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Residual Risk Evaluation

Parcel 4

Mound Plant
Miamisburg, OH

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ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances Disease Registry
ARAR	Applicable or Relevant and Appropriate Requirement
BVA	Great Miami Buried Valley Aquifer
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 Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
LOAEL	lowest observed adverse effects level
MEIMS	Mound Environmental Information and Management System
MMCIC	Miamisburg Mound Community Improvement Corporation
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
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
ppm	parts per million
PRS	Potential Release Site
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
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
UCL	upper confidence limit
UTL	upper tolerance limit
VOCs	volatile organic compounds

Parcel 4 Human Health Residual Risk Evaluation

Executive Summary

This report was prepared 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 Parcel 4. A Residual Risk Evaluation (RRE) quantifies 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. In the future, Parcel 4 may be used for commercial or industrial land use. Total risk, background risk, and incremental risk were calculated for current and future exposure scenarios for a construction worker and a site employee working in Parcel 4. Potential exposure to contaminants originating outside Parcel 4 that may reach receptors in the parcel are termed potential cumulative exposures. Potential cumulative risk was calculated for current and future exposure to groundwater and air.

To quantify future residual soil risk it was assumed that no degradation of the Constituents of Potential Concern (COPCs) would occur over time, therefore, current and future residual soil risks are the same. Current groundwater exposures were estimated using data collected from the Mound Plant production wells up through the year 2000, including approximately 17 years (1983-2000) worth of data. The Mound Plant production wells are finished in the Great Miami Buried Valley Aquifer (BVA). The concentration of contaminants in future groundwater were estimated using a model that assumes all contaminants currently detected in the bedrock aquifer of the Mound Plant property migrate to the BVA.

The terms "Release Blocks" and "Parcel" are both used in this report to designate portions of the Mound property to be evaluated for transfer. To streamline the transfer process, the Mound property was initially divided into 19 "release blocks", which are contiguous tracts of property designated for release. RREs must be completed before the transfer of a release block can be accomplished. RRE reports have been completed for Release Blocks D and H. When the Maintenance & Operations (M&O) contract for Mound oversight changed hands in 1997, the release blocks were reconfigured into 10 "Parcels" to shorten the schedule for site transfer.

COPCs in Parcel 4 soil for the construction worker scenario are identified in Table 2.2. Total, background, and incremental residual risk for the construction worker exposed to Parcel 4 soil is presented in Tables 5.1, 5.2, and 5.3, respectively. Total, background, and incremental residual non-cancer risk for a construction worker exposed to soil are all below the acceptable risk threshold of 1. Total residual cancer

risk for a construction worker exposed to soil in Parcel 4 is 3.3×10^{-5}, which falls within the acceptable risk range of 10^{-4} to 10^{-6} (increase in cancer risk of one human in ten thousand to one human in one million). Background residual cancer risk from soil for a construction worker in Parcel 4 was 6.9×10^{-6}. Incremental residual cancer risk for the construction worker exposed to soil was 2.9×10^{-5}.

COPCs in Parcel 4 surface soil for the site employee scenario are identified in Table 2.4. Total, background, and incremental residual risk for the site employee scenario exposed to Parcel 4 surface soil is presented in Tables 5.4, 5.5, and 5.6, respectively. Total, background, and incremental residual non-cancer risk for a site employee exposed to surface soil are all well below the acceptable risk threshold of 1 for non-carcinogenic risk. Total and incremental residual cancer risk from surface soil for a site employee in Parcel 4 is 1.0×10^{-4} and 6.4×10^{-5}, respectively, which fall within the acceptable risk range of 10^{-4} to 10^{-6}. Background residual risk from soil for a site employee in Parcel 4 was 4.4×10^{-5}.

Potential exposure to contaminants originating from outside Parcel 4 that may reach receptors in the parcel are termed potential cumulative exposures. Potential cumulative risk was calculated for current and future exposure to groundwater and air. The approach used to estimate potential cumulative risk for air is the same method as was used for Release Blocks D and H. Current groundwater risk was assessed using groundwater data available from the Mound Plant production wells. Potential cumulative risk from air and groundwater are reported in the Parcel 4 summary table at the end of this Executive Summary.

Potential cumulative risk was assessed for both current and future exposure to groundwater. Current groundwater exposures were estimated using data collected from the Mound Plant production wells (well numbers 271 and 076) up through the year 2000 including approximately 17 years worth of data. The Mound Plant production wells are finished in the Great Miami Buried Valley Aquifer (BVA). The concentration of contaminants in future groundwater were estimated using a model that assumes all contaminants currently detected in the Bedrock Aquifer of the Mound Plant property migrate to the BVA. Contaminant concentrations detected in the Bedrock Aquifer were added to the current contaminant concentrations detected in the Mound Plant production wells to estimate potential future exposures. Information on the derivation of future contaminant concentrations in groundwater is presented in Appendix B.

For the construction worker scenario antimony, cadmium, copper, and thorium-230 were identified as COPCs in current groundwater (Table 2.6). Total, background, and incremental residual risk for a construction worker exposed to current groundwater are presented in Table 5.7, 5.8, and 5.9, respectively. Total residual cancer risk from current groundwater for the construction worker scenario is 2.1×10^{-6}, due entirely to thorium-230. This risk level falls within the acceptable risk range of

10^{-4} to 10^{-6}. Background risk for a construction worker could not be quantified. Therefore, incremental residual cancer risk from current groundwater for a construction worker was 2.1×10^{-6}, which falls within the acceptable risk range for carcinogens. Total residual non-cancer risk from current groundwater for a construction worker is 1.3, which exceeds the acceptable risk threshold of 1 for non-carcinogenic risk. The largest contributor to this risk is antimony. Background residual non-cancer risk from current groundwater for a construction worker is 0.017. Incremental non-cancer risk for this receptor is 1.3 which, again, is largely due to antimony. The maximum concentration of antimony detected in the production wells was used to describe current groundwater to ensure that the actual risk from groundwater ingestion is not underestimated. However, these results were collected on May 6th 1991 using an uncertain analytical procedure. Uncertainty surrounding the concentration of antimony used in the current groundwater calculations is discussed further below.

For the site employee scenario antimony, cadmium, copper, actinium-227, plutonium-239/240, thorium-228, thorium-230, and uranium-234 were identified as COPCs in current groundwater (Table 2.8). Total, background, and incremental residual risk for a site employee exposed to current groundwater are presented in Table 5.10, 5.11, and 5.12, respectively.

Total residual cancer risk from current groundwater for a site employee is 2.1×10^{-5}. Background and incremental residual cancer risk from current groundwater for a site employee is 3.3×10^{-6} and 1.8×10^{-5}, respectively. All three of these risk levels fall within the acceptable risk range of 10^{-4} to 10^{-6}. Total residual non-cancer risk from current groundwater for a site employee is 1.1, which exceeds the acceptable risk threshold of 1 for non-carcinogenic risk. The largest contributor to this risk is antimony. Background residual non-cancer risk from current groundwater for a site employee is 0.014. Incremental residual non-cancer risk from current groundwater for a site employee is 1.1 which, again, is largely due to antimony. The maximum concentration of antimony detected in the production wells was used to describe current groundwater to ensure that the actual risk from groundwater ingestion is not underestimated. However, these results were collected on May 6th 1991 using an uncertain analytical procedure. Uncertainty surrounding the concentration of antimony used in the current groundwater calculations is discussed further below.

Final COPCs for future groundwater for the construction worker are identified in Table 2.10. Total, background, and incremental risks for the construction worker are presented in Tables 5.13, 5.14, and 5.15, respectively. Total residual non-carcinogenic risk from future groundwater for the construction worker is 5.5. Background non-carcinogenic risk from future groundwater for the construction worker scenario is 0.23 and increment residual non-carcinogenic risk from future groundwater is 5.4. The total and incremental non-cancer risk for the construction worker exceeds the acceptable Hazard Index (HI) of 1. Future total and incremental carcinogenic residual risk from groundwater for the construction worker scenario is 3.0×10^{-4}

and 2.9×10^{-4}, respectively, which exceed the acceptable risk range for carcinogens. Background residual carcinogenic risk from future groundwater for the construction worker scenario is 8.8×10^{-6}, which falls within the acceptable risk range.

Final COPCs for future groundwater for the site employee are identified in Table 2.12. Total, background, and incremental risks for the construction worker are presented in Tables 5.16, 5.17, and 5.18, respectively. Future total and incremental non-carcinogenic residual risk from groundwater for the site employee scenario were 5.1 and 4.9, respectively. Both of these values exceed the acceptable HI of 1. Future background non-carcinogenic risk in groundwater for the site employee is 1.2, which exceeds the acceptable Hazard Index of 1. Future total and incremental carcinogenic residual risk from groundwater for the site employee scenario was 5.9×10^{-5} and 5.4×10^{-5}, respectively. Total and incremental carcinogenic risk associated with exposure to groundwater falls within the acceptable risk range of 10^{-4} to 10^{-6} for the site employee scenario. Background carcinogenic risk from groundwater for the site employee scenario was 5.5×10^{-6}, which also falls within the acceptable risk range of 10^{-4} to 10^{-6}.

Airborne contaminant concentrations were measured at the Mound Facility in 1994 while various site restoration activities (DOE, 1994) were ongoing. This method assumes both current and future exposure to air. Both radiological and non-radiological data were collected. Since several soil-disturbing activities were going on during data collection, it is assumed that the measured air concentrations represent an upper-bound air concentration. Information on the derivation of these values is presented in Appendix D of the Release Block D RRE, December 1996 and a summary of the findings are presented in Appendix A of this report. Incremental cumulative carcinogenic risk due to exposure to contaminants in air was 2.0×10^{-7}, for the construction worker, and 9.8×10^{-7} for the site employee. In both scenarios, the result is less than the acceptable risk range. None of the COPCs identified in air have non-carcinogenic risk criteria so a HI was not calculated for exposure to contaminants in air.

Overall total, background, and incremental carcinogenic and non-carcinogenic risks are presented in the following table. The risk values in the tables are broken out by media (i.e., groundwater, air, and soil) and are the sum of risks for all pathways for the construction worker and site employee scenarios. Overall carcinogenic and non-carcinogenic risks associated with exposure to soil and air fall within the acceptable risk range of 10^{-4} to 10^{-6} and an HI of less than one for both potential receptors. Total and incremental carcinogenic and non-carcinogenic risks exceed the acceptable risk range for the future construction worker and the future site employee due to potential exposure to groundwater. Incremental carcinogenic risk is within the acceptable risk range for the current construction worker and current site employee. Total carcinogenic risk is within the acceptable risk range for the current construction worker but exceeds the acceptable risk range for the current site employee. Total and incremental non-carcinogenic risks for the

current and future construction worker, and current and future site employee exceed an HI of one due to potential exposure to groundwater. The cumulative incremental non-carcinogenic risk exceeds the standard (HI= one) for the four scenarios listed in the Overall Summary of Risks Table (presented below). The cumulative incremental excess lifetime cancer risk exceeds the acceptable risk range (10^{-4} to 10^{-6}) for the future Construction Worker Scenario (3.2×10^{-4}) and for the future Site Employee Scenario (1.2×10^{-4}). Where overall risk exceeds acceptable levels, these risks are driven by exposure to groundwater. These exceedences result from the conservative nature of the groundwater analysis. The groundwater model does not take into account natural physical and chemical processes such as dilution, dispersion, adsorption, and soil properties that may reduce contaminant levels by the time it reaches the BVA. As a result, the future groundwater exposure point concentration is biased high and conservative. Specifically, using the maximum detected value (a single measurement) from a data set that spans approximately seventeen years as the concentration representing a contaminant of potential concern, and assuming contaminants are present only in their most toxic form, overestimate the risk. Details are provided in Section 6, Uncertainties. Given the conservative nature of the RRE and the associated uncertainties, the risks presented in this table represent the upper-bound plausible limit of risks (worst case scenario). Based on the protective measures presented in the Proposed Plan for Parcel 4 and the conservative nature of the RRE, the future groundwater risks presented will be managed to be protective of human and environmental health.

To estimate future risk in the BVA, the Exposure Point Concentration (EPC) in the production wells was added to the flow tube modeled maximum detected concentration found in the bedrock wells. The flow tube model includes an assumption that the maximum concentration of a constituent detected in each of the twenty bedrock flow tubes impacts the BVA in the future. Natural physical and chemical processes such as dilution, dispersion, adsorption, and soil properties are ignored when establishing future estimated concentrations by this method. The model does not take into account chemical and physical process such as dilution, dispersion, and adsorption, which may reduce contaminant levels by the time it reaches the BVA. As a result of this methodology, the future EPC concentration is biased high and conservative. This added conservatism helps to compensate for the uncertainties in the characterization of the bedrock aquifer.

Data for the RRE was collected over a 17-year period and analytical detection limits and methods have changed. This has resulted in current lower detection limits and presents uncertainty in the data by adding potential bias to the EPC for a constituent. For groundwater, the historical and current groundwater data were used to estimate the exposure point concentration. Uncertainty is introduced because the analytical results for constituents in the groundwater, collected over a 17-year time period, may not meet the Data Quality Objectives (DQOs) currently in place for data collection at Mound. Antimony is an example of this type of uncertainty. The long time frame also means that contaminants detected in the production wells and bedrock wells may have degraded. For example, 17 years is roughly equivalent to one half-life for tritium.

The concentration of tritium in groundwater is reduced by half every 12 years.

Overall Summary of Risks

Scenario and Receptor	Overall Risk Types	Total Non-Carcinogen Risk HI			Total Excess Lifetime Cancer Risk		
		Soil	Groundwater	Air	Soil	Groundwater	Air
Current Construction Worker	Total	0.19	1.3	NA	3.3×10^{-5}	2.1×10^{-6}	2.1×10^{-7}
		Cumulative	1.5		Cumulative	3.6×10^{-5}	
	Background	0.027	0.017	NA	6.9×10^{-6}	NA	7.7×10^{-9}
		Cumulative	0.017		Cumulative	6.9×10^{-6}	
	Incremental	0.16	1.3	NA	2.9×10^{-5}	2.1×10^{-6}	2.0×10^{-7}
		Cumulative	1.5		Cumulative	3.2×10^{-5}	
Future Construction Worker	Total	0.19	5.5	NA	3.3×10^{-5}	3.0×10^{-4}	2.1×10^{-7}
		Cumulative	5.7		Cumulative	3.3×10^{-4}	
	Background	0.27	0.23	NA	6.9×10^{-6}	8.8×10^{-6}	7.7×10^{-9}
		Cumulative	0.25		Cumulative	1.6×10^{-5}	
	Incremental	0.16	5.4	NA	2.9×10^{-5}	2.9×10^{-4}	2.0×10^{-7}
		Cumulative	5.5		Cumulative	3.2×10^{-4}	
		Soil (0-2 feet bls)	Groundwater	Air	Soil (0-2 feet bls)	Groundwater	Air
Current Site Employee	Total	0.00067	1.1	NA	1.0×10^{-4}	2.2×10^{-5}	1.0×10^{-6}
		Cumulative	1.1		Cumulative	1.3×10^{-4}	
	Background	0.00064	0.014	NA	4.4×10^{-5}	3.3×10^{-6}	3.9×10^{-8}
		Cumulative	0.015		Cumulative	4.8×10^{-5}	
	Incremental	0.000032	1.1	NA	6.4×10^{-5}	1.8×10^{-5}	9.9×10^{-7}
		Cumulative	1.1		Cumulative	8.3×10^{-5}	
Future Site Employee	Total	0.00067	5.1	NA	1.0×10^{-4}	5.9×10^{-5}	1.0×10^{-6}
		Cumulative	5.1		Cumulative	1.6×10^{-4}	
	Background	0.00064	1.2	NA	5.0×10^{-5}	5.5×10^{-6}	3.9×10^{-8}
		Cumulative	1.2		Cumulative	5.0×10^{-5}	
	Incremental	0.000032	4.9	NA	6.4×10^{-5}	5.4×10^{-5}	9.9×10^{-7}
		Cumulative	4.9		Cumulative	1.2×10^{-4}	

bls = below land surface

Antimony was not used in large-scale at the Mound Plant. The highest concentrations of antimony detected (38.2 μg/L and 40.2 μg/L) were both collected on May 6th, 1991. Since both elevated results were collected on the same date, the possibility of sample contamination exists. May 6th 1991 precedes development of the Mound Quality Assurance Project Plan (DOE 1993a) by two years, so it is doubtful that the elevated antimony results meet the Mound DQOs. The Mound Environmental Information and Management System (MEIMS) database specifies the procedure used for antimony analysis as an "unknown CLP method" and the results were lab qualified as "B". When applied to inorganic compounds, like antimony, the "B" lab qualifier means that the reported value is greater than the instrument detection limit but less than the contract required reporting limit. The next highest detection of antimony (14.4 μg/L) was detected in April 7th, 1994 and antimony has not been detected in the BVA since. In addition to the monitoring data reported in MEIMS, monitoring of the production wells is conducted in accordance with the Safe Drinking Water Act (SDWA). The SDWA data for production well groundwater shows antimony at the detection limit of 0.6 μg/L. Despite this, the maximum concentration of antimony detected in the production wells (40.2 μg/L) was used to describe the current groundwater concentration.

Given the age, elevated detection limits, and uncertain analytical procedure used for the May 6th 1991 analyses, plus results of subsequent analysis that shows antimony at much lower levels, it seems highly unlikely that the concentration used to describe the current concentration of antimony in groundwater is accurate. The maximum concentration of antimony detected in the production wells was used to describe current groundwater to ensure that the actual risk from groundwater ingestion is not underestimated. However, this approach may result in an overestimation of actual current risk. Elimination of the questionable May 6th antimony results would lower the estimated current total risk from an HI of 1.3 for the construction worker down to an HI of 0.6 which is well below the acceptable risk threshold.

To estimate future maximum constituent concentrations in the BVA, the lower of the 95% UCL or maximum detected concentration in the production wells was added to the flow tube modeled maximum detected concentration found in the bedrock wells. The flow tube model includes an assumption that the maximum concentration of a constituent detected in each of the twenty bedrock flow tubes impacts the BVA in the future. Natural physical and chemical processes such as dilution, dispersion, adsorption, and soil properties are ignored when establishing future estimated concentrations by this method. It is possible that the soil and the bedrock layer would inhibit most of the groundwater sampled in the bedrock wells to ever migrate into the BVA. As a result of this methodology, the future EPC concentration is biased high and the future groundwater concentrations are overstated.

Furthermore, the Parcel 4 RRE assumed that future site users would utilize the production wells for

potable water supplies. The Miamisburg Mound Community Improvement Corporation (MMCIC), in the near future intends to tap future site-users into the municipal water supply system, therefore exposure to bedrock or BVA groundwater is unlikely. Using the production well and bedrock well data to estimate future risk is a conservative estimate of future risk.

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 weapons production facility to commercial or industrial use.

Parcel 4, the subject of this report, consists of 95.2 acres located immediately south of Operable Unit (OU) 5, the Mound Plant Production Area. A map of the Parcel 4 is included as Figure 1.2. Prior to DOE's purchase of Parcel 4 in 1981, the land had been in use for agricultural purposes. Parcel 4 remains undeveloped with the exception of a construction gate, a road from Benner Road and gravel-surface parking area, a contractor storage area, and an above ground power line running approximately north-south through the center of the property.

During past operations at the Mound facility, the release of hazardous waste has occurred. Subsequent facility investigations have identified over 400 potential release sites (PRSs). Since contamination at the Mound Plant occurs at discrete PRSs rather than being widespread across the site, a new decision-making process was formulated for Mound. The new process is known formally as the "removal site evaluation process" and informally as the "Mound 2000 process". The Mound 2000 process is consistent with the Federal Facilities Agreement (FFA) signed by DOE, the U. S. Environmental Protection Agency (EPA), and the Ohio Environmental Protection Agency (Ohio EPA), in accordance with the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) as defined in the National Contingency Plan [(NCP) EPA 1989].

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 Parcel 4. A Residual Risk Evaluation (RRE) assesses 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 Parcel 4 is ready for public use.

1.1 Purpose of Residual Risk Evaluation

The objective of the Parcel 4 RRE is to assess risks associated with residual levels of contamination that exist after completion of the removal action. Although the RRE method was developed specifically for use at Mound, the method is consistent with the CERCLA baseline risk assessment method to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks.

1.2 Scope of the Parcel 4 RRE

The RRE for Parcel 4 includes an evaluation of human health risk for potential residual contamination in the area. A remedial investigation of Parcel 4, also known as the Mound Plant New Property, was completed in February 1996. The results of this investigation were presented in the *Operable Unit 5 New Property Remedial Investigation Report* (DOE 1996). Since commercial/industrial use of Parcel 4 is anticipated, receptor scenarios were selected to represent reasonable maximum exposure (RME) conditions for a commercial/industrial setting. Residual contaminants in Parcel 4 were evaluated for two potential receptor groups: construction workers, who may be exposed to surface and subsurface soil, groundwater, and air for up to five years and site employees, such as office workers, who may be exposed to surface soil, groundwater, and air for up to 25 years. The construction worker and site employee were assumed to utilize groundwater from the Mound Plant production wells (wells 271 and 076) for their potable water supply while at work. Exposure assumptions for the construction worker and site employee scenarios are site-specific adaptations of the standard scenarios presented in EPA's Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989). These assumptions are documented in Table 1 in the Mound 2000 RREM (DOE 1997a) and are based on a RME assumptions. RME exposure assumptions are conservative and are therefore, not likely to underestimate residual risk.

The Parcel 4 residual risk evaluation included an assessment of total, background, and incremental risk. Total risk was calculated using the total concentration of identified constituents of potential concern (COPCs) detected in Parcel 4. 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 contaminant releases from past Mound Plant operations.

1.3 Organization of Report

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

The RREM consists of five elements, including:

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

The following sections describe each of these elements in more detail starting with Section 2.0, Data Compilation and Evaluation, which describes the methods used to compile Parcel 4 data and identify contaminants to be evaluated in the RRE. Section 3.0, Exposure Assessment, summarizes both the pathways through which hazardous substances may reach potential receptors and intake assumptions that will be 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, Uncertainty in the Risk Assessment, 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 Parcel 4 RRE. Newer data were used to supplement, rather than supercede 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 were 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. When a given sample was analyzed using both alpha and gamma spectroscopy methods, the more sensitive alpha spectroscopy results were used to characterize the sample.

Parcel 4 Data Set Components:

Project Code	Description	Reference	Comment
34896	New Property	Operable Unit 5 Remedial Investigation Report, Final, Rev 0, February 1996	
SWSD	Surface Water and Sediment	Operable Unit 9 Surface Water and Sediment Investigation Report, Technical Memo, Rev 2, September 1996	
RSS	Radiological Site Survey – OU9 Site Scoping Report	Operable Unit 9 Site Scoping report Volume 3; Radiological Site Survey, Final, June 1993	
SCRDATA	Mound Plant Screening Data	Not published- Data are in MEIMS	
SGCSP	Soil Gas Confirmation Sampling	Operable Unit 9 Further Assessment Soil Gas Confirmation Sampling, Final, Rev 0, May 1996	
04-2768	Regional Soils Investigation	OU 9 Regional Soils Investigation Report, Final, Rev 2, August 1995	
34897	New Property Extended Phase	Operable Unit 5 Remedial Investigation Report, Final, Rev 0, February 1996 Or Operable Unit 5 New Property Extended Phase I Field Report, Final, Rev 0, July 1995	
MND33	Operable Unit 3 LFI	Operable Unit 3 Miscellaneous Sites Limited Field Investigation Report, Final, Rev 0 July 1993	
WDSOIL	WD Building Soil Characterization		Ecotek
	Parcel 4/5 Boundary Sampling	Not published- Data are in MEIMS	
Groundwater	BVA Mound Production Well Sampling Bedrock aquifer monitoring well sampling	Compiled from the MEIMS database and reported in Release Blocks H and D RRS reports.	
Air	1994 Site Restoration activities	Mound Site Environmental Report for Calendar Year 1994, MLM-3814, (DOE 1994)	

2.1 Data Quality Assessment

Samples were collected and analyzed according to the methods outlined in the Operable Unit (OU) 9 Quality Assurance Project Plan (QAPP) (DOE 1993a) and the OU5 QAPP (DOE 1993b). Since some of the data used to characterize residual contaminant concentration in Parcel 4 were collected prior to 1993, not 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 QAPP (DOE 1993a).

2.2 Environmental Media Considered and Data Availability

Field investigations conducted for Parcel 4 are listed above. Samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), inorganic compounds, common anions, pesticides, polychlorinated biphenyls, and radionuclides. Environmental media evaluated include surface soil (0-2 ft below land surface), subsurface soil (>2 feet below land surface), sediment, groundwater, and air. Parcel 4 does contain surface drainageways and some seeps that are present year round, but no persistent surface water bodies (i.e., ponds, streams). Since ditch sediments are typically dry, sediment samples collected in Parcel 4 were evaluated with the surface soil data. However, some seeps are present year-round on Parcel 4. Since RAGs states that risk from surface water/seeps can be approximated by risk from sediment, which is treated the same as soil, exposure to contaminants in seeps is accounted for within the direct soil exposure pathway.

Current groundwater exposures were estimated using data collected from the Mound Plant production wells (wells 271 and 076), which are finished in the BVA. The concentration of constituents in future groundwater was estimated using a flow tube model that assumes all contaminants currently detected in the Bedrock Aquifer of the Mound Plant property migrate to the BVA. Future estimated modeled contaminant concentrations in the Bedrock Aquifer were added to the current maximum contaminant concentrations detected in the Mound Plant production wells. This method is described in more detail in Appendix B. The approach used to estimate potential cumulative risk from exposure to air is the same method as was used for Release Block D (Appendix D of the December 1996 report). The air risk values were not recalculated but carried forward from Release Block D. Potential cumulative risks due to contaminants released to the air are discussed in more detail in Appendix A.

2.3 Data Analysis

For each constituent detected in Parcel 4 soils and current groundwater from the production wells, 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. For future groundwater, modeled values were used as the EPC. The Flow Tube model used to predict future contaminant groundwater concentrations is described in Appendix B. The 95% UCL was calculated in accordance with the Mound 2000 RREM (DOE 1997a), 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 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 were calculated as follows:

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

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:

$$95\%\ UCL = e^{Mean + 0.5\ s2\ + H(s/(n-1)\ 1/2)}$$

Where:

UCL = upper confidence limit,
e = constant (base of the natural log, equal to 2.718)
Mean=mean of the transformed data
s = standard deviation of the transformed data
H = H statistic (e.g., from table published in Gilbert 1987),
n = number of observations in the data set

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, qualified as U or UJ) results were treated as one-half the limit of detection and included in the calculations of the mean and 95% UCL values. Samples reported as ND or zero with no detection limit were not utilized in calculating a 95% UCL.

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 Data flagged with an "R", meaning rejected, were 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. Soil data were also sorted by depth. 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.

To make the COPC selection process easier to understand, the COPC selection tables have been broken into two tables. The first table identifies initial COPCs by comparing the maximum concentration detected in a given media to background values and Mound Guideline Values (GVs) for the given receptor. The maximum concentration of a detected constituent was screened for frequency of detection. If it was detected in less than one out of 20 samples or a frequency of 5%, the constituent was not retained as a COPC. In this initial table, the constituents were also screened against corresponding background concentrations and GVs for the Mound. If the maximum concentration was less than either of these values, it was not carried through the RRE process. The second table identifies final COPCs by comparing the EPCs (minimum of either the 95% UCL or the maximum detected concentration) for the retained initial COPCs to background values. Tables 2.1 and 2.2 identify the COPCs in soil for the construction worker scenario and Tables 2.3 and 2.4 identify COPCs for the site employee scenario. Tables 2.5 and 2.6 identify the COPCs in current groundwater for the construction worker scenario and Table 2.7 and 2.8 identify COPCs in current groundwater for the site employee scenario. Tables 2.9 and 2.10 identify the COPCs in future groundwater for the construction worker scenario and Tables 2.11 and 2.12 identify the COPCs in future groundwater for the site employee scenario.

2.4.1 Screening Constituents Based on Background

Site-specific background concentrations described as the 95% Upper Tolerance Limit (UTL) of the background sample results for each constituent were calculated for Mound Plant soil and groundwater, and

are presented in the Mound 2000 RREM (DOE 1997a). Constituents with a maximum detected concentration exceeding their level in background were identified as initial COPCs and carried to the next screening 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 screening step of the RRE. These background concentrations were also used to quantify background risk.

For initial COPCs with a 95% UCL of the arithmetic mean less than 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. Eliminating these constituents is consistent with the Mound 2000 RREM and focuses the RRE on constituents detected above background.

2.4.2 Screening Constituents Based on Guideline Values

Soil and groundwater constituents with maximum detected concentrations greater than background concentration were compared to risk-based GVs for the Mound Facility (DOE 1997c). GVs are media-specific concentrations of constituents that correspond to specific human health risk levels for specified exposure scenarios. GVs were developed for the construction worker and site employee scenarios (see DOE 1997c for the detailed derivation of GVs). Construction worker and site employee GVs, were used to screen detected constituents as COPCs to be retained for the quantitative risk assessment for each of the identified receptors.

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 1.0×10^{-6} risk level for carcinogens and radionuclides, and to a Hazard Quotient (HQ) of one for each non-carcinogenic constituent. Some of the radionuclide GVs are designated as +D to indicate that cancer risk estimates and GVs include contributions from the radionuclide's short-lived decay products, or daughters. These calculations assumed equal activity concentrations (i.e. secular equilibrium) with the principal or parent nuclide in the environment. For Parcel 4, GVs for radionuclides that include daughter decay products were used for actinium-227, neptunium-237, radium-228, strontium-90, thorium-228, thorium-230, thorium-232, uranium-235, and uranium-238. When GVs were unavailable, they were calculated using the Mound GV methodology (DOE 1997c) due to updated toxicity criteria or lack of a previously calculated GV. The calculations for these updated GVs are provided in Appendix C.

A $1x10^{-6}$ risk level represents an incremental increase of one human in a million of developing cancer as a result of exposure to the GV concentration. A Hazard Quotient of one indicates that from an exposure at or below the given concentration, no adverse effects to humans are expected. Since the acceptable risk level for carcinogenic constituents specified in the NCP is a range of $1x10^{-4}$ to $1x10^{-6}$ (1 human in 10,000 to 1 human in a million), screening COPCs against the whole GV is protective. The target threshold for non-carcinogenic constituents is a Hazard Index (HI) of less than or equal to one. The GV values were calculated for a HI of one. To account for the possibility of more than one non-carcinogenic constituent, COPCs were screened using 1/10 the GV. 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. Frequency of detection was evaluated as the number of detections divided by the total number of samples analyzed for a constituent. 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.

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 Parcel 4 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 Parcel 4 area.

2.4.5 Additional Screening Procedures

In accordance with the RREM, additional screening procedures also were used to evaluate Parcel 4 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.

2.4.6 Screening Procedures for Future Groundwater

To estimate the future concentration of COPCs in groundwater, the flow tube model was applied to bedrock well data based on the maximum concentration detected. This procedure is discussed in detail in Appendix B. In accordance with the RREM, an initial screen was necessary to determine which constituents were to be carried through the flow tube model. All constituents detected in the bedrock wells were screened for frequency of detection as well as a comparison to the background and GV values. Those constituents that exceeded these criteria were retained for flow tube modeling. In addition, those constituents that were COPCs in the current groundwater RRE were retained for flow tube modeling. To obtain a final estimated future groundwater concentration for each COPC, the maximum concentrations detected in a given bedrock flow tube was modeled for future contribution to the BVA and added to the EPC (lower of the 95% UCL or the maximum concentration) detected in the production wells. The estimated future maximum constituent concentrations in the BVA are presented in Appendix B.

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 and future conditions with the area being used for industrial/commercial purposes. The information gathered in the exposure assessment is integrated with toxicity information to characterize potential risks associated with exposure to residual contamination in the Parcel 4 area.

3.1 Characterization of Exposure Setting

Parcel 4 consists of 95.2 acres located immediately south of the Mound Plant Production Area. On August 26, 1981 the DOE purchased an additional 124 acres of land contiguous with and south of the original 182 acres at Mound Plant. The new property was bounded by the Mound Plant to the north, private property to the east, Benner Road to the south, and the Miami Erie Canal to the west. The land had been in use for agricultural purposes. Following purchase of the property in 1981, DOE razed a two-story brick house, a barn, a frame tool shed and an outhouse and disposed of some farm implements and discarded appliances left by the previous owner. A farm fence was put up around the perimeter of the new property. In 1999 the north property line of this area was shifted slightly to the south to exclude an area of known contamination south of an east-west road running along the southern boundary of the Mound Plant production area. The remaining 95.2 acres is now called Parcel 4.

Parcel 4 remains undeveloped with the exception of a construction gate, a road from Benner Road and gravel-surface parking area, a contractor storage area, and an above ground power line running approximately north-south through the center of the property. Topographically, the land can be described as gently rolling in the southwest with steeply sloped bluffs in the northwest where Parcel 4 abuts to the Mound Plant production area. There are natural drainage channels within Parcel 4 and groundwater seeps that are present year round. An archaeological survey of Parcel 4 was conducted in 1987. Two sites of archaeological interest were discovered, however, neither was regarded as being eligible for the National Register, and no further work was recommended at either location (Riordan 1987).

PRS 306, 314, 406, and 419 are located in Parcel 4. PRS 306 is a groundwater seep located along the eastside of Parcel 4 approximately mid-way between the northern and southern boundaries. PRS 314 is an area that contained farm debris and was the location of potential oil releases from previous farm operations. PRS 406 is a tongue-shaped area of potential radiological contamination in the northern end of Parcel 4 and on the Mound Plant property. PRS 406 was investigated and a surface water interceptor ditch was installed in August and September 1995. PRS 419 is the new Mound Plant drainage re-route. The *Operable Unit 5 New Property Remedial Investigation Report* (RIR) (DOE 1996) concluded that no further assessment was needed for Parcel 4.

3.2 Identifying Exposure Pathways

Although many exposure pathways are possible, the RRE focuses on those pathways that are likely to occur and are likely to contribute significantly to the overall risk. 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 releases, (2) a transport media, (3) a point of potential human contact with the contaminant or 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 pictorial representation of the exposure pathways identified for potential receptors is included in a conceptual site model for the Parcel 4 (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 1997c) and the Mound 2000 RREM (DOE 1997a). Exposure assumptions used to quantify contaminant exposures are summarized in Table 3.1.

3.3 Identifying Exposure Scenarios

Residual contamination in Parcel 4 was evaluated for two potential use scenarios. Residual contamination in the Parcel 4 area was evaluated for adult construction workers and adult site employees. It was assumed that construction workers and site employees could potentially be exposed to soil/sediment, groundwater, and air. The evaluation of risk associated with exposure to residual contamination in the Parcel 4 area for these receptors will indicate whether economic redevelopment can be safely conducted in the area.

3.3.1 Construction Worker Scenario

Since it is reasonable to assume that construction activities could occur within the Parcel 4 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 the land surface. Potential exposure pathways include incidental soil ingestion, dermal contact, external radiation exposure, and inhalation of airborne dust and vapors. Although the possibility of dermal exposure to surface and subsurface soil does exist for a construction worker, quantification of risk from this route of exposure requires both a chemical-specific skin absorption value and dermal toxicity value. Of the COPCs identified for Parcel 4, chemical-specific skin absorption factors are currently available for only benzo(a)pyrene and other polycyclic aromatic hydrocarbons (PAHs). The use of dermal default absorption values for inorganic compounds is currently not recommended by EPA (EPA 1999b). For many chemicals, including most of the Parcel 4 COPCs, scientifically defensible data does not exist to derive a dermal toxicity value or for making an adjustment of on oral cancer slope factor (CSF) or reference dose (RfD) to estimate a dermal toxicity value (EPA 1999b). Without these critical input parameters, risk due to dermal exposure to soil

cannot be quantified. However, EPA recommendations for the adjustment of toxicity factors for PAHs were used. The exclusion of inorganic compounds and radionuclides from this pathway is expected to have a minimal impact on the final risk-based calculations because human exposure to these compounds in soil is generally driven by other pathways of exposure, such as external exposure or incidental ingestion.

It was also assumed that construction workers would use BVA groundwater for drinking water supply and for showering. Exposure pathways include ingestion and inhalation of vapors and dermal contact with groundwater while showering. Construction workers were assumed to be on the property 8 hours per day, 250 days per year over a 5-year period. Since construction workers are assumed to be adults, a body weight of 70-kilogram was used to assess exposure to chemical contaminants.

Current and future exposure scenarios for the construction worker are identical except for groundwater. In order to estimate the future contaminant concentrations in groundwater, the modeled future estimated concentration of contaminants detected in the bedrock aquifer were added to current contaminant concentrations in the Mound Plant production wells. 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;
- ingestion of contaminated groundwater as drinking water;
- inhalation of volatile contaminants from groundwater while showering at work;
- dermal contact with soil at or below land surface; and
- dermal contact with contaminated groundwater while showering at work.

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

3.3.2 Site Employee Scenario

Although exposures will vary depending on the type of work performed, it is reasonable to assume that a site employee at Parcel 4 will be exposed to residual contamination left on the property. The site employee scenario assumes that a worker will be employed in an office or commercial setting, with the majority of working hours spent indoors. Such occupations are not expected to involve direct work with surrounding soils, as would be expected with the construction worker. The exposure routes evaluated for the site employee are similar to those evaluated for the construction worker except the site employee is assumed

to work indoors and therefore have less exposure to site soil. Potential soil exposure pathways include incidental soil ingestion, external radiation exposures, and inhalation of airborne dust and vapors. Site employees were assumed to use BVA groundwater for potable supply, but are not expected to shower at work. Site employees were assumed to be on the property 8 hours per day, 250 days per year over a 25-year period. Since site employees were assumed to be adults, a body weight of 70-kilogram was used to assess exposure to chemical contaminants. The exposure pathways evaluated for the future site employee include:

- incidental ingestion of soil 0-2 feet below land surface;
- external exposure to ionizing radiation from radionuclides in soil 0-2 feet below land surface;
- inhalation of airborne contaminated dust;
- inhalation of volatile emissions from soil; and
- ingestion of contaminated groundwater as drinking water;

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. The EPC for soil and current groundwater used in 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 lognormally distributed, the EPC estimate was calculated as the 95% UCL using the H-statistic (EPA 1992a).

Only surface soil data (0-2 feet below land surface) were used to calculate the EPC for the site employee. Site employees are assumed to spend most of their time indoors and have limited contact with surface soil. Construction workers were assumed to be exposed to both surface and subsurface soil. Therefore, the EPC for the construction worker was calculated using soil sample data collected at any depth.

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 Risk Assessment Guidance for Superfund (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.

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. There is a fundamental difference between exposures to chemical contaminants as compared to radionuclide contaminants. Radionuclides can have deleterious effects on humans without being taken into the body. Radiation exposure can result from exposure to gamma and x-ray emitting radionuclides that are external to the receptor.

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. The slope factors for radionuclides are expressed as the average risk per unit intake or exposure for an individual in a stationary population; therefore, radionuclide intakes and slope factors are not expressed as a function of body weight and time.

Another key difference in the method used to assess radiological risk is the inclusion of short-lived decay products, or daughter products, for radionuclides designated with the suffix +D. The calculation of risk for radioactive decay chain products assumed equal activity concentrations (i.e. secular equilibrium) with the principal or parent nuclide in the environment. Risk calculations for decay chain products were assessed by summing the ingestion, inhalation, and external slope factors for the parent radionuclide and decay members of continuous decay chains (EPA 2000).

Chemical intakes from oral and inhalation exposure 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.

3.5.1 Soil Exposure Pathways

Exposure to soil through incidental ingestion was evaluated for construction workers and site

employees under current and future land use scenarios. Intake estimates for the chemical contaminants in the soil ingestion pathway were estimated by means of the following equation:

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

Where:

C_{SO}	=	Contaminant concentration in soil (mg/kg)
IR	=	Ingestion rate (mg/day)
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 intake estimates for the soil via incidental ingestion was estimated by means of the following equation:

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

Where:

C_{SO}	=	Radiological activity in soil (pCi/g)
IR	=	Ingestion rate (mg/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (10^{-3} g/mg)

Unlike inhalation and ingestion exposure to soil, the external radiation exposure term is defined as an equivalent radionuclide concentration in soil that an onsite receptor would be exposed to for a particular duration. This exposure term is adjusted for exposure time and shielding. For the Parcel 4 area RRE a default-shielding factor of 20% for the site employee and 10% for the construction worker scenarios were assumed. These assumptions provide for a conservative estimate of external radiation exposure.

The intake equation for radionuclide contaminants via the external exposure pathway was estimated using the following equation:

$$IR_{ext}\ \text{(pCi/g-yr)} = Cso \times ED_{ex} \times (1\text{-}Se) \times Te$$

Where:

IR_{ext}	=	External exposure contact rate (pCi-yr/g)
Cso	=	Radiological activity of soil (pCi/g)
ED_{ex}	=	Exposure Duration x 0.685 (days worked/days in a year= 250/365) (year)
Se	=	Gamma Shielding Factor (unitless)
Te	=	Gamma Exposure Time Factor (unitless)

Intake of soil (fugitive dust) via inhalation was evaluated for construction workers and site employees under current and future use scenarios. The intake equation for chemical contaminants by this means is provided below:

$$\text{Intake (mg / kg – day)} = \frac{C_{so} \times IR_{air} \times EF \times ED}{PEF \times BW \times AT}$$

Where:

C_{so}	=	Contaminant concentration in soil (mg/kg)
IR_{air}	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
PEF	=	Particulate emission factor (4.28×10^9 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:

$$\text{Intake (pCi)} = \frac{C_{so} \times IR_{air} \times EF \times ED \times CF}{PEF}$$

Where:

C_{SO}	=	Radiological activity in soil (pCi/g)
IR_{air}	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (1000 g/kg)
PEF	=	Particulate emission factor (4.28×10^9 m^3/kg, EPA default value)

The PEF relates the concentration of the contaminant in soil to the concentration of respirable particles in the air from fugitive dust emissions. These emissions result from wind erosion. The default value of 4.28×10^9 m^3/kg was taken from Risk-Based Guideline Values (DOE 1997c).

Volatilization of chemical contaminants from soil may result in exposures via inhalation for construction workers and site employees; however, no volatile COPCs were identified in the Parcel 4 area. Therefore, this pathway was not evaluated for chemical constituents.

3.5.2 Groundwater Exposure Pathways

Intake from the ingestion of groundwater was evaluated for construction workers and site employees under current and future use scenarios. The current concentration of contaminants in groundwater was derived from concentrations detected in the Mound Plant production wells. The future concentration of contaminants in groundwater assumes that all contaminants detected in the bedrock wells will migrate to the BVA and be withdrawn at the Mound Plant production wells. Historical and current bedrock well data was screened and modeled to predict future contribution to the BVA from bedrock using a Flow Tube Model. This future bedrock estimated concentration was then added to the EPCs in the Mound Plant production wells to provide the estimated future contaminant concentrations in groundwater used to calculate future groundwater risk. The discussion of the Flow Tube Model and future bedrock estimated concentrations and total future estimated groundwater concentrations are presented in Appendix B. Risk was then calculated for current and future intake of groundwater under the construction worker and site employee scenarios. The following equation was used to estimate current and future intake of chemical COPCs from the ingestion of groundwater as a drinking water source for both the construction worker and the site employee:

$$\text{Constituent Intake (mg / kg–day)} = \frac{C_W \times IR_W \times EF \times ED}{BW \times AT}$$

Where:

C_W	=	constituent concentration in water (mg/L)
IR_W	=	ingestion rate (L/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)

In addition to groundwater ingestion, the construction worker was assumed to shower at work. While showering, workers were assumed to have dermal exposure to contaminants in groundwater and to

inhale volatile contaminants while showering. The dermal absorbed dose from dermal contact with constituents in groundwater was calculated as follows:

$$\text{Constituent DAD (mg/kg-day)} = \frac{DA_{event} \times EV \times EF \times SA \times ED}{BW \times AT}$$

Where:

DAD	=	dermal absorbed dose (mg/kg-day)
DA_{event}	=	absorbed dose per event in water (mg/cm^2-event)
EV	=	events per day (day^{-1})
EF	=	exposure frequency (days/year)
SA	=	surface area of skin exposed (cm^2)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)

For inorganics, DA_{event} (mg/cm^2-event) was calculated as follows:

$$DA_{event} = K_p \times C_w \times t_{event} \times 10^{-3}\ L/cm^3$$

Where:

DA_{event}	=	absorbed dose per event in water (mg/cm^2-event)
K_p	=	chemical-specific permeability coefficient (cm/hr)
C_w	=	concentration of chemical in water (mg/L)
t_{event}	=	duration of event (hr/event)

For organics, DA_{event} (mg/cm^2-event) was calculated as follows:

$$DA_{event} = 2 \times K_p \times C_w\ 10^{-3}\ L/cm^3 \times (6 \times T \times t_{event}/л)^{1/2}$$

Where:

DA_{event}	=	absorbed dose per event in water (mg/cm^2-event)
K_p	=	permeability coefficient from water (constituent-specific, cm/hr)
C_w	=	concentration of chemical in water ($mg/cm^3 = 10^{-3}$ mg/L)
t_{event}	=	duration of event (hr/event)
T	=	lag time (hour)
л	=	constant (3.14159)

Constituent-specific permeability coefficient values (K_p) and the formula for the calculation of K_p was taken from Chapter 5 of *Dermal Exposure Assessment: Principles and Applications* (EPA 1992b). If a K_p was not found, it was calculated using the following formula:

$$\log(PC) = -2.72 + 0.71 \log(K_{o/w}) - 0.0061\ MW$$

Where:

log PC	=	log of the constituent-specific permeability coefficient
$K_{o/w}$	=	octanol/water coefficient (constituent-specific)
MW	=	molecular weight (g/mole)

The following equation was used to calculate the intake of radionuclides from dermal contact with water:

$$\text{Intake(pCi)} = C_w x SA x K_p x EF x ED x ET_s x 1000 x \frac{L}{m^3}$$

Where:

C_w	=	concentration of contaminant in water (pCi/L)
SA	=	surface area of skin exposed (cm^2)
K_p	=	chemical-specific permeability constant (cm/hr)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
ETs	=	duration of event (hours/day)

The following equation will be used in the RRE to calculate chemical contaminant intake from inhalation during showering:

$$\text{Intake } (m\ /kg - d) = \frac{C_w \times K \times IR_{air} \times EF \times ED \times ET \times CF}{BW \times AT}$$

Where:

C_w	=	contaminant concentration in water (mg/L)
K	=	volatilization factor (L/m^3)
IR_{air}	=	inhalation rate (m^3/d)
EF	=	exposure frequency (d/yr.)
ED	=	exposure duration (yr.)
ET	=	exposure time (hr/d)
CF	=	conversion factor (1d/24 hr)
BW	=	body weight (kg)
AT	=	averaging time (yr x 365 d/yr.)

Tritium is the only radionuclide present at the Mound Plant that is volatile enough that its vapor needs to be considered for the inhalation pathway. The following equation was used to calculate tritium intake from inhalation during showering:

$$\text{Intake(pCi)} = C_W \times IR_{air} \times EF \times ED \times M_{total} \times ET_S \times \frac{L}{1000g}$$

Where:

C_W	=	Tritium concentration in water (pCi/L)
IR_{air}	=	inhalation rate (m^3/d)
EF	=	exposure frequency (d/yr)
ED	=	exposure duration (y)
M_{Total}	=	airborne mass concentration of water in shower (66.96 g/m^3, HAZWRAP, 1995)
ET_S	=	shower duration (hr/d)

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 Parcel 4. The RRE for the Parcel 4 area evaluated chronic exposures. The RRE utilized methods recommended by EPA for evaluating human cancer effects resulting from exposure to the COPCs. 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. HEAST contains slope factors needed to evaluate the carcinogenicity of radionuclides. 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 deleterious 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. EPA classifies all radionuclides as carcinogens and the process of carcinogenesis 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 slope factor (CSF), is

calculated. The HEAST lists ingestion, inhalation, and external exposure CSF for radionuclides in the units of picocuries (pCi). Ingestion and inhalation slope factors are central estimates in a linear model of the age-averaged, lifetime-attributable radiation cancer incidence (fatal and nonfatal) risk per unit of activity inhaled or ingested. 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 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. For the Parcel 4 RRE oral administered-dose, EPA recommended compound-specific gastrointestinal absorption factors used for adjusting toxicity values were only available for PAHs.

5.0 RISK CHARACTERIZATION

This section presents the risk characterization for the Parcel 4 area. In risk characterization, 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 Parcel 4 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 Parcel 4 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:

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

Where:

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

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

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

Where:

Risk_t	=	The combined excess lifetime cancer risk across chemical carcinogens
Risk_i	=	The risk estimate for the ith chemical of n chemicals under evaluation.

5.1.2 Quantification of Non-carcinogenic Risk

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

$$\text{HQ} = \text{Intake}/\text{RfD}$$

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).

$$HI = \sum_{i=1}^{n} HQ$$

Where:

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

EPA has established acceptable risk levels for use in determining the need for site remediation. For non-carcinogenic effects, EPA has set the acceptable HQ at one. If the HQ is greater than 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 Parcel 4 by potential receptor. Risk estimates for individual soil COPCs for all scenarios and pathways are presented in Tables 5.1 through 5.6. Tables 5.1 through 5.3 present soil risk estimates based on construction worker exposure parameters, and Tables 5.4 through 5.6 present soil risk estimates based on site employee exposure parameters. Total risk was calculated using the total concentration of the COPCs detected in Parcel 4. 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 5.19 through 5.21 present summaries of the risk results for all scenarios and media for exposure pathways assessed in the RRE.

Current groundwater risk was assessed using the EPC for the COPCs and the risk equations presented in Section 3.5.2. Appendix B presents the methodology for calculation and values of the future groundwater COPCs. Risks due to exposure to current and future groundwater are presented in Tables 5.7

through 5.18. In the summary Tables 5.19 through 5.21, risk estimates that are at or above the non-cancer HI of 1 and the cancer acceptable risk level of 10^{-6} are bolded. The NCP acceptable risk range is 10^{-4} to 10^{-6} and risk is evaluated at levels above 10^{-6}.

5.2.1 Construction Worker Risk Results

Soil

Final COPCs for soil for the construction worker are identified in Table 2.2. Tables 5.1 through 5.3 present total, background, and incremental risk for a construction worker in Parcel 4, respectively. Total residual non-carcinogenic risk for a construction worker due to COPCs in soil was 0.19, which is below the target HQ of one. Most of this risk (0.15 or 80%) is due to antimony. Background and incremental residual non-carcinogenic risk for a construction worker due to COPCs in soil also fell below the target HQ of one. Total and incremental residual cancer risk from soil for a construction worker in Parcel 4 is 3.3×10^{-5} and 2.9×10^{-5}, respectively, which falls within the acceptable risk range of 10^{-4} to 10^{-6}. Background residual risk from soil for a construction worker in Parcel 4 was 6.9×10^{-6} and is based only on background concentrations of thorium-230. Incidental soil ingestion and external radiation are the exposure pathways that contributed significantly to residual cancer risk. Incidental soil ingestion contributes 60% and external radiation contributes 41% of the total residual cancer risk for a construction worker in Parcel 4 soil.

Current Groundwater

Final COPCs for current groundwater for the construction worker are identified in Table 2.6. Total, background, and incremental risk for a construction worker exposed to current groundwater is presented in Tables 5.7 through 5.9. Total and incremental non-carcinogenic residual risk from current groundwater for the construction worker is 1.3. This value exceeds the target HI of 1. Antimony is responsible for 84% of the current groundwater non-carcinogenic risk. Current background non-carcinogenic residual risk for the construction worker due to exposure to groundwater is 0.017, which does not exceed target non-carcinogenic risk. Current total and incremental carcinogenic risks associated with exposure to groundwater is 2.1×10^{-6}, which falls within the acceptable risk range of 10^{-4} to 10^{-6}. Thorium-230 is responsible for 100% of carcinogenic risk via the ingestion pathway.

Future Groundwater

Final COPCs for future groundwater for the construction worker are identified in Table 2.10. Total, background, and incremental risks for the construction worker are presented in Tables 5.13, 5.14, and 5.15, respectively. Total residual non-carcinogenic risk from future groundwater for the construction worker was 5.5. Background non-carcinogenic risk from future groundwater for the construction worker scenario was 0.23 and increment residual non-carcinogenic risk from future groundwater was 5.4. Total and incremental non-cancer risk for the construction worker exceed the target Hazard Index (HI) of 1. Future total and incremental carcinogenic residual risk from groundwater for the construction worker scenario was 3.0×10^{-4} and 2.9×10^{-4}, respectively, which exceed the acceptable risk range for carcinogens. Background residual carcinogenic risk from future groundwater for the construction worker scenario was 8.8×10^{-6}, which falls within the acceptable risk range.

Air

Potential cumulative carcinogenic risk due to exposure to contaminants in air was 2.1×10^{-7}, which is less than the acceptable risk range. None of the COPCs identified in air have non-carcinogenic risk criteria, so a HI was not calculated for exposure to contaminants in air.

5.2.2 Site Employee Risk Results

Surface Soil

Final COPCs for surface soil for the site employee are identified in Table 2.4. Total, background, and incremental residual soil risk for a site employee in Parcel 4 is presented in Tables 5.4, 5.5, and 5.6, respectively. Total residual non-cancer risk for a site employee exposed to surface soil in Parcel 4 is 0.00067, which is well below the acceptable HQ of one. Background and incremental residual non-cancer risk for a site employee exposed to surface soil in Parcel 4 is also well below the acceptable HQ of 1. Total and incremental residual cancer risk from surface soil for a site employee in Parcel 4 are 1.0×10^{-4} and 6.4×10^{-5}, respectively, which fall within the acceptable risk range of 10^{-4} to 10^{-6}. Background residual cancer risk from surface soil for a site employee in Parcel 4 is 4.4×10^{-5}. External exposure to surface soil is the exposure pathway that contributes 95% to residual soil cancer risk for the site employee from Parcel 4.

Current Groundwater

Final COPCs for current groundwater for the site employee are identified in Table 2.8. Total, background, and incremental residual current groundwater risk for a site employee in Parcel 4 is presented in Tables 5.10, 5.11, and 5.12, respectively. Total and incremental non-carcinogenic residual risk from current groundwater for the site employee scenario is 1.1, which exceeds the acceptable HI of 1. Antimony via the ingestion pathway is responsible for 85% of the non-carcinogenic risk. Current background non-carcinogenic residual risk for the site employee due to exposure to groundwater does not exceed target non-carcinogenic risk. Total and incremental carcinogenic risks for site employees exposed to current groundwater is $2.2x\ 10^{-5}$ and $1.8x10^{-5}$, respectively. These values fall within the acceptable risk range of 10^{-4} to 10^{-6}. Actinium-227, plutonium-239/240, thorium-228, thorium-230, and uranium-234 contribute equally to the carcinogenic risk via the ingestion pathway. Current background cancer risk to the site employee presents a risk of $3.3x10^{-6}$, which is within the target cancer risk range.

Future Groundwater

Final COPCs for future groundwater for the site employee are identified in Table 2.12. Total, background, and incremental risks for the site employee are presented in Tables 5.16, 5.17, and 5.18, respectively. Future total and incremental non-carcinogenic residual risk from groundwater for the site employee scenario were 5.1 and 4.9, respectively. Both of these values exceed the acceptable HI of 1. Future background non-carcinogenic residual risk in groundwater for the site employee is 1.2, which exceeds the acceptable Hazard Index of 1. Future total and incremental carcinogenic residual risk from groundwater for the site employee scenario is $5.9x10^{-5}$ and $5.4x10^{-5}$, respectively. Total and incremental carcinogenic risk associated with exposure to groundwater falls within the acceptable risk range of 10^{-4} to 10^{-6} for the site employee scenario. Background carcinogenic residual risk from groundwater for the site employee scenario was $5.5x10^{-6}$, which also falls within the acceptable risk range of 10^{-4} to 10^{-6}.

Air

Potential cumulative carcinogenic risk due to site employee exposure to contaminants in air was $9.9x10^{-7}$, which is slightly less than the acceptable risk range. None of the COPCs identified in air have non-carcinogenic risk criteria so a HI was not calculated for exposure to contaminants in air.

5.2.3 Overall Summary of Risk Results

An overall summary of total, background, and incremental cancer and non-cancer risks are presented in a table included with the Executive Summary and in Tables 5.19 through 5.21 The risk values in the tables are broken out by media (i.e., groundwater, air, and soil) and are the sum of risks for all pathways for the construction worker and site employee scenarios. Overall carcinogenic and non-carcinogenic risks associated with exposure to soil and air fall within the acceptable risk range of 10^{-4} to 10^{-6} and an HI of less than one for both potential receptors. Total and incremental carcinogenic and non-carcinogenic risks exceed the acceptable risk range for the future construction worker and the future site employee due to potential exposure to groundwater. Incremental carcinogenic risk is within the acceptable risk range for the current construction worker and current site employee. Total carcinogenic risk is within the acceptable risk range for the current construction worker but exceeds the acceptable risk range for the current site employee. Total and incremental non-carcinogenic risks for the current and future construction worker, and current and future site employee exceed an HI of one due to potential exposure to groundwater. The cumulative incremental non-carcinogenic risk exceeds the standard (HI= one) for the four scenarios listed in the Overall Summary of Risks Table (presented below). The cumulative incremental excess lifetime cancer risk exceeds the acceptable risk range (10^{-4} to 10^{-6}) for the future Construction Worker Scenario (3.2×10^{-4}) and for the future Site Employee Scenario (1.2×10^{-4}). Where overall risk exceeds acceptable levels, these risks are driven by exposure to groundwater. These exceedances result from the conservative nature of the groundwater analysis. The groundwater model does not take into account natural physical and chemical processes such as dilution, dispersion, adsorption, and soil properties that may reduce contaminant levels by the time it reaches the BVA. As a result, the future groundwater exposure point concentration is biased high and conservative. Specifically, using the maximum detected value (a single measurement) from a data set that spans approximately seventeen years as the concentration representing a contaminant of potential concern, and assuming contaminants are present only in their most toxic form, overestimate the risk. Details are provided in Section 6, Uncertainties. Given the conservative nature of the RRE and the associated uncertainties, the risks presented in this table represent the upper-bound plausible limit of risks (worst case scenario). Based on the protective measures presented in the Proposed Plan for Parcel 4 and the conservative nature of the RRE, the future groundwater risks presented will be managed to be protective of human and environmental health.

6.0 UNCERTAINTY IN THE RISK ASSESSMENT

In the following section, an evaluation is presented of the sources of uncertainty in the Parcel 4 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.

Data for the RRE was collected over a 17-year period (1983-2000) and analytical detection limits and methods have changed. This has resulted in current lower detection limits and presents uncertainty in the data by adding potential bias to the EPC for a constituent. The earlier data with higher detection limits resulted in non-detected concentrations that were higher in some cases than current maximum detected concentrations. Since ½ the detection limit was substituted for non-detected concentration limits this tends to bias the EPC high. For groundwater, the historical and current groundwater data were collected and used to develop the EPC by a conservative approach and model presented in Mound 2000 RREM. Uncertainty is introduced because the analytical results for constituents in the groundwater, collected over a 17-year time period, may not meet the DQOs currently in place for data collection at Mound. Antimony is an example of this type of uncertainty. The long time frame also means that contaminants detected in the production wells

and bedrock wells may have degraded. For example, 17 years is greater than one half-life for tritium. The concentration of tritium in groundwater is reduced by half every 12 years.

Although antimony was detected in 5 out of 29 analyses of groundwater collected from the two production wells, there was no large-scale use of antimony at the Mound facility. The highest concentrations of antimony detected (38.2 μg/L and 40.2 μg/L) were both collected on May 6th, 1991. Since both elevated results were collected on the same date the possibility of sample contamination exists. May 6th 1991 precedes development of the Mound Quality Assurance Project Plan (DOE 1993a) by two years, so it is doubtful that these antimony results meet the data quality objectives currently in place at Mound. The minimum and maximum concentrations of antimony excluding the May 6th 1991 samples range from 2.8 μg/L and 14.4 μg/L, respectively. The MEIMS database specifies the procedure used for antimony analysis as an "unknown CLP method" and the results were lab qualified as "B". When applied to inorganic compounds, like antimony, the "B" lab qualifier means that the reported value is greater than the instrument detection limit but less than the contract required detection limit. The next highest detection of antimony (14.4 μg/L) was detected in April 7th, 1994 and antimony has not been detected in the BVA since. In addition to the monitoring data reported in MEIMS, monitoring of the production wells is conducted in accordance with the Safe Drinking Water Act (SDWA). The SDWA data for production well groundwater shows antimony at the detection limit of 0.6 μg/L. The maximum concentration of antimony detected in the production wells (40.2 μg/L) was used to describe the current groundwater concentration due to the 95% UCL being greater than the maximum detected concentration value.

Given the age, elevated detection limits, and uncertain analytical procedure used for the May 6th 1991 analyses, plus results of subsequent analysis that shows antimony at much lower levels, it seems highly unlikely that the concentration used to describe the current concentration of antimony in groundwater is accurate. The maximum concentration of antimony detected in the production wells was used to describe current groundwater to ensure that the actual risk from groundwater ingestion is not underestimated. However, this approach may result in an overestimation of actual current risk. Elimination of the questionable May 6th antimony results would lower the estimated current total risk from an HI of 1.3 for the construction worker down to an HI of 0.6 which is well below the acceptable risk threshold.

To estimate future risk in the BVA, the EPC in the production wells was added to the flow tube modeled maximum detected concentration found in the bedrock wells. The flow tube model includes an assumption that the maximum concentration of a constituent detected in each of the twenty bedrock flow

tubes impacts the BVA in the future. Natural physical and chemical processes such as dilution, dispersion, adsorption, and soil properties are ignored when establishing future estimated concentrations by this method. The model does not take into account chemical and physical process such as dilution, dispersion, and adsorption, which may reduce contaminant levels by the time it reaches the BVA. As a result of this methodology, the future EPC concentration is biased high and conservative. This added conservatism helps to compensate for the uncertainties in the characterization of the bedrock aquifer. It was agreed through the implementation of Mound 2000, source removal and the RREM that extensive characterization of the bedrock groundwater was not needed due to the following: 1. A restriction on the use of the aquifer would be implemented; 2. The groundwater yield from the bedrock is low (i.e. one gallon per minute); and 3. Characterization and remediation of fractured bedrock is technically difficult. It is important to recognize the uncertainties of the assumptions, but it is also important to maintain the conservative nature of the assumptions.

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 Parcel 4 RRE. Exposure assumption values were also used to develop site-specific risk-based guideline values for the Mound Plant which were approved by DOE, Ohio EPA, and EPA. Exposure assumptions are based on best professional judgement regarding potential land use, assumptions concerning contaminant fate and transport, and receptor behavior. Uncertainty associated with the exposure assumptions used in the risk assessment is low to moderate, and most likely overestimates the actual risks.

One of the exposure assumptions used in the Parcel 4 RRE is that future site users would utilize the production wells for potable water supplies. The MMCIC intends to tap future site users into the municipal water supply system in the near future, therefore exposure to bedrock or BVA groundwater is unlikely. Using the production well and bedrock well data to estimate future risk is a conservative estimate of future risk, but appropriate because the production wells are located in a productive portion of the BVA and could be used in the future as a water resource.

Another source of uncertainty in the Parcel 4 RRE involves external exposure to gamma-emitting radionuclides. External exposure refers to the irradiation of tissues by radiation emitted by radionuclides located outside the body either dispersed in air, on skin surfaces, or deposited on ground surfaces. Gamma

and x-rays are the most penetrating of the emitted radiation and comprise the primary contribution to radiation dose from external exposures. The calculation of risk from external radiation exposure assumes that any gamma-emitting radionuclide in soil is uniformly distributed in soil. The calculation of external radiation exposure risk includes a gamma-shielding factor (S_e) to account for attenuation of radiation by structures, terrain, or engineered barriers. S_e is expressed as a fractional value between 0 and 1, representing the possible risk reduction range from 0% to 100% due to shielding. For the Parcel 4 RRE a default value of 0.2 or 20% shielding for the site employee and 0.1 or 10% shielding for the construction worker scenarios was used in the risk calculations.

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 measurements.

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, several of the COPCs identified in Parcel 4 could not be quantified for lack of EPA-approved toxicity values. 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.

6.5 Conclusion

The residual risk in Parcel 4 exceeds the acceptable risk range and is primarily driven by the conservative groundwater analysis. Risk due to soil and air contaminants is within acceptable risk range for industrial/commercial reuse.

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Table 2.1 Initial Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

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	Reference	Rationale for Contaminant Deletion or Selection
Metals												
7429-90-5	Aluminum	363	21400.00	mg/kg	B409	65-65	12700	21400.00	19000.00	21000.00	b, f	YES
7440-36-0	Antimony	0.27	42.20	mg/kg	MND33-0103	20-48	12.6	42.20		8.50	a	YES
7440-38-2	Arsenic	1.7	17.10	mg/kg		65-65	6.99	17.10	8.60	6.40	a	YES
7440-39-3	Barium	2	133.00	mg/kg	CH	65-65	86.5	133.00	180.00	1500.00	b	NO:2,3
13966-02-4	Beryllium	0.12	0.94	mg/kg	CH	50-65	0.66	0.94	1.30	0.70	c	NO:2
14733-03-0	Bismuth	0.76	70.40	mg/kg	CJ	48-51	73.3	70.40				YES
7440-43-9	Cadmium	0.31	7.70	mg/kg	MND33-0103	14-65	1.02	7.70	2.10	21.00	a	NO:3
7440-70-2	Calcium	812	175000.00	mg/kg	NPS1	65-65	108000	175000.00	310000.00			NO:2
	Cerium	23.60	50.90	mg/kg		8-8	NC	50.90				YES
7440-47-3	Chromium	1	30.50	mg/kg	MND33-0103	65-65	17.9	30.50	20.00	110.00	a	NO:3
10198-40-0	Cobalt	0.37	14.40	mg/kg	B409	65-65	12.0	14.40	19.00			NO:2
7440-50-8	Copper	1.4	27.50	mg/kg		65-65	17.5	27.50	26.00	790.00	a, f	NO:3
57-12-5	Cyanide	0.12	0.38	mg/kg	MND33-0103	8-65	0.31	0.38		430.00	a	NO:3
7439-89-6	Iron	1300	40500.00	mg/kg		65-65	22100	40500.00	35000.00			NO:4
15067-28-4	Lead	2	255.00	mg/kg		65-65	20.6	255.00	48.00			YES
7439-93-2	Lithium	2.7	41.40	mg/kg	B409	45-46	17.6	41.40	26.00			YES
7439-95-4	Magnesium	583	68800.00	mg/kg	MND33-0103	65-65	21700	68800.00	40000.00			YES
7439-96-5	Manganese	42.3	5240.00	mg/kg		65-65	1010	5240.00	1400.00	2700.00	b	YES
7439-97-6	Mercury	0.14	0.42	mg/kg	NPS6	4-65	0.07	0.42		6.40	b	NO:3
7439-98-7	Molybdenum	0.56	15.70	mg/kg		45-46	9.52	15.70	27.00			NO:2
	Neodymium	16.5	33.40	mg/kg		7-8	NC	33.40				YES
7440-02-0	Nickel	2.8	26.20	mg/kg	CJ	62-65	22.0	26.20	32.00	430.00	a	NO:2,3
13966-00-2	Potassium	157	4320.00	mg/kg	B409	60-65	2530	4320.00	1900.00			NO:4
7782-49-2	Selenium	0.29	2.20	mg/kg	CJ	10-65	0.54	2.20		110.00	a, f	NO:3
7440-22-4	Silver	0.35	17.00	mg/kg	MND33-0103	9-65	1.88	17.00	1.70	110.00	a	NO:3
13966-32-0	Sodium	26.7	865.00	mg/kg		50-65	410	865.00	240.00			NO:4
14913-50-9	Thallium	0.35	2.10	mg/kg		11-50	0.66	2.10	0.46	1.70	a, f	YES
7440-31-5	Tin	1.6	41.10	mg/kg		7-52	6.9	41.10	20.00	13000.00	a, f	NO:3
7440-62-2	Vanadium	0.45	37.00	mg/kg	B409	63-65	34.9	37.00	25.00	150.00	a	NO:3
7440-66-6	Zinc	4.1	1310.00	mg/kg		65-65	65.5	1310.00	140.00	6400.00	a	NO:3

Table 2.1 Initial Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4.
(Maximum Detected Concentration Compared to Background and Mound Guideline Values)

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	Reference	Rationale for Contaminant Deletion or Selection
Semi-Volatile Organic Compounds												
120-82-1	1,2,4-Trichlorobenzene	33.0	33.00	ug/kg	MND33-0104	1-58	239	33.00				NO:1
95-57-8	2-Chlorophenol	38.0	38.00	ug/kg	MND33-0104	1-58	238	38.00				NO:1
91-57-6	2-Methylnaphthalene	63.0	110.00	ug/kg		2-58	238	110.00				NO:1
59-50-7	4-Chloro-3-methylphenol	7.0	7.00	ug/kg	MND33-0104	1-58	263	7.00				NO:1
	Acenaphthene	42.0	120.00	ug/kg		2-58	252	120.00				NO:1
	Acenaphthylene	44.0	290.00	ug/kg		4-58	243	290.00				YES
	Anthracene	50.0	690.00	ug/kg		7-58	243	690.00		6400000.00	a	NO:3
56-55-3	Benzo(a)anthracene	58.0	2800.00	ug/kg		10-58	325	2800.00		4100.00	d	NO:3
50-32-8	Benzo(a)pyrene	40.0	2500.00	ug/kg		11-58	330	2500.00		410.00	d	YES
205-99-2	Benzo(b)fluoranthene	35.0	4800.00	ug/kg		21-58	439	4800.00		4100.00	d	YES
191-24-2	Benzo(g,h,i)perylene	47.0	250.00	ug/kg		8-58	241	250.00				YES
207-08-9	Benzo(k)fluoranthene	58.0	8600.00	ug/kg		19-58	524	8600.00		41000.00	d	NO:3
65-85-0	Benzoic Acid	12.0	86.00	ug/kg		5-55	1710	86.00		85000000.00	a	NO:3
117-81-7	Bis(2-ethylhexyl)phthalate	34.0	340.00	ug/kg	B401	11-58	241	340.00		215000.00	d	NO:3
	Carbazole	41.0	420.00	ug/kg		4-50	219	420.00				YES
218-01-9	Chrysene	43.0	2400.00	ug/kg		12-58	321	2400.00		410000.00	d	NO:3
84-74-2	Di-n-butyl Phthalate	25.0	420.00	ug/kg	NPS5	8-58	252	420.00		2100000.00	a	NO:3
117-84-0	Di-n-octyl Phthalate	47.0	130.00	ug/kg	B408	3-58	240	130.00		430000.00	a	NO:3
	Dibenz(a,h)anthracene	46.0	130.00	ug/kg		4-58	240	130.00		410.00	c, f	NO:3
	Dibenzofuran	42.0	250.00	ug/kg		2-58	243	250.00				NO:1
206-44-0	Fluoranthene	39.0	5000.00	ug/kg		21-58	433	5000.00		850000.00	a	NO:3
	Fluorene	50.0	460.00	ug/kg		5-58	246	460.00		850000.00	a, f	NO:3
	Indeno(1,2,3-cd)pyrene	67.0	850.00	ug/kg		8-58	253	850.00		410.00	c, f	YES
	Naphthalene	200.0	200.00	ug/kg		1-58	237	200.00				NO:1
85-01-8	Phenanthrene	78.0	3700.00	ug/kg		10-58	338	3700.00				YES
108-95-2	Phenol	23.0	23.00	ug/kg	MND33-0104	1-58	243	23.00		13000000.00	a	NO:1
129-00-0	Pyrene	25.0	3300.00	ug/kg		21-58	371	3300.00		640000.00	a	NO:3
Volatile Organic Compounds												
78-93-3	2-Butanone	8.5	8.50	ug/kg	NPS3	1-65	6.11	8.50		930000.00	b	NO:1
67-64-1	Acetone	12.0	55.00	ug/kg		9-65	10.3	55.00		2100000.00	a	NO:3
56-23-5	Carbon Tetrachloride	9.6	9.60	ug/kg	NPS3	1-65	3.74	9.60		12000.00	c	NO:1
100-41-4	Ethylbenzene	2.1	2.10	ug/kg	NPS3	1-65	3.61	2.10		50.00	b	NO:1
	Hexane	4.0	10.00	ug/kg		2-53	6.24	10.00		9100.00	b	NO:1
75-09-2	Methylene Chloride	6.0	97.00	ug/kg	NPS3	10-65	10.9	97.00		100000.00	b	NO:3
108-88-3	Toluene	1.0	4.70	ug/kg	NPS3	3-65	3.66	4.70		25000.00	b	NO:1
	Xylenes, Total	2.1	2.10	ug/kg		1-65	3.61	2.10		43000000.00	a	NO:1

Table 2.1 Initial Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

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	Reference	Rationale for Contaminant Deletion or Selection
Pesticides/PCBs												
72-54-8	4,4'-DDD	0.4	6.60	ug/kg	B409	2-64	2.6	6.60	4.20			NO:1
72-55-9	4,4'-DDE	0.25	3.50	ug/kg	MND22-4101	6-64	2.07	3.50	4.30	9000.00	d	NO:2,3
50-29-3	4,4'-DDT	0.19	0.48	ug/kg		4-65	2.69	0.48	13.00	9000.00	c	NO:2,3
309-00-2	Aldrin	0.074	0.35	ug/kg	B401	6-64	1.26	0.35		180.00	c, f	NO:3
5103-71-9	Alpha Chlordane	0.044	3.50	ug/kg		6-65	1.97	3.50		8500.00	c, f	NO:3
319-86-8	Delta-BHC	0.08	5.30	ug/kg	MND22-4101	3-65	1.64	5.30				NO:1
60-57-1	Dieldrin	0.31	1.20	ug/kg		4-65	2.17	1.20		185.00	c	NO:3
33213-65-9	Endosulfan I	0.051	0.27	ug/kg	B407	3-63	1.81	0.27		130000.00	a, f	NO:1
33213-65-9	Endosulfan II	0.053	7.10	ug/kg	MND22-4001	5-65	2.41	7.10		130000.00	a, f	NO:3
1031-07-8	Endosulfan Sulfate	0.13	0.56	ug/kg	MND22-4101	2-65	3.35	0.56				NO:1
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	4-60	3.34	0.93				YES
53494-70-5	Endrin Ketone	0.24	0.86	ug/kg		4-65	3.43	0.86				YES
5103-74-2	Gamma Chlordane	0.058	0.93	ug/kg	MND22-4003	2-65	1.85	0.93		8500.00	c, f	NO:1
58-89-9	Gamma-BHC (Lindane)	0.065	0.095	ug/kg	MND22-4101	2-65	1.26	0.10		2300.00	d, f	NO:1
1024-57-3	Heptachlor	0.056	1.20	ug/kg		7-65	1.17	1.20		660.00	d, f	NO:3
1024-57-3	Heptachlor Epoxide	0.072	0.94	ug/kg	MND22-4102	6-65	1.79	0.94		280.00	a, f	NO:3
72-43-5	Methoxychlor	0.13	0.95	ug/kg	MND22-4101	4-63	23.2	0.95	30.00			NO:2
Explosives												
99-65-0	1,3-Dinitrobenzene	0.098	0.098	mg/kg	B405	1-41	0.89	0.10				NO:1
118-96-7	2,4,6-Trinitrotoluene	0.20	0.20	mg/kg	B405	1-41	0.86	0.20				NO:1
	Tetryl	0.29	0.29	mg/kg		1-41	1.34	0.29				NO:1

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(Maximum Detected Concentration Compared to Background and Mound Guideline Values)

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	Reference	Rationale for Contaminant Deletion or Selection
Radionuclides												
AC-227DA	Actinium-227	0.13	2.01	pCi/g		14-130	0.23	2.01		1.00	e	YES
14596-10-2	Americium-241	0.05	0.21	pCi/g		5-188	0.13	0.21		4.95	e	NO:1
10045-97-3	Cesium-137	0.06	0.90	pCi/g		130-188	0.36	0.90	0.42	0.46	e	YES
10198-40-0	Cobalt-60	0.04	0.90	pCi/g		3-188	0.05	0.90				NO:1
14255-04-0	Lead-210	0.38	3.35	pCi/g		94-117	1.76	3.35		1.65	e, f	YES
13994-20-2	Neptunium-237	0.023	0.067	pCi/g	#6B	6-8	NC	0.07		1.50	e, f	NO:3
13981-16-3	Plutonium-238	0.013	55.40	pCi/g		142-480	87	55.40	0.13	5.50	e	YES
PU-239/240	Plutonium-239	0.01	0.011	pCi/g		3-10	NC	0.01	0.18	5.50	e	NO:2,3
PU-239/240	Plutonium-239/240	0.0039	0.21	pCi/g		18-63	0.02	0.21	0.18	5.50	e	NO:3
13982-10-0	Plutonium-242	0.0102	0.01	pCi/g	GJ	1-31	0.02	0.01				NO:1
13966-00-2	Potassium-40	10.5	34.46	pCi/g	B405	56-67	22.6	34.46	37.00			NO:2
13982-63-3	Radium-226	0.39	3.26	pCi/g		137-180	1.34	3.26	2.00	0.14	e	YES
	Radium-228	0.636	2.57	pCi/g		10-10	NC	2.57		0.10	e, f	YES
10098-97-2	Strontium-90	0.158	2.77	pCi/g	B405	4-37	1.07	2.77	0.72	3.00	e	NO:3
14274-82-9	Thorium-228	0.195	1.79	pCi/g		66-80	1.07	1.79	1.50	0.16	e	YES
14269-63-7	Thorium-230	0.15	2.69	pCi/g		79-178	3.57	2.69	1.90		g	YES
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	184-491	0.83	5.60	1.40	0.10	e, f	YES
10028-17-8	Tritium	0.066	3.00	pCi/g		7-64	0.88	3.00	1.60	23500.00	e	NO:3
13966-29-5	Uranium-234	0.33	1.17	pCi/g	B406	56-65	0.77	1.17	1.10	37.50	e	NO:3
15117-96-1	Uranium-235	0.019	0.20	pCi/g	B406	46-51	0.09	0.20	0.11	3.35	e	NO:3
24678-82-8	Uranium-238	0.32	1.95	pCi/g		110-115	1.08	1.95	1.20	0.12	e	YES

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
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria
g= Guideline Value was removed(under Core Team review)

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:2,3 - <Background,Screening Toxicity
NO:4 - Essential Human Nutrient

Table 2.2 Final Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4. (Exposure Point Concentration (EPC) Compared to Background)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening (EPC)	Background Value	Rationale for Contaminant Deletion or Selection
Metals										
7429-90-5	Aluminum	363	21400.00	mg/kg	B409	65-65	12700	12700.00	19000.00	NO
7440-36-0	Antimony	0.27	42.20	mg/kg	MND33-0103	20-48	12.6	12.60		YES
7440-38-2	Arsenic	1.7	17.10	mg/kg		65-65	6.99	6.99	8.60	NO
14733-03-0	Bismuth	0.76	70.40	mg/kg	CJ	48-51	73.3	70.40		YES
	Cerium	23.60	50.90	mg/kg		8-8	NC	50.90		YES
15067-28-4	Lead	2	255.00	mg/kg		65-65	20.6	20.60	48.00	NO
7439-93-2	Lithium	2.7	41.40	mg/kg	B409	45-46	17.6	17.60	26.00	NO
7439-95-4	Magnesium	583	68800.00	mg/kg	MND33-0103	65-65	21700	21700.00	40000.00	NO
7439-96-5	Manganese	42.3	5240.00	mg/kg		65-65	1010	1010.00	1400.00	NO
	Neodymium	16.5	33.40	mg/kg		7-8	NC	33.40		YES
14913-50-9	Thallium	0.35	2.10	mg/kg		11-50	0.66	0.66	0.46	YES
Semi-Volatile Organic Compounds										
	Acenaphthylene	44.0	290.00	ug/kg		4-58	243	243.00		YES
50-32-8	Benzo(a)pyrene	40.0	2500.00	ug/kg		11-58	330	330.00		YES
205-99-2	Benzo(b)fluoranthene	35.0	4800.00	ug/kg		21-58	439	439.00		YES
191-24-2	Benzo(g,h,i)perylene	47.0	250.00	ug/kg		8-58	241	241.00		YES
	Carbazole	41.0	420.00	ug/kg		4-50	219	219.00		YES
	Indeno(1,2,3-cd)pyrene	67.0	850.00	ug/kg		8-58	253	253.00		YES
85-01-8	Phenanthrene	78.0	3700.00	ug/kg		10-58	338	338.00		YES
Pesticides/PCBs										
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	4-60	3.34	0.93		YES
53494-70-5	Endrin Ketone	0.24	0.86	ug/kg		4-65	3.43	0.86		YES
Radionuclides										
AC-227DA	Actinium-227	0.13	2.01	pCi/g		14-130	0.23	0.23		YES
10045-97-3	Cesium-137	0.06	0.90	pCi/g		130-188	0.36	0.36	0.42	NO
14255-04-0	Lead-210	0.38	3.35	pCi/g		94-117	1.76	1.76		YES
13981-16-3	Plutonium-238	0.013	55.40	pCi/g		142-480	87	55.40	0.13	YES
13982-63-3	Radium-226	0.39	3.26	pCi/g		137-180	1.34	1.34	2.00	NO
	Radium-228	0.636	2.57	pCi/g		10-10	NC	2.57		YES
14274-82-9	Thorium-228	0.195	1.79	pCi/g		66-80	1.07	1.07	1.50	NO
14269-63-7	Thorium-230	0.15	2.69	pCi/g		79-178	3.57	2.69	1.90	YES
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	184-491	0.83	0.83	1.40	NO
24678-82-8	Uranium-238	0.32	1.95	pCi/g		110-115	1.08	1.08	1.20	NO

UCL - Upper Confidence Limit
EPC Exposure Point Concentration= minimum of either 95% UCL or maximum detected concentration

Table 2.3 Initial Identification of Surface Soil Constituents of Potential Concern for the Site Employee in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guidance Values	Reference	Rationale for Contaminant Deletion or Selection
Metals												
7429-90-5	Aluminum	1680	21400	mg/kg	B409	22-22	8570.00	21400	19000.00	190000.00	b, f	YES
7440-36-0	Antimony	26.1	42.2	mg/kg	MND33-0103	8-21	367.00	42.20		82.00	a	NO:3
7440-38-2	Arsenic	3.90	11.80	mg/kg	B406	22-22	7.00	11.80	8.60	61.00	a	NO:3
7440-39-3	Barium	12.4	111.00	mg/kg		22-22	58.30	111.00	180.00	14000.00	b	NO:2,3
13966-02-4	Beryllium	0.12	0.85	mg/kg		21-22	0.70	0.85	1.30	1.30	c	NO:2,3
14733-03-0	Bismuth	0.76	28.50	mg/kg	CJ	12-14	NC	28.50				YES
7440-43-9	Cadmium	0.31	7.70	mg/kg	MND33-0103	11-22	40.10	7.70	2.10	200.00	a	NO:3
7440-70-2	Calcium	812	150000.00	mg/kg		22-22	662000.00	150000.00	310000.00			NO:2
7440-47-3	Chromium	1.7	30.50	mg/kg	MND33-0103	22-22	26.70	30.50	20.00	1000.00	a	NO:3
10198-40-0	Cobalt	1.4	14.40	mg/kg	B409	22-22	10.80	14.40	19.00			NO:2
7440-50-8	Copper	3.4	21.70	mg/kg		22-22	18.10	21.70	26.00	7600.00	a, f	NO:2,3
57-12-5	Cyanide	0.12	0.38	mg/kg	MND33-0103	8-22	0.35	0.38		4100.00	a	NO:3
7439-89-6	Iron	2790	28800.00	mg/kg		22-22	17600.00	28800.00	35000.00			NO:2
15067-28-4	Lead	5.4	32.00	mg/kg	B401	22-22	19.20	32.00	48.00			NO:2
7439-93-2	Lithium	2.7	27.30	mg/kg	B409	12-13	NC	27.30	26.00			YES
7439-95-4	Magnesium	583	68800.00	mg/kg	MND33-0103	22-22	110000.00	68800.00	40000.00			NO:4
7439-96-5	Manganese	116	1250.00	mg/kg	MND22-4101	22-22	722.00	1250.00	1400.00	15000.00	b	NO:2,3
7439-97-6	Mercury	0.14	0.14	mg/kg		1-22	0.07	0.14		61.00	b	NO:1
7439-98-7	Molybdenum	0.56	6.20	mg/kg	B409	13-13	NC	6.20	27.00			NO:2
7440-02-0	Nickel	2.8	25.80	mg/kg		21-22	30.10	25.80	32.00	4100.00	a	NO:2,3
13966-00-2	Potassium	270	3550.00	mg/kg	B409	22-22	1650.00	3550.00	1900.00			NO:4
7440-22-4	Silver	12	17.00	mg/kg	MND33-0103	8-22	149.00	17.00	1.70	1000.00	a	NO:3
13966-32-0	Sodium	26.7	530.00	mg/kg	MND22-4101	21-22	407.00	530.00	240.00			NO:4
14913-50-9	Thallium	0.43	0.44	mg/kg		8-22	0.89	0.44	0.46	16.00	a, f	NO:2,3
7440-31-5	Tin	2.6	4.80	mg/kg	MND22-4102	3-14	NC	4.80	20.00			NO:2
7440-62-2	Vanadium	0.75	37.00	mg/kg	B409	22-22	33.20	37.00	25.00	1400.00	a	NO:3
7440-66-6	Zinc	6.7	74.10	mg/kg		22-22	45.50	74.10	140.00	61000.00	a	NO:2,3
Semi-Volatile Organic Compounds												
120-82-1	1,2,4-Trichlorobenzene	33	33	ug/kg	MND33-0104	1-15	NC	33.00		2040000.00	b, f	NO:3
95-57-8	2-Chlorophenol	38	38	ug/kg	MND33-0104	1-15	NC	38.00		10200000.00	a, f	NO:3
91-57-6	2-Methylnaphthalene	63	63	ug/kg	B401	1-15	NC	63.00				YES
59-50-7	4-Chloro-3-methylphenol	7	7	ug/kg	MND33-0104	1-15	NC	7.00				YES
56-55-3	Benzo(a)anthracene	58	58	ug/kg	B401	1-15	NC	58.00		7800.00	d	NO:3
50-32-8	Benzo(a)pyrene	51	51	ug/kg	B401	1-15	NC	51.00		780.00	d	NO:3
205-99-2	Benzo(b)fluoranthene	37	98	ug/kg	B401	4-15	NC	98.00		7800.00	d	NO:3
207-08-9	Benzo(k)fluoranthene	65	170	ug/kg	B401	4-15	NC	170.00		78000.00	d	NO:3
65-85-0	Benzoic Acid	12	12	ug/kg	MND33-0104	1-15	NC	12.00		820000000.00	a	NO:3
218-01-9	Chrysene	78	78	ug/kg	B401	1-15	NC	78.00		780000.00	a	NO:3
84-74-2	Di-n-butyl Phthalate	25	68	ug/kg		3-15	NC	68.00		20000000.00	a	NO:3
206-44-0	Fluoranthene	39	110	ug/kg	B401	4-15	NC	110.00		8200000.00	a	NO:3
85-01-8	Phenanthrene	78	78	ug/kg	B401	1-15	NC	78.00				YES
108-95-2	Phenol	23	23	ug/kg	MND33-0104	1-15	NC	23.00		120000000.00	a	NO:3
129-00-0	Pyrene	25	120	ug/kg	MND33-0103	7-15	NC	120.00		6100000.00	a	NO:3
Volatile Organic Compounds												
67-64-1	Acetone	13	17	ug/kg	MND22-4101	2-22	7.16	17.00		20000000.00	a	NO:3
75-09-2	Methylene Chloride	6	14	ug/kg		7-22	9.54	14.00		100000.00	d	NO:3
108-88-3	Toluene	2	2	ug/kg		1-22	3.12	2.00		25000.00	b	NO:1

Table 2.3 Initial Identification of Surface Soil Constituents of Potential Concern for the Site Employee in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guidance Values	Reference	Rationale for Contaminant Deletion or Selection
Pesticides/PCBs												
72-54-8	4,4'-DDD	0.4	6.60	ug/kg	B409	2-21	4.04	6.60	4.20			YES
72-55-9	4,4'-DDE	0.25	3.50	ug/kg	MND22-4101	3-22	2.36	3.50	4.30	17000.00	d	NO:2,3
50-29-3	4,4'-DDT	0.19	0.25	ug/kg	B406	3-22	5.46	0.25	13.00	17000.00	c	NO:2,3
309-00-2	Aldrin	0.074	0.35	ug/kg	B401	6-22	2.38	0.35		340.00	c, f	NO:3
5103-71-9	Alpha Chlordane	0.04	1.10	ug/kg	MND22-4003	3-22	6.87	1.10		16000.00	c, f	NO:3
319-86-8	Delta-BHC	0.08	5.3	ug/kg	MND22-4101	3-22	4.67	5.3				YES
60-57-1	Dieldrin	0.96	0.96	ug/kg	MND22-4003	1-22	1.95	0.96		360.00	c	NO:1
33213-65-9	Endosulfan I	0.05	0.27	ug/kg	B407	3-22	6.11	0.27		1200000.00	a, f	NO:3
33213-65-9	Endosulfan II	0.05	7.10	ug/kg	MND22-4001	4-22	4.45	7.10		1200000.00	a, f	NO:3
1031-07-8	Endosulfan Sulfate	0.13	0.56	ug/kg	MND22-4101	2-22	10.20	0.56				YES
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	3-22	9.30	0.93				YES
53494-70-5	Endrin Ketone	0.24	0.25	ug/kg	B407	2-22	10.10	0.25				YES
5103-74-2	Gamma Chlordane	0.058	0.93	ug/kg	MND22-4003	2-22	5.92	0.93		16000.00	c, f	NO:3
58-89-9	Gamma-BHC (Lindane)	0.065	0.095	ug/kg	MND22-4101	2-22	2.05	0.10		4400.00	d, f	NO:3
1024-57-3	Heptachlor	0.056	0.32	ug/kg	MND22-4102	3-22	1.62	0.32		1300.00	c, f	NO:3
1024-57-3	Heptachlor Epoxide	0.072	0.94	ug/kg	MND22-4102	4-22	7.05	0.94		630.00	c, f	NO:3
72-43-5	Methoxychlor	0.13	0.95	ug/kg	MND22-4101	4-22	204.00	0.95	30.00			NO:2
Explosives												
99-65-0	1,3-Dinitrobenzene	0.10	0.10	mg/kg	B405	1-7	NC	0.10		20.00	a, f	NO:3
118-96-7	2,4,6-Trinitrotoluene	0.2	0.20	mg/kg	B405	1-7	NC	0.20		100.00	a, f	NO:3
Radionuclides												
AC-227	Actinium-227	0.13	2.01	pCi/g		14-124	0.24	2.01		1.10	e	YES
14596-10-2	Americium-241	0.05	0.21	pCi/g		5-137	0.09	0.21		9.20	e	NO:1
10045-97-3	Cesium-137	0.055	0.895	pCi/g		119-137	0.37	0.90	0.42	0.42	e	YES
10198-40-0	Cobalt-60	0.04	0.09	pCi/g		3-137	0.04	0.09		0.09	e	NO:1
14255-04-0	Lead-210	0.38	3.35	pCi/g		94-117	1.76	3.35		3.20	e, f	YES
13994-20-2	Neptunium-237	0.023	0.067	pCi/g	#6B	4-6	NC	0.07		1.60	e, f	NO:3
13981-16-3	Plutonium-238	0.013	55.40	pCi/g		88-358	20.40	55.40	0.13	11.00	e	YES
PU-239/240	Plutonium-239	0.01	0.011	pCi/g	CANAL NW	3-5	NC	0.011	0.18	10.00	e	NO:2,3
PU-239/240	Plutonium-239/240	0.004	0.192	pCi/g		14-37	0.02	0.19	0.18	10.00	e	NO:3
13966-00-2	Potassium-40	12.5	34.46	pCi/g	B405	24-24	23.80	34.46	37.00			NO:2
13982-63-3	Radium-226	0.64	3.26	pCi/g		95-131	1.41	3.26	2.00	0.13	e	YES
	Radium-228	0.636	2.57	pCi/g		10-10	NC	2.57		0.09	e, f	YES
10098-97-2	Strontium-90	0.158	2.10	pCi/g	#4B	2-14	NC	2.10	0.72	57.00	e	NO:3
14274-82-9	Thorium-228	0.21	1.66	pCi/g	B405	38-40	1.03	1.66	1.50	0.16	e, f	YES
14269-63-7	Thorium-230	0.316	2.69	pCi/g		41-138	4.21	2.69	1.90			YES
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	141-369	0.73	5.60	1.40	0.09	e, f	YES
13966-29-5	Uranium-234	0.57	1.17	pCi/g	B406	20-25	0.86	1.17	1.10	70.00	e	NO:3
15117-96-1	Uranium-235	0.025	0.20	pCi/g	B406	24-27	0.09	0.20	0.11	3.10	e	NO:3
24678-82-8	Uranium-238	0.32	1.95	pCi/g		72-75	1.23	1.95	1.20	0.12	e, f	YES

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
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria
g= Guideline Value was removed (under Core Team review)

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:2,3 - <Background,Screening Toxicity
NO:4 - Essential Human Nutrient

Table 2.4 Final Identification of Surface Soil Constituents of Potential Concern for the Site Employee in Parcel 4. (Exposure Point Concentration Compared to Background Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening (EPC)	Background Value	Rationale for Contaminant Deletion or Selection
Metals										
7429-90-5	Aluminum	1680	21400	mg/kg	B409	22-22	8570.00	8570.00	19000.00	NO
14733-03-0	Bismuth	0.76	28.50	mg/kg	CJ	12-14	NC	28.50		YES
7439-93-2	Lithium	2.7	27.30	mg/kg	B409	12-13	NC	27.30	26.00	YES
Semi-Volatile Organic Compounds										
91-57-6	2-Methylnaphthalene	63	63	ug/kg	B401	1-15	NC	63.00		YES
59-50-7	4-Chloro-3-methylphenol	7	7	ug/kg	MND33-0104	1-15	NC	7.00		YES
85-01-8	Phenanthrene	78	78	ug/kg	B401	1-15	NC	78.00		YES
Pesticides/PCBs										
72-54-8	4,4'-DDD	0.4	6.60	ug/kg	B409	2-21	4.04	4.04	4.20	NO
319-86-8	Delta-BHC	0.08	5.3	ug/kg	MND22-4101	3-22	4.67	4.67		YES
1031-07-8	Endosulfan Sulfate	0.13	0.56	ug/kg	MND22-4101	2-22	10.20	0.56		YES
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	3-22	9.30	0.93		YES
53494-70-5	Endrin Ketone	0.24	0.25	ug/kg	B407	2-22	10.10	0.25		YES
Radionuclides										
AC-227	Actinium-227	0.13	2.01	pCi/g		14-124	0.24	0.24		YES
10045-97-3	Cesium-137	0.055	0.895	pCi/g		119-137	0.37	0.37	0.42	NO
14255-04-0	Lead-210	0.38	3.35	pCi/g		94-117	1.76	1.76		YES
13981-16-3	Plutonium-238	0.013	55.40	pCi/g		88-358	20.40	20.40	0.13	YES
13982-63-3	Radium-226	0.64	3.26	pCi/g		95-131	1.41	1.41	2.00	NO
	Radium-228	0.636	2.57	pCi/g		10-10	NC	2.57		YES
14274-82-9	Thorium-228	0.21	1.66	pCi/g	B405	38-40	1.03	1.03	1.50	NO
14269-63-7	Thorium-230	0.316	2.69	pCi/g		41-138	4.21	2.69	1.90	YES
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	141-369	0.73	0.73	1.40	NO
24678-82-8	Uranium-238	0.32	1.95	pCi/g		72-75	1.23	1.23	1.20	YES

UCL - Upper Confidence Limit
EPC Exposure Point Concentration= minimum of either 95% UCL or maximum detected concentration

Table 2.5 Initial Identification of Current Groundwater Constituents of Potential Concern for the Construction Worker Scenario
(Maximum Detected Values Compared to Background and Screening Guideline Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	Concentration Used for Screening and Risk	Background Value	Construction Worker Risk-Based GV	Reference Risk-Based GV	Initial COPC
Inorganics									
Aluminum	67.91	148.00	ug/L	7-29	148.00	37.523	10200	a, f	NO:3
Antimony	2.8	40.20	ug/L	5-29	40.20	0.578	4.1	a	YES
Barium	75	115.00	ug/L	27-29	115.00	310.209	710	a	NO:2,3
Cadmium	4.6	7.70	ug/L	6-32	7.70		5.1	a	YES
Calcium	94300	126000.00	ug/L	33-33	126000.00	111110.664			NO:4
Chromium (assume all VI)	18.3	24.91	ug/L	6-32	24.91	6.076	30	a,f	NO:3
Copper	1.6	593.00	ug/L	22-32	593.00	1.167	409	a,f	YES
Iron	18.8	1890.00	ug/L	14-31	1890.00	4064.888			NO:2
Lead	3.4	40.00	ug/L	5-32	40.00	10.05			YES
Lithium	2.9	2.90	ug/L	4-10	2.90	55.7			NO:2
Magnesium	29100	39600.00	ug/L	32-32	39600.00	40428.111			NO:2
Manganese	2.8	224.00	ug/L	30-32	224.00	229.568	51	a	NO:2
Molybdenum	1.6	2.70	ug/L	5-10	2.70	5.597			NO:2
Nickel	2.1	27.10	ug/L	5-32	27.10	34.957	200	a	NO:2,3
Potassium	2390	3761.00	ug/L	27-33	3761.00	4461.063			NO:2
Selenium	1.5	1.50	ug/L	1-32	1.50				NO:1
Silver	16.9	24.20	ug/L	6-29	24.20		51	a	NO:3
Sodium	46600	84200.00	ug/L	32-32	84200.00	62425.563			NO:4
Thallium	2.4	2.40	ug/L	1-29	2.40				NO:1
Tin	8.7	8.70	ug/L	1-10	8.70	34.382			NO:2
Vanadium	3.9	14.60	ug/L	12-29	14.60	17.1	71	a	NO:2,3
Zinc	4.5	57.70	ug/L	10-32	57.70	119.6	3100	a	NO:2,3
Volatile Organic Compounds									
1,1,1-trichloroethane	0.30	3.30	ug/L	79-193	3.30	0.668	180.00	a,f	NO:3
1,1,2 trichloro-1,2,2-trifluoroethane	2.00	34.00	ug/L	13-18	34.00		250000.00	a,f	NO:3
1,1-Dichloroethane	2.50	3.50	ug/L	2-191	3.50		950.00	a	NO:1
1,1-Dichloroethene	1.70	1.70	ug/L	1-193	1.70				NO:1
1,2-cis-Dichloroethene	0.47	4.00	ug/L	103-159	4.00	0.999	102.00	b, f	NO:3
1,2-trans-Dichloroethene	0.50	3.00	ug/L	8-195	3.00		200.00	b	NO:1
1,3-cis-Dichloropropene	0.50	1.20	ug/L	2-195	1.20				NO:1
2-Butanone	7.00	41.00	ug/L	3-12	41.00		5300.00	a	NO:3
Acetone	1.00	12.00	ug/L	6-12	12.00		1000.00	a	NO:3
Bromodichloromethane	2.20	3.70	ug/L	2-193	3.70		4.50	d	NO:1
Chloroform	0.50	5.40	ug/L	9-197	5.40	0.516			NO:1
Dichloromethane	3.00	13.00	ug/L	8-195	13.00		38.00	d	NO:1
Ethylbenzene	0.50	0.60	ug/L	2-197	0.60		69.00	a	NO:1
Tetrachloroethene	0.15	2.20	ug/L	109-196	2.20		12.00	a	NO:3
Toluene	0.60	1.50	ug/L	4-197	1.50		150.00	a	NO:1
Trichloroethene	0.47	5.90	ug/L	176-197	5.90		15.00	d	NO:3
Trichlorofluoromethane	2.20	2.50	ug/L	2-188	2.50		2200.00	a	NO:1
Xylenes, Total	0.60	3.60	ug/L	8-190	3.60		20000.00	b	NO:1

Table 2.5 Initial Identification of Current Groundwater Constituents of Potential Concern for the Construction Worker Scenario
(Maximum Detected Values Compared to Background and Screening Guideline Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	Concentration Used for Screening and Risk	Background Value	Construction Worker Risk-Based GV	Reference Risk-Based GV	Initial COPC
Radionuclides									
Actinium-227	0.50	0.50	pCi/L	1-10	0.50		1.30	c	NO:3
Americium-241	0.03	0.03	pCi/L	1-9	0.03	0.139	2.40	c	NO:2,3
Bismuth-210	0.11	0.39	pCi/L	2-19	0.39		110.00	c, f	NO:3
Plutonium-238	0.01	0.25	pCi/L	8-48	0.25	0.087	2.70	c	NO:3
Plutonium-239/240	0.002	2.00	pCi/L	6-20	2.00	0.125	2.50	c	NO:3
Radium-226	0.10	0.52	pCi/L	6-19	0.52	0.996	2.70	c	NO:2,3
Strontium-85	25.00	25.00	pCi/L	1-2	25.00		570.00	c, f	NO:3
Strontium-90	0.50	0.50	pCi/L	3-19	0.50	0.975	14.00	c	NO:2,3
Thorium-227	0.01	0.10	pCi/L	8-14	0.10		19.80	c, f	NO:3
Thorium-228	0.01	2.17	pCi/L	14-35	2.17	0.779	3.50	c, f	NO:3
Thorium-230	0.01	1.99	pCi/L	11-32	1.99		0.60	c, f	YES
Thorium-232	0.0025	0.10	pCi/L	8-33	0.10	0.314	1.60	c, f	NO:2,3
Tritium	110.00	7200.00	pCi/L	112-128	7200.00	1485.47	11000.00	e	NO:3
Uranium-233/234	0.17	0.36	pCi/L	30-30	0.36		18.00	c	NO:3
Uranium-234	0.20	8.14	pCi/L	14-19	8.14	0.792	18.00	c	NO:3
Uranium-235	0.10	2.30	pCi/L	23-43	2.30	0.814	17.00	c	NO:3
Uranium-238	0.13	8.25	pCi/L	41-48	8.25	0.688	0.56	c, f	YES

NC= 95% UCL not calculated, less than 20 samples in the data set.

a= 1/10th HI for ingestion + inhalation + dermal
b= 1/10th HI for ingestion
c= 10^{-6} cancer risk for ingestion
d= 10^{-6} cancer risk for ingestion + dermal + inhalation
e= 10^{-6} cancer risk for ingestion + inhalation + external
f= New Risk-Based Guideline Values calculated according to Mound GV 3/97 methodology
The calculations for updated GVs are presented in Appendix C.

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient

Table 2.6 Final Identification of Current Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Exposure Point Concentration Compared to Background Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	95 Percent UCL	Concentration Used for Screening EPC	Background Value	COPC for RRE
Inorganics								
Antimony	2.8	40.20	ug/L	5-29	80.30	40.20	0.578	YES
Cadmium	4.6	7.70	ug/L	6-32	5.25	5.25		YES
Copper	1.6	593.00	ug/L	22-32	22.70	22.70	1.167	YES
Lead	3.4	40.00	ug/L	5-32	7.28	7.28	10.05	NO
Radionuclides								
Thorium-230	0.01	1.99	pCi/L	11-32	1.25	1.25		YES
Uranium-238	0.13	8.25	pCi/L	41-48	0.47	0.47	0.688	NO:3

UCL= Upper Confidence Limit

EPC= Exposure point concentration minimum of 95% UCL or maximum detected concentration

NO <Background Value

NC= 95% UCL not calculated, less than 20 samples in the data set.

Table 2.7 Initial Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario
(Maximum Detected Values Compared to Background and Screening Guideline Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	Concentration Used for Screening and Risk	Background Value	Site Employee Risk-Based GV	Reference Risk-Based GV	Initial COPC
Inorganics									
Aluminum	67.91	148.00	ug/L	7-29	148.00	37.523	10000.00	a,d	NO:3
Antimony	2.8	40.20	ug/L	5-29	40.20	0.578	4.10	a	YES
Barium	75	115.00	ug/L	27-29	115.00	310.209	720.00	a	NO:2,3
Cadmium	4.6	7.70	ug/L	6-32	7.70		5.10	a	YES
Calcium	94300	126000.00	ug/L	33-33	126000.00	111110.664			NO:4
Chromium (assume all is VI)	18.3	24.91	ug/L	6-32	24.91	6.076	31.00	b,d	NO:3
Copper	1.6	593.00	ug/L	22-32	593.00	1.167	410.00	a, d	YES
Iron	18.8	1890.00	ug/L	14-31	1890.00	4064.888			NO:2
Lead	3.4	40.00	ug/L	5-32	40.00	10.05			YES
Lithium	2.9	2.90	ug/L	4-10	2.90	55.7			NO:2
Magnesium	29100	39600.00	ug/L	32-32	39600.00	40428.111			NO:2
Manganese	2.8	224.00	ug/L	30-32	224.00	229.568	51.00	a	NO:2
Molybdenum	1.6	2.70	ug/L	5-10	2.70	5.597			NO:2
Nickel	2.1	27.10	ug/L	5-32	27.10	34.957	200.00	a	NO:2,3
Potassium	2390	3761.00	ug/L	27-33	3761.00	4461.063			NO:2
Selenium	1.5	1.50	ug/L	1-32	1.50				NO:1
Silver	16.9	24.20	ug/L	6-29	24.20		51.00	a	NO:3
Sodium	46600	84200.00	ug/L	32-32	84200.00	62425.563			NO:4
Thallium	2.4	2.40	ug/L	1-29	2.40				NO:1
Tin	8.7	8.70	ug/L	1-10	8.70	34.382			NO:2
Vanadium	3.9	14.60	ug/L	12-29	14.60	17.1	72.00	a	NO:2,3
Zinc	4.5	57.70	ug/L	10-32	57.70	119.6	3100.00	a	NO:2,3
Volatile Organic Compounds									
1,1,1-Trichloroethane	0.30	3.30	ug/L	79-193	3.30	0.668	360.00	a, d	NO:3
1,1,2 Trichloro-1,2,2-trifluoroethane	2.00	34.00	ug/L	13-18	34.00		310000.00	a, d	NO:3
1,1-Dichloroethane	2.50	3.50	ug/L	2-191	3.50		1000.00	a	NO:1
1,1-Dichloroethene	1.70	1.70	ug/L	1-193	1.70				NO:1
cis-1,2-Dichloroethene	0.47	4.00	ug/L	103-159	4.00	0.999	100.00	a, d	NO:3
trans-1,2-Dichloroethene	0.50	3.00	ug/L	8-195	3.00		200.00	a	NO:1
cis-1,3-Dichloropropene	0.50	1.20	ug/L	2-195	1.20				NO:1
2-Butanone	7.00	41.00	ug/L	3-12	41.00		6100.00	a	NO:3
Acetone	1.00	12.00	ug/L	6-12	12.00		1000.00	a	NO:3
Bromodichloromethane	2.20	3.70	ug/L	2-193	3.70		4.60	c	NO:1
Chloroform	0.50	5.40	ug/L	9-197	5.40	0.516			NO:1
Dichloromethane	3.00	13.00	ug/L	8-195	13.00		38.00	c	NO:1
Ethylbenzene	0.50	0.60	ug/L	2-197	0.60		1000.00	a	NO:1
Tetrachloroethene	0.15	2.20	ug/L	109-196	2.20		100.00	a	NO:3
Toluene	0.60	1.50	ug/L	4-197	1.50		2000.00	a	NO:1
Trichloroethene	0.47	5.90	ug/L	176-197	5.90		26.00	c	NO:3
Trichlorofluoromethane	2.20	2.50	ug/L	2-188	2.50		3100.00	a	NO:1
Xylenes, Total	0.60	3.60	ug/L	8-190	3.60		20000.00	a	NO:1

Table 2.7 Initial Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario
(Maximum Detected Values Compared to Background and Screening Guideline Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	Concentration Used for Screening and Risk	Background Value	Site Employee Risk-Based GV	Reference Risk-Based GV	Initial COPC
Radionuclides									
Actinium-227	0.50	0.50	pCi/L	1-10	0.50		0.26	c	YES
Americium-241	0.03	0.03	pCi/L	1-9	0.03	0.139	0.49	c	NO:2,3
Bismuth-210	0.11	0.39	pCi/L	2-19	0.39		22.00	c,d	NO:3
Plutonium-238	0.01	0.25	pCi/L	8-48	0.25	0.087	0.54	c	NO:3
Plutonium-239/240	0.00	2.00	pCi/L	6-20	2.00	0.125	0.51	c	YES
Radium-226	0.10	0.52	pCi/L	6-19	0.52	0.996	0.54	c	NO:2,3
Strontium-85	25.00	25.00	pCi/L	1-2	25.00		110.00	c,d	NO:3
Strontium-90	0.50	0.50	pCi/L	3-19	0.50	0.975	2.90	c	NO:2,3
Thorium-227	0.01	0.10	pCi/L	8-14	0.10		4.00	c,d	NO:3
Thorium-228	0.01	2.17	pCi/L	14-35	2.17	0.779	0.69	c,d	YES
Thorium-230	0.01	1.99	pCi/L	11-32	1.99			e	YES
Thorium-232	0.00	0.10	pCi/L	8-33	0.10	0.314	0.31	c,d	NO:2,3
Tritium	110.00	7200.00	pCi/L	112-128	7200.00	1485.47	2200.00	c	YES
Uranium-233/234	0.17	0.36	pCi/L	30-30	0.36		3.60	c	NO:3
Uranium-234	0.20	8.14	pCi/L	14-19	8.14	0.792	3.60	c	YES
Uranium-235	0.10	2.30	pCi/L	23-43	2.30	0.814	3.40	c	NO:3
Uranium-238	0.13	8.25	pCi/L	41-48	8.25	0.688	0.11	c,d	YES

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion of Cr VI
c= 10^{-6} cancer risk for ingestion
d= New Risk-Based Guideline Values calculated according to Mound GV 3/97 methodology
e= Guideline Value is under review
The calculations for new or revised GVs are presented in Appendix C.
NC= 95% UCL not calculated, less than 20 samples in the data set.

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value

NO:4 - Essential Nutrient
NO:5 - short half life, one detect

Table 2.8 Final Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario (Exposure Point Concentration Compared to Background Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	95 Percent UCL	Concentration Used for Screening and EPC	Background Value	COPC for RRE
Inorganics								
Antimony	2.8	40.20	ug/L	5-29	80.30	40.20	0.578	YES
Cadmium	4.6	7.70	ug/L	6-32	5.25	5.25		YES
Copper	1.6	593.00	ug/L	22-32	22.70	22.70	1.167	YES
Lead	3.4	40.00	ug/L	5-32	7.28	7.28	10.05	NO
Radionuclides								
Actinium-227	0.50	0.50	pCi/L	1-10	NC	0.50		YES
Plutonium-239/240	0.00	2.00	pCi/L	6-20	8.87	2.00	0.125	YES
Thorium-228	0.01	2.17	pCi/L	14-35	105.00	2.17	0.779	YES
Thorium-230	0.01	1.99	pCi/L	11-32	1.25	1.25		YES
Tritium	110.00	7200.00	pCi/L	112-128	861.00	861.00	1485.47	NO
Uranium-234	0.20	8.14	pCi/L	14-19	NC	8.14	0.792	YES
Uranium-238	0.13	8.25	pCi/L	41-48	0.47	0.47	0.688	NO

UCL= Upper Confidence Limit
EPC= minimum of 95% UCL or maximum detected concentration
NO <Background Value
NC= 95% UCL not calculated, less than 20 samples in the data set.

Table 2.9 Initial Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Construction Worker Risk-Based GV	Reference	COPC?
Inorganics										
Aluminum	20.1	31500.00	ug/L	107/ 115	6840.00	31500.00	37.523	10000.00	a, d	YES
Ammonia**	110	37500.00	ug/L	34/ 61	403.00	37500.00	162			NO:5
Antimony	0.35	41.60	ug/L	21/ 122	2.82	41.60	0.578	4.10	a	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	933.00	32.997	3.10	a	YES
Barium	17.5	329.00	ug/L	112/ 114	130.00	329.00	310.209	710.00	a	NO:3
Beryllium**	0.03	2.30	ug/L	41/ 115	0.47	2.30		0.07	c	YES
Bismuth**	0.9	264.00	ug/L	23/ 103	23.20	264.00				YES
Boron**	110	110.00	ug/L	1/ 2	NC	110.00		900.00	a, d	NO:3
Cadmium	0.14	13.10	ug/L	11/ 124	0.75	13.10		5.10	a	YES
Calcium	116	1510000.00	ug/L	164/ 164	199000.00	1510000.00	111110.664			NO:4
Chloride**	8100	17700000.00	ug/L	74/ 74	908000.00	17700000.00	105821			NO:5
Chromium*	0.27	44800.00	ug/L	78/ 120	5010.00	44800.00	6.076	30.00	a, d	YES
Cobalt**	0.31	295.00	ug/L	46/ 115	18.50	295.00	1.032	600.00	a, d	NO:3
Copper	0.38	514.00	ug/L	81/ 117	26.80	514.00	1.167	400.00	a, d	YES
Cyanide**	5.5	14.20	ug/L	3/ 45	4790.00	14.20		200.00	a	NO:3
Dissolved Solids	499000	32500000.00	ug/L	47/ 47	2480.00	32500000.00				NO:4
Fluoride**	150	2400.00	ug/L	57/ 58	678.00	2400.00	419			NO:5
Iron	0.154	192000.00	ug/L	151/ 165	45400.00	192000.00	4064.888			NO:5
Lead**	0.4	32.00	ug/L	55/ 125	4.90	32.00	10.05			YES
Lithium	8.8	4280.00	ug/L	87/ 102	123.00	4280.00	55.7			YES
Magnesium	26.9	719000.00	ug/L	165/ 165	77500.00	719000.00	40428.111			NO:4
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	3030.00	229.568	51.00	a	YES
Mercury**	0.1	1.40	ug/L	3/ 115	0.06	1.40		3.10	a	NO:1
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	474.00	5.597	50.00	a, d	YES
Nickel	1.2	11600.00	ug/L	82/ 120	749.00	11600.00	34.957	200.00	a	YES
Phosphate**	60	10100.00	ug/L	31/ 41	792.00	10100.00	231			NO:5
Potassium	2.12	214000.00	ug/L	150/ 164	15200.00	214000.00	4461.063			NO:4
Selenium	1.3	7.00	ug/L	10/ 112	1.78	7.00		50.00	a, d	NO:3
Silicon**	2230	12300.00	ug/L	6/ 6	NC	12300.00				NO:4
Silver	0.72	29.40	ug/L	7/ 115	1.24	29.40		51.00	a	NO:3
Sodium	68.2	7270000.00	ug/L	162/ 162	346000.00	7270000.00	62425.563			NO:4
Sulfate	5000	456000.00	ug/L	73/ 76	205.00	456000.00				NO:4
Thallium	3.1	6.90	ug/L	6/ 107	4.44	6.90		0.80	a,d	YES
Tin	1.4	357.20	ug/L	27/ 100	14.90	357.20	34.382	6000.00	a, d	NO:3
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	277.00	17.1	71.00	a	YES
Zinc	1.4	399.00	ug/L	78/ 117	47.10	399.00	119.6	3100.00	a	NO:3

Table 2.9 Initial Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Construction Worker Risk-Based GV	Reference	COPC?
Organic Compounds										
1,1,1-Trichloroethane	0.40	7.00	ug/L	20/ 238	0.67	7.00	0.668	180.00	a,d	NO:3
1,1,2 Trichloro-1,2,2-trifluoroethane	2.20	2.20	ug/L	1/ 118	1.08	2.20		250000.00	a,d	NO:1
1,1-Dichloroethane^^	2.00	2.00	ug/L	1/ 238	0.75	2.00		950.00	a	YES
cis-1,2-Dichloroethene	0.06	17.00	ug/L	48/148	1.61	17.00	0.999	100.00	a,d	NO:3
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	35.00				YES
trans-1,2-Dichloroethene	0.43	10.00	ug/L	13/217	0.76	10.00		200.00	b	NO:3
1,3-Dichlorobenzene**	1.50	1.50	ug/L	1/ 147	3.92	1.50				NO:1
2-Butanone	3.00	65.00	ug/L	14/ 106	6.48	65.00		5300.00	a	NO:3
4-Methylphenol	12.00	61.00	ug/L	2/ 71	6.05	61.00		48.00	a	NO:1
Acetone	1.00	17.00	ug/L	25/ 81	9.19	17.00		1000.00	a	NO:3
Alpha Chlordane**	0.01	0.069	ug/L	3/ 62	0.11	0.07				NO:1
Benzene**	2.50	2.50	ug/L	1/ 241	1.26	2.50		7.50	c	NO:1
Benzoic Acid**	1.00	890.00	ug/L	2/ 68	35.70	890.00		40000.00	a	NO:1
Bis(2-ethylhexyl)phthalate**	0.50	950.00	ug/L	16/ 72	17.20	950.00	8.41	12.00	c	NO:6
Carbon Tetrachloride**	1.50	1.50	ug/L	1/ 238	0.94	1.50		2.00	c	NO:1
Chloroform	0.50	0.70	ug/L	2/ 239	0.65	0.70	0.516			NO:1
Chloromethane**	3.40	3.40	ug/L	1/ 85	4.12	3.40				NO:1
Dibromomethane**	2.80	2.80	ug/L	1/ 182	1.01	2.80				NO:1
Dichloromethane	1.00	610.00	ug/L	41/ 239	3.28	610.00		38.00	c	YES
Di-n-butyl Phthalate**	0.50	3.00	ug/L	5/ 71	5.80	3.00		410.00	a	NO:6
Tetrachloroethene**	0.30	25.00	ug/L	55/ 247	3.37	25.00		12.00	a	YES
Toluene	0.50	8.00	ug/L	13/ 243	1.27	8.00		150.00	a	NO:3
Trichloroethene	0.44	46.00	ug/L	152/ 273	5.12	46.00		15.00	c	YES
Radionuclides										
Americium-241	0.6750	0.17	pCi/L	6/ 43	2.87	0.17	0.139	2.40	d	NO:3
Bismuth-210	0.12	0.26	pCi/L	2/ 55	7.99	0.26		110.00	d,e	NO:1
Gross Alpha**	1.03	1930.00	pCi/L	8/ 12	NC	1930.00				NO:4
Plutonium-238	0.012	1.870	pCi/L	8/ 60	0.15	1.87	0.087	2.70	d	NO:3
Plutonium-239/240	0.003	0.18	pCi/L	12/ 51	0.42	0.18	0.125	2.50	d	NO:3
Potassium-40**	129.000	258.00	pCi/L	3/ 61	133.00	258.00				NO:1
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	39.47	0.996	2.70	d	YES
Radium-228**	1.50	1.50	pCi/L	1/ 1	NC	1.50		1.70	d,e	NO:3
Strontium-90	0.74	42.40	pCi/L	7/ 57	2.22	42.40	0.975	14.00	d	YES
Thorium-228	0.02	8.50	pCi/L	39/ 54	90.70	8.50	0.779	3.50	d	YES
Thorium-230	0.0044	4.07	pCi/L	43/ 56	0.57	4.07				YES
Thorium-232	0.0005	2.11	pCi/L	31/ 63	0.78	2.11	0.314	1.60	d,e	YES
Tritium	2.95	2816310.00	pCi/L	4440/4455	206000.00	2816310.00	1485.47	11000.00	c	YES
Uranium-233/234	0.154	0.928	pCi/L	4/ 4	NC	0.93		18.00	d	NO:3
Uranium-234	0.03	59.10	pCi/L	60/ 69	2.12	59.10	0.792	18.00	d	YES
Uranium-235	0.01	0.36	pCi/L	18/ 45	5.71	0.36	0.814	17.00	d	NO:2,3
Uranium-235/236**	0.04	0.05	pCi/L	2/ 26	0.10	0.05		17.00	d	NO:3
Uranium-238	0.03	1.34	pCi/L	57/ 75	0.51	1.34	0.688	0.60	d,e	YES

a= 1/10th HI for ingestion + inhalation + dermal
b= 1/10th HI for ingestion
c= 10^{-6} cancer risk for ingestion+ inhalation+dermal
d=10^{-6} cancer risk for ingestion
e= Risk-Based Guideline Values calculated using the methodology, equations, and parameters presented in Mound Screening GV 3/97
NC= 95% UCL not calculated, less than 20 samples in the data set.
* = Chromium conservatively assumed to be present in the hexavalent state.
** = Constituent detected in bedrock well, but not in production well
^^ = Constituent detected in production well, not in bedrock wells; reported frequency of detection based on production wells analyses

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient or General Quality Parameter
NO:5 - Water Quality Parameter
NO:6 - Common laboratory contaminant (EPA, 1998)

Table 2.10 Final Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Bedrock 95% UCL or Maximum Detected Concentration Compared to Background Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	COPC?
Inorganics								
Aluminum	20.1	31500.00	ug/L	107/ 115	6840.00	6840.00	37.523	YES
Antimony	0.35	41.60	ug/L	21/ 122	2.82	2.82	0.578	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	11.80	32.997	NO
Beryllium**	0.03	2.30	ug/L	41/ 115	0.47	0.47		YES
Bismuth**	0.9	264.00	ug/L	23/ 103	23.20	23.20		YES
Cadmium	0.14	13.10	ug/L	11/ 124	0.75	0.75		YES
Chromium*	0.27	44800.00	ug/L	78/ 120	5010.00	5010.00	6.076	YES
Copper	0.38	514.00	ug/L	81/ 117	26.80	26.80	1.167	YES
Lead**	0.4	32.00	ug/L	55/ 125	4.90	4.90	10.05	NO
Lithium	8.8	4280.00	ug/L	87/ 102	123.00	123.00	55.7	YES
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	737.00	229.568	YES
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	32.50	5.597	YES
Nickel	1.2	11600.00	ug/L	82/ 120	749.00	749.00	34.957	YES
Thallium	3.1	6.90	ug/L	6/ 107	4.44	4.44		YES
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	33.00	17.1	YES
Organic Compounds								
1,1-Dichloroethane^^	2.00	2.00	ug/L	1/ 238	0.75	0.75		NO:1
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	6.61		YES
Dichloromethane	1.00	610.00	ug/L	41/ 239	3.28	3.28		YES
Tetrachloroethene**	0.30	25.00	ug/L	55/ 247	3.37	3.37		YES
Trichloroethene	0.44	46.00	ug/L	152/ 273	5.12	5.12		YES
Radionuclides								
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	2.34	0.996	YES
Strontium-90	0.74	42.40	pCi/L	7/ 57	2.22	2.22	0.975	YES
Thorium-228	0.02	8.50	pCi/L	39/ 54	90.70	8.50	0.779	YES
Thorium-230	0.0044	4.07	pCi/L	43/ 56	0.57	0.57		YES
Thorium-232	0.0005	2.11	pCi/L	31/ 63	0.78	0.78	0.314	YES
Tritium	2.95	2816310.00	pCi/L	4440/4455	206000.00	206000.00	1485.47	YES
Uranium-234	0.03	59.10	pCi/L	60/ 69	2.12	2.12	0.792	YES
Uranium-238	0.03	1.34	pCi/L	57/ 75	0.51	0.51	0.688	NO

UCL= Upper Confidence Limit

NC= 95% UCL not calculated, less than 20 samples in the data set.

* = Chromium conservatively assumed to be present in the hexavalent state.

** = Constituent detected in bedrock well, but not in production well

^^ = Constituent detected in production well, not in bedrock wells; reported frequency of detection based on production wells analyses

Table 2.11 Initial Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Site Employee Risk-Based GV	Reference Risk-Based GV	COPC?
Inorganics										
Aluminum	20.1	31500.00	ug/L	107/ 115	6840.00	31500.00	37.523	10000.00	a,d	YES
Ammonia**	110	37500.00	ug/L	34/ 61	4030.00	37500.00	162			NO:5
Antimony	0.35	41.60	ug/L	21/ 122	2.82	41.60	0.578	4.10	a	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	933.00	37.295	3.10	a	YES
Barium	17.5	329.00	ug/L	112/ 114	130.00	329.00	310.209	720.00	a	NO:3
Beryllium**	0.03	2.30	ug/L	41/ 115	0.47	2.30		0.07	c	YES
Bismuth**	0.9	264.00	ug/L	23/ 103	23.20	264.00				YES
Boron**	110	110.00	ug/L	1/ 2	NC	110.00		920.00	a,d	NO:3
Cadmium	0.14	13.10	ug/L	11/ 124	0.75	13.10		5.10	a	YES
Calcium	116	1510000.00	ug/L	164/ 164	199000.00	1510000.00	111110.664			NO:4
Chloride**	8100	17700000.00	ug/L	74/ 74	908000.00	17700000.00	105821			NO:5
Chromium*	0.27	44800.00	ug/L	78/ 120	5010.00	44800.00	6.076	31.00	a,d	YES
Cobalt**	0.31	295.00	ug/L	46/ 115	18.50	295.00	1.032	610.00	a,d	NO:3
Copper	0.38	514.00	ug/L	81/ 117	26.80	514.00	1.167	410.00	a,d	YES
Cyanide**	5.5	14.20	ug/L	3/ 45	4.79	14.20		200.00	a	NO:3
Dissolved Solids	499000	32500000.00	ug/L	47/ 47	2480.00	32500000.00				NO:5
Fluoride**	150	2400.00	ug/L	57/ 58	678.00	2400.00	419			NO:5
Iron	0.154	192000.00	ug/L	151/ 165	45400.00	192000.00	4064.888			NO:4
Lead**	0.4	32.00	ug/L	55/ 125	4.90	32.00	10.05			YES
Lithium	8.8	4280.00	ug/L	87/ 102	123.00	4280.00	55.7			YES
Magnesium	26.9	719000.00	ug/L	165/ 165	77500.00	719000.00	40428.111			NO:4
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	3030.00	229.568	51.00	a	YES
Mercury**	0.1	1.40	ug/L	3/ 115	0.06	1.40	na	3.10	a	NO:1
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	474.00	5.597	51.00	a,d	YES
Nickel	1.2	11600.00	ug/L	82/ 120	749.00	11600.00	34.957	200.00	a	YES
Phosphate**	60	10100.00	ug/L	31/ 41	792.00	10100.00	231			NO:5
Potassium	2.12	214000.00	ug/L	150/ 164	15200.00	214000.00	4461.063			NO:4
Selenium	1.3	7.00	ug/L	10/ 112	1.78	7.00		51.00	a,d	NO:3
Silicon**	2230	12300.00	ug/L	6/ 6	NC	12300.00				NO:4
Silver	0.72	29.40	ug/L	7/ 115	1.24	29.40		51.00	a	NO:3
Sodium	68.2	7270000.00	ug/L	162/ 162	346000.00	7270000.00	62425.563			NO:4
Sulfate	5000	456000.00	ug/L	73/ 76	205.00	456000.00		0.82	a	NO:5
Thallium	3.1	6.90	ug/L	6/ 107	4.44	6.90				YES
Tin	1.4	357.20	ug/L	27/ 100	14.90	357.20	34.382	6100.00	a,d	NO:3
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	277.00	17.1	72.00	a	YES
Zinc	1.4	399.00	ug/L	78/ 117	47.10	399.00	119.6	3100.00	a	NO:3

Table 2.11 Initial Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Site Employee Risk-Based GV	Reference Risk-Based GV	COPC?
Organic Compounds										
1,1,1-Trichloroethane	0.40	7.00	ug/L	20/ 238	0.67	7.00	0.668	360.00	a,d	NO:3
1,1,2 Trichloro-1,2,2-trifluoroethane	2.20	2.20	ug/L	1/ 118	1.08	2.20				NO:1
1,1-Dichloroethane^^	2.00	2.00	ug/L	1/ 238	0.75	2.00		1000.00	a	NO:1
cis-1,2-Dichloroethene	0.06	17.00	ug/L	48/148	1.61	17.00	0.999			YES
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	35.00				YES
trans-1,2-Dichloroethene	0.43	10.00	ug/L	13/217	0.76	10.00		200.00	a	NO:3
1,3-Dichlorobenzene**	1.50	1.50	ug/L	1/ 147	3.92	1.50				NO:1
2-Butanone	3.00	65.00	ug/L	14/ 106	6.48	65.00		6100.00	a	NO:3
4-Methylphenol	12.00	61.00	ug/L	2/ 71	6.05	61.00		1000000	a	NO:1
Acetone	1.00	17.00	ug/L	25/ 81	9.19	17.00		1000.00	a	NO:3
Alpha Chlordane**	0.01	0.069	ug/L	3/ 62	0.11	0.07				NO:1
Benzene**	2.50	2.50	ug/L	1/ 241	1.26	2.50		9.90	c	NO:1
Benzoic Acid**	1.00	890.00	ug/L	2/ 68	35.70	890.00		8.20E+08	a	NO:1
Bis(2-ethylhexyl)phthalate**	0.50	950.00	ug/L	16/ 72	17.20	950.00	8.41	20.00	c	NO:6
Carbon Tetrachloride**	1.50	1.50	ug/L	1/ 238	0.94	1.50		2.20	c	NO:1
Chloroform	0.50	0.70	ug/L	2/ 239	0.65	0.70	0.516			NO:1
Chloromethane**	3.40	3.40	ug/L	1/ 85	4.12	3.40				NO:1
Dibromomethane**	2.80	2.80	ug/L	1/ 182	1.01	2.80				NO:1
Dichloromethane	1.00	610.00	ug/L	41/ 239	3.28	610.00		38.00	c	YES
Di-n-butyl Phthalate**	0.50	3.00	ug/L	5/ 71	5.80	3.00		1000.00	a	NO:3
Tetrachloroethene**	0.30	25.00	ug/L	55/ 247	3.37	25.00		100.00	a	NO:3
Toluene	0.50	8.00	ug/L	13/ 243	1.27	8.00		2000.00	a	NO:3
Trichloroethene	0.44	46.00	ug/L	152/ 273	5.12	46.00		26.00	c	YES
Radionuclides										
Americium-241	0.6750	0.17	pCi/L	6/ 43	2.87	0.17	0.139	0.49	c	NO:3
Bismuth-210	0.12	0.26	pCi/L	2/ 55	7.99	0.26				NO:1
Gross Alpha**	1.03	1930.00	pCi/L	8/ 12	NC	1930.00				NO:5
Plutonium-238	0.012	1.870	pCi/L	8/ 60	0.15	1.87	0.087	0.54	c	YES
Plutonium-239/240	0.003	0.18	pCi/L	12/ 51	0.42	0.18	0.125	0.51	c	NO:3
Potassium-40**	129.000	258.00	pCi/L	3/ 61	133.00	258.00				NO:1
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	39.47	0.996	0.54	c	YES
Radium-228**	1.50	1.50	pCi/L	1/ 1	NC	1.50		0.33	c,d	YES
Strontium-90	0.74	42.40	pCi/L	7/ 57	2.22	42.40	0.975	2.90	c	YES
Thorium-228	0.02	8.50	pCi/L	39/ 54	90.70	8.50	0.779	0.69	c	YES
Thorium-230	0.0044	4.07	pCi/L	43/ 56	0.57	4.07				YES
Thorium-232	0.0005	2.11	pCi/L	31/ 63	0.78	2.11	0.314	0.31	c,d	YES
Tritium	2.95	2816310.00	pCi/L	4440/4455	206000.00	2816310.00	1485.47	2200.00	c	YES
Uranium-233/234	0.154	0.928	pCi/L	4/ 4	NC	0.93		3.60	c	NO:3
Uranium-234	0.03	59.10	pCi/L	60/ 69	2.12	59.10	0.792	3.60	c	YES
Uranium-235	0.01	0.36	pCi/L	18/ 45	5.71	0.36	0.814	3.40	c	NO:2,3
Uranium-235/236**	0.04	0.05	pCi/L	2/ 26	0.10	0.05		3.40	c	NO:3
Uranium-238	0.03	1.34	pCi/L	57/ 75	0.51	1.34	0.688	0.11	c,d	YES

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion of Cr VI
c= 10^{-6} cancer risk for ingestion
d= Risk-Based Guideline Values calculated using the methodology, equations, and parameters in Mound Screening GV 3/97
NC= 95% UCL not calculated, less than 20 samples in the data set.
* = Chromium conservatively assumed to be present in the hexavalent state.
** = Constituent detected in bedrock well, but not in production well
^^ = Constituent detected in production well, not in bedrock wells; reported frequency of detection based on production wells analyses

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient
NO:5 - General Water Quality Parameter

Table 2.12 Final Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario (Bedrock 95% UCL or Maximum Detected Concentration Compared to Background Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	COPC?
Inorganics								
Aluminum	20.1	31500.00	ug/L	107/ 115	6840.00	6840.00	37.523	YES
Antimony	0.35	41.60	ug/L	21/ 122	2.82	2.82	0.578	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	11.80	32.997	NO
Beryllium**	0.03	2.30	ug/L	41/ 115	0.47	0.47		YES
Bismuth**	0.9	264.00	ug/L	23/ 103	23.20	23.20		YES
Cadmium	0.14	13.10	ug/L	11/ 124	0.75	0.75		YES
Chromium*	0.27	44800.00	ug/L	78/ 120	5010.00	5010.00	6.076	YES
Copper	0.38	514.00	ug/L	81/ 117	26.80	26.80	1.167	YES
Lead**	0.4	32.00	ug/L	55/ 125	4.90	4.90	10.05	NO
Lithium	8.8	4280.00	ug/L	87/ 102	123.00	123.00	55.7	YES
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	737.00	229.568	YES
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	32.50	5.597	YES
Nickel	1.2	11600.00	ug/L	82/ 120	749.00	749.00	34.957	YES
Thallium	3.1	6.90	ug/L	6/ 107	4.44	4.44		YES
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	33.00	17.1	YES
Organic Compounds								
1,2-cis-Dichloroethene	0.06	17.00	ug/L	48/ 148	1.61	1.61	0.999	YES
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	6.61		YES
Dichloromethane	1.00	610.00	ug/L	41/ 239	3.28	3.28		YES
Trichloroethene	0.44	46.00	ug/L	152/ 273	5.12	5.12		YES
Radionuclides								
Plutonium-238	0.012	1.870	pCi/L	8/ 60	0.15	0.15	0.087	YES
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	2.34	0.996	YES
Radium-228**	1.50	1.50	pCi/L	1/ 1	NC	1.50		YES
Strontium-90	0.74	42.40	pCi/L	7/ 57	2.22	2.22	0.975	YES
Thorium-228	0.02	8.50	pCi/L	39/ 54	90.70	8.50	0.779	YES
Thorium-230	0.0044	4.07	pCi/L	43/ 56	0.57	0.57		YES
Thorium-232	0.0005	2.11	pCi/L	31/ 63	0.78	0.78	0.314	YES
Tritium	2.95	2816310.00	pCi/L	4440/4455	206000.00	206000.00	1485.47	YES
Uranium-234	0.03	59.10	pCi/L	60/ 69	2.12	2.12	0.792	YES
Uranium-238	0.03	1.34	pCi/L	57/ 75	0.51	0.51	0.688	NO

UCL= Upper confidence Limit

NC= 95% UCL not calculated, less than 20 samples in the data set.

* = Chromium conservatively assumed to be present in the hexavalent state.

** = Constituent detected in bedrock well, but not in production well

^^ = Constituent detected in production well, not in bedrock wells; reported frequency of detection based on production wells analyses

Table 3.1 Exposure Assumptions for Site Employee and Construction Worker Scenarios in Parcel 4

Parameter	Units	Construction Worker Adult	Site-Employee Adult	Reference
Medium/pathway				
Surface soil (0 - 2 ft.) & Sediment				
Incidental ingestion				
Soil ingestion rate	mg/day	480	50	a
Exposure frequency	days/year	250	250	b
Exposure duration	years	5	25	c
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Conversion Factor	kg/mg	1.00E-06	1.00E-06	
Inhalation of VOCs and dust				
Inhalation rate	m^3/day	20	20	f
Exposure frequency	days/year	250	250	b
Exposure duration	years	5	25	c
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Conversion Factor	days/hour	0.042	0.042	
Air Exchange Rate	air changes/hour	N/A	0.45	h
Surface/Subsurface soil (0 - 10 ft.)				
Incidental ingestion				
Soil ingestion rate	mg/day	480	50	a
Exposure frequency	days/year	250	250	b
Exposure duration	years	5	25	c
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Conversion Factor	kg/mg	$1x10^{-6}$	$1x10^{-6}$	
Inhalation of VOCs and dust				
Inhalation rate	m^3/day	20	20	f
Exposure frequency	days/year	250	250	b
Exposure time	hours/day	8	8	g
Exposure duration	years	5	25	c
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Particle Emissions Factor	m^3/kg	4.28×10^9	4.28×10^9	
Conversion Factor	g/kg	1000	1000	
Conversion Factor	days/hour	0.042	0.042	
External Exposure				
Gamma Shielding Factor		0.1	0.2	
Gamma Exposure Time Factor		1/3	1/12	
Exposure Duration 2	years	5 x 0.685	25 x 0.685	c
Exposure Frequency	day/year	250	250	b

Table 3.1 Exposure Assumptions for Site Employee and Construction Worker Scenarios in Parcel 4

Parameter	Units	Construction Worker Adult	Site-Employee Adult	Reference
Groundwater				
Drinking water ingestion				
Drinking water ingestion rate	L/day	1	1	i
Exposure frequency	days/year	250	250	b
Exposure time	years	5	25	g
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Dermal contact while showering				
Skin surface area available for contact	cm^2	19400	NA	j
Exposure time	hr/day	0.167	NA	g
Exposure frequency	days/year	250	NA	b
Exposure duration	years	5	NA	c
Body weight	kg	70	NA	d
Carcinogen averaging time	days	25550	NA	e
Noncarcinogen averaging time	days	1825	NA	e
Conversion factor	L/cm^3	0.001	NA	
Inhalation of VOCs while showering				
Inhalation rate	m^3/day	20	NA	f
Exposure time	hr/day	0	NA	g
Exposure frequency	days/year	250	NA	b
Exposure duration	years	5	NA	c
Body weight	kg	70	NA	d
Carcinogen averaging time	days	25550	NA	e
Noncarcinogen averaging time	days	1825	NA	e

Table 3.1 (references)
Exposure Assumption References

a	Soil ingestion rate	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989)
b	Exposure frequency	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989)
c	Exposure duration	Exposure duration for the construction worker and site employee is based on Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989)
d	Body weight	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989).
e	Averaging time	Carcinogenic averaging time = 70 yrs * 365 days/year. Non-carcinogenic averaging time = exposure duration (yrs) * 365 days/year.
f	Inhalation rate	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and EFH Volume I, Table 1-2.
g	Exposure time	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989)
h	Air exchange rate	Volume of residential homes, EFH, Volume III, Table 17-3. 50th percentile air exchange rate of 0.45 air changes per hour, EFH, Volume III, Table 17-10 (EPA 1997).
i	Drinking water ingestion	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio.(DOE 1997c) and RAGS Part A (EPA 1989).
j	Skin surface available for contact	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989).

Table 4.1 Toxicity Criteria and other Physical Chemical Values

Constituent	RfD (mg/kg/day) Oral RfDo		Adjusted RfDa	Inhalation RfDi		CSF (kg-day/mg) Oral CSFo		Adjusted CSFa	Inhalation CSFi		CSFex	GI Factor		Kp(cm/hr)	T (hr)		Dermal Absorption Abs	
Volatile Organic Compounds (VOCs)																		
1,1,1-Trichloroethane	3.50E-02	a	3.50E-02	2.90E-01	a	NA		NA	NA		NA	0.90	d	0.017	0.570	e	NA	
1,1,2-Trichloro-1,2,2trifluoroeth	3.00E+01	b	3.00E+01	8.60E+00	c	NA		NA	NA		NA	0.80	d	0.009		e	NA	
cis-1,2-Dichlorethene	1.00E-02	c	1.00E-02	NA		NA		NA	NA		NA	1.00	d	0.010	0.340	e	NA	
1,2-Dichloroethene	9.00E-03	b	NA	NA		NA		NA	NA		NA	1.00	d	0.010	0.340	e	NA	
Alpha Chlordane	NA		NA	NA		NA		NA	NA		NA	0.50	d	0.046	28.000	e	NA	
Carbon Tetrachloride	7.00E-04	b	7.00E-04	5.70E-04	a	1.30E-01	b	2.00E-01	5.25E-02	b	NA	0.65	d	0.022	0.760	e	NA	
Chloroform	1.00E-02	b	1.00E-02	8.60E-05	a	6.10E-03	b	3.05E-02	8.05E-02	b	NA	0.20	d	0.009	0.470	e	NA	
Semivolatile Organic Compounds (SVOCs)																		
2-Methylnaphthalene	NA		NA	NA		NA		NA	NA		NA	NA					NA	
4-Chloro-3-methylphenol	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Acenaphthylene	NA		NA	NA		NA		NA	NA		NA	0.31	d				0.10	d
Benzo(a)pyrene	NA		NA	NA		7.3E+00		7.30E+00	3.10E+00		NA	0.89	f				0.13	f
Benzo(b)fluoranthene	NA		NA	NA		7.3E-01		7.30E-01	3.10E-01		NA	0.89	f				0.13	f
Benzo(g,h,i)perylene	NA		NA	NA		NA		NA	NA		NA	0.89	f				0.13	f
Carbazole	NA		NA	NA		2.0E-02		2.00E-02	NA		NA	0.70	d				0.10	d
Indeno(1,2,3-cd)pyrene	NA		NA	NA		7.3E-01		7.30E-01	3.10E-01		NA	0.89	f				0.13	f
Phenanthrene	NA		NA	NA		NA		NA	NA		NA	0.73	d				0.10	d
Pesticides																		
Delta-BHC	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Endosulfan Sulfate	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Endrin Aldehyde	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Endrin Ketone	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Metals																		
Aluminum	1.00E+00	a	1.00E-01	1.40E-03	a	NA		NA	NA		NA	0.10	d	0.001		e		
Antimony	4.00E-04	b	6.00E-05	NA		NA		NA	NA		NA	0.15	d	0.001		e	0.0010	d
Beryllium	2.00E-03	b	1.40E-05	5.71E-03	b	4.30E+00	b	NA	8.40E+00	b	NA	0.01	d	0.001		e		
Bismuth	NA		NA	NA		NA		NA	NA		NA	NA		0.001		e	NA	
Boron	9.00E-02	b	8.10E-03	5.71E-03	c	NA		NA	NA		NA	0.09	d	0.001		e		
Cadmium	5.00E-04	b	5.00E-06	5.70E-05	a	NA		NA	6.30E+00	b	NA	0.03	d	0.001		e		
Cerium	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Chromium VI	3.00E-03	b	7.50E-05	NA		NA		NA	4.10E+01	c	NA	0.03	d	0.001		e		
Cobalt	6.00E-02	a	NA	NA		NA		NA	NA		NA	NA	d	0.001		e		
Copper	4.00E-02	a	#VALUE!	NA		NA		NA	NA		NA	NA	d	0.001		e		
Lead	NA		NA	NA		NA		NA	NA		NA	0.15	d	0.001		e		
Lithium	NA		NA	NA		NA		NA	NA		NA	NA		0.001		e	NA	
Manganese	2.40E-02	b	9.60E-04	1.43E-05	b	NA		NA	NA		NA	0.04	d	0.001		e		
Molybdenum	5.00E-03	c	NA	NA		NA		NA	NA		NA	NA	d	0.001		e		
Neodymium	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Nickel	2.00E-02	b	8.00E-04	NA		NA		NA	NA		NA	0.04	d	0.001		e		
Selenium	5.00E-03	b	4.00E-03	NA		NA		NA	NA		NA	0.80	d	0.001		e		
Thallium	8.00E-05	b	8.00E-05	NA		NA		NA	NA		NA	1.00	d	0.001		e	0.0010	
Tin	6.00E-01	c	6.00E-02	NA		NA		NA	NA		NA	0.10	d	0.001		e		
Vanadium	7.00E-03	c	1.82E-04	NA		NA		NA	NA		NA	0.026	d	0.001		e		

Table 4.1 Toxicity Criteria and other Physical Chemical Values

Constituent	RfD (mg/kg/day) Oral RfDo	Adjusted RfDa	Inhalation RfDi	CSF (kg-day/mg) Oral CSFo		Adjusted CSFa	Inhalation CSFi		CSFex		GI Factor		Kp(cm/hr)	T (hr)	Dermal Absorption Abs
Radionuclides															
Actinium-227+D	NA	NA	NA	6.26E-10	c	NA	7.87E-08	c	9.30E-07	c	NA*		NA		
Bismuth-210	NA	NA	NA	7.29E-12	c	NA	5.12E-11	c	0.00E+00	c	NA*		NA		
Cobalt-60	NA	NA	NA	1.89E-11	c	NA	6.88E-11	c	9.76E-06	c					
Lead-210	NA	NA	NA	6.75E-10	c	NA	1.67E-09	c	1.12E-10	c					
Neptunium-237+D	NA	NA	NA	3.00E-10	c	NA	3.45E-08	c	4.62E-07	c					
Plutonium-238	NA	NA	NA	2.95E-10	c	NA	2.74E-08	c	1.94E-11	c	NA*		NA		
Plutonium-239/240	NA	NA	NA	3.16E-10	c	NA	2.78E-08	c	1.26E-11	c	NA*		NA		
Radium-226	NA	NA	NA	2.96E-10	c	NA	2.75E-09	c	6.74E-06	c	NA*		NA		
Radium-228+D	NA	NA	NA	4.79E-10	c	NA	9.78E-10	c	9.48E-06	c					
Strontium-90+D	NA	NA	NA	5.59E-11	c	NA	6.93E-11	c	0.00E+00	c					
Thorium-227	NA	NA	NA	4.04E-11	c	NA	4.31E-09	c	1.74E-07	c	NA*		NA		
Thorium-228+D	NA	NA	NA	2.31E-10	c	NA	9.68E-08	c	6.20E-06	c	NA*		NA		
Thorium-230+D	NA	NA	NA	1.34E-09	c	NA	2.38E-08	c	6.74E-06	c	NA*		NA		
Thorium-232+D	NA	NA	NA	5.12E-10	c	NA	1.17E-07	c	9.48E-06	c	NA*		NA		
Tritium	NA	NA	NA	7.15E-14	c	NA	9.59E-14	c	0.00E+00	c	1.00	c	1.50E-05		
Uranium-234	NA	NA	NA	4.44E-11	c	NA	1.40E-08	c	2.14E-11	c	NA*		NA		
Uranium-235+D	NA	NA	NA	4.70E-11	c	NA	1.30E-08	c	1.72E-11	c	NA*		NA		
Uranium-238+D	NA	NA	NA	1.43E-09	c	NA	5.08E-08	c	7.01E-06	c	NA*		NA		

NA= Not Available
a=NCEA
b= IRIS
c=HEAST
d=values compiled by ORNL, DOE-OR/ERD site and presented on RAIS web page.
e=Dermal Exposure Assessment Principles and Applications, 1992, EPA/600/8-91/011B for Kp and lag time
f=values provided by Mark Johnson USEPA for the Draft Dermal Risk Assessment Guidance for RAGS
NA* HEAST does not recommend adjusting CSFo for dermal

Table 5.1 Total Residual Risk for a Construction Worker Exposed to Soil in Parcel 4

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													
Endrin Aldehyde	0.00093	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Endrin Ketone	0.00086	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Antimony	12.60	NC	NC	NA	NAP	NAP	NA	1.5E-01	1.7E-03	NA	NAP	NAP	1.5E-01
Bismuth	70.40	NC	NC	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Cerium	50.90	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Neodymium	33.40	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.66	NC	NC	NC	NAP	NAP	NA	3.9E-02	5.8E-05	NA	NAP	NAP	3.9E-02
SVOCs													
Acenaphthylene	0.243	NC	NA	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene	0.33	8.1E-07	3.3E-07	3.3E-12	NAP	NAP	1.1E-06	NA	NA	NA	NAP	NAP	NA
Benzo(b)fluoranthene	0.439	1.1E-07	4.4E-08	4.4E-13	NAP	NAP	1.5E-07	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.241	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.219	1.5E-09	4.6E-10	NA	NAP	NAP	1.9E-09	NA	NA	NA	NAP	NAP	NA
Indeno(1,2,3-cd)pyrene	0.253	6.2E-08	2.5E-08	2.6E-13	NAP	NAP	8.7E-08	NA	NA	NA	NAP	NAP	NA
Phenanthrene	0.338	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g												
Actinium-227	0.23	8.6E-08	NAP	1.1E-10	NAP	8.8E-08	1.7E-07	NA	NAP	NA	NAP	NA	NA
Lead-210	1.76	1.1E-06	NAP	4.0E-11	NAP	1.1E-10	1.1E-06	NA	NAP	NA	NAP	NA	NA
Plutonium-238	55.40	9.8E-06	NAP	8.9E-09	NAP	4.4E-10	9.8E-06	NA	NAP	NA	NAP	NA	NA
Radium-228*	2.57	7.4E-07	NAP	9.78-08	NAP	1.0E-05	1.1E-05	NA	NAP	NA	NAP	NA	NA
Thorium-230*	2.69	2.2E-06	NAP	3.7E-10	NAP	7.5E-06	9.6E-06	NA	NAP	NA	NAP	NA	NA
TOTAL		1.5E-05	4.0E-07	9.4E-09	0.0E+00	1.8E-05	3.3E-05	1.9E-01	1.7E-03	NA	NA	0.0E+00	1.9E-01

EPC	Exposure point concentration
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds.

Numbers written as 1.0E-03 equal $1x10^{-3}$.

* Toxicity criteria used to calculate risk include all daughter radionuclides

Table 5.2 Background Residual Risk for a Construction Worker Exposed to Soil in Parcel 4

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													
Endrin Aldehyde		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Endrin Ketone		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Antimony		NC	NC	NA	NAP	NAP	NA	0.0E+00	0.0E+00	NA	NAP	NAP	NA
Bismuth		NC	NC	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Cerium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Neodymium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.46	NC	NC	NC	NAP	NAP	NA	2.7E-02	4.0E-05	NA	NAP	NAP	2.7E-02
SVOCs													
Acenaphthylene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(b)fluoranthene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Indeno(1,2,3-cd)pyrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g												
Actinium-227		NA	NAP	NA	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Lead-210		NA	NAP	NA	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Plutonium-238	0.13	2.3E-08	NAP	2.1E-11	NAP	1.0E-12	2.3E-08	NA	NAP	NA	NAP	NA	NA
Radium-228*		NA	NAP	9.78-08	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Thorium-230*	1.9	1.5E-06	NAP	2.6E-10	NAP	5.3E-06	6.8E-06	NA	NAP	NA	NAP	NA	NA
TOTAL		1.6E-06	NA	2.8E-10	NA	5.3E-06	6.8E-06	2.7E-02	4.0E-05	NA	NA	NA	2.7E-02

EPC	Exposure point concentration
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds.

Numbers written as 1.0E-03 equal $1x10^{-3}$.

* Toxicity criteria used to calculate risk include all daughter radionuclides

Table 5.3 Incremental Residual Risk for a Construction Worker Exposed to Soil in Parcel 4

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													
Endrin Aldehyde	0.00093	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Endrin Ketone	0.00086	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Antimony	12.60	NC	NC	NA	NAP	NAP	NA	1.5E-01	1.7E-03	NA	NAP	NAP	1.5E-01
Bismuth	70.40	NC	NC	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Cerium	50.90	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Neodymium	33.40	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.20	NC	NC	NC	NAP	NAP	NA	1.2E-02	1.7E-05	NA	NAP	NAP	1.2E-02
SVOCs													
Acenaphthylene	0.243	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene	0.33	8.1E-07	3.3E-07	3.3E-12	NAP	NAP	**1.1E-06**	NA	NA	NA	NAP	NAP	NA
Benzo(b)fluoranthene	0.439	1.1E-07	4.4E-08	4.4E-13	NAP	NAP	1.5E-07	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.241	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.219	1.5E-09	4.6E-10	NA	NAP	NAP	1.9E-09	NA	NA	NA	NAP	NAP	NA
Indeno(1,2,3-cd)pyrene	0.253	6.2E-08	2.5E-08	2.6E-13	NAP	NAP	8.7E-08	NA	NA	NA	NAP	NAP	NA
Phenanthrene	0.338	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g												
Actinium-227	0.64	2.4E-07	NAP	2.9E-10	NAP	2.5E-07	4.9E-07	NA	NAP	NA	NAP	NA	NA
Lead-210	1.84	1.1E-06	NAP	4.1E-11	NAP	1.1E-10	**1.1E-06**	NA	NAP	NA	NAP	NA	NA
Plutonium-238	75.98	1.3E-05	NAP	1.2E-08	NAP	6.1E-10	**1.3E-05**	NA	NAP	NA	NAP	NA	NA
Radium-228*	2.57	7.4E-07	NAP	9.78-08	NAP	1.0E-05	**1.1E-05**	NA	NAP	NA	NAP	NA	NA
Thorium-230*	0.79	6.4E-07	NAP	1.1E-10	NAP	2.2E-06	**2.8E-06**	NA	NAP	NA	NAP	NA	NA
TOTAL		1.7E-05	4.0E-07	1.3E-08	NA	**1.2E-05**	**3.0E-05**	1.6E-01	1.7E-03	NA	NA	NA	1.6E-01

EPC	Exposure point concentration
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds.

Numbers written as 1.0E-03 equal $1x10^{-3}$.

* Toxicity criteria used to calculate risk include all daughter radionuclides

Table 5.4 Total Residual Risk for a Site Employee Exposed to Surface Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides											
Delta-BHC	0.004670	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endosulfan Sulfate	0.000560	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endrin Aldehyde	0.000930	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endrin Ketone	0.000250	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Metals											
Bismuth	28.50	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Lithium	27.30	NA	NA	NAP	NAP	NA	6.7E-04	NA	NAP	NAP	6.7E-04
Semi-Volatile Organic Compounds											
2-Methylnaphthalene	0.063	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
4-Chloro-3-methylphenol	0.007	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Phenanthrene	0.078	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g										
Actinium-227	0.24	4.7E-08	5.5E-10	NAP	4.6E-07	**5.0E-07**	NA	NA	NAP	NA	NA
Lead-210	1.76	3.7E-07	8.6E-11	NAP	4.0E-10	3.7E-07	NA	NA	NAP	NA	NA
Plutonium-238	20.40	1.9E-06	1.6E-08	NAP	8.1E-10	**1.9E-06**	NA	NA	NAP	NA	NA
Radium-228*	2.57	3.8E-07	7.3E-09	NAP	5.0E-05	**5.0E-05**	NA	NA	NAP	NA	NA
Thorium-230*	2.69	1.1E-06	1.9E-09	NAP	3.7E-05	**3.8E-05**	NA	NA	NAP	NA	NA
Uranium-238*	1.23	5.5E-07	1.8E-09	NAP	1.8E-05	**1.8E-05**	NA	NA	NAP	NA	NA
TOTAL		**4.4E-06**	2.8E-08	NA	**1.0E-04**	**1.1E-04**	6.7E-04	NA	NA	NA	6.7E-04

EPC	Exposure point concentration
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not an applicable pathway.
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds.

Numbers written as 1.0E-03 equal $1x10^{-3}$.

* Toxicity criteria used to calculate risk include radionuclide daughters

Table 5.5 Background Residual Risk for a Site Employee Exposed to Surface Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides											
Delta-BHC		NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endosulfan Sulfate		NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endrin Aldehyde		NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endrin Ketone		NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Metals											
Bismuth		NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Lithium	26	NA	NA	NAP	NAP	NA	6.4E-04	NA	NAP	NAP	6.4E-04
Semi-Volatile Organic Compounds											
2-Methylnaphthalene		NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
4-Chloro-3-methylphenol		NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g										
Actinium-227		NA	NA	NAP	NA	NA	NA	NA	NAP	NA	NA
Lead-210		NA	NA	NAP	NA	NA	NA	NA	NAP	NA	NA
Plutonium-238	0.13	1.2E-08	1.0E-10	NAP	5.1E-12	1.2E-08	NA	NA	NAP	NA	NA
Radium-228*		NA	NA	NAP	NA	NA	NA	NA	NAP	NA	NA
Thorium-230*	1.90	8.0E-07	1.3E-09	NAP	2.6E-05	**2.7E-05**	NA	NA	NAP	NA	NA
Uranium-238*	1.20	5.4E-07	1.8E-09	NAP	1.7E-05	**1.8E-05**	NA	NA	NAP	NA	NA
TOTAL		**1.3E-06**	3.2E-09	NA	**4.3E-05**	**4.5E-05**	6.4E-04	NA	NA	NA	6.4E-04

EPC	Exposure point concentration
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not an applicable pathway.
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds.

Numbers written as 1.0E-03 equal $1x10^{-3}$.

* Toxicity criteria used to calculate risk include radionuclide daughters

Table 5.6 Incremental Residual Risk for a Site Employee Exposed to Surface Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides											
Delta-BHC	0.004670	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endosulfan Sulfate	0.000560	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endrin Aldehyde	0.000930	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endrin Ketone	0.000250	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Metals											
Bismuth	28.50	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Lithium	1.30	NA	NA	NAP	NAP	NA	3.2E-05	NA	NAP	NAP	3.2E-05
Semi-Volatile Organic Compounds											
2-Methylnaphthalene	0.063	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
4-Chloro-3-methylphenol	0.007	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Phenanthrene	0.078	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g										
Actinium-227	0.24	4.7E-08	5.5E-10	NAP	4.6E-07	**5.0E-07**	NA	NA	NAP	NA	NA
Lead-210	1.76	3.7E-07	8.6E-11	NAP	4.0E-10	3.7E-07	NA	NA	NAP	NA	NA
Plutonium-238	20.27	1.9E-06	1.6E-08	NAP	8.0E-10	**1.9E-06**	NA	NA	NAP	NA	NA
Radium-228*	2.57	3.8E-07	7.3E-09	NAP	5.0E-05	**5.0E-05**	NA	NA	NAP	NA	NA
Thorium-230*	0.79	3.3E-07	5.5E-10	NAP	1.1E-05	**1.1E-05**	NA	NA	NAP	NA	NA
Uranium-238*	0.03	1.3E-08	4.5E-11	NAP	4.3E-07	4.4E-07	NA	NA	NAP	NA	NA
TOTAL		**3.0E-06**	2.5E-08	NA	**6.1E-05**	**6.5E-05**	3.2E-05	NA	NA	NA	3.2E-05

EPC	Exposure point concentration
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not an applicable pathway.
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds.

Numbers written as 1.0E-03 equal $1x10^{-3}$.

* Toxicity criteria used to calculate risk include radionuclide daughters

Table 5.7 *Current Total Residual Groundwater Risk for the Construction Worker Scenario*

Constituent	Total EPC	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation $VOC_{(shower)}$	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Metals	**mg/L**									
Antimony	0.0402	NA	NA	NAP		NA	9.8E-01	1.6E-01	NAP	**1.1E+00**
Cadmium	0.00525	NA	NA	NAP		NA	1.0E-01	3.3E-02	NAP	1.4E-01
Copper	0.0227	NA	NA	NAP		NA	5.6E-03	6.0E-05	NAP	5.6E-03
Radionuclides	**pCi/L**									
Thorium-230	1.25	2.1E-06	NA	NAP		**2.1E-06**	NA	NA	NAP	NAP
TOTAL		**2.1E-06**	NA	NA		**2.1E-06**	**1.1E+00**	1.9E-01	NA	**1.3E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.8 Current Background Residual Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Metals	**mg/L**								
Antimony	0.000578	NA	NA	NAP	NA	1.4E-02	2.3E-03	NAP	1.6E-02
Cadmium		NA	NA	NAP	NA	0.0E+00	0.0E+00	NAP	NA
Copper	0.001167	NA	NA	NAP	NA	2.9E-04	3.1E-06	NAP	2.9E-04
Radionuclides	**pCi/L**								
Thorium-230		0.0E+00	NA	NAP	NA	NA	NA	NAP	NAP
TOTAL		NA	NA	NA	NA	1.4E-02	2.3E-03	NA	1.7E-02

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.9 Current Incremental Residual Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Metals	**mg/L**								
Antimony	0.039622	NA	NA	NAP	NA	9.7E-01	1.6E-01	NAP	**1.1E+00**
Cadmium	0.00525	NA	NA	NAP	NA	1.0E-01	3.3E-02	NAP	1.4E-01
Copper	0.021533	NA	NA	NAP	NA	5.3E-03	5.7E-05	NAP	5.3E-03
Radionuclides	**pCi/L**								
Thorium-230	1.25	2.1E-06	NA	NAP	**2.1E-06**	NA	NA	NAP	NAP
TOTAL		**2.1E-06**	NA	NAP	**2.1E-06**	**1.1E+00**	1.9E-01	NAP	**1.3E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.10 Current Total Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Route-Specific Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
Metals	mg/L				
Antimony	0.0402	NA	NA	9.8E-01	**9.8E-01**
Cadmium	0.00525	NA	NA	1.0E-01	1.0E-01
Copper	0.0227	NA	NA	5.6E-03	5.6E-03
Radionuclides	pCi/L				
Actinium-227	0.5	2.0E-06	**2.0E-06**	NA	NA
Plutonium-239/240	2	4.0E-06	**4.0E-06**	NA	NA
Thorium-228+D	2.17	3.1E-06	**3.1E-06**	NA	NA
Thorium-230+D	1.25	1.0E-05	**1.0E-05**	NA	NA
Uranium-234	8.14	2.3E-06	**2.3E-06**	NA	NA
TOTAL		**2.2E-05**	**2.2E-05**	**1.1E+00**	**1.1E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.11 Current Background Residual Groundwater Risk for the Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
Metals	**mg/L**				
Antimony	0.000578	NA	NA	1.4E-02	1.4E-02
Cadmium		NA	NA	NA	NA
Copper	0.001167	NA	NA	2.9E-04	2.9E-04
Radionuclides	**pCi/L**				
Actinium-227		NA	NA	NA	NA
Plutonium-239/240	0.996	2.0E-06	**2.0E-06**	NA	NA
Thorium-228+D	0.779	1.1E-06	**1.1E-06**	NA	NA
Thorium-230+D		NA	NA	NA	NA
Uranium-234	0.792	2.2E-07	2.2E-07	NA	NA
TOTAL		**3.3E-06**	**3.3E-06**	1.4E-02	1.4E-02

mg/L	Milligram per liter.
NA	Not available.
NAP	Not applicable pathway; not a VOC.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.12 Current Incremental Residual Groundwater Risk for the Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Route-Specific Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
Metals	**mg/L**				
Antimony	0.039622	NA	NA	9.7E-01	**9.7E-01**
Cadmium	0.00525	NA	NA	1.0E-01	1.0E-01
Copper	0.021533	NA	NA	5.3E-03	5.3E-03
Radionuclides	**pCi/L**				
Actinium-227	0.5	2.0E-06	**2.0E-06**	NA	NA
Plutonium-239/240	1.004	2.0E-06	**2.0E-06**	NA	NA
Thorium-228+D	1.391	2.0E-06	**2.0E-06**	NA	NA
Thorium-230+D	1.25	1.0E-05	**1.0E-05**	NA	NA
Uranium-234	7.348	2.0E-06	**2.0E-06**	NA	NA
TOTAL		**1.8E-05**	**1.8E-05**	**1.1E+00**	**1.1E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.13 Future Total Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
VOCs	**mg/L**								
1,2-Dichloroethene	0.0095	NA	NA	NA	NA	1.0E-02	1.3E-03	NA	1.2E-02
Dichloromethane	0.0156	8.2E-08	1.3E-08	1.2E-09	9.7E-08	2.5E-03	4.2E-04	1.2E-05	3.0E-03
Tetrachloroethene	0.0016	5.9E-08	2.6E-07	1.6E-10	3.1E-07	1.6E-03	6.9E-03	1.0E-05	8.5E-03
Trichloroethene	0.0040	3.1E-08	2.5E-08	1.2E-09	5.7E-08	6.5E-03	5.2E-03	4.6E-04	1.2E-02
Inorganics									
Aluminum	2.0617	NA	NA	NAP	NA	2.0E-02	NA	NAP	2.0E-02
Antimony	0.0436	NA	NA	NAP	NA	1.1E+00	2.3E-02	NAP	**1.1E+00**
Beryllium	0.0002	NA	NA	NAP	NA	9.3E-04	4.3E-06	NAP	9.3E-04
Bismuth	0.0098	NA	NA	NAP	NA	NA	NA	NAP	NA
Cadmium	0.0063	NA	NA	NAP	NA	1.2E-01	1.6E-02	NAP	1.4E-01
Chromium VI*	0.9540	NA	NA	NAP	NA	3.1E+00	4.0E-01	NAP	**3.5E+00**
Copper	0.0366	NA	NA	NAP	NA	9.7E-03	NA	NAP	9.7E-03
Lithium	0.1195	NA	NA	NAP	NA	5.8E-02	NA	NAP	5.8E-02
Manganese	0.1792	NA	NA	NAP	NA	7.3E-02	5.9E-03	NAP	7.9E-02
Molybdenum	0.0151	NA	NA	NAP	NA	2.9E-02	NA	NAP	2.9E-02
Nickel	0.1884	NA	NA	NAP	NA	9.2E-02	7.5E-03	NAP	1.0E-01
Thallium	0.0035	NA	NA	NAP	NA	4.3E-01	1.4E-03	NAP	4.3E-01
Vanadium	0.0252	NA	NA	NAP	NA	3.5E-02	4.4E-03	NAP	4.0E-02
Radionuclides	**pCi/L**								
Radium-226	1.6902	3.5E-13	NA	NAP	3.5E-13	NA	NA	NAP	NA
Strontium-90	1.3177	6.7E-08	NA	NAP	6.7E-08	NA	NA	NAP	NA
Thorium-228	2.5351	7.3E-07	NA	NAP	7.3E-07	NA	NA	NAP	NA
Thorium-230+D	1.4261	2.4E-06	NA	NAP	**2.4E-06**	NA	NA	NAP	NA
Thorium-232+D	0.1747	1.1E-07	NA	NAP	1.1E-07	NA	NA	NAP	NA
Tritium	66806.3960	6.0E-06	2.9E-04	7.5E-08	**3.0E-04**	NA	NA	NAP	NA
Uranium-234	8.7303	4.8E-07	NA	NAP	4.8E-07	NA	NA	NAP	NA
TOTAL		**9.9E-06**	**2.9E-04**	7.7E-08	**3.0E-04**	**5.1E+00**	4.8E-01	4.8E-04	**5.5E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.
*	Chromium was conservatively assumed to be in the hexavalent state.

Table 5.14 Future Background Goundwater Risk for the Construction Worker Scenario

Constituent	Total EPC mg/L	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation VOC(shower)	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
VOCs									
1,2-Dichloroethene		NA	NA	NA	NA	NA	NA	NA	NA
Dichloromethane		NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene		NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene		NA	NA	NA	NA	NA	NA	NA	NA
Inorganics									
Aluminum	0.037523	NA	NA	NAP	NA	3.7E-04	NA	NAP	3.7E-04
Antimony	0.000578	NA	NA	NAP	NA	1.4E-02	3.1E-04	NAP	1.4E-02
Beryllium		NA	NA	NAP	NA	NA	NA	NAP	NA
Bismuth		NA	NA	NAP	NA	NA	NA	NAP	NA
Cadmium		NA	NA	NAP	NA	NA	NA	NAP	NA
Chromium VI*	0.006076	NA	NA	NAP	NA	2.0E-02	2.6E-03	NAP	2.2E-02
Copper	0.001167	NA	NA	NAP	NA	3.1E-04	NA	NAP	3.1E-04
Lithium	0.055707	NA	NA	NAP	NA	2.7E-02	NA	NAP	2.7E-02
Manganese	0.229568	NA	NA	NAP	NA	9.4E-02	7.6E-03	NAP	1.0E-01
Molybdenum	0.005597	NA	NA	NAP	NA	1.1E-02	NA	NAP	1.1E-02
Nickel	0.034957	NA	NA	NAP	NA	1.7E-02	1.4E-03	NAP	1.8E-02
Selenium		NA	NA	NAP	NA	NA	NA	NAP	NA
Thallium		NA	NA	NAP	NA	NA	NA	NAP	NA
Vanadium	0.017076	NA	NA	NAP	NA	2.4E-02	3.0E-03	NAP	2.7E-02
Radionuclides	pCi/L								
Radium-226	0.996	3.7E-07	NA	NAP	3.7E-07	NA	NA	NAP	NA
Strontium-90	0.975	5.0E-08	NA	NAP	5.0E-08	NA	NA	NAP	NA
Thorium-228	0.779	2.2E-07	NA	NAP	2.2E-07	NA	NA	NAP	NA
Thorium-230+D		NA	NA	NAP	NA	NA	NA	NAP	NA
Thorium-232+D	0.314	2.0E-07	NA	NAP	2.0E-07	NA	NA	NAP	NA
Tritium	1485.473	1.3E-07	6.5E-06	1.7E-09	**6.6E-06**	NA	NA	NAP	NA
Uranium-234	0.792	4.4E-08	NA	NAP	4.4E-08	NA	NA	NAP	NA
Uranium-238+D	0.688	1.2E-06	NA	NAP	**1.2E-06**	NA	NA	NAP	NA
TOTAL		**2.3E-06**	**6.5E-06**	1.7E-09	**8.7E-06**	2.1E-01	1.5E-02	0.0E+00	2.2E-01

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.
*	Chromium was conservatively assumed to be in the hexavalent state.

Table 5.15 Future Incremental Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
VOCs	mg/L								
1,2-Dichloroethene	0.0095	NA	NA	NA	NA	1.0E-02	1.3E-03	NA	1.2E-02
Dichloromethane	0.0156	8.2E-08	1.3E-08	1.2E-09	NA	2.5E-03	4.2E-04	1.2E-05	3.0E-03
Tetrachloroethene	0.0016	5.9E-08	2.6E-07	1.6E-10	3.1E-07	1.6E-03	6.9E-03	1.0E-05	8.5E-03
Trichloroethene	0.0040	3.1E-08	2.5E-08	1.2E-09	5.7E-08	6.5E-03	5.2E-03	4.6E-04	1.2E-02
Inorganics									
Aluminum	2.0242	NA	NA	NAP	NA	2.0E-02	NA	NAP	2.0E-02
Antimony	0.0430	NA	NA	NAP	NA	1.1E+00	2.3E-02	NAP	**1.1E+00**
Beryllium	0.0002	NA	NA	NAP	NA	9.3E-04	4.3E-06	NAP	9.3E-04
Bismuth	0.0098	NA	NA	NAP	NA	NA	NA	NAP	NA
Cadmium	0.0063	NA	NA	NAP	NA	1.2E-01	1.6E-02	NAP	1.4E-01
Chromium VI*	0.9479	NA	NA	NAP	NA	3.1E+00	4.0E-01	NAP	**3.5E+00**
Copper	0.0355	NA	NA	NAP	NA	9.4E-03	NA	NAP	9.4E-03
Lithium	0.0638	NA	NA	NAP	NA	3.1E-02	NA	NAP	3.1E-02
Manganese	-0.0504	NA	NA	NAP	NA	-2.1E-02	-1.7E-03	NAP	-2.2E-02
Molybdenum	0.0095	NA	NA	NAP	NA	1.9E-02	NA	NAP	1.9E-02
Nickel	0.1534	NA	NA	NAP	NA	7.5E-02	6.1E-03	NAP	8.1E-02
Thallium	0.0035	NA	NA	NAP	NA	4.3E-01	1.4E-03	NAP	4.3E-01
Vanadium	0.0082	NA	NA	NAP	NA	1.1E-02	1.4E-03	NAP	1.3E-02
Radionuclides	pCi/L								
Radium-226	0.6942	2.6E-07	NA	NAP	2.6E-07	NA	NA	NAP	NA
Strontium-90	0.3427	1.8E-08	NA	NAP	1.8E-08	NA	NA	NAP	NA
Thorium-228	1.7561	5.1E-07	NA	NAP	5.1E-07	NA	NA	NAP	NA
Thorium-230+D	1.4261	2.4E-06	NA	NAP	**2.4E-06**	NA	NA	NAP	NA
Thorium-232+D	-0.1393	-8.9E-08	NA	NAP	-8.9E-08	NA	NA	NAP	NA
Tritium	65320.9230	5.8E-06	2.8E-04	7.3E-08	**2.9E-04**	NA	NA	NAP	NA
Uranium-234	7.9383	4.4E-07	NA	NAP	4.4E-07	NA	NA	NAP	NA
TOTAL		**9.6E-06**	**2.8E-04**	7.6E-08	**2.9E-04**	**4.9E+00**	**4.6E-01**	**4.8E-04**	**5.3E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.
*	Chromium was conservatively assumed to be in the hexavalent state.

Note: Negative risk values were not added into the total incremental risk.

Table 5.16 Future Total Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
VOCs	**mg/L**				
cis-1,2-Dichloroethene	0.0007	NA	NA	6.8E-04	6.8E-04
1,2-Dichloroethene	0.0095	NA	NA	1.0E-02	1.0E-02
Dichloromethane	0.0156	4.1E-07	4.1E-07	2.5E-03	2.5E-03
Trichloroethene	0.0040	1.5E-07	1.5E-07	6.5E-03	6.5E-03
Metals					
Aluminum	2.0617	NA	NA	2.0E-02	2.0E-02
Antimony	0.0436	NA	NA	1.1E+00	**1.1E+00**
Beryllium	0.0002	NA	NA	9.3E-04	9.3E-04
Bismuth	0.0098	NA	NA	NA	NA
Cadmium	0.0063	NA	NA	1.2E-01	1.2E-01
Chromium VI*	0.9540	NA	NA	3.1E+00	**3.1E+00**
Copper	0.0080	NA	NA	2.1E-03	2.1E-03
Lithium	0.1195	NA	NA	5.8E-02	5.8E-02
Manganese	0.1792	NA	NA	7.3E-02	7.3E-02
Molybdenum	0.0151	NA	NA	2.9E-02	2.9E-02
Nickel	0.1884	NA	NA	9.2E-02	9.2E-02
Thallium	0.0035	NA	NA	4.3E-01	4.3E-01
Vanadium	0.0252	NA	NA	3.5E-02	3.5E-02
Radionuclides	**pCi/L**				
Actinium-227+D**	0.5000	2.0E-06	**2.0E-06**	NA	NA
Plutonium-238	0.2901	5.4E-07	5.4E-07	NA	NA
Plutonium-239/240**	2.0914	4.1E-06	**4.1E-06**	NA	NA
Radium-226	1.6902	3.1E-06	**3.1E-06**	NA	NA
Radium-228+D	0.0154	4.6E-08	4.6E-08	NA	NA
Strontium-90	1.3177	3.4E-07	**3.4E-07**	NA	NA
Thorium-228+D	2.5351	3.7E-06	**3.7E-06**	NA	NA
Thorium-230+D	1.4261	1.2E-05	1.2E-05	NA	NA
Thorium-232+D	0.1747	5.6E-07	5.6E-07	NA	NA
Tritium	66806.3960	3.0E-05	**3.0E-05**	NA	NA
Uranium-234	8.7303	2.4E-06	**2.4E-06**	NA	NA
TOTAL		**5.9E-05**	**5.9E-05**	**5.1E+00**	**5.1E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.
*	Chromium was conservatively assumed to be in the hexavalent state.
**	COPC for current groundwater, therefore, retained as future COPC.

Table 5.17 Future Background Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
VOCs	**mg/L**				
cis-1,2-Dichloroethene	0.999	NA	NA	9.8E-01	9.8E-01
1,2-Dichloroethene		NA	NA	NA	NA
Dichloromethane		NA	NA	NA	NA
Trichloroethene		NA	NA	NA	NA
Metals					
Aluminum	0.037523	NA	NA	3.7E-04	3.7E-04
Antimony	0.000578	NA	NA	1.4E-02	1.4E-02
Beryllium		NA	NA	NA	NA
Bismuth		NA	NA	NA	NA
Cadmium		NA	NA	NA	NA
Chromium VI*	0.006076	NA	NA	2.0E-02	2.0E-02
Copper	0.001167	NA	NA	3.1E-04	3.1E-04
Lithium	0.055707	NA	NA	2.7E-02	2.7E-02
Manganese	0.229568	NA	NA	9.4E-02	9.4E-02
Molybdenum	0.005597	NA	NA	1.1E-02	1.1E-02
Nickel	0.034957	NA	NA	1.7E-02	1.7E-02
Thallium		NA	NA	NA	NA
Vanadium	0.017076	NA	NA	2.4E-02	2.4E-02
Radionuclides	**pCi/L**				
Actinium-227+D**		NA	NA	NA	NA
Plutonium-238	0.087	1.6E-07	1.6E-07	NA	NA
Plutonium-239/240**	0.125	2.5E-07	2.5E-07	NA	NA
Radium-226	0.996	1.8E-06	**1.8E-06**	NA	NA
Radium-228+D		NA	NA	NA	NA
Strontium-90	0.975	2.5E-07	2.5E-07	NA	NA
Thorium-228+D	0.779	1.1E-06	**1.1E-06**	NA	NA
Thorium-230+D*		NA	NA	NA	NA
Thorium-232+D	0.314	1.0E-06	**1.0E-06**	NA	NA
Tritium	1485.473	6.6E-07	6.6E-07	NA	NA
Uranium-234	0.792	2.2E-07	2.2E-07	NA	NA
TOTAL		**5.5E-06**	**5.5E-06**	**1.2E+00**	**1.2E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.
*	Chromium was conservatively assumed to be in the hexavalent state.
**	COPC for current groundwater, therefore, retained as future COPC.

Table 5.18 Future Incremental Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Route-Specific Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
VOCs	**mg/L**				
1,2-cis-dichloroethene	-0.9983	NA	NA	-9.8E-01	-9.8E-01
1,2-Dichloroethene	0.0095	NA	NA	1.0E-02	1.0E-02
Dichloromethane	0.0156	4.1E-07	4.1E-07	2.5E-03	2.5E-03
Trichloroethene	0.0040	1.5E-07	1.5E-07	6.5E-03	6.5E-03
Metals					
Aluminum	2.0242	NA	NA	2.0E-02	2.0E-02
Antimony	0.0430	NA	NA	1.1E+00	**1.1E+00**
Beryllium	0.0002	NA	NA	9.3E-04	9.3E-04
Bismuth	0.0098	NA	NA	NA	0.0E+00
Cadmium	0.0063	NA	NA	1.2E-01	1.2E-01
Chromium VI*	0.9479	NA	NA	3.1E+00	**3.1E+00**
Copper	0.0068	NA	NA	1.8E-03	1.8E-03
Lithium	0.0638	NA	NA	3.1E-02	3.1E-02
Manganese	-0.0504	NA	NA	-2.1E-02	-2.1E-02
Molybdenum	0.0095	NA	NA	1.9E-02	1.9E-02
Nickel	0.1534	NA	NA	7.5E-02	7.5E-02
Thallium	0.0035	NA	NA	4.3E-01	4.3E-01
Vanadium	0.0082	NA	NA	1.1E-02	1.1E-02
Radionuclides	**pCi/L**				
Actinium-227+D**	0.5000	2.0E-06	**2.0E-06**	NA	NA
Plutonium-238	0.2031	3.8E-07	3.8E-07	NA	NA
Plutonium-239/240**	1.9664	3.9E-06	**3.9E-06**	NA	NA
Radium-226	0.6942	1.3E-06	**1.3E-06**	NA	NA
Radium-228+D	0.0154	4.6E-08	4.6E-08	NA	NA
Strontium-90	0.3427	8.8E-08	8.8E-08	NA	NA
Thorium-228	1.7561	2.5E-06	**2.5E-06**	NA	NA
Thorium-230+D	1.4261	1.2E-05	**1.2E-05**	NA	NA
Thorium-232+D	-0.1393	-4.5E-07	-4.5E-07	NA	NA
Tritium	65320.9230	2.9E-05	**2.9E-05**	NA	NA
Uranium-234	7.9383	2.2E-06	**2.2E-06**	NA	NA
TOTAL		**5.4E-05**	**5.4E-05**	**4.9E+00**	**4.9E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.
*	Chromium was conservatively assumed to be in the hexavalent state.
**	COPC for current groundwater, therefore, retained as future COPC.

Note: Negative risk values were not added into the total incremental risk.

Table 5.19 Total Residual Risk for Parcel 4 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncarcinogen Risk HI	Total Carcinogenic Risk ELCR
Construction Worker Scenario	Soil (all sample depths) Current and Future	Chemical and Radiological	Ingestion	1.9E-01	**1.5E-05**
			Dermal Contact	1.7E-03	4.0E-07
			Inhalation of Dust	NA	9.4E-09
			Inhalation of VOCs	NA	NA
			External	NA	**1.8E-05**
		Soil Total Risk		1.9E-01	**3.3E-05**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	**2.1E-06**
			Dermal Contact	1.9E-01	NA
			Inhalation While Showering	NA	NA
		Current Groundwater Total Risk		**1.3E+00**	**2.1E-06**
	Groundwater (Future)	Chemical and Radiological	Ingestion	**5.1E+00**	**9.9E-06**
			Dermal Contact	4.8E-01	**2.9E-04**
			Inhalation While Showering	4.8E-04	7.7E-08
		Future Groundwater Total Risk		**5.5E+00**	**3.0E-04**
	Air*	Radiological	Inhalation	NA	2.1E-07
		Air Total Risk		NA	2.1E-07
	Cumulative Total Current Risk			**1.5E+00**	**3.6E-05**
	Cumulative Total Future Risk			**5.7E+00**	**3.3E-04**
Site Employee Scenario	Soil (0-2 ft bls) Current and Future	Chemical and Radiological	Ingestion	6.7E-04	4.4E-06
			Inhalation of Dust	NA	2.8E-08
			Inhalation of VOCs	NA	NA
			External	NA	**1.0E-04**
		Soil Total Risk		6.7E-04	**1.0E-04**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	**2.2E-05**
		Current Groundwater Total Risk		**1.1E+00**	**2.2E-05**
	Groundwater (Future)	Chemical and Radiological	Ingestion	**5.1E+00**	**5.9E-05**
		Future Groundwater Total Risk		**5.1E+00**	**5.9E-05**
	Air*	Radiological	Inhalation	NA	1.0E-06
		Air Total Risk		NA	1.0E-06
	Cumulative Total Current Risk			**1.1E+00**	**1.3E-04**
	Cumulative Total Future Risk			**5.1E+00**	**1.6E-04**

bls - below land surface

NA - Not applicable

*RRE values for air were brought forward from the Technical Position Report for Release Blocks D and H. (DOE 1999).

Numbers written as 1.0E-03 equal 1×10^{-3}

Table 5.20 Background Residual Risk for Parcel 4 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncarcinogen Risk HI	Total Carcinogenic Risk ELCR
Construction Worker Scenario	Soil (all sample depths) Current and Future	Chemical and Radiological	Ingestion	2.7E-02	**1.6E-06**
			Dermal Contact	4.0E-05	NA
			Inhalation of Dust	NA	2.8E-10
			Inhalation of VOCs	NA	NA
			External	NA	**5.3E-06**
		Soil Total Risk		2.7E-02	**6.9E-06**
	Groundwater (Current)	Chemical and Radiological	Ingestion	1.4E-02	NA
			Dermal Contact	2.4E-03	NA
			Inhalation While Showering	NA	NA
		Current Groundwater Total Risk		1.7E-02	NA
	Groundwater (Future)	Chemical and Radiological	Ingestion	2.1E-01	**2.3E-06**
			Dermal Contact	1.5E-02	**6.5E-06**
			Inhalation While Showering	NA	1.7E-09
		Future Groundwater Total Risk		2.3E-01	**8.8E-06**
	Air*	Radiological	Inhalation	NA	7.7E-09
		Air Total Risk		NA	7.7E-09
	Cumulative Background Current Risk			1.7E-02	**6.9E-06**
	Cumulative Background Future Risk			2.5E-01	**1.6E-05**
Site Employee Scenario	Soil (0-2 ft bls) Current and Future	Chemical and Radiological	Ingestion	6.4E-04	**1.3E-06**
			Inhalation of Dust	NA	3.2E-09
			Inhalation of VOCs	NA	NA
			External	NA	**4.3E-05**
		Soil Total Risk		6.4E-04	**4.4E-05**
	Groundwater (Current)	Chemical and Radiological	Ingestion	1.4E-02	**3.3E-06**
		Current Groundwater Total Risk		1.4E-02	**3.3E-06**
	Groundwater (Future)	Chemical and Radiological	Ingestion	**1.2E+00**	**5.5E-06**
		Future Groundwater Total Risk		**1.2E+00**	**5.5E-06**
	Air*	Radiological	Inhalation	NA	3.9E-08
		Air Total Risk		NA	3.9E-08
	Cumulative Background Current Risk			1.5E-02	**4.8E-05**
	Cumulative Background Future Risk			**1.2E+00**	**5.0E-05**

bls - below land surface

NA - Not applicable

*RRE values for air were brought forward from the Technical Position Report for Release Blocks D and H. (DOE 1999).

Numbers written as 1.0E-03 equal $1x10^{-3}$

Table 5.21 Incremental Residual Risk for Parcel 4 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncarcinogen Risk HI	Total Carcinogenic Risk ELCR
Construction Worker Scenario	Soil (all sample depths) Current and Future	Chemical and Radiological	Ingestion	1.6E-01	**1.7E-05**
			Dermal Contact	1.7E-03	4.0E-07
			Inhalation of Dust	NA	1.3E-08
			Inhalation of VOCs	NA	NA
			External	NA	**1.2E-05**
		Soil Total Risk		1.6E-01	**2.9E-05**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	**2.1E-06**
			Dermal Contact	1.9E-01	NA
			Inhalation While Showering	NA	NA
		Current Groundwater Total Risk		**1.3E+00**	**2.1E-06**
	Groundwater (Future)	Chemical and Radiological	Ingestion**	**4.9E+00**	**9.6E-06**
			Dermal Contact**	4.6E-01	**2.8E-04**
			Inhalation While Showering	4.8E-04	7.6E-08
		Future Groundwater Total Risk		**5.4E+00**	**2.9E-04**
	Air*	Radiological	Inhalation	NA	2.0E-07
		Air Total Risk		NA	2.0E-07
	Cumulative Incremental Current Risk			**1.5E+00**	**3.2E-05**
	Cumulative Incremental Future Risk			**5.5E+00**	**3.2E-04**
Site Employee Scenario	Soil (0-2 ft bls) Current and Future	Chemical and Radiological	Ingestion	3.2E-05	**3.0E-06**
			Inhalation of Dust	NA	2.5E-08
			Inhalation of VOCs	NA	NA
			External	NA	**6.1E-05**
		Soil Total Risk		3.2E-05	**6.4E-05**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	**1.8E-05**
		Current Groundwater Total Risk		**1.1E+00**	**1.8E-05**
	Groundwater (Future)	Chemical and Radiological	Ingestion**	**4.9E+00**	**5.4E-05**
		Future Groundwater Total Risk		**4.9E+00**	**5.4E-05**
	Air*	Radiological	Inhalation	NA	9.9E-07
		Air Total Risk		NA	9.9E-07
	Cumulative Incremental Current Risk			**1.1E+00**	**8.3E-05**
	Cumulative Incremental Future Risk			**4.9E+00**	**1.2E-04**

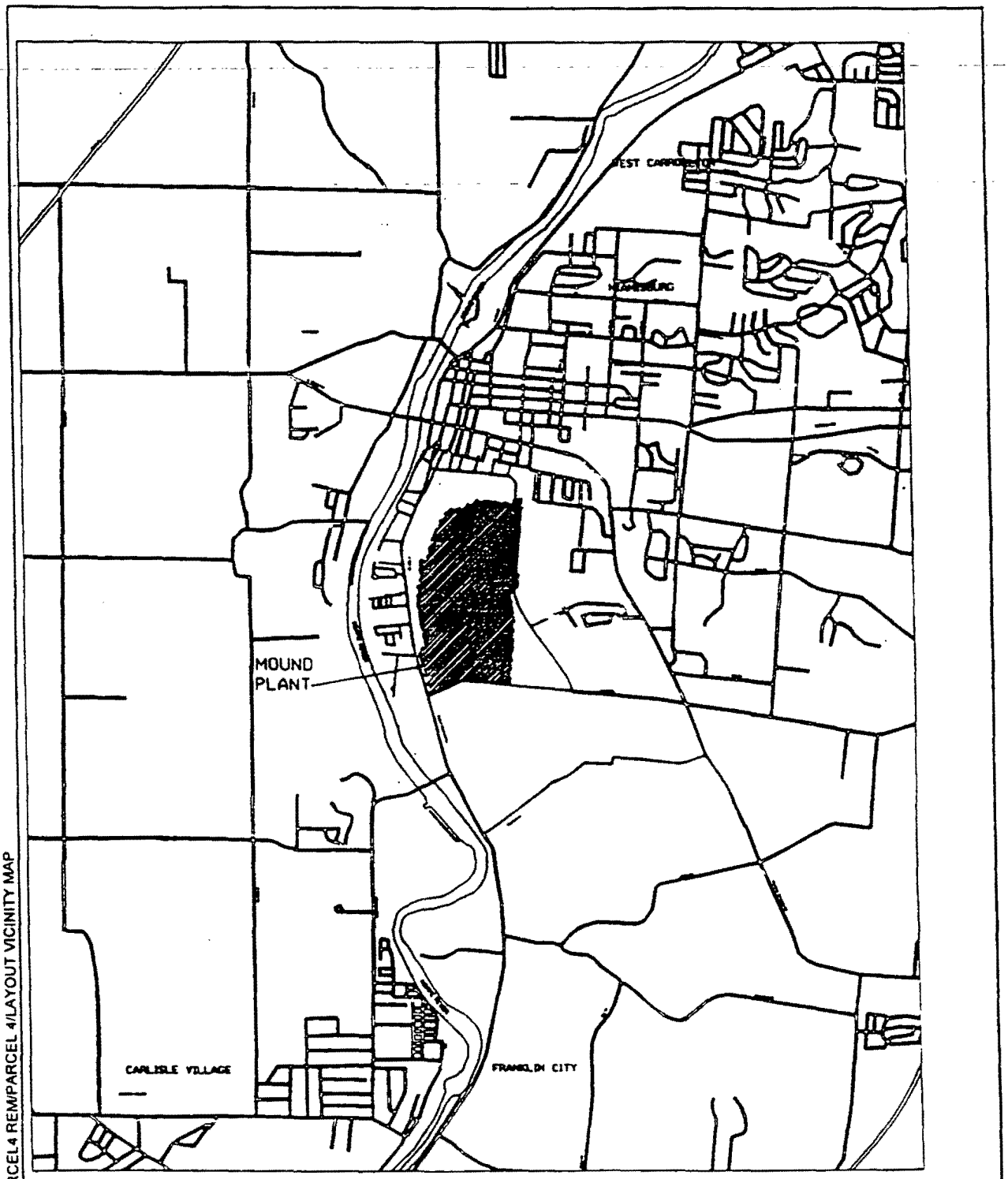
bls - below land surface

NA - Not applicable

*RRE values for air were brought forward from the Technical Position Report for Release Blocks D and H. (DOE 1999).

** For Future Groundwater, incremental risk resulted in negative values for several constiuents (manganese, cis,1,2-dichloroethene, and thorium-232+D) carried through the RRE. The negative incremental risk was not added into the total incremental risk.

Numbers written as 1.0E-03 equal $1x10^{-3}$



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Mound Plant Parcel 4
Vicinity Area Map
Miamisburg, Ohio

Science Applications International Corporation — Columbus, OH

DRAWN BY	DATE	SCALE	PROJECT	FIGURE NO.
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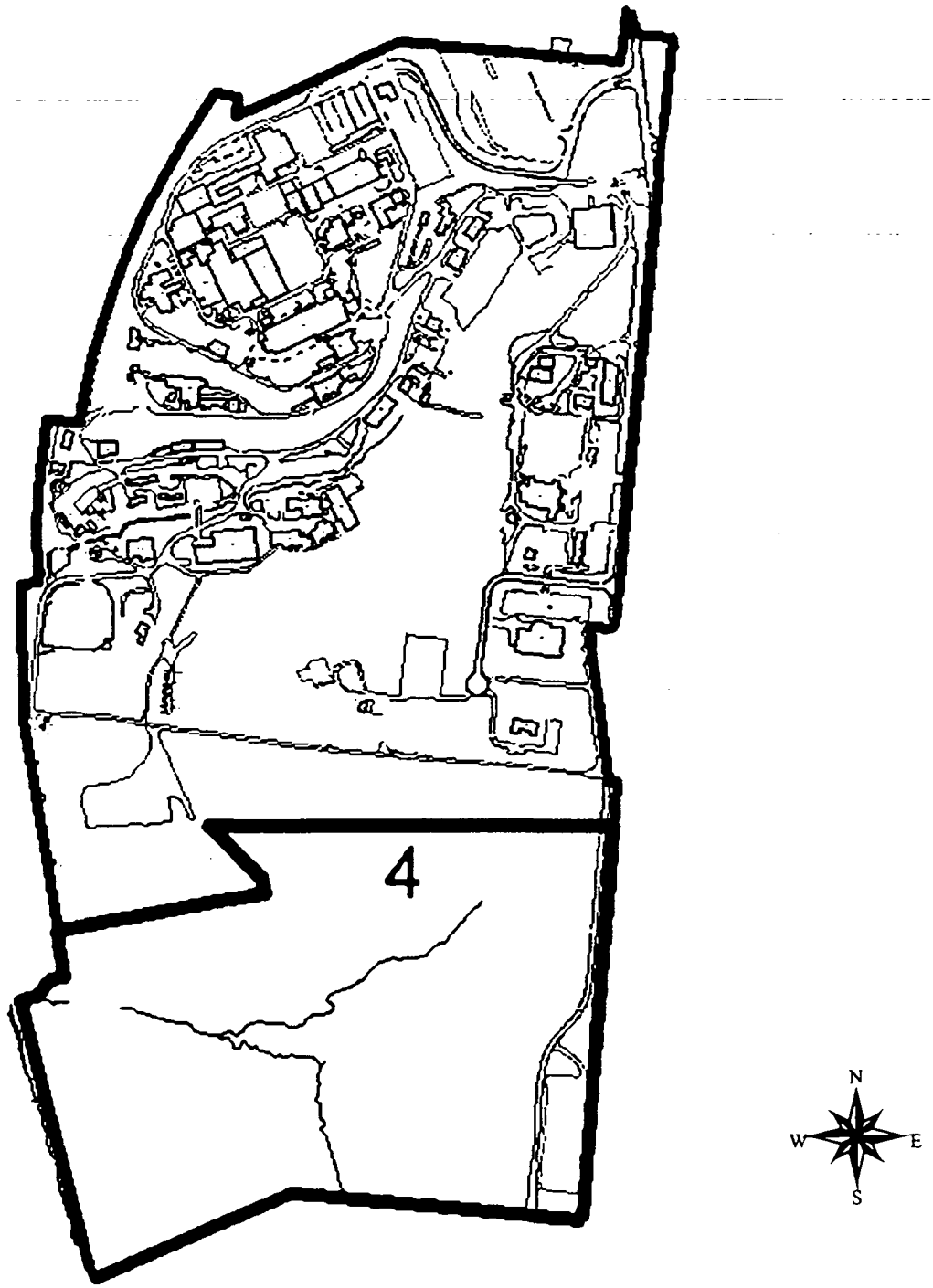

Mound Plant Parcel 4			
Area Map			
Miamisburg, Ohio			
Science Applications International Corporation Columbus, OH			
DRAWN BY LMA	DATE 5-8-00	SCALE NOT SHOWN	FIGURE NO. 1.2

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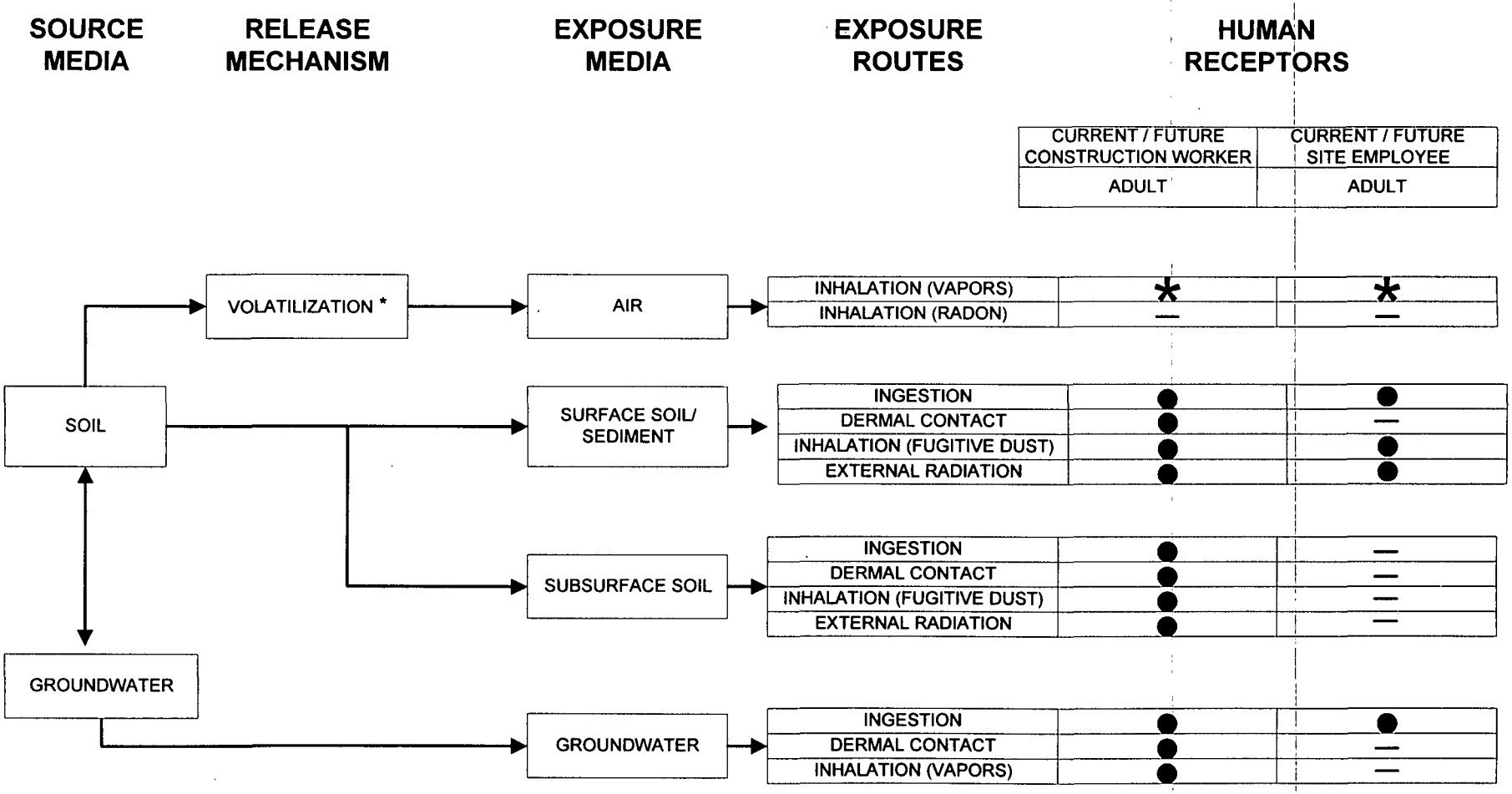

● COMPLETE PATHWAY EVALUATED QUANTITATIVELY
○ COMPLETE PATHWAY EVALUATED QUALITATIVELY
— INCOMPLETE PATHWAY, NOT EVALUATED
* NO VOLATILE COPCs IN AREA

Figure 3.1
Conceptual Site Model for the Parcel 4 RRE

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Appendix A

Evaluation of Potential Cumulative Exposure –Air

A1.1 EVALUATION OF POTENTIAL CUMULATIVE EXPOSURE – AIR

Potential exposure to contaminants originating from outside Parcel 4 that may reach a receptor in the Parcel 4 are termed potential cumulative exposures. This appendix presents potential cumulative exposures that may come from air.

Airborne contaminant concentrations were measured at the Mound Facility in 1994 during various site restoration activities (DOE, 1994). Both radiological and non-radiological data were collected. It is assumed that the measured concentrations would represent an upper-bound air concentration. These data are shown in Table A1-1. Risks due to inhalation of the radionuclides by construction workers and site employees were calculated and are also presented in Table A1-1.

The calculated risks attributable to the potential upper-bound exposure of airborne contaminants would total 2.0E-07 for the construction worker and 9.8E-07 for the site employee. Note that the potential exposures and associated risks are based on the assumption of long-term consumption of this upper-bound concentration that was measured during site restoration activities.

Table A1-1 Concentration of Radionuclides in Air in 1994 (EG&G Mound Applied Technologies- Mound Site Environmental Report for Calendar Year 1994, pg. 4-15 to 4-17) MLM-3814

Radionuclide	Maximum Concentration* (μCi/mL)	Risks to Construction Worker*	Risks to Site Employees**
Tritium oxide (H-3)	7.54 ± 4.61E-12	1.8E-08	9.0E-08
Plutonium-238	259.65 ± 289.58E-18	1.75E-07	8.8E-07
Plutonium-239/240	3.50 ±2.75E-18	2.5E-09	1.2E-08
Total		2.0E-07	9.8E-07

* Error limits are estimates of the standard error of the estimated means at the 95% confidence level. Values given are from the location on the site with the highest concentration (based on the average of two or more samples).

** Calculated risks assumed that the maximum concentration shown here was the C_{air} value needed for the calculation of risk by inhalation for construction workers and site employees.

Note: Calculation and methodology information is provided in Appendix D of the Release Block D RREM, December 1996. Risk from air was not recalculated.

Appendix B

Methodology and Evaluation of Groundwater Exposure for Mound RRE

Potential Future Maximum Concentrations of COPCs in Groundwater

This Appendix describes the steps completed to estimate the potential future concentration of contaminants in the Mound Plant Production Wells. In summary, very conservative estimates of future contaminant concentrations were developed by assuming all contaminants currently detected in the Bedrock Aquifer of the Mound Property would migrate to the Buried Valley Aquifer (BVA), from which the Mound Plant Production Wells withdraw potable water for Mound facility use. The calculated potential bedrock contaminant concentrations were then added to the current contaminant concentrations in the Mound Plant Production Wells to obtain the estimated future contaminant concentrations.

The techniques used to forecast future contaminant concentrations were purposely designed to represent the most conservative (worst-case) future scenario possible. This overly conservative approach assures no significant chemical of concern would be prematurely removed from the risk evaluation process. The steps completed to develop this initial "model" of the future contaminant concentrations in the Mound Plant Production Wells are summarized as follows.

1. Using established groundwater flow net analysis techniques, a topographic map of the bedrock surface underlying the Mound facility was used to create 20 evaluation areas of similar size termed "flow tubes." Ground water flow within the Bedrock Aquifer was assumed to generally follow the topography of the bedrock surface. The flow tubes were delineated based on drainage patterns suggested by the bedrock topographic map (see Figure B-1). Within each flow tube it is assumed ground water flows in the same general direction, on a slope of the same general gradient. Based on topography and gradient, ground water from the majority of these flow tubes will eventually flow into the BVA. Although several of the flow tubes do not appear to contribute to the BVA directly, they were considered to contribute to the BVA to make the future scenario as conservative as possible.

2. All contaminant concentration data from bedrock wells currently maintained or archived in the MEIMS database were examined for each flow tube. The maximum concentration of each analyte for any of the bedrock wells or selected bedrock seeps was assumed to be representative of the contamination within the flow tube. This maximum concentration was multiplied by the volume of water per unit time that flows within each flow tube in order to determine the mass of each contaminant that could be contributed to the BVA production wells.

3. The total flow of each tube was determined by measuring the width and the gradient of the flow tube from the bedrock topographic map. These were multiplied by the assumed thickness of the bedrock aquifer (40 feet), and by the assumed hydraulic conductivity (0.1 feet/day). The product of these values is the volume of ground water flow per flow tube per unit time.

4. The maximum concentration of each analyte from each flow tube was applied to the total flow of each tube to determine a potential mass of contaminant entering the BVA per year per flow tube.

5. The contaminant mass from each flow tube was summed to provide the total potential mass of each contaminant contributed by the bedrock aquifer to the BVA per year.

6. The total mass of each contaminant was divided by an assumed Mound Plant water use of 260,000 gallons per day (94,900,000 gallons per year) to obtain the theoretical concentration of the bedrock contribution for all bedrock contaminants. Therefore, the very conservative assumption is made that the masses of contaminants that enter the BVA from the bedrock contribute to the production wells without any dilution or degradation.

7. This theoretical concentration was added to the current concentration of contaminants observed in the Mound Plant Production wells to obtain the theoretical worst-case future ground water concentration.

This approach represents the most conservative scenario possible using currently available ground water data. A more realistic estimate of the future ground water concentrations would require consideration of dilution and degradation of contaminants within the bedrock and the BVA aquifers, quantification of the actual amounts of bedrock water intercepted by the Mound production wells and replacement of the maximum contaminant concentrations with more representative values.

Table B-1 lists all contaminants of potential concern detected in either a bedrock well, seep or a Mound Plant Production well, their respective concentrations, and the calculated combined estimated future maximum concentration.

Antimony – An Example

The wells and seeps selected to best represent the water quality of the consolidated lithologic units beneath the Mound are summarized in Table B-2. Upon review of the data in the MEIMS database for these monitoring locations, antimony was detected in the bedrock monitoring wells and seeps in 21 out of 122 analyses for this parameter. All designated wells and seeps were assigned to specific flow tubes. The highest concentration measured in each monitoring well or seep within a flow tube was used to calculate a potential annual contribution of antimony to the groundwater. Table B-3 summarizes the water volume and concentrations used to project antimony loading to the Mound production wells.

As shown in Table B-1, the calculated COPC concentration obtained from the flow tube model is added to the existing concentration measured in the production wells. It is this potential future maximum constituent concentration which is the RRE modeling process.

Table B-1
Estimated Future Maximum Constituent Concentrations in the BVA Bedrock Flow Tube Model Results

Constituents in Production and Bedrock Wells & Seeps	Bedrk. Contribution to BVA (mg/L or pCi/L)	Current Production Well Concentration (mg/L or pCi/L)	Est. Future Max. Conc. (mg/L or pCi/L)
1,2-cis-Dichloroethene	0.0007	0.00122	0.00187
1,2-Dichloroethene	0.0023	0.00720	0.00945
Actinium-227		0.5000	0.5000
Aluminum	1.9876	0.07410	2.06172
Americium-241	1.8656	0.0300	1.8956
Antimony	0.0034	0.0402	0.0436
Beryllium	0.0002		0.0002
Bismuth	0.0098		0.0098
Cadmium	0.0010	0.00525	0.00625
Chromium	0.9377	0.01630	0.95400
Cobalt	0.0080		0.0080
Copper	0.0139	0.02270	0.03664
Dichloromethane	0.0148	0.00081	0.01562
Lithium	0.1166	0.0029	0.1195
Manganese	0.1577	0.02150	0.17918
Molybdenum	0.0124	0.0027	0.0151
Nickel	0.1740	0.01430	0.18835
Plutonium-238	0.0401	0.2500	0.29012
Plutonium-239/240	0.0914	2.0000	2.0914
Radium-226	1.1702	0.5200	1.6902
Radium-228	0.0154		0.0154
Selenium	0.0007	0.00313	0.00384
Stronium-90	0.8177	0.5000	1.3177
Tetrachloroethene	0.0006	0.00104	0.00161
Thallium	0.0021	0.00143	0.00354
Thorium-228	0.3651	2.1700	2.5351
Thorium-230	0.1761	1.2500	1.42609
Thorium-232	0.0747	0.1000	0.17472
Tin	0.0051	0.0087	0.0138
Trichloroethene	0.0016	0.00243	0.00401
Tritium	65945.3956	861.0000	66806.3956
Uranium-234	0.5903	8.1400	8.7303
Uranium-235	2.7326	1.5700	4.30259
Uranium-238	0.1452	0.47000	0.61518
Vanadium	0.0106	0.0146	0.0252

12/12/00

Table B-2
Locations and Details of Water Quality Monitoring Sites
Used in Bedrock Flow Tube Calculations

Well / Seep I.D.	Parcel	Flow Tube	Well Depth (feet)	Screen Length (feet)	Depth into Bedrock (feet)	Comments
Bedrock Monitoring Wells						
0034 (a)	8	11	20.61	3	7.5	Abandoned - Historical Data Only. Use in Flow Tube 11
0035 (a)	8	12	20+	2	6.0	Abandoned - Historical Data Only. Use in Flow Tube 12
0112	7	11	36.70	10	13.0	Use in Flow Tube 11
0113	6	Recharge Area	55.72	3 (upper) 3 (lower)	56.5	Use in Flow Tube 15. At top of recharge area.
0114	8	Recharge Area	51.31	3 (upper) 3 (lower)	39.5	Use in Flow Tube 15. At top of recharge area.
0115	8	15	40.25	10	27.5	Use in Flow Tube 15. At top of recharge area.
0116	8	Recharge Area	81.95	10	69.5	Use in Flow Tube 15. At top of recharge area.
0117	8	12	18.10	10	15.0	Use in Flow Tube 12
0120	8	12	32.86	10	28.5	Use in Flow Tube 12
0227 (a)	8	13	35.29	2	3.0	Abandoned - Historical Data Only. Use in Flow Tube 13
0242 (a)	8	12	15.36	2	11.5	Abandoned - Historical Data Only. Use in Flow Tube 12
0312	8	13	34.50	10	6.5	Use in Flow Tube 13
0318	7	9	31.07	10	17.0	Use in Flow Tube 9
0322	7	20	56.27	10	12.5	Use in Flow Tube 20
0323	8	13	17.53	5	8.0	Use in Flow Tube 13
0324	8	13	19.82	5	19.0	Use in Flow Tube 13
0325	7	7	31.93	10	26.0	Use in Flow Tube 7
0326	7	8	35.06	10	19.0	Use in Flow Tube 8
0332	MMCIC	20	31.56	10	19.0	Use in Flow Tube 20
0335	Off Site	15	54.51	5	33.0	Use in Flow Tube 15. In discharge area
0351	MMCIC	4	21.39	10	16.7	Use in Flow Tube 4. At top of recharge area.
0354	4	4	26.06	10	11.5	Use in Flow Tube 4.
0372	8	6	64.16	10	12.0	Use in Flow Tube 6
0380	8	6	63.08	10	28.0	Use in Flow Tube 6. At base of Flow Tube in discharge area
0381	8	6	39.59	10	12.0	Use in Flow Tube 6
0382	8	6	37.25	10	17.8	Use in Flow Tube 6
0399	4	3	34.93	10	29.0	Use in Flow Tube 3
0411	5	5	39.70	10	24.0	Use in Flow Tube 5
P004	8	6	64.51	10	12.4	Use in Flow Tube 6
P021	7	12	33.08	5	8.0	Use in Flow Tube 12
P024	9	6	42.58	5	5.0	Use in Flow Tube 6

Table B-2 (continued) Locations and Details of Water Quality Monitoring Sites Used in Bedrock Flow Tube Calculations						
Well / Seep I.D.	**Parcel**	**Flow Tube**	**Well Depth (feet)**	**Screen Length (feet)**	**Depth into Bedrock (feet)**	**Comments**
Interface Monitoring Wells - Partially Screened into Bedrock						
0314	8	6	45.47	10	6.5	Use in Flow Tube 6. At base of Flow Tube in discharge area
0353	8	5	22.12	5	2.0	Use in Flow Tube 5, although very shallow
Bedrock Seeps with Annual Flow						
601	8	14	NA	NA	NA	Use in Flow Tube 14
607	3	18	NA	NA	NA	Use in Flow Tube 18
a - abandoned						

Table B-3. Contribution of Antimony Attributed to Bedrock -derived Groundwater for the Future Maximum Concentration Evaluation			
Flow Tube (#)	**Flow Tube Discharge (liters/yr)**	**Parameter Max. Conc. (mg/L)**	**Annual Bdrk Contribution (mg/yr)**
1	**3158986**	**0.0067**	**21165**
2	**2622525**	**0.0067**	**17571**
3	2986588	0.0067	20010
4	3497913	0.0018	6296
5	5926541	0.0076	45042
6	5179894	0.0076	39367
7	4577574	0.00075	3433
8	5311033	0.002	10622
9	3438297	0.016	55013
10	**4286151**	**0.016**	**68578**
11	3020572	0.0023	6947
12	4278420	0.00062	2653
13	3684327	0.0176	64844
14	1624763	0.0302	49068
15	3136537	0.0062	19447
16	**3742041**	**0.0062**	**23201**
17	**8624724**	**0.0416**	**358788**
18	5031433	0.0416	209308
19	**4424896**	**0.0416**	**184076**
20	1925159	0.0058	11166
Averages	4098873	0.0132785	60830
Totals	81977457		***1216595***

Mound Water Use:		
	260000	gallons/day
	94900000	gallons/year
	359224970	liters/year

Projected Antimony contribution from bedrock
to the BVA: 0.003387 mg/L

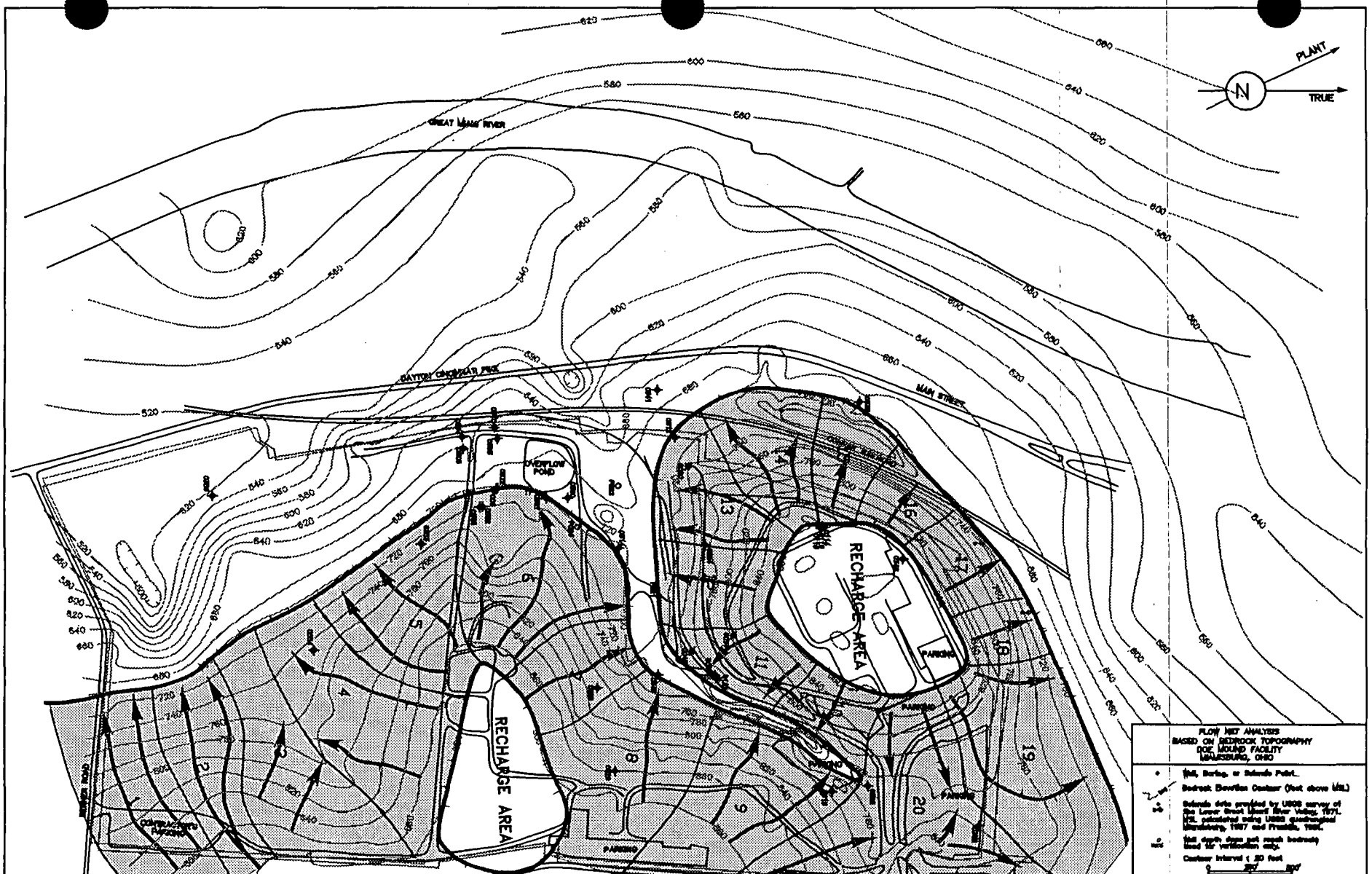

Figure B-1. Flow tube designations for calculating future constituents concentrations at the Mound Facility.

Appendix C

Calculations for Updated Screening Guidance Values

The following equations were used to calculate new soil guideline values in accordance with the methodology presented in Risk Based Guideline Values, Mound Plant, March 1997a.

The equations are the same for construction worker and site employee scenarios, only the input parameters to the equations are different.

Soil Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Chemicals- Nonradiological

$$\text{RBGV (mg/kg)} = \frac{\text{TCR x BW x AT x 365}}{\text{EF x ED [(CSFo x CF1 x IRsoil) + (CSFi x IRair x (1/PEF+ 1/VF)]}}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
BW=	Body Weight	70 kg	70 kg
EF=	Exposure Frequency	250 days/yr	250 days/yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
CF1=	Conversion Factor	0.000001 kg/mg	0.000001 kg/mg
IR soil=	Ingestion Rate Soil	50 mg/day	480 mg/day
CSFi=	Inhalation Cancer Slope Factor	chemical specific	chemical specific
IR air=	Inhalation Rate Air	20 m3/day	20 m3/day
PEF=	Particulate Emissions Factor	4.28E+09 m3/kg	4.28E+09 m3/kg
VF=	Volatilization Factor	chemical specific	chemical specific
AT=	Averaging time	70 yr	70 yr
ED=	Exposure Duration	25 yr	5 yr

Soil Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Radiological Constituents

$$\text{RBGV (pCi/g)} = \frac{\text{TCR}}{\text{\{EF x ED1x [(CSFo x CF1 x IRsoil) + (CSFi x CF2 x IRair x (1/PEF+ 1/VF))]\} + (ED2 x CSFex x (1-Se) x Te)}}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
BW=	Body Weight	70 kg	70 kg
ED1=	Exposure Duration	25 yr	5 yr
EF=	Exposure Frequency	250 days/yr	250 days/yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
CF1=	Conversion Factor	0.001 g/mg	0.001 g/mg
IR soil=	Ingestion Rate Soil	50 mg/day	480 mg/day
CSFi=	Inhalation Cancer Slope Factor	chemical specific	chemical specific
CF2=	Conversion Factor	1000 g/kg	1000 g/kg
IR air=	Inhalation Rate Air	20 m3/day	20 m3/day
PEF=	Particulate Emissions Factor	4.28E+09 m3/kg	4.28E+09 m3/kg
VF=	Volatilization Factor	chemical specific	chemical specific
ED2=	External Duration Factor	25 x 250/365 yr	5 x 250/365 yr
CSFex=	External Cancer Slope Factor	chemical specific	chemical specific
Se=	Gamma Shielding Factor	0.2 unitless	0.1 unitless
Te=	Gamma Exposure Time Factor	2/24 unitless	8/24 unitless

Soil Non-cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Nonradiological Chemicals

$$\text{RBGV (mg/kg)} = \frac{\text{THI x BW x AT x 365}}{\text{EF x ED [(1/RfDo) x CF1 x IRsoil) + ((1/RfDi) x IRair x (1/PEF+ 1/VF)]}}$$

Where:

		Site Employee	Construction Worker
THI=	Target Hazard Index	1 unitless	1 unitless
BW=	Body Weight	70 kg	70 kg
ED=	Exposure Duration	25 yr	5 yr
EF=	Exposure Frequency	250 days/yr	250 days/yr
RfDo=	Oral Reference Dose Factor	chemical specific	chemical specific
CF1=	Conversion Factor	0.000001 kg/mg	0.000001 kg/mg
IR soil=	Ingestion Rate Soil	50 mg/day	480 mg/day
RfDi=	Inhalation Reference Dose Factor	chemical specific	chemical specific
IR air=	Inhalation Rate Air	20 m3/day	20 m3/day
PEF=	Particulate Emissions Factor	4.28E+09 m3/kg	4.28E+09 m3/kg
VF=	Volatilization Factor	chemical specific	chemical specific
AT=	Averaging time	25 yr	5 yr

Constituent	TOXICITY VALUES FOR SOIL GVS						
	RfD (mg/kg/day)				CSF (kg-day/mg)		
	Oral	Adjusted	Inhalation		Oral	Adjusted	Inhalation
	RfDo	RfDa	RfDi		CSFo	CSFa	CSFi
PAHs							
Dibenzo(a,h)anthracene	NA	NA	NA		7.3E+00	NC	3.1E+00
Fluorene	4.0E-02	NA	NA		NC	NC	NC
Indeno(1,2,3-cd)pyrene	NA	NA	NA		7.3E-01	NC	NC
Bis(2-ethylhexyl)phthalate	2.0E-02	2.0E-02	NA		1.4E-02	1.4E-02	NA
Fluoranthene	4.0E-02	3.4E-02	NA		NC	NC	NC
Pyrene	3.0E-02	2.6E-02	NA		NC	NC	NC
Pesticides							
Aldrin	3.0E-05	NA	3.0E-05		1.7E+01	NA	1.7E+01
Alpha Chlordane	5.0E-04	NA	7.0E-04		3.5E-01	NA	3.5E-01
Delta-BHC	NA	NA	NA		NA	NA	NA
Endosulfan I	6.0E-03	NA	NA		NA	NA	NA
Endosulfan II	6.0E-03	NA	NA		NA	NA	NA
Endosulfan Sulfate	NA	NA	NA		NA	NA	NA
Endrin Aldehyde	NA	NA	NA		NA	NA	NA
Endrin Ketone	NA	NA	NA		NA	NA	NA
Gamma Chlordane	5.0E-04	NA	7.0E-04		3.5E-01	NA	3.5E-01
Gamma BHC (lindane)	3.0E-04	NA	NA		1.3E+00	NA	1.3E+00
Heptachlor	5.0E-04	NA	NA		4.5E+00	NA	4.5E+00
Heptachlor epoxide	1.3E-05	NA	NA		9.1E+00	NA	9.1E+00
Methoxychlor	5.0E-03	NA	NA		NA	NA	NA
Metals							
Aluminium	1.0E+00	NA	1.4E-03	n	NA	NA	NA
Copper	3.7E-02	0.0E+00	NA		NC	NC	NC
Selenium	5.0E-03	0.0E+00	NA		NC	NC	NC
Thallium	8.0E-05	0.0E+00	NA		NC	NC	NC
Tin	6.0E-01	NA	NA	h	NA	NA	NA

Constituent	TOXICITY VALUES FOR SOIL GVS						
	RfD (mg/kg/day)			CSF (kg-day/mg)			
	Oral	Adjusted	Inhalation	Oral	Adjusted	Inhalation	
	RfDo	RfDa	RfDi	CSFo	CSFa	CSFi	
Radionuclides							External
Americium-241	NA	NA	NA	3.28E-10		3.85E-08	4.59E-09
Bismuth-210	NA	NA	NA	7.29E-12		5.12E-11	0.00E+00
Radium-228+D	NA	NA	NA	4.79E-10		9.78E-08	9.48E-06
Strontium-85	NA	NA	NA	1.40E-12		1.14E-12	1.54E-06
Strontium-90	NA	NA	NA	4.09E-11		5.94E-11	0.00E+00
Thorium-227	NA	NA	NA	4.04E-11		4.31E-09	1.70E-07
Thorium-228 +D	NA	NA	NA	2.31E-10		9.68E-08	6.20E-06
Thorium-230 ***	NA	NA	NA	1.34E-09		2.38E-08	6.74E-06
Thorium-232 +D	NA	NA	NA	5.12E-10		1.17E-07	9.48E-06
Uranium-238 +D	NA	NA	NA	1.43E-09		5.08E-08	7.01E-06

Not calculated for GVs because under review

Soil Guideline Values for Construction Worker at DOE Mound

Constituent	GV	CANCER EFFECTS			NON-CANCER EFFECTS			1/10 HI
		Route-Specific RRSs (mg/kg)		Cancer	Route-Specific RRSs (mg/kg)		Non-Cancer	
		Ingestion	Inhalation	Effects PRG	Ingestion	Inhalation	Effects PRG	
	mg/kg	(RRSo)c	(RRSi)c	RRSc	(RRSo)nc	(RRSi)nc	RRSnc	
PAHs								
Dibenzo(a,h)anthracene	4.1E-01	4.1E-01	3.3E+03	4.1E-01	NA	NA	NA	NA
Fluorene	8.5E+02	NC	NC	NC	8.5E+03	NA	8.5E+03	8.5E+02
Indeno(1,2,3-cd)pyrene	4.1E+00	4.1E+00	2.0E+04	4.1E+00	NA	NA	NA	NA
Pesticides								
Aldrin	1.8E-01	1.8E-01	1.8E+04	1.8E-01	6.4E+00	6.6E+05	6.4E+00	6.4E-01
Alpha Chlordane	8.5E+00	8.5E+00	8.7E+05	8.5E+00	1.1E+02	1.5E+07	1.1E+02	1.1E+01
Delta-BHC	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	1.3E+02	NA	NA	NA	1.3E+03	NA	1.3E+03	1.3E+02
Endosulfan II	1.3E+02	NA	NA	NA	1.3E+03	NA	1.3E+03	1.3E+02
Endosulfan Sulfate	NA	NA	NA	NA	NA	NA	NA	NA
Endrin Aldehyde	NA	NA	NA	NA	NA	NA	NA	NA
Endrin Ketone	NA	NA	NA	NA	NA	NA	NA	NA
Gamma Chlordane	8.5E+00	8.5E+00	8.7E+05	8.5E+00	1.1E+02	1.5E+07	1.1E+02	1.1E+01
Gamma BHC (lindane)	2.3E+00	2.3E+00	2.4E+05	2.3E+00	6.4E+01	NA	6.4E+01	6.4E+00
Heptachlor	6.6E-01	6.6E-01	6.8E+04	6.6E-01	1.1E+02	NA	1.1E+02	1.1E+01
Heptachlor epoxide	2.8E-01	3.3E-01	3.4E+04	3.3E-01	2.8E+00	NA	2.8E+00	2.8E-01
Methoxychlor	1.1E+02	NA	NA	NA	1.1E+03	NA	1.1E+03	1.1E+02
Metals								
Aluminium	2.1E+04	NA	NA	NA	2.1E+05	3.1E+07	2.1E+05	2.1E+04
Copper	7.9E+02	NC	NC	NC	7.9E+03	NA	7.9E+03	7.9E+02
Selenium	1.1E+02	NC	NC	NC	1.1E+03	NA	1.1E+03	1.1E+02
Thallium	1.7E+00	NC	NC	NC	1.7E+01	NA	1.7E+01	1.7E+00
Tin	1.3E+04	NA	NA	NA	1.3E+05	NA	1.3E+05	1.3E+04

*	All detected chromium is conservatively assumed to be chromium VI.
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NC	Not a suspected carcinogen.
RRS	Risk Reduction Standard for soil (mg/kg).

Soil Guideline Values for Site Employee at DOE Mound

Constituent	GV	CANCER EFFECTS Route-Specific RRSs (mg/kg) Ingestion	Inhalation	Cancer Effects PRG	NON-CANCER EFFECTS Route-Specific RRSs (mg/kg) Ingestion	Inhalation	Non-Cancer Effects PRG	1/10 HI
		(RRSo)c	(RRSi)c	RRSc	(RRSo)nc	(RRSi)nc	RRSnc	
PAHs (mg/kg								
Dibenzo(a,h)anthracene	7.8E-01	7.8E-01	6.6E+02	7.8E-01	NA	NA	NA	NA
Fluorene	8.2E+03	NC	NC	NC	8.2E+04	NA	8.2E+04	8.2E+03
Indeno(1,2,3-cd)pyrene	7.8E+00	7.8E+00	NC	7.8E+00	NA	NA	NA	NA
Pesticides (mg/kg)								
Aldrin	3.4E-01	3.4E-01	3.6E+03	3.4E-01	6.1E+01	6.6E+05	6.1E+01	6.1E+00
Alpha Chlordane	1.6E+01	1.6E+01	1.7E+05	1.6E+01	1.0E+03	1.5E+07	1.0E+03	1.0E+02
Delta-BHC	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	1.2E+03	NA	NA	NA	1.2E+04	NA	1.2E+04	1.2E+03
Endosulfan II	1.2E+03	NA	NA	NA	1.2E+04	NA	1.2E+04	1.2E+03
Endosulfan Sulfate	NA	NA	NA	NA	NA	NA	NA	NA
Endrin Aldehyde	NA	NA	NA	NA	NA	NA	NA	NA
Endrin Ketone	NA	NA	NA	NA	NA	NA	NA	NA
Gamma Chlordane	1.6E+01	1.6E+01	1.7E+05	1.6E+01	1.0E+03	1.5E+07	1.0E+03	1.0E+02
Gamma BHC (lindane)	4.4E+00	4.4E+00	4.7E+04	4.4E+00	6.1E+02	NA	6.1E+02	6.1E+01
Heptachlor	1.3E+00	1.3E+00	1.4E+04	1.3E+00	1.0E+03	NA	1.0E+03	1.0E+02
Heptachlor epoxide	6.3E-01	6.3E-01	6.7E+03	6.3E-01	2.7E+01	NA	2.7E+01	2.7E+00
Methoxychlor	1.0E+03	NA	NA	NA	1.0E+04	NA	1.0E+04	1.0E+03
Metals (mg/kg)								
Aluminium	1.9E+05	NA	NA	NA	2.0E+06	3.1E+07	1.9E+06	1.9E+05
Copper	7.6E+03	NC	NC	NC	7.6E+04	NA	7.6E+04	7.6E+03
Selenium	1.0E+03	NC	NC	NC	1.0E+04	NA	1.0E+04	1.0E+03
Thallium	1.6E+01	NC	NC	NC	1.6E+02	NA	1.6E+02	1.6E+01
Tin	1.2E+05	NA	NA	NA	1.2E+06	NA	1.2E+06	1.2E+05
Volatile Organic Compounds.(mg/kg)								
1,2,4-Trichlorobenzene	2.0E+03	NA	NA	NA	2.0E+04	1.2E+09	2.0E+04	2.0E+03
2-Chlorophenol	1.0E+03	NA	NA	NA	1.0E+04	1.1E+08	1.0E+04	1.0E+03
Explosives (mg/kg)								
1,3-Ditrobenzene	2.0E+01	NA	NA	NA	2.0E+02	2.2E+06	2.0E+02	2.0E+01
2,4,6-Trinitrotoluene	1.0E+02	1.9E+02	2.0E+06	1.91E+02	1.0E+03	1.1E+07	1.0E+03	1.0E+02

*	All detected chromium is conservatively assumed to be chromium VI.
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NC	Not a suspected carcinogen.
RRS	Risk Reduction Standard for soil (mg/kg).

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	U-238+D	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
U-238+D	**Target Risk**	1.00E-06

Slope Factors

1.43E-09	Oral Cancer Slope factor risk/pCi
5.08E-08	Inhalation Cancer slope factor risk/pCi
7.01E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 0.11834378

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	U-238+D	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
U-238+D	**Target Risk**	1.00E-06

Slope Factors

1.43E-09	Oral Cancer Slope factor risk/pCi
5.08E-08	Inhalation Cancer slope factor risk/pCi
7.01E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 0.12405755

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	**Th-228+D**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Th-228+D	**Target Risk**	1.00E-06

Slope Factors

2.31E-10	Oral Cancer Slope factor risk/pCi
9.68E-08	Inhalation Cancer slope factor risk/pCi
6.20E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV=	0.139849944

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	**Th-228+D**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Th-228+D	**Target Risk**	1.00E-06

Slope Factors

2.31E-10	Oral Cancer Slope factor risk/pCi
9.68E-08	Inhalation Cancer slope factor risk/pCi
6.20E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV=	0.15363106

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4
For: Ra-228+D Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Ra-228+D Target Risk 1.00E-06

Slope Factors

4.79E-10	Oral Cancer Slope factor risk/pCi
9.78E-08	Inhalation Cancer slope factor risk/pCi
9.48E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 0.09113537

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97
For: Ra-228+D Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Ra-228+D Target Risk 1.00E-06

Slope Factors

4.79E-10	Oral Cancer Slope factor risk/pCi
9.78E-08	Inhalation Cancer slope factor risk/pCi
9.48E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 0.09971978

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	Th-232+D	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,	
Th-232+D	**Target Risk**		1.00E-06

Slope Factors

5.12E-10	Oral Cancer Slope factor risk/pCi
1.17E-07	Inhalation Cancer slope factor risk/pCi
9.48E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 0.0910498

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	Th-232+D	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,	
Th-232+D	**Target Risk**		1.00E-06

Slope Factors

5.12E-10	Oral Cancer Slope factor risk/pCi
1.17E-07	Inhalation Cancer slope factor risk/pCi
9.48E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 0.09952328

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	**Pb-210+D**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Pb-210+D	**Target Risk**	1.00E-06

Slope Factors

1.01E-09	Oral Cancer Slope factor risk/pCi
3.86E-09	Inhalation Cancer slope factor risk/pCi
1.45E-10	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 3.166655776

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	**Pb-210+D**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Pb-210+D	**Target Risk**	1.00E-06

Slope Factors

1.01E-09	Oral Cancer Slope factor risk/pCi
3.86E-09	Inhalation Cancer slope factor risk/pCi
1.45E-10	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 1.649759368

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	**Pu-238**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Pu-238	**Target Risk**	1.00E-06

Slope Factors

3.00E-10	Oral Cancer Slope factor risk/pCi
2.70E-08	Inhalation Cancer slope factor risk/pCi
1.90E-11	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 10.66418486

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	**Pu-238**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Pu-238	**Target Risk**	1.00E-06

Slope Factors

3.00E-10	Oral Cancer Slope factor risk/pCi
2.70E-08	Inhalation Cancer slope factor risk/pCi
1.90E-11	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 5.554949181

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	K-40	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
K-40	**Target Risk**	1.00E-06

Slope Factors

1.25E-11	Oral Cancer Slope factor risk/pCi
7.46E-12	Inhalation Cancer slope factor risk/pCi
6.11E-07	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV=	1.425588724

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	K-40	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
K-40	**Target Risk**	1.00E-06

Slope Factors

1.25E-11	Oral Cancer Slope factor risk/pCi
7.46E-12	Inhalation Cancer slope factor risk/pCi
6.11E-07	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV=	1.574053305

Site Employee Variables defined in table 5.1.2 p1108
Equations 5.1.2 p 107 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	**Freon**	
Freon	**Target Hazard Index**	1.00E+00

Slope Factors

3.00E+01	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV=	6.13E+07

Construction Worker Variables from Table 4.1.2 pg 91, and Equations from Table 4.1.2 page 90 RBGV Report 3/97

For:	**Freon**	
Freon	**Target Hazard Index**	1.00E+00

Slope Factors

3.00E+01	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day

RBGV=	6.39E+06

Site Employee Variables defined in table 5.1.2 p1108
Equations 5.1.2 p 107 RBGV Report 3/97

For: **4-trichlorobenzene**
1,2,4-trichlo Target Hazard Index 1.00E+00

RfDs

1.00E-02	Oral Reference Dose	iris
5.70E-02	Inhalation Reference Dose	heast

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 2.04E+04

Construction Worker Variables from Table 4.1.2 pg 91, and Equations from Table 4.1.2 page 90 RBGV Report 3/97
For: **4-trichlorobenzene**
1,2,4-trichlo Target Hazard Index 1.00E+00

RfDs

1.00E-02	Oral Reference Dose
5.70E-02	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 2.13E+03

Site Employee Variables defined in table 5.1.2 p1108
Equations 5.1.2 p 107 RBGV Report 3/97

For: **2-chlorophenol**
2-chlorophTarget Hazard Index 1.00E+00

RfDs

5.00E-03	Oral Reference Dose	iris
	Inhalation Reference Dose	

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 1.02E+04

Construction Worker Variables from Table 4.1.2 pg 91, and Equations from Table 4.1.2 page 90 RBGV Report 3/97
For: **2-chlorophenol**
2-chlorophTarget Hazard Index 1.00E+00

RfDs

5.00E-03	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 1.06E+03

Site Employee Variables defined in table 5.1.1 p105
Equations 5.1.1 p 104 RBGV Report 3/97

For: **dibenz(a,h)anthracene**
dibenz(a,h Target Hazard Index 1.00E+00

CSF

7.30E+00	Oral Reference Dose	r
3.10E+00	Inhalation Reference Dose	r

RBGV=TCR*BW*365/[(EF*CSFo*CF1*IRsoil) + (CSFi*IRair*(1/PEF)]

TCR=	1.00E-06	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
AT=	7.00E+01	yr
ED=	25	yr
RBGV=	7.84E-01	

Construction Worker Variables from Table 4.1.1 pg 88-89, and Equations from Table 4.1.1 page 87 RBGV Report 3/97

For: **dibenz(a,h)anthracene**
dibenz(a,h Target Hazard Index 1.00E+00

CSF

7.30E+00	Oral Reference Dose
3.10E+00	Inhalation Reference Dose

RBGV=TCR*BW*70*365/[(EF*5*CSFo*CF1*IRsoil) + (CSFi*IRair*(1/PEF)]

TCR	1.00E-06	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
AT=	7.00E+01	yr
ED=	5	yr
RBGV=	4.08E-01	

Site Employee Variables defined in table 5.1.1 p105
Equations 5.1.1 p 104 RBGV Report 3/97

For: **indeno(1,2,3-cd)pyrene**
indeno(1,2 Target Hazard Index 1.00E+00

CSF

7.30E+00	Oral Reference Dose	r
3.10E+00	Inhalation Reference Dose	r

RBGV=TCR*BW*365/[(EF*CSFo*CF1*IRsoil) + (CSFi*IRair*(1/PEF)]

TCR=	1.00E-06	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
AT=	7.00E+01	yr
ED=	25	yr
RBGV=	7.84E-01	

Construction Worker Variables from Table 4.1.1 pg 88-89, and Equations from Table 4.1.1 page 87 RBGV Report 3/97

For: **indeno(1,2,3-cd)pyrene**
indeno(1,2 Target Hazard Index 1.00E+00

CSF

7.30E+00	Oral Reference Dose
3.10E+00	Inhalation Reference Dose

RBGV=TCR*BW*70*365/[(EF*5*CSFo*CF1*IRsoil) + (CSFi*IRair*(1/PEF)]

TCR	1.00E-06	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
AT=	7.00E+01	yr
ED=	5	yr
RBGV=	4.08E-01	

Site Employee Variables defined in table 5.1.2 p1108
Equations 5.1.2 p 107 RBGV Report 3/97

For: **fluorene**
fluorene **Target Hazard Index** 1.00E+00

RfDs

4.00E-02	Oral Reference Dose	iris
	Inhalation Reference Dose	

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 8.18E+04

Construction Worker Variables from Table 4.1.2 pg 91, and Equations from Table 4.1.2 page 90 RBGV Report 3/97

For: **fluorene**
fluorene **Target Hazard Index** 1.00E+00

RfDs

4.00E-02	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 8.52E+03

The following equations were used to calculate new groundwater guideline values in accordance with the methodology presented in Risk Based Guideline Values, Mound Plant, March 1997a.

The equations are generally the same for construction worker and site employee scenarios. Input parameters differ. The construction worker includes ingestion and shower exposure while the site employee only includes groundwater ingestion.

Water Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Chemicals- Nonradiological

$$\text{RBGVTotal (mg/L)} = \frac{1}{1/\text{RBGVingestion} + 1/\text{RBGVinhalation} + 1/\text{RBGVdermal}}$$

$$\text{RBGVingestion (mg/L)} = \frac{\text{TCR*AT*BW}}{\text{IRw*EF*ED*CSFo}}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
BW=	Body Weight	70 kg	70 kg
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	25 yr	5 yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
AT=	Averaging time	70 yr	70 yr
IRw=	Ingestion Rate Water	1 L/day	1 L/day

$$\text{RBGVinhalation (mg/L)} = \frac{\text{TCR*BW*AT}}{\text{K*IRair*EF*ET*ED*(1/24)*CSFi}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
CSFi=	Inhalation Cancer Slope Factor	NA	chemical specific
IR air=	Inhalation Rate Air	NA	20 m3/day
K=	Volatilization Factor	NA	0.5 l/m^3
ET=	Exposure Time	NA	0.167 hrs/day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr

$$\text{RBGVdermal (mg/L) Organics} = \frac{\text{TCR*BW*AT}}{2*\text{Kp*EF*EV*0.001*(CSFa)*SSAa*ED*}(6*\text{T*tevent}/3.1412)^{1/2}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
T=	Lag Time	NA	chemical specific
tevent	Exposure time	NA	chemical specific

$$\text{RBGVdermal (mg/L) Inorganics} = \frac{\text{TCR*BW*AT}}{\text{Kp*EF*EV*0.001*t event*(CSFa)*SSAa*ED}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
tevent	Exposure time	NA	chemical specific

Water Non-Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Nonradiological Chemicals.

$$\text{RBGVTotal (mg/L)} = \frac{1}{1/\text{RBGVingestion} + 1/\text{RBGVinhalation} + 1/\text{RBGVdermal}}$$

$$\text{RBGVingestion (mg/L)} = \frac{\text{THI*AT*BW}}{\text{IRw*EF*ED*(1/RfDo)}}$$

Where:

		Site Employee	Construction Worker
THI=	Target Hazard Index	1	1
BW=	Body Weight	70 kg	70 kg
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	25 yr	5 yr
RfDo=	Oral Reference Dose Factor	chemical specific	chemical specific
AT=	Averaging time	25 yr	5 yr
IRw=	Ingestion Rate Water	1 L/day	1 L/day

$$\text{RBGVinhalation (mg/L)} = \frac{\text{THI*BW*AT}}{\text{K*IRair*EF*ET*ED*(1/24)*(1/RfDi)}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
RfDi=	Inhalation Reference Dose Factor	NA	chemical specific
IR air=	Inhalation Rate Air	NA	20 m3/day
K=	Volatilization Factor	NA	0.5 l/m^3
ET=	Exposure Time	NA	0.167 hrs/day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	5 yr
ED=	Exposure Duration	NA	5 yr

$$\text{RBGVdermal (mg/L) Organics} = \frac{\text{THI*BW*AT}}{\text{2*Kp*EF*EV*0.001*(1/RfDa)*SSAa*ED*(6*T*tevent)/3.1412)}^{1/2}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
RfDa=	Dermal Reference Dose Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
T=	Lag Time	NA	chemical specific
tevent	Exposure time	NA	chemical specific

$$\text{RBGVdermal (mg/L) Inorganics} = \frac{\text{THI*BW*AT}}{\text{Kp*EF*EV*0.001*t event*(1/RfDa)*SSAa*ED}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
RfDa=	Dermal Reference Dose Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
tevent	Exposure time	NA	chemical specific

Water Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Radiolnuclides

$$\text{RBGVingestion (pCi/L)} = \frac{\text{TCR}}{\text{IRw*EF*ED*CSFo}}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	25 yr	5 yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
IRw=	Ingestion Rate Water	1 L/day	1 L/day

For tritium dermal and inhalation pathways are also evaluated for water and total tritium is calculated as follows

$$\text{RBGVTotal (mg/L)} = \frac{1}{1/\text{RBGVingestion} + 1/\text{RBGVinhalation} + 1/\text{RBGVdermal}}$$

RBGVingestion same as above for all radionuclides

$$\text{RBGV tritium inhalation (pCi/L)} = \frac{\text{TCR}}{\text{IRa*EF*ED*ETs*CF1*CFt*M*CSFi}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
EF=	Exposure Frequency	NA	250 days/yr
CF1=	Conversion Factor mass of water	NA	1/1000 L/g
CFt=	Conversion Factor for time	NA	1/24 day/hrs
ETs=	Exposure Time shower	NA	.167 hr/day
ED=	Exposure Duration	NA	5 yr
M=	Air Mass conc of water in shower	NA	66.96 g/m^3
CSFi=	Inhalation Cancer Slope Factor	NA	chemical specific
IRa=	Ingestion Rate Air	NA	20 m^3hr/day

$$\text{RBGVdermal (pCimg/L) tritium} = \frac{\text{TCR}}{\text{Kp*EF*1000*ETs*(CSFa)*SSA*ED}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
Kp=	Permeability Constant	NA	1.50E-05
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EF=	Exposure Frequency	NA	250 days/yr
ETs=	Exposure Time shower	NA.	.167 hr/day
ED=	Exposure Duration	NA	5 yr

Constituent	TOXICITY VALUES FOR GROUNDWATER GVS						
	RfD (mg/kg/day)			CSF (kg-day/mg)			
	Oral	Adjusted	Inhalation	Oral	Adjusted	Inhalation	
Organics	RfDo	RfDa	RfDi	CSFo	CSFa	CSFi	
1,1,1,2-Tetrachloroethane	3.0E-02	3.00E-02	3.0E-02	2.6E-02	2.60E-02	2.6E-02	
1,1,2,2-Tetrachloroethane	6.0E-02	6.00E-02	6.0E-02	2.0E-01	2.00E-01	2.0E-01	
1,1,1-Trichloroethane	3.5E-02	3.50E-02	2.9E-01	NA	NA	NA	
1,1,2-Trichloro-1,2,2trifluoroethane	3.00E+01	3.00E+01	8.57E+00	NA	NA	NA	
cis-1,2-Dichloroethylene	1.0E-02	1.00E-02	2.3E-01	---	---	---	
Inorganics							
Aluminum	1.0E+00	1.00E+00	1.4E-03	---	---	---	
Boron	9.0E-02	9.00E-02	5.7E-03	---	---	---	
Chromium (VI)	3.0E-03	3.00E-03	2.9E-05	---	---	4.2E+01	
Cobalt	6.0E-02	6.00E-02	5.7E-06	---	---	---	
Copper	4.0E-02	4.00E-02	2.9E-04	---	---	---	
Molybdenum	5.0E-03	5.00E-03	1.4E-03	---	---	---	
Selenium	5.0E-03	5.00E-03	5.7E-05	---	---	---	
Thallium and compounds (as thallium	8.0E-05	8.00E-05	2.9E-05	---	---	---	
Tin	6.0E-01	6.00E-01		---	---	---	
Radionuclides							External
Americium-241	NA	NA	NA	3.28E-10		3.85E-08	4.59E-09
Bismuth-210	NA	NA	NA	7.29E-12		5.12E-11	0.00E+00
Radium-228+D	NA	NA	NA	4.79E-10		9.78E-08	9.48E-06
Strontium-85	NA	NA	NA	1.40E-12		1.14E-12	1.54E-06
Strontium-90	NA	NA	NA	4.09E-11		5.94E-11	0.00E+00
Thorium-227	NA	NA	NA	4.04E-11		4.31E-09	1.70E-07
Thorium-228 +D	NA	NA	NA	2.31E-10		9.68E-08	6.20E-06
Thorium-230 ***	NA	NA	NA	1.34E-09		2.38E-08	6.74E-06
Thorium-232 +D	NA	NA	NA	5.12E-10		1.17E-07	9.48E-06
Uranium-238 +D	NA	NA	NA	1.43E-09		5.08E-08	7.01E-06

Not calculated for GVs because under review

Groundwater Guideline Values for Construction Worker at DOE Mound

Constituent	GV	CANCER EFFECTS					NON-CANCER EFFECTS				
		Route-Specific RRSs (mg/L)			Weight Of Evidence	Cancer GW GV (TRC-06)	Route-Specific RRSs (mg/L)			Non-Cancer GW GVs mg/L	Non-Cancer 1/10 GW GVs mg/L
		Oral	Dermal	Inhalation			Oral	Dermal	Inhalation		
		(RRSo)c	(RRSd)c	(RRSi)c		RRSc	(RRSo)nc	(RRSd)nc	(RRSi)nc		
Inorganics (mg/L)											
Aluminum	1.0E+01	---	---	NA	NA	---	1.0E+02	5.3E+03	---	1.0E+02	1.0E+01
Boron	9.0E-01	---	---	NA	NA	---	9.2E+00	4.7E+02	---	9.0E+00	9.0E-01
Chromium (VI)	3.0E-02	---	---	NA	A	---	3.1E-01	1.6E+01	---	3.0E-01	3.0E-02
Cobalt	6.0E-01	---	---	NA	NA	---	6.1E+00	3.2E+02	---	6.0E+00	6.0E-01
Copper	4.0E-01	---	---	NA	D	---	4.1E+00	2.1E+02	---	4.0E+00	4.0E-01
Molybdenum	5.0E-02	---	---	NA	NA	---	5.1E-01	2.6E+01	---	5.0E-01	5.0E-02
Selenium	5.0E-02	---	---	NA	D	---	5.1E-01	2.6E+01	---	5.0E-01	5.0E-02
Thallium and compounds (as thallium	8.0E-04	---	---	NA	NA	---	8.2E-03	4.2E-01	---	8.0E-03	8.0E-04
Tin	6.0E+00	---	---	NA	NA	---	6.1E+01	3.2E+03	---	6.0E+01	6.0E+00
Organics (mg/L)											
1,1,1,2-Tetrachloroethane	5.1E-02	5.5E-02	---	7.9E-01	C	5.1E-02	3.1E+00	---	4.4E+01	2.9E+00	2.9E-01
1,1,2,2-Tetrachloroethane	3.0E-03	7.2E-03	5.3E-03	1.0E-01	D	3.0E-03	6.1E+00	4.5E+00	8.8E+01	2.5E+00	2.5E-01
1,1,1-Trichloroethane	1.8E-01	NA	NA	NA	D	NA	3.6E+00	3.6E+00	4.3E+02	1.8E+00	1.8E-01
1,1,2-Trichloro-1,2,2trifluoroethane	2.5E+02	NA	NA	NA		NA	3.1E+03	---	1.3E+04	2.5E+03	2.5E+02
cis-1,2-Dichloroethylene	1.0E-01	---	---	---	D	---	1.0E+00	---	---	1.0E+00	1.0E-01
Radionuclides (pCi/L)											
Americium-241	2.4E+00	2.4E+00	NA	NA		2.4E+00	NA	NA	NA		
Bismuth-210	1.1E+02	1.1E+02	NA	NA		1.1E+02	NA	NA	NA		
Radium-228+D	1.7E+00	1.7E+00	NA	NA		1.7E+00	NA	NA	NA		
Strontium-85	5.7E+02	5.7E+02	NA	NA		5.7E+02	NA	NA	NA		
Strontium-90	1.4E+01	1.4E+01	NA	NA		1.4E+01	NA	NA	NA		
Thorium-227	2.0E+01	2.0E+01	NA	NA		2.0E+01	NA	NA	NA		
Thorium-228+D	3.5E+00	3.5E+00	NA	NA		3.5E+00	NA	NA	NA		
Thorium-230+D	6.0E-01	6.0E-01	NA	NA		6.0E-01	NA	NA	NA		
Thorium-232+D	1.6E+00	1.6E+00	NA	NA		1.6E+00	NA	NA	NA		
Uranium-238+D	5.6E-01	5.6E-01	NA	NA		5.6E-01	NA	NA	NA		

mg/kg	milligrams/kilograms
NA	Not applicable
RRS	Risk Reduction Standard

Groundwater Guideline Values for Site Employee at DOE Mound

Constituent	GV	CANCER EFFECTS					NON-CANCER EFFECTS				
		Route-Specific RRSs (mg/L)				Cancer	Route-Specific RRSs (mg/L)			Non-Cancer	1/10
		Oral	Dermal	Inhalation	Weight Of Evidence	GW GV (TRC-06)	Oral	Dermal	Inhalation	W RRE GV mg/L	HI mg/L
Organics (mg.L)		(MSCo)c	(MSCd)c	(MSCi)c			(MSCo)nc	(MSCd)nc	(MSCi)nc		
1,1,1,2-Tetrachloroethane	1.1E-02	1.1E-02	NA	NA	C	1.1E-02	3.1E+00	NA	NA	3.1E+00	3.1E-01
1,1,2,2-Tetrachloroethane	1.4E-03	1.4E-03	NA	NA	D	1.4E-03	6.1E+00	NA	NA	6.1E+00	6.1E-01
1,1,1-Trichloroethane	3.6E-01	NA	NA	NA	D	NA	3.6E+00	NA	NA	3.6E+00	3.6E-01
1,1,2-Trichloro-1,2,2trifluoroethane	3.1E+02	NA	NA	NA		NA	3.1E+03	NA	NA	3.1E+03	3.1E+02
cis-1,2-Dichloroethylene	1.0E-01	---	NA	NA	D	---	1.0E+00	NA	NA	1.0E+00	1.0E-01
Inorganics (mg/L)											
Aluminum	1.0E+01	---	NA	NA	NA	---	1.0E+02	NA	NA	1.0E+02	1.0E+01
Boron	9.2E-01	---	NA	NA	NA	---	9.2E+00	NA	NA	9.2E+00	9.2E-01
Chromium (VI)	3.1E-02	---	NA	NA	A	---	3.1E-01	NA	NA	3.1E-01	3.1E-02
Cobalt	6.1E-01	---	NA	NA	NA	---	6.1E+00	NA	NA	6.1E+00	6.1E-01
Copper	4.1E-01	---	NA	NA	D	---	4.1E+00	NA	NA	4.1E+00	4.1E-01
Molybdenum	5.1E-02	---	NA	NA	NA	---	5.1E-01	NA	NA	5.1E-01	5.1E-02
Selenium	5.1E-02	---	NA	NA	D	---	5.1E-01	NA	NA	5.1E-01	5.1E-02
Thallium and compounds (as thallium chlorid	8.2E-04	---	NA	NA	NA	---	8.2E-03	NA	NA	8.2E-03	8.2E-04
Tin	6.1E+00	---	NA	NA	NA	---	6.1E+01	NA	NA	6.1E+01	6.1E+00
Radionuclides (pCi/L)											
Americium-241	4.9E-01	4.9E-01	NA	NA		4.9E-01	NA	NA	NA	NA	
Bismuth-210	2.2E+01	2.2E+01	NA	NA		2.2E+01	NA	NA	NA	NA	
Radium-228+D	3.3E-01	3.3E-01	NA	NA		3.3E-01	NA	NA	NA	NA	
Strontium-85	1.1E+02	1.1E+02	NA	NA		1.1E+02	NA	NA	NA	NA	
Strontium-90	3.9E+00	3.9E+00	NA	NA		3.9E+00	NA	NA	NA	NA	
Thorium-227	4.0E+00	4.0E+00	NA	NA		4.0E+00	NA	NA	NA	NA	
Thorium-228 +D	6.9E-01	6.9E-01	NA	NA		6.9E-01	NA	NA	NA	NA	
Thorium-230+D	1.2E-01	1.2E-01	NA	NA		1.2E-01	NA	NA	NA	NA	
Thorium-232 +D	3.1E-01	3.1E-01	NA	NA		3.1E-01	NA	NA	NA	NA	
Uranium-238 +D	1.1E-01	1.1E-01	NA	NA		1.1E-01	NA	NA	NA	NA	

mg/kg milligrams/kilograms
NA Not applicable
RRS Risk-Reduction Standard

Appendix D

Parcel 4 Database (Provided on CD provided with this report)

CLP Laboratory Data Qualifiers and their Used in the RRE

Inorganic Chemical Data	Definition	Included in RRE?
B	Reported value is <CRDL[a], but >IDL[b].	Yes
U	Compound was analyzed for but not detected.	Yes, 1/2 SQL[c]
E	Value is estimated due to matrix interference.	Yes
N	Spiked sample not within control limits.	Yes
J	Value is an estimated quantity.	Yes[d]
R	Quality control indicates that data is unusable.	No

Organic Chemical Data	Definition	Included in RRE?
U	Compound was analyzed for but not detected.	Yes, 1/2 SQL[c]
J	Value is estimated, spectral identification criteria are met but the value is <CRDL.	Yes[d]
B	Analyte found in associated blank as well as in sample.	Yes[e]
E	Concentration exceeds calibration range of GC/MS[d] instrument.	Yes
D	Compound identified in an analysis at a secondary dilution factor	Yes

a. CRDL means contract required detection limits
b. IDL means instrument detection limits
c. "U" qualified data, result was recorded as 1/2 the detection limit.
d. "J" qualified data with results less than the detection limit, recorded as 1/2 the detction limit.
e. "B" qualified organic results. If blank sample contained a common lab contaminant, result considered positive only if concentration exceeded 10x the amount detected in the blank. If blank sample contained a constituent that is not a common lab contaminant, result considered positive only if concentration exceeded 5X the amount detected in the blank.