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ESC-072/01
April 24, 2001

01-TC/04-24

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

ATTENTION: Robert S. Rothman

SUBJECT: Contract No. DE-AC24-97OH20044
PARCEL 3 CERCLA DOCUMENTS – PUBLIC REVIEW

REFERENCE: Statement of Work Requirement C.7.1e—Regulator Reports

Dear Mr. Provencher:

Rob Rothman of your office has approved the release for public review of the following documents for Parcel 3:

Human Health Residual Risk Evaluation
Proposed Plan

The public review period will be from April 24 to May 24. If you have any questions regarding the documents, or if additional support is needed, please contact Dave Rakel at extension 4203.

Sincerely,

DA Rakel
for
Jeffrey S. Stapleton
Manager, Environmental Safeguards & Compliance

JSS/DAR:jdg

cc: Tim Fischer, USEPA, (2) w/attachments
Brian Nickel, OEPA, (2) w/attachments
Ruth Vandegrift, ODH, (1) w/attachments
John Ebersole DOE/OH, (1) w/attachment
Monte Williams, BWXTO, (1) w/attachment
Dann Bird MMCIC, (2) w/attachments
Public Reading Room, (5) w/attachments
Administrative Record, (2) w/ attachments
DCC

3001-0302110001

Residual Risk Evaluation

Parcel 3

Mound Plant
Miamisburg, OH

Public Review Draft

April 2001

Department of Energy
Ohio Field Office

BWXT of Ohio, Inc.

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ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
BVA	Buried Valley Aquifer
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COPCs	constituents of potential concern
CSF	cancer slope factor
DOE	Department of Energy
EPC	exposure point concentration
FFA	Federal Facilities Agreement
GH	Guard House
GP	Guard Post
GIS	Guard Island Station
GV	Guideline Value
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 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
OEPA	Ohio Environmental Protection Agency
OHPO	Ohio Historical Preservation Office
OSE	Operation Support East
OU	Operable Unit
pCi	picocuries
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
SVOC	semi-volatile organic compounds
UCL	upper confidence limit
USEPA	U.S. Environmental Protection Agency
UTL	upper tolerance limit
VOCs	volatile organic compounds

PARCEL 3 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 non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 3. 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 3 may be used for commercial or industrial land use. Therefore, 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 3.

The terms "release block" 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 or parcel can be completed. RRE reports have been completed for Release Blocks D and H and Parcel 4. In 1997 - 1998 the release blocks were reconfigured into 10 "parcels" to shorten the schedule for site transfer. Release Block H forms the eastern boundary of Parcel 3.

For the construction worker scenario, plutonium-238 was identified as a constituent of potential concern (COPC) in soil (Table 2). Since non-carcinogenic toxicity criteria are not available for plutonium-238 only the total, background, and incremental cancer risks were quantified for this parcel. Total, background, and incremental residual risks for the construction worker scenario in Parcel 3 are presented in Tables 15, 16, and 17, respectively. To quantify future residual soil risk, it was assumed that no degradation of the COPCs would occur over time, therefore, current and future residual soil risks are the same.

Total residual cancer risk from soil for the construction worker scenario in Parcel 3 is 6.2×10^{-6}, which falls within the acceptable risk range of 10^{-4} to 10^{-6} (increased cancer risk of 1 human in 10,000 to 1 human in 1 million) specified in the *National Oil & Hazardous Substances Pollution Contingency Plan* (NCP, EPA 1990). Background residual risk from soil for the construction worker scenario in Parcel 3 is 2.3×10^{-8}. Incremental residual risk from soil for the construction worker scenario is 6.1×10^{-6}.

For the site employee scenario plutonium-238 was identified as the only COPC in soil (Table 4). Since non-carcinogenic toxicity criteria are not available for plutonium-238 only the total, background, and incremental cancer risks were quantified for this parcel. Total, background, and incremental residual risks for the site employee scenario in Parcel 3 are presented in Tables 18, 19, and 20, respectively. To quantify future residual soil risk it was assumed that no further degradation of plutonium-238 would occur over time, therefore, current and future residual soil risks are the same.

Total residual cancer risk from soil for the site employee scenario in Parcel 3 is 2.6×10^{-6}, which falls within the acceptable risk range of 10^{-4} to 10^{-6}. Background residual risk from soil for the site employee scenario in Parcel 3 is 1.2×10^{-7}. Incremental residual soil risk for the site employee scenario is 2.6×10^{-6}.

Potential exposure to contaminants originating from outside Parcel 3 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 production wells (well numbers 0271 and 0076). Potential cumulative risk from exposure to contaminants in air and groundwater are reported in the Parcel 3 summary tables at the end of this Executive Summary.

Airborne contaminant concentrations were measured at the Mound Facility in 1994 while various site restoration activities were ongoing (DOE 1994). Both radiological and non-radiological data were collected. Since several soil-disturbing activities were going on during data collection, it was 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 in Appendix A of this report.

Potential cumulative risk for groundwater 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 0271 and 0076 between 1983 through 2000) and includes 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 detected in the Bedrock Aquifer of the Mound Plant property migrate to the BVA. The groundwater model estimated potential future contaminant concentrations by adding contaminant concentration detected in the Bedrock Aquifer to current contaminant concentrations detected in the Mound Plant production wells. Additional 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 6). Total, background, and incremental residual risks for a construction worker exposed to current groundwater are presented in Tables 21, 22, and 23, respectively.

Total and incremental 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}. Since the background concentration of thorium-230 in groundwater has not been quantified, background cancer risk for the construction worker scenario could not be quantified. Total residual non-cancer hazard from current groundwater for the construction worker scenario is 1.3, which exceeds the acceptable threshold of 1. The largest contributor to this is antimony. Background residual non-cancer hazard from current groundwater for the construction worker scenario is 0.017. Incremental non-cancer hazard 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 actual risk from groundwater is not underestimated. Uncertainty surrounding the concentration of antimony used in the current groundwater calculations is described in detail in Section 6.1.

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 8). Total, background, and incremental residual risks for the site employee exposed to current groundwater are presented in Tables 24, 25, and 26, respectively.

Total residual cancer risk from current groundwater for the site employee scenario is 2.2×10^{-5}. Background and incremental residual cancer risks from current groundwater for the site employee scenario are 1.6×10^{-6} and 2.0×10^{-5}, respectively. All three of these risk levels fall within the acceptable risk range of 10^{-4} to 10^{-6}. Total residual non-cancer hazard from current groundwater for the site employee scenario is 1.1, which just exceeds the acceptable hazard threshold of 1. The largest contributor to this is antimony. Background residual non-cancer hazard from current groundwater for the site employee scenario is 0.014. Incremental residual non-cancer hazard from current groundwater for the site employee scenario 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 actual risk from groundwater is not underestimated. Uncertainty surrounding the concentration of antimony used in the current groundwater calculations is described in detail in Section 6.1.

Final COPCs for future groundwater for the construction worker scenario are identified in Table 10. Total, background, and incremental risks for the construction worker scenario are presented in Tables 27, 28, and 29, respectively. Total residual non-carcinogenic hazard from future groundwater for the construction worker scenario is 5.5. Background residual non-carcinogenic hazard from future groundwater for the construction worker scenario is 0.12 and incremental residual non-carcinogenic risk from future groundwater is 5.3. Total and incremental non-cancer hazards for the construction worker scenario exceed the acceptable Hazard Index (HI) of 1. Future total and incremental carcinogenic residual risk from groundwater for the construction worker scenario are 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 8.5×10^{-6}, which falls within the acceptable risk range.

Final COPCs for future groundwater for the site employee scenario are identified in Table 12. Total, background, and incremental risks for the construction worker scenario are presented in Tables 30, 31, and 32, respectively. Future total and incremental non-carcinogenic residual hazards from groundwater for the site employee scenario are 5.0 and 4.9, respectively. Both of these values exceed the acceptable HI of 1. Future background non-carcinogenic residual hazard in groundwater for the site employee scenario is 0.11, which does not exceed the acceptable HI of 1. Future total and incremental carcinogenic residual risks from groundwater for the site employee scenario are 5.9×10^{-5} and 5.4×10^{-5}, respectively. Total and incremental cancer risks associated with exposure to groundwater fall 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 is 4.5×10^{-6}, which also falls within the acceptable risk range of 10^{-4} to 10^{-6}.

Potential cumulative incremental carcinogenic risk due to exposure to contaminants in air is 2.0×10^{-7} for the construction worker scenario and 9.9×10^{-7} for the site employee scenario. 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 table 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 a HI of less than 1 for both potential receptors.

Total and incremental carcinogenic risks are within the acceptable risk range for the current construction worker and current and future site employee scenarios. Total and incremental non-carcinogenic hazard for the current and future construction worker scenario, and current and future site employee scenario exceed a HI of 1 due to potential exposure to groundwater. Cumulative incremental non-carcinogenic risks exceed an acceptable HI of 1 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 (3.0×10^{-4}). Where overall risk exceeds acceptable levels, risks are driven by exposure to groundwater and are due to 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 they reach the BVA. As a result, the future groundwater exposure point concentration (EPC) is biased high and conservative. In addition to the conservative nature of the groundwater model, for antimony the maximum detected concentration (a single measurement) from a data set that spans approximately seventeen years is used as the EPC. Chromium was assumed to be present only in its most toxic hexavalent form. These assumptions are likely to result in an overestimation of groundwater 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 3 and the conservative nature of the RRE, the future groundwater risks presented will be managed to be protective of human and environmental health.

Overall Summary of Risks

Scenario and Receptor	Overall Risk Types	Total Non-cancer HI			Total Excess Lifetime Cancer Risk		
		Soil	Groundwater	Air	Soil	Groundwater	Air
Current Construction Worker	Total	NA	1.3	NA	6.2×10^{-6}	2.1×10^{-6}	2.1×10^{-7}
		Cumulative	1.3		Cumulative	8.5×10^{-6}	
	Background	NA	0.017	NA	2.3×10^{-8}	NA	7.7×10^{-9}
		Cumulative	0.017		Cumulative	3.1×10^{-8}	
	Incremental	NA	1.3	NA	6.1×10^{-6}	2.1×10^{-6}	2.0×10^{-7}
		Cumulative	1.3		Cumulative	8.4×10^{-6}	
Future Construction Worker	Total	NA	5.5	NA	6.2×10^{-6}	3.0×10^{-4}	2.1×10^{-7}
		Cumulative	5.5		Cumulative	3.1×10^{-4}	
	Background	NA	0.12	NA	2.3×10^{-8}	8.5×10^{-6}	7.7×10^{-9}
		Cumulative	0.12		Cumulative	8.5×10^{-6}	
	Incremental	NA	5.3	NA	6.1×10^{-6}	2.9×10^{-4}	2.0×10^{-7}
		Cumulative	5.3		Cumulative	3.0×10^{-4}	
		Soil (0-2 feet bls)	Groundwater	Air	Soil (0-2 feet bls)	Groundwater	Air
Current Site Employee	Total	NA	1.1	NA	2.6×10^{-6}	2.2×10^{-5}	1.0×10^{-6}
		Cumulative	1.1		Cumulative	2.6×10^{-5}	
	Background	NA	0.014	NA	1.2×10^{-7}	1.6×10^{-6}	3.9×10^{-8}
		Cumulative	0.014		Cumulative	1.8×10^{-6}	
	Incremental	NA	1.1	NA	2.6×10^{-6}	2.0×10^{-5}	9.9×10^{-7}
		Cumulative	1.1		Cumulative	2.4×10^{-5}	
Future Site Employee	Total	NA	5.0	NA	2.6×10^{-6}	5.9×10^{-5}	1.0×10^{-6}
		Cumulative	5.0		Cumulative	6.3×10^{-5}	
	Background	NA	0.11	NA	1.2×10^{-7}	4.5×10^{-6}	3.9×10^{-8}
		Cumulative	0.11		Cumulative	4.7×10^{-6}	
	Incremental	NA	4.9	NA	2.6×10^{-6}	5.4×10^{-5}	9.9×10^{-7}
		Cumulative	4.9		Cumulative	5.8×10^{-5}	

bls = below land surface

NA = Not applicable due to lack of toxicity criteria or not an applicable pathway.

1.0 INTRODUCTION

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

Parcel 3, the subject of this report, consists of an approximately 5.76 acre parcel of land located on the Main Hill at the Mound Plant. A map of Parcel 3 is included as Figure 2. In this report residual risk at Parcel 3 is evaluated for future commercial/industrial use of the parcel.

During past operations at the Mound facility, the release of hazardous materials occurred. During subsequent facility investigations, over 400 Potential Release Sites (PRSs) have been identified. Since contamination at the Mound Plant occurred 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 (USEPA), and the Ohio Environmental Protection Agency (OEPA), in accordance with the Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA) as defined in the National Contingency Plan [(NCP) EPA 1990].

This report was developed using the Mound 2000 Residual Risk Evaluation Methodology [RREM (DOE 1997a)] to quantify the potential for cancer and non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 3. 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 a parcel is ready for release and economic redevelopment.

1.1 Purpose of Residual Risk Evaluation

The objective of the Parcel 3 RRE is to assess risks associated with residual levels of contamination remaining after all necessary actions within the parcel have been taken. 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 3 RRE

The Parcel 3 RRE was completed using the Mound 2000 RREM (DOE 1997a) and includes an evaluation of human health risk for residual contamination in the parcel. Since commercial/industrial use of Parcel 3 is anticipated, receptor scenarios were selected to represent reasonable maximum exposures (RME) in a commercial/industrial setting. Residual contaminants in Parcel 3 were evaluated for two potential receptor groups: construction workers, who may be directly exposed to soil, groundwater, and air for up to five years, and site employees, such as office workers, who may be exposed to 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 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 were documented in Table 1 in the Mound 2000 RREM (DOE 1997a) and are based on RME assumptions. RME exposure assumptions are conservative and are therefore, not likely to underestimate residual risk.

Parcel 3 residual risks were calculated as total, background, and incremental risk. Total risk was calculated using the total concentration of identified constituents of potential concern (COPCs) detected in Parcel 3. Background risk was calculated based on background levels of the COPCs as documented in the RREM (DOE 1997a) and incremental risk was calculated as total risk minus background risk. 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 3 data and identify contaminants to be evaluated in the RRE. Section 3.0, Exposure Assessment, summarizes the pathways through which hazardous substances may reach potential receptors and intake assumptions that will be used to quantify exposure. In Section 4.0, Toxicity Assessment, exposure point concentrations (EPCs), intake equations, and toxicological reference values are presented. Information from the exposure assessment is combined with information from the toxicity assessment to characterize human health risks in Section 5.0, Risk Characterization. Section 6.0, Uncertainties, presents some of the sources of uncertainty inherent in risk assessments and in the RRE. Section 7.0, References, contains a list of all documents cited in this report.

2.0 DATA COMPILATION AND EVALUATION

Identification of contaminants to be carried through the RRE calculations is a multi-step process beginning with the identification of all contaminants detected in Parcel 3 and then eliminating contaminants based upon a set of established screening criteria described in the RREM (DOE 1997a).

All available sampling data were compiled from the Mound Environmental Information Management System (MEIMS) for use in the Parcel 3 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 parcel. 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.

Data used to characterize Parcel 3 were drawn from the following data sets:

Project Code	Description	Reference
PRS 99-100	Data from Further Assessment of PRS 100 and Removal Action at PRS 99	PRS 99 On-Scene Coordinator Report, August 2000 PRS 99/100 Package, August 2000
RSS	Radiological Site Survey	Operable Unit 9 Site Scoping Report, Volume 3, Radiological Site Survey, June 1993 (DOE 1993c)
SCRDATA	Mound Plant Screening Data	Compiled from the MEIMS database
Groundwater	BVA Mound Production Well Sampling Bedrock aquifer monitoring well sampling	Compiled from the MEIMS database
Air	1994 Site Restoration activities	Mound Site Environmental Report for Calendar Year 1994, MLM-3814, (DOE 1994)

2.1 Data Quality Assessment

Samples collected after 1993 were analyzed according to the methods outlined in the Operable Unit (OU) 9 Quality Assurance Project Plan (QAPP) (DOE 1993a). Since some of the data used to characterize residual contaminant concentrations in Parcel 3 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 3 are listed above. Samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), inorganic compounds, common anions, polychlorinated biphenyls, pesticides, and radionuclides. Environmental media that were evaluated include surface soil (0-2 ft below land surface), subsurface soil (greater than 2 feet below land surface), air, and groundwater. Parcel 3 does not contain surface water.

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. The concentrations of contaminants in future groundwater were estimated by adding modeled contaminant concentrations detected in the Bedrock Aquifer to the lower of the 95% UCL or maximum detected concentration 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 Blocks D and H and Parcel 4. 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 3 soils and current groundwater, the 95% upper confidence limit of the mean (UCL) was calculated to estimate the potential concentration that receptors in the area may be exposed to. The 95% UCL is then compared to the maximum detected concentration for each constituent. If the 95% UCL exceeds the maximum detected concentration then the maximum detected concentration is used for the calculation of residual risk. The concentration used to calculate risk is known as the EPC. For future groundwater, modeled values for COPCs detected in the bedrock wells were added to the current groundwater EPCs for COPCs detected in the production wells. The Flow Tube model used to predict future contaminant concentrations is described in Appendix B.

The 95% UCL for each constituent 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 of the arithmetic mean, was 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

n = number of observations in the data set

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

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

Where:

UCL = upper confidence limit

H = H statistic (Table A12, Gilbert 1987)

s = standard deviation

n = number of observations in the data set

e = constant

If the 95% UCL exceeded the maximum value observed, 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 included in the calculations of the mean and 95% UCLs as one-half the detection limit. Samples reported as ND or zero with no detection limit were not utilized in calculating a 95% UCL.

Blind field duplicates are collected to assess variability in the sampling process. They are used in the data quality assessment but were not included in the calculation of the EPCs. If a data set had less than twenty observations (n less than 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", meaning estimated values, at concentrations less than the detection limit, were evaluated as half the detection limit. For "J" data, which were greater than the detection limit or reported without the sample detection limit, the reported value was used in the 95% UCL calculations. Data flagged with an "R", meaning rejected, were not used in the Parcel 3 database. An explanation of the laboratory data qualifiers used in the Parcel 3 data base is presented in Appendix F.

2.4 Data Screening Process

All constituents detected one or more times were listed in constituent summary tables and sorted by media. Soil data was also sorted by depth. The constituent screening methods described below were then used to generate a final list of COPCs for each media and receptor.

The constituent summary tables also provide minimum detected concentrations, maximum detected concentrations, 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 for each receptor (construction worker and site employee) for current/future soil, current groundwater, and future groundwater. The first table for each receptor and media 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 second table identifies final COPCs to be carried through the RRE by comparing the EPCs for the initial COPCs to background values. Tables 1 and 2 identify the COPCs in soil for the construction worker scenario and Tables 3 and 4 identify COPCs in soil for the site employee scenario. Tables 5 and 6 identify the COPCs in current groundwater for the construction worker scenario and Table 7 and 8 identify COPCs in current groundwater for the site employee scenario. Tables 9 and 10 identify the COPCs in future groundwater for the construction worker scenario, and Tables 11 and 12 identify the COPCs in future groundwater for the site employee scenario.

For the future groundwater screening process an additional step was incorporated to determine the final COPCs to be carried through the RRE for Parcel 3. The final flow tube modeled concentrations for COPCs were compared to background concentrations and if the future concentrations were less than background, the COPC was not carried through the RRE process. Only two COPCs (manganese and thorium-232) had future concentrations less than background and were screened out of the RRE.

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 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 values were compared to risk-based GVs for the Mound Facility (DOE 1997b). GVs are media-specific concentrations of constituents that correspond to specific human health risk levels for specified exposure scenarios. GVs were developed for construction worker and site employee scenarios (see DOE 1997b for the detailed derivation of GVs). Construction worker and site employee GVs were screened against detected constituents to determine 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 DOE, USEPA, and OEPA after a public review. The GVs correspond to the $1x10^{-6}$ risk level for carcinogens and radionuclides. A $1x10^{-6}$ risk level represents the probability of an incremental increase of one person in one million people developing cancer as a result of exposure to the GV concentrations.

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.

Some GVs were unavailable for a detected constituent in the Parcel 3 soils or groundwater data set, and were required to be calculated for screening purposes. These GVs were calculated using the Mound GV methodology (DOE 1997b). When a GV was required for screening purposes and new toxicity criteria were available, GVs were updated using the new toxicity criteria. Calculations for new and updated GVs are provided in Appendix C.

A Hazard Quotient (HQ) 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 $1x10^{-6}$ (increased cancer risk of 1 human in 10,000 to 1 human in 1 million), screening COPCs against the whole GV is protective. The acceptable threshold for non-carcinogenic constituents is a Hazard Index (HI) of less than or equal to one. The GVs 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 also 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." Calcium, chloride, iron, magnesium, potassium, and sodium are considered essential nutrients to humans. These compounds were detected in the Parcel 3 area at levels below or slightly elevated above background levels 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 Parcel 3.

2.4.5 Additional Screening Procedures

In accordance with the RREM, additional screening procedures were used to evaluate Parcel 3 constituents. For example, in accordance with USEPA's Functional Guideline for Organics (EPA 1999a), if a blank contains measurable levels of a common laboratory contaminant, then the associated sample results were considered as positive results only if 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 groundwater COPCs, 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 bedrock wells were screened for frequency of detection as well as a comparison to the background and GVs. Constituents that exceeded these criteria were retained for flow tube modeling. In addition, constituents that were identified as 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 were 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.

An additional screening step was required to determine the final COPCs to carry through the RRE process for future groundwater. The future modeled concentration for each identified COPC was compared to background. Manganese and thorium-232 had future modeled concentrations less than the respective background concentrations. These constituents were screened out and not evaluated in the RRE.

3.0 EXPOSURE ASSESSMENT

The goal of the RRE exposure assessment is to estimate the type and magnitude of contaminant exposures for specific receptors that may occur under current conditions and in the future. The information gathered in the exposure assessment is integrated with toxicity information to characterize potential risks associated with exposure to residual contamination in Parcel 3.

3.1 Characterization of Exposure Setting

Parcel 3 consists of approximately 5.76 acres and includes two buildings. Parcel 3 includes parts of the plant site that were developed as part of the original plant construction project [e.g., Guard House (GH) Building and the parking area west of GH Building]. Some of these areas were used for disposal (e.g., the parking area south of GH Building) and for additional development (e.g., construction, parking areas). A brief discussion of the histories of the areas and buildings (both past and present) located in Parcel 3 follows.

GH BUILDING: GH Building was constructed in 1948, in a grassy area on the northern end of the Main Hill at what was, in 1948, the main entrance to the plant site. The Ohio Historic Preservation Office (OHPO) declared GH Building eligible for the National Register. GH Building, originally designated as the "Guard House" was constructed as a one-story structure with a reinforced concrete roof bearing on exterior walls of face brick and masonry block. It was constructed to serve as an office area to house guard personnel and their equipment. It included a change room and office area for Mound site security staff.

In 1949, GH building also served as a visitors control center. The visitors control function remained in GH Building until about 1993. In the early 1950s, the Purchasing Group had offices at GH Building. From 1982 until 1994, GH Building was used as an office area for newly hired Mound employees who were not yet security cleared and could not access the site without escort. From 1994 to 1996 GH Building was used as an office area for the "Mound Transition Center" offering employment search services to displaced Mound workers. In 1996 until early 1997 GH Building served as an office area for Mound Health Physics staff. In early 1997 the Health Physics staff moved out and GH Building has remained vacant since that time.

Today GH Building is an unoccupied office complex surrounded by parking areas. The structure currently has 5,347 square feet of floor space. GH Building also has a utility penthouse that was built in 1966 out of built-up-membrane coal tar.

GIS BUILDING: GIS (the "Guard Island Station") Building was constructed in about 1948, as one of the original structures in a grassy island in the roadway to the north of GH Building. This building was constructed as a guard station; a function that it served until it was demolished in 1997.

GP-1 BUILDING: Guard Post 1 (or GP-1) was constructed around 1950. This date is based upon the engineering drawings dated late 1949 and upon aerial photographs from late 1949.

In the original architectural drawings, this building was designated as "Guard Station-1," a "trooper post". It was constructed to serve as a training center and to provide office space for security personnel. It was used as an office and training area until it was vacated in the late 1990s, in anticipation of its transfer to the Miamisburg Mound Community Improvement Corporation (MMCIC).

Initially GP-1 measured approximately 15'-0"x21' and 7-1/2." Additions to GP-1 in 1961, 1963, 1968, and 1981, increased the square footage of GP-1 significantly. Today, GP-1 is about 8,000 ft^2. Following the construction of these additions, GP-1 also housed a practice firing range (previously located outside) and fitness center for the guard force.

PAVED PARKING AREA WEST OF GH BUILDING AND THE ROADWAY: This parking area covers part of the area that was constructed to serve as the original Mound Laboratory parking area in 1948. Although the area has been reconfigured with the removal of the original grassy islands, and diminished in size due to the encroachment of buildings (e.g., Operational Support East (OSE) and the former Building 91), this area has remained in use as a parking area since the late 1940s.

PAVED PARKING AREA SOUTH OF GH BUILDING: This area was a sloped area on the northern side of the Main Hill. Through time, this area was used as a "landfill", receiving debris and waste materials from plant operations and construction projects. The hillside has been filled in, and the area leveled off to the approximate elevation of adjacent areas to the north and south. It was paved in about 1984 and used as a parking area. In 1999, as part of the plant site's cleanup program, parts of the "landfill" (PRSs 99 and 100) were sampled to determine if they were contaminated. A CERCLA Removal Action followed. The area was then back-filled and re-paved. It is again in use as a parking area.

PAVED PARKING AREA NORTH OF THE ROADWAY: This parking area is a smaller lot constructed atop an area that had been back-filled. Initially, this lot was gravel and mat pavement, with space for 35 cars. In plant site photographs from the 1970's and 1980's this area appears as a paved parking lot.

CERCLA PRSs IN PARCEL 3: The PRSs located in Parcel 3 include PRSs 99, 100, and 241. PRSs 99 and 100 are discussed above in conjunction with the paved parking area south of

GH Building (a.k.a., the GH Parking Lot). PRS 241 includes all of the existing parking areas, the roadway, and the parts of the GH Parking Lot not included in PRSs 99 and 100. PRS 241 boundaries extend to the west beyond this parcel to encompass the DOE parking area. No remedial actions were needed at PRS 241.

OTHER STRUCTURES AND FEATURES IN PARCEL 3: A modular structure was located near the current OSE Building within the Parcel 3 area in the late 1980s. This structure was located just outside the fence north of the former Building 91 location, and east of OSE Building. The purpose of this structure was to serve as an entrance to the plant site (through the lobby and OSE Building). This building was a guard post, containing x-ray equipment used for surveillance of materials carried into the plant site.

Also included in Parcel 3 is a concrete stairway down the north end of the Main Hill extending to the fence line. This stairway once served as access to an emergency supply water pump-house and tank constructed in 1948. The City of Miamisburg provided water for the system through a hookup to a municipal water main. Today the stairway is somewhat overgrown with vegetation; a metal gate at the base of the stairway allows access to the plant property.

The small parking area on the bend in the roadway (east of GH Building) was constructed prior to opening of the Mound site in 1949. Based upon the lot's location, this area may have been used for a parking area for visitors being processed for access through GH Building and GIS Building or for vehicles that were not cleared for site access.

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 release; (2) 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 3 (Figure 3). The conceptual site model summarizes the pathways that hazardous substances may take to reach potential receptors. Exposure assumptions used to evaluate potential exposure pathways were drawn from the Mound Plant *Risk-Based Guideline Values* (DOE 1997b) and the Mound 2000 RREM (DOE 1997a). Exposure assumptions used to quantify contaminant exposures are summarized in Table 13.

3.3 Identifying Exposure Scenarios

Residual contamination in Parcel 3 was evaluated for two potential use scenarios. Residual contamination in Parcel 3 was evaluated for adult construction workers and for adult site employees. It was assumed that construction workers and site employees could potentially be exposed to soil, air, and groundwater. The evaluation of risk associated with exposure to residual contamination in Parcel 3 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 Parcel 3, 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. A chemical-specific skin absorption factor is currently not available for plutonium-238, which was the only soil COPC identified for evaluation in this RRE. The use of dermal default absorption values for inorganic compounds is currently not recommended by USEPA (EPA 1999b). For many chemicals, including plutonium-238 , scientifically defensible data does not exist to derive a dermal toxicity value or for making an adjustment of an oral cancer slope factor (CSF) or reference dose (RfD) to estimate a dermal toxicity value. Without these critical input parameters, risk due to dermal exposure to soil cannot be quantified. The exclusion of this pathway is expected to have a minimal impact on the final risk-based calculations because human exposure to radionuclides 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 the BVA groundwater for a 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 concentrations 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, and
- dermal contact with contaminated groundwater while showering at work.

The parameters used to evaluate these pathways and their references are provided in Table 13.

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 3 will be exposed to residual contamination left on the property. 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 scenario 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 water 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 scenario 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 13.

3.4 Exposure Point Concentrations

EPCs 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 log normally 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 scenario. Site employees are assumed to spend most of their time indoors and have limited contact with surface soil. Construction workers are 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.

Groundwater data from the production wells were used to calculate the EPC for both the site employee and construction worker for the current scenario. For the future groundwater EPC, groundwater data from bedrock monitoring wells were modeled using the flow tube model for bedrock contribution to the BVA. The maximum concentration for each analyte in a flow tube from the bedrock aquifer was added to the EPC (the lower of the 95% UCL or maximum detected concentration) of each COPC in the BVA wells (production wells) to establish the final EPC for future groundwater risk calculations. This approach is very conservative and does not take into account dilution, dispersion, adsorption, and other physical and chemical properties that naturally occur and impact contaminant fate and transport.

Another assumption made for calculating future groundwater EPCs is that all of the detected chromium was present in the hexavalent state. Chromium can exist in two valence states, hexavalent and trivalent with the hexavalent state being the more toxic form. Hexavalent chromium is highly reactive, not naturally occurring, and found only under strongly reducing conditions. Therefore, the assumption that all the chromium detected occurs in the hexavalent state is very conservative.

3.5 Human Intake Equations and Assumptions

This section presents the exposure equations and assumptions used to derive contaminant-specific intake estimates for the populations and exposure pathways evaluated in the risk assessment. The use of the intake equations presented in this section is in accordance with methods presented by EPA in RAGS Part A (EPA 1989) and the RREM (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 13.

For chemicals, exposure generally refers to the intake (e.g., inhalation, ingestion, dermal absorbed dose) 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 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. 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; which 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:

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

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 3 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:

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

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:

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

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 x 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 x 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 x 10^9 m^3/kg was taken from Risk-Based Guideline Values (DOE 1997b).

Volatilization of chemical contaminants from soils may result in exposures via inhalation for construction workers and site employees; however, no volatile COPCs were identified in the Parcel 3 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 two of the Mound Plant production wells (0271 and 0076). The method for estimating 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 were screened and modeled to predict future contribution to the BVA from bedrock using a Flow

Tube Model. This future bedrock estimated concentration for each final COPC was then added to the respective EPC (lower of 95% UCL or maximum detected concentration) in the Mound Plant production wells to provide the estimated future contaminant concentrations in groundwater used to calculate future groundwater risk. 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:

$$\text{Constituent Intake (mg / kg – d)} = \frac{C_w \times IR_w \times EF \times ED}{BW \times AT}$$

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:

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

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:

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

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:

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

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 ($mg/cm^3 = 10^{-3}$ mg/L)
t_{event}	=	duration of event (hr/event)
T	=	lag time (hour)
π	=	constant (3.14159)

Constituent-specific permeability coefficient values (K_p) and the formula for the calculation of K_p were 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:

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

Where:

$\log K_p$	=	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:

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

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 was used in the RRE to calculate chemical contaminant intake from inhalation during showering:

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

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:

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

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, DOE 1997b)
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 3. The RRE for Parcel 3 evaluated chronic exposures. The RRE utilized methods recommended by USEPA for evaluating human cancer and non-cancer effects resulting from exposure to the COPCs. All of the Parcel 3 COPCs for soil are radionuclides. All radionuclides are considered to be human carcinogens. These particular constituents do not have non-cancer toxicity criteria so non-carcinogenic health effects were not evaluated in soils. A cancer and non-cancer toxicity assessment for COPCs in groundwater was conducted as part of the Parcel 3 RRE. Risks due to exposures to groundwater and soil are summed in Tables 33 through 35.

The toxicity criteria used in the RRE were obtained from the most current update of the EPA Integrated Risk Information System (IRIS) or, if the information was not available in IRIS, the EPA Health Effects Assessment Summary Tables (HEAST). IRIS is an electronic database containing the most current descriptive and quantitative USEPA 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 USEPA. HEAST contains slope factors needed to evaluate the carcinogenicity of radionuclides. The National Center for Environmental Assessment (NCEA) was another possible source for toxicity values not available from IRIS or HEAST. Table 14 presents a summary of toxicological criteria used to calculate risk for soil and groundwater COPCs, along with the chemical-specific characteristics used to estimate dermal absorbed dose and the concentrations present in vapors or dust. Since air risk was not recalculated for Parcel 3, no toxicity criteria are presented in Table 14 for COPCs in air that were not present in soil or groundwater. Additionally, for those constituents that required calculation of new or updated GVs, the toxicity criteria are found in Appendix C.

In assessing the potential for non-cancer health effects, USEPA 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. USEPA 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.

USEPA 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. USEPA does not, therefore, estimate an effective threshold for carcinogenic chemicals. USEPA 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 risk per picocuries (risk/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 CSF 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 or hazard index. For the Parcel 3 RRE, oral administered-dose toxicity values were adjusted by using compound-specific gastrointestinal absorption factors. For non-carcinogens, the administered dose toxicity value (i.e., the RfD) was multiplied by the gastrointestinal absorption factor. For carcinogens, the slope factor was divided by the gastrointestinal absorption factor.

5.0 RISK CHARACTERIZATION

This section presents the risk characterization for Parcel 3. In risk characterization, information from the exposure assessment (Section 3) combined with information from the toxicity assessment (Section 4) is used 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 USEPA acceptable levels for human health effects. The results of a risk assessment may support the determination of site release or the need for site remediation.

The RRE reports the incremental risk, total risk, and risk from background for each contaminant evaluated in the Parcel 3 RRE. 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. Total risk is the sum of the background and incremental risk. This risk characterization presents a separate evaluation of non-carcinogenic and carcinogenic effects. 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 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 USEPA (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 a 70-year 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 estimate for each COPC was summed to provide an overall estimate of total carcinogenic risk (EPA 1989).

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

Where:

$Risk_t$	=	The combined excess lifetime cancer risk across chemical carcinogens
$Risk_i$	=	Risk estimate for the i^{th} chemical of n chemicals under evaluation.

5.1.2 Quantification of Non-carcinogenic Hazard

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

$$HQ = Intake/RfD$$

Where:

HQ	=	Hazard Quotient: potential for adverse non-carcinogenic effects
Intake	=	Average daily intake for subchronic or chronic exposure (mg/kg body weight/day)
RfD	=	Acceptable intake for subchronic or chronic exposure (mg/kg body weight/day).

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

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

Where:

HI = Hazard Index

HQ: = Hazard quotient estimate for the i^{th} chemical of n chemicals under evaluation.

For non-carcinogenic effects, USEPA 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 greater than 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, USEPA 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 Parcel 3 by potential receptor. Risk estimates for individual soil COPCs for all scenarios and pathways are presented in Tables 15 through 20. Tables 15 through 17 present soil risk estimates based on construction worker exposure parameters, and Tables 18 through 20 present soil risk estimates based on site employee exposure parameters. Total risk was calculated using the total concentration of the COPCs detected in Parcel 3. 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 33 through 35 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 each COPC and the risk equations presented in Section 3.5.2. Appendix B presents the methodology for calculation and

EPC values of the future groundwater COPCs that were then applied to equations presented in Section 3.5.2. Risks due to exposure to current and future groundwater are presented in Tables 21 through 32. In Tables 33 through 35, 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

Tables 15 through 17 present total, background, and incremental risk for the construction worker scenario in Parcel 3, respectively. No soil COPCs with non-carcinogenic toxicity criteria were identified in Parcel 3, therefore, the total, background, and incremental non-cancer risk from soil was not calculated. Plutonium-238 was identified as the COPC in Parcel 3 soil. Total residual cancer risk from soil for the construction worker scenario is 6.2×10^{-6}, which falls within the acceptable risk range of 10^{-4} to 10^{-6}. Background residual risk from soil for the construction worker scenario in Parcel 3 is 2.3×10^{-8} and is based only on background concentrations of plutonium-238. Incremental residual soil risk is 6.1×10^{-6}. Ingestion is the exposure pathway that contributes most significantly to residual cancer risk. The ingestion pathway contributes 100% of the total residual cancer risk for the construction worker scenario in Parcel 3.

Current Groundwater

Total, background, and incremental risk for a construction worker exposed to current groundwater is presented in Tables 21 through 23. Total and incremental non-carcinogenic residual hazards from current groundwater for the current construction worker scenario are both 1.3. This value exceeds the acceptable HI of 1. Antimony is responsible for 85% of the current groundwater non-carcinogenic hazard. Current background non-carcinogenic residual hazard for the construction worker scenario due to exposure to groundwater is 0.017, which does not exceed the acceptable non-carcinogenic threshold. 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 (oral) pathway.

Future Groundwater

Final COPCs for future groundwater for the construction worker scenario are identified in Table 10. Total, background, and incremental risks for the construction worker scenario are presented in Tables 27, 28, and 29, respectively. Total residual non-carcinogenic hazard from future groundwater for the construction worker scenario was 5.5. Background residual non-carcinogenic hazard from future groundwater for the construction worker scenario was 0.12 and incremental residual non-carcinogenic hazard from future groundwater was 5.3. Total and incremental non-cancer hazard for the construction worker scenario exceed the acceptable HI of 1. Future total and incremental carcinogenic residual risk from groundwater for the construction worker scenario was $3.0x10^{-4}$ and $2.9x10^{-4}$, respectively, which exceed the acceptable risk range for carcinogens. Background residual carcinogenic risk from future groundwater for the construction worker scenario was $8.5x10^{-6}$, which falls within the acceptable risk range.

Air

Potential cumulative total and incremental cancer risks due to exposure to contaminants in air are $2.1x10^{-7}$ and $2.0x10^{-7}$, respectively, which is less than the acceptable risk range. None of the COPCs identified in air have non-carcinogenic hazard criteria so a HI was not calculated for exposure to contaminants in air.

5.2.2 Site Employee Risk Results

Soil

Total, background, and incremental residual soil risks for the site employee scenario in Parcel 3 are presented in Tables 18, 19, and 20, respectively. For the site employee scenario, plutonium-238, was the only COPC identified in soil for RRE calculations. No non-carcinogenic soil COPCs were identified in Parcel 3; therefore, the total, background, and incremental non-cancer hazard from soil was not calculated. Total residual cancer risk from soil for the site employee scenario in Parcel 3 is $2.6x10^{-6}$, which falls within the acceptable risk range of 10^{-4} to 10^{-6}. Background residual risk from soil for the site employee scenario in Parcel 3 is $1.2x10^{-7}$ and is based on background concentrations of plutonium-238. Incremental residual soil risk is $2.6x10^{-6}$. Ingestion is the exposure pathway that contributes 100% to residual cancer risk for the site employee scenario from Parcel 3 soil.

Current Groundwater

Total, background, and incremental residual current groundwater risks for the site employee scenario in Parcel 3 are presented in Tables 24, 25, and 26, respectively. The total and incremental non-carcinogenic hazard 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 89% of the non-carcinogenic risk. The current groundwater background non-carcinogenic hazard for the site employee scenario is 0.014 and does not exceed the acceptable non-carcinogenic level (HI=1). Total and incremental carcinogenic risks for site employees exposed to current groundwater is $2.2x\ 10^{-5}$ and $2.0x10^{-5}$, respectively. These values fall within the acceptable risk range of 10^{-4} to 10^{-6}. Thorium-230 contributes 45% of the risk via the ingestion (oral) pathway. Actinium-227, plutonium-239/240, thorium-228, and uranium-234 contribute a range of 18% to 9% of the carcinogenic risk via the ingestion pathway. Current background cancer risk to the site employee presents a risk of $1.6x10^{-6}$, which is within the acceptable cancer risk range.

Future Groundwater

Final COPCs for future groundwater for the site employee scenario are identified in Table 12. Total, background, and incremental risks for the site employee scenario are presented in Tables 30, 31, and 32, respectively. Future total and incremental non-carcinogenic residual hazard from groundwater for the site employee scenario were 5.0 and 4.9, respectively. Both these values exceed the acceptable HI of 1. Future background non-carcinogenic residual hazard in groundwater for the site employee scenario is 0.11, which does not exceed the acceptable HI of 1. Future total and incremental carcinogenic residual risks from groundwater for the site employee scenario was $5.9x10^{-5}$ and $5.4x10^{-5}$, respectively. Total and incremental carcinogenic risks associated with exposure to groundwater fall within the acceptable risk range of 10^{-4} to 10^{-6} for the site employee scenario. Background carcinogenic residual risk from future groundwater for the site employee scenario was $4.5x10^{-6}$, which also falls within the acceptable risk range of 10^{-4} to 10^{-6}.

Air

Potential cumulative total and incremental cancer risks due to site employee exposure to contaminants in air are 1.0×10^{-6} and 9.9×10^{-7}, respectively, which are less than or within 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

Overall total, background, and incremental cancer and non-cancer risks are presented in a table included with the Executive Summary and in Tables 33 through 35. The values in the tables are the sum of all of the media and associated pathways for the construction worker and site employee scenarios. Total and incremental non-carcinogenic hazard exceed acceptable criteria for the current and future construction worker and site employee scenarios largely due to potential exposures to groundwater. Total and incremental carcinogenic risks exceed acceptable criteria for the future construction worker largely due to potential exposures to groundwater.

6.0 UNCERTAINTY IN THE RISK ASSESSMENT

In the following section, an evaluation is presented of the sources of uncertainty in the Parcel 3 RRE and the relative influence of these sources on the results of the evaluation. Uncertainty is inherent in the selection of input parameters and in every step of the risk assessment process. Risk assessment of contaminated sites must not be viewed as yielding single value, invariant results. Rather, the results of risk assessment are estimates that span a range of possible values, and which must be understood only in light of the assumptions and methods used in the evaluation.

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

6.1 Uncertainty in Analytical Data

Uncertainty is introduced to the RRE when sample locations are selected and when samples are collected and analyzed. In the RRE, the long-term exposure concentrations were upper estimates of site concentrations (e.g., maximum detect or 95% UCL); therefore, a conservative bias to overestimate potential exposure has been incorporated into the risk estimates. The uncertainty associated with the statistical analysis of environmental data is low, with little introduction of bias. However, it is possible that contaminated areas of Parcel 3 were not sampled.

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. The earlier data with higher detection limits resulted in non-detected concentrations that were higher, in some cases, than current maximum detected concentrations. Substitution of one-half the detection limit for non-detected concentration limits 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 6^{th}, 1991. Since both elevated results were collected on the same date the possibility of sample contamination exists. May 6^{th} 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 6^{th} 1991 samples) range from 2.8 μg/L and 14.4 μg/L, respectively. The Mound Environmental Information Management System (MEIMS) database specifies the procedure used for antimony analysis (on May 6, 1991) 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.

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 hazard. Elimination of the questionable May 6th results would lower the estimated current total hazard due to antimony from a HI of 1.3 for the construction worker scenario down to an HI of 0.4, which is well below the acceptable threshold.

To estimate future maximum constituent concentrations in the BVA, the EPC (lower of maximum detected concentration or 95% UCL) 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. The model does not take into account chemical and physical processes such as dilution, dispersion, and adsorption, which may reduce contaminant levels by the time they reach the BVA. As a result of this methodology, the future groundwater EPCs are 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 the Mound 2000 Process 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 and costly. 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 USEPA procedures that were used in the Parcel 3 RRE. Exposure assumptions were also used to develop site-specific risk-based guideline values for the Mound Plant which were approved by OEPA and USEPA after public review. Exposure assumptions are based on speculation regarding potential land use, assumptions concerning contaminant fate and transport, and receptor behavior. The uncertainty associated with the exposure assumptions used in the risk assessment is moderate, and most likely overestimates the actual risks.

One of the exposure assumptions used in the Parcel 3 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 3 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 3 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. The shielding default values are consistent with values previously used in the calculation of the GVs by DOE.

6.3 Uncertainties Related to Toxicity Information

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

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

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

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

Toxicity values derived from oral administered dose studies have been converted to absorbed dose toxicity values for use in evaluating the dermal contact pathway. This is considered a more accurate approach than using unadjusted oral toxicity values for the dermal pathway. Uncertainty is introduced in the use of the gastrointestinal absorption factors. Limited information is available on the gastrointestinal absorption of some analytes and many have no information at all. In addition, no adjustments have been made for the medium of exposure (e.g., when the medium of exposure in the site differs from the medium of exposure assumed by the toxicity value). The uncertainty associated with using the absorbed dose toxicity values for the dermal pathway is moderate and the bias unknown.

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

To estimate potential impact associated with simultaneous exposure to multiple chemicals, cancer risks were summed for all COPCs and hazard indexes were summed for all COPCs. 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 synergistic or antagonistic effects 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 Conclusions

The residual risk in Parcel 3 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.

7.0 REFERENCES

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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 3 that may reach a receptor in the Parcel 3 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-Dichloroethene	0.0023	0.00720	0.00945
Actinium-227		0.5000	0.5000
Aluminum	1.9876	0.07410	2.06172
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
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
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
Trichloroethene	0.0016	0.00243	0.00401
Tritium	65945.3956	861.0000	66806.3956
Uranium-234	0.5903	8.1400	8.7303
Uranium-238	0.1452	0.47000	0.61518
Vanadium	0.0106	0.0146	0.0252

2/16/01

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

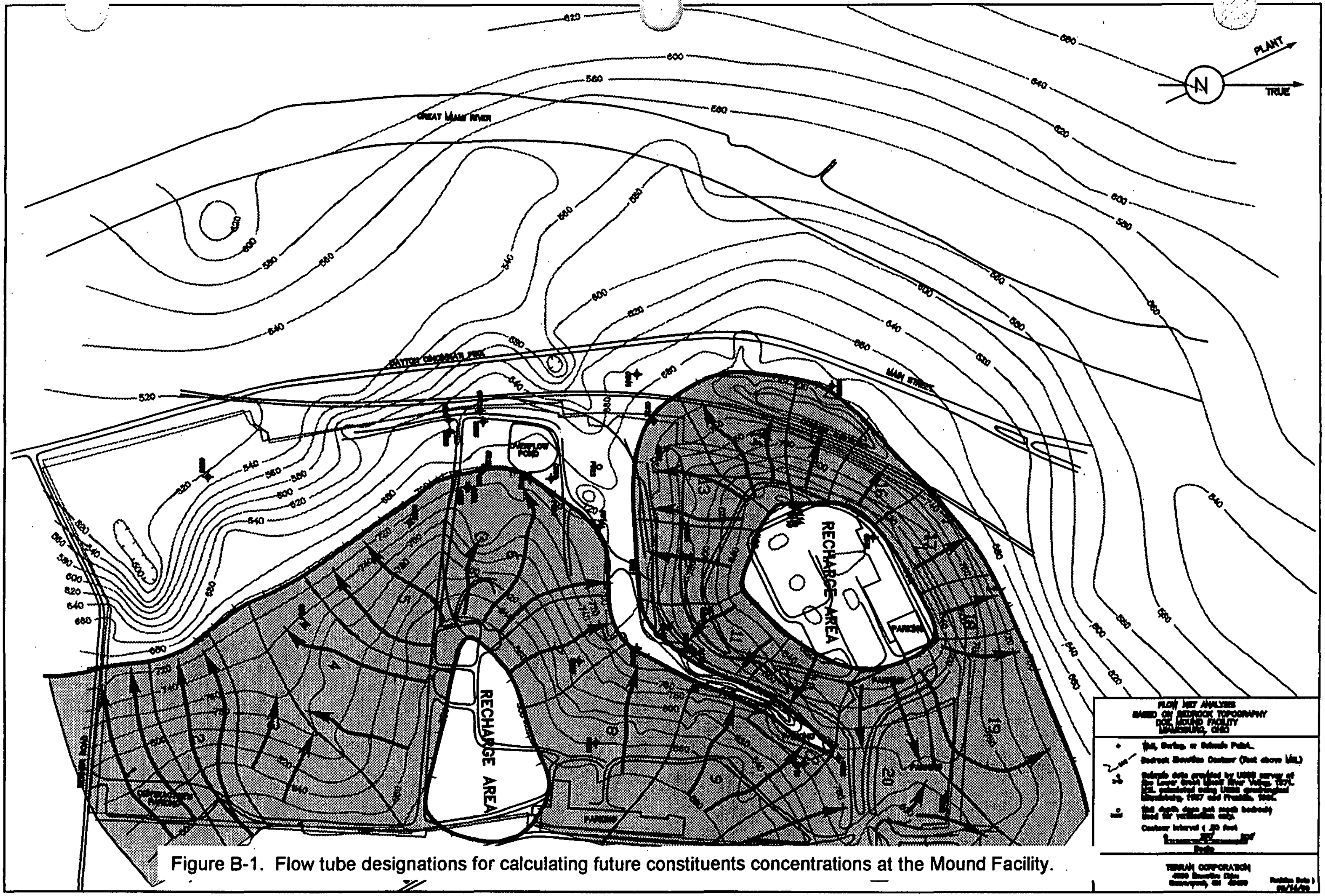


Figure B-1. Flow tube designations for calculating future constituents concentrations at the Mound Facility.

APPENDIX C

Calculations for Updated Guideline Values

Appendix C Table 1: Toxicity Criteria for Soil and Groundwater GVs

Constituent	RfD (mg/kg/day)			CSF (kg-day/mg)			
	Oral	Adjusted	Inhalation	Oral	Adjusted	Inhalation	
Organics	RfDo	RfDa	RfDi	CSFo	CSFa	CSFi	
1,1,1-Trichloroethane	3.5E-02	3.50E-02	2.9E-01	NA	NA	NA	
1,1,2-Trichloro-1,2,2trifluoroethane (freon)	3.00E+01	3.00E+01	8.57E+00	NA	NA	NA	
cis-1,2-Dichloroethene	1.0E-02	1.00E-02	NA	---	---	---	
Inorganics							
Aluminum	1.0E+00	NA	1.4E-03	---	---	---	
Boron	9.0E-02	9.00E-02	5.7E-03	---	---	---	
Chromium (VI)	3.0E-03	7.50E-05	NA	---	---	2.9E+02	
Cobalt	6.0E-02	6.00E-02	5.7E-06	---	---	---	
Copper	3.7E-02	NA	NA	---	---	---	
Molybdenum	5.0E-03	NA	NA	---	---	---	
Selenium	5.0E-03	5.00E-03	5.7E-05	---	---	---	
Thallium	8.0E-05	8.00E-05	NA	---	---	---	
Tin	6.0E-01	6.00E-01	NA	---	---	---	
Radionuclides							External
Bismuth-210	NA	NA	NA	7.29E-12		5.12E-11	NA
Lead-210+D	NA	NA	NA	1.01E-09		3.86E-09	1.45E-10
Radium-228+D	NA	NA	NA	4.79E-10		9.78E-08	9.48E-06
Potassium-40	NA	NA	NA	1.25E-11		7.46E-12	6.11E-07
Strontium-85	NA	NA	NA	1.40E-12		1.14E-12	1.54E-06
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-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

NA: not available/applicable

Equations for Updated/Newly-calculated Soil GVs

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

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

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

$$RBGV\ (pCi/g) = \frac{TCR}{\{EF \times ED1 \times [(CSFo \times CF1 \times IRsoil) + (CSFi \times CF2 \times IRair \times (1/PEF + 1/VF))]\} + (ED2 \times CSFex \times (1-Se) \times Te)}$$

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

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

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

Appendix C Table 2: Soil Guideline Values for Construction Worker at DOE Mound

Constituent	GV mg/kg	CANCER EFFECTS: Route-Specific RRSs (mg/kg) Ingestion (RRSo)c	Inhalation (RRSi)c	External (RRSex)c	Cancer Effects PRG RRSc	NON-CANCER EFFECTS: Route-Specific RRSs (mg/kg) Ingestion (RRSo)nc	Inhalation (RRSi)nc	Non-Cancer Effects PRG RRSnc	1/10 HI
Organics									
1,1,2-trichloro-1,2,2-trifluoroethane (freon)	7.0E+03	NA	NA		NA	6.4E+06	7.0E+04	7.0E+04	7.0E+03
Metals									
Chromium *	6.4E+01	NA	NA		NA	6.4E+02	NA	6.4E+02	6.4E+01
Radionuclides									
Lead-210+D	1.6E+00	1.7E+00	4.4E+04	6.7E+03	1.6E+00	NA	NA	NA	NA
Potassium-40	1.6E+00	1.3E+02	2.3E+07	1.6E+00	1.6E+00	NA	NA	NA	NA
Thorium-228 +D	1.5E-01	7.2E+00	1.8E+03	1.6E-01	1.5E-01	NA	NA	NA	NA
Thorium-232 +D	1.0E-01	3.3E+00	1.5E+03	1.0E-01	1.0E-01	NA	NA	NA	NA
Uranium-238 +D	1.2E-01	1.2E+00	3.4E+03	1.4E-01	1.2E-01	NA	NA	NA	NA

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

Appendix C Table 3: Soil Guideline Values for Site Employee at DOE Mound

Constituent	GV	CANCER EFFECTS				NON-CANCER EFFECTS			1/10 HI
		Route-Specific RRSs (mg/kg)			Cancer Effects PRG	Route-Specific RRSs (mg/kg)		Non-Cancer Effects PRG	
		Ingestion	Inhalation	External		Ingestion	Inhalation		
	mg/kg	(RRSo)c	(RRSi)c	(RRSex)c	RRSc	(RRSo)nc	(RRSi)nc	RRSnc	
Organics									
1,1,2-trichloro-1,2,2-trifluoroethane (freon)	7.0E+03	NA	NA		NA	6.1E+07	7.0E+04	7.0E+04	7.0E+03
Radionuclides									
Lead-210+D	3.2E+00	3.2E+00	8.9E+03	6.0E+03	3.17E+00	NA	NA	NA	NA
Potassium-40	1.4E+00	2.6E+02	4.6E+06	1.4E+00	1.43E+00	NA	NA	NA	NA
Thorium-228 +D	1.4E-01	1.4E+01	3.5E+02	1.4E-01	1.40E-01	NA	NA	NA	NA
Thorium-232 +D	9.1E-02	6.3E+00	2.9E+02	9.2E-02	9.10E-02	NA	NA	NA	NA

mg/kg: milligram per kilogram
NA: Not available; insufficient toxicity data
NC: Not a suspected carcinogen
RRS: Risk Reduction Standard for soil (mg/kg)

Calculation Sheets for Updated/Newly-calculated Soil GVs

Construction Worker:

- chromium VI
- 1,1,2-trichloro-1,2,2-trifluoroethane (freon)
- lead-210+D
- potassium-40
- thorium-228+D
- thorium-232+D
- uranium-238+D

Site Employee:

- 1,1,2-trichloro-1,2,2-trifluoroethane (freon)
- lead-210+D
- potassium-40
- thorium-228+D
- thorium-232+D

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

For:	Chromium VI	
Chromium VI	**Target Hazard Index**	1.00E+00

RfDs

3.00E-03	Oral Reference dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]
Note: No inhalation reference dose only ingestion route evaluated

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+03

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

For:	Chromium VI	
Chromium VI	**Target Hazard Index**	1.00E+00

RfDs

3.00E-03	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]
Note: No inhalation reference dose only ingestion route evaluated

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+02

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	(1,1,2-Trichloro-1,2,2-trifluoroethane)	
Freon	**Target Hazard Index**		1.00E+00

Slope Factors

3.0E+01	Oral Reference Dose
8.6E+00	Inhalation Reference Dose

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

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
VF=	1.60E+03	m3/kg

RBGV=	7.00E+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:	Freon	
Freon	**Target Hazard Index**	1.00E+00

Slope Factors

3.0E+01	Oral Reference Dose
8.6E+00	Inhalation Reference Dose

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

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
VF=	1.60E+03	m3/kg

RBGV=	7.0E+04

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: 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 5.1.3 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: 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: 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

Equations for Updated/Newly-calculated Groundwater GVs

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

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

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

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

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

		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

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

		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

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

		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.

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

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

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

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

		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

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

		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

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

		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

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

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

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

RBGVingestion same as above for all radionuclides

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

		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

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

		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

Appendix C Table 4: Groundwater Guideline Values for Site Employee at DOE Mound

Constituent	GV	CANCER EFFECTS: Route-Specific RRSs (mg/L) Oral (MSCo)c	Dermal (MSCd)c	Inhalation (MSCi)c	Weight Of Evidence	Cancer GW GV (TRC-06)	NON-CANCER EFFECTS: Route-Specific RRSs (mg/L) Oral (MSCo)nc	Dermal (MSCd)nc	Inhalation (MSCi)nc	Non-Cancer W RRE G mg/L	1/10 HI mg/L
Organics (mg/L)											
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-Dichloroethene	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
Tin	6.1E+00	---	NA	NA	NA	---	6.1E+01	NA	NA	6.1E+01	6.1E+00
Radionuclides (pCi/L)											
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	
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-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 C Table 5: Groundwater Guideline Values for Construction Worker at DOE Mound

		CANCER EFFECTS					NON-CANCER EFFECTS				
		Route-Specific RRSs (mg/L)				Cancer	Route-Specific RRSs (mg/L)			Non-Cancer	Non-Cancer
Constituent	GV	Oral	Dermal	Inhalation	Weight Of Evidence	GW GV (TRC-06)	Oral	Dermal	Inhalation	GW GVs mg/L	1/10 GW GVs mg/L
		(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
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
Organics (mg/L)											
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-Dichloroethene	9.6E-02	---	---	---	D	---	1.0E+00	---	1.5E+01	9.6E-01	9.6E-02
Radionuclides (pCi/L)											
Bismuth-210	1.1E+02	1.1E+02	NA	NA		1.1E+02	NA	NA	NA		
Strontium-85	5.7E+02	5.7E+02	NA	NA		5.7E+02	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-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

APPENDIX D

Tables

Table 1: Initial Identification of Current and Future Soil Constituents of Potential Concern for the Construction Worker Scenario in Parcel 3

(Maximum Detected Concentrations Compared to Background and Risk-Based Guideline Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration (depth in ft)	Detection Frequency	Concentration Used for Screening	Background Value	Construction Worker Risk-Based GV	Reference Risk-Based GV	COPC?
Metals											
7440-43-9	Cadmium	0.09	0.75	mg/kg	G4 (16)	132-144	0.75	2.1	21.00	a	NO:2,3
7440-47-3	Chromium**	0.98	26.00	mg/kg	X10 (16)	150-297	26.00	20	63.90	a,e	NO:3
7439-92-1	Lead	3.60	41.70	mg/kg	X1 (8)	144-144	41.70	48			NO:2
7440-02-0	Nickel	4.10	64.10	mg/kg	D3 (12)	144-144	64.10	32	430.00	a	NO:3
Volatile Organic Compounds											
76-13-1	1,1,2 Trichloro-1,2,2-trifluoroethane	1.41	1.41	ug/kg	607 (0)	1-10	1.41		7000000.00	a, e	NO:3
78-93-3	2-Butanone	3.33	28.13	ug/kg	603 (0)	10-10	28.13		930000.00	b	NO:3
67-64-1	Acetone	12.59	142.36	ug/kg	603 (0)	9-10	142.36		2100000.00	a	NO:3
100-41-4	Ethylbenzene	18.01	18.01	ug/kg	602 (0)	1-10	18.01		48.00	b	NO:3
75-09-2	Methylene Chloride	8.07	20.24	ug/kg	602 (0)	10-10	20.24		100000.00	c	NO:3
79-34-5	Tetrachloroethene	2.94	2.94	ug/kg	602 (0)	1-10	2.94		210000.00	a	NO:3
108-88-3	Toluene	1.33	23.44	ug/kg	602 (0)	3-10	23.44		25000.00	b	NO:3
1330-20-7	Xylenes, Total	76.99	76.99	ug/kg	602 (0)	1-10	76.99		43000000.00	a	NO:3
Radionuclides											
7440-34-8	Actinium-227+D	0.07	0.54	pCi/g	PRS99/100	40-139	0.54		1.00	d	NO:3
14596-10-2	Americium-241	0.02	0.15	pCi/g	PRS99/100	8-166	0.15		4.95	d	NO:1
10045-97-3	Cesium-137+D	0.02	0.50	pCi/g	S011 (0)	54-165	0.50	0.42	0.46	d	YES
7440-48-4	Cobalt-60	0.02	0.06	pCi/g	PRS99/100	9-165	0.06		0.10	d	NO:3
14255-04-0	Lead-210+D *	0.47	2.99	pCi/g	4459 (0)	70-145	2.99	1.2	1.65	d, e	YES
13981-16-3	Plutonium-238	0.02	34.80	pCi/g	602 (0)	36-177	34.80	0.13	5.50	d	YES
13981-16-3	Plutonium-239/240	0.01	0.31	pCi/g	602 (0)	5-24	0.31	0.18	5.50	d	NO:3
13966-00-2	Potassium-40	3.70	31.20	pCi/g	601 (0)	24-24	31.20	37	1.57	d, e	NO:2
13982-63-3	Radium-226+D	0.40	3.53	pCi/g	4444 (0)	142-164	3.53	2	0.14	d	YES
14274-82-9	Thorium-228+D	0.44	0.95	pCi/g	D1 (8)	24-24	0.95	1.5	0.16	d, e	NO:2
14269-63-7	Thorium-230	0.40	10.10	pCi/g	X5 (8)	145-156	10.10	1.9		f	YES
7440-29-1	Thorium-232+D	0.17	4.47	pCi/g	C0004 (3)	155-175	4.47	1.4	0.10	d, e	YES
13966-29-5	Uranium-234	0.16	0.37	pCi/g	X5 (8)	13-13	0.37	1.1	37.50	d	NO:2,3
15117-96-1	Uranium-235	0.02	0.03	pCi/g	PRS99/100 (12)	2-13	0.03	0.11	3.35	d	NO:2,3
7440-61-1	Uranium-238+D	0.18	0.34	pCi/g	X5 (8)	13-13	0.34	1.2	0.12	d, e	NO:2

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= 10^{-6} cancer risk for ingestion
d= 10^{-6} cancer risk for ingestion + inhalation + external

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

e = Risk-Based Guideline Values calculated using the methodology, equations, and parameters presented in Mound Screening GV 3/97, calculations presented in Appendix C
f = Guideline Value is under review
CAS= Chemical Abstract Service
COPC= Constituent of Potential Concern
GV= Mound Risk Based Guideline Value
** the chromium data set includes Cr-III and Cr-VI measurements
* Lead-210 background value is based upon its parent uranium-238 background value.

Table 2: Final Identification of Current and Future Soil Constituents of Potential Concern for the Construction Worker Scenario in Parcel 3

(Exposure Point Concentration Compared to Background Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration (depth in ft)	Detection Frequency	95 Percent UCL	Concentration Used for Screening	Background Value	COPC for RRE
Radionuclides										
10045-97-3	Cesium-137+D	0.02	0.50	pCi/g	S011 (0)	54-165	0.07	0.07	0.42	NO
14255-04-0	Lead-210+D*	0.47	2.99	pCi/g	4459 (0)	70-145	0.85	0.85	1.2	NO
13981-16-3	Plutonium-238	0.02	34.80	pCi/g	602 (0)	36-177	67.20	34.80	0.13	YES
13982-63-3	Radium-226+D	0.40	3.53	pCi/g	4444 (0)	142-164	1.48	1.48	2	NO
14269-63-7	Thorium-230	0.40	10.10	pCi/g	X5 (8)	145-156	1.27	1.27	1.9	NO
7440-29-1	Thorium-232+D	0.17	4.47	pCi/g	C0004 (3)	155-175	0.75	0.75	1.4	NO

CAS = Chemical Abstract Service
COPC = Constituent of Potential Concern
NO < Background
RRE = Residual Risk Evaluation
UCL = Upper Confidence Limit
* Lead-210 background value is based upon its parent Uranium-238 background value.

Table 3: Initial Identification of Current and Future Soil Constituents of Potential Concern for the Site Employee Scenario in Parcel 3

(Maximum Detected Concentrations Compared to Background and Risk-Based Guideline Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration (depth in ft)	Detection Frequency	Concentration Used for Screening	Background Value	Site Employee Risk Based GV	Reference Risk-Based GV	Initial COPC
Volatile Organic Compounds											
76-13-1	1,1,2 Trichloro-1,2,2-trifluoroethane	1.41	1.41	ug/kg	607 (0)	1-10	1.41		7000000.00	a, e	NO:3
78-93-3	2-Butanone	3.33	28.13	ug/kg	603 (0)	10-10	28.13		930000.00	b	NO:3
67-64-1	Acetone	12.59	142.36	ug/kg	603 (0)	9-10	142.36		20000000.00	a	NO:3
100-41-4	Ethylbenzene	18.01	18.01	ug/kg	602 (0)	1-10	18.01		48.00	b	NO:3
75-09-2	Methylene Chloride	8.07	20.24	ug/kg	602 (0)	10-10	20.24		100000.00	c	NO:3
79-34-5	Tetrachloroethane	2.94	2.94	ug/kg	602 (0)	1-10	2.94		2000000.00	b	NO:3
108-88-3	Toluene	1.32	23.44	ug/kg	602 (0)	3-10	23.44		25000.00	b	NO:3
1330-20-7	Xylenes, Total	76.90	76.90	ug/kg	602 (0)	1-10	76.90		410000000.00	a	NO:3
Radionuclides											
7440-34-8	Actinium-227+D	0.07	0.54	pCi/g	PRS99/100	40-139	0.54		1.10	d	NO:3
14596-10-2	Americium-241	0.02	0.15	pCi/g	PRS99/100	8-142	0.15		9.20	d	NO:3
10045-97-3	Cesium-137+D	0.02	0.50	pCi/g	S011 (0)	53-142	0.50	0.42	0.42	d	YES
7440-48-4	Cobalt-60	0.02	0.06	pCi/g	PRS99/100	9-142	0.06		0.09	d	NO:3
14255-04-0	Lead-210+D*	0.47	2.99	pCi/g	4459 (0)	70-145	2.99	1.2	3.20	d, e	NO:3
13981-16-3	Plutonium-238	0.02	34.80	pCi/g	602 (0)	28-160	34.80	0.13	11.00	d	YES
PU-239/240	Plutonium-239/240	0.01	0.31	pCi/g	602 (0)	5-10	0.31	0.18	10.00	d	NO:3
13966-00-2	Potassium-40	16.80	31.20	pCi/g	601 (0)	10-10	31.20	37	1.43	d, e	NO:2
13982-63-3	Radium-226+D	0.40	3.53	pCi/g	4444 (0)	119-141	3.53	2	0.13	d	YES
14274-82-9	Thorium-228+D	0.60	0.82	pCi/g	601 (0)	10-10	0.82	1.5	0.13	d, e	NO:2
14269-63-7	Thorium-230	0.40	6.09	pCi/g	4442 (0)	131-142	6.09	1.9		f	YES
7440-29-1	Thorium-232+D	0.17	2.71	pCi/g	PRS99/100	139-158	2.71	1.4	0.09	d, e	YES

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= 10^{-6} cancer risk for ingestion
d= 10^{-6} cancer risk for ingestion + inhalation + external
e= Risk-Based Guideline Values calculated using the methodology, equations, and parameters presented in Mound Screening GV 3/97
f = Guideline Value is under review
The calculations for new or revised GVs are presented in Appendix C.
CAS = Chemical Abstract Service
COPC = Constituent of Potential Concern
GV = Guideline Value
* Lead-210 background value is based upon its parent Uranium-238 background value.

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

Table 4: Final Identification of Current and Future Soil Constituents of Potential Concern for the Site Employee Scenario in Parcel 3

(Exposure Point Concentration Compared to Background Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration (depth in ft)	Detection Frequency	95 Percent UCL	Concentration Used for Screening (EPC)	Background Value	COPC for RRE
Radionuclides										
10045-97-3	Cesium-137+D	0.02	0.50	pCi/g	S011 (0)	53-142	0.05	0.05	0.42	NO
13981-16-3	Plutonium-238	0.02	34.80	pCi/g	602 (0)	28-160	28.20	28.20	0.13	YES
13982-63-3	Radium-226+D	0.40	3.53	pCi/g	4444 (0)	119-141	1.48	1.48	2	NO
14269-63-7	Thorium-230	0.40	6.09	pCi/g	4442 (0)	131-142	1.27	1.27	1.9	NO
7440-29-1	Thorium-232+D	0.17	2.71	pCi/g	PRS99/100	139-158	0.73	0.73	1.4	NO

CAS - Chemical Abstract Service
COPC - Constituent of Potential Concern
EPC - Exposure Point Concentration
NO <Background Value
UCL - Upper Confidence Limit
RRE - Residual Risk Evaluation

Table 5: Initial Identification of Current Groundwater Constituents of Potential Concern for the Construction Worker Scenario

(Maximum Detected Concentrations Compared to Background and Risk-Based 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	100.00	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	24.00	d	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 5: Initial Identification of Current Groundwater Constituents of Potential Concern for the Construction Worker Scenario

(Maximum Detected Concentrations Compared to Background and Risk-Based 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+D	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+D	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+D	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			g	YES
Thorium-232+D	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+D	0.13	8.25	pCi/L	41-48	8.25	0.688	0.56	c, f	YES

COPC - Constituent of Potential Concern
GV - Guideline Values
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
g = Guideline Value is under review
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 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+D	0.13	8.25	pCi/L	41-48	0.47	0.47	0.688	NO

COPC= Constituent of Potential Concern
EPC= Exposure Point Concentration, minimum of 95% UCL or maximum detected concentration
NO <Background Value
RRE= Residual Risk Evaluation
UCL= Upper Confidence Limit

Table 7: Initial Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario

(Maximum Detected Concentrations Compared to Background and Risk-Based 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 (trichloromethane)	0.50	5.40	ug/L	9-197	5.40	0.516	47.00	c	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	f	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 7: Initial Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario

(Maximum Detected Concentrations Compared to Background and Risk-Based 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+D	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	0.002	2.00	pCi/L	6-20	2.00	0.125	0.51	c	YES
Radium-226+D	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+D	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+D	0.0025	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+D	0.13	8.25	pCi/L	41-48	8.25	0.688	0.11	c,d	YES

COPC - Constituent of Potential Concern
GV - Guideline Value
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
The calculations for new or revised GVs are presented in Appendix C.
e= Guideline Value is under review
f = 10^{-6} cancer risk for ingestion + inhalation

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 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+D	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+D	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+D	0.13	8.25	pCi/L	41-48	0.47	0.47	0.688	NO

COPC= Constituent of Potential Concern
EPC= minimum of 95% UCL or maximum detected concentration
NC= Not calculated, fewer than 20 samples in the data set
NO <Background Value
RRE= Residual Risk Evaluation
UCL= Upper Confidence Limit

Table 9: Initial Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario

(Maximum Detected Concentration Compared to Background and Risk-Based 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, e	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, e	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, e	YES
Cobalt**	0.31	295.00	ug/L	46/ 115	18.50	295.00	1.032	600.00	a, e	NO:3
Copper	0.38	514.00	ug/L	81/ 117	26.80	514.00	1.167	400.00	a, e	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	2480000.00	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, e	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, e	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	205000.00	456000.00				NO:4
Thallium	3.1	6.90	ug/L	6/ 107	4.44	6.90		0.80	a, e	YES
Tin	1.4	357.20	ug/L	27/ 100	14.90	357.20	34.382	6000.00	a, e	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 9: Initial Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario

(Maximum Detected Concentration Compared to Background and Risk-Based 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, e	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, e	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, e	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	24.00	c	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+D	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 + D	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 + D	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 + D	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, see Appendix C
COPC= Constituent of Potential Concern
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)
GV= Guideline Value

Table 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	NO:1
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+D	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 + D	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 + D	0.0005	2.11	pCi/L	31/ 63	0.78	0.78	0.314	NO:1
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 + D	0.03	1.34	pCi/L	57/ 75	0.51	0.51	0.688	NO

NO:1 = Flow tube modeled manganese (179.2 ug/L) and thorium-232 (0.1747pCi/L) concentrations were below backgroud values and are screened out of the RRE.
COPC= Constituent of Potential Concern
UCL= Upper Confidence Limit
* = 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 11: Initial Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario

(Maximum Detected Concentration Compared to Background and Risk-Based 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	32.997	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	2480000.00	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	205000.00	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 11: Initial Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario

(Maximum Detected Concentration Compared to Background and Risk-Based 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		310000.00	a,d	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	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	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		51	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	47.00	c	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										
Actinium-227+D^^	0.50	0.50	pCi/L	1/ 10	NA	0.50	0.26		c	YES
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		22.00	c,d	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				YES:2
Radium-226+D	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 + D	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 + D	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 + D	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, see Appendix C.
* = 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 pro

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
NO:6 - common laboratory contaminant
YES:2 - COPC in current groundwater, therefore, COPC in future groundwater

GV= Guideline Value
COPC= Constituent of Potential Concern
NC= 95% UCL not calculated, less than 20 samples in the data set.

Table 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	NO:1
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-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								
Actinium-227+D^^	0.500	0.500	pCi/L	1/10	NA	0.50		YES
Plutonium-238	0.012	1.870	pCi/L	8/ 60	0.15	0.15	0.087	YES
Plutonium-239/240	0.003	0.18	pCi/L	12/ 51	0.42	0.18	0.125	YES:2
Radium-226+D	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 + D	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 + D	0.0005	2.11	pCi/L	31/ 63	0.78	0.78	0.314	NO:1
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 + D	0.03	1.34	pCi/L	57/ 75	0.51	0.51	0.688	NO

COPC= Constituent of Potential Concern

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

UCL= Upper confidence Limit

NO:1 = Future groundwater concentrations (modeled bedrock plus current concentrations) for manganese (179.2 ug/L) and thorium-232 (0.1747 pCi/L) are below background values and are screened out of the RRE.

* = 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

YES:2 - Current groundwater COPC, therefore, future groundwater COPC

Table 13: Exposure Assumptions for the Construction Worker and Site Employee in Parcel 3

Parameter	Units	Construction Worker Adult	Site-Employee Adult	Reference
Medium/pathway				
Surface soil (0 - 2 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	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
Subsurface soil				
Incidental ingestion				
Soil ingestion rate	mg/day	480	NA	a
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	kg/mg	1.00E-06	NA	
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 13: Exposure Assumptions for the Construction Worker and Site Employee in Parcel 3

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	0.167	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

Table 13 (continued)
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 14: Toxicity Criteria and other Physical Chemical Values (Supporting Tables 15-32)

Constituent	Oral RfDo		RfD (mg/kg/day) Adjusted RfDa	Inhalation RfDi		Oral CSFo		CSF (kg-day/mg) Adjusted CSFa	Inhalation CSFi		CSFex		GI Factor		Kp(cm/hr)	T (hr)	
VOCs																	
1,2-Dichloroethene	9.00E-03	b	9.00E-03	NA		NA		NA	NA		NA		1	d	1.00E-02	3.40E-01	e
Dichloromethane	6.00E-02	b	3.00E-02	8.60E-01	c	7.50E-03	b	1.50E-02	1.60E-03	c	NA		0.5	d	4.50E-03	6.90E-01	e
Tetrachloroethene	1.00E-02	b	5.00E-03	1.10E-01	a	5.20E-02	a	1.04E-01	2.00E-03	a	NA		0.5	d	4.80E-02	4.30E+00	e
Trichloroethene	6.00E-03		3.00E-03	6.00E-03		1.10E-02	a	2.20E-02	6.00E-03	a	NA		0.5	d	1.60E-02	1.30E+00	e
Metals																	
Aluminum	1.00E+00	a	NA	1.40E-03	a	NA		NA	NA		NA			d	1.00E-03		e
Antimony	4.00E-04	b	6.00E-05	NA		NA		NA	NA		NA		0.15	d	1.00E-03		e
Beryllium	2.00E-03	b	2.00E-05	5.71E-06	b	NA	b	NA	8.40E+00	b	NA		0.01	d	1.00E-03		e
Bismuth	NA		NA	NA		NA		NA	NA		NA				1.00E-03		e
Cadmium	5.00E-04	b	5.00E-06	NA	a	NA		NA	6.30E+00	b	NA		0.01	d	1.00E-03		e
Chromium VI	3.00E-03	b	7.50E-05	NA		NA		NA	2.90E+02	c	NA		0.025	d	1.00E-03		e
Copper	3.71E-02	c	NA	NA		NA		NA	NA		NA		NA	d	1.00E-03		e
Lithium	2.00E-03		NA	NA		NA		NA	NA		NA		NA		1.00E-03		e
Molybdenum	5.00E-03	c	NA	NA		NA		NA	NA		NA		NA	d	1.00E-03		e
Nickel	2.00E-02	b	8.00E-04	NA		NA		NA	NA		NA		0.04	d	1.00E-03		e
Thallium	8.00E-05	b	8.00E-05	NA		NA		NA	NA		NA		1	d	1.00E-03		e
Vanadium	7.00E-03	c	1.82E-04	NA		NA		NA	NA		NA		0.026	d	0.001		e
Radionuclides																	
Actinium-227+D	NA		NA	NA		6.26E-10	c	NA	7.87E-08	c	9.30E-07	c	NA*		NA		
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+D	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	NA		NA	NA		4.09E-11	c	NA	5.94E-11	c	0.00E+00	c					
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		
Tritium	NA		NA	NA		7.15E-14	c	7.15E-14	9.59E-14	c	0.00E+00	c	1.00E+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-238	NA		NA	NA		4.27E-11	c	NA	1.24E-08	c	1.50E-11	c	NA*		NA		

NA= Not Available
a=NCEA
b= IRIS
c=HEAST
d= GI 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
NA* HEAST does not recommend adjusting CSFo for dermal

Table 15: Total Residual Soil Risk for a Construction Worker in Parcel 3

Constituent	EPC pCi/g	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
Radionuclides													
Plutonium-238	34.8	6.2E-06	NA	5.6E-09	NAP	6.9E-10	**6.2E-06**	NA	NA	NA	NAP	NA	NA
TOTAL		6.2E-06	NA	5.6E-09	NA	6.9E-10	**6.2E-06**	NA	NA	NA	NA	NA	NA

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/g: picocuries per gram
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 16: Background Residual Soil Risk for a Construction Worker in Parcel 3

Constituent	EPC pCi/g	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
Radionuclides													
Plutonium-238	0.13	2.3E-08	NA	2.1E-11	NAP	2.6E-12	2.3E-08	NA	NA	NA	NAP	NA	NA
TOTAL		2.3E-08	NA	2.1E-11	NA	2.6E-12	2.3E-08	NA	NA	NA	NA	NA	NA

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/g: picocuries per gram
VOCs: volatile organic compounds

Table 17: Incremental Residual Soil Risk for Construction Worker in Parcel 3

Constituent	EPC	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
Radionuclides	**pCi/g**												
Plutonium-238	34.67	6.1E-06	NA	5.5E-09	NAP	6.9E-10	**6.1E-06**	NA	NA	NA	NAP	NA	NA
TOTAL		6.1E-06	NA	5.5E-09	NA	6.9E-10	**6.1E-06**	NA	NA	NA	NA	NA	NA

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/g: picocuries per gram
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 18: Total Residual Soil Risk for a Site Employee in Parcel 3

Constituent	EPC pCi/g	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
Radionuclides													
Plutonium-238	28.2	2.6E-06	NA	2.3E-08	NAP	7.7E-10	**2.6E-06**	NA	NA	NA	NAP	NA	NA
TOTAL		2.6E-06	NA	2.3E-08	NA	7.7E-10	**2.6E-06**	NA	NA	NA	NA	NA	NA

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/g: picocuries per gram
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 19: Background Residual Soil Risk for a Site Employee in Parcel 3

Constituent	EPC	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
Radionuclides	pCi/g												
Plutonium-238	0.13	1.2E-07	NA	1.0E-10	NAP	2.9E-12	1.2E-07	NA	NA	NA	NAP	NA	NA
TOTAL		1.2E-07	NA	1.0E-10	NA	2.9E-12	1.2E-07	NA	NA	NA	NA	NA	NA

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/g: picocuries per gram
VOCs: volatile organic compounds

Table 20: Incremental Residual Soil Risk for Site Employee in Parcel 3

		CANCER EFFECTS						NON-CANCER EFFECTS					
		Route-Specific Risk					Cancer	Route-Specific HQ					Non-Cancer
Constituent		Oral	Dermal	Inhalation	Inhalation	External	Risk	Oral	Dermal	Inhalation	Inhalation	External	HI
				Dust	VOCs		Total			Dust	VOCs		Total
	EPC												
Radionuclides	**pCi/g**												
Plutonium-238	28.07	2.6E-06	NA	2.2E-08	NAP	6.2E-10	**2.6E-06**	NA	NA	NA	NAP	NA	NA
TOTAL		2.6E-06	NA	2.2E-08	NA	6.2E-10	**2.6E-06**	NA	NA	NA	NA	NA	NA

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/g: picocuries per gram
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 21: 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**

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
mg/L: milligrams per liter
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/L: picocuries per liter
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 22: 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	NA	NA	NAP	NA
Copper	0.001167	NA	NA	NAP	NA	2.9E-04	3.1E-06	NAP	2.9E-04
Radionuclides	**pCi/L**								
Thorium-230		NA	NA	NAP	NA	NA	NA	NAP	NAP
TOTAL		NA	NA	NA	NA	1.4E-02	2.3E-03	NA	1.7E-02

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
mg/L: milligrams per liter
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/L: picocuries per liter
VOCs: volatile organic compounds

Table 23: 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**

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
mg/L: milligrams per liter
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/L: picocuries per liter
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 24: Current Total Residual Groundwater Risk for the Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	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+D	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**

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
mg/L: milligrams per liter
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/L: picocuries per liter
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 25: Current Background Residual Groundwater Risk for the Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	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+D		NA	NA	NA	NA
Plutonium-239/240	0.125	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
Uranium-234	0.792	2.2E-07	2.2E-07	NA	NA
TOTAL		**1.6E-06**	**1.6E-06**	1.4E-02	1.4E-02

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
mg/L: milligrams per liter
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/L: picocuries per liter
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 26: Current Incremental Residual Groundwater Risk for the Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	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	5.7E-03	5.7E-03
Radionuclides	**pCi/L**				
Actinium-227+D	0.5	2.0E-06	**2.0E-06**	NA	NA
Plutonium-239/240	1.875	3.7E-06	**3.7E-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		**2.0E-05**	**2.0E-05**	**1.1E+00**	**1.1E+00**

EPC: Exposure point concentration
HI: Hazard Index
HQ: Hazard Quotient
mg/L: milligrams per liter
NA: Not available; insufficient toxicity data
NAP: Not applicable pathway
pCi/L: picocuries per liter
VOCs: volatile organic compounds
bold: Estimates that exceed acceptable thresholds

Table 27: 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	3.0E-04	NAP	1.2E-03
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
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+D	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
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		**9.8E-06**	**2.9E-04**	7.7E-08	**3.0E-04**	**5.0E+00**	4.7E-01	4.8E-04	**5.5E+00**

bold - Estimates that exceed acceptable thresholds
EPC - Exposure Point Concentration
HI - Hazard Index
HQ - Hazard Quotient
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 28: Future Background Goundwater Risk for the Construction Worker Scenario

Constituent	Total	CANCER EFFECTS				NON-CANCER EFFECTS			
		Route-Specific Risk			Cancer Risk Total	Route-Specific HQ			Non-Cancer HI Total
		Oral	Dermal	Inhalation $VOC_{(shower)}$		Oral	Dermal	Inhalation VOCs	
	EPC								
VOCs	mg/L								
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
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
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+D	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
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		**2.0E-06**	**6.5E-06**	1.7E-09	**8.5E-06**	1.1E-01	7.2E-03	0.0E+00	1.2E-01

bold - Estimates that exceed acceptable thresholds
EPC - Exposure Point Concentration
HI - Hazard Index
HQ - Hazard Quotient
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
NC - Not a suspected carcinogen

Table 29: 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	3.0E-04	NAP	1.2E-03
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
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+D	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
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**

bold - Estimates that exceed acceptable thresholds
EPC - Exposure Point Concentration
HI - Hazard Index
HQ - Hazard Quotient
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
NC - Not a suspected carcinogen

Table 30: 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**				
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	0.0366	NA	NA	9.7E-03	9.7E-03
Lithium	0.1195	NA	NA	5.8E-02	5.8E-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+D	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
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**	**5.0E+00**	**5.0E+00**

bold: Estimates that exceed acceptable thresholds
EPC: Exposure Point Concentration
HI: Hazard Index
HQ: Hazard Quotient
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 31: Future Background Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Non-Cancer HI Total
VOCs	mg/L				
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
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+D	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
Tritium	1485.473	6.6E-07	6.6E-07	NA	NA
Uranium-234	0.792	2.2E-07	2.2E-07	NA	NA
TOTAL		**4.5E-06**	**4.5E-06**	1.1E-01	1.1E-01

bold: Estimates that exceed acceptable thresholds
EPC: Exposure Point Concentration
HI: Hazard Index
HQ: Hazard Quotient
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 32: Future Incremental Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Non-Cancer HI Total
VOCs	**mg/L**				
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	NA
Cadmium	0.0063	NA	NA	1.2E-01	1.2E-01
Chromium VI**	0.9479	NA	NA	3.1E+00	**3.1E+00**
Copper	0.0355	NA	NA	9.4E-03	9.4E-03
Lithium	0.0638	NA	NA	3.1E-02	3.1E-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
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**

bold: Estimates that exceed acceptable thresholds
EPC: Exposure Point Concentration
HI: Hazard Index
HQ: Hazard Quotient
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 33: Total Residual Risk for Parcel 3 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncancer HI	Total Cancer Risk
Construction Worker Scenario	Soil (all sample depths) (Current/Future)	Chemical and Radiological	Ingestion	NA	**6.2E-06**
			Inhalation of Dust	NA	5.6E-09
			Inhalation of VOCs	NA	NA
			External	NA	6.9E-10
		Soil Total Risk		NA	**6.2E-06**
	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	**5.0E+00**	**9.8E-06**
			Dermal Contact	4.7E-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			**1.3E+00**	**8.5E-06**
	Cumulative Total Future Risk			**5.5E+00**	**3.1E-04**
Site Employee Scenario	Soil (0-2 ft bls) (Current/Future)	Chemical and Radiological	Ingestion	NA	**2.6E-06**
			Inhalation of Dust	NA	2.3E-08
			Inhalation of VOCs	NA	NA
			External	NA	7.7E-10
		Soil Total Risk		NA	**2.6E-06**
	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	**5.0E+00**	**5.9E-05**
		Future Groundwater Total Risk		**5.0E+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**	**2.6E-05**
	Cumulative Total Future Risk			**5.0E+00**	**6.3E-05**

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 $1x10^{-3}$

bolded values exceed cancer risk of 10^{-6} or non cancer HI greater than 1

bls - below land surface

Table 34: Background Residual Risk for Parcel 3 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncancer HI	Total Cancer Risk
Construction Worker Scenario	Soil (all sample depths) (Current/Future)	Chemical and Radiological	Ingestion	NA	2.3E-08
			Inhalation of Dust	NA	2.1E-11
			Inhalation of VOCs	NA	NA
			External	NA	2.6E-12
		Soil Total Risk		NA	2.3E-08
	Groundwater (Current)	Chemical and Radiological	Ingestion	1.4E-02	NA
			Dermal Contact	2.3E-03	NA
			Inhalation While Showering	NA	NA
		Current Groundwater Total Risk		1.7E-02	NA
	Groundwater (Future)	Chemical and Radiological	Ingestion	1.1E-01	**2.0E-06**
			Dermal Contact	7.2E-03	**6.5E-06**
			Inhalation While Showering	NA	1.7E-09
		Future Groundwater Total Risk		1.2E-01	**8.5E-06**
	Air*	Radiological	Inhalation	NA	7.7E-09
		Air Total Risk		NA	7.7E-09
	Cumulative Background Current Risk			1.7E-02	3.1E-08
	Cumulative Background Future Risk			1.2E-01	**8.5E-06**
Site Employee Scenario	Soil (0-2 ft bls) (Current/Future)	Chemical and Radiological	Ingestion	NA	1.2E-07
			Inhalation of Dust	NA	1.0E-10
			Inhalation of VOCs	NA	NA
			External	NA	2.9E-12
		Soil Total Risk		NA	1.2E-07
	Groundwater (Current)	Chemical and Radiological	Ingestion	1.4E-02	**1.6E-06**
		Current Groundwater Total Risk		1.4E-02	**1.6E-06**
	Groundwater (Future)	Chemical and Radiological	Ingestion	1.1E-01	**4.5E-06**
		Future Groundwater Total Risk		1.1E-01	**4.5E-06**
	Air*	Radiological	Inhalation	NA	3.9E-08
		Air Total Risk		NA	3.9E-08
	Cumulative Background Current Risk			1.4E-02	**1.8E-06**
	Cumulative Background Future Risk			1.1E-01	**4.7E-06**

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}

bolded values exceed cancer risk of 10^{-6} or non cancer HI greater than 1

bls - below land surface

Table 35: Incremental Residual Risk for Parcel 3 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncancer HI	Total Cancer Risk
Construction Worker Scenario	Soil (all sample depths) (Current/Future)	Chemical and Radiological	Ingestion	NA	**6.1E-06**
			Inhalation of Dust	NA	5.5E-09
			Inhalation of VOCs	NA	NA
			External	NA	6.9E-10
		Soil Total Risk		NA	**6.1E-06**
	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		**5.3E+00**	**2.9E-04**
	Air*	Radiological	Inhalation	NA	2.0E-07
		Air Total Risk		NA	2.0E-07
	Cumulative Incremental Current Risk			**1.3E+00**	**8.4E-06**
	Cumulative Incremental Future Risk			**5.3E+00**	**3.0E-04**
Site Employee Scenario	Soil (0-2 ft bls) (Current/Future)	Chemical and Radiological	Ingestion	NA	**2.6E-06**
			Inhalation of Dust	NA	2.2E-08
			Inhalation of VOCs	NA	NA
			External	NA	6.2E-10
		Soil Total Risk		NA	**2.6E-06**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	**2.0E-05**
		Current Groundwater Total Risk		**1.1E+00**	**2.0E-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**	**2.4E-05**
	Cumulative Incremental Future Risk			**4.9E+00**	**5.8E-05**

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 $1x10^{-3}$

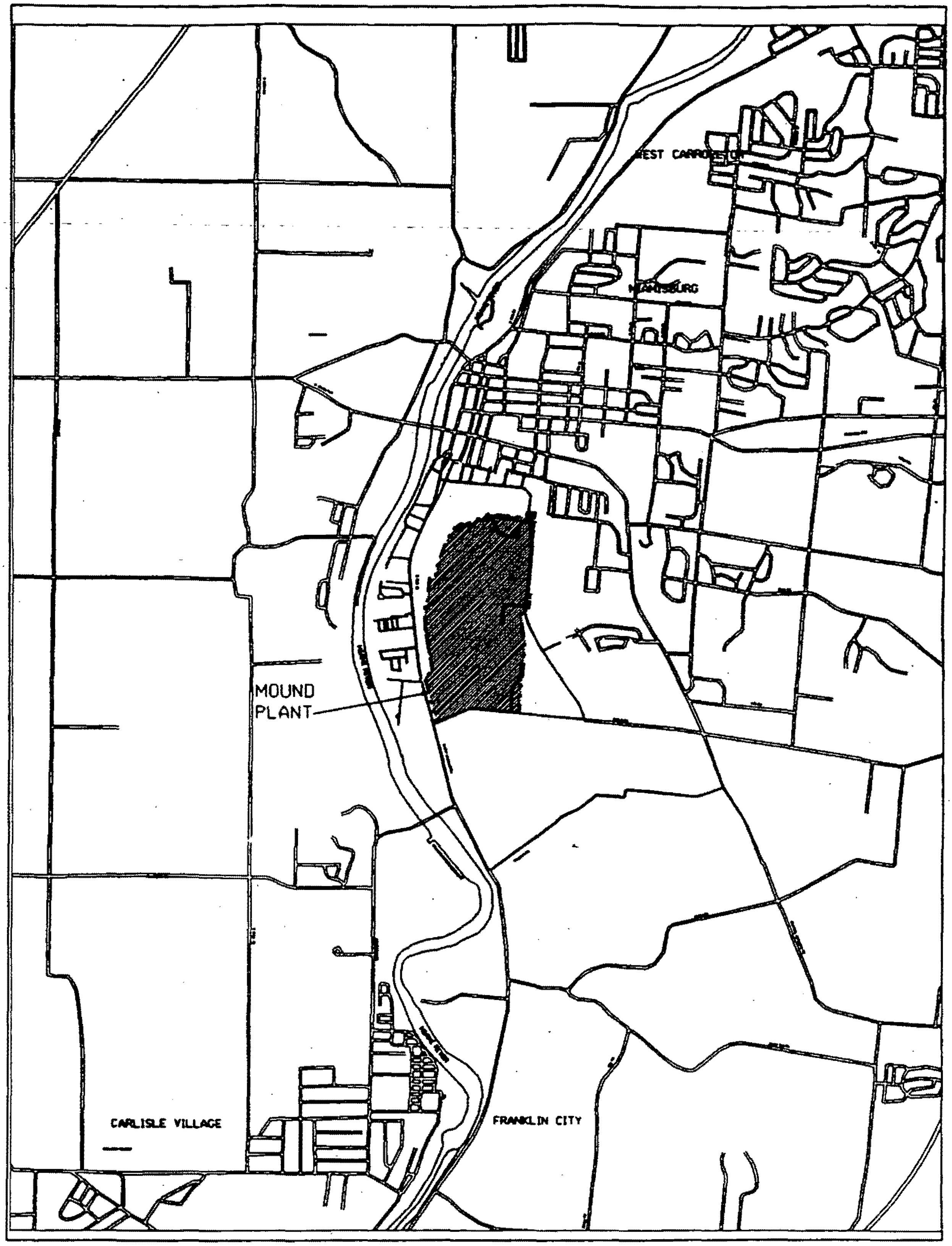
bolded values exceed cancer risk of 10^{-6} or non cancer HI greater than 1

bls - below land surface

APPENDIX E

Figures

NAME: LAYOUT1-T:\GOV\MOUND\CANOL RRE\MOUNDSITE.DWG DATE: AUG 15, 2000 TIME: 4:32 PM CTB: NONE



LEGEND

N

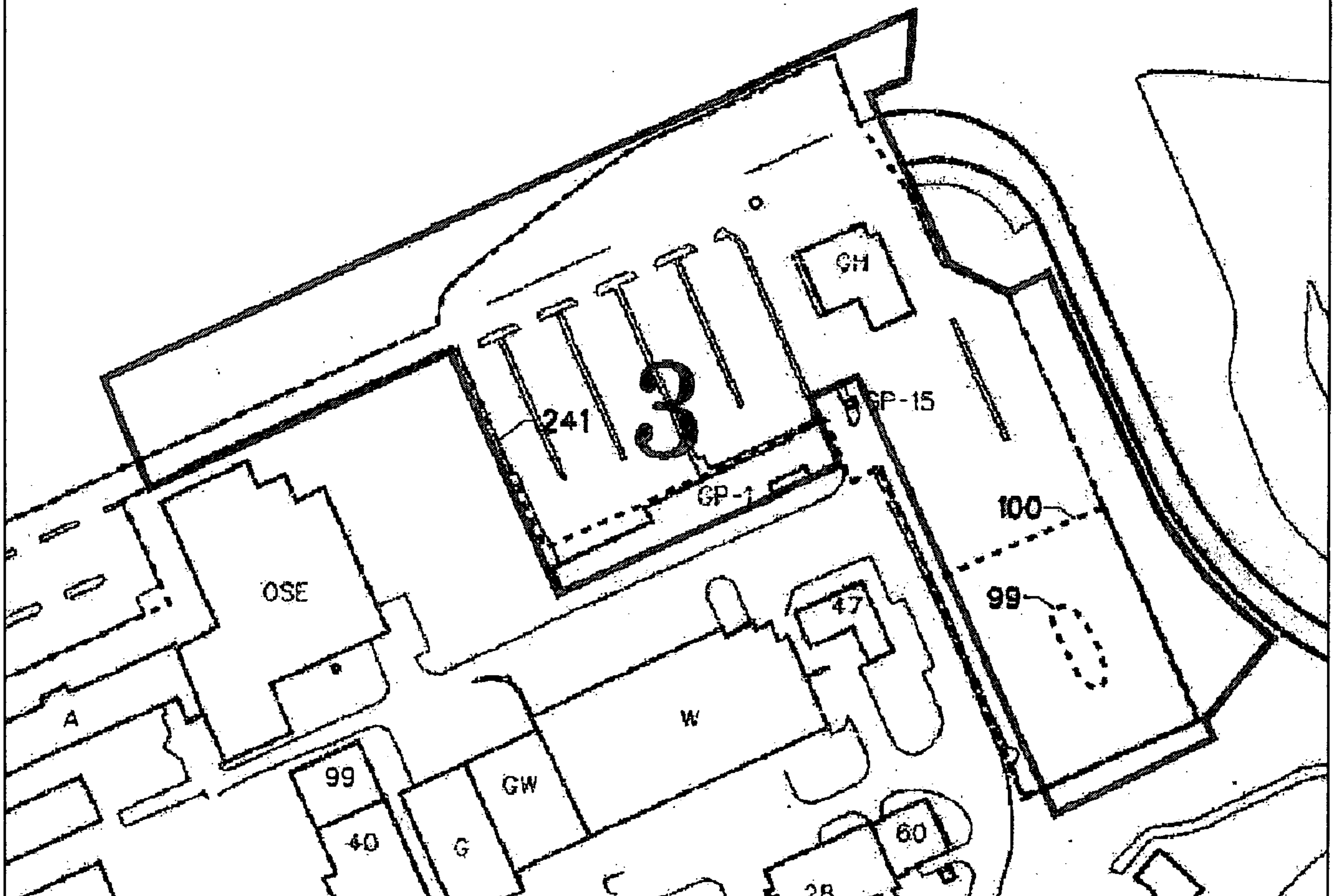
FIGURE 1 PARCEL 3

LOCATION OF MOUND PLANT

RELATIVE TO MIAMISBURG, OHIO

SAIC. Science Applications International Corporation Columbus, Ohio

DRAWN	DATE	SCALE	PROJECT NO.	FIGURE NO.
SAC	08-15-00	UNKNOWN	04-1057-008	1



N
True North

FIGURE 2 SITE MAP

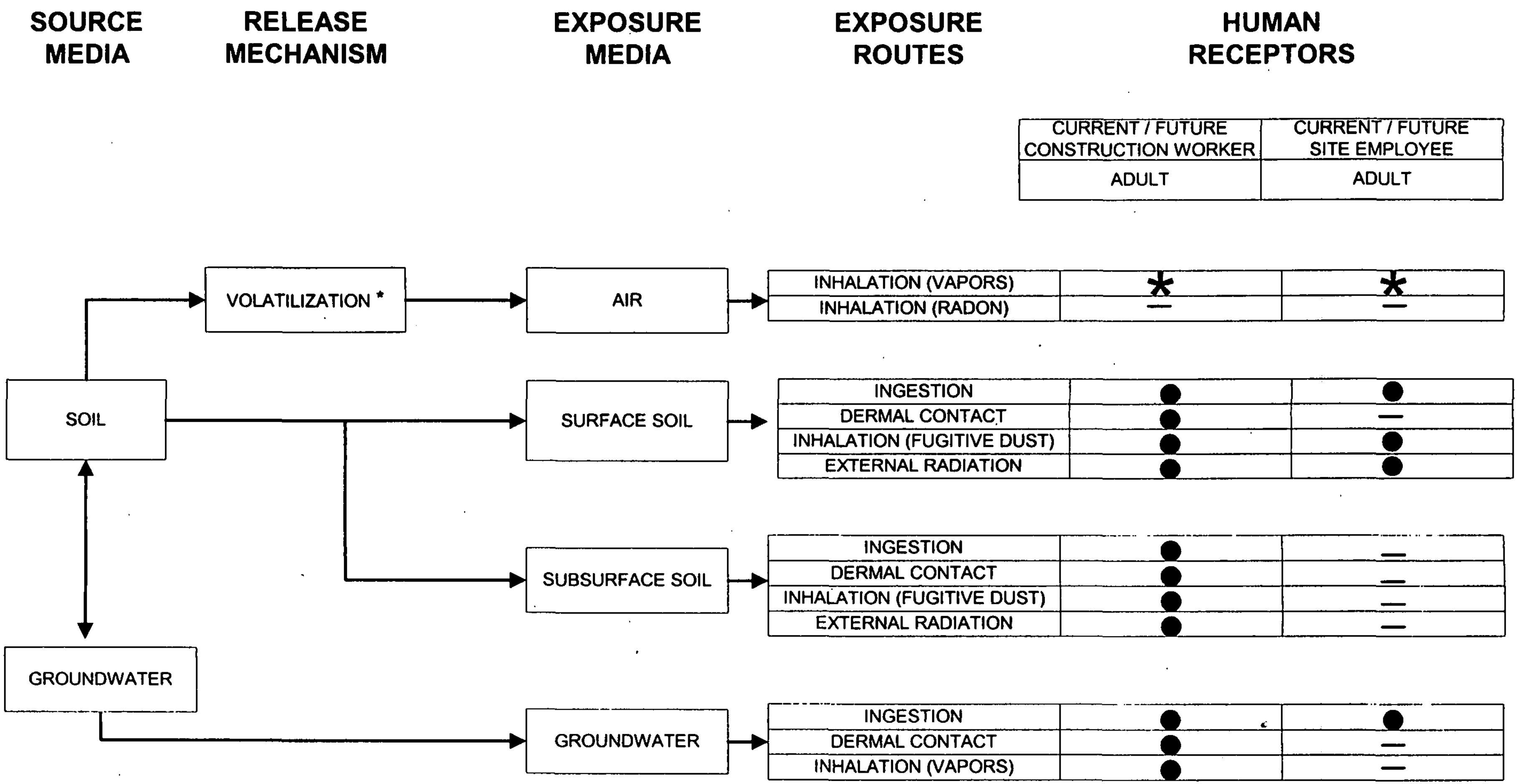
MOUND PLANT

MIAMISBURG, OHIO

SAIC Science Applications International Corporation Columbus, Ohio

DRAWN	DATE	SCALE	PROJECT NO.	FIGURE NO.
JMc	10/20/00	NONE	04-1057-004	2

NAME: LAYOUT1-T:\GOV\MOUND\PARCEL 3 DECEMBER 2000\FIGURES\PARCEL3.DWG DATE: APR 05, 2001 TIME: 5:33 PM CTB: NONE



● COMPLETE PATHWAY EVALUATED QUANTITATIVELY

○ COMPLETE PATHWAY EVALUATED QUALITATIVELY

— INCOMPLETE PATHWAY, NOT EVALUATED

* NO VOLATILE COPCs IN AREA

Figure 3
Conceptual Site Model for the Parcel 3 RRE

APPENDIX F

Parcel 3 Database Information

Includes:

1. CD containing Parcel 3 Database for soil and groundwater, flow-tube calculations for future groundwater, and data used in statistical analysis

2. List of laboratory data qualifiers