7804-000509005

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ESC-055/00
April 26, 2000

00-TC/04-26

Mr. Richard B. Provencher, Director
Miamisburg Environmental Management Project
U.S. Department of Energy
P.O. Box 66
Miamisburg, OH 45343-0066

MIAMISBURG EMMP
LOG 001369
APR 26 3 15 PM '00

ATTENTION: Dewain Eckman

SUBJECT: Contract No. DE-AC24-97OH20044
RESIDUAL RISK EVALUATION FOR MIAMI-ERIE CANAL

REFERENCE: Statement of Work Requirement C 7.1e -- Regulator Data Requests

Dear Mr. Provencher:

BWXT of Ohio is pleased to submit a preview copy of the Public Review Draft of the Residual Risk Evaluation Report in support of the completion of the Miami-Erie Canal Removal Action. Release of this document to USEPA, OEPA, and ODH was authorized by Paul Lucas of DOE/MEMP.

The draft version of this document was submitted to the regulators on February 29, 2000. Comments were received from USEPA in two teleconferences. Written comments (dated March 29, 2000) were received from OEPA and discussed in a teleconference on April 6, 2000. A responsiveness summary for the OEPA comments is also included in this transmittal. The Public Review Draft of the document incorporates changes in response to comments received from USEPA and OEPA. The primary change is the inclusion of a construction worker scenario.

If you or members of your staff have any questions regarding the document, or if additional support is needed, please contact Dave Rakel at extension 4203.

Sincerely,

JSStapleton

Jeffrey S. Stapleton
Manager, Environmental Safeguards & Compliance

JSS/DAR:jdg

Enclosures as stated

cc: Tim Fischer, USEPA, (1) w/attachments
Dave Meredith, TechLaw, Inc., (1) w/attachments
Brian Nickel, OEPA, (2) w/attachments
Ruth Vandegrift, ODH, (1) w/attachments
Art Kleinrath, MEMP, (1) w/attachments
Paul Lucas, MEMP, (1) w/attachments
John Price, BWXT of Ohio, (2) w/attachments
DCC

4

Residual Risk Evaluation
OU-4 Miami-Erie Canal Area
US DOE Mound Plant
Draft, February 22, 2000
Ohio EPA
March 29, 2000

General Comments

1. The Executive Summary makes very broad statements that are not particularly accurate and which may change before finalizing the document, e.g., specific comment #22 below. It is strongly suggested this summary be written after comments are accepted and the document is edited. As currently written, there are specific problems. See comments 1 through 3 under Specific Comments.

Response:

The Executive Summary will be revised once comments are resolved with all the Core Team members.

2. Ohio EPA is also evaluating ARARS for the canal and there is a potential that more stringent risk criteria may be Relevant and Appropriate.

Response:

The Mound 2000 RREM (DOE 1997) does not address screening COPCs against ARARs, only against background and Mound Screening Guidance Values. This method is consistent with the CERCLA process in which screening against ARARs is done during remedy selection, not during the risk assessment.

Specific Comments

3. Executive Summary
First Paragraph, Last Sentence
Please explain briefly, and add to text, the rationale for calculating the total, background and incremental risk for only recreational and residential. This should only require one or two sentences.

Response:

Additional text will be added to the executive summary to explain the selection of receptors for the RRE. The most likely and most conservative scenarios for the canal property are believed to be current/future recreational use and potential future residential use. Residual risks to these receptors were evaluated separately for adult and child exposures. These scenarios included potential exposure to surface and subsurface soil, via incidental ingestion, dermal contact, inhalation of dust and VOCs and external radiation exposure.

4. Executive Summary
Second Paragraph, Fourth Sentence
This sentence is incorrect.

Response:

Total non-radiological cancer risk for the residential adult was $1.6x10^{-4}$. Of this risk, $1.2x10^{-4}$ or 75% was due to dermal exposure to benzo(a)pyrene. Dermal exposure to dibenzo(a,h) anthracene contributed $1.9x10^{-5}$ or an additional 12% of the total cancer risk. Incremental non-radiological cancer risk was $1.5x10^{-4}$. Of this risk, $1.2x10^{-4}$ or 80% was due to dermal exposure to benzo(a)pyrene. Dermal exposure to dibenzo(a,h) anthracene contributed $1.9x10^{-5}$, or an additional 13% of the total cancer risk.

Total and incremental residual cancer risks for a hypothetical adult resident exposed to radionuclides in the canal area were $1.5x10^{-4}$ and $5.6x10^{-5}$, respectively. For total residual cancer risk due to radiological contaminants, nearly 100% of the risk is due to external exposure to radium-226. For incremental residual cancer risk due to radiological contaminants, 90% of the risk is due to external exposure to radium-226. The 4th sentence of the executive summary will be revised to exclude plutonium-238.

5. Executive Summary
Third Paragraph
The three sentences in this paragraph is too broad. What other sources and are they truly comparable with Mound? PAHs are ubiquitous in some geographic locations, but such a statement cannot apply in all situations and there is nothing presented in this document to support this claim for the canal. Radium-226 is a naturally occurring radioisotope, but even DOE's own databank indicates more occurrences of Ra-226 on-site and adjacent to the site in comparison to the occurrence of same further from the facility. The text of this document does not contain information or references to support these assertions. Please delete the paragraph.

Response:

PAHs are ubiquitous in many environments, particularly along railroad right-of-ways, such as the one running through the canal area. The third sentence regarding shielding from external radiation does not suggest that Ra-226 is not site related, but that the shielding factor used to calculate residual risk was very conservative. Support for this assertion is provided in Section 6.2 of the RRE. The paragraph will be revised in consideration of Ohio EPA's comment.

6. Section 1.2, Page 2 of 29
First paragraph, Third Sentence
Please add a comma between the words recreation and residual.

Response:

A comma will be added at the appropriate location.

7. Section 1.2, Page 2 of 29
First Paragraph, Fourth Sentence
What existing land use restrictions are referred to in this sentence? It is the impression of Ohio EPA that there are no current restrictions on the property (other than needed due to the remedial action effort).

Response:

The land use restrictions referred to in the sentence are highway right-of-way, highway set backs, utility easements. These restrictions limit the amount of the land in the vicinity of the canal that could be developed as residential property. Although the amount of developable land is small, the possibility of residential future use was assessed in the RRE.

8. Section 2.0, Page 3 of 29
Data Compilation and Evaluation – include a table that summarizes the results of confirmatory sampling that was performed after the remedial action was completed. In addition, include a table that summarizes the data points used to develop the exposure point concentrations for each pathway. These additions would enhance the end user/reader understanding of the data and any residual risk, as well as allowing the reader to draw their conclusions based on the review of the data.

Response:

A hard copy of the data will be provided as an appendix to the RRE. A key will be provided with the data to allow the reader to distinguish the various sampling events.

9. Section 2.2, Page 3 of 29
Second Paragraph
Exposure to groundwater can occur via routes other than drinking water. Under a future use scenario, it is reasonable to assume that construction activity could occur on this property. During Excavation activities, utilities installation or repair, and construction of new homes with basements, there is potential for exposure to groundwater via dermal contact, incidental ingestion and inhalation of volatiles. Including this pathway or provide justification for excluding it.

Response:

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 14th, 1999 with Ohio EPA, USEPA, DOE, BWXT and SAIC. Groundwater as a media was discussed, and a determination was made not to include groundwater since water at the canal area would 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 Mound production wells. 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.

10. Section 2.2, Page 5 of 29
Third Paragraph
The word "current" needs to be added to the sentence... it was assumed that residential and recreational receptors would currently drink municipally supplied water and not obtain BVA ground water directly.

Section 2.2, Page 5 of 29
Third Paragraph
Add the sentence "Risk from ground water will also assess at later date prior to completing the final Record of Decision."

Response:

The Miami-Erie Canal RRE assumes that exposure to groundwater is currently an incomplete exposure pathway. As discussed in the December 14th, 1999 meeting, it was assumed that municipally supplied water would be made available in the canal area for all future development, therefore, future exposure to BVA groundwater was also assumed to be an incomplete exposure pathway. A sentence regarding future assessment of site-wide groundwater will be added to this paragraph.

11. Section 2.3, Page 6 of 29
Full Paragraph. Fifth Sentence
Either explain why or provide the reference that supports the use of the maximum detection being used as the exposure point concentration when n<20.

Response:

The decision to use maximum detection as the EPC when n<20 was based on direction received at the December 14th 1999 meeting. The decision was founded on precedence established in the Release Block D and H RRE reports. UCLs can be calculated for data sets with as few as three samples, however, for statistical reliability many states require that n be equal to or greater than 10. In Ohio EPA's "How Clean is Clean Policy" (Ohio EPA 1991), a policy which was since been rescinded, Ohio EPA proposed that seven (7) samples be collected for the determination of background concentrations using the 95% UCL. The statistical package used to calculate exposure point concentrations (EPCs) for the Canal RRE can be modified to calculate the 95%UCL for n<20. This modification will result in the calculation of EPCs which are more representative of the site data. It is therefore, recommended that this issue be revisited by the Core Team members.

12. Section 2.4, Page 7 of 29
Second Sentence
Insert the word of between list and the.

Response:

Change will be made.

13. Section 2.4.1, Page 7 of 29
Screening constituents Based on Background
Include a table identifying site-specific background concentrations for each constituent in soil.

Response:

Table 2.1, 2.2, and 2.3 which identify COPCs for recreational, residential and off site construction worker receptors include site-specific background values. These values were drawn from the Mound 2000 RREM.

14. Section 2.4.3, Page 8 of 29, 2nd Paragraph
The last sentence states that "compounds unrelated to historical operations conducted within a release block were eliminated from further consideration by the RRE." Were any compounds screened out because they were unrelated to Mound activity? If so, we need to make sure that there is sufficient evidence to make this conclusion. If any compounds were eliminated based on this criteria please identify them and provide the evidence.

Response:

No compounds were eliminated from the RRE on the basis that they were not related to Mound activity. If compounds had been eliminated on this basis, evidence supporting their exclusion would have been provided.

15. Section 3.1, Page 10 of 29
Second Paragraph, Fourth Sentence
Change Overflow Hollow to Overflow Creek or Overflow Hollow to Runoff Hollow. The rainstorm washed contaminations to both so it is appropriate to list both the Overflow Creek and Runoff Hollow.

Response:

Overflow Hollow will be changed to Overflow Creek.

16. Section 3.2, Page 11 of 29
Identifying Exposure Pathways
The first sentence states that "Although many exposure pathways are possible, this RRE focuses only on the likely pathways within expected recreational land use." The use of this property for recreational purposes may involve the construction of bike paths, maintenance of hiking trails, installation of swimming pools, in addition to overall upkeep of the park grounds. Therefore, it is reasonable to assume that construction activities may occur on this site, as well as maintenance activities, including but not limited to landscaping and groundskeeper duties. In order to assess the need for land use restriction, include the park maintenance worker and the construction worker as receptors

in the RRE. These receptors could potentially be exposed to surface and subsurface soil through activities likely to occur at this site. This is especially important since a canal area does not meet 1x10-4 residential risk. Therefore it cannot be assumed to meet risk criteria for the construction scenario. Including these receptors would present the risk managers with a range of risks based on various receptor scenarios. This would help identify a range of activities that fall within the acceptable risk limits and help the risk manager focus management efforts only on those activities that present unacceptable risk.

Response:

The first sentence states, "Although many exposure pathways are possible, the RRE focuses only on those pathways that are likely to occur and are likely to contribute significantly to the overall risk." At the December 14th meeting it was agreed that the recreational user and the hypothetical future resident would meet these criteria. Since the Canal RRE assumed that future residents could be exposed to soil at all depths, with an exposure duration that is likely to be longer than that of either a construction worker or a park maintenance worker, we believe this scenario to be protective. However, additional RRE calculations for a construction worker scenario were performed and are incorporated in the revised text. The exposure assumptions for the "Off-Site Construction Worker" (see Risk Based Guideline Values for Mound, (DOE 1997)) were used for these calculations.

17. Section 3.3, Page 11 of 29
Last Sentence
For accuracy, the last sentence should read "Residential use of the canal area is unlikely, however it was included to determine if land use restrictions were needed.

Response:

Text will be modified.

18. Section 3.4, Page 13 of 29
Exposure Point Concentration
Include a summary table identifying the samples and concentrations used to develop the exposure point concentration for each pathway.

Response:

This information will be provided in an appendix. Due to the size of the data set and to avoid redundancy the data set will be presented in such as way as to provide the information requested in comment 8 as well as the information requested here.

19. Section 3.4, Page 13 of 29
Second Paragraph
For children, it is not appropriate to assume that they will spend most of their time bike riding or hiking. They are very likely to have more contact with the soil while sitting or playing on the ground. Also, Park renovation will very likely bring subsurface soils to the land surface. These assumptions used in the RRE were discussed earlier but with the park modification currently going on, they are not valid.

Response:

The recreational child scenario evaluated exposure to soil 0-2 feet below land surface via incidental ingestion of soil, dermal contact, inhalation of dust and VOCs and external exposure to ionizing radiation. These exposures are likely to occur while sitting or playing on the ground. If the exposure assumptions presented in the RRE are no longer valid, new exposure assumptions will have to be discussed. The reference to bike riding and hiking will be deleted.

Regarding the relocation of subsurface soils to the land surface, most of the data available for the canal area was collected 0-2 feet below land surface. However, since fill material was brought in to the area, these surface soils may now be located an additional 1 to 2 feet below land surface. As stated latter in the paragraph "Given the low number of subsurface samples collected the inclusion of subsurface soil had little to no effect on the EPC for the residential scenario." The inclusion of subsurface samples into the EPC for the recreational user is expected to have similar result and not have a significant impact on the assessment of residual risk for the recreational receptor.

20. Section 4.1, Page 19 of 29
Last Sentence
Change "dived" to divided

Response:

Text will be changed.

21. Section 5.1, Page 20 to 29
Second Paragraph
Risk Characterization Methods – As stated in the text "Background risk is risk resulting from sources other than the Mound-related residual contamination." Define which constituents are included in the background risk assessment. Background should be limited to naturally occurring, inorganic constituents and naturally occurring radionuclides.

Response:

Site-specific background values are provided in the Mound 2000 RREM. The Mound 2000 background values that correspond to the canal COPCs were used as the EPCs to determine background risk. This method is consistent to that used for the Release Blocks D and H RREs.

For the recreational receptor RRE background values were available for copper, lead, thallium, and radium-226. For the residential scenarios background values were available for arsenic, copper, lead, thallium, radium-226, and plutonium-238. The constituents assessed in the background risk assessment are apparent on the background risk tables

(Tables 5.2, 5.5, 5.8, and 5.11). A reference to the site-specific background values provided in the Mound 2000 RREM will be added to the text.

22. Section 5.2, Page 22 of 29
Risk Characterization Results – Report risk from total chemical, risk from total radionuclides and total risk (the sum of total chemical risk and total radionuclides) for each receptor. Do not report risk from total radionuclides only.

Response:

All risk, or the total for chemicals and radionuclides will be reported.

23. Section 5.2, Page 2 of 29
Recreational Adult, Second Sentence
Please clarify this sentence; is the "...incremental non-cancer risk 1..." referring to a hazard index?

Response:

Non-cancer risk is evaluated by the HI value. This sentence will be rewritten for clarity and will state "...incremental non-cancer risk, or HI, is less than 1 indicating that non-cancer risk is at an acceptable level."

24. Section 5.2, Page 23 of 29
Residential Adult, Third Sentence
As stated in text, "total cancer risk" of 1.5 E-04 for the residential adult exceeds the risk range of 1E-04 to 1E-06. Revise this sentence to clarify that this risk level exceeds the risk range and is not within the target risk range.

Response:

Text will state.."total cancer risk of 3.1×10^{-4} for the residential adult exceeds the target cancer risk range of 1×10^{-4} to 1×10^{-6}."

25. Section 5.2, Page 23 of 29
Residential Child, Third Sentence
The risks have not appropriately represented based on Tables 5.1 – 5.12. See comment #22 above.

The risk discussions will be modified to reflect comment # 22 regarding total risk to both chemicals and radionuclides.

26. Section 6.2, Page 25 of 29
1st Paragraph
Remove this paragraph (A major source of uncertainty.....) and the associated appendix. It was agreed within the focus group that we would not take credit for the fill being placed in the area of excavation. Also, due to park renovations the assumption that the fill will remain in place may not be hold true.

Response:

The text and appendix was included to support the assertion that the estimate of residual

risk due to exposure to external radiation is uncertain and is likely to have been estimated on the high side rather than being underestimated. The shielding factor used in the RRE is the same as that used to calculate the Mound guidance values. The RRE does not take credit for the fill but does assert that with the fill in place, residual risk is likely to be lower than what was presented in the RRE.

27. Table 3.1
Exposure Assumptions for Recreational and Residential Use of the Miami-Erie Canal Area:
In general, the child receptor is assumed to ingest a greater amount of soil than the adult receptor. Please change the ingestion rate to 200 mg/day for the recreational child or provide justification supporting the ingestion rate for the recreational child. Currently the ingestion rate is the same as the rate ingested by the recreational adult and residential adult. Also, provide justification for decreasing the inhalation rate from 20 cubic meters/day to 13 cubic meters/day for the residential adult when exposed to soil (surface and subsurface) from 0 – 10 feet.

Response:

The Exposure Assumption Table was incorrect and will be corrected. Risk to a child receptor for both recreational and residential scenarios was calculated with an ingestion rate of 200 mg/day of soil. The soil inhalation rate for an adult used to calculate risk was not decreased, a rate of 20 m^3/day was used for both recreational and residential scenarios.

RESIDUAL RISK EVALUATION
OU-4 MIAMI-ERIE CANAL AREA

PUBLIC REVIEW
DRAFT

Mound Plant
Miamisburg, Ohio

Prepared for:
U.S. Department of Energy

Prepared by:
Science Applications International Corporation
Dublin, Ohio

Managed by:
BWXT of Ohio

April 14, 2000

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TABLE OF CONTENTS

1.0 INTRODUCTION 1
- 1.1 Purpose Of Residual Risk Evaluation 1
- 1.2 Scope of the Miami-Erie Canal RRE 4
- 1.3 Organization of Report 4

2.0 DATA COMPILATION AND EVALUATION 5
- 2.1 Data Quality Assessment 6
- 2.2 Environmental Media Considered and Data Availability 6
- 2.3 Data Analysis 7
- 2.4 Data Screening Process 8
  - 2.4.1 Screening Constituents Based on Background 18
  - 2.4.2 Screening Constituents Based on Guideline Values 18
  - 2.4.3 Screening Constituents Based on Frequency of Detection 19
  - 2.4.4 Screening Constituents Based on Essential Human Nutrients 19
  - 2.4.5 Additional Screening Procedures 20

3.0 EXPOSURE ASSESSMENT 20
- 3.1 Characterization of Exposure Setting 20
- 3.2 Identifying Exposure Pathways 21
- 3.3 Identifying Exposure Scenarios 22
  - 3.3.1 Recreational Adult and Child Scenarios 22
  - 3.3.2 Residential Adult and Child Scenarios 26
  - 3.3.3 Off Site Construction Worker Scenario 27
- 3.4 Exposure Point Concentrations 27
- 3.5 Human Intake Equations And Assumptions 28

4.0 TOXICITY ASSESSMENT 33
- 4.1 Toxicity Values for Evaluating the Dermal Pathway 34
- 4.2 Toxicity Assessment for Lead 34

5.0 RISK CHARACTERIZATION 36
- 5.1 Risk Characterization Methods 36
  - 5.1.1 Quantification of Carcinogenic Risk 36
  - 5.1.2 Quantification of Non-carcinogenic Risk 37
- 5.2 Risk Characterization Results 38

6.0 UNCERTAINTY IN THE RISK ASSESSMENT 63
- 6.1 Uncertainty in Analytical Data 63
- 6.2 Uncertainty in Exposure Assessment 63
- 6.3 Uncertainties Related to Toxicity Information 64
- 6.4 Uncertainties In Risk Characterization 66

7.0 REFERENCES 67

LIST OF TABLES

Table 2.1	Identification of Constituents of Potential Concern for the Recreational RRE of the Miami-Erie Canal Area
Table 2.2	Identification of Constituents of Potential Concern for the Residential RRE of the Miami-Erie Canal Area
Table 2.3	Identification of Constituents of Potential Concern for the Off-Site Construction Worker RRE of the Miami-Erie Canal Area
Table 3.1	Exposure Assumptions for Recreation, Residential and Off-Site Construction Worker Scenarios in the Miami-Erie Canal Area
Table 4.1	Toxicity Values and Chemical-Specific Parameters for Constituents of Potential Concern in the Miami-Erie Canal Area
Table 5.1	Total Residual Risk for a Recreational Adult at the Miami-Erie Canal Area
Table 5.2	Background Risk for a Recreational Adult at the Miami-Erie Canal Area
Table 5.3	Incremental Residual Risk for a Recreational Adult at the Miami-Erie Canal Area
Table 5.4	Total Residual Risk for a Recreational Child at the Miami-Erie Canal Area
Table 5.5	Background Risk for a Recreational Child at the Miami-Erie Canal Area
Table 5.6	Incremental Residual Risk for a Recreational Child at the Miami-Erie Canal Area
Table 5.7	Total Residual Risk for a Residential Adult at the Miami-Erie Canal Area
Table 5.8	Background Risk for a Residential Adult at the Miami-Erie Canal Area
Table 5.9	Incremental Residual Risk for a Residential Adult at the Miami-Erie Canal Area
Table 5.10	Total Residual Risk for a Residential Child at the Miami-Erie Canal Area
Table 5.11	Background Risk for a Residential Child at the Miami-Erie Canal Area
Table 5.12	Incremental Residual Risk for a Residential Child at the Miami-Erie Canal Area
Table 5.13	Total Residual Risk for an Off-Site Construction Worker at the Miami-Erie Canal Area
Table 5.14	Background Risk for an Off-Site Construction Worker at the Miami-Erie Canal Area
Table 5.15	Incremental Residual Risk for an Off-Site Construction Worker at the Miami-Erie Canal Area
Table 5.16	Total Miami-Erie Canal Residual Risk Evaluation Summary Table
Table 5.17	Background Miami-Erie Canal Risk Evaluation Summary Table
Table 5.18	Incremental Miami-Erie Canal Residual Risk Evaluation Summary Table

LIST OF FIGURES

Figure 1.1	Mound Plant Vicinity Map
Figure 1.2	Miami-Erie Canal Area Map
Figure 3.1	Conceptual Site Model for the Miami-Erie Canal RRE

LIST OF APPENDICES

Appendix A	Miami Erie Canal Database (Provided on 3.5 inch disk provided with this report)

ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances Disease Registry
ARAR	Applicable or Relevant and Appropriate
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
GV	Guideline Values
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
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
RAGS	Risk Assessment Guidance for Superfund
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
VOCs	volatile organic compounds

Miami-Erie Canal Human Health Residual Risk Evaluation

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 via incidental ingestion, dermal contact, inhalation of dust and volatile organic compounds and external radiation exposure.

Total, background and incremental non-cancer risks for all receptors in all scenarios were below the target hazard level. This suggests that non-carcinogenic risks are within acceptable levels. Total, background and incremental carcinogenic risks for the recreational scenario (adult and child), the residential child and the adult off site construction worker fell within the acceptable risk range of 10^{-4} to 10^{-6} for both current and future scenarios. Background carcinogenic risks for the hypothetical adult residential scenario were within the acceptable carcinogenic risk range. Total and incremental carcinogenic risk for the hypothetical adult resident slightly exceeded the acceptable risk range of 10^{-4} to 10^{-6}.

Total cancer risk for the residential adult was 3.1×10^{-4}. Of this risk, 1.2×10^{-4} or 39% was due to dermal exposure to benzo(a)pyrene. An additional 1.5×10^{-4} or 48% of this risk is due to external exposure to radium-226. Incremental cancer risk was 2.1×10^{-4}. Of this risk, 1.2×10^{-4} or 60% was due to dermal exposure to benzo(a)pyrene. An additional 5.0×10^{-5} or 24% of this risk is due to external exposure to radium-226.

PAHs are ubiquitous in many environments, particularly along railroad right-of-ways, such as the one running through the canal area. Radium-226 is a naturally occurring radioisotope that is present in background soils.

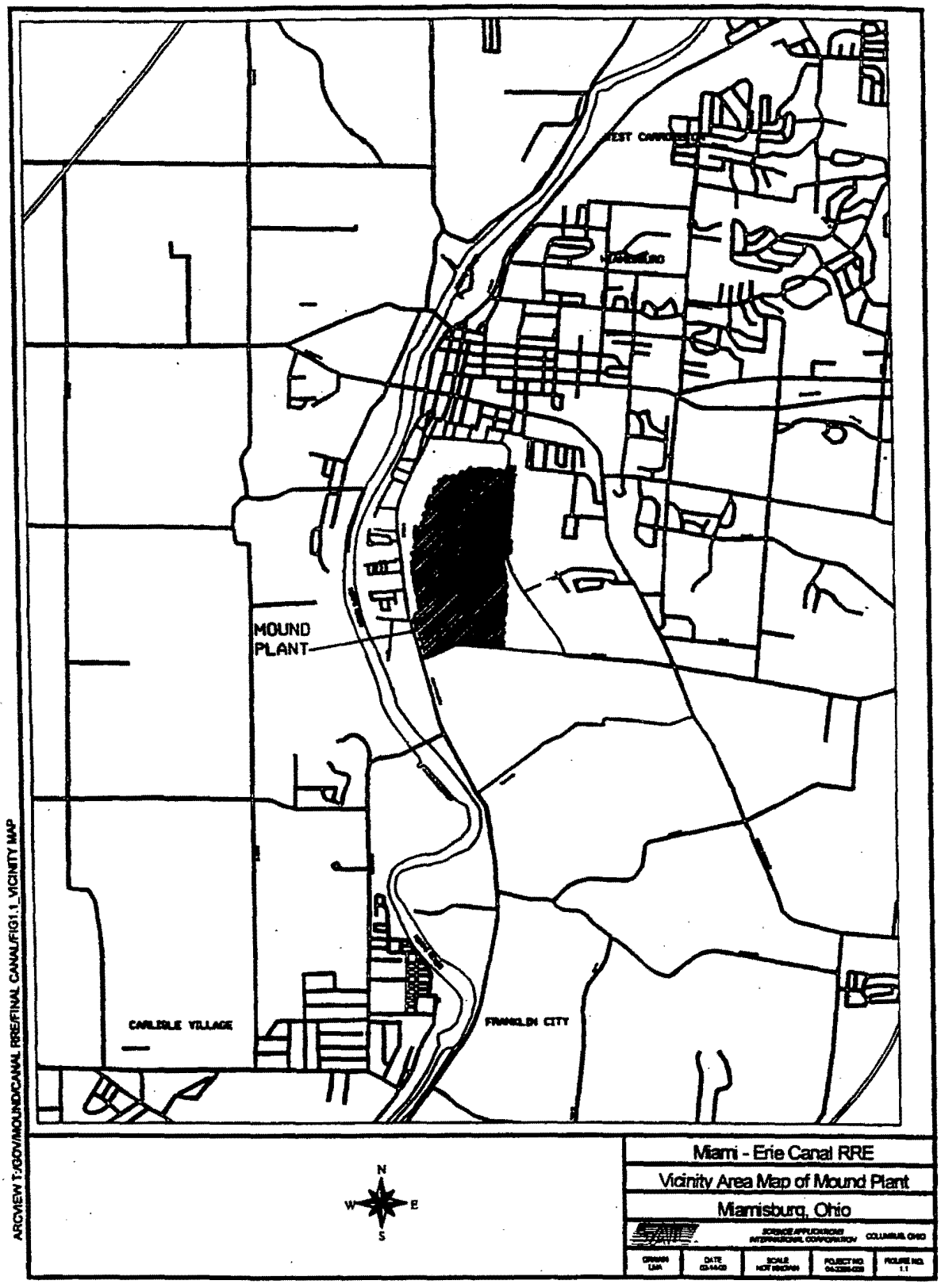
1.0 INTRODUCTION

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 1.1 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 1.2.

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 (OU-4). 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.


MOUND PLANT
CARLISLE VILLAGE
FRANKLIN CITY
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Miami - Erie Canal RRE
Vicinity Area Map of Mound Plant
Miamisburg, Ohio
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
COLUMBUS, OHIO
ARCVIEW T:/GOV/MOUND/CANAL RRE/FINAL CANAL/FIG1.1_VICINITY MAP

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 recreation purposes, residual risks were evaluated for the recreational scenario. Although residential use of the canal area is unlikely, given existing physical constraints, a residential risk calculation was performed to evaluate the need for additional 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).

Residual risks 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:

1. identification of the contaminants to be evaluated,
2. exposure assessment,
3. toxicity assessment,
4. risk characterization,
5. 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.

All available sampling data were 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, OU-4 Miami-Erie Canal Removal Action, Final, June, 1999
Water Park/Tennis Court Sampling Results *Samples obtained in park area as part of previous investigations*	OU-9 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, Unpublished

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.

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 38,000 yds^3 of soil were removed. Only 16 out 15,214 analyses 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. Potential risks due to exposure to BVA groundwater will be assessed prior to completion 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 range of contaminant detection limits, 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 2.1, 2.2 and 2.3 identify the COPCs for the recreational, residential, and off site construction worker scenarios, respectively.

Table 2.1 Identification of Constituents of Potential Concern for the Recreational RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95 Percent UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Semi-Volatile Organic Compounds														
91-57-6	2-Methylnaphthalene	23	J	150	J	UG/KG	97VS1N23	25-128	229.00	150.00				YES
106-44-5	4-Methylphenol	64	J	64	J	UG/KG	97VN6N21	1-128	262.00	64.00		5500000.0	a	NO:1
83-32-9	Acenaphthene	20	J	750	J	UG/KG	97VN5N20	30-128	195.00	195.00				YES
208-96-8	Acenaphthylene	19	J	650	J	UG/KG	97VN4L22	41-128	213.00	213.00				YES
120-12-7	Anthracene	23	J	2300	J	UG/KG	97VN5N20	59-128	254.00	254.00		330000000.0	a	NO:3
56-55-3	Benzo(a)anthracene	21	J	7300		UG/KG	97VN5N20	117-128	654.00	654.00		35000.0	d	NO:3
50-32-8	Benzo(a)pyrene	21	J	7900		UG/KG	97VN5N20	111-128	688.00	688.00		3500.0	d	NO:3
205-99-2	Benzo(b)fluoranthene	23	J	7100		UG/KG	97VN5N20	117-128	681.00	681.00		35000.0	d	NO:3
191-24-2	Benzo(g,h,i)perylene	22	J	4700		UG/KG	97VN5N20	110-128	477.00	477.00				YES
207-08-9	Benzo(k)fluoranthene	22	J	7000		UG/KG	97VN5N20	113-128	669.00	669.00		350000.0	d	NO:3
65-85-0	Benzoic Acid	20	JB	220	J	UG/KG	97VS51L6	37-125	1070.00	220.00		4400000000.0	a	NO:3
117-81-7	Bis(2-ethylhexyl)phthalat	20	JB	44000	D	UG/KG	97VN35L13	68-128	1070.00	1070.00		1800000.0	d	NO:3
85-68-7	Butyl Benzyl Phthalate	20	J	380	J	UG/KG	97VS25N33	11-128	257.00	257.00		220000000.0	a	NO:3
86-74-8	Carbazole	22	J	930	J	UG/KG	97VN5N20	48-128	191.00	191.00				YES
218-01-9	Chrysene	25	J	8100		UG/KG	97VN5N20	120-128	747.00	747.00		3500000.0	d	NO:3
84-74-2	Di-n-butyl Phthalate	22	J	4300		UG/KG	97VS20N23	31-128	368.00	368.00		110000000.0	a	NO:3
53-70-3	Dibenz(a,h)anthracene	20	J	1500	J	UG/KG	97VN21L17	59-128	240.00	240.00		3500.0	d	NO:3
132-64-9	Dibenzofuran	20	J	510	J	UG/KG	97VN5N20	26-128	195.00	195.00				YES
84-66-2	Diethyl Phthalate	44	J	59	J	UG/KG	97VS20N23	2-128	262.00	59.00				NO:1
206-44-0	Fluoranthene	20	J	17000		UG/KG	97VN5N20	122-128	1440.00	1440.00		44000000.0	a	NO:3
86-73-7	Fluorene	20	J	1200	J	UG/KG	97VN5N20	34-128	210.00	210.00				YES
193-39-5	Indeno(1,2,3-cd)pyrene	20	J	4600		UG/KG	97VN21L17	109-128	462.00	462.00		35000.0	d	NO:3
91-20-3	Naphthalene	19	J	140	J	UG/KG	97VS1N23	24-128	229.00	140.00				YES
87-86-5	Pentachlorophenol	30	J	70	J	UG/KG	97VS2N22	2-128	658.00	70.00		210000.0	d	NO:1
85-01-8	Phenanthrene	21	J	13000		UG/KG	97VN5N20	113-128	773.00	773.00				YES
108-95-2	Phenol	21	J	270	J	UG/KG	97VN3L15	16-128	248.00	248.00		660000000.0	a	NO:3
129-00-0	Pyrene	28	J	17000		UG/KG	97VN5N20	121-128	1310.00	1310.00		33000000.0	a	NO:3
Volatile Organic Compounds														
107-06-2	1,2-Dichloroethane	1	J	1	J	UG/KG	CT	1-3	3.92	1.00		63000.0	c	NO:3
75-09-2	Methylene Chloride	2	J	2	J	UG/KG	CT	1-3	3.34	2.00		100000.0	b	NO:3
108-88-3	Toluene	1	J	1	J	UG/KG	CT	1-3	3.92	1.00		220000000.0	b	NO:3

Footnotes on page 3.

Table 2.1 Identification of Constituents of Potential Concern for the Recreational RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Metals														
7429-90-5	Aluminum	3080.00		15300.00		MG/KG	97VN47L14	128-128	9890.00	9890.00	19000			NO:2
7440-36-0	Antimony	0.45	B	81.10		MG/KG	97VN5L2	31-128	2.15	2.15		44.0	a	NO:3
7440-38-2	Arsenic	3.70		27.00	J	MG/KG	97VN35L13	128-128	9.50	9.50	8.6	33.0	a	NO:3
7440-39-3	Barium	24.00	B	234.00		MG/KG	97VRHN1	128-128	88.40	88.40	180	77000.0	b	NO:2,3
7440-41-7	Beryllium	0.17	B	1.10	B	MG/KG	97VN47L14	127-128	0.62	0.62	1.3	6.0	c	NO:2,3
7440-69-9	Bismuth	1.20		63.9		MG/KG	CT	17-128	3.10	3.10				YES
7440-43-9	Cadmium	0.08	B	4.20		MG/KG	97VS31N17	65-128	0.34	0.34	2.1	1100.0	a	NO:2,3
7440-70-2	Calcium	4080.00		144000.00		MG/KG	97VS26N25	128-128	43200.00	43200.00	310000			NO:2,4
7440-47-3	Chromium	4.50		126.00		MG/KG	97VS28N5	128-128	22.40	22.40	20	5500.0	a	NO:3
7440-48-4	Cobalt	3.40	B	15.50		MG/KG	97VN18L12	128-128	9.21	9.21	19			NO:2
7440-50-8	Copper	9.90		141.00		MG/KG	97VS31N17	128-128	34.70	34.70	26			YES
57-12-5	Cyanide	0.36	B	6.80		MG/KG	97VS51L6	6-128	0.30	0.30		22000.0	a	NO:1
7439-89-6	Iron	7040.00		46800.00		MG/KG	97VN35L13	128-128	20500.00	20500.00	35000			NO:2,4
7439-92-1	Lead	5.50		8190.00		MG/KG	97VS43N24	128-128	226.00	226.00	48			YES
7439-95-4	Magnesium	2080.00		83200.00		MG/KG	97VS26N25	128-128	16700.00	16700.00	40000			NO:2,4
7439-96-5	Manganese	213.00		1130.00		MG/KG	97VS41N2	128-128	551.00	551.00	1400	130000.0	b	NO:2,3
7439-97-6	Mercury	0.05	B	1.30		MG/KG	97VS31N17	97-128	0.21	0.21		330.0	b	NO:3
7440-02-0	Nickel	7.50	B	31.80		MG/KG	97VN35L13	128-128	19.30	19.30	32	22000.0	a	NO:2,3
7440-09-7	Potassium	529.00	B	2690.00		MG/KG	97VN27L15	128-128	1600.00	1600.00	1900			NO:2,4
7782-49-2	Selenium	0.51	B	2.20		MG/KG	97VN13L8	62-128	0.91	0.91				YES
7440-22-4	Silver	0.20	B	11.20		MG/KG	97VS19N5	21-128	0.44	0.44	1.7	5500.0	a	NO:2,3
7440-23-5	Sodium	72.50	B	600.00	B	MG/KG	97VS48N4	125-128	180.00	180.00	240			NO:2
7440-28-0	Thallium	0.94	B	3.20		MG/KG	97VS55L3	33-128	0.88	0.88	0.46			YES
7440-62-2	Vanadium	8.40		34.40		MG/KG	97VS1AN13	128-128	22.00	22.00	25	7700.0	a	NO:2,3
7440-66-6	Zinc	28.30		481.00		MG/KG	97VS43N24	128-128	91.00	91.00	140	330000.0	a	NO:2,3

Footnotes on page 3.

Table 2.1 Identification of Constituents of Potential Concern for the Recreational RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95 Percent UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Pesticides/PCBS														
60-57-1	Dieldrin	1.100		1.100		UG/KG	CT	1-3	1.33	1.10		1600.0	c	NO:3
53494-70-5	Endrin Ketone	0.430	J	2.000		UG/KG	CT	3-3	2.47	2.00				YES
5103-74-2	Gamma Chlordane	0.300	J	0.300	J	UG/KG	CT	1-3	0.34	0.30				YES
Radionuclides														
10045-97-3	Cesium-137	0.19		0.19		PCI/G	CT	1-3	0.25	0.19	0.42	0.8	e	NO:2,3
13981-16-3	Plutonium-238	0.01	J	715		PCI/G	97VS34N9	683-702	23.00	23.00	0.13	110.0	e	NO:3
PU-239/240	Plutonium-239/240	0.00		4.17		PCI/G	97VS43N16	412-680	0.10	0.10	0.18	100.0	e	NO:2,3
13966-00-2	Potassium-40	11.10		14.90		PCI/G	CT	3-3	16.00	14.90	37			NO:2
13982-63-3	Radium-226	1.84		3.04		PCI/G	CT	2-3	4.09	3.04	2	0.3	e	YES
10098-97-2	Strontium-90	0.61		7.20		PCI/G	CT	3-3	9.22	7.20	0.72	570.0	e	NO:3
14274-82-9	Thorium-228	0.87		7.67		PCI/G	97VS19N5	126-126	1.27	1.27	1.5	1.7	e	NO:2,3
14269-63-7	Thorium-230	0.87		7.99		PCI/G	97VS8N21	126-126	1.57	1.57	1.9	820.0	e	NO:2,3
7440-29-1	Thorium-232	0.51		2.17		PCI/G	97VS47N29	126-126	1.00	1.00	1.4	950.0	e	NO:2,3
10028-17-8	Tritium	0.05		79.60		PCI/G	97VS19N5	106-124	5.96	5.96	1.6	45000.0	e	NO:3
13966-29-5	Uranium-234	0.62		1.28		PCI/G	97VS17N6	126-126	0.95	0.95	1.1	710.0	e	NO:2,3
15117-96-1	Uranium-235	0.01		0.10		PCI/G	97VN31N17	97-126	0.05	0.50	0.11	6.6	e	NO:3
7440-61-1	Uranium-238	0.64		1.62		PCI/G	97VN35L13	126-126	1.00	1.00	1.2	31.0	e	NO:2,3

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= 10^{-6} cancer risk for ingestion + inhalation
d= 10^{-6} cancer risk for ingestion
e= 10^{-6} cancer risk for ingestion + inhalation + external
"J" = estimated quantitiy
"B" = analyte detected in associated blank

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:4 - Essential Human Nutrient
1.00E-06 is equivalent to 1.00 x 10^{-6}

Table 2.2 Identification of Constituents of Potential Concern for the Residential RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Metals														
7429-90-5	Aluminum	3080.00		15300.00		MG/KG	97VN47L14	128-128	9890.00	9890.00	19000			NO:2
7440-36-0	Antimony	0.45	B	81.10		MG/KG	97VN5L2	31-128	2.15	2.15		11.00	a	NO:3
7440-38-2	Arsenic	3.70		27.00	J	MG/KG	97VN35L13	128-128	9.50	9.50	8.6	8.20	a	YES
7440-39-3	Barium	24.00	B	234.00		MG/KG	97VRHN1	128-128	88.40	88.40	180	1900.00	b	NO:2,3
7440-41-7	Beryllium	0.17	B	1.10	B	MG/KG	97VN47L14	127-128	0.62	0.62	1.3	0.15	c	NO:2
7440-69-9	Bismuth	1.20		63.9		MG/KG	CT	17-128	3.10	3.10				YES
7440-43-9	Cadmium	0.08	B	4.20		MG/KG	97VS31N17	65-128	0.34	0.34	2.1	27.00	a	NO:2,3
7440-70-2	Calcium	4080.00		144000.00		MG/KG	97VS26N25	128-128	43200.00	43200.00	310000			NO:2,4
7440-47-3	Chromium	4.50		126.00		MG/KG	97VS28N5	128-128	22.40	22.40	20	140.00	a	NO:3
7440-48-4	Cobalt	3.40	B	15.50		MG/KG	97VN18L12	128-128	9.21	9.21	19			NO:2
7440-50-8	Copper	9.90		141.00		MG/KG	97VS31N17	128-128	34.70	34.70	26			YES
57-12-5	Cyanide	0.36	B	6.80		MG/KG	97VS51L6	6-128	0.30	0.30		550.00	a	NO:1
7439-89-6	Iron	7040.00		46800.00		MG/KG	97VN35L13	128-128	20500.00	20500.00	35000			NO:2,4
7439-92-1	Lead	5.50		8190.00		MG/KG	97VS43N24	128-128	226.00	226.00	48			YES
7439-95-4	Magnesium	2080.00		83200.00		MG/KG	97VS26N25	128-128	16700.00	16700.00	40000			NO:2
7439-96-5	Manganese	213.00		1130.00		MG/KG	97VS41N2	128-128	551.00	551.00	1400	3800.00	b	NO:2,3
7439-97-6	Mercury	0.05	B	1.30		MG/KG	97VS31N17	97-128	0.21	0.21		8.20	b	NO:3
7440-02-0	Nickel	7.50	B	31.80		MG/KG	97VN35L13	128-128	19.30	19.30	32	550.00	a	NO:2,3
7440-09-7	Potassium	529.00	B	2690.00		MG/KG	97VN27L15	128-128	1600.00	1600.00	1900			NO:2,4
7782-49-2	Selenium	0.51	B	2.20		MG/KG	97VN13L8	62-128	0.91	0.91				YES
7440-22-4	Silver	0.20	B	11.20		MG/KG	97VS19N5	21-128	0.44	0.44	1.7	140.00	a	NO:2,3
7440-23-5	Sodium	72.50	B	600.00	B	MG/KG	97VS48N4	125-128	180.00	180.00	240			NO:2,4
7440-28-0	Thallium	0.94	B	3.20		MG/KG	97VS55L3	33-128	0.88	0.88	0.46			YES
7440-62-2	Vanadium	8.40		34.40		MG/KG	97VS1AN13	128-128	22.00	22.00	25	190.00	a	NO:2,3
7440-66-6	Zinc	28.30		481.00		MG/KG	97VS43N24	128-128	91.00	91.00	140	8200.00	a	NO:2,3

Footnotes on page 3.

Table 2.2 Identification of Constituents of Potential Concern for the Residential RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Semi-Volatile Organic Compounds														
91-57-6	2-Methylnaphthalene	23	J	150	J	UG/KG	97VS1N23	25-128	229.00	150.00				YES
106-44-5	4-Methylphenol	64	J	64	J	UG/KG	97VN6N21	1-128	262.00	64.00		140.00	a	NO:1
83-32-9	Acenaphthene	20	J	750	J	UG/KG	97VN5N20	30-128	195.00	195.00				YES
208-96-8	Acenaphthylene	19	J	650	J	UG/KG	97VN4L22	41-128	213.00	213.00				YES
120-12-7	Anthracene	23	J	2300	J	UG/KG	97VN5N20	59-128	254.00	254.00		8200000.00	a	NO:3
56-55-3	Benzo(a)anthracene	21	J	7300		UG/KG	97VN5N20	117-128	654.00	654.00		880.00	d	NO:3
50-32-8	Benzo(a)pyrene	21	J	7900		UG/KG	97VN5N20	111-128	688.00	688.00		88.00	d	YES
205-99-2	Benzo(b)fluoranthene	23	J	7100		UG/KG	97VN5N20	117-128	681.00	681.00		880.00	d	NO:3
191-24-2	Benzo(g,h,i)perylene	22	J	4700		UG/KG	97VN5N20	110-128	477.00	477.00				YES
207-08-9	Benzo(k)fluoranthene	22	J	7000		UG/KG	97VN5N20	113-128	669.00	669.00		8800.00	d	NO:3
65-85-0	Benzoic Acid	20	JB	220	J	UG/KG	97VS51L6	37-125	1070.00	220.00		110000000.00	a	NO:3
117-81-7	Bis(2-ethylhexyl)phthala	20	JB	44000	D	UG/KG	97VN35L13	68-128	1070.00	1070.00		46000.00	d	NO:3
85-68-7	Butyl Benzyl Phthalate	20	J	380	J	UG/KG	97VS25N33	11-128	257.00	257.00		5500000.00	a	NO:3
86-74-8	Carbazole	22	J	930	J	UG/KG	97VN5N20	48-128	191.00	191.00				YES
218-01-9	Chrysene	25	J	8100		UG/KG	97VN5N20	120-128	747.00	747.00		88000.00	d	NO:3
84-74-2	Di-n-butyl Phthalate	22	J	4300		UG/KG	97VS20N23	31-128	368.00	368.00		2700000.00	a	NO:3
53-70-3	Dibenz(a,h)anthracene	20	J	1500	J	UG/KG	97VN21L17	59-128	240.00	240.00		88.00	d	YES
132-64-9	Dibenzofuran	20	J	510	J	UG/KG	97VN5N20	26-128	195.00	195.00				YES
84-66-2	Diethyl Phthalate	44	J	59	J	UG/KG	97VS20N23	2-128	262.00	59.00				NO:1
206-44-0	Fluoranthene	20	J	17000		UG/KG	97VN5N20	122-128	1440.00	1440.00		1100000.00	a	NO:3
86-73-7	Fluorene	20	J	1200	J	UG/KG	97VN5N20	34-128	210.00	210.00				YES
193-39-5	Indeno(1,2,3-cd)pyrene	20	J	4600		UG/KG	97VN21L17	109-128	462.00	462.00		880.00	d	NO:3
91-20-3	Naphthalene	19	J	140	J	UG/KG	97VS1N23	24-128	229.00	140.00				YES
87-86-5	Pentachlorophenol	30	J	70	J	UG/KG	97VS2N22	2-128	658.00	70.00		5300.00	d	NO:1
85-01-8	Phenanthrene	21	J	13000		UG/KG	97VN5N20	113-128	773.00	773.00				YES
108-95-2	Phenol	21	J	270	J	UG/KG	97VN3L15	16-128	248.00	248.00		16000000.00	a	NO:3
129-00-0	Pyrene	28	J	17000		UG/KG	97VN5N20	121-128	1310.00	1310.00		820000.00	a	NO:3
Volatile Organic Compounds														
107-06-2	1,2-Dichloroethane	1	J	1	J	UG/KG	CT	1-3	3.92	1.00		1600.00	c	NO:3
75-09-2	Methylene Chloride	2	J	2	J	UG/KG	CT	1-3	3.34	2.00		100000.00	b	NO:3
108-88-3	Toluene	1	J	1	J	UG/KG	CT	1-3	3.92	1.00		25000.00	b	NO:3

Footnotes on page 3.

Table 2.2 Identification of Constituents of Potential Concern for the Residential RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Pesticides/PCBS														
60-57-1	Dieldrin	1.100		1.100		UG/KG	CT	1-3	1.33	1.10		40.00	c	NO:3
53494-70-5	Endrin Ketone	0.430	J	2.000		UG/KG	CT	3-3	2.47	2.00				YES
5103-74-2	Gamma Chlordane	0.300	J	0.300	J	UG/KG	CT	1-3	0.34	0.30				YES
Radionuclides														
10045-97-3	Cesium-137	0.19		0.19		PCI/G	CT	1-3	0.25	0.19	0.42	0.05	e	NO:2
13981-16-3	Plutonium-238	0.01	J	715.00		PCI/G	97VS34N9	689-718	22.50	22.50	0.13	2.70	e	YES
PU-239/240	Plutonium-239/240	0.00		4.17		PCI/G	97VS43N16	412-680	0.10	0.10	0.18	2.50	e	NO:2,3
13966-00-2	Potassium-40	11.10		14.90		PCI/G	CT	3-3	16.00	14.90	37			NO:2
13982-63-3	Radium-226	1.84		3.04		PCI/G	CT	2-3	4.09	3.04	2	0.02	e	YES
10098-97-2	Strontium-90	0.52		7.20		PCI/G	CT	3-3	9.22	7.20	0.72	14.00	e	NO:3
14274-82-9	Thorium-228	0.61		7.67		PCI/G	97VS19N5	126-126	1.27	1.27	1.5	0.11	e	NO:2
14269-63-7	Thorium-230	0.87		7.99		PCI/G	97VS8N21	126-126	1.57	1.57	1.9	21.00	e	NO:2,3
7440-29-1	Thorium-232	0.51		2.17		PCI/G	97VS47N29	126-126	1.12	1.00	1	24.00	e	NO:3
10028-17-8	Tritium	0.05		79.60		PCI/G	97VS19N5	106-124	5.96	5.96	1.6	11000.00	e	NO:3
13966-29-5	Uranium-234	0.62		1.28		PCI/G	97VS17N6	126-126	0.95	0.95	1.1	18.00	e	NO:2,3
15117-96-1	Uranium-235	0.01		0.10		PCI/G	97VN31N17	97-126	0.05	0.05	0.11	0.41	e	NO:2,3
7440-61-1	Uranium-238	0.64		1.62		PCI/G	97VN35L13	126-126	1.03	1.03	1.2	1.80	e	NO:2,3

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= 10^{-6} cancer risk for ingestion + inhalation
d= 10^{-6} cancer risk for ingestion
e= 10^{-6} cancer risk for ingestion + inhalation + external
"J" = estimated quantitiy
"B" = analyte detected in associated blank

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:4 - Essential Human Nutrient
1.00E-06 is equivalent to 1.00×10^{-6}

Table 2.3 Identification of Constituents of Potential Concern for the Off Site Construction Worker RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Metals														
7429-90-5	Aluminum	3080.00		15300.00		MG/KG	97VN47L14	128-128	9890.00	9890.00	19000			NO:2
7440-36-0	Antimony	0.45	B	81.10		MG/KG	97VN5L2	31-128	2.15	2.15		8.50	a	NO:3
7440-38-2	Arsenic	3.70		27.00	J	MG/KG	97VN35L13	128-128	9.50	9.50	8.6	6.40	a	YES
7440-39-3	Barium	24.00	B	234.00		MG/KG	97VRHN1	128-128	88.40	88.40	180	1500.00	b	NO:2,3
7440-41-7	Beryllium	0.17	B	1.10	B	MG/KG	97VN47L14	127-128	0.62	0.62	1.3	3.50	c	NO:2,3
7440-69-9	Bismuth	1.20		63.9		MG/KG	CT	17-128	3.10	3.10				YES
7440-43-9	Cadmium	0.08	B	4.20		MG/KG	97VS31N17	65-128	0.34	0.34	2.1	21.00	a	NO:2,3
7440-70-2	Calcium	4080.00		144000.00		MG/KG	97VS26N25	128-128	43200.00	43200.00	310000			NO:2,4
7440-47-3	Chromium	4.50		126.00		MG/KG	97VS28N5	128-128	22.40	22.40	20	110.00	a	NO:3
7440-48-4	Cobalt	3.40	B	15.50		MG/KG	97VN18L12	128-128	9.21	9.21	19			NO:2
7440-50-8	Copper	9.90		141.00		MG/KG	97VS31N17	128-128	34.70	34.70	26			YES
57-12-5	Cyanide	0.36	B	6.80		MG/KG	97VS51L6	6-128	0.30	0.30		430.00	a	NO:1
7439-89-6	Iron	7040.00		46800.00		MG/KG	97VN35L13	128-128	20500.00	20500.00	35000			NO:2,4
7439-92-1	Lead	5.50		8190.00		MG/KG	97VS43N24	128-128	226.00	226.00	48			YES
7439-95-4	Magnesium	2080.00		83200.00		MG/KG	97VS26N25	128-128	16700.00	16700.00	40000			NO:2
7439-96-5	Manganese	213.00		1130.00		MG/KG	97VS41N2	128-128	551.00	551.00	1400	2700.00	b	NO:2,3
7439-97-6	Mercury	0.05	B	1.30		MG/KG	97VS31N17	97-128	0.21	0.21		6.40	b	NO:3
7440-02-0	Nickel	7.50	B	31.80		MG/KG	97VN35L13	128-128	19.30	19.30	32	430.00	a	NO:2,3
7440-09-7	Potassium	529.00	B	2690.00		MG/KG	97VN27L15	128-128	1600.00	1600.00	1900			NO:2,4
7782-49-2	Selenium	0.51	B	2.20		MG/KG	97VN13L8	62-128	0.91	0.91				YES
7440-22-4	Silver	0.20	B	11.20		MG/KG	97VS19N5	21-128	0.44	0.44	1.7	110.00	a	NO:2,3
7440-23-5	Sodium	72.50	B	600.00	B	MG/KG	97VS48N4	125-128	180.00	180.00	240			NO:2,4
7440-28-0	Thallium	0.94	B	3.20		MG/KG	97VS55L3	33-128	0.88	0.88	0.46			YES
7440-62-2	Vanadium	8.40		34.40		MG/KG	97VS1AN13	128-128	22.00	22.00	25	150.00	a	NO:2,3
7440-66-6	Zinc	28.30		481.00		MG/KG	97VS43N24	128-128	91.00	91.00	140	6400.00	a	NO:2,3

Footnotes on page 3.

Table 2.3 Identification of Constituents of Potential Concern for the Off Site Construction Worker RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Semi-Volatile Organic Compounds														
91-57-6	2-Methylnaphthalene	23	J	150	J	UG/KG	97VS1N23	25-128	229.00	150.00				YES
106-44-5	4-Methylphenol	64	J	64	J	UG/KG	97VN6N21	1-128	262.00	64.00		110000.00	a	NO:1
83-32-9	Acenaphthene	20	J	750	J	UG/KG	97VN5N20	30-128	195.00	195.00				YES
208-96-8	Acenaphthylene	19	J	650	J	UG/KG	97VN4L22	41-128	213.00	213.00				YES
120-12-7	Anthracene	23	J	2300	J	UG/KG	97VN5N20	59-128	254.00	254.00		6400000.00	a	NO:3
56-55-3	Benzo(a)anthracene	21	J	7300		UG/KG	97VN5N20	117-128	654.00	654.00		20000.00	d	NO:3
50-32-8	Benzo(a)pyrene	21	J	7900		UG/KG	97VN5N20	111-128	688.00	688.00		2000.00	d	NO:3
205-99-2	Benzo(b)fluoranthene	23	J	7100		UG/KG	97VN5N20	117-128	681.00	681.00		20000.00	d	NO:3
191-24-2	Benzo(g,h,i)perylene	22	J	4700		UG/KG	97VN5N20	110-128	477.00	477.00				YES
207-08-9	Benzo(k)fluoranthene	22	J	7000		UG/KG	97VN5N20	113-128	669.00	669.00		200000.00	d	NO:3
65-85-0	Benzoic Acid	20	JB	220	J	UG/KG	97VS51L6	37-125	1070.00	220.00		85000000.00	a	NO:3
117-81-7	Bis(2-ethylhexyl)phthala	20	JB	44000	D	UG/KG	97VN35L13	68-128	1070.00	1070.00		430000.00	a	NO:3
85-68-7	Butyl Benzyl Phthalate	20	J	380	J	UG/KG	97VS25N33	11-128	257.00	257.00		4300000.00	a	NO:3
86-74-8	Carbazole	22	J	930	J	UG/KG	97VN5N20	48-128	191.00	191.00				YES
218-01-9	Chrysene	25	J	8100		UG/KG	97VN5N20	120-128	747.00	747.00		2000000.00	d	NO:3
84-74-2	Di-n-butyl Phthalate	22	J	4300		UG/KG	97VS20N23	31-128	368.00	368.00		2100000.00	a	NO:3
53-70-3	Dibenz(a,h)anthracene	20	J	1500	J	UG/KG	97VN21L17	59-128	240.00	240.00		2000000.00	d	NO:3
132-64-9	Dibenzofuran	20	J	510	J	UG/KG	97VN5N20	26-128	195.00	195.00				YES
84-66-2	Diethyl Phthalate	44	J	59	J	UG/KG	97VS20N23	2-128	262.00	59.00				NO:1
206-44-0	Fluoranthene	20	J	17000		UG/KG	97VN5N20	122-128	1440.00	1440.00		850000.00	a	NO:3
86-73-7	Fluorene	20	J	1200	J	UG/KG	97VN5N20	34-128	210.00	210.00				YES
193-39-5	Indeno(1,2,3-cd)pyrene	20	J	4600		UG/KG	97VN21L17	109-128	462.00	462.00		20000.00	d	NO:3
91-20-3	Naphthalene	19	J	140	J	UG/KG	97VS1N23	24-128	229.00	140.00				YES
87-86-5	Pentachlorophenol	30	J	70	J	UG/KG	97VS2N22	2-128	658.00	70.00		120000.00	d	NO:1
85-01-8	Phenanthrene	21	J	13000		UG/KG	97VN5N20	113-128	773.00	773.00				YES
108-95-2	Phenol	21	J	270	J	UG/KG	97VN3L15	16-128	248.00	248.00		13000000.00	a	NO:3
129-00-0	Pyrene	28	J	17000		UG/KG	97VN5N20	121-128	1310.00	1310.00		640000.00	a	NO:3
Volatile Organic Compounds														
107-06-2	1,2-Dichloroethane	1	J	1	J	UG/KG	CT	1-3	3.92	1.00		55000.00	c	NO:3
75-09-2	Methylene Chloride	2	J	2	J	UG/KG	CT	1-3	3.34	2.00		100000.00	b	NO:3
108-88-3	Toluene	1	J	1	J	UG/KG	CT	1-3	3.92	1.00		25000.00	b	NO:3

Footnotes on page 3.

Table 2.3 Identification of Constituents of Potential Concern for the Off Site Construction Worker RRE of the Miami-Erie Canal Area

CAS Number	Chemical	Minimum Concentration		Maximum Concentration		Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Ref. GV	COPC?
Pesticides/PCBS														
60-57-1	Dieldrin	1.100		1.100		UG/KG	CT	1-3	1.33	1.10		930.00	c	NO:3
53494-70-5	Endrin Ketone	0.430	J	2.000		UG/KG	CT	3-3	2.47	2.00				YES
5103-74-2	Gamma Chlordane	0.300	J	0.300	J	UG/KG	CT	1-3	0.34	0.30				YES
Radionuclides														
10045-97-3	Cesium-137	0.19		0.19		PCI/G	CT	1-3	0.25	0.19	0.42	2.30	e	NO:2,3
13981-16-3	Plutonium-238	0.01	J	715.00		PCI/G	97VS34N9	689-718	22.50	22.50	0.13	28.00	e	NO:3
PU-239/240	Plutonium-239/240	0.00		4.17		PCI/G	97VS43N16	412-680	0.10	0.10	0.18	26.00	e	NO:2,3
13966-00-2	Potassium-40	11.10		14.90		PCI/G	CT	3-3	16.00	14.90	37			NO:2
13982-63-3	Radium-226	1.84		3.04		PCI/G	CT	2-3	4.09	3.04	2	0.70	e	YES
10098-97-2	Strontium-90	0.52		7.20		PCI/G	CT	3-3	9.22	7.20	0.72	150.00	e	NO:3
14274-82-9	Thorium-228	0.61		7.67		PCI/G	97VS19N5	126-126	1.27	1.27	1.5	4.30	e	NO:2,3
14269-63-7	Thorium-230	0.87		7.99		PCI/G	97VS8N21	126-126	1.57	1.57	1.9	220.00	e	NO:2,3
7440-29-1	Thorium-232	0.51		2.17		PCI/G	97VS47N29	126-126	1.12	1.00	1	250.00	e	NO:3
10028-17-8	Tritium	0.05		79.60		PCI/G	97VS19N5	106-124	5.96	5.96	1.6	120000.00	e	NO:3
13966-29-5	Uranium-234	0.62		1.28		PCI/G	97VS17N6	126-126	0.95	0.95	1.1	190.00	e	NO:2,3
15117-96-1	Uranium-235	0.01		0.10		PCI/G	97VN31N17	97-126	0.05	0.05	0.11	17.00	e	NO:2,3
7440-61-1	Uranium-238	0.64		1.62		PCI/G	97VN35L13	126-126	1.03	1.03	1.2	55.00	e	NO:2,3

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= 10^{-6} cancer risk for ingestion + inhalation
d= 10^{-6} cancer risk for ingestion
e= 10^{-6} cancer risk for ingestion + inhalation + external
"J" = estimated quantitiy
"B" = analyte detected in associated blank

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:4 - Essential Human Nutrient
1.00E-06 Is equivalent to 1.00×10^{-6}

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), 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

Soil constituents present at concentrations that exceed background concentration were compared to Risk-Based Guideline Values (GVs) for the Mound Facility (DOE 1997b). GVs are media-specific concentrations of constituents that correspond to specific human health risk levels for specified exposure scenarios. GVs 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 GVs, were used to screen COPCs for retention in the quantitative risk assessment.

The GVs used to screen COPCs were developed specifically for Mound, and were approved by the DOE, the U.S. EPA, and Ohio EPA. The GVs 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 1×10^{-6} risk level represents an incremental increase of one chance in one million of developing cancer as a result of exposure to the GV 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 GV 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 GVs 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 GV for non-carcinogenic constituents. Carcinogenic or radioactive constituents that exceed their GVs and non-carcinogenic constituents that exceed one-tenth of their GV 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 GVs 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. No compounds were eliminated on the basis that they were unrelated to historical operations conducted within the canal area.

Infrequent detection was defined as five percent or less. This 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 were considered in the decision to include or exclude infrequently detected constituents.

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. 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 soils is largely due to the pre-1970 disposal of tritiated process liquids. Some of the tritiated water released to the canal area may have infiltrated and migrated to the regional aquifer known as the Buried Valley Aquifer (BVA), however, groundwater in the canal area is currently not used.

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 38,000 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 risk-based GVs 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 will once again be used as a City of Miamisburg park after a DOE easement is canceled.

3.2 Identifying Exposure Pathways

Although many exposure pathways are possible, this RRE focuses only on the likely pathways within expected recreational land use. Pathways for residential and off site construction worker use were added to evaluate the need for 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.

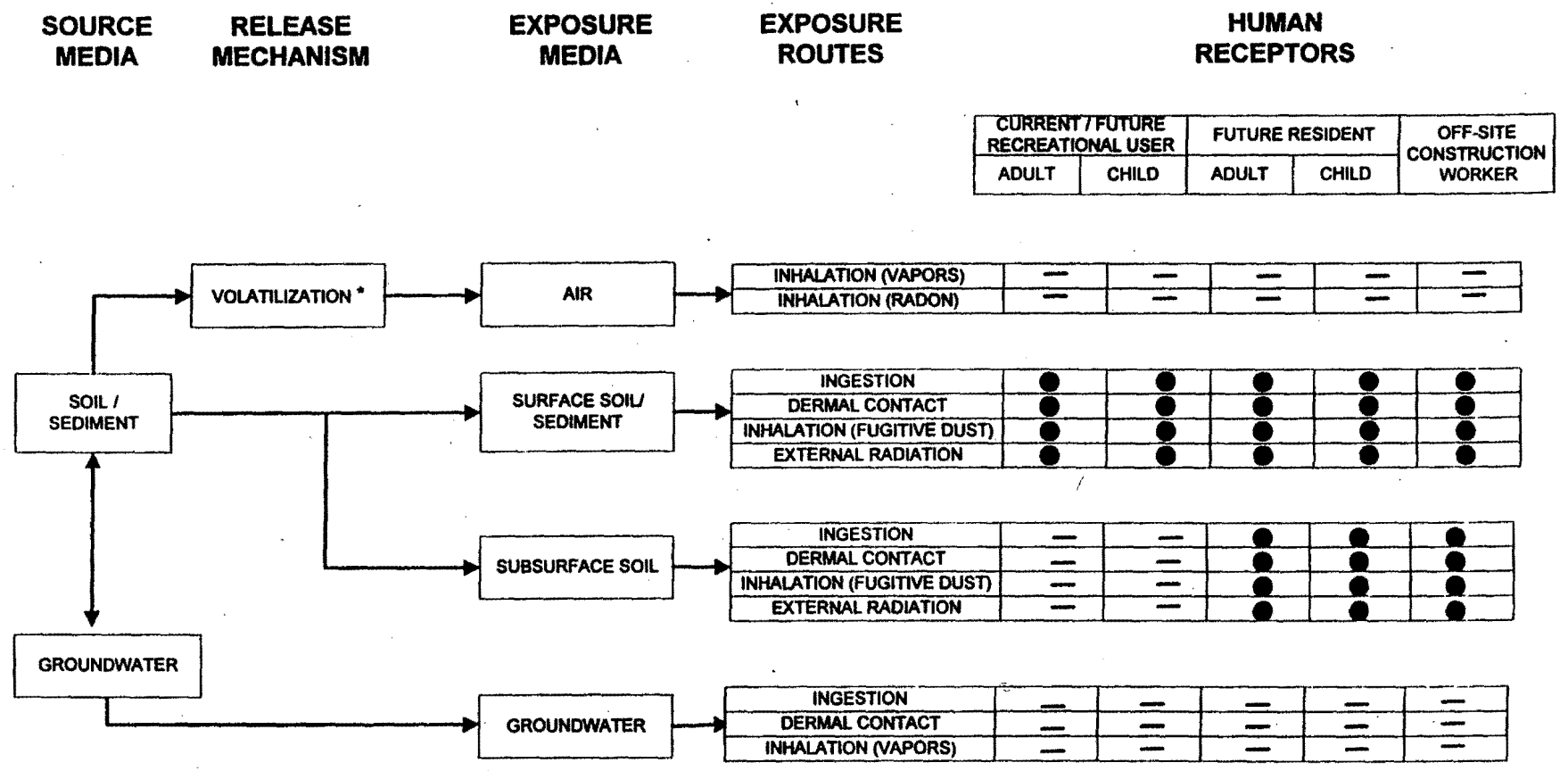
A graphical representation of the exposure pathways identified for potential receptors is included in the conceptual site model for the Miami-Erie Canal (Figure 3.1). The conceptual site model summarizes the pathways that hazardous substances may take to reach potential receptors. Exposure assumptions 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 *Risk Assessment Guidance for Superfund* (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 3.1.

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 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.



● COMPLETE PATHWAY EVALUATED QUANTITATIVELY

○ COMPLETE PATHWAY EVALUATED QUALITATIVELY

— INCOMPLETE PATHWAY, NOT EVALUATED

* NO VOLATILE COPCs IN AREA

Figure 3.1
Conceptual Site Model for the Miami-Erie Canal RRE

X/MOUND/CANALRRE/FINAL CANAL/FIG3.1APRIL 14, 2000

Table 3.1 Exposure Assumptions for Recreational and Residential Use of 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 contact	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 3.1 Exposure Assumptions for Recreational and Residential Use of 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 contact	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	

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 3.1.

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.

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 3.1.

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 at or below land surface. Potential exposure pathways include incidental soil 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 construction workers would use municipally supplied water for potable supply.

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

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

The parameters used to evaluate these pathways and their references are provided in Table 3.1.

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). A detailed description of these calculations can be found in Section 2.3.

Only surface soil data (0-2 feet below land surface) were used to calculate the exposure point concentration for the recreational user. Recreational users are assumed to have 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 3.1.

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 decay rate 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 (Table 5.16-5.18)

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:

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

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:

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

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^{-6} 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:

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

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:

$$Absorbed\ Dose\ (pCi/g) = Cso \times ED \times Te \times (1\text{-}Se)$$

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 (4.63×10^9 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 (4.63 x 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 4.63 x 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. Table 4.1 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 harmless 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. 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 (μg/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 (μg/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.

Table 4.1 Toxicity Values and Chemical-Specific Parameters for Constituents of Potential Concern in the Miami-Erie Canal Area

	Non-Cancer			Cancer				Dermal Exposure Parameters		
								General		Soil
Chemical	Oral RFDo (mg/kg/day)	Dermal Adjusted RFDa (mg/kg/day)	Inhalation RFDi (mg/kg/day)	Oral CSFo $(mg/kg/day)^{-1}$	Dermal Adjusted CSFa $(mg/kg/day)^{-1}$	External Radiation $(mg/kg/day)^{-1}$	Inhalation CSFi $(mg/kg/day)^{-1}$	GI Factor (Unitless)	Source (Unitless)	Dermal ABS (Unitless)
INORGANICS										
Arsenic	3.00E-04	1.23E-04	5.00E-04	1.50E+00	NA	NA	1.50E+01	0.41	a	0.01
Bismuth	NA	NA	NA	NA	NA	NA	NA	NA	a	0.01
Copper	3.70E-02	1.11E-02	NA	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	2.20E-03	NA	NA	NA	NA	NA	0.44	c	0.01
Thallium	8.00E-05	1.20E-05	NA	NA	NA	NA	NA	0.15	a	0.01
SVOCs						NA				
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	0.8		0.3
Acenaphthene	6.00E-02	1.86E-02	NA	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	2.52E+00	NA	3.10E+00	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	NA	NA	NA	0.7	a	0.3
Dibenz(a,h)anthracene	NA	NA	NA	7.30E+00	1.66E+00	NA	3.10E+00	0.7	a	0.3
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	0.31	b	0.3
Fluorene	4.00E-02	2.00E-02		NA	NA	NA	NA	0.5	b	0.3
Naphthalene	2.00E-02	1.00E-02	8.60E-04	NA	NA	NA	NA	0.5	a	0.3
Phenanthrene	NA	NA	NA	NC	NC	NA	NC	0.65	a	0.3
Pesticides/PCBs										
Edrin Ketone	NA	NA	NA	NA	NA	NA	NA	0.5	a	0.3
Gamma Chlordane	5.00E-04	2.50E-04	2.00E-04	3.50E-01	1.25E-02	NA	3.50E-01	0.5	a	0.3
Radionuclides										
Plutonium-238	NA	NA	NA	2.95E-10	NA	2.95E-10	2.74E-08	NA		NA
Radium-226	NA	NA	NA	3.00E-10	NA	3.00E-10	2.80E-09	NA		NA

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; the GI absorption factor for PCBs was used for each Aroclor congener.
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; ORNL has also listed 7% as GI abs. Factor for inorganic salts of mercury.

NA = Not Available
RfD = Reference Dose
CSF = Cancer Slope Factor
GI = Gastrointestinal
ABS = Dermal Absorption Factor

SVOCs = Semi-volatile Organic Compounds
PCBs = Polychlorinated biphenyls
VOCs = Volatile Organic Compounds
1.00E-06 is equivalent to 1.00×10^{-6}

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 poses 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. 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:

$$Risk = CDI \times CSF$$

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).

$$Risk_T = \sum_{i=1}^{n} Risk_i$$

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 average daily intake experienced by 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).

$$HI = \sum HQ_i$$

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 5.1 through 5.18) are presented at the end of the Section. Risk estimates for individual COPCs for all scenarios and pathways are presented in Tables 5.1 through 5.15. Tables 5.1 through 5.6 present risk estimates based on recreational exposure parameters, Tables 5.7 through 5.12 present risk estimates based on residential exposure parameters and Tables 5.13 through 5.15 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 5.16 through 5.18 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 5.1 through 5.3 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 9.4×10^{-6}, which falls within the target risk range of 10^{-4} to 10^{-6}. The only constituent to exceed 1×10^{-6} was radium-226. Residual risk due to radium-226 was driven by external exposure to radium-226 in soil. The majority (66%) of this risk is due to background levels (6.2×10^{-6}). The incremental risk due to radium-226 in the canal area to a recreational adult is 3.2×10^{-6}, which again falls within the target risk range.

Recreational Child

Tables 5.4 through 5.6 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 2.4×10^{-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 (67%) is due to background levels (1.6×10^{-6}). The incremental risk due to radium-226 in the canal area to a recreational child is 2.1×10^{-7}, which falls below the target risk range.

Residential Adult

Tables 5.7 through 5.9 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 3.1×10^{-4} for the residential adult exceeds the target cancer risk range of 10^{-4} to 10^{-6}. Risk from exposure to radionuclides for a residential adult is 1.5×10^{-4}. Constituents that exceed 1×10^{-6} include benzo(a)pyrene, dibenz(a,h)anthracene, arsenic, plutonium-238 and radium-226. Background cancer risk to a residential adult is 1.1×10^{-4}, which accounts for 34% of the total residual risk. Incremental residual cancer risk for a residential adult in the canal area is 2.1×10^{-4}, which exceeds the target risk range. 62% of the incremental risk is due to benzo(a)pyrene which is ubiquitous the environment, particularly near rail roads and roadways.

Residential Child

Tables 5.10 through 5.12 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 1.3×10^{-4}, which slightly exceeds the target risk range of 10^{-4} to 10^{-6}. Constituents that exceed 1×10^{-6} include benzo(a)pyrene, dibenz(a,h)anthracene, arsenic, plutonium-238 and radium-226. Background cancer risk to a residential child is 4.2×10^{-5}, which accounts for 32% of the total residual risk. Incremental residual cancer risk for a residential child in the canal area is 9.0×10^{-5}, which falls within the target risk range. 69% of the incremental risk is due to benzo(a)pyrene which is ubiquitous in the environment, particularly near rail roads and roadways.

Off Site Construction Worker

Tables 5.12 through 5.15 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 7.2×10^{-6}, which is within the acceptable risk range of 10^{-4} to 10^{-6}. The only constituent that exceeds 1×10^{-6} is radium-226 via external exposure. Background and incremental, chemical

and radiological cancer risk to an off site construction worker is 5.1×10^{-6} and 2.2×10^{-6} respectively. Both these values fall within the target risk range of 10^{-4} to 10^{-6}.

Table 5.1 **Total Residual Risk for a Recreational Adult at the Miami-Erie Canal Area**

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides/PCBS													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	7.3E-12	2.4E-10	5.7E-17	NAP	NAP	2.5E-10	1.2E-07	4.0E-06	2.4E-12	NAP	NAP	4.1E-06
Metals													
Bismuth	3.10	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	34.70	NA	NA	NA	NAP	NAP	0.0E+00	1.9E-04	3.5E-04	NA	NAP	NAP	5.4E-04
Lead	226.00	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	3.7E-05	4.6E-05	NA	NAP	NAP	8.3E-05
Thallium	0.88	NA	NA	NA	NAP	NAP	0.0E+00	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	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	6.6E-07	3.5E-05	NA	NAP	NAP	3.6E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	2.7E-10	1.4E-08	NA	NAP	NAP	1.4E-08	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	1.1E-06	3.5E-05	0.0E+00	NAP	NAP	3.6E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	1.4E-06	4.7E-05	2.6E-10	NAP	NAP	4.8E-05
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Total Chemcial		2.7E-10	1.4E-08	5.7E-17	0.0E+00	0.0E+00	1.5E-08	2.5E-03	8.7E-03	2.6E-10	0.0E+00	0.0E+00	1.1E-02
Radionuclides	EPC pCi/g												
Radium-226	3.04	1.1E-07	NAP	8.3E-12	NAP	9.3E-06	9.4E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclides		1.1E-07	NAP	8.3E-12	0.0E+00	9.3E-06	9.4E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Overall Risk		1.1E-07	1.4E-08	8.3E-12	0.0E+00	9.3E-06	9.4E-06	2.5E-03	8.7E-03	2.6E-10	0.0E+00	0.0E+00	1.1E-02

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

Table 5.2 Background Residual Risk for a Recreational Adult at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides/PCBS													
Endrin Ketone		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Metals													
Bismuth		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	26	NA	NA	NA	NAP	NAP	0.0E+00	1.4E-04	2.6E-04	NA	NAP	NAP	4.0E-04
Lead	48	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Thallium	0.46	NA	NA	NA	NAP	NAP	0.0E+00	1.2E-03	4.3E-03	NA	NAP	NAP	5.4E-03
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Acenaphthylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole		0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Naphthalene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Phenanthrene		NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Total Chemical		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-03	4.5E-03	0.0E+00	0.0E+00	0.0E+00	5.8E-03
Radionuclides	EPC pCi/g												
Radium-226	2	7.5E-08	NAP	5.5E-12	NAP	6.1E-06	6.2E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclides		7.5E-08	NAP	5.5E-12	NAP	6.1E-06	6.2E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Overall Risk		7.5E-08	0.0E+00	5.5E-12	0.0E+00	6.1E-06	6.2E-06	1.3E-03	4.5E-03	0.0E+00	0.0E+00	0.0E+00	5.8E-03

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

Table 5.3 **Incremental Residual Risk for a Recreational Adult at the Miami-Erie Canal Area**

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides/PCBS													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	7.3E-12	2.4E-10	5.7E-17	NAP	NAP	2.5E-10	1.2E-07	4.0E-06	2.4E-12	NAP	NAP	4.1E-06
Metals													
Bismuth	3.10	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	8.70	NA	NA	NA	NAP	NAP	0.0E+00	4.8E-05	8.7E-05	NA	NAP	NAP	1.3E-04
Lead	178.00	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	3.7E-05	4.6E-05	NA	NAP	NAP	8.3E-05
Thallium	0.42	NA	NA	NA	NAP	NAP	0.0E+00	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	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	6.6E-07	3.5E-05	NA	NAP	NAP	3.6E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	2.7E-10	1.4E-08	NA	NAP	NAP	1.4E-08	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	1.1E-06	3.5E-05	0.0E+00	NAP	NAP	3.6E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	1.4E-06	4.7E-05	2.6E-10	NAP	NAP	4.8E-05
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Total Chemical		2.7E-10	1.4E-08	5.7E-17	0.0E+00	0.0E+00	1.5E-08	1.2E-03	4.1E-03	2.6E-10	0.0E+00	0.0E+00	5.3E-03
Radionuclides	EPC pCi/g												
Radium-226	1.04	3.9E-08	NAP	2.8E-12	NAP	3.2E-06	3.2E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		3.9E-08	NAP	2.8E-12	0.0E+00	3.2E-06	3.2E-06	NA	NA	NA	NAP	NAP	NAP
Total Overall Risk		3.9E-08	1.4E-08	2.8E-12	0.0E+00	3.2E-06	3.2E-06	1.2E-03	4.1E-03	2.6E-10	0.0E+00	0.0E+00	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
NC	Not a suspected carcinogen
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 5.4 **Total Residual Risk for a Recreational Child at the Miami-Erie Canal Area**

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides/PCBS													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	1.7E-11	1.1E-10	2.9E-17	NAP	NAP	1.3E-10	1.1E-06	7.2E-06	4.8E-12	NAP	NAP	8.4E-06
Metals													
Bismuth	3.10	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	34.70	NA	NA	NA	NAP	NAP	0.0E+00	1.8E-03	6.3E-04	NA	NAP	NAP	2.4E-03
Lead	226.00	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	3.5E-04	8.3E-05	NA	NAP	NAP	4.3E-04
Thallium	0.88	NA	NA	NA	NAP	NAP	0.0E+00	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	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	6.2E-06	6.3E-05	NA	NAP	NAP	6.9E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	6.2E-10	6.4E-09	NA	NAP	NAP	7.0E-09	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	1.0E-05	6.3E-05	0.0E+00	NAP	NAP	7.3E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	1.3E-05	8.4E-05	5.2E-10	NAP	NAP	9.8E-05
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Total Chemicals		6.4E-10	6.5E-09	2.9E-17	0.0E+00	0.0E+00	7.1E-09	2.3E-02	1.6E-02	5.3E-10	0.0E+00	0.0E+00	3.9E-02
Radionuclides	EPC pCi/g												
Radium-226	3.04	5.7E-08	NAP	9.0E-13	NAP	2.3E-06	2.4E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclides		5.7E-08	NAP	9.0E-13	0.0E+00	2.3E-06	2.4E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Overall Risk		5.8E-08	6.5E-09	9.0E-13	0.0E+00	2.3E-06	2.4E-06	2.3E-02	1.6E-02	5.3E-10	0.0E+00	0.0E+00	3.9E-02

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

Table 5.5 Background Residual Risk for a Recreational Child at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides/PCBS													
Endrin Ketone		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Metals													
Bismuth		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	26	NA	NA	NA	NAP	NAP	0.0E+00	1.3E-03	4.7E-04	NA	NAP	NAP	1.8E-03
Lead	48	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Thallium	0.46	NA	NA	NA	NAP	NAP	0.0E+00	1.1E-02	7.7E-03	NA	NAP	NAP	1.9E-02
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Acenaphthylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole		0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Naphthalene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Phenanthrene		NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Total Chemical		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E-02	8.2E-03	0.0E+00	0.0E+00	0.0E+00	2.0E-02
Radionuclides	EPC pCi/g												
Radium-226	2	3.7E-08	NAP	5.9E-16	NAP	1.5E-06	1.6E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclides		3.7E-08	NAP	5.9E-16	NAP	1.5E-06	1.6E-06	NAP	NAP	NAP	NAP	NAP	NAP
Total Overall Risk		3.7E-08	0.0E+00	5.9E-16	#VALUE!	1.5E-06	1.6E-06	1.2E-02	8.2E-03	0.0E+00	0.0E+00	0.0E+00	2.0E-02

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

Table 5.6 **Incremental Residual Risk for a Recreational Child at the Miami-Erie Canal Area**

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides/PCBS													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	1.3E-11	8.1E-11	2.2E-17	NAP	NAP	9.4E-11	8.5E-07	5.4E-06	3.6E-12	NAP	NAP	6.3E-06
Metals													
Bismuth	3.10	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	8.70	NA	NA	NA	NAP	NAP	0.0E+00	3.3E-04	1.2E-04	NA	NAP	NAP	4.5E-04
Lead	178.00	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	2.6E-04	6.2E-05	NA	NAP	NAP	3.2E-04
Thallium	0.42	NA	NA	NA	NAP	NAP	0.0E+00	7.5E-03	5.3E-03	NA	NAP	NAP	1.3E-02
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	4.6E-06	4.7E-05	NA	NAP	NAP	5.2E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	4.7E-10	4.8E-09	NA	NAP	NAP	5.2E-09	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	7.5E-06	4.7E-05	0.0E+00	NAP	NAP	5.5E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	1.0E-05	6.3E-05	3.9E-10	NAP	NAP	7.3E-05
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Total Chemical		4.8E-10	4.9E-09	2.2E-17	0.0E+00	0.0E+00	5.3E-09	8.1E-03	5.6E-03	4.0E-10	0.0E+00	0.0E+00	1.4E-02
Radionuclides	EPC pCi/g												
Radium-226	1.04	1.9E-08	NAP	3.1E-13	NAP	7.9E-07	8.1E-07	NAP	NAP	NAP	NAP	NAP	NAP
Total Radionuclide		1.9E-08	NAP	3.1E-13	0.0E+00	7.9E-07	8.1E-07	NA	NA	NA	NAP	NA	NAP
Total Overall Risk		2.0E-08	4.9E-09	3.1E-13	0.0E+00	7.9E-07	8.2E-07	8.1E-03	5.6E-03	4.0E-10	0.0E+00	0.0E+00	1.4E-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
NC	Not a suspected carcinogen
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 5.7 Total Residual Risk for a Residential Adult at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	4.5E-06	2.4E-04	NA	NAP	NAP	2.4E-04
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene	0.688	2.4E-06	1.2E-04	4.7E-11	NAP	NAP	1.3E-04	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	1.8E-09	4.2E-08	NA	NAP	NAP	4.4E-08	NA	NA	NA	NAP	NAP	0.0E+00
Dibenz(a,h)anthracene	0.24	8.2E-07	1.9E-05	1.6E-11	NAP	NAP	2.0E-05	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	7.2E-06	2.4E-04	0.0E+00	NAP	NAP	2.4E-04
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	9.6E-06	3.1E-04	1.0E-08	NAP	NAP	3.2E-04
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	4.9E-11	1.6E-09	2.3E-15	NAP	NAP	1.7E-09	8.2E-07	2.7E-05	9.6E-11	NAP	NAP	2.8E-05
Metals													
Arsenic	9.5	6.7E-06	8.9E-06	3.1E-09	NAP	NAP	1.6E-05	4.3E-02	5.8E-02	1.2E-06	NAP	NAP	1.0E-01
Bismuth	3.1	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	34.7	NA	NA	NA	NAP	NAP	0.0E+00	1.3E-03	2.3E-03	NA	NAP	NAP	3.6E-03
Lead	226	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	2.5E-04	3.1E-04	NA	NAP	NAP	5.6E-04
Thallium	0.88	NA	NA	NA	NAP	NAP	0.0E+00	1.5E-02	5.5E-02	NA	NAP	NAP	7.0E-02
Total Chemical		9.9E-06	1.5E-04	3.2E-09	NAP	NAP	1.6E-04	6.0E-02	1.2E-01	1.2E-06	0.0E+00	0.0E+00	1.8E-01
Radionuclides	EPC pCi/g												
Plutonium-238	22.5	5.6E-06	NA	2.4E-08	NAP	3.1E-09	5.6E-06	NA	NA	NA	NAP	NA	0.0E+00
Radium-226	3.04	7.7E-07	0.0E+00	3.3E-10	NAP	1.5E-04	1.5E-04	NA	NA	NA	NAP	NA	0.0E+00
Total Radionuclide		6.3E-06	0.0E+00	2.5E-08	NAP	1.5E-04	1.5E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Overall Total Risk		1.6E-05	1.5E-04	2.8E-08	NAP	1.5E-04	3.2E-04	6.0E-02	1.2E-01	1.2E-06	NAP	0.0E+00	1.8E-01

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

Table 5.8 Background Residual Risk for a Residential Adult at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Acenaphthylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole		0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Dibenz(a,h)anthracene		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Naphthalene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Phenanthrene		NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Metals													
Arsenic	8.6	6.1E-06	8.1E-06	2.8E-09	NAP	NAP	1.4E-05	3.9E-02	5.2E-02	1.1E-06	NAP	NAP	9.2E-02
Bismuth		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	26	NA	NA	NA	NAP	NAP	0.0E+00	9.6E-04	1.8E-03	NA	NAP	NAP	2.7E-03
Lead	48	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Thallium	0.46	NA	NA	NA	NAP	NAP	0.0E+00	7.9E-03	2.9E-02	NA	NAP	NAP	3.7E-02
Total Chemical		6.1E-06	8.1E-06	2.8E-09	0.0E+00	0.0E+00	1.4E-05	4.8E-02	8.3E-02	1.1E-06	0.0E+00	0.0E+00	1.3E-01
Radionuclides	EPC pCi/g												
Plutonium-238	0.13	3.2E-08	NA	1.4E-10	NAP	1.8E-11	3.2E-08	NA	NA	NA	NAP	NA	0.0E+00
Radium-226	2	5.0E-07	0.0E+00	2.2E-10	NAP	9.6E-05	9.7E-05	NA	NA	NA	NAP	NA	0.0E+00
Total Radionuclide		5.4E-07	0.0E+00	3.6E-10	NAP	9.6E-05	9.7E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Overall Total Risk		6.6E-06	8.1E-06	3.2E-09	NAP	9.6E-05	1.1E-04	4.8E-02	8.3E-02	1.1E-06	0.0E+00	0.0E+00	1.3E-01

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

Table 5.9 ***Incremental* Residual Risk for a Residential Adult at the *Miami-Erie Canal Area***

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	4.5E-06	2.4E-04	NA	NAP	NAP	2.4E-04
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene	0.688	2.4E-06	1.2E-04	4.7E-11	NAP	NAP	1.3E-04	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	1.8E-09	4.2E-08	NA	NAP	NAP	4.4E-08	NA	NA	NA	NAP	NAP	0.0E+00
Dibenz(a,h)anthracene	0.24	8.2E-07	1.9E-05	1.6E-11	NAP	NAP	2.0E-05	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	7.2E-06	2.4E-04	0.0E+00	NAP	NAP	2.4E-04
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	9.6E-06	3.1E-04	1.0E-08	NAP	NAP	3.2E-04
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	4.9E-11	1.6E-09	2.3E-15	NAP	NAP	1.7E-09	8.2E-07	2.7E-05	9.6E-11	NAP	NAP	2.8E-05
Metals													
Arsenic	0.9	6.3E-07	8.4E-07	3.0E-10	NAP	NAP	1.5E-06	4.1E-03	5.5E-03	1.2E-07	NAP	NAP	9.6E-03
Bismuth	3.1	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	8.7	NA	NA	NA	NAP	NAP	0.0E+00	3.2E-04	5.9E-04	NA	NAP	NAP	9.1E-04
Lead	178	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	2.5E-04	3.1E-04	NA	NAP	NAP	5.6E-04
Thallium	0.88	NA	NA	NA	NAP	NAP	0.0E+00	1.5E-02	5.5E-02	NA	NAP	NAP	7.0E-02
Total Chemical		3.8E-06	1.4E-04	3.6E-10	0.0E+00	0.0E+00	1.5E-04	2.0E-02	6.2E-02	1.3E-07	0.0E+00	0.0E+00	8.2E-02
Radionuclides	EPC pCi/g												
Plutonium-238	22.37	5.5E-06	NA	2.4E-08	NAP	3.1E-09	5.6E-06	NA	NA	NA	NAP	NAP	0.0E+00
Radium-226	1.04	2.6E-07	0.0E+00	1.1E-10	NAP	5.0E-05	5.0E-05	NA	NA	NA	NAP	NAP	0.0E+00
Total Radionuclide		5.8E-06	0.0E+00	2.4E-08	NAP	5.0E-05	5.6E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Overall Total Risk		9.6E-06	1.4E-04	2.5E-08	NAP	5.0E-05	2.0E-04	2.0E-02	6.2E-02	1.3E-07	NAP	NAP	8.2E-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
NC	Not a suspected carcinogen
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 5.10 Total Residual Risk for a Residential Child at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	4.2E-05	4.3E-04	NA	NAP	NAP	4.7E-04
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene	0.688	5.5E-06	5.6E-05	2.4E-11	NAP	NAP	6.2E-05	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	4.2E-09	1.9E-08	NA	NAP	NAP	2.3E-08	NA	NA	NA	NAP	NAP	0.0E+00
Dibenz(a,h)anthracene	0.24	1.9E-06	8.7E-06	8.3E-12	NAP	NAP	1.1E-05	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	6.7E-05	4.3E-04	0.0E+00	NAP	NAP	4.9E-04
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	8.9E-05	5.7E-04	2.1E-08	NAP	NAP	6.6E-04
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	1.2E-10	7.3E-10	1.2E-15	NAP	NAP	8.5E-10	7.7E-06	4.9E-05	1.9E-10	NAP	NAP	5.6E-05
Metals													
Arsenic	9.5	1.6E-05	4.0E-06	1.6E-09	NAP	NAP	2.0E-05	4.0E-01	1.0E-01	2.5E-06	NAP	NAP	5.1E-01
Bismuth	3.1	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	34.7	NA	NA	NA	NAP	NAP	0.0E+00	1.2E-02	4.2E-03	NA	NAP	NAP	1.6E-02
Lead	226	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	2.3E-03	5.6E-04	NA	NAP	NAP	2.9E-03
Thallium	0.88	NA	NA	NA	NAP	NAP	0.0E+00	1.4E-01	9.9E-02	NA	NAP	NAP	2.4E-01
Total Chemical		2.3E-05	6.9E-05	1.6E-09	NAP	NAP	9.2E-05	5.6E-01	2.1E-01	2.5E-06	NAP	NAP	7.7E-01
	EPC pCi/g												
Radionuclides													
Plutonium-238	22.5	2.8E-06	NA	2.6E-09	NAP	7.9E-10	2.8E-06	NA	NA	NA	NA	NA	0.0E+00
Radium-226	3.04	3.8E-07	0.0E+00	3.6E-11	NAP	3.7E-05	3.7E-05	NA	NA	NA	NA	NA	0.0E+00
Total Radionuclide		3.2E-06	0.0E+00	2.7E-09	NAP	3.7E-05	4.0E-05	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Overall Total Risk		2.6E-05	6.9E-05	4.3E-09	NAP	3.7E-05	1.3E-04	5.6E-01	2.1E-01	2.5E-06	NAP	NAP	7.7E-01

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

Table 5.11 esidential Child at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Acenaphthylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole		0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Dibenz(a,h)anthracene		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Naphthalene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Phenanthrene		NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Metals													
Arsenic	8.6	1.4E-05	3.6E-06	1.4E-09	NAP	NAP	1.8E-05	3.7E-01	9.5E-02	2.2E-06	NAP	NAP	4.6E-01
Bismuth		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	26	NA	NA	NA	NAP	NAP	0.0E+00	9.0E-03	3.2E-03	NA	NAP	NAP	1.2E-02
Lead	48	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Thallium	0.46	NA	NA	NA	NAP	NAP	0.0E+00	7.4E-02	5.2E-02	NA	NAP	NAP	1.3E-01
Total Chemical		1.4E-05	3.6E-06	1.4E-09	0.0E+00	0.0E+00	1.8E-05	4.5E-01	1.5E-01	2.2E-06	0.0E+00	0.0E+00	6.0E-01
Radionuclides	EPC pCi/g												
Plutonium-238	0.13	1.6E-08	NA	1.5E-11	NAP	4.5E-12	1.6E-08	NA	NA	NA	NAP	NAP	0.0E+00
Radium-226	2	2.5E-07	0.0E+00	2.4E-11	NAP	2.4E-05	2.4E-05	NA	NA	NA	NAP	NAP	0.0E+00
Total Radionuclide		2.7E-07	0.0E+00	3.9E-11	NAP	2.4E-05	2.4E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Overall Total Risk		1.4E-05	3.6E-06	1.5E-09	NAP	2.4E-05	4.2E-05	4.5E-01	1.5E-01	2.2E-06	NAP	NAP	6.0E-01

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

Table 5.12 Incremental Residual Risk for a Residential Child at the Miami-Erie Canal Area **Incremental**

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	4.2E-05	4.3E-04	NA	NAP	NAP	4.7E-04
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene	0.688	5.5E-06	5.6E-05	2.4E-11	NAP	NAP	6.2E-05	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	4.2E-09	1.9E-08	NA	NAP	NAP	2.3E-08	NA	NA	NA	NAP	NAP	0.0E+00
Dibenz(a,h)anthracene	0.24	1.9E-06	8.7E-06	8.3E-12	NAP	NAP	1.1E-05	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	6.7E-05	4.3E-04	0.0E+00	NAP	NAP	4.9E-04
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	8.9E-05	5.7E-04	2.1E-08	NAP	NAP	6.6E-04
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	1.2E-10	7.3E-10	1.2E-15	NAP	NAP	8.5E-10	7.7E-06	4.9E-05	1.9E-10	NAP	NAP	5.6E-05
Metals													
Arsenic	0.9	1.5E-06	3.8E-07	1.5E-10	NAP	NAP	1.9E-06	3.8E-02	9.9E-03	2.3E-07	NAP	NAP	4.8E-02
Bismuth	3.1	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	8.7	NA	NA	NA	NAP	NAP	0.0E+00	3.0E-03	1.1E-03	NA	NAP	NAP	4.1E-03
Lead	178	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	2.3E-03	5.6E-04	NA	NAP	NAP	2.9E-03
Thallium	0.88	NA	NA	NA	NAP	NAP	0.0E+00	1.4E-01	9.9E-02	NA	NAP	NAP	2.4E-01
Total Chemical		8.9E-06	6.5E-05	1.8E-10	0.0E+00	0.0E+00	7.4E-05	1.8E-01	1.1E-01	2.6E-07	0.0E+00	0.0E+00	3.0E-01
Radionuclides	EPC pCi/g												
Plutonium-238	22.37	2.8E-06	NA	2.6E-09	NAP	7.8E-10	2.8E-06	NA	NA	NA	NAP	NA	0.0E+00
Radium-226	1.04	1.3E-07	0.0E+00	1.2E-11	NAP	1.3E-05	1.3E-05	NA	NA	NA	NAP	NA	0.0E+00
Total Radionuclide		2.9E-06	0.0E+00	2.6E-09	NAP	1.3E-05	1.6E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Overall Total Risk		1.2E-05	6.5E-05	2.8E-09	NAP	1.3E-05	9.0E-05	1.8E-01	1.1E-01	2.6E-07	NAP	NAP	3.0E-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
NC	Not a suspected carcinogen
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 5.13 Total Residual Risk for an Off Site Construction Worker at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	1.5E-05	3.1E-05	NA	NAP	NAP	4.6E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	2.6E-10	2.3E-10	NA	NAP	NAP	4.9E-10	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	2.5E-05	3.1E-05	0.0E+00	NAP	NAP	5.5E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	3.3E-05	4.1E-05	7.4E-09	NAP	NAP	7.4E-05
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	7.0E-12	8.8E-12	6.9E-17	NAP	NAP	1.6E-11	2.8E-06	3.5E-06	6.9E-11	NAP	NAP	6.3E-06
Metals													
Arsenic	9.5	9.6E-07	4.9E-08	9.3E-11	NAP	NAP	1.0E-06	1.5E-01	7.6E-03	8.7E-07	NAP	NAP	1.6E-01
Bismuth	3.1	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	34.7	NA	NA	NA	NAP	NAP	0.0E+00	4.4E-03	3.1E-04	NA	NAP	NAP	4.7E-03
Lead	226	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	8.5E-04	4.0E-05	NA	NAP	NAP	9.0E-04
Thallium	0.88	NA	NA	NA	NAP	NAP	0.0E+00	5.2E-02	7.2E-03	NA	NAP	NAP	5.9E-02
Total Chemical		9.6E-07	4.9E-08	9.3E-11	0.0E+00	0.0E+00	1.0E-06	2.1E-01	1.5E-02	8.8E-07	0.0E+00	0.0E+00	2.2E-01
	EPC pCi/g												
Radionuclides													
Radium-226	3.04	1.1E-07	0.0E+00	9.9E-12	NAP	6.1E-06	6.2E-06	NA	NA	NA	NAP	NA	0.0E+00
Total Radionuclide		1.1E-07	0.0E+00	9.9E-12	NAP	6.1E-06	6.2E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Overall Total Risk		1.1E-06	4.9E-08	1.0E-10	0.0E+00	6.1E-06	7.2E-06	2.1E-01	1.5E-02	8.8E-07	0.0E+00	0.0E+00	2.2E-01

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

Table 5.14 Background Residual Risk for an Offsite construction Worker at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Acenaphthylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole		0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Naphthalene		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Phenanthrene		NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00
Metals													
Arsenic	8.6	8.7E-07	4.4E-08	8.4E-11	NAP	NAP	9.1E-07	1.3E-01	6.8E-03	7.9E-07	NAP	NAP	1.4E-01
Bismuth		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	26	NA	NA	NA	NAP	NAP	0.0E+00	3.3E-03	2.3E-04	NA	NAP	NAP	3.5E-03
Lead	48	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium		NA	NA	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Thallium	0.46	NA	NA	NA	NAP	NAP	0.0E+00	2.7E-02	3.8E-03	NA	NAP	NAP	3.1E-02
Total Chemical		8.7E-07	4.4E-08	8.4E-11	0.0E+00	0.0E+00	9.1E-07	1.6E-01	1.1E-02	7.9E-07	0.0E+00	0.0E+00	1.8E-01
Radionuclides	EPC pCi/g												
Radium-226	2	7.2E-08	0.0E+00	6.5E-12	NAP	4.0E-06	4.1E-06	NA	NA	NA	NAP	NA	0.0E+00
Total Radionuclide		7.2E-08	0.0E+00	6.5E-12	NAP	4.0E-06	4.1E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Overall Total Risk		9.4E-07	4.4E-08	9.1E-11	0.0E+00	4.0E-06	5.0E-06	1.6E-01	1.1E-02	7.9E-07	0.0E+00	0.0E+00	1.8E-01

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

Table 5.15 Incremental Residual Risk for an Offsite Construction Worker at the Miami-Erie Canal Area

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Semi-Volatile Organic Compounds													
2-Methylnaphthalene	0.15	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Acenaphthene	0.195	NA	NA	NA	NAP	NAP	0.0E+00	1.5E-05	3.1E-05	NA	NAP	NAP	4.6E-05
Acenaphthylene	0.213	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.477	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.191	2.6E-10	2.3E-10	NA	NAP	NAP	4.9E-10	NA	NA	NA	NAP	NAP	0.0E+00
Dibenzofuran	0.195	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Fluorene	0.21	NA	NA	NA	NAP	NAP	0.0E+00	2.5E-05	3.1E-05	0.0E+00	NAP	NAP	5.5E-05
Naphthalene	0.14	NA	NA	NA	NAP	NAP	0.0E+00	3.3E-05	4.1E-05	7.4E-09	NAP	NAP	7.4E-05
Phenanthrene	0.773	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Pesticides													
Endrin Ketone	0.002	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Gamma Chlordane	0.0003	7.0E-12	8.8E-12	6.9E-17	NAP	NAP	1.6E-11	2.8E-06	3.5E-06	6.9E-11	NAP	NAP	6.3E-06
Metals													
Arsenic	0.9	9.1E-08	4.6E-09	8.8E-12	NAP	NAP	9.5E-08	1.4E-02	7.2E-04	8.2E-08	NAP	NAP	1.5E-02
Bismuth	3.1	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Copper	8.7	NA	NA	NA	NAP	NAP	0.0E+00	1.1E-03	7.7E-05	NA	NAP	NAP	1.2E-03
Lead	178	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Selenium	0.91	NA	NA	NA	NAP	NAP	0.0E+00	8.5E-04	4.0E-05	NA	NAP	NAP	9.0E-04
Thallium	0.88	NA	NA	NA	NAP	NAP	0.0E+00	5.2E-02	7.2E-03	NA	NAP	NAP	5.9E-02
Total Chemical		9.1E-08	4.8E-09	8.8E-12	0.0E+00	0.0E+00	9.6E-08	6.8E-02	8.1E-03	9.0E-08	0.0E+00	0.0E+00	7.6E-02
Radionuclides	EPC pCi/g												
Radium-226	1.04	3.7E-08	0.0E+00	3.4E-12	NAP	2.1E-06	2.1E-06	NA	NA	NA	NAP	NA	0.0E+00
Total Radionuclide		3.7E-08	0.0E+00	3.4E-12	NAP	2.1E-06	2.1E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Overall Total Risk		1.3E-07	4.8E-09	1.2E-11	0.0E+00	2.1E-06	2.2E-06	6.8E-02	8.1E-03	9.0E-08	0.0E+00	0.0E+00	7.6E-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
NC	Not a suspected carcinogen
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds
1.00E-06	Is equivalent to 1.00×10^{-6}

Table 5.16 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 5.16 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 5.17 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 5.17 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 5.18 Incremental Residual Risk for the Miami-Erie Canal Area Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Incremental Noncarcinogen Risk HI	Incremental Carcinogenic Risk ELCR
Resident Adult Scenario	Soil (all sample depths)	Chemical	Ingestion	2.0E-02	**3.8E-06**
			Dermal	6.2E-02	**1.4E-04**
			Inhalation of Dust	1.3E-07	3.6E-10
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	8.2E-02	**1.5E-04**
		Radionuclides	Ingestion	NAP	**5.8E-06**
			Inhalation of Dust	NAP	2.4E-08
			External	NAP	**5.0E-05**
			TOTAL	NAP	**5.6E-05**
		Chemical & Radionuclide Total		8.2E-02	**2.1E-04**
Resident Child Scenario	Soil (all sample depths)	Chemical	Ingestion	1.8E-01	**8.9E-06**
			Dermal	1.1E-01	**6.5E-05**
			Inhalation of Dust	2.6E-07	1.8E-10
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	3.0E-01	**7.4E-05**
		Radionuclides	Ingestion	NAP	**2.9E-06**
			Inhalation of Dust	NAP	2.6E-09
			External	NAP	**1.3E-05**
			TOTAL	NAP	**1.6E-05**
		Chemical & Radionuclide Total		3.0E-01	**9.0E-05**
Recreational Adult Scenario	Soil (0-2 ft bls)	Chemical	Ingestion	1.2E-03	2.7E-10
			Dermal	4.1E-03	1.4E-08
			Inhalation of Dust	1.0E-09	2.2E-16
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	5.3E-03	1.5E-08
		Radionuclides	Ingestion	NAP	3.9E-08
			Inhalation of Dust	NAP	1.1E-11
			External	NAP	**3.2E-06**
			TOTAL	NAP	**3.2E-06**
		Chemical & Radionuclide Total		5.3E-03	**3.2E-06**
Recreational Child Scenario	Soil (0-2 ft bls)	Chemical	Ingestion	8.1E-03	4.8E-10
			Dermal	5.6E-03	4.9E-09
			Inhalation of Dust	2.4E-09	1.3E-16
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	1.4E-02	5.3E-09
		Radionuclides	Ingestion	NAP	1.9E-08
			Inhalation of Dust	NAP	1.8E-12
			External	NAP	7.9E-07
			TOTAL	NAP	8.1E-07
		Chemical & Radionuclide Total		1.4E-02	**8.1E-07**

Table 5.18 Incremental Residual Risk for the Miami-Erie Canal Area Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Incremental Noncarcinogen Risk HI	Incremental Carcinogenic Risk ELCR
Off Site Construction Worker Scenario	Soil (0-10 ft bls)	Chemical	Ingestion	6.8E-02	9.1E-08
			Dermal	8.1E-03	4.8E-09
			Inhalation of Dust	9.0E-08	8.8E-12
			Inhalation of VOCs	0.0E+00	0.0E+00
			TOTAL	7.6E-02	9.6E-08
		Radionuclides	Ingestion	NAP	3.7E-08
			Inhalation of Dust	NAP	3.4E-12
			External	NAP	**2.1E-06**
			TOTAL	NAP	**2.1E-06**
		Chemical & Radionuclide Total		7.6E-02	**2.2E-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}

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 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.

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.

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Appendix A