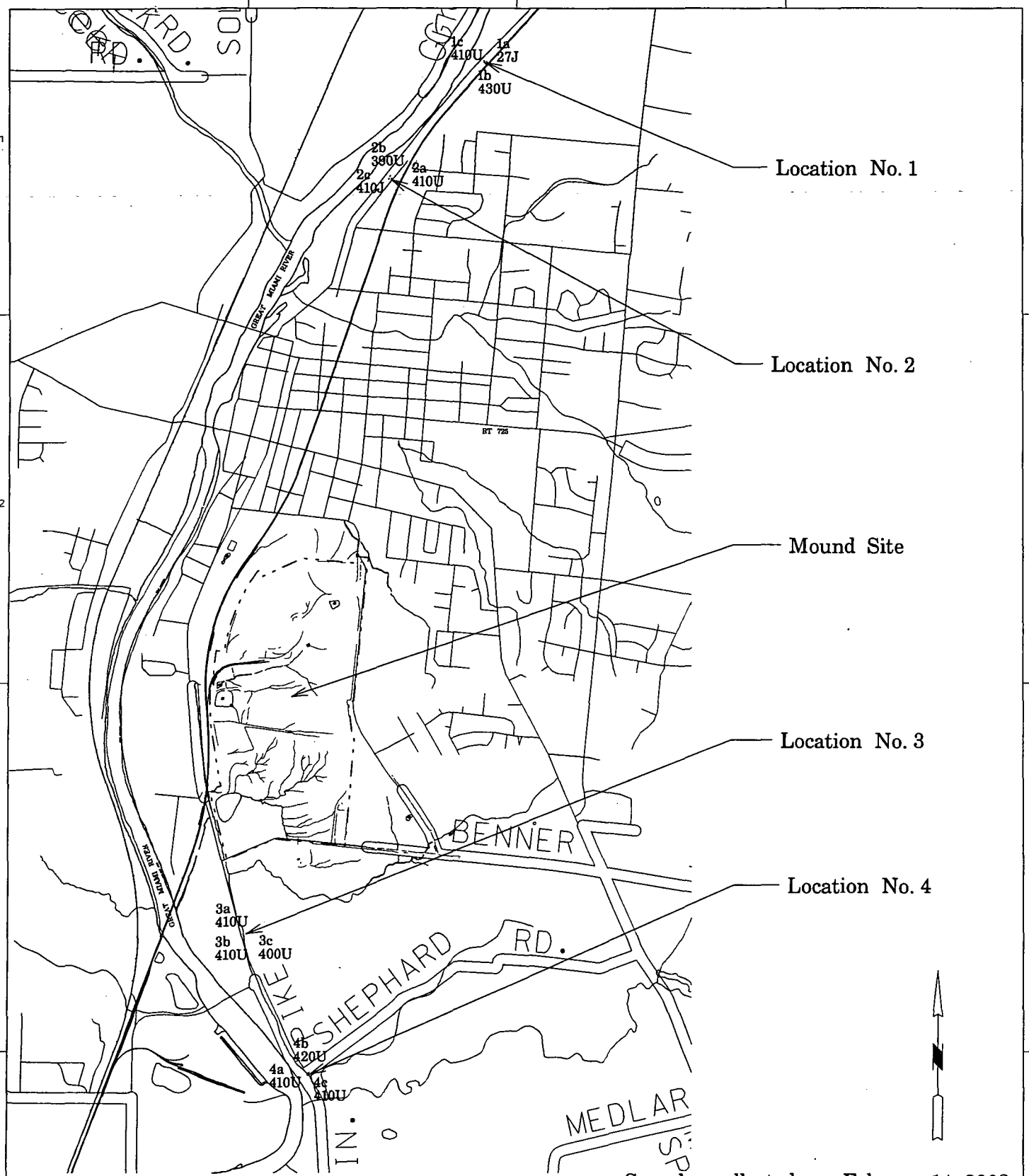
South Canal





MOUND

Environmental Restoration Geographic Information System



Samples collected on Febuary 14, 2002

GRAPHIC SCALE

1000 500 0 1000 2000FT 3000 4000FT

MOUND

Environmental Restoration Geographic Information System

SHEET	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ISSUE																					

SHEET	1	2	3	4	5	6
ISSUE	A					

PART CLASSIFICATION

FIGURE 8
OFF-SITE
PAH SAMPLE LOCATIONS
AND DbA RESULTS

DRAWING CLASSIFICATION: UNCLASSIFIED | SIZE | DRAWING NUMBER: offsite_samples.dgn | JOB NUMBER: *

DWG TYPE: STE | PRMG: ER-GIS | CADEC | SCALE: GRAPHIC | SHEET 1 OF *

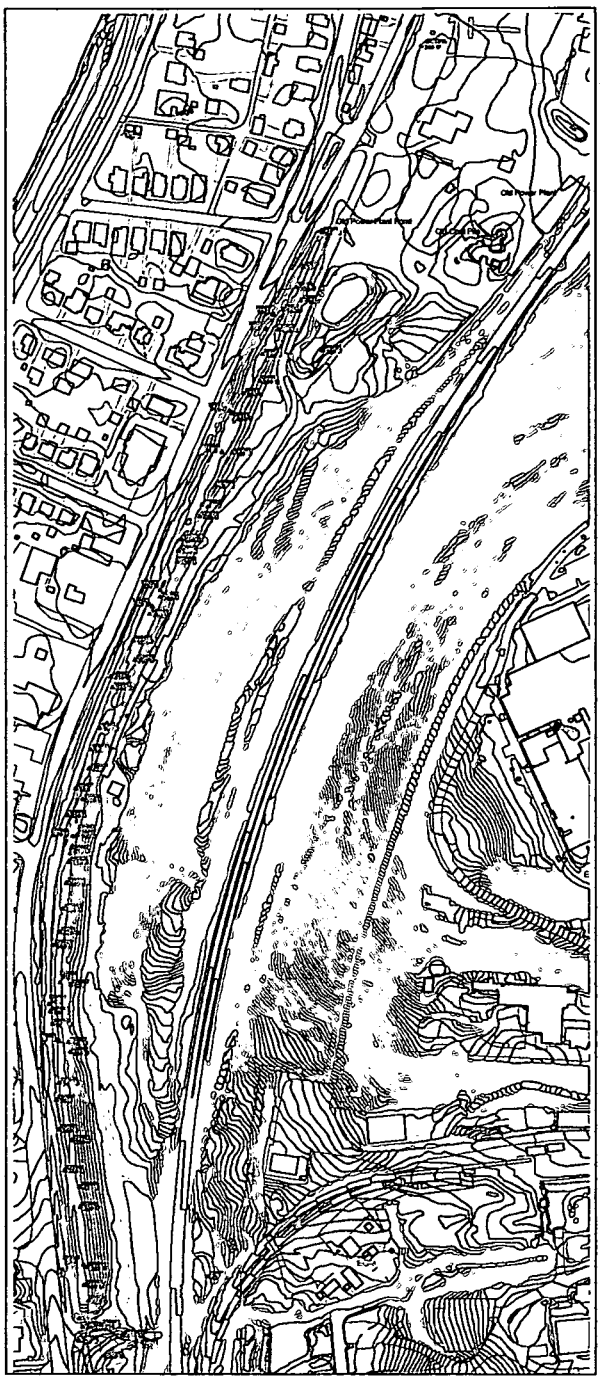
STATUS: MD-REL-03/06/02 | ORIGIN: MSTATION / J

ISS	DATE	REVISION	BY	CHKR	ENG	LPMEC	APVD	M
	10/09/02	ISSUE FOR DATA REPORT	SSP					

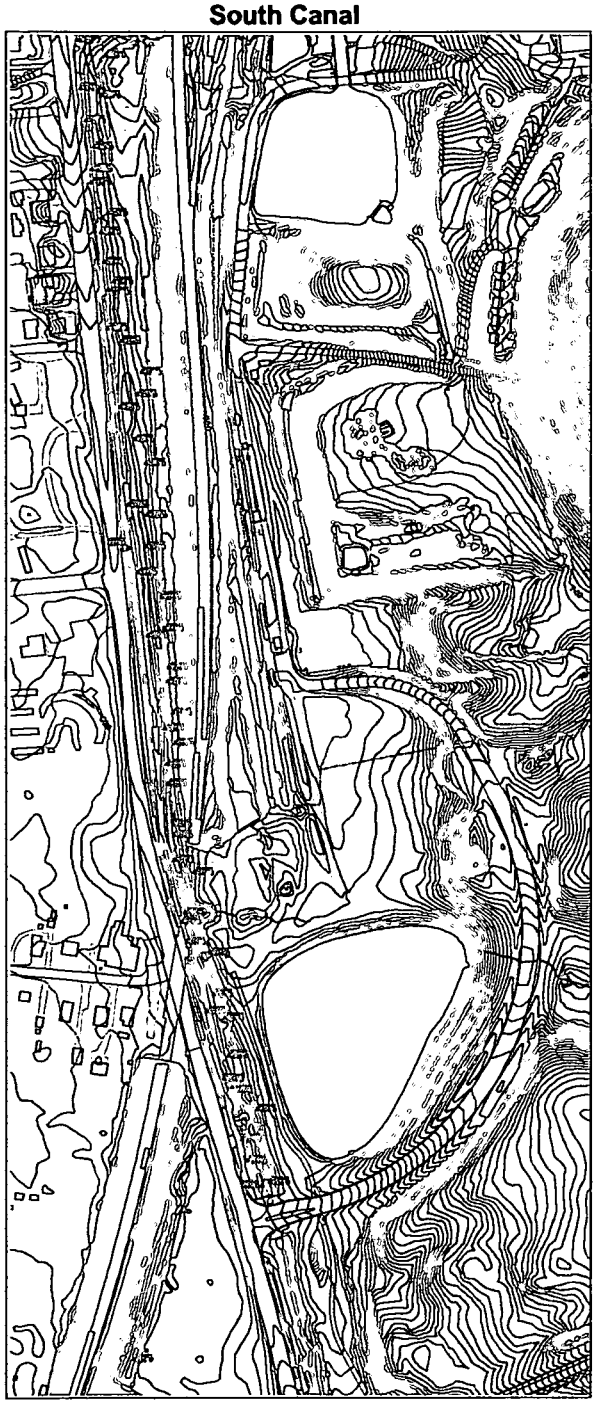
Miami/Erie Canal Verification Project

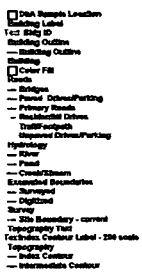
Sample Locations with Dibenz(a,h)anthracene (DbA) results in ug/kg

North Canal



South Canal





200 0 200 400 600 800 1000 Feet

MOUND

Environmental Restoration Geographic Information System

10/10/02

APPENDIX C

SAMPLE FIELD TRACKING SHEET

APPENDIX D

FIELD LOGBOOK

APPENDIX E

Method A-003

APPENDIX F

CHAIN OF CUSTODY

APPENDIX E

Background Comparison

Appendix E: Background Comparison

Identification of contaminants to be carried through the Residual Risk Evaluation (RRE) calculations is a multi-step process beginning with the identification of all contaminants detected in the area and then eliminating contaminants based upon a set of established screening criteria described in the *Mound 2000 Residual Risk Evaluation Methodology* (RREM) (DOE 1997). One of the screening criteria utilized to identify constituents of potential concern (COPCs) were regulator-approved background levels presented in Appendix A of the RREM guidance (DOE 1997a). The approved background values listed in the RREM are 95% upper tolerance limit (95%UTL) values while the exposure point concentrations used to quantify total risk are the lower of the 95% upper confidence limit (95%UCL) or the maximum detected concentration. The 95%UTLs estimate the high end of the detected range of concentrations while 95%UCLs estimate a bounding concentration based on the central tendency of the distribution. This difference could pose a problem for the screening of COPCs and for the characterization of background risk. To characterize the magnitude of the difference, a comparison of the 95%UTLs and the 95%UCLs for analytes in the background data set was conducted. The attached table (Table 1) presents the results of the 95%UTL/95%UCL comparison for background.

The approved background values for Mound were first published in *OU9, Background Soils Investigation: Soil Chemistry Report* which was completed in September 1994. (DOE 1994). Given the time elapsed since the background values were first presented, summary statistics were calculated for the current background data set to verify that the correct data set had been retrieved from the Mound Environmental Information Management System (MEIMS). Summary statistics included:

- Minimum detected value
- Maximum detected value

- Median
- Mean (normal and log normal)
- Standard deviation
- Coefficient of variation
- Frequency of detection
- Distribution

Summary statistics were initially run using half the detection limit as a surrogate value for non-detected results. With this substitution summary statistics for analytes with a high proportion of non-detected values did not match for a number of summary statistics. Summary statistics were then run substituting half the reported value as a surrogate value for non-detected results. With this substitution the first six summary statistics listed above matched, indicating that the background data set was the same data set as was used in 1994 and that half the reported value was used as a surrogate value for non-detected results. Frequency of detection matched for all but two of the analytes. One additional detected value was found for vanadium and U235/236.

The background data set for each analyte was then evaluated and assigned a distribution. Distribution assignments are an important aspect of sample set characterization needed to make statistical inferences about the population. Distribution assignments are provided in the 3rd and 4th column of Table 1. Data set distributions included normal, log normal, and distribution free or non-parametric.

In the original OU9 report the d'Agostino's test was used to determine the distribution for data sets with 50 or more observations. The d'Agostino test is not available in the Statistical Analysis System (SAS) program used for the background comparison. The recent work used the Shapiro-Wilk test to determine data set distributions. Using the Shapiro-Wilk test for distribution assignment, 25 of the 41 background analytes matched previous distribution assignments and 16 did not match. In addition to differences in the

tests used to make distribution assignments, substitution of half the reported value as opposed to half the detection limit for non-detected data may have impacted the data set distribution assignments.

For each of the background analytes the 95%UTL was calculated using the formulas supplied in Appendix K of *OU9, Background Soils Investigation: Soil Chemistry Report* (DOE 1994). When the new distribution assignment was different than the old distribution assignment, 95%UTLs were calculated using both the old and new distribution assignment. Table 1 includes the background values reported in the 1994 report and 95%UTLs calculated using both old and new distribution assignments. When the new distribution assignment differed, even though the same data set was used to calculate background statistics, the OU9 95%UTL values could not be exactly replicated. Factors that may contribute to variance in the 95%UTL values include:

- For analytes with a nonparametric distribution the OU9 report substituted the median value for the mean in the standard UTL equation, current methods use an order-based statistic for 95%UTL calculations.
- Differences due to rounding and the number of decimal places carried through statistical calculations.
- OU9 background values included 95%UTLs calculated with as few as 4 detected values out of 96 analyses. Current methods default to a maximum detected value for sample sets with a frequency of detection less than 50%.
- Outlier testing was not done.
- Additional adjustments may have been used that were not enumerated in Appendix K of *OU9, Background Soils Investigation: Soil Chemistry Report* (DOE 1994).

Although the 95%UTL values published in the RREM could not be duplicated exactly, when the 95%UTLs were compared to the 95%UCLs, for all analytes, this ratio was less than an order of magnitude. Generally, the variance between the 95%UTL and the

95%UCL is greater when the frequency of detection is low. The ratio of the OU9 background values to the 95%UCLs are presented in Table 1. When the ratio equals one there is essentially no difference between the two values. The average ratio was 2.1 indicating that on average the 95%UTL is 2.1 times the 95%UCL. Since the difference between the OU9 background values (95% UTLs) and the 95%UCLs is less an order of magnitude, utilizing the OU9 background values to characterize background risk will have a small impact on risk calculations. The uncertainty associated with this technique is described in Section 2.4.1 of the Miami-Erie Canal RRE report.

Statistically comparing UTLs to UCLs on a chemical-by-chemical basis isn't possible since this would be a straight comparison of two point estimates. One method to assess whether one statistic is giving higher or lower estimates than the other is a Paired Difference test. A Paired Difference test entails taking the difference between the UTL and UCL for each chemical, to examine the overall difference, or the average difference for all chemicals. If there is a strong unidirectional trend the average difference will be either strongly positive or negative.

Appendix E, Table 1 includes a Paired Difference Test which shows the arithmetic difference between the background value (95% UTL) and the calculated 95% UCL. The results of this comparison are dominated by a single analyte. More than 83% of the total difference is from calcium. Since the Paired Difference test does not correct for the magnitude of each analyte concentration this statistical evaluation is of limited value.

Therefore, a Sign Test was also run. The Paired Difference Test showed that for all but two of the analytes the background (95% UTL) is greater than the 95% UCL and the average ratio of the 95% UTL to the 95% UCL is 2.1. The last 3 columns of Table 1 present the results of the Sign Test. For the Sign Test the 95%UCL values were multiplied by 2.1 or the average ratio of UTL to UCL and then subtracted from the 95%UTLs. The test statistic (z) was then compared to a standard normal distribution to

determine the significance. The calculated z was 1.4 which is less than the critical value of 1.96, so the two sets of data are not significantly different at the 95% confidence level. Since the difference between the OU9 background values (95%UTLs) and the 95%UCLs is less an order of magnitude, utilizing the OU9 background values to characterize background risk will have a small impact on risk calculations.

To date, the principle constituents requiring cleanup at the Mound Closure Project include plutonium-238 (Pu-238), thorium-232 (Th-232), thorium-230 (Th-230), radium-226 (Ra-226), uranium-238 (U-238), and cesium-137 (Cs-137). Of these analytes, Pu-238 has the highest 95%UTL/95%UCL ratio at 2.7. This difference is not likely to have a large impact on the RRE process for Pu-238.

References

Department of Energy, 1994. OU9, Background Soils Investigation: Soil Chemistry Report ER Program, Mound Plant, Revision 2. September 1994.

Department of Energy, 1997. Mound 2000 Residual Risk Evaluation Methodology, Final Revision 0, January 6, 1997.

Table 1. Summary Statistics for Comparison of Mound OU9 Background Values and the 95%UCL of the Same Data Set.

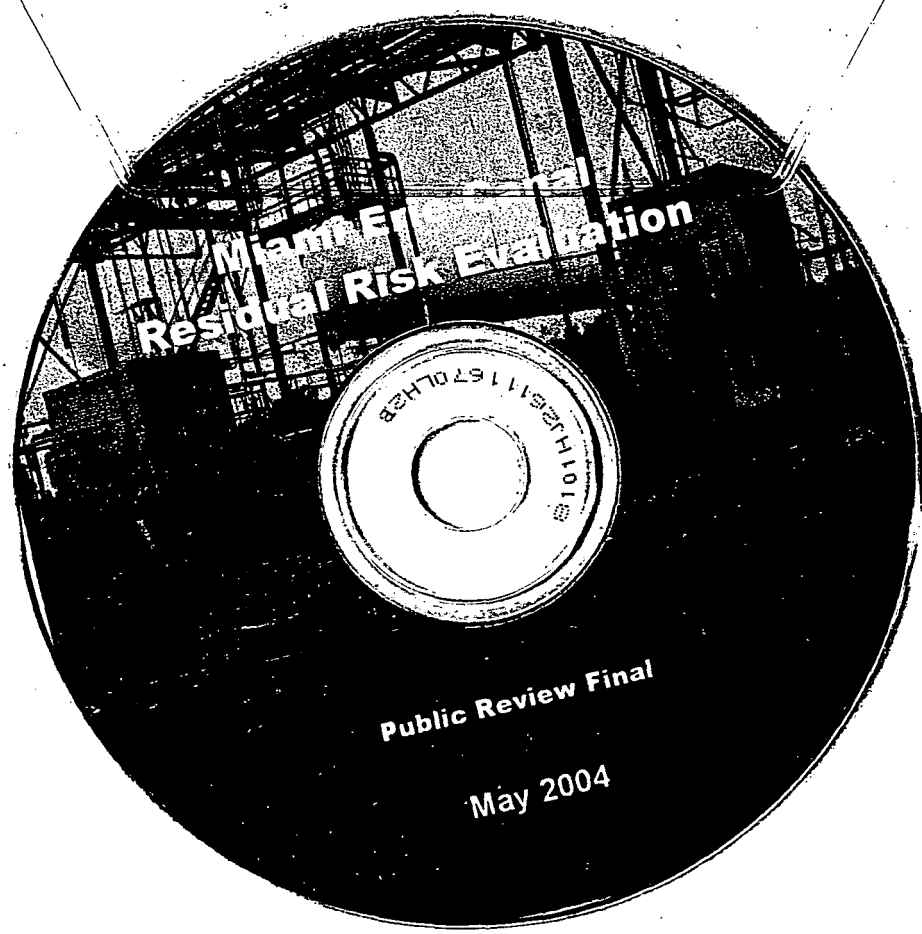
Analyte (units)	CAS Number	New Distribution	Old Distribution	Results >Detection Limit	Minimum Detect	Maximum Detect	New 95% UCL	95%UTL with New Distributions	95% UTL with Old Distributions	Mound OU9 Background	Ratio of OU9 Background to 95%UCL	Paired Difference Test*	Sign Test
Aluminum (mg/kg)	7429-90-5	X	X	96/ 96	466.00	70800.00	11300.00	24100.00	24100.00	19000.00	1.7	7700.00	4730
Arsenic (mg/kg)	7440-38-2	N	N	96/ 96	1.40	11.10	5.73	8.48	8.48	8.60	1.5	2.87	3.433
Barium (mg/kg)	7440-39-3	L	L	96/ 96	30.00	251.00	95.00	185.00	185.00	180.00	1.9	85.00	19.5
Beryllium (mg/kg)	7440-41-7	L	L	87/ 96	0.29	2.40	0.81	1.60	1.60	1.30	1.6	0.49	0.401
Cadmium (mg/kg)	7440-43-9	D	X	25/ 96	0.45	3.20	0.45	3.20	1.15	2.10	4.6	1.65	-1.1466
Calcium (mg/kg)	7440-70-2	X	L	96/ 96	929.00	259000.00	87200.00	120000.00	312000.00	310000.00	3.6	222800.00	-126880
Chromium (mg/kg)	7440-47-3	L	N	96/ 96	4.60	32.00	14.00	24.80	21.00	20.00	1.4	6.00	9.4
Cobalt (mg/kg)	7440-48-4	X	N	85/ 96	5.40	28.60	11.80	19.80	18.60	19.00	1.6	7.20	5.78
Copper (mg/kg)	7440-50-8	X	X	95/ 96	8.70	42.90	17.20	24.90	24.90	26.00	1.5	8.80	10.12
Iron (mg/kg)	7439-89-6	X	N	96/ 96	11400.00	52800.00	23400.00	36100.00	35700.00	35000.00	1.5	11600.00	14140
Lead (mg/kg)	7439-92-1	L	L	95/ 95	6.80	84.60	22.60	48.40	48.40	48.00	2.1	25.40	-0.54
Lithium (mg/kg)	7439-93-2	D	L	38/ 96	4.20	27.70	10.50	27.70	25.80	26.00	2.5	15.50	-3.95
Magnesium (mg/kg)	7439-95-4	X	L	96/ 96	1110.00	56100.00	18400.00	33700.00	62000.00	40000.00	2.2	21600.00	-1360
Manganese (mg/kg)	7439-96-5	L	L	96/ 96	228.00	1740.00	716.00	1380.00	1380.00	1400.00	2.0	684.00	103.6
Molybdenum (mg/kg)	7439-98-7	X	N	71/ 96	11.10	31.00	22.20	30.90	25.70	27.00	1.2	4.80	19.62
Nickel (mg/kg)	7440-02-0	X	X	95/ 96	6.90	50.20	21.00	32.30	32.30	32.00	1.5	11.00	12.1
Potassium (mg/kg)	7440-09-7	X	X	72/ 96	133.00	2440.00	991.00	1550.00	1550.00	1900.00	1.9	909.00	181.1
Silver (mg/kg)	7440-22-4	D	X	10/ 96	1.30	5.10	0.72	5.10	1.60	1.70	2.4	0.98	-0.1901
Sodium (mg/kg)	7440-23-5	L	L	56/ 96	34.70	401.00	99.60	238.00	238.00	240.00	2.4	140.40	-30.84
Thallium (mg/kg)	7440-28-0	D	X	13/ 96	0.22	0.47	0.16	0.47	0.27	0.46	2.9	0.30	-0.1261
Tin (mg/kg)	7440-31-5	D	X	33/ 96	4.20	22.50	5.99	22.50	12.30	20.00	3.3	14.01	-7.421
Vanadium (mg/kg)	7440-62-2	N	N	95/ 96	7.30	31.10	17.80	25.20	25.20	25.00	1.4	7.20	12.38
Zinc (mg/kg)	7440-66-6	X	X	80/ 96	30.70	738.00	71.20	220.00	220.00	140.00	2.0	68.80	9.52
4,4'-DDD (UG/KG)	72-54-8	D	X	4/ 96	2.60	21.00	2.14	21.00	21.00	4.20	2.0	2.06	0.294
4,4'-DDE (UG/KG)	72-55-9	D	X	5/ 96	2.30	39.00	2.29	39.00	39.00	4.30	1.9	2.01	0.509
4,4'-DDT (UG/KG)	50-29-3	D	X	10/ 96	1.90	920.00	3.56	920.00	183.00	13.00	3.7	9.44	-5.524
Aroclor-1254 (UG/KG)	11097-69-1	D	X	4/ 96	24.00	65.00	21.60	65.00	39.40	58.00	2.7	36.40	-12.64
Methoxychlor (UG/KG)	72-43-5	D	X	7/ 96	10.00	50.00	11.00	50.00	21.00	30.00	2.7	19.00	-6.9
Cesium-137 (PCI/G)	10045-97-3	X	N	60/ 96	0.09	0.74	0.30	0.53	0.49	0.42	1.4	0.12	0.21
Plutonium-238 (PCI/G)	13981-16-3	D	L	31/ 96	0.03	0.25	0.05	0.25	0.13	0.13	2.7	0.08	-0.0292
Plutonium-239/240 (PCI	PU-239/240	D	L	44/ 96	0.03	0.32	0.07	0.32	0.18	0.18	2.7	0.11	-0.0393
Potassium-40 (PCI/G)	13966-00-2	X	N	96/ 96	10.90	37.90	22.40	32.20	33.40	37.00	1.7	14.60	10.04
Radium-226 (PCI/G)	13982-63-3	X	X	96/ 96	0.20	2.95	1.24	1.82	1.82	2.00	1.6	0.76	0.604
Strontium-90 (PCI/G)	10098-97-2	D	X	32/ 96	0.30	21.90	0.36	21.90	4.45	0.72	2.0	0.36	0.0276
Thorium-228 (PCI/G)	14274-82-9	X	N	95/ 96	0.45	2.13	1.05	1.56	1.48	1.50	1.4	0.45	0.705
Thorium-230 (PCI/G)	14269-63-7	X	X	95/ 96	0.71	5.14	1.91	2.85	2.85	1.90	1.0	-0.01	2.111
Thorium-232 (PCI/G)	7440-29-1	N	N	95/ 96	0.40	1.69	1.05	1.43	1.43	1.40	1.3	0.35	0.805
Tritium (PCI/G)	10028-17-8	X	L	61/ 96	0.02	8.28	0.44	1.84	1.60	1.60	3.6	1.16	-0.6739
Uranium-234 (PCI/G)	13966-29-5	L	N	96/ 96	0.54	1.16	0.85	1.15	1.10	1.10	1.3	0.25	0.6829
Uranium-235/236 (PCI/G	U-235/236	D	L	35/ 96	0.03	0.12	0.05	0.12	0.11	0.11	2.2	0.06	-0.00647
Uranium-238 (PCI/G)	7440-61-1	L	N	96/ 96	0.53	1.29	1.20	1.20	1.3	1.2	1.0	0.00	1.330085
										Average Ratio	2.1	265780.60	
												6482.45	
													z= 1.405564

N = normal
L = log normal
X = nonparametric
D = greater than 50% nondetect, assumed to be nonparametric.
* Difference between OU9 Background and 95%UCL.

APPENDIX A

Miami-Erie Canal Database

(Provided on CD)


Residual Risk Evaluation
Public Review Final
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